# Blowing Agents for Polyurethane Foams

**S.N. Singh**

*(Huntsman Polyurethanes)*

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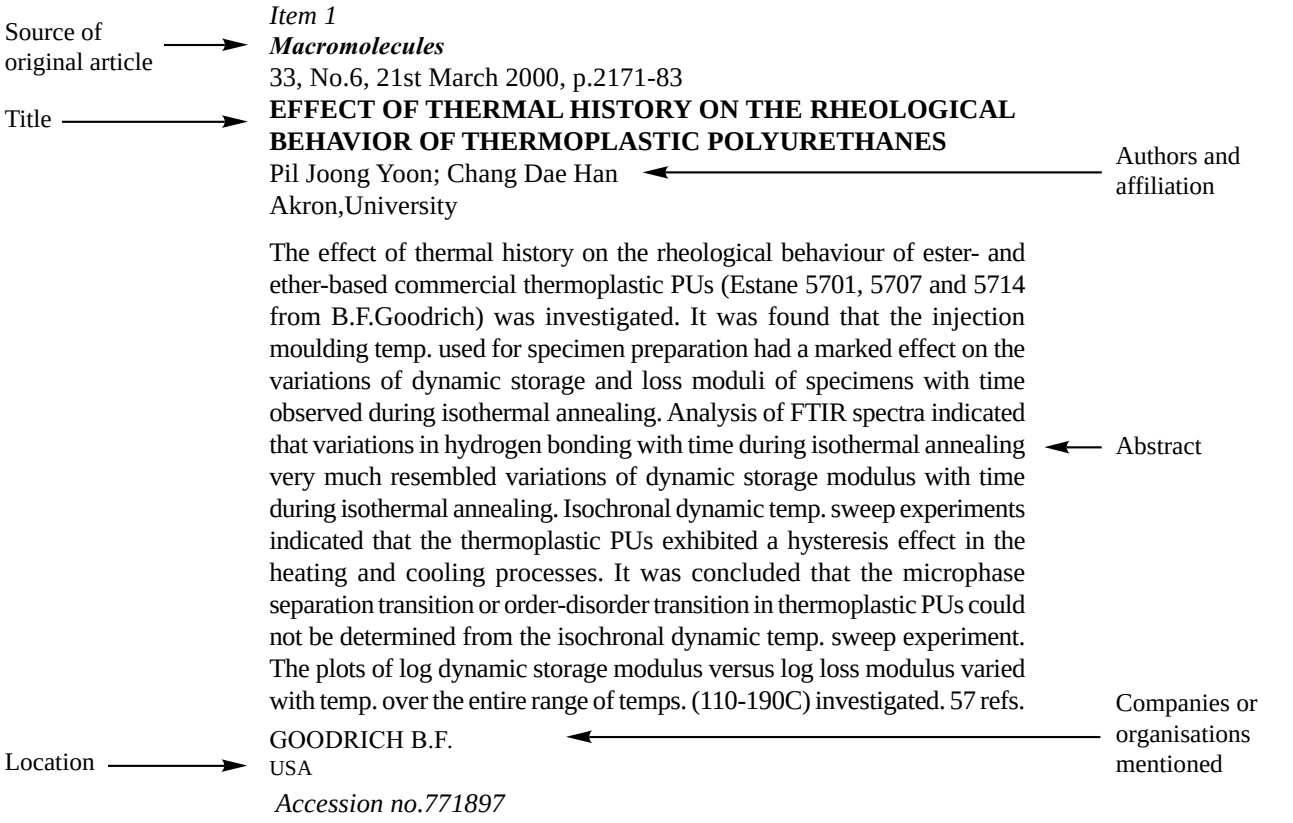


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# Contents

# 1 Introduction

Foamed plastics are being used in a variety of applications for insulation, cushioning, weight reduction, energy dissipation, buoyancy, convenience and comfort. Among the different foamed plastics, none is as versatile, both in finished product properties and ease of production and application, as polyurethane (PU) foam. Polyurethanes are generally made by reactions of isocyanates with active hydrogen-containing compounds. To make foam, the PU polymer is expanded or blown by the introduction of bubbles and a gas.

## 1.1 Blowing Agents up to the mid 1980s

Until the late 1950s, PU foam had been blown with the carbon dioxide liberated as a result of isocyanate reacting with water. Large-scale use of polyurethane foam was greatly accelerated by the discovery and use of chlorofluorocarbons (CFCs) in the late 1950s as a physical blowing agent. Diffusion of the $CO_2$ or the physical blowing agent into bubbles previously nucleated in the reacting medium causes expansion of the medium to make foam.

The use of CFCs, in particular trichlorofluoromethane (CFC-11), as a blowing agent led to the production of closed cell rigid foam with low densities, good mechanical properties and extremely low k-factor, which could not be achieved with other plastic foams. It also led to the attainment of low density and tailored load bearing properties for many cushioning products. As listed in **Table 1**, CFC-11 has about the ideal characteristics to be a blowing agent: low molecular weight, boiling point around room temperature, low toxicity, non-flammability and low thermal conductivity. This along with excellent chemical and thermal stability and low cost made CFCs the blowing

**Table 1 Physical and environmental properties of CFC, $CO_2$ and methylene chloride blowing agents**

| | **CFC-11** | **CFC-12** | **$CO_2$** | **Methylene chloride** |
|---|---|---|---|---|
| Chemical formula | $CCl_3F$ | $CCl_2F_2$ | $CO_2$ | $CH_2Cl_2$ |
| Molecular weight | 137.4 | 120.9 | 44 | 85 |
| Boiling point (°C) | 23.8 | -29.8 | -78.3 | 40 |
| Liquid specific gravity at 25 °C | 1.477 | 1.31 | N/A | 1.33 |
| Heat of vaporisation at boiling point (kJ/mole) | 24.8 | 20.0 | 6.8 | 28.0 |
| Gas phase thermal conductivity (mW/m.K)<br>at 10 °C<br>at 25 °C | <br>7.4<br>7.9 | <br>9.2<br>9.9 | <br>15.3<br>16.4 | <br>NA<br>NA |
| Vapour pressure (kPa)<br>at 10 °C<br>at 25 °C | <br>60<br>106 | <br>418<br>644 | <br>4502<br>6434 | <br>31<br>57 |
| Flammable limit in air (vol%) | None | None | None | 12-19 |
| TLV (ACGIH) or OEL (ppm) | 1000 | 1000 | N/A | 35-100 |
| Ozone depleting potential (ODP) (with CFC-11 = 1) | 1 | 1 | 0 | 0.007 |
| Global warming potential (GWP) (100 yr., CO2 = 1 | 4600 | 10600 | 1 | 0.02 |
| Atmospheric lifetime (years) | 45 | 100 | 120 | 0.5 |

TLV: threshold limit value as determined by the American Conference of Governmental Industrial Hygienists
OEL: occupational exposure limit
ODP: stratospheric ozone depleted by unit mass of a given product compared to that of CFC-11
GWP: the contribution of a given mass of a chemical to global warming compared to the same mass of $CO_2$

agent of choice for all PU foam, especially rigid thermal insulation foam. Another CFC, dichlorodifluorocarbon (CFC-12), saw some limited use in the manufacture of rigid PU foams as a frothing and as a dispensing agent. Methylene chloride was introduced in the mid 1970s as a blowing agent for flexible and integral skin foam.

### 1.2 The Montreal Protocol and Other Regulations

However, the chemical stability of CFCs led a number of scientists to question their ultimate environmental fate as it was recognised that almost all usage of CFCs resulted in release to the atmosphere. In 1974, two American scientists, Rowland and Molina, published their now famous ozone depletion hypothesis in which they claimed that CFCs would diffuse into the stratosphere, where they would break down to release chlorine atoms which would catalytically destroy ozone (a.1). The destruction of stratospheric ozone would lead to an increase in UV-B radiation in the 290-320 nm region at the earth's surface with consequent implications for human health, and other biological systems. This led to the development of an international protocol, known as the Montreal Protocol, which required a sharp curtailment in the production and use of substances that deplete the ozone layer. The Montreal Protocol profoundly changed the direction and the pace of technology development in the PU industry. The choice of blowing agent in all the different applications of PU foam across the globe continues to be intricately affected by the Montreal Protocol.

At a conference held in Montreal, Canada, under the auspices of the United Nations Environment Programme (UNEP), 24 countries signed an accord in September of 1987 to control the production and consumption of ozone depleting substances (ODS). The protocol was designed so that the control measures could be revised on the basis of periodic scientific and technological assessments. Following such assessments, the Protocol was amended at London in 1990, Copenhagen in 1992, Vienna in 1995, Montreal in 1997, and Beijing in 1999. New control measures including accelerated phase-out schedules and additional controlled substances were added to the protocol, e.g., the 1990 London Amendment accelerated the phase out of CFCs. While most nations (181 as of November 2001) of the world have ratified the 1987 Montreal Protocol, many have not ratified some of the amendments. As of November 2001, 1990 London, 1992 Copenhagen, 1997 Montreal, and 1999 Beijing amendments have been ratified by 155, 131, 69 and 16 countries respectively.

The Montreal Protocol sets out the time schedule for freeze and reduction of ODS based on whether a country is deemed Developed (referred to as non-Article 5(1) parties) or Developing (referred to as Article 5(1) parties), and on their annual per capita calculated consumption level of ODS. Australia, Canada, the Czech Republic, France, Germany, Greece, Italy, Japan, the Netherlands, Russia, Spain, the UK and the USA are the non-Article 5(1) parties. Argentina, Brazil, Chile, China, Egypt, India, Indonesia, both North and South Korea, Mexico, Saudi Arabia, South Africa and Zimbabwe are among the 113 countries listed as Article 5(1) parties. **Table 2** shows the phaseout schedule of CFCs. Developed countries indeed successfully eliminated CFC consumption by the end of 1995. Article 5(1) countries must freeze their consumption by 2002 based on average 1995-1997 consumption levels and

**Table 2 Montreal Protocol phase out schedule for CFCs[1]**

| Date | Control measure (ODP, weighted % reduction) | |
|---|---|---|
| | **Non-Article 5(1) parties** | **Article 5(1) parties** |
| July 1, 1989 | Freeze at 1986 level | - |
| January 1, 1994 | 75% of 1986 level | - |
| January 1, 1996 | Phased out | - |
| July 1, 1999 | - | Freeze at 1995-97 average level |
| January 1, 2005 | - | 50% of 1995-97 average level |
| January 1, 2007 | - | 85% of 1995-97 average level |
| January 1, 2010 | - | Phased out |

[1]Up to and including 1997 Montreal Amendment and applicable to production and consumption

complete their phase-out by the end of 2009. A financial mechanism has been established for providing monetary support and the transfer of technologies to the 'Article 5(1) parties', to enable their compliance with the control measures of the protocol. The Multilateral Fund (MLF) established by the United Nations with funding provided by developed countries supports the phase out of CFCs from developing countries (81, 339).

Hydrochlorofluorocarbons (HCFCs) were developed as the first major replacements for CFCs. Their ozone depletion potential ranges from 0.01 to 0.13. In 1992, the Parties to the Montreal Protocol added the Copenhagen Amendment that outlines the phaseout allowable HCFC consumption between 1996 and 2040. Thus HCFCs are viewed as transitional alternatives to be used while zero ODP alternatives are developed.

In addition to the Montreal Protocol, other bodies such as the European Union and national governments/ agencies have imposed more strict regulations and phase out schedules.

In the USA, the Environmental Protection Agency (EPA) imposed a fiscal measure in the form of a tax levy to limit CFC use in foam. HCFCs have been banned from use in all foams except those used for thermal insulation since January 1, 1996. The EPA has also accelerated the phaseout of HCFCs with the highest ODP compound, namely HCFC-141b, being phased out of production for domestic foam use on January 1, 2003. HCFC-142b and HCFC-22 are currently allowed for use until January 1, 2010. However this date is subject to change given the dynamics of the environmental and regulatory communities (18, 42). In Canada, manufacture, import, sale or use of all HCFCs is banned after January 1, 2015.

Countries throughout the world met in Kyoto, Japan in 1997 under the auspices of the United Nations Framework Convention on Climate Change and have agreed to binding greenhouse gas emission reduction goals. This agreement, known as the Kyoto Protocol, still needs definition of many of the control measures and has not yet been ratified by most countries in the world.

The European Union has opted to phaseout HCFCs for use as blowing agents by the end of 2003, significantly ahead of the Montreal Protocol timelines and this is reflected in **Table 3** (a.2). Within the European Union

**Table 3 Phase out schedule for HCFCs**

| Date | Montreal Protocol reduction[1] | | US reduction[4] | EU reduction[8] |
|---|---|---|---|---|
| | Non-Article 5(1) parties | Article 5(1) parties | | |
| January 1, 1996 | Freeze at cap[2] | - | - | - |
| January 1, 2003 | - | - | 141b – 100%[5] | 100% appliances, & lamination[9] |
| January 1, 2004 | 35 % of cap[2] | - | - | Phased out |
| January 1, 2010 | 65 % of cap[2] | - | 142b & 22 – 100%[6] | - |
| January 1, 2015 | 90 % of cap[2] | - | Phased out[7] | - |
| January 1, 2016 | - | Freeze at 2015 level | - | - |
| January 1, 2020 | 99.5 % of cap[3] | - | 142b & 22 – 100% | - |
| January 1, 2030 | Phased out | - | Phased out | - |
| January 1, 2040 | - | Phased out | - | - |

1 Up to and including 1997 Montreal Amendment and applicable to production only
2 ODP weighted HCFC consumption cap = 100% 1989 HCFC + 2.8% (Montreal Protocol) or 2.6% (EU) of 1989 CFC consumption
3 Phased out except for service of existing refrigeration and air-conditioning equipment
4 As of January 1, 2002
5 Production only
6 Except for use in equipment manufactured before 1/1/2010
7 Except for use in equipment manufactured before 1/1/2020
8 As of November 1, 2001 (51)
9 Except in refrigerated transport

and in Europe generally, several states have even more rapid phase out schedules and many of the phase out dates are application dependent. In addition, product labels such as 'contains ozone-depleting CFC or HCFC' have been required by some countries and this, in effect, accelerated the phase-out.

In Japan, HCFC-141b will be phased out by the end of 2003 (a.3). In addition to these international and national regulation, there are some corporate edicts. For example, Coca-Cola will stop using any products made using HCFC from 2004 onward where cost-efficient alternatives are commercially available (a.4).

In an attempt to facilitate compliance by the PU foam industry with all of the regulations, UNEP has set up the Flexible and Rigid Foams Technical Options Committee, which has issued periodic reports detailing the available technical options that can be implemented by each foam type (324, a.5).

## 2 Blowing Agents - Considerations Since the mid 1980s

The search for the blowing agent to reduce and/or replace CFCs in polyurethane foams has been a challenge due to the high number of selection factors that must be considered. As discussed below, some factors are mandated by the environmental considerations, some are necessary by feasibility considerations, whereas many others have to be balanced from performance considerations (319, 361). Many of the blowing agent selection considerations are common across all applications and geographical locations and are discussed next. Others are specific to an application/location and are discussed in Sections 4-6.

### 2.1 Environmental Considerations

Although stratospheric ozone depletion was the only reason to move away from CFCs, many other environmental issues such as ground level air pollution, tropospheric degradation, global warming, etc., have to be considered when choosing a replacement blowing agent. The environmental properties of many of the candidate blowing agents have been studied and agreed by industry sponsored programmes such as the Alternative Fluorocarbons Environmental Acceptability Study (AFEAS, www.afeas.org). The ozone depletion potential of a blowing agent is one such environmental property. Clearly, the lower the ODP of a blowing agent, the better it is, with zero being the goal.

Blowing agent selection became more complex in the early 1990s because of growing concern about global warming and resultant climate change. It is thought that some of the gases present in the lower atmosphere reflect infrared radiation (heat) back to earth and thereby raise earth's surface temperature, i.e., cause global warming (136). How much a given mass of a chemical contributes to global warming, over a given time period, usually 100 years, compared to the same mass of carbon dioxide is referred to as its global warming potential (GWP). The GWP of a blowing agent is a function of its atmospheric lifetime and its ability to absorb infrared radiation. The atmospheric lifetime characterises the overall stability of the blowing agent in the atmosphere. Given the ongoing and complex nature of atmospheric science, there is some debate about the atmospheric lifetime and GWP numbers of many compounds. In this review, the most recent published numbers have been used wherever possible (a.6).

Some of the blowing agents currently under investigation/use, such as pentanes, are classified as volatile organic compounds (VOCs). They undergo photochemical reactions in the lower atmosphere and contribute to smog formation. Thus their use may be strictly regulated, mostly on a regional basis. For example, the USA strictly regulates emissions of hydrocarbons in many parts of the country.

Although ODP, GWP, VOC and atmospheric lifetime are the four main environmental factors to consider when choosing a blowing agent, others need to be included too, such as long-term breakdown products, halogen free nature, acidification potential, etc., (40, 157).

### 2.2 Feasibility Considerations

Many factors must be considered prior to deciding the feasibility of a blowing agent in the marketplace. These include toxicity, flammability, compatibility with materials of construction, safe and economic manufacturing process, etc. Toxicity concerns over the human health impacts include worker and consumer exposure to blowing agents and exposure to possible decomposition products formed in foams. Both acute and chronic effects must be considered. Toxicity testing studies for some blowing agents were co-ordinated by

an international consortia of CFC producers and were known collectively as the Programme for Alternative Fluorocarbon Toxicity Testing (PAFT). Many candidate blowing agents, including some HCFCs and HFCs have been rejected as blowing agents due to toxicity considerations.

Unlike CFCs, many of the alternative blowing agents, such as HCFC-141b, hydrocarbons, HFC-365mfc, etc., have varying degrees of flammability. In order to safely use flammable alternatives, it is necessary to evaluate manufacturing risks from ignition, storage and transportation of blowing agent, fire performance of foam and finished products.

Another important feasibility consideration is the need for a manufacturing process to produce the blowing agent at a cost which is compatible with its value to the customer. Each of these factors must be considered on an application by application basis. Generally, a number of blowing agent options would meet many of the feasibility considerations, but typically the most economical solution prevails in the long run.

### 2.3 Performance Considerations

The many attributes of a compound that must be considered while choosing a blowing agent include:

- boiling point,
- molecular weight,
- vapour pressure in the temperature range of use,
- heat of vaporisation,
- solubility in components and foam,
- compatibility with materials of construction,
- reactivity.

Though some performance attributes such as non-reactivity and compatibility of the blowing agent with materials of construction are common to all, most depend on the final application of the foam product. There are guidelines about preferred attributes across the applications. For example, a lower molecular weight (or perhaps lower cost per mole) blowing agent that meets all the other performance criteria is more desirable. This is because, generally, the lower the molecular weight, the higher the gas volume that can be generated per unit weight of the blowing agent. Similarly, a higher heat of vaporisation with a high blowing efficiency is desired as it reduces the maximum exotherm temperature. High temperature during foaming may result in thermal degradation of foam and a higher residual stress gradient in composite products.

Ultimately, the acceptability of alternative blowing agents is dependent upon the performance, cost-effectiveness and competitiveness of the finished product in a particular application. The market price of any alternative system is often the determining factor as to whether a substitute can be used and sold competitively in the market.

## 3 Alternative Blowing Agents

After extensive and thorough screening of plausible chemical families against the above considerations, a few different families of compounds have emerged as candidate blowing agents (319, 361). These can be categorised in many different ways such as, low or zero ODP, liquid or gas (at room temperature), flammable or non-flammable, chemical or physical blowing agents, etc. Below are the main characteristics of the leading blowing agents currently being used or evaluated, categorised by chemical family.

### 3.1 Hydrochloroflurocarbons (HCFCs)

Featuring at least one hydrogen atom in the molecule and a carbon hydrogen bond, HCFCs are chemically less stable than CFCs and tend to breakdown in the lower atmosphere into simple inorganic species, such as hydrogen halides. Consequently, the ability of HCFCs to migrate to the atmosphere and to decompose into ozone-damaging chlorine is much lower than that of CFCs. Also, the breakdown products do not contribute significantly to the photochemical smog formation in urban areas or acid rain. Thus, HCFCs have low ODP, generally between 0.01-0.13, and are not classed as VOCs.

The search for a suitable liquid HCFC to replace CFC-11 in the late 1980s resulted in the short listing of two blowing agents, namely HCFC-123 ($CHCl_2CF_3$) and HCFC-141b ($CH_3CCl_2F$) as the prime candidates (361). Unfavourable intermediate toxicity data with HCFC-123 stopped the development of this blowing agent (311). The search for replacements for CFC-12 focussed on two existing commercial products, namely, HCFC-22 ($CHClF_2$) and HCFC-142b ($CH_3CClF_2$). **Table 4** lists the properties of the most widely evaluated HCFCs and another alternative, 2-chloropropane (333). The very low ODP and GWP of 2-chloropropane

| Table 4 Physical and environmental properties of HCFCs available as blowing agents | | | | |
|---|---|---|---|---|
| | **HCFC-141b** | **HCFC-22** | **HCFC-142b** | **2-chloropropane** |
| Chemical formula | $CH_3CCl_2F$ | $CHClF_2$ | $CH_3CClF_2$ | $CH_3CH_2ClCH_3$ |
| Molecular weight | 116.9 | 86.5 | 100.5 | 78.5 |
| Boiling point (°C) | 32.9 | -40.8 | -9.8 | 35.7 |
| Liquid specific gravity at 25 °C | 1.233 | 1.19 | 1.12 | 0.87 |
| Heat of vaporisation at boiling point (kJ/mole) | 25.8 | 20.2 | 22.4 | 26.5 |
| Gas phase thermal conductivity (W/m.K)<br>at 10 °C<br>at 25 °C | <br>8.8<br>10 | <br>9.9<br>10.7 | <br>8.4<br>9.5 | <br>NA<br>NA |
| Vapour pressure (kPa)<br>at 10 °C<br>at 25 °C | <br>46<br>79 | <br>665<br>934 | <br>209<br>337 | <br>40<br>70 |
| Flammable limits in air (vol%) | 7.6-17.7 | None | 6.4-14.9 | 2.8-10.7 |
| TLV or OEL (ppm) | 500 | 1000 | 1000 | NA |
| ODP (with CFC-11 = 1) | 0.11 | 0.055 | 0.065 | 0.003 |
| GWP (100 yr, $CO_2$ = 1) | 700 | 1900 | 2300 | 9.9 |
| Atmospheric lifetime, years | 9.2 | 11.8 | 18.5 | 0.75 |

attracted much attention at one time, but it has not been widely used. One HCFC that has received some attention lately is 2-chloro-1,1,1,2-tetrafluoroethane, i.e., HCFC-124 which has an ODP of 0.02; a GWP of 470; boiling point of -12.1 °C, and gas phase thermal conductivity of 12.3 mW/m.K at 25 °C (15, 58). Thus far it has not received commercial acceptance.

HCFC-141b and HCFC-22 have emerged as the two most widely used transitional blowing agents in the PU foam industry.

### 3.2 Hydrofluorocarbons (HFCs)

These are compounds with no chlorine in them and thus have zero ODP. The environmental pressure in parts of Europe to use a zero ODP blowing agent as early as possible was very high in the early 1990s.This led to an evaluation of many zero ODP compounds even before a systematic evaluation of HFCs could be carried out. One compound 1,1,1,4,4,4-hexafluorobutane (HFC-356) with a boiling point of 24.6 °C, gas phase thermal conductivity of 9.5 mW/m.K at 20 °C, low atmospheric lifetime (~0.4 years) and very low GWP was extensively evaluated in the early 1990s (293). Azeotropic compositions of HFC-356 and pentane were also evaluated (160, 188). Another compound 1,1,2-trifluoroethane (HFC-143) with a boiling point of 5 °C, gas phase thermal conductivity of 12.3 mW/m.K at 25 °C, atmospheric lifetime of 4.2 years and low GWP was evaluated for rigid foam applications in the early 1990s (254, 408). Large-scale commercial use of these blowing agents appears unlikely.

A thorough and systematic evaluation of hydrofluorocarbons which show potential to be a viable liquid or gaseous blowing agent led to a short list of compounds for closer scrutiny (272, 319). Although many HFCs, e.g., HFC-32 ($CH_2F_2$), HFC-125 ($CHF_2CF_3$), HFC-245ca ($CHF_2CF_2CH_2F$), HFC-236ea ($CF_3CHFCHF_2$) and HFC-227 ($CF_3CHFCF_3$) have received close scrutiny, two liquid and two gaseous HFCs have been selected for large scale commercialisation (277, 382). HFC-245fa ($CF_3CH_2CHF_2$) and HFC-365mfc ($CF_3CH_2CF_2CH_3$) are the two liquid HFCs (34, 63, 75, a.7). The gaseous HFCs are HFC-134a ($CH_2FCF_3$) and HFC-152a ($CHF_2CH_3$) (189, 272).

| Table 5 Physical and environmental properties of HFCs available as blowing agents | | | | |
|---|---|---|---|---|
| | **HFC-134a** | **HFC-245fa** | **HFC-365mfc** | **HFC-152a** |
| Chemical formula | $CH_2FCF_3$ | $CF_3CH_2CHF_2$ | $CF_3CH_2CF_2CH_3$ | $CHF_2CH_3$ |
| Molecular weight | 102 | 134 | 148 | 66 |
| Boiling point (°C) | -26.5 | 15.3 | 40.2 | -24.7 |
| Liquid specific gravity at 25 °C | 1.20 | 1.32 | 1.25 | 0.90 |
| Heat of vaporisation at boiling point (kJ/mole) | 22.1 | 28 | 26.2 | 21.7 |
| Gas phase thermal conductivity (W/m.K)<br>at 10 °C<br>at 25 °C | <br>12.4<br>13.8 | <br>NA<br>12.5 | <br>10.6<br>11.6 | <br>NA<br>14.7 |
| Vapour pressure (kPa)<br>at 10 °C<br>at 25 °C | <br>425<br>670 | <br>85<br>146 | <br>26<br>59 | <br>273<br>500 |
| Flammable limits in air (vol%) | None | None | 3.8-13.3 | 3.9-16.9 |
| TLV or OEL (ppm) | 1000 | 500 | NA | 1000 |
| ODP (with CFC-11 = 1) | 0 | 0 | 0 | 0 |
| GWP (with $CO_2$ = 1) | 1600 | 990 | 910 | 140 |
| Atmospheric lifetime (years) | 14 | 7.4 | 10.8 | 1.7 |

**Table 5** lists the physical and environmental properties of these HFCs (75, 272, a.6). Toxicity testing on HFC-245fa and HFC-365mfc is now complete and no toxicity concerns have been identified. Like HCFCs, breakdown products from these HFCs in the lower atmosphere have been studied and found to have insignificant effect on the photochemical smog formation in urban areas or acid rain. The flammability limit of HFC-365mfc in air has led to the introduction of a non-flammable blend with HFC-227 ($CF_3CHFCF_3$) in the weight ratio of 94:6 (a.8). Many other types of tests, such as thermal and hydrolytic stability and compatibility with materials of construction have been completed and found to be acceptable (a.6). An important factor to keep in mind though is that the long term fate of HFCs as blowing agents is somewhat uncertain due to the provisions of the Kyoto Protocol (see Section 1.2).

### 3.3 Hydrocarbons (HCs)

The advantages of hydrocarbons (HCs) namely, low cost, ready availability, halogen-free nature, zero ODP, and nearly zero GWP have been known for some time. However, safety concerns due to their high flammability blocked serious consideration as blowing agents for PU foam. Efforts by many changed this in the late 1980s and three isomers of pentanes (*cyclo*-, *iso*- and *n*-) that are all liquid at room temperature, and *iso*-butane which is gaseous, were investigated (378, 406). **Table 6** lists the physical and environmental properties of these HCs.

The flammability limits of pentanes in air are around 1.4 to 8.0 vol% and the energy of ignition is extremely low. Also, the density of pentane vapour is about 2.5-fold greater than the density of air. All these factors translate into a need for careful consideration of equipment and procedures in storage, handling, manufacturing and shipping. Safe handling of pentane from storage to metering (26, 331) to detection (70) has been studied. The extent of the plant modifications required may vary significantly, depending on local codes and regulations, however, in general, improved ventilation, explosion-proofing and alarm systems are required. Hydrocarbons are classified as VOCs and are subject to emissions control in many urban areas especially in the USA.

Pentanes have emerged as the dominant HCs for PU foam. *iso*-Butane or other hydrocarbons are not used very widely.

| Table 6 Physical and environmental properties of HCs available as blowing agents | | | | |
|---|---|---|---|---|
| | **cyclopentane** | ***n*-pentane** | ***iso*-pentane** | ***iso*-butane** |
| Chemical formula | $(CH_2)_5$ | $C_5H_{12}$ | $C_5H_{12}$ | $C_4H_{10}$ |
| Molecular weight | 70.1 | 72.0 | 72.0 | 58 |
| Boiling point (°C) | 49.3 | 36.2 | 27.8 | -12 |
| Liquid specific gravity at 25 °C | 0.75 | 0.63 | 0.62 | 0.55 |
| Heat of vaporisation at boiling point (kJ/mole) | 27.3 | 25.7 | 24.6 | 21.3 |
| Gas phase thermal conductivity (W/m.K)<br>at 10 °C<br>at 25 °C | <br>11.4<br>12.8 | <br>13.7<br>15.0 | <br>12.8<br>14.3 | <br>14.8<br>16.2 |
| Vapour pressure (kPa)<br>at 10 °C<br>at 25 °C | <br>24<br>43 | <br>40<br>69 | <br>54<br>91 | <br>220<br>350 |
| Flammable limits in air (vol%) | 1.4-8.0 | 1.3-8.0 | 1.4-7.8 | 1.8-8.4 |
| TLV or OEL (ppm) | 600 | 600 | 600 | NA |
| ODP (with CFC-11 = 1) | 0 | 0 | 0 | 0 |
| GWP (with $CO_2$ = 1) | 11 | 11 | 11 | 11 |
| Atmospheric lifetime (years) | Few days | Few days | Few days | Few days |

### 3.4 Other Physical Blowing Agents

Methyl chloroform ($CCl_3CH_3$, ODP 0.1, GWP 140, boiling point 74 °C), acetone ($CH_3COCH_3$, ODP 0, boiling point 56.1 °C) and liquid $CO_2$ are some of the other physical blowing agents used to make, primarily, non-insulation foams. With a critical temperature of 31 °C and pressure of 7.38 MPa, liquid $CO_2$ has long been considered an attractive blowing agent for PU foam. Readily available from the air and other natural sources, it is inexpensive and safe.

Perfluorocarbons, e.g., perfluoropentane (C5F12) and perfluorohexane (C6F14) have been evaluated as blowing agents and as a co-blowing agent with HCFCs (309, 327). They are not considered viable blowing agent options as they are characterised by very long atmospheric lifetimes (of the order of hundreds to thousands of years) and are very infrared-active and thus have high GWP.

Fluorinated ethers, such as HFE-245 ($CF_3CH_2OCF_2H$), HFE-356 ($CF_3CHFCF_2OCH_3$) and HFE-254mf ($CH_3CF_2OCCF_2H$) have been evaluated in laboratories in rigid foam applications, but substantial development work will be required to determine their ultimate commercial viability (104, 317). Similarly fluoroiodocarbons such as heptafluoro-2-iodopropane and hydrogen containing fluoromorpholine have been evaluated in laboratories, but high cost has meant no commercial use (245, 401).

### 3.5 Chemical Blowing Agents

Chemical blowing agents are used extensively in many plastics where the processing temperature causes chemical breakdown of the blowing agent to form gases. Although this type of chemical blowing agent is not used often in PU chemistry, $CO_2$ generated by the reaction of water with isocyanate has been the work-horse. At present all PU foams, rigid or flexible, low or high density, are at least partially blown with $CO_2$.

The isocyanate group can react with another isocyanate group to form carbodiimide and give $CO_2$, especially in the presence of specific catalysts. Although this has been evaluated, it is not practised widely (314). Hydrolysis of dimethylcarbonate and dialkyl dicarbonates, such as diisobutyl dicarbonate, to give $CO_2$, has been studied to make flexible foam (44, 321).

# 4 Blowing Agents for Low Density Rigid Foam

Low density rigid foams are characterised by a density of about 24 to 50 kg/m$^3$ and are used primarily in applications where thermal energy loss is to be minimised. Rigid foam also plays a key role in the preservation of the quality of food. Its properties have led to it being used in the entire food chain, from the insulation of large warehouses, through refrigerated transport, to storage in display cabinets in shops, and finally in refrigerators and freezers in the home. PU foams are also standard in the insulation of buildings and industrial facilities: they are used in fabrication of roofing boards, perimeter insulation, sprayed walls/ceilings, industrial tanks, etc. PU foams are used in many non-insulating applications too, e.g., marine flotation, taxidermy, floral foams, etc.

## 4.1 Specific Performance Criteria

Low density rigid foam insulation needs to be closed cell in order to make heat transfer by convection impossible. Such foam needs to enclose a gas whose thermal conductivity is lower than that of air. If the low thermal conductivity has to be retained for the useful life of the product then this gas must not be diluted or escape. Thus a key specific criteria for blowing agents used in rigid foam insulation is that they should have a low thermal conductivity and low permeability through the polymer (361).

It has been shown that, all other factors being equal, the foam with the higher initial blowing agent cell pressure provides better insulation characteristics compared to the lower initial pressure (319). Although there are various means of influencing this initial blowing agent cell pressure, a lower boiling point blowing agent will result in a higher initial pressure. This becomes especially important at low service temperatures where a higher boiling point blowing agent will condense, deteriorating the insulation value and raising concerns about the dimensional stability of the closed cell foam. Increased blowing agent pressure can also be obtained by selecting a blowing agent with minimal solubility in the polyurethane polymer. Of course the performance need for low boiling point and low solubility in the foam polymer needs to be balanced against the handling and processing needs of the components to make homogeneous foam.

An important consideration while choosing a blowing agent for insulation foam stems from the fact that many of the blowing agents with low thermal conductivity and other desirable characteristics have high GWP. Many recent studies have shown that the energy efficiency of thermal insulation blown with blowing agents with relatively high GWP can reduce $CO_2$ produced by the burning of fossil fuel sufficiently to decrease the overall global warming effect from such blowing agents (28, 136). Such studies on the total environmental warming impact (TEWI) include not only the direct effect of blowing agents on global warming, but also the indirect effect due to energy saving. TEWI calculations are specific to a system, e.g., a refrigerator with a certain insulation and energy consumption pattern located in a region with a certain level of $CO_2$ emission per unit of electricity generation.

An issue that is likely to play an increasingly large role in the future growth rate of rigid insulation foam and the choice of blowing agent is the international treaty limiting the emission of greenhouse gases, the Kyoto Protocol (see Section 1.2).

## 4.2 General Developments

Although the unique requirements of each end-use market required targeted effort, a lot of the developments were common across market/region and are discussed below. Market/region specific developments are discussed under Section 4.3. It is important to reiterate that CFCs along with $CO_2$ generated by the reaction of water and isocyanate (henceforth referred to as $CO_2$ (water)) provided all the blowing in all rigid foam applications across the globe until the mid 1980s. $CO_2$ (water) was only a minor fraction of the total blowing in most cases. This is not the case any more. A minimum of 10-30 vol% $CO_2$ blowing is used in all applications now. The exact amount depends on the balance of properties required for the application at hand. For ease of reading, $CO_2$ (water) as a co-blowing agent is specified in the following discussions only when it is used in an amount outside of this range.

### *4.2.1 Reducing Consumption of CFC-11*

In the late 1980s a lot of effort was focussed on replacing part of the CFC-11 by an equivalent molar amount of $CO_2$ generated by reaction with water added to the polyol blend, while maintaining acceptable performance. This was successful in almost all cases

to some degree and generally led to the development of new systems. Some examples are: lamination, pipe and domestic appliances, where about 50% by weight of CFC-11 could be replaced with little change in the k-factor of the foam insulation (357, 359). Such findings are still relevant as many Article 5(1) countries are using CFC-11 in year 2002 and are mandated to reduce consumption as per the schedule outlined in **Table 1**.

### *4.2.2 Liquid HCFCs*

In the early 1990s, one liquid HCFC, namely HCFC-141b, emerged as the leading interim blowing agent for many applications. Given the volatility and solubility characteristics of HCFC-141b, it is considered a 'drop-in' replacement to CFC-11 which meant that all changes can be incorporated into the foam system, and no changes in the production process are necessary.

Characteristics such as higher boiling point, higher solvency, etc., of HCFC-141b necessitated many new developments in raw materials, in systems, and even in the test methods used to measure performance. New systems have been developed which, in some cases, involved simple reformulation using the existing components (113, 187). New polyols have been developed primarily to overcome the poor dimensional stability associated with higher boiling point and solvency (66). Tailoring of the formulations to HCFC-141b led to the development of specialised catalyst systems. Many new catalysts, such as amino acid salt catalysts derived from sarcosine (190), specialised amine catalysts (149, 268, 390), and new quaternary ammonium salts (149) have also been developed. Evaluation of the fire performance of HCFC-141b blown foam suggested that existing products and technology would enable passing the requisite flammability tests (388). The change in blowing agent along with changes to other components meant an assessment of the surfactant. New surfactants resulting in improved processability and physical properties have been identified (233, 366).

Efforts to maintain the thermal insulation characteristics of HCFC-141b blown foam at CFC-11 levels, despite its higher gas phase thermal conductivity, led to the development of new technology, additives, etc., and these are discussed in Section 4.2.10. Also, the thermal conductivity and dimensional stability ageing characteristics of HCFC-141b blown foam are different (see Sections 4.2.11 and 4.2.12, respectively).

### *4.2.3 Liquid HFCs*

Liquid HFCs have been deemed to be the natural progression from CFC-11 and HCFC-141b, and are considered as 'drop in' replacements. Two blowing agents, HFC-245fa and HFC-365mfc, have been extensively evaluated in a variety of polyurethane and polyisocyanurate rigid foam formulations and are slated for commercial production by the end of 2002 (a.7, a.8).

A considerable body of data has been generated to establish that HFC-245fa is a non-flammable liquid blowing agent, suited to produce foams with low thermal conductivity and good dimensional stability at a wide range of service temperatures, using traditional liquid processing techniques (208, 400). Although the lower boiling point and higher vapour pressure of HFC-245fa have contributed to stronger foam with a better k-factor over a range of temperatures, it impacts on the processing and storage of polyol blend containing blowing agent (i.e., premixes). Addition of compounds such as alpha-methyl styrene, isobutanol and/or isopropanol has been found to reduce vapour pressure over the premix and improve processing (41).

Information relating to manufacture and performance of foam blown with HFC-365mfc such as solubility, vapour pressure, a discussion of the effect of surfactants on foam properties, cell gas content, foam ageing and k-factor versus mean use temperature has been generated (107). The relatively high boiling point and low vapour pressure of HFC-365mfc has meant easy processing and storage of premixes, but possible condensation at low service temperature yielding higher thermal conductivity and poorer dimensional stability. Also, the minimum ignition energy and flammability limits in air for HFC-365mfc has meant that it must be handled as flammable liquid although its associated risk can be managed more easily than that for hydrocarbons (107). These two effects, i.e., condensation and flammability, have led to a search for suitable blends of HFC-365mfc with other compounds. Non-azeotropic blends with each of HFC-245fa, HFC-134a and HFC-227 have been proposed, with preference being given to HFC-227 (21, 75, a.8). This non-azeotropic blend needs to be stored/used in a closed loop in order to avoid loss of HFC-227 via the vapour phase. Azeotropic blends of HFC-365mfc with all three pentane isomers have been evaluated and found to give improved thermal conductivity and dimensional stability (74).

Efforts to optimise formulations with each liquid HFC have generally been specific to a given application,

although new polyols and new catalyst systems have been developed to improve performance across many applications (380, a.9).

### *4.2.4 Low Boiling Blowing Agents (LBBA)*

While liquids such as CFC-11, HCFC-141b, HFC-245fa, etc., have been the mainstay blowing agents for rigid PU foam, use of low boiling point blowing agents (LBBAs), i.e., compounds with boiling point well below room temperature, say 7 to -50 °C, have been increasing. In addition to historic use as propellants and frothing agents, LBBAs are being used as a co-blowing agent with higher boiling blowing agents or with $CO_2$ (water). This is because they remain in the vapour phase in closed cells of the foam to much lower temperature than the higher boiling liquid blowing agents and for much longer time than $CO_2$. Thus they improve the dimensional stability, compressive strength and thermal conductivity of the foam, especially at low temperatures and over a long use life. In addition, use of LBBAs improves processing, in particular flow, in most cases.

LBBAs such as HCFC-22, HFC-134a HCFC-142b, HFC-152a and *iso*-butane have been extensively evaluated, especially the first two. HCFC-22 has been evaluated as the sole physical blowing agent (336, 337) and as a co-blowing agent (326) specifically to assist flow with HCFC-141b in a variety of applications. Foams blown with $CO_2$ (water) and increasingly higher amounts of HFC-134a have been deemed as the zero ODP solution for many applications (97, 272).

The major challenge in the use of LBBAs has been the difficulty in foam processing due to the moderate to low solubility in rigid foam polyols and due to high vapour pressure under manufacturing conditions. Solubility of LBBAs in polyol has been studied both experimentally and via modelling, and improved products have been developed (153, 249). Silicone surfactants with improved emulsification with LBBAs without sacrificing other attributes have been investigated (280). Novel blending systems for making pre-mixes with LBBA, mixed well enough to ensure an efficient manufacturing process, have been developed (26, 53). New high pressure dispensing and nucleating equipment that also incorporates facilities for LBBA loading and for quantitative measurement of dissolved and dispersed gaseous blowing agent has been developed (316). Simple metering and mixing devices for LBBAs have been developed too (177). In summary, by appropriate selection of components, together with modification of equipment, LBBAs are successfully being used in larger and larger quantities.

### *4.2.5 Degradation Products of HCFCs and HFCs*

The presence of hydrogen in HCFCs and HFCs raises questions about the formation of degradation products, especially haloalkenes, by dehydrohalogenation, both during storage of blowing agent premix and during foam forming conditions. It has been found that, in general, the commercial HCFCs and HFCs do not contribute negatively to premix stability and that systems with commercially acceptable shelf life can be formulated (156, 157). In the relatively few cases where it is found to be an issue, a variety of solutions have been proposed depending on the specific blowing agent, polyol, storage time and temperature. Addition of specific stabiliser and polyol are examples of this (219, 304).

It has been established that a very small concentration of HCFC-1131a ($CH_2$=CClF) and HCFC-151a ($CH_3CHClF$) can be formed under some very specific conditions, such as high index polyisocyanurate (PIR) rigid foam production using a specific catalyst (335). Two similar cases are: the formation of *cis* and *trans* isomers of HFC-1234ze ($CF_3CH$=CF) in HCFC-245fa blown foam and the formation of the Z and E isomers of 1,1,1,3-tetrafluorobutene-2 and 1,1,3,3-tetrafluorobutene-1 from HFC-365mfc (156, 157). In all these cases, the toxicity of the decomposition products has been tested and has raised no cause for concern. A variety of solutions for reducing the formation of degradation product has been identified including the use of specific catalysts (114, 184, 335), specific polyol (362) and specific stabiliser (156). Through careful formulation it has been possible to produce foam without concern about producing undesirable degradation products.

### *4.2.6 Liquid Hydrocarbons*

Many of the chemical and physical properties, such as polarity, solubility characteristics, molecular weight, etc., of pentanes are very different to that of the other physical blowing agents used by the rigid foam industry. Pentanes are essentially non-polar and their solubility characteristics are very different from any fluorocarbons (130). The molecular weight of pentane is much lower, which means that smaller amounts are necessary to achieve standard foam density and thus the viscosity of a drop-in polyol blend would be higher. All this along with flammability issues means that pentanes cannot be considered as a drop-in replacement and significant modifications are required in both equipment and systems (406).

The solubility of pentanes has been systematically evaluated in various components and in polyol premixes and routes to improve it have been identified (130, 154). Many trends between pentane solubility and parameters, such as the propylene oxide content of the polyol, the type of initiator and the water content of the polyol blend, etc., have been established. In most cases, with careful selection of the components, based on such trends, it has been possible to formulate soluble or emulsion systems with the required stability for the application at hand. At the same time, various, novel routes to enhance solubility have been identified. Some examples are: the use of hydroxy substituted fatty acids especially castor oil (246); polyester polyol produced by esterification of fatty acids derived from triglycerides with polyalcohols (364); diethanolamide derived from vegetable matter (207); and amidation products of castor oil with polyamines (169). In addition, organic and silicone surfactants to enhance the emulsion stability of polyol premixes to meet the processing needs of the application have been developed (233, 269). Selection of such surfactants has been guided by hydrophile-lipophile balance (HLB) principles in many cases (98, 130, 206). In many applications, such as continuous lamination, a soluble system or an emulsion with long stability is not necessary, as pentane can be added at or near the mix-head.

The relatively high boiling point and low vapour pressure of cyclopentane has raised concern about possible condensation at low service temperature, yielding higher thermal conductivity and poorer dimensional stability. Such is not the case with *iso*-pentane and only slightly with *n*-pentane. At the same time the vapour thermal conductivity of cyclopentane is lower than that of *iso*- or *n*-pentane. Many blends of pentanes including some proprietary ones have been developed to get the desired balance of properties (247, 381). Blends of pentanes with HFCs, or with other functional blowing agents have also been proposed (110, 226).

Efforts to optimise formulations with pentane have generally been specific to a given application although new polyols and new catalyst systems have been developed to improve performance across many applications (20, 226, 390). It has been found that, though pentane blown foams require higher amounts of flame retardant additives and/or other formulation optimisation such as higher index, they show behaviour comparable to fluorocarbon blown foams in large scale fire tests (251, 406).

### *4.2.7 Blends of Blowing Agents*

Although the first generation substitutes for CFCs have generally been single products of either low or zero ODP, as the replacement technologies have matured, there is a strong trend to optimise blends of two or more blowing agents. This is because the processing characteristics, the foam properties and the production economics of many single blowing agents do not meet all the needs of the market place. Some blowing agent blends have been described above and many others that are specific to an application are discussed under Section 4.3. Here we discuss the blowing agent blends that are common to many applications.

With the aim to get zero ODP and zero GWP, several binary and ternary azeotropic blends consisting of C5-C7 aliphatic hydrocarbons, C2-C4 carboxylic esters, C3-C4 ketones, and C4 ethers have been evaluated (399). Blends of HFC-245fa with pentane and with HCFC-141b have been considered with the aim to get a good balance of properties at reasonable cost (73, 83). An azeotrope-like blend of HFC-245fa with tetramethylsilane has been considered and so have binary or ternary blends of HCFC-142b/124 with *n*-/*iso*-pentanes (52, 84). Other azotrope or azeotrope-like compositions have been evaluated as blowing agents for rigid foam (109, 112). Surprisingly, none of these blends are in commercial use at present.

### *4.2.8 All $CO_2$ Blown*

Using $CO_2$ alone to make rigid foam is an appealing option from environmental and safety considerations as it is free from ODP, GWP, health, and flammability issues. $CO_2$ generated *in situ* from the reaction of water and isocyanate used to be the route to blow foam before the advent of CFC-11 and has been extensively evaluated since the mid 1980s. Such foams, however, bring one or more of the following challenges:

(a) high surface friability and poor adhesion to facing,

(b) higher initial and aged thermal conductivity materials and

(c) poor dimensional stability especially under hot/humid ageing.

Much effort has been made to understand the cause and find solutions to these challenges.

High surface friability and poor adhesion to facing materials has generally been associated with a

simultaneous increase in urea content formed during the water-isocyanate reaction. Thus alternative methods to produce $CO_2$ and reduce urea formation have been evaluated. These include the reaction between two isocyanate groups to form carbodiimide and give $CO_2$ (237), use of the reaction between isocyanate and formic acid (108) and the reaction with formate salts such as potassium formate (267). Other approaches to improve adhesion include optimisation of the molecular weight and composition of the polyether polyol (24).

The vapour thermal conductivity of $CO_2$ is higher than most blowing agents discussed above and its permeability through PU foam is high. This high permeability reduces the cell pressure in the foam and increases the mole fraction of air, which does diffuse into the cell but at a much slower rate. Thus both the initial and aged thermal conductivity of all $CO_2$ blown foam is high unless ageing is retarded with the use of an impervious barrier layer in a sandwich construction. The different diffusion rates also reduce the total cell pressure early in the ageing and this causes foam shrinkage at nominal densities. By proper selection of raw material and processing parameters, it has been possible to increase the ingress rate of air components to foam to a point that dimensionally stable closed cell foams can be made at densities as low as 25 kg/m$^3$ (407). Another approach has been to strengthen the foam by formulating with new polyol (66, 398). Another solution has been to open the cells and this is discussed in Section 4.2.9.

Many solutions have been found which address more than one issue. These include the use of novel polyol (133) or increasing the functionality of the polyol (145). New catalyst systems have been found to help in adhesion, dimensional stability and k-factor (308, 390).

### *4.2.9 Partially Open Cell Foam*

One solution to overcome foam shrinkage in all $CO_2$ blown foam has been to make the cell windows open and thus avoid cell pressure change with ageing. This does not change the aged thermal resistance of unfaced or permeabily faced foam products significantly as, even with closed cell foam, air-filled condition is reached within a fairly short period of time. Thus, for applications where the insulation value of air-filled foam is acceptable, or where foam is used primarily for structural support, $CO_2$ blown foams with open cell content in the range 20-70% have found a home. The insulation value of such foam can be improved by optimising cell size, density and material balance between struts and window (263).

One approach has been the use of specific additives, which act as cell openers (276). One such additive is fatty acid and its derivatives (50), another is fine solid particles dispersed in polyol (172). Another approach has been to use novel polyol (36, 171). A specially designed cell opening surfactant with tailored catalyst has also been developed (33, 365). Many of these developments in additive, polyol and surfactant have stemmed from a need to get cell opening over a wide range of overpack. This has also been achieved by tailoring the formulation (238).

### *4.2.10 Thermal Conductivity Improvement Technology*

Total heat transmission through a closed cell foam ($k_{foam}$), is the sum of that conducted through gas contained in the cells ($k_{gas}$), that conducted through the solid polymer of the cells ($k_s$) and that radiated across the cell walls ($k_{rad}$). Given that the gas phase thermal conductivity of all alternative blowing agents is higher than that of CFC-11, in order to minimise $k_{foam}$, much effort has been spent on basic understanding of all aspects of heat transfer through foam, including how it is affected by foam cellular structure, morphology and composition (405). To allow for an objective comparison of the impact of blowing agent selection on $k_{gas}$, analytical techniques to measure cell gas composition have been developed (209, 243). Experimental measurements of the thermal conductivity of a gas mixture and the refinement of equations to predict it have been carried out (94, 120). This research has enabled formulators to choose blowing agent composition more analytically.

A technology that has been evaluated to reduce $k_{gas}$ post-foaming is *in situ* $CO_2$ removal by reaction with compounds such as alkali metal hydroxide and organic epoxide (115, 232).

To reduce $k_{rad}$, technology has been developed to reduce cell size and/or to increase the thermal opacity to infrared radiation of the cell. Perfluorinated hydrocarbons (318, 341), vinyl fluoroalkane (252) and unsaturated perfluorinated compounds (193) are among the many additives evaluated to reduce the cell size of foam (310). Despite the relatively low dosage required to get cell size and thus $k_{foam}$ reduction, such additives are not used widely due to high cost and environmental concerns. Ultrasonic excitation immediately after impingement mixing of the polyol and isocyanate mixture is another method demonstrated to reduce cell size (48). The cell size of foams produced today is smaller than in past years and has been achieved primarily via formulation and process optimisation.

Thermal opacity to infrared radiation of cell windows and struts has been increased by using solid additives such as carbon black (182) and silica (168). To get a reduction in $k_{foam}$, such an additive needs to be located dominantly in the windows of the cell. Although demonstrated in many laboratories, this is rarely practised on a large scale due to the very narrow processing and formulation window necessary to place such solid particles in the thin windows of the cell without breaking them open. In some instances, $k_{rad}$ reduction via cell size decrease and the use of thermal opacifiers together has been demonstrated (395).

### *4.2.11 Thermal Conductivity Ageing of Foam*

Generally, closed cell rigid foam undergoes a gradual outward diffusion of the blowing agents with a concomitant inward diffusion of air. This causes the cell gas composition, and thus $k_{gas}$, to change and eventually the thermal conductivity of the foam goes up as the thermal conductivity of air is higher (about 26.0 mW/m.K at 25 °C) than that of blowing agents. The rate at which the concentration of different gases change depends on foam parameters such as density, cell size, cell window thickness, polymer composition, etc., along with the characteristics of the gases involved and the actual ageing conditions (328). The diffusion coefficients of various blowing agents and air have been calculated using a variety of techniques, such as the constant-volume sorption technique (356); the desorption technique (19); the thin-slice gravimetric desorption method (25, 270); and gas chromatography with a specially developed sampling device (405).

It has been found that in essentially all unfaced foam, $CO_2$ is the fastest diffusing gas, the physical blowing agents the slowest and air diffuses at a rate in between (79, 356, 405). Formulation and processing techniques to reduce these diffusion co-efficients have been explored (274, 328). An often used and effective method to retard diffusion and ageing has been the use of impermeable or semi-permeable facing material.

Diffusion of gases is not the only process that controls the thermal ageing of foam. Blowing agent condensation at the temperature of use, equilibriation of blowing agent between cell gas and the polymer matrix, and plasticisation of the matrix by atmospheric moisture are the others (302, 405).

With the basic understanding of all the processes that affect thermal ageing in place, it has been possible to simulate thermal ageing of foams of various shapes and sizes under any set of temperature and time history using numerical analysis (405). Thus measurement of the initial cell gas composition and diffusion coefficients of the relevant gases in foam enables one to predict the long-term thermal conductivity of foam in any chosen set of conditions. Physical test methods to predict the long-term thermal conductivity of foam have also been developed (186). Such analysis has helped in objective selection of blowing agent and a rational design of formulation with the chosen blowing agent.

### *4.2.12 Dimensional Stability of Foam*

A key requirement of any foam is to maintain its shape and size, i.e., be dimensionally stable through all of its useful life, which may range from a couple of years to over 50 years in a wide variety of environmental conditions. Many of the same transport processes that affect thermal conductivity ageing play a role in dimensional stability too. Thus diffusion of gases in and out of foam cells, blowing agent condensation, and equilibriation of blowing agent between cell gas and the polymer matrix at the use/storage conditions, all affect dimensional stability. Unlike thermal ageing, the emphasis with dimensional stability has been to define test methods which can best simulate the most deformation a foam will see in the course of its useful life. The existing test methods were not able to do so for the new blowing agent mixtures.

One new method, referred to as the Dimvac test method, accelerates the outward diffusion of the $CO_2$ present in almost all foams made today without allowing the diffusion of air in to the foam. This is followed by conditioning at atmospheric pressure for a chosen time and temperature (244). The conditioning temperature and time depend on the choice of blowing agent, the composition of the foam polymer, and the end use (128, 151). This test method and others based on the same basic idea have been used widely and this has led to better quantification of the formulation and processing parameters influencing the long-term dimensional stability (17, 72, 131, 132). Uniaxial compression creep (191) and hydrostatic compression creep (369) are two other test methods evaluated to quantify the long-term dimensional stability. The plasticisation effect of blowing agent has been quantified by measuring the loss in compressive strength of foam equilibriated to high levels of blowing agent in the polymer matrix by a special conditioning (128, 155). These tests have enabled the polyurethane foam industry to successfully use foams made with the new blowing agents with confidence about their long-term dimensional performance.

### 4.3 Blowing Agent Technology by End Use Market

Given the wide array of markets that PU rigid foams serve, the unique process, performance and cost requirements of each of these markets, and the versatility of chemistry, a variety of blowing agent options exist. These options vary not only by the end-use market but also by the geographical region and time horizon. Each type of PU rigid foam blowing agent currently in use and the options available in future are discussed next.

#### *4.3.1 Household Refrigerators and Freezers*

This represents a large, global, and visible application of PU rigid foam and thus environmental issues have been at the forefront of blowing agent selection. The market has been impacted by, not only ozone depletion issues, but also by national or regional energy efficiency mandates, chemical restrictions (such as halogen free), 'eco-label' requirements, etc. Energy efficiency requirements continue to play a significant role in blowing agent selection in the USA (59). Eco-label requirements, currently active in parts of Europe, encompass chemical restrictions and energy efficiency (93). Blowing agent emission levels within the appliance and their impact on food safety need to be considered too.

Some large commercial refrigerators and freezers are discussed in Sections 4.3.2 and 4.3.4.

##### *4.3.1.1 Low ODP Blowing Agent Technologies*

Many systems which replaced up to 50% of the total blowing from CFC-11 to $CO_2$ (water) with minimal impact on energy consumption were developed using new/optimised components and k-factor improvement technology in the late 1980s (351, 352). Such reduced CFC-11 foams are currently in use in a few plants in Article 5(1) countries (a.5).

HCFC-141b alone or in a mixture with HCFC-22 are the dominant physical blowing agents being used in 2002 by most manufacturers in North America, by some in Japan and to a lesser degree in other non-Article 5(1) countries (181, 228). These are the second leading option for CFC-11 replacement in many Article 5 (1) countries (370). Such systems were developed in the early 1990s (312, 342) and have since been further optimised to increase energy efficiency, reduce cost, improve robustness, etc., (178, 395). Foam processing conditions have also been optimised to improve performance (179, 288). Foams blown with LBBAs, such as HCFC-22 (310) and a 40/60 blend of HCFC-22/142b (310, 311), as the sole physical blowing agents have been evaluated and are being used in a few cases (93). These LBBAs are being considered as one of the options in the United States once HCFC-141b is phased out at the end of 2002 (23).

Concern about HCFC attacking the plastic liners used in appliances necessitated a need to study plastics liner/blowing agent interactions (250) and the development of more suitable liner materials (164, 344). Adhesion between foam and liner has also been a concern and has led to changes to liner material, foam formulation, and/or processing conditions (227). Blowing agent emission and food migration studies have found no issues with these blowing agents (289).

##### *4.3.1.2 Zero ODP Technologies*

Environmental issues in play in the early 1990s, such as halogen-free foam for the 'Blue Angel' eco-label in Germany and a push to use zero ODP blowing agent, led many European appliance manufacturers to use cyclopentane as early as 1993 (261, 262, 292). Currently, cyclopentane alone or in mixtures with lower boiling hydrocarbons are widely used blowing agents in Europe, Japan, Australia and many other, including many Article 5(1), countries (234, 371). They are the leading replacement option for those still using CFC-11 in some Article 5(1) countries. Such wide use has been possible because foaming equipment manufacturers have developed features that can allow appliance moulders to use highly flammable hydrocarbon gas safely. This has involved the development and use of specific pre-blending stations, storage tanks, metering machines, foaming fixtures, ventilation equipment, gas monitoring networks, alarms, etc., (89, 222, 224, 225).

Foam systems using 'pure' grade (95% purity) or 'technical' grade (75-80% purity) cyclopentane have been developed by optimising various resin components such as polyol, catalyst, surfactant and foaming conditions, such as index and overpack (180, 260, 394, 396). The drive to reduce density and improve thermal and dimensional performance at the operating temperature for refrigerators and freezers has led to the development and use of blends of cyclopentane with lower boiling hydrocarbons, in particular *iso*-/*n*-pentane and *iso*-/*n*-butane (92, 121, 229). Further studies, along the same line, have led to the development of formulations using *iso*-pentane and/or *n*-pentane (182, 205, 229). Regular CFC-grade high impact polystyrene (HIPS) and acrylonitrile-butadiene-styrene terpolymers

(ABS) have been found acceptable as liner material with pentanes (229, 262).

Even though hydrocarbons have been in wide use, they have not emerged as the preferred zero ODP option for the USA. Combinations of cabinet energy penalties, capital conversion cost and high insurance cost have made them less desirable (a.5). Through the various comparative studies, HFC-245fa has emerged as the leading zero ODP candidate for the USA (58, 59, 138). The relatively high cost of HFC-245fa has led to numerous studies on formulation and process optimisation with the goal of meeting energy requirements while maximising $CO_2$ (water) co-blowing (27, 91, a.10). This has led to development of new components, especially polyol and surfactant (139, a.11). The high cost of HFC-245fa has also caused some appliance manufacturers to look at HFC-134a (a.12). The consistent and significant improvements in technology involving the use of HFC-134a have made it more attractive now, but its long-term viability remains in question due to the poorer energy efficiency of cabinets (23, 281). Regular CFC-grade HIPS and ABS are compatible with HFC-245fa and HFC-134a (27, 400). Also, blowing agent emission and food migration studies have found no concerns (140).

All $CO_2$ (water) blown foam has been evaluated but not found acceptable due to poor energy efficiency of the cabinet (230, 259). HFC-365mfc has not been evaluated in North America for patent reasons, and none of the HFCs have been considered seriously in Western Europe for eco-label reasons. An option that has been evaluated in Western Europe, Japan and the USA has been the use of vacuum insulation panel (VIP). One route to make such panel is to encapsulate sheets of fully open celled rigid PU foam into gas tight film, under vacuum (78, 313, 393). The vacuum panels require suitable getter systems to absorb various gas sources in the panel, such as residual blowing agent in foam, ingressed air, etc., (90). Such vacuum panel is put in place in an appliance using all $CO_2$ (water) blown foam with superior flow performance, lower pressure and exotherm (230, 393). The relatively high cost of making VIPs, even when scaled up to mass production, coupled with the additional labour to install them, makes the use of VIPs an exception despite potential to get high energy efficiency.

### *4.3.2 Water Heaters and Other Appliances*

This section includes water heaters, commercial refrigerators and freezers, vending machines, picnic coolers, flasks and thermoware. Some large commercial refrigerators and freezers are made using panels and are discussed in Section 4.3.4

HCFC-141b is the dominant physical blowing agent currently being used in 2002 by the North American and Japanese water heater manufacturers (173). Even though closed cell all $CO_2$ (water) blown foams have been found to meet the existing energy standards, their use is limited due to higher density requirements (291). In order to meet the emerging energy standards, effective in the USA in 2004, HFC-245fa, HFC-134a and pentanes have been compared (a.13). It appears that cyclopentane alone or in mixtures with lower boiling pentanes is the most cost-effective solution and will be the blowing agent of choice for larger manufacturers. HFC-245fa, HFC-134a and HFC-365mfc (outside North America) each co-blown with large amounts of $CO_2$ (water) will be used by smaller manufacturers. The water heater market in the remaining parts of the world is relatively small and use of all $CO_2$ (water) blown foam or alternative insulation such as fibreglass are common.

For other appliances, a variety of HCFCs including HCFC-141b, HCFC-22 and HCFC22/142b are currently being used in North America, Western Europe and Japan. Some manufacturers of vending machines are using all $CO_2$ (water) blown foam. Zero ODP options in these countries appear to be HFC-134a co-blown with large amounts of $CO_2$ (water), though cyclopentane in mixtures with lower boiling pentanes is likely to be used by the largest manufacturers. In Article 5(1) countries, CFC-11 and reduced CFC-11 are still the primary blowing agents, especially in picnic coolers, flasks and thermoware, although some manufacturers are using pentane (a.5, 2001 Report).

### *4.3.3 Flexible Faced Laminates (Boardstock)*

This includes polyurethane and polyisocyanurate (PIR) foam made by continuous lamination on facing materials such as black glass facer, roofing felt, aluminium foil, trilaminate, paper, oriented strand board and plasterboard. Such products are used extensively in the building and construction industry with commercial roofing, sheathing for residential housing and exterior ventilated facades being the three largest uses. Boardstock products are often subject to stringent building codes and need to meet flammability standards set by the insulation, construction and insurance industries. One example of such a standard is the Factory Mutual Calorimeter test for insulated roof deck, fire class B2 (DIN 4102) for roofs in Europe, another example is the Factory Mutual corner test for

wall insulation. Boardstock products are extremely cost sensitive as there are several substitution products such as polystyrene, mineral wool, etc. Also long-term dimensional stability and thermal insulation issues, discussed in Sections 4.2.12 and 4.2.11 respectively, play an important role in this market.

#### *4.3.3.1 HFC-141b*

There are two main technology streams in use in 2002, one blown with HCFC-141b (including 10 mole% of HCFC-22) in wide use in North America and Japan and the other with pentanes in wide use in Western Europe. There is currently little production of boardstock in Article 5(1) countries.

In industrial use since 1993, HCFC-141b blown formulations were initially evaluated on industrial laminators in the early 1990s (350, 353). Such formulations have since been further optimised via development of new components including polyols, catalysts and surfactants (183, 301, 384, 387). Replacement of about 10 mole% of the total HCFC-141b blowing by LBBA HCFC-22 have improved performance and this is in wide use (386). Although use of HCFC-22/$CO_2$ (water) and 2-chloropropane have been evaluated, these are not being used anymore (332, 333).

#### *4.3.3.2 Pentane*

Pentane blown foams have been used by many laminators in Western Europe since 1993 and have become the zero ODP blowing agent of choice in North America and Japan. Generally, *n*- and *iso*-pentane and their blends have emerged as the pentane of choice in Europe, whereas cyclopentane blends with *iso*- and/or *n*-pentane have emerged as the optimum blowing agent used/considered in America (76). Significant exceptions to this do occur as the primary determinant, the long term thermal resistance (LTTR) requirements of the local market, keep evolving. Formulations meeting the local fire tests have been developed in America (76, 240) and in Europe (203, 264). Formulation and process optimisation often using new/optimum components, such as polyols, catalysts and surfactants, have been necessary to meet the needs of this market (64, 98, 132, 148). It has been demonstrated that performance, especially the LTTR, of pentane blown foam can be improved by co-blowing with HFC-245fa (34), HFC-365mfc (a.8) and HFC-134a (a.14). Although use of such blends appears unlikely at present, they may play a role in future as various issues such as harmonisation of fire standards in Europe using Euroclassification, standardisation of building codes in the USA, climate change policy in Europe and Japan, etc., come to force in the market place.

#### *4.3.3.3 Carbon Dioxide*

All $CO_2$ blown foam, some using specially developed polyol while others using alternative routes to generate $CO_2$ (other than water plus isocyanate reaction) has been evaluated, but the poor LTTR of such foam has meant little industrial use (66, 242, 349). A range of facing materials which enables retaining the LTTR close to the initial thermal conductivity have been developed and may play a role in future (360).

To underscore the safe use of boardstock products, a study was conducted to estimate the concentration of blowing agent that might accumulate in the living space of a house insulated with foam sheathing. It was found to be 4-5 orders of magnitude lower than the industrial hygiene based permissible exposure levels (338).

### ***4.3.4 Rigid Faced Laminates***

Also referred to as composite or sandwich or metal panel, these are used for the construction of industrial and commercial buildings and in many stages of the food chain, including cold storage, refrigerated transport containers (Reefers) and trucks, and display cabinets. Metal panels are often subject to stringent building codes and must pass certain flammability criteria, such as Factory Mutual standard 4880 approval for Class 1 fire (also known as open corner fire test), UL 723/ASTM E-84 Tunnel test in USA (278); ULC S127 and ULC S102 in Canada. In Europe, each country has its own fire regulations, such as the German DIN 4102 B2 and the French NF P 92-501 M1: a big effort is underway to develop European standards, such as EN 13823 Single Burning Item (SIB) (6). The choice of blowing agent and formulation depends very strongly on the flammability characteristics the foam and panel must meet.

Metal panels can be produced by a continuous or by a discontinuous process. The continuous process, commonly used in Europe, is analogous to the flexible faced lamination using formulation similar to boardstock. The discontinuous process, commonly used in North America and Article 5(1) countries, is essentially a press injection technique and utilises lower index polyurethane foam. PU foam provides three key attributes to this application, namely low

thermal conductivity, structural strength and auto-adhesion. As the density of the foam used in this application is high and it is sandwiched between impermeable steel facer, dimensional stability and foam ageing is generally not an issue. However, metal panels are often produced in high thicknesses, up to 240 mm, and this creates issues about post expansion, and horizontal and/or angled splits (236). Overall, the choice of blowing agent and formulation depends on the fire specification of the foam/panel, the initial thermal conductivity, the method of production, the ability to produce defect free panel and cost.

#### *4.3.4.1 HCFCs*

HCFC-141b is the physical blowing agent of choice currently (2002) in North America, Japan and to a lesser degree in Europe for both continuous and discontinuous processes (278, 389). It is currently being used in many Article 5(1) countries and will be the main replacement blowing option for the few still using CFC-11 (163, 367). Formulations meeting the toughest fire tests and defect free thick products have been developed using HCFC-141b (236, 278, 279). HCFC-22 and HCFC 22/142b co-blown with high amounts of $CO_2$ (water) are being used by some manufacturers globally (334). Formulations using such blowing agents can meet all the requirements except thermal conductivity, which is generally 5-10% higher as compared to those using HCFC-141b (306, 334, 343). With the exception of Western Europe, systems blown with HCFC other than HCFC-141b can be used long after 2002 and thus it is likely that the use of HCFC-22 and HCFC-22/142b will increase (a.15).

#### *4.3.4.2 Pentane*

Many continuous production lines in Europe have been using *n*-pentane or blends of *iso*-and *n*-pentane since the mid 1990s (129). With proper thickness of the metal, innovative design of the sandwich panel, and further optimisation of formulations, it is now possible to pass the most stringent fire test, including French NF P 92-501, M1, and obtain Euroclass B (a.15). The certified aged thermal conductivity value of 20-25 mW/m.K is attainable with panels made using such foam, is the same as those obtained with CFC-11 or HCFC-141b (129). Recently, it has been demonstrated that it is possible to meet the most stringent fire tests in the USA and Canada and attain thermal conductivity comparable to foams blown with HCFC-141b using blends of cyclopentane and *iso*-pentane in continuous process (a.15). Thus it is anticipated that pentane will be the zero ODP blowing agent of choice in most parts of the world for continuous rigid faced lamination, especially when the most stringent fire and thermal conductivity performance is required. Recent work has shown promise of meeting the most stringent fire tests with pentane blown discontinuous panels too (a.16). Successful, safe use of pentane for the production of metal panels has been aided by innovation in foaming equipment (54, 99).

#### *4.3.4.3 Carbon Dioxide*

All $CO_2$ (water) blown foams have been in use at some manufacturers in Europe for many years (134, 204). It has been demonstrated that many of the fire tests in North America and Japan can be met with all $CO_2$ (water) blown PIR foams (167, 239). Further optimisation of formulation has yielded aged thermal conductivity comparable to that obtained with HCFC-141b (a.17). Learning from its experience in flexible slabstock, Cannon has proposed the use of liquid $CO_2$ co-blowing to improve the cost-effectiveness of $CO_2$ (water) blown foam (201).

HFC-134a with a relatively large amount of $CO_2$ (water) is currently in use in a few European and Article 5(1) country facilities (131, a.15). Liquid HFCs, especially with relatively large amounts of $CO_2$ (water), have also been evaluated but their use is unlikely given the present cost structure and aged thermal conductivity requirements (152, a.15).

### *4.3.5 Entry and Garage Doors*

This is predominantly a North American market for PU foam and generally uses a discontinuous pour-in-place process. Most doors are non-fire rated but some do have relatively easy to meet fire ratings. The key requirement for blowing agents and formulations for this application is to maintain dimensional stability and avoid delamination. HCFC-141b is by far the dominant physical blowing agent currently in use (150, 273). All $CO_2$ (water), and HFC-134a with a relatively large amount of $CO_2$ (water), are considered the leading zero ODP options (305). HFC-245fa and pentane has been evaluated and will likely be a niche player at best (150).

### *4.3.6 Slabstock*

Also referred to as bunstock or block foam, this is a semi-finished product from which a variety of

insulation product shapes and forms are fabricated. It is used as insulation for pipes, storage tanks, construction, refrigerated transport containers, etc. It is produced by continuous and by discontinuous process and can be fire rated. The key requirement for blowing agents and formulations for this application is overall exotherm control, good dimensional stability and reasonable thermal conductivity. HCFC-141b is by far the dominant physical blowing agent in 2002 (134). Pentane is deemed to be the primary zero ODP blowing option especially for the continuous process (a.5). Liquid HFC, in particular HFC-245fa, has been evaluated and is likely to be the zero ODP option with smaller, especially discontinuous, producers (134).

### *4.3.7 Spray*

Spray foams are used to insulate residential and commercial buildings, industrial storage tanks, piping and ductwork, and refrigerated transport trailers and tanks. Roofing and building envelope insulation, the two largest markets, are often subject to building codes and must pass certain flammability tests, such as ASTM E-84, class II in the USA. On-site *in situ* applications using hand-held pressurised spray gun put some very unique requirements on the blowing agent and system used. The system needs to be soluble and must have high reactivity to prevent dripping or running during application in a variety of climates. Most of the existing spray machines in the field operate at a polyol stream to isocyanate stream volume ratio of 1:1, and need the stream viscosity to be below 2 Pascal-seconds at the preferred line temperature of 38-45 °C, for adequate atomisation.

#### *4.3.7.1 HCFC-141b*

HCFC-141b is currently (2002) being used by all system suppliers in North America, Japan and by most European suppliers. CFC-11 is still being used in many Article 5(1) countries and HCFC-141b is expected to be the replacement blowing agent. Formulations with HCFC-141b were developed in the early 1990s and have since been further optimised using new components (66, 303).

#### *4.3.7.2 HFC*

Although a variety of zero ODP blowing options have been evaluated, none appear to provide acceptable solution for wide commercial use in major markets (65, a.5). Liquid HFCs, especially HFC-245fa, have been extensively evaluated but the high cost remains an issue (35, 139). In an effort to reduce cost, HFC-245fa with over 50% $CO_2$ (water) blowing is being field evaluated in North American roofing and Japanese wall applications. The system can use existing shipping containers and existing spray equipment, and the foam quality and properties measured thus far are equivalent or superior to the current HCFC-141b foam (a.7). In Europe, blends of HFC-365mfc with HFC-227ea in a weight ratio of 94:6 are being evaluated, in addition to HFC-245fa (a.18). As the mixture of HFC-365mfc and HFC-227ea is not an azeotrope, special care must be taken to avoid any flammability issues during handling of the blend and premix containing such blend (a.19).

#### *4.3.7.3 Carbon Dioxide*

All $CO_2$ (water) systems have been evaluated especially in the Japanese market (66, 385). New technology developments are bringing the performance of such systems closer to that of HCFC-141b, however, density and thermal conductivity penalties still exist (66). Although partially open cell foam has been developed to offset the density penalty of all $CO_2$ (water), its commercial viability remains in question due to the fact that many building codes require >90% closed cell. The use of a small quantity of LBBA HFC-134a, while permitting use of existing shipping containers and existing spray equipment, has been proposed as another solution (a.20).

A somewhat unique application of spray foam is insulation for cryogenic propellant tanks on space launch vehicles. These currently use HCFC-141b blown PUR/PIR foam (315, 347). Water blown formulations suitable for use under such cryogenic conditions have been developed and are likely to be the zero ODP option (397).

### *4.3.8 Pipe Insulation*

PU foam insulated pipes are used in heating networks primarily in Europe and in transportation of oil, gas and other fluids globally. Such pipes generally consist of inner steel pipe, surrounded by foam insulation and protected by a plastic outer skin. They are generally made by pour-in-place or spray techniques in a continuous or discontinuous process. The performance requirements of the foam for pipe used for district heating are specified in the European standard, EN 253. The key requirements for blowing agents and formulations for this application are good flow, good adhesion to inner/outer substrate, low foam thermal

conductivity and thermal stability to withstand long exposure to a service temperature of 130-150 °C (202).

Cyclopentane, alone or in blends with *iso*- and/or *n*-pentane is the dominant blowing agent being used in this application. Formulations were developed in the early 1990s and have been modified to withstand higher temperatures using special polyols (147, 202). Pipe fabrication equipment tailored for pentane has been developed (368). All $CO_2$ (water) blown systems have been evaluated too and are in industrial use (239, 329). It is likely that smaller producers using a discontinuous process who are currently using HCFC-141b, will switch to HFC-245fa or HFC-365mfc/HFC-227ea when HCFCs are phased out.

#### *4.3.9 One Component Foam (OCF)*

Sometimes referred as froth foam or aerosol foam, such foams are used primarily for gap filling throughout the construction industry, e.g., for draft proofing, sealing door and window frames, joining insulating panel, etc. OCF blowing agents are typically gaseous, as they function both as a blowing agent and a propellant for the foam. HCFC-22 and hydrocarbon/ether blends such as mixtures of butane, propane and dimethyl ether are currently the two most used blowing agents for OCF production (a.5). HCFC-142b/22 blends and HFC-134a are also used in some cases. Safety concerns and VOC issues with the use of hydrocarbons have led to investigation of HFC-152a, a low GWP, LBBA. Recently, the use of some non-liquifiable gases such as $CO_2$ and nitrous oxide (N2O) has also been proposed (46).

#### *4.3.10 Marine Flotation*

These applications use closed cell foam as positive flotation material for watercraft. Many such foams need to meet specifications such as the US Coast Guard immersion test (CGD 75-168, 33 CFR Section 183.114). Most flotation foams currently utilise systems with HCFC-22/$CO_2$ (water) blowing technology. However, these applications are converting to HFC-134a for pressurised dispensing systems and all $CO_2$ (water) for conventional dispensing systems (185).

#### *4.3.11 Miscellaneous Applications*

Low density rigid foams are used in numerous other applications such as taxidermy, floral pots, packaging of heavy equipment, insulation for bath and spa, etc. Although physical blowing agents have been used in some of these applications, they are all amenable to all $CO_2$ (water) blowing.

## 5 Blowing Agents for Low Density Flexible Foam

Low density flexible foams are characterised by a density ranging from 10 kg/m$^3$ to about 80 kg/m$^3$ and are used for cushioning, comfort, noise/vibration/energy abatement, etc. They are dominant in the furniture, bedding, carpet underlay and transportation industries.

### 5.1 Specific Performance Criteria

The primary function of the blowing agent in flexible foam is to reduce density while developing a polymer morphology and foam cellular structure that allow the foam to meet the performance characteristics of the application. Unlike insulation foam, the blowing agent is not retained in flexible foam. The foam is generally open celled and permeable to air. Historically, flexible PU foams have been blown by $CO_2$, generated *in situ* by the reaction of water and isocyanate. Auxiliary blowing agents have been used because there are limits on the foam properties that can be achieved with chemically generated $CO_2$ as the sole blowing agent and because of the exothermic nature of the water-isocyanate reaction. Until the late 1980s, CFC-11 was the auxiliary blowing agent of choice for low density flexible foam. With the adoption of the Montreal Protocol and national standards, foam formulations have evolved towards higher water levels using less or no auxiliary blowing agents.

### 5.2 Blowing Agent by Manufacturing Process

The choice of blowing agent for low density flexible foams depends on many factors such as the attributes of the foam, the choice of raw material, and the available manufacturing method. Flexible foams have been categorised by their attributes, type of raw materials used, and mode of production.

Attributes include resiliency as conventional, high and low; hardness as hypersoft, supersoft, soft, intermediate and hard; and flammability as combustion modified or not. In addition, there are other attributes such as

antistatic, high load bearing, etc. Raw material categorisation includes: isocyanates used, such as toluene diisocyanate (TDI) (65:35 and 80:20 *para* to *ortho*-isomer), TDI/diphenylmethane diisocyanate (MDI) blend and all MDI; and the polyol used, such as polyether (filled/grafted/copolymer or conventional) or polyester. Production methods include moulding in place, or slabs produced continuously or discontinuously and then cut into the required shape and size.

Each end use application has a distinct set of attribute requirements and preferred raw material and production route and these do depend somewhat on geographical location. Given the large number of possible combinations for attributes or raw materials, the discussion below on blowing agent options is related to the manufacturing process. Besides, blowing agent options for low density PU foam depend more on the manufacturing process used to make the foam and less on other factors. Unique requirements of an end use or attribute are discussed as necessary.

### *5.2.1 Continuous Slabstock*

Flexible slabstock foams are used in upholstered furniture, bedding, transportation (cushioning and sound dampening), carpet underlay, packaging, textile lamination and other miscellaneous applications. Continuous slabstock is the most heavily and widely used manufacturing process.

#### *5.2.1.1 All $CO_2$ (Water) Blown*

Historically the cut-off point for the use of auxiliary blowing agent has been at around 23 kg/m$^3$, i.e., unfilled, conventional resilience, soft foam of density around 23 kg/m$^3$ and higher, generally blown with water alone (283). With the adoption of the Montreal Protocol and national standards, extensive effort has been made to expand the range of foams, both in terms of density and attributes, that can be made using water as the sole blowing agent while avoiding bun self-ignition due to high exotherm (322). A range of new products and technologies have been developed from special polyols, isocyanate prepolymers, softening additives, and catalysts to complete PU systems with special raw materials.

By understanding the critical aspects of raw material structure and how it impacts foam morphology and the resulting bulk properties, new polyols and polymer modifying technologies have been developed (290, 323, 379). New modified polyether polyols have been able to provide a larger range of foam hardness at lower densities (255, 284, 295). Some of these polyols allow the use of lower TDI indexes which in turn lowers the exotherm and foam density (373). Other modified polyols have expanded the types of products such as combustion-modified high resiliency foam with both MDI and TDI (215, 255, 256). Some of the more recent developments are new polyols and systems for ultrasoft foam (38, 135) and low resiliency or viscoelastic energy absorbing foam (37, a.21). Ethylene oxide content, molecular weight, functionality, and copolymer content are some of the variables changed to produce these new polyols (38, 217, 373). Entirely new ranges of polyols such as ULTRACEL® by ARCO/Bayer (255) and CELLTREK™ by Dow (322) have been introduced. Even though these developments have expanded all water blown technology, it is still not possible to produce the full range of products using these new polyols alone.

Special softening additives that alter the polymer morphology and soften the foam have been developed (373). Modifiers such as Geolite® facilitate the production of numerous foam grades at very low indexes while maintaining acceptable physical properties (162). Other modifiers such as Unilink® 4200 are shown to improve the blowing efficiency of $CO_2$ (water) and thus decrease density, while retaining physical properties including softness (253). Proprietary compounds that enable a reduction in foam density without thermal degradation hazards have been identified (283). In addition, new catalysts have been developed which reduce the foam hardness thus reducing the need for softening additives or modifiers (392).

Slabstock foams have traditionally been made using TDI but the need for expanding the hardness range with all water blown foam has led to the development of all MDI based foam systems (216, 296). The use of MDI allows for a lower exotherm, a wider range of hardness with index change, enhanced resistance to flame ignition and reduced risk of hazardous vapours (257, 377). All MDI-based systems for high resiliency furniture/bedding foam and low resilience packaging foam have been developed (296). Technology to produce foam with a wide range of hardness/density combinations from a small number of raw material components along with remarkable stability and fast cure time have been developed (258, 377). CELLQUEST™ by Dow (284) and WATERLILY® by Huntsman/ICI (294) are some examples of all-MDI based water blown slabstock technology.

*5.2.1.2 Alternative Auxiliary Blowing Agents*

CFC-11 used to be the dominant auxiliary blowing agent in flexible foam until the mid 1980s, but its use has declined substantially worldwide since 1986. For example, the flexible foam industry in the USA reduced their usage of CFC-11 by more than 90% between 1986 and 1990 (348) and 99.88% by 1992 (325). Although some HCFCs, especially HCFC-22 and HCFC-141b, have been evaluated and were found to successfully produce low density (13-19 kg/m$^3$) foams, use has not been permitted by regulators in most places (355).

Methylene chloride's combinations of physical properties along with low cost had led to its introduction as a blowing agent around 1975, well before phase out of CFC-11. Since 1986, the use of methylene chloride has increased significantly. At the same time toxicity concerns have brought it under government regulation in many parts of the world (322). Methylene chloride is frequently classified either as an air pollutant (VOC), with limitations on the total amount which can be emitted from a foam plant, or as a workplace health hazard, with strict limits on the allowable worker exposure, or both. For example, as of November 2001, the permitted methylene chloride emission level in the workplace has been lowered twenty-fold to 25 ppm by OSHA in the USA (85). It has been banned altogether from some European countries, such as Germany and is not well accepted in Italy (283).

Methylene chloride is still a widely used auxiliary blowing agent, especially in Article (5) countries. It has been used to make superior soft and ultrasoft foam by formulating with special polyol (38, 391). The stability of methylene chloride blown low density foam has been improved by specially developed modifiers such as Geolite® which also improves yield, and softness (374). Contamination of methylene chloride with iron can cause severe scorching and thus only 'urethane grade' material should be used.

Methyl chloroform was introduced as an auxiliary blowing agent in 1989 as an interim replacement for CFC-11 (322). However, the production of chloroform was phased out in the US as of 1/1/96 and it is no longer used. The same is the case in most of the world too.

Formic acid has been evaluated as an auxiliary blowing agent as it reacts with isocyanate to generate one mole each of $CO_2$ and CO. Thus for each mole of urea produced, the volume of gas generated is twice as much with formic acid as compared to the reaction with water (108). This translates into softer foam at the same density. It has been of limited industrial use due to the high cost of monitoring and protecting against CO emissions (283). Acetone and pentane are some of the other compounds evaluated as auxiliary blowing agents, but their flammable nature requires significant changes to foam processes, in particular modifications to make foam lines and curing areas explosion proof (287).

Although use of the above mentioned auxiliary blowing agents has been decreasing worldwide in favour of liquid $CO_2$ co-blown or all water blown formulations, they still remain popular in many Article 5(1) countries and are used to make special foams.

*5.2.1.3 Liquid $CO_2$ Blowing Technology*

Given that liquid $CO_2$ is inexpensive, readily available from natural sources, expands three times more than competing available alternatives and has no adverse effect on workers' health or factory safety, the concept of using it as an auxiliary blowing agent has been discussed for a long time. It was not put into commercial practice due to the processing difficulties such as 'chimneys' or cavities in the foam resulting from the uncontrolled expansion of liquid $CO_2$ along with the need to accurately meter and thoroughly mix this blowing agent, which is liquid only at high pressures around room temperature. Recently three equipment manufacturers, Cannon, Hennecke and Beamech have developed highly specific machines and technology to overcome these difficulties. Although different in detail, they all involve premixing the liquid $CO_2$ to polyol followed by mixing with other components, all at high pressure, and then a precisely controlled let down of pressure during the lay down phase.

Cannon named its proprietary technology CarDio® and introduced it commercially in Europe in 1994 on existing Maxfoam production lines (16, 47, 248). It made foam at a density as low as about 14 kg/m$^3$ in various grades including soft (375, 404, 409). By 1997, this process was in use across all continents to make a wide range of foam grades, including filled combustion modified high resilience (HR) foams at densities as low as 10-11 kg/m$^3$ (125, 174, 197, 223). Cannon has recently launched the new CarDio 2000 machine which incorporates a pressure-adjustable laydown device to cover an even wider range of foam outputs and a wider range of liquid $CO_2$ loading (117).

Hennecke and Bayer developed and commercialised liquid $CO_2$ technology in the mid 1990s and named it the NovaFlex® process (241). It can be incorporated

on all continuous slabstock machines and is used to make a wide range of foams (124, 196). Hennecke recently introduced a new more versatile liquid $CO_2$ technology called MultiFlex™ (61). Beamech's proprietary technology is called CO-2™ process and it has been used with Maxfoam/Varimax, Vertifoam and continuous inclined conveyor processes (176, 195).

Use of liquid $CO_2$ as the auxiliary blowing agent necessitated understanding the role of each foam component, especially surfactants, and to optimise them to get trouble free processing and optimum foam quality (31, 80, 95). One major need was to develop silicone surfactant which can control/steer nucleation during the rapid pressure let-down process and stabilise the foam cell structure (175, 194). How surfactant structure affects the froth stability, cell structure and flammability performance of the foam has been studied (96, 126). New surfactants optimised for liquid $CO_2$ technology have been developed which improve the cell structure as a consequence of optimised nucleation, frothing support and coalescence prevention (62, a.22).

Liquid $CO_2$ is emerging as the auxiliary blowing agent of choice worldwide to make a full range of slabstock foam. Some of the more recent developments include use in making high performance, viscoelastic foam for high comfort bedding (39).

#### *5.2.1.4 Alternative Manufacturing Technology*

A number of modifications to the foaming process to circumvent the need for auxiliary blowing agents and use water as the sole blowing agent have been developed. Forced cooling by rapidly blowing air through foam block is one such technology that has been successfully used by several producers (286, 287). Enviro-Cure technology developed by Crain Industries Inc., the Rapid Cure process developed by the General Foam Division of PMC Inc., and the E-Max process from Uniform AG are some examples of rapid cooling process technologies (286, 287). Through optimum adaptation of the process and the processing variables to individual plant conditions, and optimisation of the formulation, especially polyol and modifiers, it has been possible to produce a full range of density and hardness using no auxiliary blowing agents (285). To overcome the loss of properties from the shortened cure time of this process, new catalysts have been developed (392).

Another alternative manufacturing technology developed to eliminate auxiliary blowing agents is variable pressure foaming also referred to as VPF technology. Here the entire foaming operation is encapsulated in a vacuum/pressure chamber where the pressure can be varied on the rising foam (176, 376). It is possible to produce all foam grades using water alone using this technology. It is in commercial use at many locations despite of its high initial capital cost (195).

### *5.2.2 Discontinuous Slabstock*

Also referred to as box foam, this is generally used in developing countries or to make speciality foam. Chemically it is virtually identical to continuous slabstock, but the types of blowing agent used are somewhat limited due to the low capital outlays and relative simplicity of the process. $CO_2$ produced by the water-isocyanate reaction is the primary blowing agent, with methylene chloride as the dominant auxiliary blowing agent to get low density/hardness. Chemical foam modifiers have been developed to stabilise low density foam blown using high levels of methylene chloride (374). Special polyol has been used to make superior soft and ultrasoft foam (38, 391).

Liquid $CO_2$ as the auxiliary blowing agent has been evaluated for discontinuous slabstock but the need for accurate metering has severely limited its adaptation. The use of forced cooling has been evaluated in Asia but it has not been very successful. A foaming technology that has been somewhat successful is the control environment foaming technology which is very similar to VPF technology but much less complex. FoamOne (210) is one such batch process where pressure settings can be varied from 7 kPa absolute to 190 kPa absolute.

### *5.2.3 Moulded Foam*

Nearly 20% of low density flexible foam is produced as finished products by moulding in closed moulds. By virtue of their superior vibration damping capability over a wide range of frequencies at low material density and their ability to be moulded in thin, intricate sections, PU foams are found not only in automotive seats but also in various acoustical parts and other energy absorbing applications. Thus, low density moulded flexible foams are used for vehicle seating and interior trim, including sound absorbing trim, in upholstered furniture and bedding, and in packaging.

The PU foam used in moulded products can be classified into four main chemistries or technologies. These are the hot cure process using TDI, and the cold cure process using all TDI, TDI/MDI blend and all

MDI. The cold cure process is more often referred to as the high resilience (HR) process. The level to which these technologies are used in a given part of the world depends on existing manufacturing facilities, performance requirements, and market conditions (86). In North America, TDI based HR foam technology is dominant with some TDI/MDI blends and some all MDI based HR, but very little hot cure technology. In Europe, Asia/Pacific and Latin America, all four technologies are used although HR technology, especially all MDI and TDI/MDI blend, is steadily growing (a.23).

Historically, the density of moulded foams has been higher, about 25 to 55 kg/m$^3$, as compared to slabstock and thus water has been the primary blowing agent. Auxiliary blowing agents especially CFC-11 and methylene chloride have still been used in many cases, primarily to reduce hardness in hot cure formulations and to reduce density and gain flow in cold cure/MDI formulations. With the adoption of the Montreal Protocol and national standards, all moulded foams have converged to $CO_2$ as the blowing agent, although exactly how the $CO_2$ is produced or what new additives/ technologies are used depends on which of the above described four main chemistries are in use (86). Methylene chloride is occasionally used, however, its high heat capacity makes it less effective.

#### *5.2.3.1 All $CO_2$ (Water) Blown*

The use of $CO_2$ generated by water-isocyanate reactions meets many of the environmental (no ODP or GWP), health and safety (no emissions), and economic requirements of the global transportation and packaging industries. Thus the focus has been on development of formulations and processing technologies which overcome the challenges associated with all water blown foam, such as foam stability, flowability, and hardness. This has led to numerous studies to understand the contribution of different formulation and processing variables on end properties, and then to develop new formulations using, in many cases, newly developed isocyanates, polyols, catalysts, cross-linkers, additives, etc., (30, 141). Many such studies are specific to one chemistry, e.g., hot cure, while others apply to many (118, a.23). This is an ongoing process as the requirements keep expanding and becoming very specific to the exact targeted application and to the manufacturing technology. For example, automotive manufacturers continuously demand improvement in seating comfort and durability, whilst maintaining focus on both weight and cost reduction. Additionally, the range of products made using PU foam keeps expanding.

In hot moulding, new copolymer polyols and additives have been developed to make a wide variety of foam grades ranging from very soft, low density foams for automotive rear backrests, to high load bearing, high density foams for front seats, of various sizes, thickness and complexity (212). In addition, foam softening agents have been developed to counteract the hardening effect of the extra water blowing while maintaining processability and keeping physical properties within the required limits (372).

For TDI based HR foam, new modified TDI has been developed which makes low density with good softness with standard polyols (119, 213). A new generation of polymer polyols, referred to as POSTech and based on suspended polystyrene particles has been developed, which allows the production of an exceptionally wide range of TDI based HR foams (69). Another new series of polyols is Hyperlite® which shows significant improvement in automotive physical properties when compared to standard foam (282). Other specially designed polyols and copolymer polyols have extended the density range and product range (199, 200). New catalysts and surfactants have improved the processing latitude and properties (106).

For TDI/MDI based HR foams, which are especially popular in Japan, new polyol systems with narrow molecular weight distribution and lower amounts of monols have been developed (60, 105, 142). These and other new polyols extend the product range and processing latitude (29).

For all-MDI based HR foam, a range of new products and technologies which generally involve new isocyanate prepolymers, special polyols, and other additives have been developed to expand the range of all water blown foams (22, 231). This has led to the ability to produce complex parts such as dual hardness, foam-in-fabric automotive seats (146). Combustion modified HR foam for the furniture, HR foam for foam-in-fabric applications and low resilience foam for vibration damping are just some examples of the expanded range of products (218). In addition to full PU systems, many new isocyanate compositions which enable moulders to expand their product range have also been developed (87, 345). Other developments include new catalyst systems for all water blown HR foam, barium sulphate (BaSO4) filled HR foam and TDI/MDI HR foam (307). In addition, cell opening additives along with new catalyst systems have been developed which allow production of low density, low hardness, cold cure moulded foam (214, 265, 340).

Moulded foam for packaging applications uses $CO_2$ (water) as the sole blowing agent. Such foams, generally called pour-in-place packaging foam, have a density range of about 5-35 kg/m$^3$ and can be soft, semi-rigid or rigid in hardness.

#### *5.2.3.2 Added $CO_2$ Blowing Technology*

Addition of $CO_2$, liquid or gas, as an auxiliary blowing agent has been evaluated to reduce foam densities by 10% to 20% compared to conventional foaming processes primarily in cold cure technologies (198). For liquid $CO_2$, equipment to directly inject into the mixhead (103, 158), into one of the reactive components prior to the mixhead (127, 158, 159, 165) or into the reactive component batch tank (158, 165, 201), has been developed. Cannon calls its process CannOxide™ and recommends batch mixing for smaller quantities of liquid $CO_2$ (< 1.5% on the polyol) and in-line mixing into polyol using a special TriOxide mixing head for larger quantities (101, 159, 201). The NovaForm™ process from Hennecke uses liquid $CO_2$ and can be used to make even large complicated parts at densities as low as 35 kg/m$^3$ (88). Gusmer-Admiral's process introduces liquid $CO_2$ directly into the mixhead and uses a proprietary pressure let down system within the mixhead to maximise capture and incorporation of $CO_2$ into the foam cells (103).

Gaseous $CO_2$ has also been used as an auxiliary blowing agent. It is generally premixed into the reactive component batch tank, especially isocyanate, at elevated pressure to keep it as dissolved gas (102, 127). By addition of gaseous $CO_2$ and appropriate reformulation, it has been possible to reduce the weight by 20% and still retain the load bearing characteristics and improve compression set and dynamic properties (82). A novel idea involving gaseous $CO_2$ or other gases, such as methylene chloride and air, has been to encapsulate the gas in a shell comprising a polymer having a melting point in the reaction temperature range (144).

The use of added $CO_2$ in moulded applications has not been as widespread as that in slabstock. This is primarily because of the myriad of moulded parts, the complexity of the parts and ever increasing performance requirements.

#### *5.2.3.3 Alternative Manufacturing Technologies*

Foaming under vacuum inside the mould cavity and thus eliminating the use of auxiliary blowing agents altogether has been developed by Hennecke and is called VakuForm™ (88). It requires special mould design to accommodate the vacuum and results in parts with minimal quantities of flash.

# 6 High Density Foams and Elastomers

Foams of this type are characterised by a density range of 50 kg/m$^3$ to about 1,000 kg/m$^3$ and include a variety of products, namely integral skin foam, semi-rigid foam, high density rigid foam and microcellular elastomers. Such products are almost always made as moulded products and are used primarily in the automotive and footwear industries.

## 6.1 Specific Performance Criteria

The primary role of the blowing agent in high density foams and elastomers is to reduce density and provide flow. Such foams are open or closed cell depending primarily on core density. Foams with core density <400 kg/m$^3$ are generally open celled whereas those above about 400 kg/m$^3$ are dominantly closed cell, although there are exceptions. $CO_2$ from the isocyanate-water reaction has been the historic blowing agent for such foam and auxiliary blowing agents have been used only to get the decorative skin of the integral skin foam, or as flow additives to enhance flow to fill large intricate moulded parts.

## 6.2 Flexible Integral Skin Foam

Integral skin foam (ISF) has a combined structure of a cellular core and an elastomeric skin. It is widely used in a variety of applications such as steering wheels, instrument panels and other internal and external automotive parts, shoe soles, bicycle saddles, furniture fitments and leisure equipment. One of the main requirements of these products is to form an abrasion-resistant, defect-free, decorative skin. Physical blowing agents, primarily CFC-11, have historically been used in this application primarily to control skin quality rather than to reduce density per se. It is widely accepted that the skin is formed through the condensation of the physical blowing agent at the cold mould surface under pressure.

#### ***6.2.1 Low ODP Technology***

It was demonstrated that HCFC-22 could be used to replace CFC-11 in integral skin and shoe sole

formulations in such a way that the resulting ODP is reduced by 95% while retaining the surface quality and appearance (354). The feasibility of using HCFC-141b has been demonstrated too (358). However, HCFCs have been banned in the US from use in integral skin applications since January 1, 1994, with the exception of automotive safety applications, which were granted an extension until January 1, 1996. In Europe, HCFC-141b was banned from use in integral skin foam after January 1, 2000, except for safety applications (a.24).

### *6.2.2 Zero ODP Technology*

For some applications such as shoe sole and toys, polyether and polyester based systems have been developed using water as the blowing agent, which provides integral skin type moulding akin to that achieved with CFC-11 (320, 402). It has been possible to reduce the overall density of shoe sole systems and open new markets while still using all $CO_2$ (water) as the blowing agent (137, 166). In particular, new isocyanate prepolymers have been developed that extend the versatility of polyurethane foam systems for use in footwear applications (67, 77). New catalyst systems and surfactants have been developed to improve the skin formation and the physical properties (68, 271). Systems which have improved innate mechanical properties to such levels that they do not require the integral skin have also been developed (346). All $CO_2$ (water) blown systems have been developed, even for steering wheel and armchair applications, using novel polyols (298, 299).

All $CO_2$ (water) blown foam still has some problems, such as too thin a skin for some applications, colour inhomogenity, poor touch feeling, relatively high density, longer demould time, post-blowing and skin-peeling phenomena with the mould inserts. In some cases in-mould coating (IMC) has been used with all $CO_2$ (water) blown foam to improve abrasion resistance and improve colour homogeneity (211). In other cases, improved foam technology has been developed to address many of the problems associated with earlier water blown systems (123, 170, 363, 383). Such technologies have led to the production of automotive parts at lower moulded densities, with lower demould time and can be used without the protection of IMC (55, 122).

Another idea evaluated to make water blown ISF for very demanding applications such as steering wheel with air-bag systems, has been the controlled release of water using microporous materials such as zeolites, silica gels and activated carbon (235). This technology, generally referred to as molecular sieve technology, has been introduced in Europe first and involves trapped water being released at high temperatures. At some point in the reaction, isocyanate is no longer available for reaction and the water vapour condenses at the mould surface forming a skin. Proprietary formulations with water as a blowing agent and different additives such as monoethylenically unsaturated carboxylic acids (100) have also been proposed.

Pentane has been evaluated in shoe sole foams (278). Some moulders in Europe and North America are producing integral skin products using pentane as blowing agent (161). The development of vacuum degassing equipment to rapidly extract pentane from moulded parts led to commercial adaptation of pentane as a blowing agent (221, 403). *n*-Pentane blown foam has been used for applications such as instrument panels in trucks, where a very durable skin is required (143). *i*-Hexane (71) has also been proposed.

HFC-134a, alone or in combination with water, has been found to give products that show resistance to abrasion and cracking on flex comparable to CFCs, BASF has patents on some of these developments (111, 116, 192, 220, 278). Further optimisation has resulted in attributes such as shipping and handling the HFC-134a containing blend under normal conditions (57, 123). HFC-134a is being used in many parts of the world, sometimes with IMC. More recently technology has been developed to produce very thick skin that resists moisture and scratches, absorbs energy and can take on a variety of colours and textures for parts used in trucks, buses and heavy vehicles (143).

HFC-245fa and HFC-365mfc have been evaluated as they both offer better solubility than HFC-134a in resin pre-mixes (56). The advantages of using HFC-245fa alone include, skin formation similar to CFC-11, low in-mould pressure and the ability to use normal drums for shipping (32, 49). Given the high cost of HFC-245fa, co-blowing with up to 30 mole % $CO_2$ (water) has also been evaluated and performance deteriorates only slightly as compared to all HFC-245fa (a.24).

Although the large or new manufacturers of ISF products in Article 5(1) countries have been using CFC-free technology, many small and medium enterprises continue to use CFC-11 as the blowing agent. Phase out of CFC-11 in these applications is slow and linked to problems inherent to small and medium sized enterprises (UNEP 2001 and 1998 Reports, a.5).

### 6.3 Rigid Integral Skin Foam

This also referred to as rigid structural foam. These are generally moulded products where the primary reason for using PU chemistry is its ability to mould large, complex shapes and surfaces economically. The density of such foams can range from 50 kg/m$^3$ to about 1,000 kg/m$^3$ and they are predominantly closed cell. This foam type is used for a variety of industrial parts, building, furniture, electrical, automotive, and sports/ leisure articles. Some examples are window profile, furniture mouldings (simulated wood), cabinets for electronic equipment, door panel, skis, etc.

$CO_2$ (water) is the dominant blowing agent in this application. However, some CFCs have been used as the auxiliary blowing agent primarily to ensure good skin quality and to improve flowability of the chemical components, as many parts are large and made to small dimensional tolerances using closed moulds. Many such flow issues have been overcome by reformulation and by improved distribution of chemical in the mould (297). Some applications use *n*-pentane or acetone as an auxiliary blowing agent (43).

### 6.4 Semi-Rigid Foam

Semi-rigid foam is dominantly open cell foam of core density range of about 30-120 kg/m$^3$ with much higher compression hardness and a lower resilience than flexible foams. These foams recover slowly but completely from high levels of compression and thus they are used extensively for impact energy management, for example, in automotive applications for parts such as door panels, instrument panels, headliners, knee bolsters, arm rests, headrests, bumpers, etc. Non-automotive usage includes crash helmets, protective sportswear and protective packaging. Because of their sound absorption properties, semi-rigid foams are used to reduce noise and vibration harshness (NVH) in vehicles.

CFC-11 was used as the auxiliary blowing agent in the 1980s, but $CO_2$ (water) is now the predominant blowing agent for such foam (300). Gaseous $CO_2$ dissolved in the polyol and/or isocyanate component has been used to lower the weight of automotive parts, e.g., carpeting and dashboard (330). The attribute requirements on semi-rigid foam used in automotive and other applications keep expanding, but it has been possible to meet them with all water blown formulations (266, 275).

### 6.5 Microcellular Elastomers

Microcellular elastomers are typically closed cell foam of density range from about 400-800 kg/m$^3$ with cells so small that they are difficult to see with the naked eye. These are generally used for vibration dampening in high dynamic load situations such as springing systems for freight vehicles (45). Such high density materials are blown with all $CO_2$ (water).

## Additional References


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# References from the Rapra Abstracts Database

*Item 1*
***Plastics Technology***
47, No.11, Nov.2001, p.25
**HFC-245FA TESTED IN PUR SPRAYED FOAM ROOFING**

This succinct article reports briefly on the results of tests done by Honeywell Fluorine Products in the USA - the company ran a trial of a PU roofing foam system from BASF sprayed with new HFC-245fa ozone-friendly blowing agent. HFC-245fa is a substitute for HCFC-141b, which is due to be phased out.

HONEYWELL FLUORINE PRODUCTS; AEROSPACE ELECTRONICS SYSTEMS; BASF CORP.; WEST ROOFING SYSTEMS
USA

*Accession no.832611*

*Item 2*
BLOWING AGENTS AND FOAMING PROCESSES CONFERENCE 2001. Proceedings from a conference held Frankfurt, 13th-14th March 2001.
Shawbury, Rapra Technology Ltd., 2001, Paper 21. 012
**NEW BLOWING AGENTS FOR INSULATED PANELS**
Colvin B G
IFS Chemicals Ltd.
(Rapra Technology Ltd.)

In an attempt to improve the thermal conductivity of polyurethane foams based upon zero ozone depleting substances, several potential candidate blowing agents were evaluated. Each was subjected to laboratory evaluation prior to the implementation of the most promising candidate in commercial trials for discontinuous panel production by a cold room panel manufacturer. Results are examined of trials of HFC-245fa and HFC-365mfc/227 in comparison with both cyclopentane and HCFC-141b. Flammability, minimum energy ignition and resin pressures in closed containers were compared, and the solubility of the blowing agents in different polyol types was also determined. Comparisons were made of the foam expansion characteristics both in terms of density as a function of blowing agent level, and by means of rise height/gelation properties. 8 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; UK; WESTERN EUROPE

*Accession no.826297*

*Item 3*
BLOWING AGENTS AND FOAMING PROCESSES CONFERENCE 2001. Proceedings from a conference held Frankfurt, 13th-14th March 2001.
Shawbury, Rapra Technology Ltd., 2001, Paper 20. 012
**HFC-245FA & HFC-245FA BLENDS: BLOWING AGENT SOLUTIONS FOR ALL RIGID AND INTEGRAL SKIN FOAM APPLICATIONS**
Williams D; Bogdan M
Honeywell Inc.
(Rapra Technology Ltd.)

An update is presented of the commercialisation of HFC-245fa as a blowing agent for rigid and integral skin polyurethane and polyisocyanurate foams. Included is an analysis of the blowing agent needs of each major rigid and integral skin foam market segment: appliances, boardstock, spray foam, and systems for panels, doors, water heaters, pour-in-place, etc. An HFC-245fa based blowing agent solution is provided for each of these segments that is claimed to meet their unique environmental, performance and economic requirements. Field and laboratory evaluations are included of HFC-245fa blends with water, hydrocarbons and other co-blowing agents. Also discussed are costs of these blends from a chemical, manufacturing, and performance perspective.

EUROPEAN COMMUNITY; EUROPEAN UNION; UK; USA; WESTERN EUROPE

*Accession no.826296*

*Item 4*
BLOWING AGENTS AND FOAMING PROCESSES CONFERENCE 2001. Proceedings from a conference held Frankfurt, 13th-14th March 2001.
Shawbury, Rapra Technology Ltd., 2001, Paper 18. 012
**WHAT COMES AFTER CYCLOPENTANE?**
Seifert H; Biedermann A; Wiegmann W
Elastogran
(Rapra Technology Ltd.)

Cyclopentane is one of the candidates besides HFCs such as HFC-134a, HFC245fa, and HFC356mfc, which are offered as alternatives to CFC-11 commonly used by producers of foamed polyurethanes use in domestic appliances. Alternative blowing agent are discussed, which are claimed to demonstrate that processing, dimensional stability and compressive strength are at least comparable to the features of CFC-11 blown systems. Developments with cyclopentane-blown systems are shown to approximate those of CFC-11 blown systems with respect to thermal conductivity, meet the EC regulations regarding energy consumption, but do not provide economic benefits. A blend of cyclopentane and HFC134A is claimed to provide low thermal conductivity together with economic benefits, but does not allow the use of an environmentally friendly sign due to it containing approximately 1% HCF134a in the finished rigid foam. Comparative property data are given. 8 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; UK; WESTERN EUROPE

*Accession no.826294*

*Item 5*
BLOWING AGENTS AND FOAMING PROCESSES CONFERENCE 2001. Proceedings from a conference held Frankfurt, 13th-14th March 2001.
Shawbury, Rapra Technology Ltd., 2001, Paper 17. 012
**METHYLAL OR DIMETHOXYMETHANE AS A BLOWING AGENT FOR POLYURETHANE FOAMS?**
Beaujean M
Lambiotte & Cie SA
(Rapra Technology Ltd.)

The use of methylal as a blowing agent for polyurethane foams is discussed in terms of its performance and environmental impacts. Since the number of blowing agents which can be used for the production of polyurethane foams is continually being reduced due to government legislation, the choice is becoming limited. The properties of methylal are examined, and its use alone or in combination with other blowing agents is examined. Properties examined include: flammability, solvent power, thermal conductivity, toxicology, ecotoxicology, miscibility and solubility of liquid and gaseous carbon dioxide. Its use in rigid, flexible, and integral foams is described. 5 refs.

BELGIUM; EUROPEAN COMMUNITY; EUROPEAN UNION; UK; WESTERN EUROPE

*Accession no.826293*

*Item 6*
UTECH 2000. Proceedings of a conference held The Hague, Netherlands, 28th-30th March 2000.
London, 2000, Rigid Foam Development Session, Paper 1, pp.6, 012
**CHALLENGES FOR METAL FACED SANDWICH PANELS WITH POLYURETHANE CORE**
van den Bosch R; Ottens A; Bertucelli L
Dow Benelux NV; Dow Deutschland Inc.; Dow Italia SpA
(Crain Communications Ltd.; European Isocyanate Producers' Association)

Data are presented, which show that it is possible to meet the B classification on fire within the EN 13823 (SBI) (Single Burning Item) with steel sandwich panels having a PU core. Compliance was achieved using PU water blown, polyisocyanurate pentane and polyisocyanurate HCFC 141b technology. An S2 classification on smoke was obtained with PU water blown technology for panels with improved joint design. 4 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; ITALY; NETHERLANDS; WESTERN EUROPE

*Accession no.824845*

*Item 7*
UTECH 2000. Proceedings of a conference held The Hague, Netherlands, 28th-30th March 2000.
London, 2000, Construction Session, Paper 4, pp.7, 012
**HFC-365MFC, THE KEY FOR HIGH PERFORMANCE RIGID POLYURETHANES FOAMS**
Zipfel L; Dournel P
Solvay Fluor & Derivate GmbH; Solvay Research & Technology
(Crain Communications Ltd.; European Isocyanate Producers' Association)

The project status of Solvay's third generation fluorocarbon blowing agent, HFC-365mfc, is outlined and the physical properties of HFC-365mfc and blends thereof with other hydrofluorocarbons and hydrocarbons, such as isopentane, are reported. The miscibility of HFC-365mfc in PU raw materials and suitability of HFC-365mfc in premix systems are demonstrated and the results are reported of trials carried out on spray foams and pour-in-place foams and continuously produced panels containing blends of HFC-365mfc as blowing agent. 5 refs.

BELGIUM; EUROPEAN COMMUNITY; EUROPEAN UNION; NETHERLANDS; WESTERN EUROPE

*Accession no.824822*

*Item 8*
UTECH 2000. Proceedings of a conference held The Hague, Netherlands, 28th-30th March 2000.
London, 2000, Innovations: Flexible Foam Developments Session, Paper 2, pp.6, 012
**COMPARISON OF THREE MAJOR MACHINE TECHNOLOGIES TO PRODUCE FLEXIBLE SLABSTOCK FOAM USING CO2 AS AUXILIARY BLOWING AGENT**
Desnier M-C; Fis J; Lawler L; McVey S
Osi Specialties
(Crain Communications Ltd.; European Isocyanate Producers' Association)

The results are reported of a comparison of three different silicone stabilisers used in the manufacture of a PU foam made with 3000MW polyol and 3500MW polyol on three different machines, namely the Beamech CO-2 machine, Hennecke-Krauss-Maffei Novaflex machine and Cannon CarDio equipment. Stabilisers evaluated were Niax Silicones SC-155, L-580 and L-631. The properties of the foams are tabulated and their cell structures compared.

EUROPEAN COMMUNITY; EUROPEAN UNION; NETHERLANDS; SWITZERLAND; USA; WESTERN EUROPE

*Accession no.823969*

*Item 9*
UTECH 2000. Proceedings of a conference held The Hague, Netherlands, 28th-30th March 2000.
London, 2000, Automotive Developments Session, Paper 9, pp.5, 012
**PERFORMANCE OF HFC-245FA IN INTEGRAL SKIN FOAM APPLICATIONS**

Bogdan M C; Logsdon P B; Williams D J; Verbiest P; Stoehr R T
Honeywell; Carpenter Chemical Co.
(Crain Communications Ltd.; European Isocyanate Producers' Association)

A comparison is made of integral-skin PU foams made using non-flammable blowing agents (HFC-134a, water and HFC-245fa) with those produced using CFC-11. The physical and environmental properties of the blowing agents employed are presented along with free rise data for CFC-11 and HFC-245fa foams, the results of an ageing study on HFC-245fa in a medium density polyether polyol system and a comparison of the physical and mechanical properties of foams produced using the various blowing agents.

BELGIUM; EUROPEAN COMMUNITY; EUROPEAN UNION; NETHERLANDS; USA; WESTERN EUROPE

*Accession no.823963*

*Item 10*
UTECH 2000. Proceedings of a conference held The Hague, Netherlands, 28th-30th March 2000.
London, 2000, Other Rigid Foam Developments Session, Paper 4, pp.8, 012
**LCA ON HFC-365MFC AND HIGH PERFORMANCE RIGID POLYURETHANE FOAMS**
Kraehling H; Zipfel L
Solvay Management Support GmbH
(Crain Communications Ltd.; European Isocyanate Producers' Association)

The results are reported of a life cycle assessment (LCA) to support the application, development and market positioning of HFC-365mfc as a blowing agent for PU rigid foams. tests were carried out on HFC 141b-, water/CO2-, HFC 365mfc-blown sprays as a thermal insulation for a warm flat roof of an industry building and HFC 141b-, n-pentane, HFC365mfc-blown boards as thermal insulation for cavity walls and warm pitched roofs of domestic houses. It is shown that HFC 365mfc is potentially suitable as a replacement for HFC 141b in rigid PU foam for thermal insulation.

EUROPEAN COMMUNITY; EUROPEAN UNION; NETHERLANDS; WESTERN EUROPE

*Accession no.823954*

*Item 11*
***Plastics Technology***
47, No.8, Aug.2001, p.24
**PENTANE FOAM SYSTEMS FOR SHOTS OR CONTINUOUS POUR**

Linden/EMB is offering two new PUR systems designed to use pentane blowing agents, it is briefly reported. Penta-Meter is a high-pressure metering unit designed for pentane injection at the mixhead. It is typically used for continuous foam production lines. Penta-Fusion is a low-pressure polyol/pentane blending station that is typically used for applications involving discrete shots.

LINDEN/EMB
USA

*Accession no.823318*

*Item 12*
***Journal of Cellular Plastics***
37, No.4, July 2001, p.293-309
**APPLIANCE FOAMS WITH REDUCED LEVELS OF HFC-245FA**
Doerge H P; Schilling S L
Bayer Corp.

The effect of reducing the content of the blowing agent HFC-245fa, a non-ozone depleting alternative to HCFC-141b, on PU foam thermal conductivity, physical properties and demould characteristics was studied. Thermal stability and pressure generation studies on HFC-245fa-containing masterbatches were studied which provided insight into handling the new generation formulations. The information obtained should assist manufacturers of household refrigerator in selecting the most cost-effective solution to their manufacturing concerns when replacing HCFC-141b with HFC-245fa. 5 refs.

USA

*Accession no.821773*

*Item 13*
***Journal of Applied Polymer Science***
81, No.2, 11th July 2001, p.486-93
**PROPERTIES OF RIGID POLYURETHANE FOAMS BLOWN BY HCFC 141B AND DISTILLED WATER**
Jung H C; Ryu S C; Kim W N; Lee Y-B; Choe K H; Kim S-B
Korea,University; Korea Gas Corp.; Kyonggi,University

Rigid PU foams (PUFs) were synthesised from poly-4,4'-diphenylmethane diisocyanate and a polyester polyol. HCFC-141B, distilled water and a mixture of the two were used as blowing agents. The cellular structure, thermal properties and mechanical properties were studied by SEM, DSC and a universal testing machine respectively. The density of the PUF blown by distilled water and/or HCFC-141B decreased from 175.7 to 28.2 kg/cu.m with an increase in blowing agents. The average cell size of the PUF blown by distilled water imcreased from 150 to 290 micrometres with the distilled water content. The glass transition temperature of the PUF blown by distilled water increased from 85.7 to 101.7C with increasing distilled water content, whereas that of the PUF blown by HCFC-141B remained unchanged with HCFC-141B content. The compressive strength and the modulus of the PUF blown by a mixture of distilled water and HCFC-141B was increased from 0.13 to 0.25 MPa and from 3.00

 

to 7.23 MPa respectively with the distilled water content at the sample density of about 44.0 kg/cu.m. The increase in the compressive strength and modulus of the PUF at the same density was related to the increase in the glass transition temperature from 86.0 to 100.9C. 27 refs.

KOREA

*Accession no.817625*

*Item 14*

Patent Number: US 6156814 A1 20001205

**AMIDO FUNCTIONAL AMINE CATALYSTS FOR THE PRODUCTION OF POLYURETHANES**

Chen N; Van Court Carr R; Listemann M L; Underwood R P

Air Products & Chemicals Inc.

The use of 3-(3-(dimethylamino)propyl)-propionamide and 3,3'-((3-(dimethylamino)propyl)imino)bis-propanamide as catalysts in the production of polyurethanes is described. The above compounds are especially useful in catalysing the synthesis of polyurethanes from isocyanates and polyols. In the presence of water they catalyse both polyurethane formation and the production of carbon dioxide by hydrolysis of the isocyanate, producing polyurethane foam. They are less volatile, and hence less of an odour and health hazard, than the commonly used tertiary amine catalysts.

USA

*Accession no.809266*

*Item 15*

***Plastics Technology***

46, No.11, Nov.2000, p.62/7

**POLYURETHANES 2000 - THE CLOCK IS TICKING FOR HCFC'S**

Sherman L M

After a ten-year struggle to find "greener" substitutes for HCFC blowing agents, in order to meet legislative deadlines, the polyurethanes industry has now shifted its focus towards maximising cost-effectiveness of the potential alternatives. This article looks at the latest developments, in particular in the areas of building applications, insulation panels, pipe insulation, appliances and automotive applications.

ALLIANCE FOR THE POLYURETHANES INDUSTRY; SOLVAY SA; BAYER AG; HONEYWELL CORP.; HUNTSMAN POLYURETHANES; CANNON USA; DOW POLYURETHANES; GOLDSCHMIDT CHEMICAL CO.; SHELL CHEMICAL CO.; SOLVAY RESEARCH & TECHNOLOGY; US,ENVIRONMENTAL PROTECTION AGENCY; MISA; DOW ITALIA; MANNI

BELGIUM; EUROPE-GENERAL; EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; ITALY; NORTH AMERICA; USA; WESTERN EUROPE

*Accession no.804691*

*Item 16*

Patent Number: US 6127442 A1 20001003

**PROCESS FOR FOAM PRODUCTION USING DISSOLVED UNDER PRESSURE CARBON DIOXIDE**

Sulzbach H-M; Steilen H; Raffel R; Eiben R; Ebeling W

Hennecke GmbH; Bayer AG

A process is described for the continuous production of polyurethane block foam using carbon dioxide, which is physically dissolved under pressure, as a foaming agent. Before the polyol and isocyanate components are mixed, the carbon dioxide is dissolved in the polyol component and air or nitrogen is dissolved in the isocyanate component, both components are fed to a mixing chamber in which a pressure prevails which is 70 to 150% of the solution pressure of the CO2 in the polyol component, the isocyanate component is fed to the mixing chamber at a pressure of at least 30 bar and is injected therein with depressurisation down to the mixing chamber pressure. Air or nitrogen in an amount of at least 1 g per kg CO2 is dissolved in the isocyanate component. After emerging from the mixing chamber, the mixture is subjected to depressurisation to atmospheric pressure.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; USA; WESTERN EUROPE

*Accession no.802932*

*Item 17*

***Journal of Cellular Plastics***

36, No.6, Nov./Dec.2000, p.475-99

**ESTIMATION OF THE LONG TERM DIMENSIONAL STABILITY PERFORMANCE OF HYDROCARBON BLOWN RIGID POLYURETHANE FOAMS FOR INSULATION - A NOVEL APPROACH**

Kaneda T; Hayashi O; Shibata M; Kawasaki H; Inque H; Fujino H

Mitsui Chemicals Inc.

For years, HCs with zero ODP and low GWP have been used as alternative blowing agents (BAs) in the appliance industries. The improvement of insulation performance and lowering costs are significant factors in the development of rigid PU (R-PU) foams especially blown with HCs. The development of R-PU foam with a lower density for cost effectiveness is progressing. Positive experiences as to the long-term dimensional stability of pentane blown R-PU foam have accelerated this movement. The most important factor in the development of R-PU foam with a lower density is long-term dimensional stability. A novel long-term dimensional stability test and its appropriateness is proposed and discussed. The influence of formulation and the boiling point of BA on long-term dimensional stability are also studied. The use of a blowing agent mixture of cyclopentane and iso- or n-pentane with a lower BP allows density savings to be achieved. The understanding of the

relation between the formulation and long-term dimensional stability is an important issue for the development R-PU foam. 8 refs.

JAPAN

*Accession no.802584*

*Item 18*

***Modern Plastics International***

30, No.12, Dec.2000, p.34-5

**EPA RULING ROILS DECISION-MAKING IN RIGID PUR, PS FOAM MARKETS**

Leaversuch R D

In large part, the increasingly confused and complex nature of decisions facing manufacturers of rigid PUR insulation and appliance foams stems from a US regulatory decision to institute early deadlines for the phaseout of ozone-depleting blowing agents. Under rules set forth at mid-year by the US EPA, the production of HCFC141b would end in 2003, while use of stocks in inventory would terminate in 2005. Furthermore, the production of HCFC142b, a prime ingredient in blends used to foam extruded PS insulation board, would end in 2005, or five years earlier than had previously been anticipated. The efforts being made by companies to develop alternative blowing agents are outlined.

ENVIRONMENTAL PROTECTION AGENCY

USA

*Accession no.801775*

*Item 19*

***Journal of Applied Polymer Science***

79, No.4, 24th Jan.2001, p.696-702

**TRANSPORT OF BLOWING AGENTS IN POLYURETHANE**

Hong S U; Albouy A; Duda J L

Taejon,National University of Technology; Pennsylvania,State University

Desorption experiments were conducted for several blowing agents in PU at room temperature and with various blowing agent pressures. The diffusivity and solubility data for blowing agents were compared with the corresponding values for chlorofluorocarbon. The solubility and diffusivity for these blowing agents in PU were explained in terms of the solubility and van der Waals volumes. 12 refs.

KOREA; USA

*Accession no.799606*

*Item 20*

Patent Number: US 6100308 A1 20000808

**PREPARATION OF POLYURETHANES HAVING IMPROVED CURING**

Guettes B; Dinsch S; Knorr G; Seifert H

BASF AG

Polyurethanes having improved curing are prepared by reacting a) organic and/or modified organic diisocyanates and/or polyisocyanates with b) polyether polyols based on aromatic amines, able to be prepared by reacting specific amine combinations and, if desired, further coinitiators in a stage wise molecular addition of alkylene oxide, and also, if desired, further relatively high molecular weight compounds containing at least two reactive hydrogen atoms and, if desired, c) low molecular weight chain extenders and/or crosslinkers in the presence of d) blowing agents, e) catalysts and, if desired, f) further auxiliaries and/or additives, wherein the specific amine combination used is a mixture of amines of the diphenylmethane series consisting of from 5 to 20% by weight of 4- ring amine, from 15 to 30% by weight of 3-ring amine, from 20 to 35% by weight of amines having more than 4 rings and from 25 to 50% by weight of 2-ring amine, wherein the proportions add up to 100% by weight, in combination with further aromatic amines.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; USA; WESTERN EUROPE

*Accession no.797945*

*Item 21*

Patent Number: US 6080799 A1 20000627

**MIXTURES CONTAINING 1,1,1,3,3 PENTAFLUOROBUTANE**

Kruecke W; Zipfel L

Solvay Fluor und Derivate GmbH

Mixtures containing 50 to 99% by weight of 1,1,1,3,3-pentafluorobutane and 1 to 50% by weight of at least one fluorohydrocarbon, such as 1,1,1,2-tetrafluoroethane, 1,1,1,3,3-pentafluoropropane, 1,1,1,3,3,3-hexafluoropropane or 1,1,1,2,3,3,3-heptafluoropropane are extremely well suited for use as foaming gases for a blowing agent to produce foamed plastic materials, particularly polyurethane foams. The mixtures are not combustible and exhibit improved insulating properties, particularly when used at low temperatures.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; USA; WESTERN EUROPE

*Accession no.794792*

*Item 22*

Polyurethanes Conference 2000. Conference proceedings.

Boston, Ma., 8th-11th Oct.2000, p.595

**ALL-MDI FULLY WATER BLOWN FLEXIBLE FOAM SYSTEMS FOR FURNITURE APPLICATIONS**

Casagrande G; Fregni S; Honkomp D

Dow Italia SpA; Flexible Products Co.

(American Plastics Council,Alliance for the Polyurethanes Industry)

Dow Chemical has recently made significant advances in the design of a new generation of cost effective high resilience all-MDI flexible foam systems. This new technology uses Dow's high molecular weight and high

efficiency polyols in combination with MDI prepolymers that have been designed to fit different physical mechanical properties requirements and a reduced level of non-reactive additives that result in improved foam emission performances. Brief details are given.

EUROPEAN COMMUNITY; EUROPEAN UNION; ITALY; USA; WESTERN EUROPE

*Accession no.794344*

*Item 23*
Polyurethanes Conference 2000. Conference proceedings.
Boston, Ma., 8th-11th Oct.2000, p.567-572
**SMOOTH TRANSITION FOR THE APPLIANCE INDUSTRY USING SAFE AND COST-EFFECTIVE GASEOUS BLOWING AGENTS**
Wheeler I; Crooker R; Wu J; Albouy A
Atofina Chemicals Inc.; Atofina
(American Plastics Council,Alliance for the Polyurethanes Industry)

By 2003, the United States plans to phase out the use of HCFC-141b as an insulating and blowing agent for foams. The US appliance industry, as well as other insulation dependent industries, needs to find a replacement that is technically and economically viable. Atofina Chemicals, formerly Elf Atochem North America, as a leading supplier of several products used in the appliance industry, has invested significant resources worldwide toward extensive research, development and production of CFC substitutes. The company has developed and produced technically viable and cost-effective substitutes that will enable customers to achieve their objectives. The options for HCFC-14lb replacements have included several gaseous blowing agents (GBAs). The leading replacements are products with lower ozone depleting potential (ODP) such as HCFCs 22, 142b and 124 and other products with zero ODP such as HFCs 134a, 245fa and 365mfc as well as hydrocarbons and CO2. All these options have advantages and disadvantages. Emphasis is placed on the needs of the North American appliance industry and the potential role of GBAs in future applications. 11 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; FRANCE; USA; WESTERN EUROPE

*Accession no.794340*

*Item 24*
Polyurethanes Conference 2000. Conference proceedings.
Boston, Ma., 8th-11th Oct.2000, p.555-60
**RESEARCH OF ADHESION FOR WATER BLOWN RIGID POLYURETHANE FOAM**
Yang J G; Lim H; Kim H S; Chung H K
Korea Polyol Co.Ltd.
(American Plastics Council,Alliance for the Polyurethanes Industry)

The rigid PU and polyisocyanurate foam industry has been faced with the challenge to eliminate CFC-11 and replace it with more environmentally acceptable HCFCs, HFCs, pentanes and water. This challenge includes dimensional stability, foam flowability, formulation viscosity, friability, thermal conductivity, flammability, substrate adhesion and cost. Water blown rigid foams lack performance in many of these areas, but has the advantages of utilizing the present equipment. The adhesion of water blown rigid polyurethane foam is investigated as a function of molecular weight of polyol and the PO/EO content in order to maintain the adhesion fundamental property of PU foam. Konix KR-621, 50% less CFC-11 system, is used to obtain the basic data on adhesion with varying the content of water and CFC-11. Physical properties and characteristics of mould foam as a function of water content are measured by FT-IR, DMTA, UTM and SEM. Adhesion is good at 50% water content, and water blown rigid PU foam is prepared under this condition with varying molecular weight of polyol and EO content. Adhesion strength relates closely to the compressive modulus of water blown rigid PU foam and increases in suitable range of modulus even though it has slight differences, depending on polyol used. 8 refs.

SOUTH KOREA

*Accession no.794337*

*Item 25*
Polyurethanes Conference 2000. Conference proceedings.
Boston, Ma., 8th-11th Oct.2000, p.547
**EFFECTIVE DIFFUSIVITY OF HCFC-141B, HFC-134A, HFC-245FA AND CYCLOPENTANE IN PIR FOAM BY THIN-SLICE GRAVIMETRIC ANALYSIS**
Booth J R; Yarbrough D W; Wilkes K E; Gabbard W A
Tennessee,Technological University; Oak Ridge National Laboratory
(American Plastics Council,Alliance for the Polyurethanes Industry)

Thin slices of polyisocyanurate (PIR) slab-stock insulation, containing the blowing agent CFC-11, produced for a Joint Industry/Government Ageing Study (JIGAS) are initially used to demonstrate their utility in insulation ageing evaluations. Additional thin slices from the JIGAS are prepared using specimen T3B4 No.3 in September 1992. These slices are placed into a controlled environment at 75 deg.F and 50% relative humidity for intermittent diffusion weight loss measurement to depletion in 1998. It is necessary to determine the air-filled, blowing agent depleted weights and physical dimensions of each foam slice before resaturation. Brief details are given.

*Accession no.794334*

*Item 26*
Polyurethanes Conference 2000. Conference proceedings.
Boston, Ma., 8th-11th Oct.2000, p.453-7

**PROCESS SOLUTIONS FOR ALTERNATIVE BLOWING AGENTS**

Gula G; Shaner L
Cannon USA
(American Plastics Council,Alliance for the Polyurethanes Industry)

A large portion of the PU industry is being forced to evaluate the use of alternative blowing agents. While there have been many updates on the chemical alternatives that are being developed, little has been said about the equipment modifications that will be required in order to process each of the new alternatives. Manufacturers will need to decide which blowing agent to switch to, but in order to do this they need to evaluate the equipment impact associated with each potential change. They need to know the design changes, cost and production impact of the new equipment or retrofits in order to make a final decision. The latest updates in the regulatory codes, the subsequent process modifications that will be required, the modifications suitability for use with other alternatives (in the event that a processor would be required to switch again), as well as the estimated costs associated with the implementation of each of these solutions are presented.

USA

*Accession no.794317*

*Item 27*

Polyurethanes Conference 2000. Conference proceedings.
Boston, Ma., 8th-11th Oct.2000, p.445-452

**APPLIANCE FOAMS WITH REDUCED LEVELS OF HFC-254FA**

Doerge H P; Schilling S L
Bayer Corp.
(American Plastics Council,Alliance for the Polyurethanes Industry)

The HCFC-141b blowing agent used in most appliance foams in the USA is scheduled for phase-out on January 1, 2003. The most promising replacement is HFC-245fa. It has met many of the requirements for a blowing agent such as zero ozone depletion potential, low toxicity, good miscibility with polyols, low vapour phase thermal conductivity and a reasonable boiling point of 59.5 deg.F. Because it is non-flammable, HFC-245fa will also save manufacturers of household refrigerated appliances the costs associated with retrofitting their factories to safely handle flammable blowing agents. However, refrigerator manufacturers have concerns about higher product manufacturing costs. Foam insulation costs may rise. New processing equipment and procedures may need to be installed in factories for new blowing agents. Refrigerator producers want to know if their foam operation productivity and product quality will be affected. They are also concerned about staying compliant with the 2001 Energy Consumption Standards. Work carried out to address these concerns is reported. The effects of lowering the level of HFC 245fa on foam thermal conductivity, physical properties and demould characteristics are shown. Thermal stability and pressure generation studies on HFC 245fa-containing masterbatches are presented which provide insight into handling the new generation formulations. The information presented will assist household refrigerator producers in selecting the most cost-effective solution to their manufacturing concerns when replacing HCFC 141b with HFC 245fa. 5 refs.

USA

*Accession no.794316*

*Item 28*

Polyurethanes Conference 2000. Conference proceedings.
Boston, Ma., 8th-11th Oct.2000, p.439-444

**EFFECT OF BLOWING AGENT ON REFRIGERATOR/FREEZER TEWI**

Johnson R W
Whirlpool Corp.
(American Plastics Council,Alliance for the Polyurethanes Industry)

When evaluating alternative blowing agents from a global environmental standpoint, it is appropriate to use a total environmental warming impact (TEWI) analysis that includes both direct and indirect environmental warming effects. Parameters that relate to the foam blowing agent and TEWI of a refrigerator include initial thermal conductivity and resulting product energy consumption, rate of increase in product energy consumption due to ageing of the foam, the direct global warming potential of the blowing agent and the amount of blowing agent released to the atmosphere. Energy consumption and foam ageing data are available from co-operative studies conducted by the Appliance Research Consortium. Information regarding the direct GWP of alternative blowing agents is also known. However, there is only limited information available regarding the rate and to what extent the blowing agent escapes from the foam and enters the atmosphere. TEWI calculations are presented, using available data and simplifying assumptions and estimates in order to provide comparisons between products foamed with different blowing agents. Calculations indicate that for countries with a significant portion of electricity produced foam fossil fuels, there is little difference in TEWI when comparing products foamed with HFCs to those foamed with hydrocarbons.

USA

*Accession no.794315*

*Item 29*

Polyurethanes Conference 2000. Conference proceedings.
Boston, Ma., 8th-11th Oct.2000, p.355-63

**LOW DENSITY HR-MOULDED FOAM SYSTEMS FOR AUTOMOTIVE SEAT CUSHION**

Utsumi H; Isobe M; Hiraide T; Ohkubo K; Sakai S

 

Mitsui Chemicals Inc.
(American Plastics Council,Alliance for the Polyurethanes Industry)

1998 flexible PU foam production in Japan is estimated at about 156,000 tpa including 85,000 tpa of moulded foam. Almost all of these moulded foams were used for automotive seats, and the proportion of HR-moulded foam is increasing for this application. The following are required for seat cushions, especially HR (cold cure) moulded foams, in Japan: lower density for cost or weight reduction of car; suitable properties for each cushion application; keeping or improvement of the durability; good mouldability. Low-density HR-moulded foam based on Mitsui's New Polyol-2 is discussed. Seat cushion pads with 35-37kg/cub.m of core density made from conventional materials cannot satisfy both durability and mechanical strength. An attempt is made to achieve weight reduction using New Polyol-2. This polyol makes a good balance between durability and mechanical strength of foams, but the system cannot match practical use because of the poor mouldability. New Polyol-2 is developed in order to reduce density to less than 40 Kg/cub.m. These systems provide a good balance between mobility of soft segment and degree of crosslinking, giving good durability and mechanical properties. Its controlled progress in degree of crosslinking during blowing improves mouldability. Reduced weight seat pads, with 35-37 kg/cub.m of core density made from New Polyol-2, satisfy not only durability and mechanical strength, but also mouldability for practical use. These low-density HR-moulded foam systems have been adopted by plural Japanese OEMs. 10 refs.

JAPAN

*Accession no.794304*

*Item 30*
Polyurethanes Conference 2000. Conference proceedings.
Boston, Ma., 8th-11th Oct.2000, p.341-53
**POLYURETHANE FOAM MOULDING TECHNOLOGIES FOR IMPROVING TOTAL PASSENGER COMPARTMENT COMFORT**
Broos R; Sonney J-M; Phan Thanh H; Casati F M
Dow Benelux NV; Dow Europe SA
(American Plastics Council,Alliance for the Polyurethanes Industry)

Improvements in passenger compartment comfort continue to be one of the key needs of the global transportation industry. Since their introduction more than 40 years ago, flexible moulded PU foams have successfully contributed to the comfort provided by all forms of transportation seating. Initially required to provide just a wide range of load bearing, seating foams are now being designed for longer service life and better vibration damping and are considered to be a functional part of the overall acoustical package. New performance requirements are being placed on the NVH grade of foams and all interior components of passenger compartments must contribute to a reduction in odour and emissions. Several new chemical technologies developed by Dow are described. Specific data are presented to illustrate new foam chemistries that offer low emissions, reduced density, improved vibration management, noise abatement, durability and processing. Attention is focused on how the choice of PU raw materials impacts foam resilience, mechanical damping and resonance as well as acoustic absorption and noise transmission. The results presented will help foam producers, seat assemblers, acoustic part manufacturers and OEM interior designers in their efforts to further improve the comfort performance of transportation systems based on flexible moulded PU foams. 26 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; NETHERLANDS; SWITZERLAND; WESTERN EUROPE

*Accession no.794303*

*Item 31*
Polyurethanes Conference 2000. Conference proceedings.
Boston, Ma., 8th-11th Oct.2000, p.329-38
**PHYSICAL PROPERTIES OF FLEXIBLE POLYURETHANE 'LIQUID CO2' SLABSTOCK FOAMING MIXTURES**
Koot W; Maas W P M
Shell Global Solutions International BV; Shell Research & Technology Centre
(American Plastics Council,Alliance for the Polyurethanes Industry)

In commercial slabstock foaming, liquid CO2 technology is increasingly applied to replace previously used liquid auxiliary blowing agents like CFCs and methylene chloride. Knowledge of physical properties of mixtures used in liquid CO2 foaming may contribute to the further development of liquid CO2 technology. Equations are determined which do predict, for specific operational conditions and formulations, the pressures required in commercial foam operation to keep the CO2 dissolved both in the polyol/CO2, and in the foaming mixture/CO2 solutions. The evident dependence on temperature of CO2 solubility, established for both polyol and foaming mixtures, strongly support tight temperature control of the feedstocks in slabstock liquid CO2 foaming. 10 refs.

BELGIUM; EUROPEAN COMMUNITY; EUROPEAN UNION; NETHERLANDS; WESTERN EUROPE

*Accession no.794302*

*Item 32*
Polyurethanes Conference 2000. Conference proceedings.
Boston, Ma., 8th-11th Oct.2000, p.251-5
**PERFORMANCE OF HFC-245FA IN INTEGRAL SKIN FOAM APPLICATIONS**
Williams D; Bogdan M

Honeywell International Inc.
(American Plastics Council,Alliance for the Polyurethanes Industry)

Hydrochlorofluorocarbons have been banned in the US from use in integral skin applications in 1994, with the exception of automotive application, which was granted an extension until January 1996. In Europe, HFC-141b was banned from use in integral skin foam after January 1 2000, except for safety applications. Rules for the continued use of HCFC-14lb for integral skin foam for safety applications are currently under review in Europe. Other blowing agents, such as CO2 (water), HFC-134a and hydrocarbons, are currently being used with varying degrees of success. CO2 (water) based integral skin foams require higher foam densities and produce poor skin quality. HFC-134a has been added to these formulations to minimise pinholes associated with CO2 (water) blown foams. In some instances CO2 (water) also requires the use of more expensive pure MDI versus polymeric MDI to achieve desired properties. HFC-245fa (1,1,1,3,3-pentafluoropropane) has been evaluated by several foam manufacturers and shows promise as a potential blowing agent for integral skin foam applications. The physical properties of these foams are excellent, comparable to CFC-11 based foams, especially in the areas of skin quality and thickness. A CFC-11 based formulation was used to compare the physical properties of foams prepared using CFC-11 versus HFC-245fa. The resulting foam showed favourable properties in terms of skin thickness, skin quality and processing. Comparative work on CFC-11 and HFC-245fa produces some unexpected results. 2 refs.

USA

*Accession no.794293*

*Item 33*
Polyurethanes Conference 2000. Conference proceedings.
Boston, Ma., 8th-11th Oct.2000, p.239-43
**NEW GENERATION OF CELL OPENERS FOR RIGID FOAMS - IMPROVED BALANCE OF STABILISATION AND CELL OPENING**
Boinowitz T; Klincke M; Burkhart G
Goldschmidt Th.,AG
(American Plastics Council,Alliance for the Polyurethanes Industry)

Goldschmidt's latest findings in respect to additives for opening cells in rigid and semi-rigid foams are presented. Three new products named Tegostab B 8871, B 8934 and B 8935, are introduced. Special attention is given to systems for automotive headliners, however the products are also suitable in other applications such as energy absorption, packaging and acoustic insulation, among others. These new additives are products combining stabilisation and cell opening properties. These two functions are relevant in different phases of the foaming process. The mechanism of cell opening and how to influence it by chemical means are demonstrated. The open-cell content of these foams can be controlled by varying the concentration of the new additives in the formulation over a broad range, while maintaining a relatively fine cell structure. Evaluations prove that the choice and the concentration of cell-opener depend strongly on the composition and characteristics of the foam formulation and the processing technology. Both the Tegostab B 8934 and B 8935 are developed and tested with good results in laboratory experiments and pilot plant trials.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

*Accession no.794291*

*Item 34*
Polyurethanes Conference 2000. Conference proceedings.
Boston, Ma., 8th-11th Oct.2000, p.179-182
**QUALITY, COST EFFECTIVE, FLAMMABLE HFC BLOWING AGENT ALTERNATIVE FOR CONSTRUCTION FOAM APPLICATIONS: BLENDS OF HFC-245FA AND HYDROCARBONS**
Bogdan M; Williams D
Honeywell International Inc.
(American Plastics Council,Alliance for the Polyurethanes Industry)

Azeotropes have long been recognised as providing unique advantages as blowing agents. HFC-245fa forms an azeotrope over a wide range of concentrations with isopentane, cyclopentane and/or n-pentane. The use of these blends allows the foam manufacturer to optimise k factor and foam properties while minimising costs. Although these HFC-245fa/hydrocarbon blends are flammable the foams co-blown with HFC-245fa have significant advantages over foams blown only with hydrocarbons. The physical properties, environmental properties and polyol miscibility of azeotropic blends of HFC-245fa/hydrocarbon are compared to the hydrocarbons, HFC-245fa, and HCFC-14lb. 9 refs.

USA

*Accession no.794284*

*Item 35*
Polyurethanes Conference 2000. Conference proceedings.
Boston, Ma., 8th-11th Oct.2000, p.163-170
**HFC-245FA SYSTEMS CO-BLOWN WITH CO2 (WATER): QUALITY, COST EFFECTIVE HFC ALTERNATIVE FOR CONSTRUCTION FOAM APPLICATIONS**
Bogdan M; Williams D
Honeywell International Inc.
(American Plastics Council,Alliance for the Polyurethanes Industry)

HFC-245fa/CO2 (water) technology provides a non-flammable blowing agent alternative. HFC-245fa foams

 

co-blown with relatively high levels of CO2 (water) demonstrate exceptional physical properties. The foams in some applications have physical properties similar to CFC11 foams. The advantages of this technology vs. CFC-11, HCFC-141b and HFC-245fa technology are discussed. Details of the latest construction trials are also included. The trials demonstrate that the HFC-245fa/CO2 (water) technology meets the requirements of existing manufacturing equipment and system shipping containers. In addition, an economic model and yield analysis based on the results of the roofing spray foam trial illustrates that the HFC-245fa/CO2 (water) technology produces foams, which are both quality and cost competitive with current HFC-14lb technology. 8 refs.

USA

*Accession no.794282*

*Item 36*

Polyurethanes Conference 2000. Conference proceedings.
Boston, Ma., 8th-11th Oct.2000, p.135-140

**NOVEL POLYOLS FOR ALL-WATER-BLOWN OPEN-CELL RIGID POLYURETHANE FOAM**

Hotta H; Sato H; Ochi T; Takeyasu H
Asahi Glass Co.Ltd.
(American Plastics Council,Alliance for the Polyurethanes Industry)

A series of novel polyols for all water blown open cell foam, WB-4500, WB4550 and WB-4600, to solve the problems normally associated with this sector, including dimensional instability and high surface friability. WB-4500 is designed for rapid reaction rate and suitable for 20kg/cub.m density foam in the board foam market. WB-4550 is designed for higher reactivity rate than WB-4500 and suitable for lower than 20kg/cub.m density foam in the board foam market. WB-4600 is designed for mild reactivity rate and makes dimensional stability foam at low moulded density without foam surface friability in pour-in-place moulding.

JAPAN

*Accession no.794278*

*Item 37*

Polyurethanes Conference 2000. Conference proceedings.
Boston, Ma., 8th-11th Oct.2000, p.117-126

**NEW TECHNOLOGY FOR VISCOELASTIC FOAM**

Hager S; Skorpenske R; Triouleyer S; Joulak F
Bayer Corp.
(American Plastics Council,Alliance for the Polyurethanes Industry)

The production and use of slow recovery viscoelastic PU foams have increased rapidly. Their unique performance characteristics, including shape conformance, vibration and sound damping, and energy and shock absorption, make these the foams of choice for many diverse applications such as pillows, mattress toppers, automotive trim, sports and medical equipment, and ergonomic cushions and pads. These diverse applications require a wide range of foam grades with tailored performance properties. New polyol and formulating technology is being developed to meet the increased demands for improved processing, wider grade latitude and improved performance properties of viscoelastic foam. The results of systematic experimental design studies conducted in the laboratory to help develop this technology are reported. A key advance is the development of polyol compositions that enable the production of high quality, soft viscoelastic foams at 100 index and above. This eliminates processing inconsistencies associated with low index foaming, and yields foams with superior performance characteristics such as improved compressions set, reduced discoloration and finer cell structure with improved feel. Formulating routes to optimise key foam performance features such as low resilience, slow but complete recovery, maintenance of slow recovery characteristics with use, reduced temperature sensitivity, good airflow, and good strength properties are also identified. The results of machine foam studies are presented along with additional foam performance results. 1 ref.

EUROPEAN COMMUNITY; EUROPEAN UNION; FRANCE; USA; WESTERN EUROPE

*Accession no.794276*

*Item 38*

Polyurethanes Conference 2000. Conference proceedings.
Boston, Ma., 8th-11th Oct.2000, p.97-102

**NEW HIGH ETHYLENE OXIDE POLYETHER POLYOL FOR SOFT AND ULTRASOFT FOAM PRODUCTION**

D'Aandrea F; Quintas F L; Hager S; Skorpenske R
Bayer SA; Bayer Corp.
(American Plastics Council,Alliance for the Polyurethanes Industry)

Soft and ultrasoft flexible slabstock foams have found new applications opportunities, particularly in furniture and bedding. This has been driven by new furniture designs and changes in bedding construction that places more emphasis on comfort while demanding higher quality and increased durability. At the same time, new regulatory protocols involving the use of chemicals like CFCs and other auxiliary blowing agents have restricted production of the desired soft and ultrasoft foam grades. In response to this scenario, the PU industry has developed new mechanical and chemical alternatives to overcome these restrictions. Machine manufacturers have introduced variable pressure foaming and liquid CO2 machines that facilitate production of soft foam grades. Chemical and additive suppliers have provided new products to support these processes and have developed new soft foam

technologies for conventional foam equipment. Bayer has developed Ultracel and Softcel foam technologies, which provide a broad range of soft foam grades for the industry. The company has also recently introduced a new high ethylene oxide (EO) polyether polyol, Arcol Polyol I-9000, for the production of soft and ultrasoft foam grades with a unique 'silky' feel. This polyol can be used as the major polyol component or as an additive for producing a wide range of soft foam grades with excellent durability and good compression set resistance. It offers broader processing latitude and wider grade flexibility than prior high EO polyols and can even be used in formulations with methylene chloride, where still allowed. Formulations have been developed to produce unique foams for high quality upholstery, enhanced comfort bedding and various other applications currently employing fibrefill. Typical polyol features, formulating principles, manufacturing parameters for discontinuous and continuous foam processes, and typical performance properties for a wide range of foams made with this new polyol, are described. 4 refs.

SWITZERLAND; USA; WESTERN EUROPE

*Accession no.794273*

*Item 39*

Polyurethanes Conference 2000. Conference proceedings.
Boston, Ma., 8th-11th Oct.2000, p.91-5

**LOW RESILIENCE-HIGH PERFORMANCE RECENT ADVANCES IN VISCOELASTIC FLEXIBLE SLABSTOCK FOAM**

Kintrup S; Treboux J P; Mispreuve H
Dow Europe SA
(American Plastics Council,Alliance for the Polyurethanes Industry)

The use of low resiliency (viscoelastic) PU flexible foam has gained attention over the past few years. Its unique ability of conforming to a shape, providing total support and eliminating pressure points, makes it more and more attractive for use in high comfort bedding. Various technologies for the production of continuous viscoelastic slabstock foam are available, using in general a blend of a high and a low molecular weight polyols at an index below 100. Depending on its formulation low resilience foam can be provided with different resilience and recovery rates. TDI-based low resilience foam is characterised by its soft touch, very low resilience and very slow recovery. Processing and permeability are critical for such foam, which often implicates the use of special TDI. MDI-based foam is usually easier to process and can be produced in a wider index and density range. However general strength properties are lower, resilience is higher and compression set is better than for TDI based foam. Dow Europe has recently developed formulations, based on TDI, using special additives that gives sufficient processing at higher index. The different technologies are compared, focusing on these recent developments. These formulations have been scaled up on a continuous semi-production machine including the use of liquid CO2 as a blowing agent. 3 refs.

SWITZERLAND; WESTERN EUROPE

*Accession no.794272*

*Item 40*

Polyurethanes Conference 2000. Conference proceedings.
Boston, Ma., 8th-11th Oct.2000, p.23-31

**LCA ON RIGID POLYURETHANE FOAMS: ENVIRONMENTAL COMPETITIVENESS OF 365-MFC-BLOWN PRODUCTS**

Kraehling H; Zipfel L
Solvay Management Support GmbH; Solvay Fluor und Derivate GmbH
(American Plastics Council,Alliance for the Polyurethanes Industry)

Insulation products manufactured using third generation blowing agents have to prove their environmental competitiveness to achieve market acceptance. In this context information is required for dialogue with all stake holders as well as to support company internal decision making. Solvay Fluor und Derivate commissioned a life cycle assessment to support the application development and the market positioning of 365 mfc as a blowing agent for PU rigid foams. Elastogran, Kingspan and Synthesia as experts and stake holders in the PU industry were invited and accepted to join the project as partners.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

*Accession no.794263*

*Item 41*

Patent Number: US 6086788 A1 20000711

**HYDROFLUOROCARBON BLOWN FOAM AND METHOD FOR PREPARATION THEREOF**

Bogdan M C; Bement L B; Decaire B R; Konopa D P; Kieta H J; Singh R R
AlliedSignal Inc.

The invention relates to the addition of alpha-methyl styrene, isobutanol and/or isopropanol to reduce vapour pressure, improve k-factor, enhance the solubility of the blowing agent in the premix and/or improve the processing characteristics of polyurethane and polyisocyanurate closed-cell foams prepared with a blowing agent comprising a hydrofluorocarbon selected from the group consisting of 1,1,1,3,3-pentafluoropropane, 1,1,1,2-tetrafluoroethane, 1,1,2,2- tetrafluoroethane, and mixtures thereof.

USA

*Accession no.793929*

*Item 42*

***Chemical and Engineering News***
78, No.44, 30th Oct.2000, p.22-3

**REGULATORY ISSUES HEAT UP FOR BLOWING AGENTS**
McCoy M

In an unexpected response to a petition filed by fluorocarbon producer Atofina last year, the EPA has proposed accelerating the phaseout of three commonly used fluorocarbons used to blow PU and other foams. Atofina and other companies are now protesting the proposal, calling it fundamentally flawed. HCFC-141b, seen only as a stopgap measure until non-ozone depleters such as HFCs could be developed, was targeted for phaseout on 31 December 2002. Other products had until 2010. EPA has proposed moving the phaseout dates for HCFCs 142b and 22 to January 2005. Honeywell has won board approval to build an HFC-245fa plant, slated to start up by 1 July 2002, in time for customers to switch to the new product by the end of that year. Atofina maintains that existing non-ozone-depleting options are not adequate to replace 141b in all applications.

WORLD

*Accession no.792799*

*Item 43*
***Polymer Engineering and Science***
40, No.9, Sept.2000, p.2046-57
**CHEMICAL AND PHYSICAL BLOWING AGENTS IN STRUCTURAL POLYURETHANE FOAMS: SIMULATION AND CHARACTERIZATION**
Modesti M; Adriani V; Simioni F
Padova,Universita

Physical blowing agents such as n-pentane and methyl formate and, for comparison, chemical blowing agents such as water were used to prepare structural PU rigid foams of different densities by reaction injection moulding. Experimental runs were carried out with formulations based on oligomeric isocyanate and a mixture of polyether polyols. The constitutive equations for the vapourisation rate of the two blowing agents and the polymerisation kinetics data were reported. Experimental results were compared with the prediction of a simplified theoretical model and they showed a satisfactory agreement in terms of temps. and density profile. All the specimens were characterised in terms of physical-mechanical properties such as hardness, impact strength, flexural strength and elastic modulus and the results were reported as a function of the densities. The best mechanical performance was obtained with the physical blowing agents, as a result of a better density distribution profile and a thicker skin layer. 11 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; ITALY; WESTERN EUROPE

*Accession no.788878*

*Item 44*
Patent Number: EP 1010720 A1 20000621
**METHOD FOR PREPARATION OF FLEXIBLE LOW-DENSITY POLYURETHANE FOAMS**
Okon S F; Stefani D; Benetti E D; Tartari V
Enichem SpA

Flexible polyurethane foams having a density of between 12 and 17 Kg/cu.m. are made by reacting a polyisocyanate with a polyol in the presence of a blowing agent consisting of water, dimethylcarbonate and a hydrofluorocarbon blowing agent having from 1 to 6 carbon atoms.

EUROPEAN COMMUNITY; EUROPEAN UNION; ITALY; WESTERN EUROPE; WESTERN EUROPE-GENERAL

*Accession no.778759*

*Item 45*
Patent Number: US 6013692 A 20000111
**CELLULAR POLYURETHANE ELASTOMERS**
Daum U; Feeken A; Jarre W; Schmidt A; Sklenarz R
Lonza AG

Cellular polyurethane elastomer is disclosed which is produced by reacting: (a) an isocyanate component which includes methylenebis(phenyl isocyanate) (MDI) and/or tolylene diisocyanate (TDI) in monomeric form or as liquefied polymer with (b) compounds with at least two isocyanate-reactive atoms and (c) 4,4'-methylenebis(3-chloro-2,6-dialylaniline) or a mixture of 4,4'-methylenebis-(3-chloro-2,6-dialylaniline) with one or more aromatic, aliphatic or cycloaliphatic diamines as chain extending agent, if desired with further polyol, and (d) a blowing agent in the presence of the usual catalysts and, if desired, other additives.

SWITZERLAND; WESTERN EUROPE

*Accession no.777632*

*Item 46*
Patent Number: US 6013691 A 20000111
**EXPANSIBLE SEALANT COMPOSITIONS AND BLOWING AGENTS**
Braun R; Garcia J; Kissack D; Pietrzyk G; Schutter D
Insta-Foam Products Inc.

The present invention discloses a foam frothing alternative for blowing or frothing single component foams using gases which are incapable of being liquefied within the limits of DOT aerosol cans, referred to herein as non-liquefiable gases. In this invention, it is demonstrated that non-liquefiable gases such as CO2 and N2O can be used to provide foams using conventional single component foam chemical raw materials. The present invention provides an adhesive/sealant, expanded by non-liquefiable gas propelled from a container initially and expanded by a blowing agent consisting primarily or exclusively of a non-liquefiable gas and formulated from a moisture curable polyurethane prepolymer using a low molecular weight isocyanate of two or more functionality. In one or more variations, the compositions of the present invention contain solubility enhancers for non-liquefiable gases such as CO2 or supplemental propellants/liquefiable blowing

agents, as well as other additives such as, for example, catalysts, fire retardants, and surfactants which include, but are not limited to, cell openers.

USA

*Accession no.777631*

*Item 47*

Patent Number: US 6019919 A 20000201

**PROCESS FOR FOAM PRODUCTION USING CARBON DIOXIDE DISSOLVED UNDER PRESSURE**

Sulzbach H-M; Althausen F; Raffel R; Eiben R; Ebeling W

Bayer AG; Hennecke GmbH

A process and device for the continuous production of slabstock foam by foaming a polyurethane reactive mixture containing carbon dioxide dissolved under pressure, comprising the steps of a) feeding said polyurethane reactive mixture into a linear extended pressure distribution chamber at a pressure above that of the solubility vapour pressure of said dissolved carbon dioxide, b) reducing pressure to a pressure below said solubility vapour pressure of said dissolved carbon dioxide in a linear extended pressure reduction zone, c) feeding said polyurethane reactive mixture from said pressure reduction zone into a foaming chamber with a widening cross-section of flow to form a foamed reactive mixture, and d) applying said foamed reactive mixture (froth) substantially perpendicularly and free-flowing onto a conveyer belt of a continuous slabstock foam plant.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; USA; WESTERN EUROPE

*Accession no.773305*

*Item 48*

***Polymer Plastics Technology and Engineering***

39, No.1, 2000, p.163-85

**ENVIRONMENTALLY FRIENDLY PROCESSING OF POLYURETHANE FOAM FOR THERMAL INSULATION**

Kim C; Youn J R

Seoul,National University

An environmentally friendly processing method of PU foam is proposed and evaluated for the application of thermal insulation. For the production of PU foam, CFC gases are eliminated to minimise environmental destruction. Carbon dioxide gas is used as a blowing agent instead of the CFC gas. Ultrasonic excitation is also applied to the mixture of polyol and isocyanate to increase the rate of nucleation and decrease the thermal conductivity. Nucleation and growth of bubbles are studied theoretically and experimentally. Water is used as a chemical blowing agent and carbon dioxide gas as the physical blowing agent. Experiments are carried out with different saturation pressures, and experimental results are evaluated to determine the best foaming conditions. Rate of bubble nucleation, final bubble sizes, conversion during polymerisation reaction, and other parameters are predicted theoretically with the assumption that negative pressure is generated by the ultrasonic field and the bubble growth is controlled by diffusion of the gas from the resin into the bubble. The best results such as low thermal conductivity and small size of bubbles are obtained when the polyol which has been mixed with water is saturated with carbon dioxide gas and the ultrasonic excitation is applied to the mixture of polyol and isocyanate right after the impingement mixing. 12 refs.

KOREA

*Accession no.772201*

*Item 49*

Patent Number: US 6010649 A 20000104

**METHOD OF MAKING A LOW DENSITY, MOLDED INTEGRAL SKIN POLYURETHANE FOAM**

Valoppi V L; Bredeson E S

BASF Corp.

Non-chlorinated pentafluoropropane blowing agents may be used alone or in combination with water to make the above foams, which may be used to make shoe soles. Foams produced using 1,1,1,3,3-pentafluoropropane (HFA-245fa) with or without water exhibit physical properties, such as abrasion resistance and resistance to cracking upon flexing comparable to conventional chlorinated fluorocarbon blown foams.

USA

*Accession no.767980*

*Item 50*

Patent Number: US 6001890 A 19991214

**OPEN CELLED CELLULAR POLYURETHANE PRODUCTS**

Hamilton J A

Imperial Chemical Industries PLC

Process for making open celled (semi-)rigid polyurethane foams using as cell opening agent a fatty acid or a fatty acid amine or a fatty acid amide or a fatty acid ester.

EUROPEAN COMMUNITY; EUROPEAN UNION; UK; WESTERN EUROPE

*Accession no.766322*

*Item 51*

***Urethanes Technology***

17, No.1, Feb./March 2000, p.8

**EU AGREES HCFC DATES**

The European Parliament has adopted phase-out dates for the use of HCFCs in rigid foam applications which are basically in line with those in the USA and Japan. From 1 January 2000, the use of HCFCs for integral skin PU and PE foams is prohibited. From 1 January 2002, the use of

HCFCs in expanded PS foams is prohibited. From 1 January 2003, the use of HCFCs in flexible-faced PU foam laminates, appliances and sandwich panels is prohibited.

EUROPEAN PARLIAMENT
WESTERN EUROPE-GENERAL

*Accession no.764567*

*Item 52*
Patent Number: US 5958992 A 19990928
**BLOWING AGENT BLENDS**
Jinhuang Wu, Dillon D R; Crooker R M
Elf Atochem North America Inc.

Foam blowing agents blends of 10-90% of n- and/or i-pentane with 90-10% of 142b or 124 are provided, as are polyol premixes and polyurethane foam compositions containing such blends.

USA

*Accession no.759124*

*Item 53*
Patent Number: US 5958991 A 19990928
**OPEN-LOOP METHOD FOR PRODUCING A CONTROLLED BLEND OF POLYOL AND BLOWING AGENT FOR USE IN THE MANUFACTURE OF POLYURETHANE FOAM**
Bartlett H W

A novel methodology and apparatus have been discovered which is of value in the production of polyurethane foam. This invention relates to a one-pass, on demand process and apparatus for producing a controlled, homogeneous blend of the polyol-blowing agent mixture used in the manufacture of polyurethane foam using either a low-boiling point or high boiling point blowing agent. A method is provided to control the amount of each material in the mixture, ensure homogeneous blending of the two materials after mixing, a pressure control means to maintain blowing agents in their liquid state (where necessary), and a monitoring means which allows rapid verification of the operating status of the entire system. The process is comprised of: (a) using variable flow rate displacement pumps for both materials; (b) using mass flow meters to determine the mass flow rates of both materials; (c) using electronic controllers to control the output of the pumps based on preselected input values, and thereby controlling the ratio of the mixture formed by the combination of the two materials; (d) feeding the mixture of materials into a blending zone; (e) application of kinetic blending energy to produce a homogeneous mixture; (f) the use of a back pressure control device to ensure that the processing of the materials is carried out at a pressure above the vapour pressure of the blowing agent; and (g) passing the blended material through a mass flow meter to ensure the accuracy of the mixture, that is, the sum of mass flow rates of the ingredient materials should equal the total mass flow rate of the blended materials.

USA

*Accession no.759123*

*Item 54*
Patent Number: US 5972260 A 19991026
**PROCESS FOR VACUUM FOAMING OF PANELS**
Manni L
Manni SpA

A process and an apparatus for blowing in inert gas and vacuum foaming of insulating panels; an upper shell and a lower shell defining the outer in-sight surfaces and a foaming cavity of a panel, are positioned between the opposing platens of a press, together with a peripheral frame for retaining the foam; the frame comprises an interior channel connected to the foaming cavity of the panel, respectively to an annular manifold arranged in one of the press platens. At first, air in the foaming cavity is removed by blowing in an inert gas through the interior channel of the foam retaining frame; successively the foaming cavity is connected to a vacuum source and a metered quantity of a polyurethane mixture with a pentane blowing agent is injected, allowing the mixture to flow and foam in the panel under the vacuum effect.

EUROPEAN COMMUNITY; EUROPEAN UNION; ITALY; WESTERN EUROPE

*Accession no.758883*

*Item 55*
Polyurethanes Expo '99. Conference proceedings. Orlando, Fl., 12th-15th Sept.1999, p.519-20
**NOVEL BLOWING AGENT TECHNOLOGY FOR POLYURETHANE SEMI-RIGID INTEGRAL SKIN APPLICATIONS**
Guidetti G; Pellacani L
Dow Italia SpA; Dow Deutschland Inc.
(American Plastics Council,Alliance for the Polyurethanes Industry)

Dow Chemical has been exploring alternative blowing agent technologies for many years. These research activities have focused on both chemical and physical blowing agents, including HFCs and particularly HFC-134a. Today Dow offers a broad range of fully-formulated two component HFC systems, commercialised worldwide under the trademark Specflex. These systems are tailored to meet most car manufacturers' specifications. In order to offer a wider range of blowing technology options, Dow Chemical has been strongly committed to the development of sustainable blowing agent techniques for PU SRIS applications. Special focus has been given to carbon dioxide blowing technologies. As a result, an innovative carbon dioxide blowing technology has been developed and is now being successfully applied in the manufacture of SRIS items, such as steering wheels. Advantages include better skin formation, resulting in improved wear properties; lower internal mould pressure, resulting in lower post blowing deformation, with a possible reduction of demoulding time; more homogeneous surface colour, which may allow moulding without any IMC; better feeling to the touch.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; ITALY; WESTERN EUROPE

*Accession no.756965*

*Item 56*
Polyurethanes Expo '99. Conference proceedings. Orlando, Fl., 12th-15th Sept.1999, p.515-6
**RELATIVE PERFORMANCE OF HFC-245FA IN INTEGRAL SKIN FOAM APPLICATIONS**
Logsdon P; Williams D; Bogdan M; Bowman J; Stoehr R T
AlliedSignal Inc.; Carpenter Co.
(American Plastics Council,Alliance for the Polyurethanes Industry)

HCFCs have been banned from use in non-automotive integral skin applications since 1994, with the exception of automotive safety applications which were granted an extension until January 1996. Other blowing agents, such as water (CO2), HFC-134a and hydrocarbons, are currently used with varying degrees of success. Water-based integral-skin foams require higher foam densities and produce poor skin quality. HFC-134a has been added to these formulations to minimise pinholes associated with water blown foams. In some instances, water also requires the more expensive pure MDI versus polymeric MDI. HFC-245fa has been evaluated by several integral skin foam manufacturers and shows promise as a potential blowing agent for integral skin foam applications. A CFC-11 based formulation is used to compare the physical properties of foams prepared using CFC-11 versus HFC-24fa.

USA

*Accession no.756964*

*Item 57*
Polyurethanes Expo '99. Conference proceedings. Orlando, Fl., 12th-15th Sept.1999, p.501-3
**INTEGRAL SKIN FOAMS WITH SKIN FORMATION BY USING A MODERN COMBINATION OF BLOWING AGENTS**
Strietholt W A; Grassi F
Enichem Deutschland GmbH; Enichem SPI
(American Plastics Council,Alliance for the Polyurethanes Industry)

PUs are widely used in the area of integral skin foams, covering the whole range of different hardness requirements, from very soft Shore A less than 40 safety parts via harder Shore A applications like the typical automotive steering wheels or gear knobs, up to very hard and stiff technical parts in the Shore D range. The challenge in this market area in the last decade was and still is the blowing agent issue. The target is to achieve a skin formation without using any CFCs or HCFCs. Alternative available blowing agents are well known, but all of them have at least one negative prospect regarding environmental, flammability or low skin formation aspects. The challenges and properties of common alternative blowing agents like pentane and water technology are demonstrated and compared with the traditional HCFC 141 b systems, which will be phased out in Europe by the end of 1999. Typical market relevance and future properties will be dealt with. The options and results of the use of HFC 134a (tetrafluoroethane) in combination with or without Enichem patented alternative blowing agents are presented. Using this new combination, a significant visible skin formation is found. The abrasion test results pass major tested OEM requirements. All other physical and processing parameters are comparable to common technologies. This technology is mainly designed for customers changing to alternative and more environmental friendly technologies in automotive as well as non-automotive areas without losing the typical skin formation.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; ITALY; WESTERN EUROPE

*Accession no.756962*

*Item 58*
Polyurethanes Expo '99. Conference proceedings. Orlando, Fl., 12th-15th Sept.1999, p.427-35
**NEW DEVELOPMENTS WITH APPLIANCE RIGID FOAM SYSTEMS UTILISING LIQUID AND GASEOUS BLOWING AGENTS TO ACHIEVE OPTIMUM DENSITY, FLOWABILITY, CABINET ENERGY AND PRODUCT APPEARANCE**
Haworth J; Irwin P; Latham D; Morgan R
Maytag Corp.; Dow Chemical Co.
(American Plastics Council,Alliance for the Polyurethanes Industry)

With the new energy regulations scheduled to become effective in July 2001 and the ban on the use of the HCFC-141b in 2003, extensive development work has centred around new rigid foam systems for the appliance industry. Without a clear consensus on the choice of a single blowing agent as a replacement for the HCFC-141b, a number of blowing agents have been studied. All expected candidates carry one expected common theme, that of an anticipated cost increase in the insulation of the future appliance cabinets. This increase may be from an increase in the cost of the blowing agent, an increase of the in-place foam density, the cost of cabinet redesign, an increase in the capital required to process the new foam system, or a combination of these factors. Higher k-factor foams resulting in higher energy usage would require use of more costly energy components. Most of the expected alternative blowing agents, with the exception of the hydrocarbons, could be considered as gaseous products. Each of these candidates will bring their own particular challenge to the appliance OEM. The role of key physical properties on the foam's performance in the cabinet is examined. The alternative blowing agent candidates

 

compared in the study include HFC-134a, HFC-245fa, HCFC-124, cyclopentane and blends. 4 refs.

USA

*Accession no.755712*

*Item 59*

Polyurethanes Expo '99. Conference proceedings. Orlando, Fl., 12th-15th Sept.1999, p.421-6

**NEXT STEP: COMMERCIALISATION TIMELINE FOR HFC-245FA**

Logsdon P B; Williams D J

AlliedSignal Inc.

(American Plastics Council,Alliance for the Polyurethanes Industry)

HCFC-141b is to be phased out for use as a blowing agent in thermal insulation foams in the USA by 2003. A significant amount of work has been completed by the appliance industry on the development of HFC-245fa (1,1,1,3,3-pentafluoropropane) as a replacement for HCFC-141b. It is shown that HFC-245fa is the customer-preferred replacement offering an excellent match in terms of thermal conductivity, dimensional stability and compressive strength. In addition, results of the Food Migration Study on HFC-245fa conducted by AHAM (Association of Home Appliance Manufacturers) are very favourable. The industry is at the point where larger scale trials are the next step in the evaluation of HFC-245fa. These trials will ultimately lead to its commercial use. The commercial development of HFC-245fa for the appliance industry is described. A timeline is discussed that details the events that need to take place for HFC-245fa to be commercial some time in the year 2002. These events include Significant New Alternatives Program application for approval as an HCFC-141b replacement and the Pre-Manufacture Notice. Another topic covered is a cost/benefit model developed and presented at SPI 1998. This model is been refined and updated to reflect current industry information. 14 refs.

USA

*Accession no.755711*

*Item 60*

Polyurethanes Expo '99. Conference proceedings. Orlando, Fl., 12th-15th Sept.1999, p.389-94

**NEW GENERATION PREMINOL FOR DYNAMICALLY COMFORTABLE AUTOMOTIVE SEATING FOAMS**

Toyota Y; Wada H; Horie A; Sasaki T; Takahashi K; Takeyasu H; Min K

Asahi Glass Co.Ltd.

(American Plastics Council,Alliance for the Polyurethanes Industry)

Asahi Glass has developed Preminol II, which is claimed to lower the transmissibility at a resonance frequency more than its predecessor Preminol I. The foam properties of the new polyol, studying the relationship between properties and morphology of the resultant high resilience foams, are described.

JAPAN

*Accession no.755707*

*Item 61*

Polyurethanes Expo '99. Conference proceedings. Orlando, Fl., 12th-15th Sept.1999, p.289-92

**MULTIFLEX - SLABSTOCK EQUIPMENT INNOVATIONS FOR THE NEXT MILLENNIUM: ECOLOGICAL AND ECONOMICAL REVOLUTION IN FLEXIBLE FOAM**

Fries K-W; Klahre H; Kurt E; Ferrand J

Hennecke GmbH; Bayer Corp.

(American Plastics Council,Alliance for the Polyurethanes Industry)

Recent advances in the area of slabstock processing equipment have primarily focused on modifications geared at processing carbon dioxide blown systems. Hennecke has developed NovaFlex technology, currently the most widely used process in this market segment. The company has also introduced the versatile Multiflex technology, which provides foamers with the capability to process void free, striation free foam buns with a yield of over 96%. Advantages offered by MultiFlex technology include: elimination of costly cleaning activities involved with trough systems, quick reacting polyols can be easily processed, flexibility for a wide range of foam densities, side walls are precisely adjustable, a vibration free conveyor band, and improved operator safety as a result of reaction fumes being removed directly in the foaming zone. Additionally, and most importantly, absolutely square blocks across the complete range of polyether formulations, can be produced consistently. The hard and thick cover crust on useful foam is eliminated, while the density distribution is optimised throughout the bun. Improvements in material yield of up to 10%, as compared to the conventional dome block method, are possible. State-of-the-art controls provide process control and data management capabilities, not typically found in the industry. The control package also minimises on-the-fly formulation changes, and allows for precise reproducibility of given formulations.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

*Accession no.755695*

*Item 62*

Polyurethanes Expo '99. Conference proceedings. Orlando, Fl., 12th-15th Sept.1999, p.275-82

**NEW SURFACTANTS FOR USE IN CO2 TECHNOLOGY**

Redgway D H; Kniss J G; Mercando L A; Huhtasaari M

Air Products & Chemicals Inc.

(American Plastics Council,Alliance for the Polyurethanes Industry)

The adaptation of the Montreal Protocol in 1987 and new restrictions on the use of methylene chloride by OSHA have meant the flexible PU foam (FPF) industry has had to find new methods of producing low density foams at the desired hardness level. Additional pending restrictions by the EPA have heightened the search for substitutes. Alternative auxiliary blowing agents such as acetone and pentane and mechanical forced cooling technologies have helped to fill the gap left by the demise of the industry's traditional use of methylene chloride. To date, the most widely accepted of the new technologies is blowing foam with liquid CO2. At least three different machine configurations have been introduced to the FPF industry and are being used to produce foam commercially. As is common with all new technologies, production problems have been encountered which prevent CO2 blown foam technology from being universally accepted. Some of the most persistent and troublesome shortcomings of these technologies, such as poor cell structure and striations, can be remedied by correct choice of surfactant. A surfactant which performs well with CO2 technology would have to provide good nucleation, a high degree of emulsification, excellent froth stability, and good bulk stability. Work to develop surfactants which possess all of these desired properties is reported. Evaluations on commercial CO2 machines are performed and the results indicate these new surfactants provide improved foam properties compared to current surfactants. The improved foam properties include excellent fine cell structure, elimination of striations, improved airflow and enhanced sidewall integrity.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; USA; WESTERN EUROPE

*Accession no.755693*

*Item 63*

Polyurethanes Expo '99. Conference proceedings. Orlando, Fl., 12th-15th Sept.1999, p.256A-256G

**HFC-245A SPRAY POLYURETHANE FOAM SYSTEMS CO-BLOWN WITH WATER: QUALITY, COST EFFECTIVE, SAFE SUBSTITUTE FOR HCFC-141B**

Bogdan M; Williams D; Verviest P
AlliedSignal Inc.; AlliedSignal Europe NV
(American Plastics Council,Alliance for the Polyurethanes Industry)

The effective use of insulation is key to energy conservation. The effectiveness of insulation is dependent upon many factors. In the case of rigid foam insulation, a key factor is the blowing agent used. Industry evaluations have shown that HFC-245fa produces foams with the highest insulation value of any HCFC-141b alternative blowing agent in the construction market. Chemical and manufacturing changes can have a significant effect on product cost. The higher vapour pressure of HFC-245fa and its potential impact on packaging has also been a concern to the spray foam industry. The latest results of the use of HFC-245fa foam systems co-blown with water meeting the needs of the spray foam market are presented. They are cost effective, produce foams with low k-factors, good physical properties, and can be stored and shipped in existing drums. HFC-245fa and water used as co-blowing agents provide a wide range of benefits in spray foam. Since less HFC-245fa is used vapour pressure is lower, and the cost of the system reduced while improving the physical properties of the foam. There is, however, an increase in k-factor. It is determined that the addition of low levels of alpha-methyl styrene to a spray foam polyol blend lowers the vapour pressure of the polyol blend and enhances the k-factor of the foams produced. Data from laboratory evaluations of these blends is presented. The costs of these blends are discussed from a chemical, manufacturing and performance perspective. HFC-245fa/water co-blown spray foam is concluded to be a quality, cost-effective and safe alternative to HCFC-141b blown foams. 7 refs.

BELGIUM; EUROPEAN COMMUNITY; EUROPEAN UNION; USA; WESTERN EUROPE

*Accession no.755689*

*Item 64*

Polyurethanes Expo '99. Conference proceedings. Orlando, Fl., 12th-15th Sept.1999, p.247-55

**SURFACTANTS FOR HYDROCARBON LAMINATION FOAMS**

Miller J W; McDaniel P L; Sabram K A; Braun A; Grimminger J
Air Products & Chemicals Inc.
(American Plastics Council,Alliance for the Polyurethanes Industry)

With the lamination segment of the US PU industry likely to change from HCFC-141b to hydrocarbons as the leading alternative blowing agent, there exists a technological need to introduce specialised surfactants. These surfactants must address issues such as compatibility of the surfactant in standard polyols and the ability to enhance the emulsification of hydrocarbons leading to better physical and processing properties. Critical physical properties in the lamination segment include thermal conductivity, dimensional stability, compressive strength and density. Critical processing parameters include lateral flow, line speed, post expansion and cell isotropy. The proper surfactant can aid regulation of cell structure, percent closed cells and wetting as the foam is laid down on the lamination line. All of these attributes will enhance the physical properties and yield better process latitude. Air Products and Chemicals has developed new surfactants specifically designed for use in hydrocarbon-blown rigid foam systems. These new surfactants provide better compatibility of hydrocarbon blowing agents with polyols through improved emulsification yielding improved k-factor. The development of these new surfactants, some of which are available commercially and others which are at the

experimental stage, is discussed. Details are also given of the company's global development programme for alternative blowing agents and production experience from the European lamination market. 4 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; USA; WESTERN EUROPE

*Accession no.755688*

*Item 65*

Polyurethanes Expo '99. Conference proceedings. Orlando, Fl., 12th-15th Sept.1999, p.237-45

**SPRAY FOAM BEYOND HCFC-141B**

Feighan J; Stewart R; Singh S; AbiSaleh A
Huntsman Polyurethanes
(American Plastics Council,Alliance for the Polyurethanes Industry)

Sprayed rigid foam is a significant segment of the PU industry, and as in other rigid foam segments, spray foam formulators need to find ways to meet current product requirements when the use of HCFC-141b is phased out in January 2003. However, due to some of the unique characteristics of the spray foam industry, the choice of a replacement blowing agent is perhaps more complex than in any other rigid foam sector. The alternatives receiving the most consideration today are HFC-245fa, hydrocarbons and water. All of these potential blowing agents have significant hurdles to overcome before they could serve as satisfactory replacements for HCFC-141b in the spray foam market. As of May 1999, a firm commitment to commercialise HFC-245fa has not been made. The use of hydrocarbons in spray would require significant improvements in safe handling procedures and modifications to spray equipment due to flammability issues. And with water-blown systems, dimensional stability and adhesion are two technical hurdles that must be overcome. It is conceded as well that insulation performance will not be as good for a water-blown foam as with HCFC-141b. The objective is to develop zero-ODP technology meeting performance characteristics currently achieved with HCFC-141b spray foam roofing systems. Emphasis is on the development of water-blown technology for roofing systems. Foams are processed via high-pressure spray equipment in a controlled environment. The effects of polyol, catalyst, blowing agent and processing variables on foam quality are examined. 12 refs.

CANADA; USA

*Accession no.755687*

*Item 66*

Polyurethanes Expo '99. Conference proceedings. Orlando, Fl., 12th-15th Sept.1999, p.209-15

**NOVEL POLYOLS FOR ALL WATER-BLOWN AND HCFC-141B BLOWN RIGID POLYURETHANE FOAMS**

Sato H; Suzuki C; Tanaka H; Tsukida N; Takeyasu H
Asahi Glass Co.Ltd.
(American Plastics Council,Alliance for the Polyurethanes Industry)

A series of novel polyols is developed to improve the poor dimensional stability of HCFC-141b and all water blown rigid foams. Use of these novel polyols is claimed to ensure that foam shrinkage dose not occur, even at remarkably low density. 3 refs.

JAPAN

*Accession no.755684*

*Item 67*

Polyurethanes Expo '99. Conference proceedings. Orlando, Fl., 12th-15th Sept.1999, p.193-6

**NEW GENERATION OF MDI-PREPOLYMERS FOR MICROCELLULAR POLYURETHANES**

Madaj E J; Walter K E; Yajko D F; Slack W E
Bayer Corp.
(American Plastics Council,Alliance for the Polyurethanes Industry)

Water-blown PUs have come to dominate the market for polyether-based shoe sole materials due to their ease of handling and properties which, in several respects, approach those of polyesters. Using such technology, it is possible to adopt a polyether-polyester hybrid approach that combines advantages of both types of formulation. Bayer has further expanded the possibilities in water-blown foams by developing a new generation of MDI prepolymers providing even greater formulating and processing latitude. These new prepolymers have several strong points. They are less sensitive to crystallisation than other commercial prepolymers and have inherently low viscosities. Because of this, more freedom exists in formulating them and therefore the range of properties accessible to microcellular foams can be expanded. Storage, handling and processing are also easier. All of this extends the versatility of microcellular foam systems. Results obtained with these new materials are described. The primary application considered is footwear, showing the benefits of this technology in both polyether and polyester formulations. Other areas of microcellular foams are also briefly discussed. 5 refs.

USA

*Accession no.755681*

*Item 68*

Polyurethanes Expo '99. Conference proceedings. Orlando, Fl., 12th-15th Sept.1999, p.171-9

**CATALYSTS AND SURFACTANTS DEVELOPED FOR WATER-BLOWN POLYURETHANE INTEGRAL-SKIN FOAMS USED IN FOOTWEAR APPLICATIONS**

Dimitroff M A
Witco Corp.
(American Plastics Council,Alliance for the Polyurethanes Industry)

Suppliers to the footwear industry are developing new high-performance, lower-density PU systems for use in shoe sole, mid-sole and inner liner applications. To meet new requirements for these systems, new catalysts and surfactants as well as evaluation methods for these new additives are developed and are discussed. Once-common CFC- and HCFC-blown systems have been converted to water-blown systems. Water-blown PU integral-skin systems generally have less surface skin formation and thus have greater difficulty in obtaining surface durability and paintability especially at lower densities. Additives improving surface skin formation and mouldability are key to the development of these new water-blown systems. Most of the systems used today are based on polyester polyols, but new developments have made systems based on polyether polyols competitive. Both these new water-blown systems require new catalyst and surfactant additives that have different requirements than those used in previous systems. The improvements achieved by these new additives, are improved skin formation, increased mouldability reduced density and decreased demould time. Also discussed are the methods and test equipment used to determine skin formation and flowability, including scanning electron microscopy and flow test mould design. 3 refs.

USA

*Accession no.755678*

*Item 69*

Polyurethanes Expo '99. Conference proceedings.
Orlando, Fl., 12th-15th Sept.1999, p.163-8

**UNIQUE POSTECH POLYMER POLYOLS FOR COLD CURE MOULDING AUTOMOTIVE SEATING APPLICATIONS**

Boelens M M H A; Van Eetvelde E
Shell Coordination Centre SA
(American Plastics Council,Alliance for the Polyurethanes Industry)

During recent years there has been a trend in the flexible moulded automotive seating foam market towards the production of high quality, low weight foams. In order to meet this need reactive base polyols and polymer polyols have been developed to be used in TDI chemistry driven technologies. For such systems, Shell Chemicals recently introduced a new type of polymer polyol to the automotive market based on its unique proprietary POSTech technology. The new product, a BHT-lean polymer polyol Caradol MD32-04, allows production of intermediate hardness high resilience foams used in automotive seating applications and also exhibits an interestingly wide processing latitude. With respect to the mechanical foam properties, the use of Caradol MD32-04 offers superior tear strengths, resulting in shorter demould times, as well as excellent foam durability performance, which enhances both the static and dynamic seating comfort. In addition, POSTech polyols display an improved cell opening capacity, while preserving good foam process stability and cure. The processing performance of the newly developed POSTech polyols is described, as are the obtainable foam physical properties. These new developments are positioned within the broad range of moulded PU foam applications. 5 refs.

BELGIUM; EUROPEAN COMMUNITY; EUROPEAN UNION; WESTERN EUROPE

*Accession no.755677*

*Item 70*

Polyurethanes Expo '99. Conference proceedings.
Orlando, Fl., 12th-15th Sept.1999, p.11-7

**ROLE OF HAZARDOUS GAS AND VAPOUR DETECTION IN THE MANUFACTURE OF PENTANE-BLOWN POLYURETHANE FOAM**

Gardner C W
Bacharach Inc.
(American Plastics Council,Alliance for the Polyurethanes Industry)

PU foam production involves the handling and reaction of several potentially hazardous chemicals. While the industry has recognised the hazards associated with the isocyanates used in foam making, it is now becoming faced with a new set of hazards, flammable solvents used as foam-blowing agents. As foam processors begin to replace the more inert fluorocarbon blowing agents with the more environmentally friendly pentanes and cyclopentane, this aspect cannot be ignored. In order to protect workers and facilities, foam manufacturers must consider the use of hazardous vapour detection systems. These systems are available both for isocyanates, which present a health hazard to plant workers, and for flammable vapours, such as pentane, which present a facility hazard. Both types of vapour monitoring systems are described. Operating characteristics are presented as well as guidelines for installation and maintenance. For flammable gas detection systems, the two major sensor types are critically reviewed as to their suitability for use in PU foam manufacturing plants. 5 refs.

USA

*Accession no.755661*

*Item 71*

***Kunststoffe Plast Europe***
89, No.8, Aug.1999, p.35-6
English; German

**THICK SKIN, FLEXIBLE CORE**

Eisen N
Bayer AG

For proper skin formation with flexible integral foam, a physical blowing agent in the suitable boiling range is absolutely essential. In view of the ban on CFCs and the lack of useful HFC alternatives, there are only hydrocarbons available as environmentally friendly blowing agents. In this category, i-hexanes produce foam qualities that are reminiscent of R11 products of the past. (Translated from Kunststoffe p.96-8).

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

*Accession no.753248*

 

*Item 72*
***Journal of Cellular Plastics***
35, No.5, Sept./Oct.1999, p.438-57
**QUANTIFICATION OF PARAMETERS INFLUENCING THE LONG-TERM DIMENSIONAL STABILITY PERFORMANCE OF PENTANE BLOWN LAMINATES**
Baes M; Galina C; Vanlandschoot K
Shell Chemicals

A series of pentane-blown laminates based on different PU formulations and processed on a variety of equipment was evaluated at the most severe condition in the 'dimvac' test. It was found that a set of formulation and processing requirements had to be fulfilled in order to ensure the dimensional stability of the laminates in service. The requirements were different for each formulation, production line and product. A systematic laboratory study was carried out to quantify the influence of polyether polyol composition and type of non-reactive liquid fire retardant. For foams without fire retardant, a clear model was obtained predicting the dimvac performance in terms of foam density and polymer network parameters. For formulations including fire retardants, deviations from the model were observed and differentiation could be made between dilution and plasticisation. 8 refs.

BELGIUM; EUROPEAN COMMUNITY; EUROPEAN UNION; WESTERN EUROPE

*Accession no.750963*

*Item 73*
Patent Number: US 5925612 A 19990720
**AZEOTROPE-LIKE COMPOSITIONS OF 1,1,1,3,3-PENTAFLUOROPROPANE AND 1,1-DICHLORO-1-FLUOROETHANE**
Lund E A E; Parker R C; Shankland I R; Knopeck G M
AlliedSignal Inc.

These are used in the manufacture of PU and polyisocyanurate foams.

USA

*Accession no.744708*

*Item 74*
***Journal of Cellular Plastics***
35, No.4, July/Aug.1999, p.345-64
**NEXT GENERATION BLOWING AGENTS: FROM ONE SINGLE PRODUCT TO A PRODUCT RANGE**
Zipfel L; Barthelemy P; Dournel P
Solvay Fluor & Derivate GmbH; Solvay & Cie.SA

The search for the ideal 'third generation' blowing agent to replace HCFC-141b in rigid PU foams is made difficult by the high number of selection criteria that have to be taken into account. Some criteria are mandated by the environmental considerations, others are imposed by common sense, while many others are dictated by the application itself or economical considerations. Although not as straightforward as once thought, the introduction of HCFC-141b about 5 years ago was still a relatively easy step in comparison to the difficulty faced by the PU industry with the planned phase-out of HCFC-141b. In spite of being probably the best compromise for all main requirements, the use of HCFC-141b has been challenged very quickly, especially in Germany, to such an extent that, today, several different options are used in production facilities in Northern Europe. Solvay has begun to consider blends of single products to extend the range of suitable options based on HFC-365mfc. The main properties of each option have been summarised and examples of applications given. Here, a deeper analysis of these options is presented, taking especially into account the effect of temperature on foam thermal conductivity; due to the difference in boiling points, foam thermal conductivity for two different blowing agents might follow different trends as a function of temperature. This should also be taken into account when selecting a suitable blowing agent for a given foam end-use requirement. 6 refs.

BELGIUM; EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

*Accession no.743534*

*Item 75*
***Journal of Cellular Plastics***
35, No.4, July/Aug.1999, p.328-44
**HFC-365MFC: VERSATILE BLOWING AGENT FOR RIGID POLYURETHANE FOAMS**
Zipfel L; Borner K; Kruecke W; Barthelemy P; Dournel P
Solvay Fluor & Derivate GmbH; Solvay & Cie.SA

The last twelve months have confirmed the development of HFC-365mfc and HFC-245fa as possible future blowing agents in the field of rigid PU foams. There are two important new facts likely to influence the strategy in the development of the HFC blowing agents: growing interest in hydrocarbons in the US, a clear sign that the rigid foam industry is looking for alternatives on a large basis and include the flammable blowing agents within the scope; and mixtures of different blowing agents are being investigated and finding increasing interest in this industry. Another important fact to be taken into account is the decision by Solvay to accelerate the development of HFC-365mfc. The company's latest results concerning the development of HFC-365mfc and an original approach with blends of blowing agents being considered is presented. It is felt that, in the future, custom made blowing agents will be necessary to cope with the technical and economical requirements of different segments of the industry. 9 refs.

BELGIUM; EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

*Accession no.743533*

*Item 76*
***Journal of Cellular Plastics***
35, No.4, July/Aug.1999, p.311-27

**HYDROCARBON BLOWN RIGID POLYURETHANE FOAM FOR THE BOARDSTOCK INDUSTRY - NOVEL APPROACH**

Berrier R E; Singh S N; Costa J S; Bonapersona V
ICI Polyurethanes

Rigid polyisocyanurate (PIR) foams have had continued success as building insulation materials in North America, constituting over 50% of the low-slope roofing insulation market in 1997. This success is due to PIR foam's low density, superior thermal resistivity, good structural properties, excellent fire performance and cost-effectiveness. Such attributes are essential for maintaining a competitive edge over alternative insulation materials. Under the Montreal Protocol, the polyisocyanurate insulation industry will be forced to phase out HCFC-141b as a blowing agent. Currently two classes of zero ozone depletion potential blowing agents are being investigated as replacements: hydrocarbons and hydrofluorocarbons (HFCs). Uncertainty about the cost and availability of HFCs led to the focus on pentanes in this study. The hydrocarbon blowing agents are examined, specifically cyclo-, iso- and normal pentane, and the impact of these materials on the aforementioned attributes of polyisocyanurate foam insulation, particularly fire performance and thermal conductivity. The inherent flammability and higher vapour phase thermal conductivity of these materials compared to HCFC-141b increase the challenge of maintaining the performance of PIR foams in these two areas. The challenge to the boardstock industry remains to develop a pentane-blown polyisocyanurate foam that retains the historic competitive advantages of polyisocyanurate foams, most importantly superior thermal resistivity and good fire performance. Novel methods to reduce k-factor and improve fire performance must be identified. An attempt is made to identify some of these methods. 8 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; ITALY; USA; WESTERN EUROPE

*Accession no.743532*

*Item 77*

Patent Number: US 5889068 A 19990330

**WATER BLOWN POLYURETHANE SOLING SYSTEMS**

Madaj E J; Slack W E
Bayer Corp.

This invention relates to moulded articles comprising microcellular polyurethane foams, preferably integral skin foams. These exhibit improved properties and are particularly suitable for soling systems in footwear. The present invention also relates to a process for the production of these moulded articles. These moulded articles comprise the reaction product of (A) an isocyanate comprising a stable, liquid MDI based prepolymer containing an allophanate-modified MDI, with (B) an isocyanate reactive component, in the presence of (C) at least one blowing agent.

USA

*Accession no.740461*

*Item 78*

Patent Number: US 5889067 A 19990330

**OPEN CELL RIGID POLYURETHANE FOAM AND METHOD FOR PRODUCING THE SAME AND METHOD FOR MAKING VACUUM INSULATION PANEL USING SAME**

Mi-seon Jang; Jin-tack Hwang; Seung-joo Seo
Samsung Electronics Co.Ltd.

Disclosed is a method for producing an open cell rigid polyurethane foam which comprises reacting the mixture of a polyol for producing rigid polyurethane foam, a volatile blowing agent which is free from environmental pollution and selected from the group consisting of hydrocarbons, hydrofluoroalkanes and perfluoroalkanes or a mixture of the volatile blowing agent with water, a monohydric fatty alcohol having good solubility to hydrocarbon as a cell in the presence of an isocyanate trimer catalyst and an organic isocyanate. The resultant open cell rigid polyurethane foam has a cell size of about less than 95 microns, and is suitable for use, for example, as a core material in a vacuum heat insulating material. The foam may be enclosed in a container under vacuum of 0.1-0.01 torr and has a thermal conductivity of 0.0045-0.0050 kcal/mhr deg C.

KOREA

*Accession no.740460*

*Item 79*

***Journal of Cellular Plastics***
35, No.3, May/June 1999, p.247-71

**MODELING OF DIFFUSION IN CLOSED CELL POLYMERIC FOAMS**

Alsoy S
Pennsylvania,State University

The most popular of the models describing diffusion in foams are reviewed and effective diffusivities predicted from one model are compared with experimental data. An unsteady state model is then proposed and solved numerically using a finite difference scheme. The numerical solution algorithm is developed for efficient solution of the large number of coupled equations resulting from the model. The uptake curves predicted from both the unsteady-state model and a discrete model are compared with available experimental data for the PS-nitrogen system. From the analysis of uptake curves generated for different numbers of cells, the effective diffusivity of the PS/nitrogen system is predicted. The effect of initial cell gas composition and cell size on both the long-term ageing profile and dimensional stability of PU foam is considered. The proposed model can easily

 

be extended to include the influence of blowing agent concentration on diffusivity in the polymer phase and the isotherm describing the distribution of blowing agent between the gas and polymer phases. 32 refs.

USA

*Accession no.739063*

*Item 80*

Catalysts and Surfactants in Polyurethane Foams. Conference proceedings.
Shawbury, 20th May 1999, paper 5.

**STUDY ON NEW FR SILICONE STABILISER FOR LIQUID CO2 TECHNOLOGY**

Melle A; Desnier M-C
Witco Organosilicones Group
(Rapra Technology Ltd.)

Since the implementation of the Montreal Protocol and the Clean Air Act Amendment of 1990, the PU industry has sought ways to reduce or eliminate auxiliary blowing agents (ABAs) from foam manufacturing processes. Many possible solutions have been explored, both mechanical and chemical, with no simple cost-effective solution for total elimination. Alternative blowing agents have been explored for many years, including HCFCs, acetone and most recently carbon dioxide. Although these materials are reasonable options, carbon dioxide has shown the most promise because it is safe to use and also inexpensive. CO2 is a non-hazardous chemical which can be incorporated in the system and used to blow the foam down to low densities. There are three machine manufacturers with commercial equipment to produce flexible foam using auxiliary CO2 as a blowing agent: Cannon CarDio, Hennecke NovaFlex and Beamech CO-2 machines. With their introduction it is clear that this is a viable, inexpensive method to reduce and/or eliminate regulated blowing agents. Since these are new manufacturing processes, chemical manufacturers are diligently working with the technologies to identify the best raw materials for trouble-free processing and optimum foam quality. The mechanical and chemical differences between conventional and the Co2-based foaming processes indicate that the role of the silicone stabiliser is process dependent. Laboratory froth and foam experiments are conducted to evaluate and predict which silicone stabilisers are the most viable for this new foaming process. 2 refs.

SWITZERLAND; WESTERN EUROPE

*Accession no.734814*

*Item 81*

Utech Asia '99. Conference proceedings.
Singapore, 16th-18th March 1999, Environment Paper 2. 43C6

**THE MULTILATERAL FUND FOR THE IMPLEMENTATION OF THE MONTREAL PROTOCOL**

Veenendaal B
Rappa Inc.
(Crain Communications Ltd.)

The detrimental effect of certain chemical substances on the ozone layer, and the commitment of 156 countries united under the Montreal Protocol to phase-out the use of these chemicals, are well known. In the PU industry, this mainly concerns CFC-11 and, to a lesser extent, CFC-12, CFC-113, methyl-chloroform and halons. There are organisations, such as the Multilateral Fund and the Global Environmental Facility, that provide technical and financial support to those countries that have difficulties to meet their obligations under the Montreal Protocol. To do so, an organisational structure to implement the necessary activities, financial means and technical expertise are required. The implementing structure is provided by international organisations, called implementing agencies. The required technical know-how to prepare and to implement the programme is provided by technical experts that are contracted by the support agencies. The role and the activities of the technical expert are highlighted.

USA

*Accession no.729020*

*Item 82*

Utech Asia '99. Conference proceedings.
Singapore, 16th-18th March 1999, Automotive Paper 8. 43C6

**OPTIMISATION OF FLEXIBLE FOAMS FORMULATION WITH GASEOUS CO2 AS AN ALTERNATIVE BLOWING AGENT**

Occhiello E; Fedeli L; Grillot D
EniChem Milan; EniChem Cardano al Campo; EniChem Polyurethane France
(Crain Communications Ltd.)

A new technology for preparing flexible foams by moulding, based on added CO2 introduced in the formulation by an innovative technique, is examined. New formulations based on MDI blends, modified TDI/MDI blends and TDI are developed and optimised. Cushions for automotive and furniture application and carpet backings are produced. Potential for weight reduction up to 20% is demonstrated. Even at the lowest densities, it is possible to obtain, by appropriate formulation technology, the retention of static properties, such as load bearing characteristics and even improvements in compression set and dynamic properties.

EUROPEAN COMMUNITY; EUROPEAN UNION; FRANCE; ITALY; WESTERN EUROPE

*Accession no.729011*

*Item 83*

Patent Number: US 5866029 A 19990202

**AZEOTROPE-LIKE COMPOSITIONS OF 1,1,1,3,3-PENTAFLUOROPROPANE AND PENTANE**

Lund E A E; Parker R C; Shankland I R
AlliedSignal Inc.

Azeotrope-like compositions of 1,1,1,3,3-pentafluoropropane and at least one hydrocarbon selected from the group n-pentane, iso-pentane, cyclopentane, n-hexane and iso-hexane are provided. The compositions of the invention are useful in the preparation of polyurethane and polyisocyanurate foams.

USA

*Accession no.728969*

*Item 84*
Patent Number: US 5854296 A 19981229
**AZEOTROPE-LIKE COMPOSITIONS OF 1,1,1,3,3-PENTAFLUOROPROPANE AND TETRAMETHYLSILANE**
Werner J; Kane S A; Mortimer C E; Doerge H P; Boonstra E F
Bayer Corp.

These compositions containing from about 60 to 78 wt.% of the pentafluoropropane and from about 22 to 40 wt.% of tetramethylsilane are useful as blowing agents for the manufacture of PU foams.

USA

*Accession no.724974*

*Item 85*
***Urethanes Technology***
15, No.6, Dec.1998/Jan.1999, p.19
**MC RESTRICTED BY EPA**
Moore M

A new US EPA air pollution ruling will drastically restrict the flexible PU foam industry's use of the auxiliary blowing agent methylene chloride. Methylene chloride has been identified as 98% of the flexible PU foam industry's toxic emissions, and foam facilities have until 7 October 2001 to comply with the new standards. Under a rule from the OSHA, PU foam makers must reduce methylene chloride emissions in the workplace to 25ppm by 10 October 1999.

ENVIRONMENTAL PROTECTION AGENCY
USA

*Accession no.709464*

*Item 86*
Polyurethanes Expo '98. Conference proceedings.
Dallas, Tx., 17th-20th Sept.1998, p.417-31. 43C6
**AUTOMOTIVE SEATING FOAMS: IMPROVING THEIR COMFORT AND DURABILITY PERFORMANCE**
Casati F M; Broos R; Phan Thanh H; Herrington R M; Miyazaki Y; Cadolle D
Dow Europe SA; Dow Benelux NV; Dow Chemical Co.; Dow Polyurethanes Japan Ltd.
(SPI,Polyurethane Div.)

Technology for improving the comfort and durability performance of flexible moulded PU foams is one of the key needs of the global automotive seating industry. To meet the wide range of performance targets required by seat designers and assemblers, foam producers utilise four basic foam chemistries in production scenarios that vary widely in regards to dispensing equipment, moulds and overall processing conditions. New data assessing the relative influence of formulation and processing variables on the performance of foam pads moulded from each of the major chemistries are presented. Specific data demonstrating how comfort and durability parameters vary with choice and level of polyol, copolymer polyol, isocyanate and other chemicals components are given. Additional new data show the importance of optimising foam openness and cell structure. The impact of changes in common processing variables such as component stream temperatures and mixing is demonstrated. Comparative results obtained from industry standard tests are presented. Results recorded during accelerated dynamic fatigue testing under varying temperature and humidity conditions are presented to illustrate the utility of such studies in predicting foam comfort and durability performance with extended use. 43 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; JAPAN; NETHERLANDS; SWITZERLAND; USA; WESTERN EUROPE

*Accession no.708730*

*Item 87*
Polyurethanes Expo '98. Conference proceedings.
Dallas, Tx., 17th-20th Sept.1998, p.407-16. 43C6
**LOW DENSITY MDI-BASED HR SEAT CUSHION HAVING EXCELLENT DURABILITY**
Kasuga T; Hayashi M; Saiki K; Satou T
Nippon Polyurethane Industry Co.Ltd.
(SPI,Polyurethane Div.)

Many companies have made efforts in increasing the rebound properties in response to great demands for car seat comfort in Japan. Improvement in durability is becoming a key issue, and in particular dynamic fatigue properties. Several techniques such as dynamic creep test, long term vibration characterisation and repeated compression test with different load under various atmospheric conditions have been used to characterise foam performance. In addition, thermal measurement techniques and the spectroscopic measurement are carried out to understand morphology. Various foams with different cell structure are employed for these investigations as it is well known that the foam cell structure is also important factor for durability and comfort. Nippon Polyurethane has developed a high-performance isocyanate based on MDI technology for all-water blown HR foams which could satisfy the high durability and low density requirements for car seat cushion applications. 14 refs.

JAPAN

*Accession no.708729*

*Item 88*
Polyurethanes Expo '98. Conference proceedings.
Dallas, Tx., 17th-20th Sept.1998, p.401-6. 43C6
**WEIGHT REDUCTION TECHNOLOGIES FOR MOULDED POLYURETHANE PARTS**
Neuray M P; Fries K W
Bayer Corp.; Hennecke GmbH
(SPI,Polyurethane Div.)

The reduction of final part weight, and in effect part cost, is a continuing objective in a variety of PU markets, primarily the automotive sector. Two recently-introduced technologies from Hennecke now provide PU foam moulders the opportunity to reduce moulded foam densities by up to 20%. Trade named NovaForm and VakuForm, these two innovative processes utilise two distinct methodologies for providing similar resultant density reductions. The similarities and differences between the two processes are described. NovaForm, which incorporates the use of liquid carbon dioxide as a blowing agent, can be deployed in large complicated part applications, and can achieve densities as low as 35 kg/m3. Two NovaForm variations, in-line metering and batch processing, are explained. VakuForm uses physical means instead of chemical to also reduce foam densities, by reducing the in-mould pressure under which the part is moulded. The mould is thus a small vacuum chamber. Physical properties and part economics for NovaForm, VakuForm and control parts are contrasted. Comparative electron micrographs depicting a typical NovaForm cell structure versus a typical VakuForm cell structure are provided. Finally, the equipment required to incorporate each of the technologies in a production scenario is described. 2 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; USA; WESTERN EUROPE

*Accession no.708728*

*Item 89*
Polyurethanes Expo '98. Conference proceedings.
Dallas, Tx., 17th-20th Sept.1998, p.367-71. 43C6
**NEW INNOVATIVE MANUFACTURING OF REFRIGERATOR CABINETS WITH CFC-FREE POLYURETHANES**
Hanne D R; Pieper K H
Bayer Corp.; Hennecke GmbH
(SPI,Polyurethane Div.)

Conventional foaming operations for refrigerator cabinets have traditionally consisted of stationary foaming fixtures with dedicated equipment, such as fixtures, ovens, conveyors and mixheads. Unfortunately, as the future continues to force drastic changes, these conventional systems can not adapt to change without major capital investments, which results in a late entry of product into the market place. Hennecke's CycloFlex and LinFlex systems were developed to address the ever-changing demands of appliance manufacturers. These factors include safety, environmental regulations, flexible equipment, shorter return-on-investment periods and minimum capital investments for future upgrades. As part of the global commitment to safety and environmental issues, Bayer, Hennecke and Hennecke Machinery have developed equipment with features that allow the use of pentane as a blowing agent. The equipment and unique safety features are described.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; USA; WESTERN EUROPE

*Accession no.708717*

*Item 90*
Polyurethanes Expo '98. Conference proceedings.
Dallas, Tx., 17th-20th Sept.1998, p.359-66. 43C6
**RECENT DEVELOPMENTS IN THE OPEN CELL FOAMS-FILLED VACUUM INSULATED PANELS FOR APPLIANCES APPLICATIONS**
Manini P
SAES Getters SpA
(SPI,Polyurethane Div.)

PU foam is the preferred insulator material in a wide range of appliances such as refrigerators and freezers. The recent phase out of CFC-11 has, however, decreased its insulation performances due to the need to adopt environmentally more benign blowing agents, such as HCFC and hydrocarbons, all having higher gas thermal conductivity. This represents a serious drawback since specific regulations to reduce the energy consumption in refrigerators have been issued in recent years and even more demanding reductions are under debate and expected to be applied worldwide by the turn of the century. In response to these requirements, Vacuum Insulated Panels (VIPs) technology has been studied and developed. Suitable components, filler, bag and a getter to maintain the necessary vacuum, have to be selected to ensure the high insulation properties which can be exhibited by VIPs. Among various core materials for VIPs, open cell foams present specific advantages in term of performances, weight, processability and cost. The recent developments in the VIP technology are reviewed and discussed focusing the attention on open-celled PU. The various gas sources deteriorating the vacuum during the panel life are experimentally determined and evaluated by means of outgassing, permeation and gas analysis measurements on VIP components and finished devices. A suitable getter system able to cope with the gas load and to ensure vacuum performances and reliability is also described. 15 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; ITALY; WESTERN EUROPE

*Accession no.708716*

*Item 91*
Polyurethanes Expo '98. Conference proceedings.
Dallas, Tx., 17th-20th Sept.1998, p.351-6. 43C6
**EFFECTS OF PROCESSING VARIABLES ON A POLYURETHANE FOAM SYSTEM BLOWN WITH HFC 245FA**

Boze C D; Elsken K J
Whirlpool Corp.; Bayer Corp.
(SPI,Polyurethane Div.)

Various scientific studies have indicated a relationship between emissions of chlorine containing halocarbons and the depletion of atmospheric ozone. The Montreal Protocol was the bellwether international agreement to limit, and eventually stop, the emissions of these ozone-depleting materials. Since that time, efforts have been underway to develop alternative blowing agents. Second generation blowing agent alternatives, such as HCFC 141b and HCFC 22, reduced the rate of chlorine emissions but did not eliminate them. Many third generation blowing agents have been proposed, but at this time one of the leading candidates is HFC 245fa. Initial work with HFC 245fa has shown that it offers insulation performance similar to earlier foams blown with CFC 11 and HCFC 141b. The relationship between various processing variables and key physical properties of an experimental PU foam system blown with HFC 245fa is studied in two phases. The first phase involves studying the variables in a laboratory environment, using methods that are commonly employed to study and screen PU foam systems. Experimental design methods are employed both to define the experiment and analyse the results. The second phase involves foaming actual refrigerator cabinets. The cabinets are tested to see if the relationships discovered in the laboratory apply to refrigerator cabinet foaming. 3 refs.

USA

*Accession no.708715*

*Item 92*
Polyurethanes Expo '98. Conference proceedings.
Dallas, Tx., 17th-20th Sept.1998, p.343-50. 43C6
**COMPARISON OF TECHNOLOGY AND NEW DEVELOPMENTS WITH HYDROCARBON BLOWN RIGID FOAMS SHOWS A CLEAR TENDENCY TO CYCLOPENTANE/ HYDROCARBON BLENDS**
Altoe P; Dean G H; Parenti V; Clavel P
Dow Europe SA
(SPI,Polyurethane Div.)

Rigid foams blown with hydrocarbons have shown great progress since this technology was implemented in 1992 in Europe, and has culminated, last year, in the introduction of blends of hydrocarbons and more particularly cyclopentane/isobutane. Also recently, other blends have found favour where the more complicated handling of butane may present some difficulties. In the hydrocarbon family, cyclopentane is the best option in terms of gas k-factor but its high boiling point requires higher density and shot weights in cabinets to guarantee long term dimensional stability. The best cost option is provided by the iso-/n-pentane blend. However, the foams produced show an inferior k-factor, although final energy consumption is not affected to the same degree. In general, the addition of another co-blowing hydrocarbon such as isobutane or isopentane to c-pentane negatively affects the insulation performance of the foam, but recent PU system developments have allowed the retention of k-factor values to that of pure cyclopentane blown foams. An attempt is made to compare the different hydrocarbon blowing agent alternatives, including theoretical cell gas modelling, creep performance and compressive strength ageing tests. These methods are used to evaluate and predict, during the foam development phase, the short and long-term dimensional stability of the foam. An attempt is made to understand if the combination of all them is necessary for getting reliable information. Results from cabinets injected with these cyclopentane based hydrocarbon blends confirm the initial findings and are discussed. Data required to select the optimum technology are presented. 7 refs.

SWITZERLAND; WESTERN EUROPE

*Accession no.708714*

*Item 93*
Polyurethanes Expo '98. Conference proceedings.
Dallas, Tx., 17th-20th Sept.1998, p.329-35. 43C6
**FUTURE ENERGY STANDARDS IN EUROPEAN APPLIANCES: WILL THE POLYURETHANE FOAM BASED ON NOVEL HFC BLOWING AGENTS CONTRIBUTE TO THE SOLUTION?**
Tomlinson D; Stanley C; Cappella A; Magnani F; Biesmans G
Hotpoint Ltd.; ICI Polyurethanes
(SPI,Polyurethane Div.)

In order to address the challenges of the CFC phase-out programme, the European appliances industry implemented at a very early stage of the programme zero ODP options including HFC 134a and hydrocarbon technology. These options have resulted in a loss of insulation performance of the cabinets in comparison to the former technologies. With the upcoming legislation regarding the energy standards for appliances in Europe in 1999 and 2002, several research programmes are investigating possible options to improve the energy performance of cabinets. A possible technological solution contributing to meet the energy standards is the use of HFC 245fa, a zero ODP blowing agent option, which has been investigated by a number of appliances manufacturers in Europe. The outcome of one such evaluation programme is reported together with how the performance found might play a role in meeting future legislative energy requirements. In addition, the results report on the predicted long-term performance of the foam based upon this blowing agent via modelling and experimental evidence. This data is of importance when making a full environmental impact evaluation of this technology option. 4 refs.

USA

*Accession no.708712*

*Item 94*
Polyurethanes Expo '98. Conference proceedings.
Dallas, Tx., 17th-20th Sept.1998, p.313-8. 43C6
**EXPERIMENTAL DETERMINATION OF THE VAPOUR PHASE THERMAL CONDUCTIVITY OF BLOWING AGENTS FOR POLYURETHANE RIGID FOAM**
Heinemann T; Klaen W; Yourd R; Dohrn R
Bayer AG
(SPI,Polyurethane Div.)

Blowing agents are mainly responsible for the insulation properties of PU rigid foams. Detailed knowledge about the vapour conductivity of blowing agents and their mixtures is essential for their basic understanding. In addition to their insulation properties, blowing agents to a large extent determine the mechanical properties of the foam. Today, blowing agent mixtures are often used in an attempt to combine both worlds - low thermal conductivity and high vapour pressure at low temperatures. These investigations aim at a better understanding of the relevant practical properties of blowing agents and their mixtures, and to focus on their meaning for actual and potential foam systems of interest to the rigid foam insulation market. A newly developed transient hot wire method is used to determine the vapour phase thermal conductivity of various blowing agents used in rigid PU foam. Data for CFC-11, HCFC-141b, HFC-365mfc, HFC-356mffm, HFC-245fa, HFC-245ca, cyclopentane, isopentane, n-pentane, isobutane, n-butane and carbon dioxide are generated. In addition to the measurements of the pure compounds, current market mixtures of cyclopentane with low boiling hydrocarbons are investigated. Experiments are performed at pressures between 0.2 MPa and 1.5 MPa and temperatures between 298 and 421 deg.K. 15 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

*Accession no.708710*

*Item 95*
Polyurethanes Expo '98. Conference proceedings.
Dallas, Tx., 17th-20th Sept.1998, p.137-43. 43C6
**INFLUENCE OF SILICONE SURFACTANTS ON FROTHING USING DISSOLVED CARBON DIOXIDE**
Dounis D V; Hilker B L
Witco Corp.
(SPI,Polyurethane Div.)

Since the Montreal Protocol's ban of the use of CFCs, the PU industry has been scrambling for a viable substitute. Liquid carbon dioxide technology appears poised to become the leading candidate for auxiliary blowing agents, at least in flexible slabstock foam. As this new technology poses specific requirements for PU additives, the need has developed for a greater understanding of these additives in this process. Thus, a method has been developed for the evaluation of the frothing characteristics of silicone surfactants using a process involving dissolved carbon dioxide. First, a predetermined amount of carbon dioxide gas is dissolved in a surfactant/polyol non-reactive blend using high pressure. After equilibration, a froth is generated as the mixture flows through a pressure letdown nozzle giving it the same appearance as the froth in liquid carbon dioxide-blown foams. This froth is evaluated by microscopy where the bubble size distribution and bubble stability are measured as a function of time. The bubble stability or decay is observed to follow first-order kinetics from which a decay constant is calculated and compared for different silicone surfactants. The silicone surfactant has a large impact on the decay constant as well as the bubble size distribution. This is attributed to effective adsorption of the surfactant onto a bubble surface influencing stabilisation of the instantaneously nucleated bubbles in liquid carbon dioxide technology foaming. This technique demonstrates the ability to differentiate surfactants for use in this new technology. 16 refs.

USA

*Accession no.708687*

*Item 96*
Polyurethanes Expo '98. Conference proceedings.
Dallas, Tx., 17th-20th Sept.1998, p.129-35. 43C6
**LIQUID CARBON DIOXIDE FOAMING IN FLEXIBLE SLABSTOCK FOAM FOAM PRODUCTION - A CHALLENGE TO BE MET WITH NEW STRUCTURAL BUILDING BLOCKS**
Burkhart G; Langenhagen R; Weier A
Goldschmidt Th.,AG
(SPI,Polyurethane Div.)

The introduction of liquid carbon dioxide foaming into the production of PU foams a few years ago has created a challenge for the industry. New foaming technology has created a demand for processing conditions and ingredients that would meet the challenge of providing the additional nucleation required without sacrificing other important performance aspects. The important role of the surfactant used has been recognised even with the start of this future-shaping technology. To keep other vital performance aspects, these structural patterns have to be combined with the dimethylsiloxane-ether copolymer structure of foam surfactants commonly utilised, which are mainly based on a combination of just three structural units: the methyl-substituted siloxane backbone as well as a sophisticated combination of ethylene oxide and/or propylene oxide forming the attached polyethers. Work carried out in the liquid carbon dioxide field and the resulting structure-performance relationships of flexible slabstock PU foam surfactants is described, which also links those structure-performance relationships to different possible applications like FR- or non-FR foams. A number of building blocks is introduced for the novel design of these performance additives. Especially in view of further industrial trends, these novel structural units

should open up the possibility for new foam surfactants with adjusted and improved performance profiles. 6 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

*Accession no.708686*

*Item 97*

Polyurethanes Expo '98. Conference proceedings. Dallas, Tx., 17th-20th Sept.1998, p.79-86. 43C6

**EVALUATION OF THE NEXT GENERATION HFC BLOWING AGENTS IN RIGID POLYURETHANE FOAMS**

Wu J; Mouton D; Albouy A
Elf Atochem North America Inc.; Elf Atochem SA
(SPI,Polyurethane Div.)

The development of third generation HFC blowing agents has achieved significant progress in the past few years. Several candidates have been identified as promising substitutes for HCFC-141b in foam applications. Elf Atochem has striven to provide alternatives after HCFC-141b phases out in foam applications. The company's recent research activities in HFCs in rigid PU foam applications are summarised, including determinations of the weight loss of blowing agents during the foaming process. To predict long term ageing behaviour of PU foams, diffusion coefficients of HFC-245fa, HFC-365mfc and HCFC-141b are measured. The stability of the foam systems (PUR and PIR) using HFC-365mfc as the blowing agent is also reported. The stability is indicated by the amount of decomposition during a certain period of time. The effects of HFC-245fa foam density on the foam insulation (k-factor), dimensional stability and compressive strength is studied. Aged k-factors of HFC-245fa and HCFC-141b foams with different foam densities are determined. Finally, HFC-134a in PUR foam as well as its solubility in several polyols is investigated. 5 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; FRANCE; USA; WESTERN EUROPE

*Accession no.708672*

*Item 98*

Polyurethanes Expo '98. Conference proceedings. Dallas, Tx., 17th-20th Sept.1998, p.69-78. 43C6

**SELECTION OF SILICONE SURFACTANTS FOR POLYISOCYANURATE FOAMS BLOWN WITH N-PENTANE, CYCLO-PENTANE AND ISO-PENTANE**

Fis J; Mehta K R; Lewis K M; Hilker B L
Witco Europe SA; Witco Corp.
(SPI,Polyurethane Div.)

Growing concerns about ozone depletion and energy conservation initially engendered changes in the blowing agents used to expand rigid polyisocyanurate foams. Now, the mandate that use of HCFC-141b for insulation be discontinued by the end of 2002 is the primary impetus for change in the USA. Hydrocarbon blowing agents are already in use in European boardstock formulations and are under active consideration to replace HCFC-141b in North America and Asia. However, in Europe, the change to hydrocarbon blowing agents is accompanied by the replacement of PU with polyisocyanurate to satisfy foam flammability requirements cost effectively. The new blowing agents and their mixtures necessitate changes in foam raw materials, additives and/or formulations to yield polyisocyanurate foams with properties which meet industry standards and processing conditions. Selection of silicone surfactants affording optimum blowing agent emulsification, foam rheology, foam morphology and physical properties has been one of the challenges in meeting these objectives. The performance of Niax commercial and developmental silicone surfactants in polyisocyanurate formulations blown with n-pentane, cyclopentane and cyclopentane-isopentane blends is reported. 33 refs.

SWITZERLAND; USA; WESTERN EUROPE

*Accession no.708671*

*Item 99*

Polyurethanes Expo '98. Conference proceedings. Dallas, Tx., 17th-20th Sept.1998, p.31-3. 43C6

**UTILISING PENTANE FOR POLYURETHANE BOARDS PROVES TO BE MORE ECONOMIC AND ENVIRONMENTALLY SAFE THAN PREVIOUS BLOWING AGENTS**

Hanne D R; Kaczkowski E F; Polke D; Miller E A
Bayer Corp.; Hennecke GmbH
(SPI,Polyurethane Div.)

For years, pentane has been accepted as the blowing agent substitute for CFCs in many countries except North America - until now. Many issues have delayed North American manufacturers from utilising pentane in producing PU boards. These issues have been economics, chemical properties, safety and ecological effects. Pentane is a future-oriented solution for environment effects as opposed to currently used blowing agents in North America. The other issues (economics, chemical properties and safety) have been part of a continuing commitment by Bayer AG and Bayer Corporation to address and solve. With the continuing success of Bayer's Global Technology Exchange Process, these issues have been resolved and subsequently PU sandwich panels with pentane as the blowing agent will be implemented this year. It is shown in detail how PU boards utilising pentane will be successfully produced in the USA by presenting chemical results, proven technologies, safety features and how the economic and ecological issues were satisfied.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; USA; WESTERN EUROPE

*Accession no.708666*

*Item 100*

Patent Number: US 5731361 A 19980324

**PRODUCTION OF CHLOROFLUOROCARBON-FREE, URETHANE-CONTAINING MOLDINGS HAVING A CELLULAR CORE AND AN INTEGRAL SKIN**
Horn P; Denzinger W; Fuchs H; Bohme R
BASF AG

Chlorofluorocarbon-free, urethane-containing mouldings having a cellular core and an integral skin with an essentially pore-free surface, ie, polyurethane integral foams, are produced by reacting the conventional starting components in the presence of blowing agents, catalysts and at least one additive selected from the group consisting of partially or completely neutralised: (1) homopolymers of monoethylenically unsaturated monocarboxylic acids, dicarboxylic acids or the internal anhydrides thereof; (2) copolymers of, (2i) monoethylenically unsaturated monocarboxylic acids, dicarboxylic acids or the internal anhydrides thereof and (2ii) carboxyl-free, monoethylenically unsaturated monomers copolymerisable with (2i); and (3) copolymers or graft copolymers of (3i) monoethylenically unsaturated monocarboxylic acids and/or their salts, (3ii) monoethylenically unsaturated dicarboxylic acids, their salts and/or their internal anhydrides, and (3iii) if required, carboxyl-free, monoethylenically unsaturated monomers copolymerisable with (3i) and (3ii), in a closed mould with compaction.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

*Accession no.708522*

*Item 101*
Polyurethanes Expo '98. Conference proceedings. Dallas, Tx., 17th-20th Sept.1998, p.683. 43C6
**CANNOXIDE - POLYURETHANE FOAMS MOULDED WITH NATURAL LIQUID CARBON DIOXIDE**
Taverna M
Cannon Group
(SPI,Polyurethane Div.)

Cannon has pioneered the introduction of NLCD (Natural Liquid Carbon Dioxide) in PU slabstock foams with the CarDio process. Following the same basic concepts, Cannon has developed and is now actively marketing CannOxide, the technology required to use NLCD in PU moulding processes for both flexible and rigid foam production. The CannOxide solution opens new possibilities to PU foam moulders. Abstract only.

EUROPEAN COMMUNITY; EUROPEAN UNION; ITALY; WESTERN EUROPE

*Accession no.708467*

*Item 102*
Polyurethanes Expo '98. Conference proceedings. Dallas, Tx., 17th-20th Sept.1998, p.679-81. 43C6
**GASEOUS CO2 METERING AND BLENDING UNIT FOR MOULDED FLEXIBLE FOAM**
Cella I A
Ipianti OMS
(SPI,Polyurethane Div.)

After the Montreal Protocol and subsequent revisions, CO2 has gained interest of PUR foam manufactures because it is an economical and environment friendly auxiliary blowing agent. Now there are two main alternative technologies in using carbon dioxide as an additional blowing agent: CO2 is handled at the liquid state throughout the entire metering and blending process; and CO2 is processed in gaseous form. The OMS best solution for moulded foam, with regard to all different aspects as price/performance ratio, possible material saving, control complexity, requirements for retrofitting of existing equipment, is towards the use of gaseous carbon dioxide. It oversees CO2 metering into isocyanate with a pre-mixing device. The most important process characteristic is to ensure that CO2 is added within the component as dissolved gas. The pre-mixing device is generally independent from the high pressure foaming machine. The mixture is prepared independently from the functioning of the foaming machine and then, upon loading request, is transferred to the machine tank. Details of the OMS pre-mixing system are given.

EUROPEAN COMMUNITY; EUROPEAN UNION; ITALY; WESTERN EUROPE

*Accession no.708466*

*Item 103*
Polyurethanes Expo '98. Conference proceedings. Dallas, Tx., 17th-20th Sept.1998, p.677. 43C6
**PROCESSING MACHINERY TO ALLOW UTILISATION OF LIQUID CARBON DIOXIDE AS A BLOWING AGENT IN FLEXIBLE FOAM SYSTEMS**
Lehnert A
Gusmer-Admiral Inc.
(SPI,Polyurethane Div.)

The reaction between water and isocyanate produces carbon dioxide, which for years has been used as a blowing agent for the manufacture of flexible PU foams. This technique requires the use of excess isocyanate in the formulation and produces a relatively hard urea linkage as a product of the reaction. Both cost reduction and foam performance enhancement can be achieved by introducing carbon dioxide blowing agent into the reacting mixture as a liquid component, rather than depending on the in situ manufacture of the gas. Gusmer-Admiral's unique process introduces a stream of liquid CO2 directly into the mixhead, rather than pre-blending with a polyol prior to introduction into the mixing chamber. This technique allows a moulder to start and stop injections, of short duration, without altering CO2 concentration in the reacting mixture and without recirculating CO2 back to the machine day tank. Brief details are noted.

USA

*Accession no.708465*

*Item 104*
Polyurethanes Expo '98. Conference proceedings.
Dallas, Tx., 17th-20th Sept.1998, p.663-4. 43C6
**FUNDAMENTAL STUDY OF FLUORINATED ETHERS AS NEW GENERATION BLOWING AGENTS**
Takada N; Tamia R; Amamoto Y; Sekiya A; Tsukida N; Takeyasu H
RITE; NIMC; Asahi Glass Co.Ltd.
(SPI,Polyurethane Div.)

The development of blowing agents exhibiting lower thermal conductivity, shorter atmospheric lifetime and less adverse effects on the atmosphere is urgent. Three fluorinated ethers blowing agent alternatives (2,2,2-trifluoroethyl difluoromethyl ether (HFE-254mf), 2,2,3,3,3-pentafluoropropyl difluoromethyl ether (HFE-347mcf) and 1,1,2,2-tetrafluoroethyl-2,2,2-trifluoroethyl ether (HFE-347pc-f)) in terms of physical properties (boiling point and gaseous thermal conductivity), environmental adaptability (atmospheric lifetime), toxicity, flammability, solubility in polyols and thermal stability. Using fluorinated ethers as blowing agents, rigid PU foams are experimentally produced showing thermal conductivities lower than or equal to foams produced with the blowing agent alternative candidates, HFC-245fa and cyclopentane. Extended abstract only.

JAPAN

*Accession no.708459*

*Item 105*
Polyurethanes Expo '98. Conference proceedings.
Dallas, Tx., 17th-20th Sept.1998, p.477-82. 43C6
**NEW CONCEPT POLYOLS FOR AUTOMOTIVE SEATING WITH WIDE VARIETY OF BALL REBOUND AND HIGH DURABILITY AT LOWER DENSITY**
Tsuji T; Akiyama H; Kaku M; Yoshio K
Sanyo Chemical Industries Ltd.
(SPI,Polyurethane Div.)

Improving automotive seating durability in the wide range of ball rebound at lower density is becoming a key target for PU foam systems. This is an important factor contributing to vehicle ride comfort especially for the full foam design. As low density foam systems are becoming important in automotive seating, so is the introduction of new concept polyols for low density foam systems to improve durability and to reduce cost. Control of both durability and ball rebound at low density automotive seating is possible with Sanyo Chemical's new Sanyo HR polyol system. Details are given. 3 refs.

JAPAN

*Accession no.708418*

*Item 106*
Polyurethanes Expo '98. Conference proceedings.
Dallas, Tx., 17th-20th Sept.1998, p.445-61. 43C6
**DIMENSIONAL STABILISING ADDITIVES FOR FLEXIBLE POLYURETHANE FOAMS**
Tobias J D; Andrew G D
Air Products & Chemicals Inc.
(SPI,Polyurethane Div.)

Recent work by Air Products & Chemicals to produce additives for flexible PU foam that provide dimensional stability, as measured by overall shrinkage and reduction of Force-to-Crush (FTC) values, is described. The results show that these new additives, recently developed by the company can dramatically afford dimensional stability and processability when used in conjunction with traditional gelling catalysts such as Dabco 33LV. Additionally, improvements to the physical properties of the PU article when using the new additives, are discussed. 5 refs.

USA

*Accession no.708415*

*Item 107*
***Journal of Cellular Plastics***
34, No.6, Nov./Dec.1998, p.511-25
**HFC-365MFC AND HFC-245FA PROGRESS IN APPLICATION OF NEW HFC BLOWING AGENTS**
Zipfel L; Kruecke W; Borner K; Barthelemy P; Dournel P
Solvay Fluor & Derivate GmbH; Solvay Research & Technology

Solvay is committed to supplying zero ODP blowing agents for plastic foams as substitutes for the currently used HCFCs. In the field of rigid PU foams in particular, it is Solvay's policy to evaluate in parallel HFC-365mfc (CF3-CH2-CF2-CH3) and HFC-245fa (CF3-CH2-CHF2). Among all the existing regulations dealing with the phase-out of HCFC-141b, the earliest phase-out date is set in the USA as January 2003. A liquid HFC blowing agent must be available in line with the phase-out schedule of HCFC-141b, as there is a need for high performance rigid PU foams to cope with stringent energy standards, especially in the field of refrigerators, panels for construction, cold stores, containers, laminates etc. The foam industry needs the remaining time before the phase-out of HCFC-141b, to fully optimise the formulations and to check the long term performance of the foams. The promising results reported indicate that both HFCs under consideration in some cases have a behaviour similar to CFC-11 and definitely improved behaviour compared with HCFC-141b, or hydrocarbons. The thermal conductivity is found to be in the same range as HCFC-141b, a decisive advantage against all competing alternatives and an important factor in reducing TEWI and hence global warming. Solvay plans to start up production of small commercial quantities of either HFC-245fa or HFC-365 mfc around 2000, leading to full commercialisation before the year 2003. A liquid HFC

will therefore be available in time for the planned HCFC-141b phase-out in the USA in January 2003. 8 refs.

BELGIUM; EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

*Accession no.704290*

*Item 108*

***European Polymer Journal***

34, No.9, Sept.1998, p.1233-41

**FORMIC ACID AS A CO-BLOWING AGENT IN RIGID POLYURETHANE FOAMS**

Modesti M; Baldoin N; Simioni F

Padova,Universita

The possibility of using formic acid as a chemical blowing agent for manufacturing rigid thermally-insulating PU foams was investigated. In comparison with water, use of formic acid resulted in a higher expansion efficiency and improved foam morphology (lower cell sizes). This indicated a better initial thermal conductivity and ageing very similar to that of water-blown foams. Formic acid significantly improved mechanical performance of the foams when used in combination with HCFC 141b and also increased thermal stability. Disadvantages of using formic acid are considered. 14 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; ITALY; WESTERN EUROPE

*Accession no.695441*

*Item 109*

Patent Number: US 5723509 A 19980303

**AZEOTROPE-LIKE COMPOSITIONS OF DIMETHOXYMETHANE, CYCLOPENTANE AND 2-METHYL PENTANE AND THE USE THEREOF IN THE PRODUCTION OF FOAMS**

Werner J; Kane S A; Doerge H P; Boonstra E F; Mortimer C E

Bayer Corp.

These compositions, which consist of from about 68.1 to 69.1 wt.% of dimethoxymethane, from about 29.7 to 30.7 wt.% of cyclopentane and from about 0.7 to 1.7 wt.% of 2-methyl pentane, are used as blowing agents in the production of PU foams.

USA

*Accession no.688244*

*Item 110*

Patent Number: EP 755968 A2 19970129

**PROCESS FOR PRODUCING HARD FOAM ON BASIS OF ISOCYANATE**

Seifert H; Hempel R; Knorr G; Rotermund U

BASF AG

A novel blowing agent for rigid polyurethane foam manufacture from polyisocyanates and optionally also chain extenders and/or crosslinkers is disclosed. The blowing agent is a mixture of (i) a low boiling 3-7 C hydrocarbon; and (ii) a low molecular weight, monofunctional, primary or secondary hydroxyl group-containing 1-4 C alcohol. The (i)+(ii) mixture is also claimed per se and can be used in combination with carbon dioxide produced in situ from water and the isocyanate.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

*Accession no.687698*

*Item 111*

Patent Number: US 5700843 A 19971223

**1,1,1,2-TETRAFLUOROETHANE AS A BLOWING AGENT IN INTEGRAL SKIN POLYURETHANE SHOE SOLES**

Valoppi V L

BASF Corp.

It has been found that 1,1,1,2-tetrafluoroethane (HFC-134a) may be used alone or in combination with water as blowing agents in flexible integral skin foams. Foams prepared using HFC-134a alone or in combination with water exhibit physical characteristics such as resistance to abrasion and cracking on flex comparable to conventional chlorinated fluorocarbon blown foams. The foams of the present invention are suitable for use in shoe sole applications.

USA

*Accession no.687240*

*Item 112*

Patent Number: US 5681501 A 19971028

**COMPOSITIONS INCLUDING A HYDROFLUOROPROPANE**

Minor B H

Du Pont de Nemours E.I.,& Co.

This invention relates to the discovery of compositions which include a first component of tetrafluoropropane, trifluoropropane, difluoropropane or fluoropropane and a second component of tetrafluoropropane, trifluoropropane, difluoromethylpropane, a hydrocarbon or dimethylether. These compositions are useful as refrigerants, cleaning agents, expansion agents for polyolefin and polyurethanes, aerosol propellants, heat transfer media, gaseous dielectrics, fire extinguishing agents, power cycle working fluids, polymerisation media, particulate removal fluids, carrier fluids, buffing abrasive agents, and displacement drying agents.

USA

*Accession no.678072*

*Item 113*

Patent Number: US 5684057 A 19971104

**THREE COMPONENT POLYOL BLEND FOR USE IN INSULATING RIGID POLYURETHANE FOAMS**

White W R; Mullins J A; Lee T B; McLellan K; Wierzbicki R J

BASF Corp.

A polyisocyanate based rigid closed cell foam is provided made by reacting an organic isocyanate with a polyol composition in the presence of a blowing agent, where the polyol composition contains at least: (a) an aromatic amine initiated polyoxyalkylene polyether polyol having an hydroxyl number of 200 meq polyol/g KOH or more; (b) an aliphatic amine initiated polyoxyalkylene polyether polyol having an hydroxyl number of 200 meq polyol/g KOH or more; and (c) an aromatic polyester polyol having an hydroxyl number of 200 meq polyol/g KOH or more. The blowing agent is selected from the group consisting of cyclopentane, HFCs, HCFCs, and mixtures thereof in an amount of 5.0 wt.% or more based on the weight of the polyol composition. Preferably, the blowing agent is soluble in the polyol composition without sacrificing, and advantageously improving, the thermal insulation and dimensional stability of the resulting polyurethane foam. Also disclosed are a storage stable polyol composition and methods for making a polyisocyanate based rigid closed cell foam.

USA

*Accession no.677991*

*Item 114*
Patent Number: US 5688834 A 19971118
**CATALYSTS WHICH STABILISE HYDROHALOCARBON BLOWING AGENT IN POLYURETHANE FOAM FORMULATIONS**
Parker R C; Demmin T R
AlliedSignal Inc.

Disclosed are compositions comprising polyisocyanate, polyol, hydrohalocarbon blowing agent, surfactant and at least one catalyst for the polymerisation of the polyisocyanate and polyol. The catalyst is less volatile than N,N-dimethylcyclohexylamine or is a tertiary amine having at least one isocyanate-reactive functionality, such as hydroxyl or -NH- group, and results in a decreased amount of decomposition of the blowing agent to haloalkene during polymerisation, particularly during the use of foam samples at a temperature of at least about 54C.

USA

*Accession no.677694*

*Item 115*
***High Performance Polymers***
10, No.1, March 1998, p.81-91
**IMPROVEMENT OF THERMAL INSULATION FOR POLYURETHANE FOAM BY CONVERSION OF CARBON DIOXIDE TO ORGANIC CARBONATE COMPOUND**
Hashida T; Ueno T; Nakamoto H; Suzuki M
Matsushita Electric Industrial Co.Ltd.; Matsushita Refrigeration Co.

A new method to improve the thermal insulation of PU rigid foam blown by a non-ozone depleting agent - an alternative to chlorofluorocarbon - is developed. This method involves the reduction of the gas thermal conductivity for PU foam by the conversion of gaseous carbon dioxide in the foam to an organic carbonate. An attempt is made to perform the cyclisation of carbon dioxide in foam with an epoxy compound, and then the reduction of the thermal conductivity of the PU foam is ascertained as carbon dioxide is chemically fixed in the foam. Consequently, this method leads to a reduction of about 10% in the thermal conductivity in comparison with that of the conventional foam including carbon dioxide. In addition, the degree of progress of reaction in the foam is investigated by a quantitative analysis of carbon dioxide, epoxide and the resulting cyclic carbonate in the PU foam. It is observed that unnecessary reactions, which consume epoxide other than for the fixation of carbon dioxide, exists in the process of urethane polymerisation. The main unnecessary reaction is presumed to be a side reaction of epoxide with isocyanate. Furthermore, the unnecessary reactions are affected by the type of urethane catalyst, the selection of which is of importance in this method. 7 refs.

JAPAN

*Accession no.675054*

*Item 116*
Patent Number: US 5661190 A 19970826
**1,1,1,2-TETRAFLUOROETHANE AS A BLOWING AGENT IN INTEGRAL SKIN POLYURETHANE SHOE SOLES**
Valoppi V L
BASF Corp.

This compound (HFC-134a) may be used alone or in combination with water as, a blowing agent, in flexible integral skin foams, which exhibit physical properties, such as resistance to abrasion and cracking on flex comparable to conventional chlorinated fluorocarbon blown foams.

USA

*Accession no.672705*

*Item 117*
***European Plastics News***
25, No.1, Jan.1998, p.27
**IMPROVED CARDIO PROCESS NOW AVAILABLE**

It is briefly reported that liquid carbon dioxide blowing technology is now a well accepted processing method for PUs. Cannon has now launched the new CarDio 2000 machine which incorporates a pressure-adjustable laydown device to cover a wider range of foam outputs and a wider range of blowing agent loading.

CANNON GROUP

 

USA

*Accession no.666374*

*Item 118*
Polyurethanes World Congress '97. Conference proceedings.
Amsterdam, Netherlands, 29th Sept.-1st Oct.1997, p.402-20. 43C6

**TAILORING PERFORMANCE OF MOULDED FLEXIBLE POLYURETHANE FOAMS FOR CAR SEATS**

Casati F M; Broos R; Herrington R M; Miyazaki Y
Dow Europe SA; Dow Benelux NV; Dow Chemical Co.; Dow Mitsubishi Chemical Ltd.
(SPI,Polyurethane Div.; ISOPA)

The car seat is a major element of contact between the occupant, the vehicle and ultimately the road surface. Flexible PU foams are the material of choice for this application, not only because of the economies offered by large-scale operations, but also because the cushioning characteristics of the foam/seat assembly can be adjusted. Commercially useful foams can be made from a variety of PU moulding chemistries. Recent advances in polyol and copolymer polyol technology, together with multiple isocyanate choices and even new foam manufacturing technologies, present the foam producers, seat assemblers and seat designers with a myriad of options. The automotive original equipment manufacturers (OEMs) worldwide are seeking optimisation of the balance between foam weight and foam specifications, with more emphasis than ever on comfort and durability. This goes with specific requirements for the various foam pads. New data are presented showing how the choice of moulding chemistry impacts not only foam processing and physical properties, but also the comfort and durability that can be expected from the final seat assembly. Results from recent studies carried out by Dow Chemical on a global basis, concentrating on static and dynamic fatigue, resilience, vibration damping characteristics and humid ageing, are presented in an effort to provide foam producers and users worldwide with up-to-date information to assist in meeting present and future performance targets. 36 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; JAPAN; NETHERLANDS; SWITZERLAND; USA; WESTERN EUROPE

*Accession no.665124*

*Item 119*
Polyurethanes World Congress '97. Conference proceedings.
Amsterdam, Netherlands, 29th Sept.-1st Oct.1997, p.394-401. 43C6

**NEW TDI-BASED ISOCYANATES: ADVANCES IN FLEXIBLE MOULDED FOAMS FOR AUTOMOTIVE SEATING**

Gronen J; Schmidt M; Raffel B; Wagner J; Koshute M A; Haider K
Bayer AG; Bayer Corp.
(SPI,Polyurethane Div.; ISOPA)

With modern automotive foam seat production constantly being assessed with respect to costs, optimisation is an ongoing process. The business is based on rapid model changes in the automotive industry and just-in-time delivery. Moulded foam production therefore has to be highly flexible and optimised to meet customers' needs. In order to meet these demands, it is essential to significantly reduce foam density without sacrificing hardness, and to ensure good demould characteristics with short demould times. In developing a new family of isocyanates, therefore, attention is focused primarily on reaction kinetics and elastic modulus. The first step is to measure the complex modulus. The reaction kinetics, in the form of the increase in viscosity and modulus, are then calculated according to the recursive cascade theory and verified by experiment. The mechanical properties of moulded parts are then determined. The results confirm the predictions of the kinetics and E-modulus investigations. The results of this work yield a new family of isocyanates, TDI-HP (high performance), produced by a newly developed modification process. With these isocyanates it is possible to create TDI-HR (high resilience) moulded foams with the property profile of MDI-based foams, but with lower densities and improved flow. The most striking feature of the new foams compared with TDI 80 is their greatly increased reactivity, higher intrinsic hardness and dual hardness capability. Compared with TDI 80-based foams, much lower levels of copolymer polyol are required to adjust the hardness of foams based on the new TDI-HP isocyanates. The new family of TDI-HP based systems offers an ideal combination of the benefits of TDI and MDI cold-cure foams. 2 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; USA; WESTERN EUROPE

*Accession no.665123*

*Item 120*
Polyurethanes World Congress '97. Conference proceedings.
Amsterdam, Netherlands, 29th Sept.-1st Oct.1997, p.317-28. 43C6

**THERMAL CONDUCTIVITY OF GAS MIXTURES AS BLOWING AGENTS FOR ISOCYANATE-BASED RIGID FOAMS**

Merten A-K; Rotermund U
BASF Schwarzheide GmbH
(SPI,Polyurethane Div.; ISOPA)

Normally, the closed cells of isocyanate-based rigid foams contain gas mixtures consisting of vapours of physical blowing agents, CO2 and in most cases air from the atmosphere. The thermal conductivity (TC) of these gas mixtures causes the largest heat transfer through foam. The thermal insulation properties of the mixtures are often compared only to the gas TC of the vapours of physical blowing agents. The gas mixture conductivities are

considered to be always calculable by the Wassiljewa equation, and these data are at present adopted by most PU manufacturers. This theory is examined by measurement of gas TC with an adapted gas chromatograph thermal conductivity detector. Measurements are carried out at 40 deg.C on CFC-11, the HCFC-14 lb and -22/-142b mixture, the HFC-134, -236, -245, -365, the HC n-pentane, iso-pentane, cyclopentane, mixtures of CP with perfluorohexane, methylformate, alcohols, isopentane, butane, cyclopropane and HFC-134a, and additionally some pentanes with 3- and 4-rings with CO2, partially air and argon added to 1 bar at 25 deg.C. Due to some unforeseeable deviations, theory cannot substitute measurements for basic knowledge about the TC of gas mixtures used in rigid foams. It is demonstrated that results of gas-TC measurements, combined with gas chromatographic concentration measurements, characterise the thermal insulation and mechanical supporting potential of blowing agent mixtures as substitutes for CFC. 21 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

*Accession no.665115*

*Item 121*

Polyurethanes World Congress ’97. Conference proceedings.
Amsterdam, Netherlands, 29th Sept.-1st Oct.1997, p.308-16. 43C6

**LOWER DENSITY CYCLOPENTANE/BUTANE BLOWN RIGID FOAM: INDUSTRIAL VALIDATION FOR DOMESTIC LARGE APPLIANCE INSULATION**

Parenti V; Dean G H; Clavel P; Selin A; Zancai L; Del Perugia R
Dow Europe SA; Electrolux AB
(SPI,Polyurethane Div.; ISOPA)

Foams blown with cyclopentane now used by appliance producers fulfil the industry requirements in terms of processing and foam properties. Nevertheless, even with these improvements, the total cost disadvantage has not been completely recovered. The inferior mechanical properties derived from the use of cyclopentane necessitate increasing the minimum applied density in order to obtain a stable foam. In 1994, Dow Europe introduced iso-/n-pentane as an alternative hydrocarbon blend for the appliance industry. This proved to be a realistic approach due to the superior processing and economics of the foam produced with this blowing agent. It was successfully implemented, and it is still the most economically attractive solution in hydrocarbon refrigeration. Among the hydrocarbon molecules, some low boiling point substances have been previously identified as potential blowing agents. However their physical properties such as flammability and poor solubility in polyols (resulting in problematic processability) and their negative effect on foam k-factor has delayed their introduction into the market. In 1996, Electrolux indicated its intention to further investigate this direction, selecting butane as a preferred candidate and defined a challenging goal: to significantly reduce the overall density of the foam while maintaining or improving the insulation properties and processing performance. The various steps of the development of this new technology, and the optimisation and industrial validation both carried out in the frame of a joint project involving Electrolux and Dow Europe are presented. 7 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; ITALY; SCANDINAVIA; SWEDEN; SWITZERLAND; WESTERN EUROPE

*Accession no.665114*

*Item 122*

Polyurethanes World Congress ’97. Conference proceedings.
Amsterdam, Netherlands, 29th Sept.-1st Oct.1997, p.287-91. 43C6

**NEW CO2-BLOWN FOAM SYSTEMS FOR INTEGRAL SKIN APPLICATIONS INCLUDING LOW-DENSITY HEADRESTS**

Weber H G; Thiele W; Rasshofer W; Freitag H-A; Nakamura M
Otto-Bock Kunststoffe; Bayer AG; Sumitomo Bayer Urethane Co.Ltd.
(SPI,Polyurethane Div.; ISOPA)

Current integral skin foam part production is dominated by a change from (halogenated) hydrocarbons to carbon dioxide as a blowing agent. In Europe more than 50% of all steering wheels are foamed with carbon dioxide. With new CO2-blown foam systems for integral skin parts, two goals can be reached, which seemed to be irreconcilable until now: short demoulding times and elimination of halogenated hydrocarbons or hydrocarbons themselves. As carbon dioxide blowing agent, neither water (which yields carbon dioxide upon reacting with isocyanate) nor added free carbon dioxide is used. Instead, stable liquid adducts produced from carbon dioxide and appropriate compounds are used. A further advantage is that such systems do not necessarily require the use of monomeric MDI isocyanates; even at very short demoulding times, polymeric MDI types can be employed. Processing, property range and applications of such integral-skin foams are presented. The processing can be broadly adapted to the customer’s local needs, and demoulding times down to 60 sec have already been possible in prototyping. This allows productivity increases in existing productions and reduced investment for new projects. With these new systems all the classic integral-skin applications such as handles, headrests, armrests and steering wheels can be made, as well as air bag covers. Selected industrial applications from large-scale automotive productions are presented. The combination

 

of short demould times and the use of carbon dioxide as a blowing agent is of relevance for the continued growth of this PU application field. 2 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; JAPAN; WESTERN EUROPE

*Accession no.665111*

*Item 123*
Polyurethanes World Congress '97. Conference proceedings.
Amsterdam, Netherlands, 29th Sept.-1st Oct.1997, p.265-71. 43C6

**ADVANCES IN POLYURETHANE SEMI-RIGID INTEGRAL SKIN TECHNOLOGIES FOR AUTOMOTIVE INDUSTRY**

Guidetti G; Pellacani L
Dow Italia SpA; Dow Benelux NV
(SPI,Polyurethane Div.; ISOPA)

Integral skin semi-rigid PU mouldings are widely used in the automotive and furniture industries because of their well known excellent properties, comfort, aesthetics and ease of manufacture. International regulations and the growing demand from the automotive industry to use environmentally friendly products are requiring tremendous technology changes. The progress achieved in semi-rigid integral skin products is described, with emphasis on steering wheels. Dow has focused the development work in the field of HFCs and CO2 blown technologies due to moulders' concerns for the high investment costs for hydrocarbon safe handling. HFC-134a has enough solubility in the PU components to allow its use as sole blowing agent for steering wheel, armrest and headrest applications, exhibiting a certain skin formation which contributes to the wear properties. Dow offers a broad range of HFC-134a blown fully formulated PU systems meeting most car industry specifications. The processing and physical properties are compared for the various options for steering wheel production.

EUROPEAN COMMUNITY; EUROPEAN UNION; ITALY; NETHERLANDS; WESTERN EUROPE

*Accession no.665108*

*Item 124*
Polyurethanes World Congress '97. Conference proceedings.
Amsterdam, Netherlands, 29th Sept.-1st Oct.1997, p.236-41. 43C6

**LINKING LIQUID CARBON DIOXIDE-BASED TECHNOLOGY WITH OPPORTUNITY**

Lamb K; Klahre H; Kirschner R; Pisipati J S
Maschinenfabrik Hennecke GmbH; Bayer Corp.
(SPI,Polyurethane Div.; ISOPA)

The PU industry faces many challenges, particularly product quality, product economics and protection of the environment. Hennecke and Bayer have accepted these challenges and developed processes meeting the needs of the industry. Blowing with liquid dioxide has provided opportunities to not only produce PU foam in slabstock operations but in moulded foam applications as well. In particular, the NovaFlex process has proved to be a successful alternative to halogenated blowing agents. The operating experience of the NovaFlex process in Europe and the USA is described. Production and product development efforts over the last three years are presented.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; USA; WESTERN EUROPE

*Accession no.665104*

*Item 125*
Polyurethanes World Congress '97. Conference proceedings.
Amsterdam, Netherlands, 29th Sept.-1st Oct.1997, p.226-31. 43C6

**BREAKTHROUGH TECHNOLOGY: 10% NATURAL LIQUID CARBON DIOXIDE FOR 10 KG/CUB.M SLABSTOCK FOAMS NOW AVAILABLE**

Taverna M; Griffiths T; Meloth H
Cannon SpA; TG CellSoft Ltd.
(SPI,Polyurethane Div.; ISOPA)

Natural liquid carbon dioxide-blown slabstock foams have been successfully produced for more than three years in Europe and the USA. Cannon pioneered this technology with the CarDio process, having the most extensive industrial production experience and greatest number of installed industrial plants. Equipment has been recently introduced into Latin America, Asia Pacific and Africa, where the Montreal Fund activities are phasing out CFC-11 by using liquid carbon dioxide technologies. Cannon research and development efforts continue, in the direction of highly CO2-loaded and filled formulations, as well as new applications. The unique design of the CarDio machines allows for the introduction of high percentages of liquid carbon dioxide into the formulations as well as the use of solid fillers and polymeric polyols and colour pigments. It is reported that the same level of blowing agents and solid additives cannot be achieved by competitive systems. Cannon has now developed machine and process configurations that allow for the introduction of 10 pph (parts per hundred parts of polyol) liquid carbon dioxide into slabstock foams. The development details, including characterisation of the resulting foams and the comments of appreciative end users, are described.

CYPRUS; EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; ITALY; WESTERN EUROPE

*Accession no.665102*

*Item 126*
Polyurethanes World Congress '97. Conference proceedings.
Amsterdam, Netherlands, 29th Sept.-1st Oct.1997, p.220-5. 43C6

**NEW SILICONE STABILISERS FOR LIQUID CARBON DIOXIDE BLOWN FLEXIBLE FOAM**

Melle A; Desnier M-C; Hilker B L; Lawler L F; McVey S B
OSi Specialties SA
(SPI,Polyurethane Div.; ISOPA)

The PU industry has been seeking ways to reduce or eliminate auxiliary blowing agents (ABAs) from foam manufacturing processes. Many possible solutions have been explored with no simple cost-effective solution for total elimination. Alternative blowing agents have been explored for many years, including HCFCs, acetone and, most recently, carbon dioxide. Although these materials are reasonable options, carbon dioxide has shown the most promise because it is safe to use and also inexpensive. CO2 is also a non-hazardous chemical which can be incorporated in the system and used to blow the foam down to low densities. Today there are three machine manufacturers with commercial equipment to produce foam using auxiliary CO2 as a blowing agent: Cannon (CarDio), Hennecke (NovaFlexC) and Beamech (CO-2) machines. With the introduction of these machines, it is clear that this is a viable, inexpensive method to reduce and/or eliminate regulated blowing agents. Since these are new manufacturing processes, chemical manufacturers are diligently working with the technologies to identify the best raw materials for trouble-free processing and optimum foam quality. The mechanical and chemical differences between conventional and the CO2-based foaming processes indicate that the role of the silicone stabiliser is process dependent. Laboratory froth and foam experiments have been conducted to evaluate and predict which silicone stabilisers are the most viable for this new foaming process. 2 refs.

SWITZERLAND; WESTERN EUROPE

*Accession no.665101*

*Item 127*

Polyurethanes World Congress ’97. Conference proceedings.
Amsterdam, Netherlands, 29th Sept.-1st Oct.1997, p.185-91. 43C6

**METERING ATTACHMENTS FOR BLOWING AGENT FOR FOAM APPLICATIONS LIKE PENTANE AND CARBON DIOXIDE CO2**

Adolf H; Jung L
Elastogran GmbH
(SPI,Polyurethane Div.; ISOPA)

Over the last few years, various engineering solutions have been employed to replace R 11, the CFC used by way of physical blowing agent. On the one hand, there are now low-ODP agents used as interim solutions (HCFC); on the other hand, zero ODP agents (pentane, CO2) are now available. Regarding rigid foam applications, the European trend is definitely towards pentane-based solutions, for all blown foam systems perhaps CO2 is a future solution. Three engineering concepts used to solve the problems inherent in pentane metering and three engineering concepts for CO2 metering are outlined. One fundamental difference resides in operating modes; the main distinction to be made is between continuous (double-belt units) and discontinuous (shot-based) modes of operation.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

*Accession no.665096*

*Item 128*

Polyurethanes World Congress ’97. Conference proceedings.
Amsterdam, Netherlands, 29th Sept.-1st Oct.1997, p.169-75. 43C6

**LONG TERM PERFORMANCE OF RIGID FOAMS BLOWN WITH NON-CFC BLOWING AGENTS**

Biesmans G; Karremans M; Randall D; Singh S N
ICI Europe Ltd.; ICI Polyurethanes Group
(SPI,Polyurethane Div.; ISOPA)

A variety of novel blowing agents has been used in the PU industry since the phaseout of CFCs, ranging from HCFCs to HFC and hydrocarbons. However, the long term performance of these systems and existing test methods need to be addressed. ICI Polyurethanes has identified the need for new ways of testing. The integrated approach adopted by the company to testing and prediction of long-term performance of rigid foams is described, with special emphasis on hydrocarbon and hydrofluorocarbon-blown foams. A number of tests have been developed to look into the specific problem of long term dimensional stability: quantifying the effect of temperature changes on polymer strength, determining the effect on blowing agent diffusion and cell gas composition changes and evaluating the problem of matrix plasticisation by blowing agents. All tests have been verified and their findings compared with measurements on construction insulation foams blown with CFC and HCFC which have been in service for a number of years. This has resulted in the information necessary to develop adequate foam formulations in terms of their long term dimensional stability. ICI Polyurethanes has also developed a number of thermal test methods to quantify the various processes occurring with time. 7 refs.

USA

*Accession no.665094*

*Item 129*

Polyurethanes World Congress ’97. Conference proceedings.
Amsterdam, Netherlands, 29th Sept.-1st Oct.1997, p.159-61. 43C6

**THREE YEARS’ EXPERIENCE WITH PENTANE POLYURETHANE RIGID FOAM FOR METAL PANELS**

 

Fryn W
Fischer Profil GmbH
(SPI,Polyurethane Div.; ISOPA)

The CFC ban has forced the PU industry to find alternative blowing agents. Production lines have had to be adapted and approved accordingly. Pentane has been considered as an alternative for CFCs, HCFCs and HFCs for manufacturing PU rigid foams as was first introduced into the commercial production of metal-faced sandwich elements in 1994. As a result of the high flammability of pentane, production facilities have to be re-equipped. Long-term experience has shown that pentane offers a technical, economical and ecological alternative. The handling of pentane-blown raw material systems, as well as the necessary technical changes of the manufacturing facilities, is described. The mechanical properties are compared with metal-faced panels containing CFC. Three years' experience with pentane in the sandwich metal panel field are summarised.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

*Accession no.665092*

*Item 130*
Polyurethanes World Congress '97. Conference proceedings.
Amsterdam, Netherlands, 29th Sept.-1st Oct.1997, p.130-9. 43C6

**METHODS OF INCREASING SOLUBILITY OF HYDROCARBONS AND HFCS IN POLYURETHANE RAW MATERIALS AND EFFECTS ON PERFORMANCE AND PROCESSING CHARACTERISTICS OF CONSTRUCTION FOAMS**

Singh S N; Burns S B; Costa J S; Bonapersona V
ICI Polyurethanes
(SPI,Polyurethane Div.; ISOPA)

Liquid hydrocarbons and hydrofluorocarbons are the leading zero ozone depletion potential blowing agents considered for rigid PU insulating foams used in the construction industry. Different isomers of pentane, namely n-, iso- and cyclo-pentane are the leading hydrocarbons under consideration. The leading HFCs being evaluated are HFC-245fa (CF3-CH2-CF2H) and HFC-365mfc (CF3-CH2-CF2-CH3). The solubility of such blowing agents in many of the typical polyols and isocyanates used by the construction industry is limited. Additives have been used to improve the solubility of blowing agents in the past. For example, ethoxylated nonylphenol was added to many polyols in order to enhance CFC-11 (CC13F) compatibility. A great many additives are being proposed today for use with hydrocarbons and HFCs. The fundamental properties of various hydrohalocarbon and hydrocarbon blowing agents are examined, together with their relationship to solubility in polyurethane raw materials. The solubility of the various pentane isomers in many polyols and isocyanates used to produce insulation board stocks via a continuous lamination process is evaluated. The potential of many isocyanate modifications and polyol additives to improve blowing agent solubility is explored. The effects of blowing agent solubility on the processing characteristics and foam properties are also examined. The data is used to examine the conventional theory regarding soluble systems. Many non-reactive or monofunctional additives improving solubility are found to affect structural, thermal or flammability performance of resulting foams. Data on potential methods to obtain robust processing and good performance with the zero ozone depletion potential blowing agents being considered by the rigid foam industry are presented.

EUROPEAN COMMUNITY; EUROPEAN UNION; ITALY; USA; WESTERN EUROPE

*Accession no.665089*

*Item 131*
Polyurethanes World Congress '97. Conference proceedings.
Amsterdam, Netherlands, 29th Sept.-1st Oct.1997, p.27-35. 43C6

**INDUSTRIAL EXPERIENCES WITH CO2 BLOWN POLYURETHANE FOAMS IN MANUFACTURE OF METAL FACED SANDWICH PANELS**

Ottens A; Keller P; Vreys M; Bertucelli L
Dow Deutschland Inc.; Dow Benelux NV; Dow Italia SpA
(SPI,Polyurethane Div.; ISOPA)

Metal faced sandwich elements with a PU foam core are mainly used in building as insulating cladding or roofing panels, and in food preservation for construction of cold stores and assembly of reefers. In Europe, most of the PU foams used in these industries employ HCFCs as blowing agents. Time for phasing out HCFCs is approaching fast, as a result of the oncoming strengthening of EC regulation of ozone depleting substances (ODS), and some national regulations already limiting the marketplace for HCFC-containing products. Dow offers the metal faced sandwich panel industry a range of ODS-free PU technologies for producing CO2, HFC-134a and hydrocarbons blown foam both with continuous and discontinuous processes. HFC-245fa and HFC-365mfc are now being sampled in significant quantities by the industry, and are subject to extensive evaluation. They will be commercially available only in the years 2000-2003. An additional point of concern to the industry is how new EC fire classification would change the cost elements in favour of one or the other blowing technologies. Industrial experience with CO2 water blown PU foams in the metal faced sandwich panel production is described. Proper design of the formulation has allowed to match reactivity, rise and rise rate profile, flow properties and very nearly the curing behaviour of the current HCFC blown foams; resulting in the

processing behaviour required by the sandwich panel industry. Details are given. 6 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; ITALY; NETHERLANDS; WESTERN EUROPE

*Accession no.665079*

*Item 132*

Polyurethanes World Congress '97. Conference proceedings.
Amsterdam, Netherlands, 29th Sept.-1st Oct.1997, p.22-6. 43C6

**POLYISOCYANURATE MODIFIED RIGID FOAMS FOR CONTINUOUS PRODUCTION OF LAMINATE BOARD**

Calgua E; Schmidt H-U; Abend E; Schroeder N; Muehlberg R
Elastogran GmbH; Bauder P.,GmbH
(SPI,Polyurethane Div.; ISOPA)

Laminate board is currently produced with PU systems containing n-pentane or mixtures of n-pentane with isopentane as blowing agent. HCFCs are also still being used. However they are only an interim solution to the phaseout of CFCs. Hydrocarbons, such as n-pentane, isopentane and cyclopentane, meet the requirements regarding environmental safety, processing, ageing, insulation and availability. For these reasons, the above mentioned hydrocarbons have been used in various PU applications for some years. However, in order to pass the corresponding fire classes, for example B2 according to DIN 4102, formulations with high amounts of flame retardants are in use. Therefore, it has become necessary to find new solutions for formulations capable of meeting the requirements regarding flame retardancy with lower amounts of flame retardants. BASF/Elastogran has developed PIR formulations with halogen free flame retardants based on new polyols for the production of pentane blown PIR laminate board. They are based on polyester polyols, especially developed for the above mentioned application. They have reduced levels of halogen free flame retardants; however, they maintain the same flame retardancy. The processing of the new PU formulations is comparable to conventional PU systems. Processing properties of the foam, such as core curing and adhesion, are comparable with conventional PU foams. However, the values of dimensional stability are superior to those of the former systems.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

*Accession no.665078*

*Item 133*

Polyurethanes World Congress '97. Conference proceedings.
Amsterdam, Netherlands, 29th Sept.-1st Oct.1997, p.17-21. 43C6

**DEVELOPMENT OF ALL WATER-BLOWN POLYURETHANE RIGID FOAM FOR HOUSING INSULATION**

Goto J; Sasaki K; Mashiko S; Kataoka Y; Kambara Y; Ohki I
Nippon Polyurethane Industry Co.Ltd.
(SPI,Polyurethane Div.; ISOPA)

The new regulation of energy conservation policy for housing was introduced in Japan in 1992. For revised requirements on insulation performance, rigid PU foam is more suitable than the other insulation materials. It has been applied to insulation for roofs, walls, and floors, and the market is growing year by year. To reduce ozone depletion potentials (ODP), new types of blowing technologies have been developed for rigid PU foams instead of HCFC-141b. Water is a useful blowing agent because it generates carbon dioxide, which is not flammable with no ODP, from the reaction with isocyanate groups. Conventional water blown rigid PU foam, however, has potential problems including poor dimensional stability and high thermal conductivity, compared with HCFC blown foam. Work has been carried out to overcome the problems and to establish new all water-blown formulation. The microcellular structure and enhanced foam strength have resolved the problems. The novel all water-blown rigid PU foam is a closed cell system with good dimensional stability, low thermal conductivity, low friability and good adhesive strength, which are acceptable to the market. Foam density is similar to that of HCFC blown PU foams. This foam can be manufactured with more than 100 mm thickness without shrinkage or swelling at short demould time. This foam can be used for housing insulation, and is useful in energy conservation. 8 refs.

JAPAN

*Accession no.665077*

*Item 134*

Polyurethanes World Congress '97. Conference proceedings.
Amsterdam, Netherlands, 29th Sept.-1st Oct.1997, p.7-16. 43C6

**UTILISATION OF HFC-245A IN CONSTRUCTION INDUSTRY**

Bogdan M C; Parker R C; Williams D J
AlliedSignal Inc.
(SPI,Polyurethane Div.; ISOPA)

The effective use of insulation in both commercial and residential buildings is the key to energy conservation. The effectiveness of insulation is dependent upon many factors. If the insulation is foam, the blowing agent used is critical to its performance. There has been a transition in blowing agents over the last decade from CFCs to HCFCs, and the industry will soon see another transition from HCFCs to a third generation blowing agent. The exact timing of these transitions is dependent upon the Montreal Protocol national and local regulations. Each transition in blowing agents requires modifications to the manufacturing process for the foam products. AlliedSignal is dedicated to providing an HFC blowing agent to the construction

 

industry, and has identified HFC-245fa as its third generation blowing agent. Since 1994, it has published a series of papers on its development of this blowing agent. Some of the key considerations required in making the transition from HCFC-141b to HFC-245fa in polyisocyanurate boardstock and spray foam are discussed, as is progress made in the application of HFC-245fa in bunstock and pour-in-place panel applications. The progress in areas such as raw materials and formulation optimisation, possible equipment and processing parameters changes required to optimise performance is outlined, with an overview of foam properties compared with HCFC-141b blown foams. 2 refs.

*Accession no.665076*

*Item 135*
Polyurethanes World Congress '97. Conference proceedings.
Amsterdam, Netherlands, 29th Sept.-1st Oct.1997, p.684-7. 43C6

**DEVELOPMENTS IN SOFT AND HYPERSOFT FORMULATIONS FOR PRODUCTION OF CFC-FREE SLABSTOCK FOAMS**

Sam F O; Stefani D
EniChem SpA
(SPI,Polyurethane Div.; ISOPA)

Flexible PU foam properties can be tailored to fulfil numerous requirements in a wide range of applications by an appropriate selection of starting materials. This is mainly due to the broad spectrum of available isocyanate and polyol matrices, various additives and countless chemical reactions that occur during foam formation. The fundamental role played by catalysts, surfactants, chain extenders, etc., is a contributing factor in determining the basic characteristics of the end products. For instance, increasing the soft segment domains in the polymer backbone, by introducing varying amounts of 'soft polyol', tends to enhance phase separation, crosslinking mechanisms and the degree of incompatibility of formulation components. A systematic study of such interactions coupled with a comprehensive knowledge of the relationship between the polymer structure and properties is important to fully utilise the engineering capabilities of polyurethane foams. Therefore, a judicious use of this approach enables one to have a better control of the reaction profile and the chemical linkages. The effect of these interactions on the polymer morphology are described, together with how it could be used as a predictive tool for certain physicomechanical characteristics, such as loadbearing index of attained foams.

EUROPEAN COMMUNITY; EUROPEAN UNION; ITALY; WESTERN EUROPE

*Accession no.665065*

*Item 136*
Polyurethanes World Congress '97. Conference proceedings.
Amsterdam, Netherlands, 29th Sept.-1st Oct.1997, p.612-26. 43C6

**INFLUENCE OF GLOBAL ENVIRONMENTAL FACTORS ON SELECTION OF POLYURETHANE AND OTHER BUILDING INSULATION MATERIALS**

Ashford P
Caleb Management Services
(SPI,Polyurethane Div.; ISOPA)

Under the United Nations Framework Convention on Climate Change established in Rio in 1992, the Parties committed to returning the emissions of greenhouse gases to 1990 levels by the year 2000. At the second Conference held in Berlin during 1995, the Parties recognised that further action was necessary. The Berlin Mandate set an agenda for exploring further commitments which can be adopted by the Parties in pursuit of actual reductions in the emissions of greenhouse gases through to 2010. These potential commitments will be agreed upon and ratified at the third Conference of the Parties (COP-3) to be held at Kyoto, Japan in December 1997. The European Union has historically taken a progressive stance on these issues and is currently considering a commitment for a 15% reduction in emissions by the year 2010. To achieve this, it proposes a series of policies and measures, which will address greenhouse gas emissions on a gas-by-gas basis. This includes a strategy to minimise the use and emissions of hydrofluorocarbons (HFCs). However, a simplistic gas-by-gas approach ignores the fact that the deliberate use of some greenhouse gases can serve to reduce the emission levels of others, e.g. the use of HFCs as blowing agents in foam insulation. Of the eleven initiatives studied by the European Union, the assessment of carbon dioxide emission reductions achievable in the building sector is the one area in which it has failed to produce quantitative targets. Some of the potential areas in which significant savings can be made are examined, emphasising the areas where adoption of HFC blown insulation foams can make an additional contribution. It is concluded that the focus of attention at Kyoto should be on methods of improving the insulation standards used in building rather than the choice of materials used to effect such improvements. 5 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; UK; WESTERN EUROPE; WORLD

*Accession no.665060*

*Item 137*
Polyurethanes World Congress '97. Conference proceedings.
Amsterdam, Netherlands, 29th Sept.-1st Oct.1997, p.545-51. 43C6

**NEW GENERATION OF POLYETHER-BASED SHOE SYSTEMS**

Pittrich K; Volkert O
Elastogran GmbH; BASF AG
(SPI,Polyurethane Div.; ISOPA)

Water-blown integral skin foams for the shoe industry have the disadvantage of low elasticity and inconstant dimensional stability. Elasticity can be adjusted or increased by the reduction of the amount of urethane groups in the soft segments. Most of these urethane groups result from the low molecular weight diols being involved in the prepolymers. For this reason, the high molecular weight polyols are transferred from the polyol component (A component) to the prepolymer component (B component) and thus replace the low molecular weight diols in the prepolymer. To guarantee sufficient storage stability, the NCO content is reduced drastically to about 13%. The result is an integral skin foam with a fine cell structure, high elasticity, good mechanical properties and good processability. Because of the low NCO content, the mix ratio A:B changes completely as well as the foaming kinetics. A result of this is open-celled foams providing over a wide range of mix ratio constant dimensional stability, even at lower densities of about 250 gs/lit. This provides access to new markets of, for example, low density midsoles where actually other materials such as EVA are dominant.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

*Accession no.665052*

*Item 138*
Polyurethanes World Congress '97. Conference proceedings.
Amsterdam, Netherlands, 29th Sept.-1st Oct.1997, p.524-34. 43C6

**TECHNICAL COMPARISON OF VARIOUS BLOWING AGENTS WITH DIFFERENT POLYURETHANE SYSTEMS SET FOR THE APPLIANCE INDUSTRY**

Seifert H; Wiegmann W; White W; Rotermund U; Knorr G
Elastogran GmbH; BASF Corp.; BASF Schwarzheide GmbH
(SPI,Polyurethane Div.; ISOPA)

A technical comparison of the most common blowing agents as alternatives to CFC is presented: HCFC 141 b and 22/142 b, HFC 134 a, 236, 245, 365, HC n- and isopentane, cyclopentane and cyclopentane/butane mixtures. Basic criteria for blowing agents are not only physical data of pure compounds, but their measured physical properties in mixtures simulating the real gas mixtures in the foam, e.g. gas-thermal conductivity and vapour pressure. The interaction with the foam matrix is in certain ranges adjustable by the formulation like: absorption of blowing agent by the polymer, plasticising of the polymer by the blowing agent and permeation rates. Since these influences are dependent on time, they directly correlate with the properties of the foam after ageing. The higher thermal conductivity of CFC substitutes can be further reduced by the decrease of IR irradiation heat transfer. Beside the evaluation of a.m. properties of the various blowing agents, the advantages of cyclopentane/butane blends are taken into particular consideration. 20 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; USA; WESTERN EUROPE

*Accession no.665050*

*Item 139*
Polyurethanes World Congress '97. Conference proceedings.
Amsterdam, Netherlands, 29th Sept.-1st Oct.1997, p.474-83. 43C6

**NEW POLYOLS AND FORMULATIONS FOR ENERGY-SAVING INSULATIONS USING HFC-245FA AS BLOWING AGENT**

Tsukida N; Sato H; Aoyagi M; Takeyasu H
Asahi Glass Co.Ltd.
(SPI,Polyurethane Div.; ISOPA)

The Japanese household refrigerator and building markets have already eliminated the use of CFC blowing agent in PU insulation systems. The household refrigerator market is primarily using the blowing agent HCFC-141b and hydrocarbon blowing agent cyclopentane. However, HCFC-141b, being a transitional blowing agent, must be replaced with a next generation blowing agent by 2003, and cyclopentane, having high thermal conductivity, will not meet future energy consumption standards. The next generation blowing agent must have zero ozone depletion potential and low global warming potential. In addition to relatively low thermal conductivity, it should also be non-toxic, non-flammable and easily available. It is concluded that HFC-245fa is the most promising candidate for the next generation blowing agent in Japan. Asahi Glass has developed novel polyols, the AG-series, and useful formulations for refrigerator and building insulation. The novel polyols, which are a mixture of aromatic and aliphatic compounds, give low thermal conductivity and good flowability. The novel polyol AG-1001 was designed to efficiently nucleate HFC-245fa at an early foaming stage in order to achieve low thermal conductivity. AG1750 and 1755 are designed to achieve good solubility and reactivity. The novel formulation systems are processable in present foaming machines. 2 refs.

JAPAN

*Accession no.665045*

*Item 140*
Polyurethanes World Congress '97. Conference proceedings.
Amsterdam, Netherlands, 29th Sept.-1st Oct.1997, p.468-73. 43C6

**HFC-245FA AS BLOWING AGENT FOR APPLIANCE INDUSTRY**

Logsdon P B; Parker R C; Williams D J
AlliedSignal Inc.
(SPI,Polyurethane Div.; ISOPA)

HFC-245fa (1,1,1,3,3-pentafluoropropane) has been under development by AlliedSignal since 1994 as a potential replacement for HCFC-141b blowing agents. During 1996, a great deal of work took place that compared the physical properties of appliance foams prepared with HFC-245fa versus other blowing agents. During 1997, it is anticipated that ongoing performance optimisation work will enable appliance manufacturers to conduct plant trials using HFC-245fa as blowing agent. The domestic refrigerator appliance industry is under a time constraint to make a transition to a third generation blowing agent, such as HFC-245fa, by January 2003. In addition to the phase out of HCFCs, Department of Energy regulations will mandate an increase in the energy efficiency of refrigerators. Further optimisation studies will enhance the insulation value and physical properties of foams blown with HFC-245fa. Development work is also being performed that examines the overall system, i.e. the interaction of HFC-245fa foam blown into the walls of a refrigerator. The results of a freeze stable density study using HCFC-141b and HFC-245fa as blowing agents are discussed. Results of a surfactant screening study examining flowability are reviewed. In addition, modelling of blowing agent diffusion into a refrigerator is discussed. This work is part of a continuing effort by AlliedSignal to develop a blowing agent replacement for HCFC-141b that meets the needs of its customers well into the future. 4 refs.

USA

*Accession no.665044*

*Item 141*

Polyurethanes World Congress '97. Conference proceedings.
Amsterdam, Netherlands, 29th Sept.-1st Oct.1997, p.436-46. 43C6

**RECENT ADVANCES IN DEVELOPMENT AND CHARACTERISATION OF AUTOMOTIVE COMFORT SEATING FOAMS**

Leenslag J W; Huygens E; Tan A
ICI Polyurethanes
(SPI,Polyurethane Div.; ISOPA)

The continuous pressure from the automotive industry for cost reductions has resulted in greater demands for car seat weight reduction coupled with improved comfort. This has led to even more in-depth studies on the contribution of flexible PU seating foams to ride comfort and durability. Advanced techniques - such as small-angle X-ray scattering (SAXS), dynamic creep, vibrational characterisation and finite element analysis (FEA) - have been used to characterise the foams. Seat effective amplitude transmissibility (S.E.A.T.) analysis of comfort seat cushions has made it possible to assess their vibrational performance. Ride comfort and durability of MDI-based cushions have been verified by accelerated field evaluation. As a result of this work, ICI Polyurethanes has developed a versatile, low density foam technology based on MDI which can be tailored to specific seat requirements, ensuring superior ride comfort and durability performance. 21 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; UK; WESTERN EUROPE

*Accession no.665042*

*Item 142*

Polyurethanes World Congress '97. Conference proceedings.
Amsterdam, Netherlands, 29th Sept.-1st Oct.1997, p.421-7. 43C6

**NEW GENERATION PREMINOL: NOVEL POLYETHER POLYOL FOR HIGH PERFORMANCE HR FOAMS**

Toyota Y; Hasegawa N; Wada H; Horie A; Hatano S; Sasaki T; Oki S
Asahi Glass Co.Ltd.
(SPI,Polyurethane Div.; ISOPA)

The development of high performance and high ball rebound HR seat cushions using novel polyether polyol Preminol, which contains an extremely small amount of by-products (mono-ols) and has narrow molecular weight distribution compared to conventional polyols, has previously been reported. HR foam using Preminol is superior to conventional HR foams when taking into account comfort and high durability. The synthesis by Asahi Glass of a new high performance polyether polyol New Generation Preminol, which fully satisfies comfort properties required for car seat cushions, is described. The foam properties of TDI or MDI-based HR mould foams using New Generation Preminol are described. 6 refs.

JAPAN

*Accession no.665040*

*Item 143*

***Machine Design***
69, No.23, 11th Dec. 1997, p.122

**THICK-SKINNED URETHANE BANISHES CFCS**

Edited by: Hotter D S

Tempress Inc. in conjunction with BASF Corp. has developed an environmentally friendly blowing agent for use in the manufacture of integral skins used in the truck, bus and heavy vehicle market. The process called T-Skin, lets engineers mould thicker skins (0.100 in.) that resist moisture and scratches, absorb energy and can take on a variety of colours and textures. Details are given of the process which is said to offer a superior alternative to water blown systems.

TEMPRESS INC.; BASF CORP.
USA

*Accession no.662705*

*Item 144*

Patent Number: US 5585412 A 19961217

**PROCESS FOR PREPARING FLEXIBLE CFC-FREE POLYURETHANE FOAMS USING AN ENCAPSULATED BLOWING AGENT**
Natoli F S; Chandalia K B
Olin Corp.

This involves reacting, at a reaction temperature within a temperature range of between about 70 and 150F, a reaction mixture composed of a polyol, an organic isocyanate, water, an encapsulated blowing agent and a reaction catalyst. The encapsulated blowing agent comprises a shell and core, the shell comprising a polymer having a melting point above the initial reaction temperature and the core comprising a gaseous blowing agent or blowing agent precursor for blowing the reaction mixture at the reaction temperature. The hot PU foam may be cooled using encapsulated water contained in the foam forming reaction mixture.

USA

*Accession no.651234*

*Item 145*
***Journal of Cellular Plastics***
3, No.4, July/Aug.1997, p.372-99
**EFFECT OF POLYOL FUNCTIONALITY ON WATER BLOWN RIGID FOAMS**
Tabor R; Lepovitz J; Potts W; Latham D; Latham L
Dow Chemical Co.

Rigid foam processing and performance issues have all presented themselves as problems to be overcome as the polyurethane industry replaces CFC blowing agents with alternatives such as HCFCs, HFCs, isomers of pentane and water. These problems include dimensional stability, foam flowability, formulation viscosity, friability, substrate adhesion, cycle times, cost, temperature resistance, insulation performance, K-factor ageing, blowing agent solubility and flammability. Water blown rigid foams lack performance in many of these areas compared to the CFC blown foams of the past. Since much of the water blown rigid foam work of the past has been narrowly focused on individual applications and formulations, a broad study of the effect of polyol functionality on foam performance is necessary to address these issues. A series of five polyols, each having an equivalent weight of 110 g/equiv., and functionalities ranging from two to six, are prepared and characterised alone, in thermoset films and in water blown rigid foam formulations. Properties such as dimensional stability, cell size, K-factor, adhesion to aluminium and PS, glass transition temperature, film permeability, relative chemical conversions by photoacoustic FTIR and solvent swelling of thin sliced foams are characterised. These results are broadly applicable to the development and commercialisation of water blown rigid foam polyols and formulations. 10 refs.

USA

*Accession no.650856*

*Item 146*
Polyurethanes Expo '96. Conference Proceedings.
Las Vegas, Nv., 20th-23rd Oct.1996, p.518-24. 43C6
**LOW DENSITY ALL-MDI POLYURETHANE FOAMS FOR AUTOMOTIVE SEATING**
Tan A; Deno L; Leenslag J W
ICI Polyurethanes
(SPI,Polyurethane Div.)

An examination is made of automotive seating applications of ICI Polyurethanes' all-MDI PU foams which have significantly reduced densities as a result of changes in isocyanate/polyol ratios. Results are presented of studies of their durability and comfort performance over a wide range of temperatures and humidity levels. The fogging and flammability characteristics and recyclability of these foams are also discussed. 20 refs.

BELGIUM; EUROPEAN COMMUNITY; EUROPEAN UNION; USA; WESTERN EUROPE

*Accession no.649933*

*Item 147*
Polyurethanes Expo '96. Conference Proceedings.
Las Vegas, Nv., 20th-23rd Oct.1996, p.473-8. 43C6
**PU SYSTEMS FOR PIPE INSULATION: CHANGES AND IMPROVEMENTS THROUGH THE USE OF ALTERNATE BLOWING AGENTS OPEN NEW TECHNICAL APPLICATIONS AND NEW MARKETS**
Gabrysch G; Welte R
Bayer AG
(SPI,Polyurethane Div.)

Property requirements for PU foams used in pipe insulation are examined, and the effects on foam properties of changing from CFC-11 to alternative blowing agents such as pentanes and carbon dioxide are discussed. Some technical and environmental advantages and new insulation markets made possible by these changes are reviewed.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; USA; WESTERN EUROPE

*Accession no.649927*

*Item 148*
Polyurethanes Expo '96. Conference Proceedings.
Las Vegas, Nv., 20th-23rd Oct.1996, p.467-72. 43C6
**NEW CATALYST GENERATION FOR PIR RIGID FOAMS**
Sikorski M; Kull A H; Galla E A
Nitroil Europe GmbH; Specialty Products International Inc.
(SPI,Polyurethane Div.)

Trimerisation catalysts of the PC CAT RL series (Nitroil Europe), based on blends of alkali metal carboxylates and tertiary amines, were evaluated in the preparation of HCFC-141b and pentane blown rigid polyisocyanurate foams. The foams were investigated for reactivity, density, compression

strength and thermal conductivity. Good blowing agent solubility and foam properties were achieved in low water content pentane blown systems by the use of a new catalyst and PC TR 310, a low viscosity aliphatic polyester polyol based on raw materials from renewable resources. For high water content pentane blown foams made with the use of polyester/polyether polyol blends, reaction profiles and foam properties comparable to those of HCFC-141b blown systems were achieved.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; USA; WESTERN EUROPE

*Accession no.649926*

*Item 149*
Polyurethanes Expo '96. Conference Proceedings.
Las Vegas, Nv., 20th-23rd Oct.1996, p.452-9. 43C6
**INNOVATIVE QUATERNARY AMMONIUM AND METAL BASED CATALYST SYSTEMS FOR CFC FREE ISOCYANURATE FOAMS**
Yoshimura H; Tokumoto K; Okuzono S; Lowe D W
Tosoh Corp.; Tosoh USA Inc.
(SPI,Polyurethane Div.)

Quaternary ammonium salts, alkali metals and tertiary amines were evaluated as trimerisation catalysts for HCFC-141b/carbon dioxide and all carbon dioxide blown rigid polyisocyanurate foams. In co-blown systems, Toyocat-TR20 and TR30 quaternary ammonium salts (Tosoh Corp.) accelerated the initial foaming reaction and improved the rise rate profile compared with conventional catalysts. TR20 exhibited the higher catalytic activity required for better density distribution, flowability and mouldability, while TR30 was effective in improving flame resistance and adhesion to metals. A conventional metal catalyst, potassium ethyl hexanoate, was the most suitable for foams blown with carbon dioxide only, and in combination with TR20 gave improved flowability and mouldability and reduced smoke density. 9 refs.

JAPAN; USA

*Accession no.649924*

*Item 150*
Polyurethanes Expo '96. Conference Proceedings.
Las Vegas, Nv., 20th-23rd Oct.1996, p.448-51. 43C6
**EVALUATION OF HFC-245FA IN ENTRY DOOR FOAM SYSTEM**
McGregor M E
Bayer Corp.
(SPI,Polyurethane Div.)

HFC-245fa was evaluated as a blowing agent for rigid PU foam insulation for entry doors. Hand mixed foams were investigated for reactivity, flow, compression strength, dimensional stability, thermal conductivity and cell structure in comparison with HCFC-141b blown systems. 5 refs.

USA

*Accession no.649923*

*Item 151*
Polyurethanes Expo '96. Conference Proceedings.
Las Vegas, Nv., 20th-23rd Oct.1996, p.439-47. 43C6
**INFLUENCE OF TEMPERATURE ON COMPRESSIVE PROPERTIES AND DIMENSIONAL STABILITY OF RIGID POLYURETHANE FOAMS USED IN CONSTRUCTION**
Burns S B; Singh S N; Bowers J D
ICI Polyurethanes
(SPI,Polyurethane Div.)

The compression properties of rigid, closed-cell PU and polyisocyanurate foams used as thermal insulation in building applications were measured over a wide range of temperatures in three orthogonal directions. The data were fitted into a model based on fundamental material parameters, and the relationship between dimensional stability and compression strength in an anisotropic foam was examined. Foams expanded with CFC, HFC, HCFC and hydrocarbon blowing agents were evaluated, resulting in a methodology for predicting field performance under a wide variety of environmental exposure conditions. 18 refs.

USA

*Accession no.649922*

*Item 152*
Polyurethanes Expo '96. Conference Proceedings.
Las Vegas, Nv., 20th-23rd Oct.1996, p.434-8. 43C6
**EVALUATION OF HFC-245FA IN CONTINUOUS AND DISCONTINUOUS PANEL FORMULATIONS: MACHINE STUDY**
Rossitto F C; McGregor M E
Bayer Corp.
(SPI,Polyurethane Div.)

Continuous and discontinuous panels were produced from rigid PU and polyisocyanurate foams using HFC-245fa as blowing agent. The panels were evaluated for dimensional stability, thermal conductivity, foam flow, reactivity, compression strength, across-width density, flammability and tensile adhesion in comparison with panels produced using HCFC-141b blown foams. 3 refs.

USA

*Accession no.649921*

*Item 153*
Polyurethanes Expo '96. Conference Proceedings.
Las Vegas, Nv., 20th-23rd Oct.1996, p.428-32. 43C6
**FACTORS AFFECTING THE SOLUBILITY OF GASEOUS HCFC AND HFC BLOWING AGENTS**
Latham I
Dow Chemical Co.
(SPI,Polyurethane Div.)

The solubility of HCFC-22 and HFC-134a blowing agents in various polyols used in rigid PU foam formulations

was investigated. Most of the observed trends in solubility could be explained by the concept of hydrogen bonding. Solubility of the gaseous blowing agents increased as the equivalent weight of the polyol increased, and decreased with increasing water level and with decreasing basicity of the polyol functional groups. HCFC-22 was more soluble than HFC-134a in standard rigid foam polyols. 12 refs.

USA

*Accession no.649920*

*Item 154*
Polyurethanes Expo '96. Conference Proceedings.
Las Vegas, Nv., 20th-23rd Oct.1996, p.422-7. 43C6
**PARAMETERS AFFECTING THE COMPATIBILITY OF ALTERNATIVE BLOWING AGENTS IN POLYOLS FOR RIGID FOAM FORMULATIONS**
Peterson B H
Bayer Corp.
(SPI,Polyurethane Div.)

A study was made of the relationship between the physical properties of a number of Bayer's Multranol polyols used in rigid PU foam formulations and the miscibility of n-pentane and cyclopentane blowing agents in the polyols or polyol blends. The polyols investigated included aliphatic and aromatic amine, aliphatic triol and sugar based types. The effects of hydroxyl number, molecular weight, starter type, epoxide type and content, functionality and surface tension on the compatibility of blowing agents in the polyols were examined. 4 refs.

USA

*Accession no.649919*

*Item 155*
Polyurethanes Expo '96. Conference Proceedings.
Las Vegas, Nv., 20th-23rd Oct.1996, p.415-21. 43C6
**EFFECT OF BLOWING AGENT SOLUBILITY ON THE LONG-TERM DIMENSIONAL STABILITY OF RIGID POLYURETHANE FOAMS**
Singh S N; Biesmans G; Karremans M; Randall D
ICI Polyurethanes
(SPI,Polyurethane Div.)

An accelerated blowing agent uptake test was used to quantify the plasticisation effect of HCFC-141b, CFC-11, cyclopentane and isopentane blowing agents on the structural matrix of rigid, closed-cell PU and polyisocyanurate (PIR) modified PU foams. This technique allowed simulation of blowing agent uptake levels associated with many years of use within a matter of days. Studies of the impact of blowing agent absorption on compression strength showed that the decrease in compression strength depended strongly on the amount of blowing agent dissolved into the matrix. HCFC and CFC exhibited larger uptake potential than hydrocarbons, and PIR matrices generally showed a lesser degree of uptake than PU matrices. Used in conjunction with the Dimvac test, the new uptake test allowed for comprehensive assessment of the long-term dimensional stability of foams. 8 refs.

BELGIUM; EUROPEAN COMMUNITY; EUROPEAN UNION; USA; WESTERN EUROPE

*Accession no.649918*

*Item 156*
Polyurethanes Expo '96. Conference Proceedings.
Las Vegas, Nv., 20th-23rd Oct.1996, p.404-10. 43C6
**PROGRESS IN THE DEVELOPMENT OF A NEW HFC BLOWING AGENT: A CLOSER ANALYSIS OF TWO LEADING CANDIDATES**
Barthelemy P P; Leroy A
Solvay Research & Technology
(SPI,Polyurethane Div.)

The chemical stability of HFC-245fa and HFC-365mfc blowing agents was studied under conditions relevant to the blowing of rigid PU and polyisocyanurate foams. Both blowing agents underwent some dehydrofluorination to give decomposition products which could be analysed by gas chromatography, but these could be strongly reduced by careful selection of formulation components. The extent of dehydrofluorination was generally smaller for the HFC blowing agents than for HCFC-141b. HFC-365mfc was generally more stable than HFC-245fa in foams and premixes aged at different temperatures and for different periods of time. 5 refs.

BELGIUM; EUROPEAN COMMUNITY; EUROPEAN UNION; USA; WESTERN EUROPE

*Accession no.649916*

*Item 157*
Polyurethanes Expo '96. Conference Proceedings.
Las Vegas, Nv., 20th-23rd Oct.1996, p.394-403. 43C6
**STATUS REPORT ON THE DEVELOPMENT OF HFC-245FA AS A BLOWING AGENT**
Bogdan M C; Williams D J; Logsdon P B; Parker R C
AlliedSignal Inc.
(SPI,Polyurethane Div.)

Studies undertaken by AlliedSignal into the use of HFC-245fa as a blowing agent for PU and polyisocyanurate thermal insulation foams are reported. Blowing agent characteristics examined include physical, environmental and toxicological properties, flammability, thermal and hydrolytic stability, solubility, compatibility with foam raw materials, premix and polyol vapour pressure, and stability during the foaming reaction. The effects of surfactants on foam properties and the response of thermal conductivity to mean temperature and time are discussed. 4 refs.

USA

*Accession no.649915*

 

*Item 158*
Polyurethanes Expo '96. Conference Preprints.
Las Vegas, Nv., 20th-23rd Oct.1996, p.376-9. 43C6
**LIQUID CARBON DIOXIDE FROM BOTTLE: NEW BLOWING AGENT FOR FLEXIBLE FOAMS IN THE AUTOMOTIVE SECTOR**
Mariani V
Impianti OMS SpA
(SPI,Polyurethane Div.)

The use of pressurised liquid carbon dioxide as a blowing agent for flexible PU foams is discussed, with particular reference to the moulding of car seats. Some equipment modifications required to accommodate this blowing agent technology are described.

EUROPEAN COMMUNITY; EUROPEAN UNION; ITALY; USA; WESTERN EUROPE

*Accession no.649912*

*Item 159*
Polyurethanes Expo '96. Conference Proceedings.
Las Vegas, Nv., 20th-23rd Oct.1996, p.370-5. 43C6
**CANNOXIDE: NEW MOLDING TECHNOLOGY FOR POLYURETHANE FOAMS BLOWN WITH LIQUID CARBON DIOXIDE. FIRST INDUSTRIAL EXPERIENCES**
Taverna M
Cannon Group
(SPI,Polyurethane Div.)

The CannOxide process developed by Cannon Group for the moulding of PU foams using liquid carbon dioxide as blowing agent is described, and results are presented of trials in which this technology was used to mould flexible PU foam furniture parts having complex inserts.

DOW EUROPE SA; ILPO DIVISIONE INTEGRALI; PLURIFORM; DOW ITALIA SPA
EUROPEAN COMMUNITY; EUROPEAN UNION; ITALY; SWITZERLAND; USA; WESTERN EUROPE

*Accession no.649911*

*Item 160*
Patent Number: US 5574072 A 19961112
**AZEOTROPIC COMPOSITIONS OF 1,1,1,4,4,4-HEXAFLUOROBUTANE AND N-PENTANE AND THE USE THEREOF IN THE PRODUCTION OF FOAMS**
Werner J; Kane S A; Doerge H P; Boonstra E F
Bayer Corp.

These are composed of from about 73 to 87 wt.% of the hexafluorobutane and from about 13 to 27 wt.% of n-pentane and are used as blowing agents in PU foams.

USA

*Accession no.649580*

*Item 161*
***Plastics World***
55, No.8, Aug.1997, p.10
**INTEGRAL SKIN MOULDERS TURN TO PENTANE GAS**
Smock D

Pentane is emerging as the leading candidate to replace HCFCs for integral skin PU moulding. Universal Urethane finished a 100% conversion to cyclopentane as a blowing agent at the end of July at an estimated cost of 125,000 US dollars including lost production time. The company is said to be achieving excellent skins and the reactivity of the new cyclopentane formulation is described as very close to CFC-11.

USA

*Accession no.648006*

*Item 162*
Utech Asia '97. Conference proceedings.
Suntec City, 18th-20th Feb.1997, Paper 54. 43C6
**ADDITIVES TO PRODUCE SOFT FOAMS WITH CONVENTIONAL POLYOLS AND LOWER BLOWING AGENT LEVELS**
Lawler L F; Boo K H
OSi Specialties Group; Witco Corp.; Witco Asia Pacific
Edited by: Reed D; Ward S
(Crain Communications Ltd.; Rapra Technology Ltd.)

Geolite technology was introduced in 1990 for the production of polyether PU foams using reduced auxiliary blowing agents. Subsequent development work and industrial trials have demonstrated the unique capabilities of Geolite modifiers to provide stability during the foaming process, particularly difficult-to-process low density formulations and low index soft foam formulations. It is discussed how Geolite modifiers help in producing low index soft foams using conventional polyols at reduced ABA use levels. Other benefits of using Geolite modifiers are also covered.

SINGAPORE; USA

*Accession no.645385*

*Item 163*
Utech Asia '97. Conference proceedings.
Suntec City, 18th-20th Feb.1997, Paper 36. 43C6
**CFC-FREE REFRIGERATED ISO CONTAINERS**
Gabrysch G
Bayer AG
Edited by: Reed D; Ward S
(Crain Communications Ltd.; Rapra Technology Ltd.)

Food and other perishable goods are becoming more and more part of the global market of consumer products. These goods need effective transportation with exactly controlled temperatures over long distances so that no damage occurs to the food. To achieve this, insulated PU containers are used almost exclusively because it is possible to maintain very narrow temperature limitations for the entire time of the transport. If even higher

requirements are necessary, it is possible to control not only the temperature but the composition of the atmosphere inside the container as well. Not only are food products suitable for PU-insulated containers, but all temperature sensitive products e.g. electronic equipment, pharmaceutical preparations, and fine chemicals. Together with dry freight containers, insulated containers are transported on special container ships some of which have a loading capacity of up to 5,000 TEU. Currently worldwide there are approximately 600,000 refrigerated or insulated containers. The majority contain PU insulation and typically R1 has been used as a blowing agent. Details are given.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

*Accession no.645367*

*Item 164*
Utech Asia '97. Conference proceedings.
Suntec City, 18th-20th Feb.1997, Paper 30. 43C6
**POLYURETHANE FOAM FOR GLOBAL APPLIANCE MARKET: BLOWING AGENTS - PROCESSABILITY AND LINER COMPATIBILITY**
Morgan r E; Dean G; Clavel P; Kawabata H; Watkins J
Dow Chemical Co.; Dow Europe SA; Dow Mitsubishi Chemical Ltd.
Edited by: Reed D; Ward S
(Crain Communications Ltd.; Rapra Technology Ltd.)

Since the inception of the Montreal Protocol, any discussion about PU foams centres around the topic of what the next generation of blowing agents will be. CFC-11 has passed the phase-out date of 1995 in the developed countries and is approaching its phase-out date of 2010 in the developing countries. In the appliance market in Europe, the replacement of choice is hydrocarbons (cyclopentane, iso-/n-pentane); in the USA, it is HCFC-141b. In Asia and the Pacific, HCFC-141b is widely used, but cyclopentane is gaining in popularity. The development programmes underway at Dow Chemical are reviewed as the current systems based on cyclopentane and HCFC- 141b are being optimised and the next generations of hydrocarbons and HFCs are being examined. The normal/iso-pentanes - HFC-134a, HFC-245fa and HFC-236ea - are described and compared to current HCFC- 141b and cyclopentane systems. Equally important to the development of the foam systems is the understanding of the processing characteristics of each blowing agent. The process development of this work as it pertains to the global appliance market is reviewed. Finally, the respective solvency characteristics of the different blowing agents will have different effects on the various liner materials. This nature of these blowing agents toward different liner resins/structures is examined. 6 refs.

JAPAN; SWITZERLAND; USA; WESTERN EUROPE

*Accession no.645361*

*Item 165*
Utech Asia '97. Conference proceedings.
Suntec City, 18th-20th Feb.1997, Paper 15. 43C6
**COST REDUCTION FOR FLEXIBLE FOAM; EMPLOYING CO2 AS BLOWING AGENT IN CONJUNCTION WITH GBE 2000/CO2 METERING UNITS**
Bauer A
Krauss-Maffei Kunststofftechnik GmbH
Edited by: Reed D; Ward S
(Crain Communications Ltd.; Rapra Technology Ltd.)

For some time now, CO2 has been employed with slabstock foam production as a relatively easy to handle and environmentally friendly blowing agent. With the production of mouldings, however, and the different demands, employment of CO2 as a blowing agent has only materialised fairly recently. From the technical aspect there are several possibilities for CO2 metering, which differ clearly with regard to investment costs, retrofitting suitability to existing plant, production reliability and safety, foam quality, etc. After considering all aspects of importance to the processor, Krauss Maffei has decided to incorporate CO2 metering into one of the components in its day-tank. This process offers by far the best price/performance ratio and - with regard to maximum possible material savings under production conditions - is almost comparable to the processes employing liquid CO2. CO2 metering is achieved by modifications to the well-proven GHE 2000 metering unit.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

*Accession no.645347*

*Item 166*
Utech Asia '97. Conference proceedings.
Suntec City, 18th-20th Feb.1997, Paper 13. 43C6
**WATER BLOWN INTEGRAL SKIN FOAM WITH LOW DENSITY**
Kim K M; La M C
Hanwha BASF
Edited by: Reed D; Ward S
(Crain Communications Ltd.; Rapra Technology Ltd.)

In theory, the use of CFCs in blowing foam has contributed to ozone loss. Many integral skin foam producers have tried to develop new integral skin foam systems based on blowing agents such as HCFCs, pentane and water to phase out CFCs and recently many successful developments have been achieved in this area. However the use of HCFCs also has an effect on the loss of ozone, and the use of water has some problems, e.g. high density (600-700kg/cub.m ), insufficient skin layer, hard to texture, etc. In Korea, Hanwha BASF's customers wanted full water blown integral skin foam systems giving low density foams of 400kg/cub.m and with good skins similar to CFCs systems. To solve the high density problem of water blown systems, the company has developed a new system with a good skin and a foam density of 400kg/cub.m using water as a

 

blowing agent. Details are given of a water blown PU integral skin foam system which meets the performance of the CFCs systems at the same densities (400 kgcub.m).

KOREA

*Accession no.645345*

*Item 167*

Polyurethanes Expo '96. Conference Proceedings. Las Vegas, Nv., 20th-23rd Oct.1996, p.349-55. 43C6

**FIRE RESISTANT ALL WATER BLOWN POLYISOCYANURATE FOAM**

Moriya K; Naruse A; Kurita M; Sasaki K
Nippon Polyurethane Industry Co.Ltd.
(SPI,Polyurethane Div.)

Formulations were developed for the manufacture of highly fire resistant water blown polyisocyanurate foams for thermal insulation applications. The foams were characterised for combustibility, oxygen index, smoke emission, thermal conductivity, density, compression strength and dimensional stability. Studies were made of the relationship between isocyanate index and absorption of isocyanurate end groups and of the effects of polyol functionality on dimensional stability and smoke density and of surfactants and catalysts on trimerisation. 12 refs.

JAPAN; USA

*Accession no.643075*

*Item 168*

Polyurethanes Expo '96. Conference Proceedings. Las Vegas, Nv., 20th-23rd Oct.1996, p.334-42. 43C6

**SILICA ADDITIVE SYSTEMS FOR POLYURETHANE AND POLYISOCYANURATE FOAMS**

Okoroafor M O; McDonald W H; Wang A E; Kresta J E; Tabakovic R; Yao X; Ashida K; Frisch K C
PPG Industries Inc.; Detroit,Mercy University
(SPI,Polyurethane Div.)

Silica/surfactant combinations were evaluated as additives in the preparation of rigid PU and polyisocyanurate foams using HCFC-141b or pentane, cyclopentane, isopentane and mixtures thereof as blowing agents. Effects on thermal conductivity before and after ageing and on density, closed cell content, compression strength and dimensional stability were investigated. 7 refs.

USA

*Accession no.643073*

*Item 169*

Polyurethanes Expo '96. Conference Proceedings. Las Vegas, Nv., 20th-23rd Oct.1996, p.320-4. 43C6

**MODIFIED CASTOR OIL: A VERSATILE POLYOL FOR RIGID POLYURETHANE FOAM APPLICATIONS**

Heinemann T; Scholl H J; Welte R
Bayer AG
(SPI,Polyurethane Div.)

Castor oils for use as polyols for rigid PU foams were chemically modified with low molecular weight compounds having different functionalities and containing hydroxyl or amino groups. The modified castor oils obtained were characterised by a broad spectrum of hydroxyl numbers, functionalities and viscosities. The hydroxyl numbers were increased and the amount of primary hydroxyl groups could be adjusted through the nature of the compounds used for modification. Foams were produced using different blowing agents from formulations in which the modified castor oils were used as the sole polyol component or in combination with other polyols, and were characterised for density, open cell content, flow, thermal conductivity and compression strength. 4 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; USA; WESTERN EUROPE

*Accession no.643070*

*Item 170*

Polyurethanes Expo '96. Conference Proceedings. Las Vegas, Nv., 20th-23rd Oct.1996, p.253-6. 43C6

**NEW DEVELOPMENTS IN WATER-BLOWN INTEGRAL SKIN POLYURETHANES**

Madaj E J
Bayer Corp.
(SPI,Polyurethane Div.)

Developments in Bayer's Bayflex water-blown integral skin PU foams are described, with particular reference to systems used in footwear soling applications. Methods for promoting skin formation and improving abrasion resistance and flexural properties are discussed. 3 refs.

USA

*Accession no.643062*

*Item 171*

Polyurethanes Expo '96. Conference Proceedings. Las Vegas, Nv., 20th-23rd Oct.1996, p.205-13. 43C6

**REDUCED DENSITY, INCREASED STRENGTH CARBON DIOXIDE BLOWN FOAM**

Nichols J B; Latham I; Jackson H
Dow Chemical Co.
(SPI,Polyurethane Div.)

An experimental design approach was used to develop carbon dioxide blown open cell PU foams having good processability and dimensional stability and increased compression strength, while maintaining or reducing the in-place density usually obtained with CFC-11/HCFC-141b blown systems. The studies resulted in the development of an aliphatic, trifunctional polyether polyol which used higher levels of water and gave open cell foams with a 10-15% reduced density, good dimensional stability at elevated temperatures and acceptable compression strength. 7 refs.

USA

*Accession no.643056*

*Item 172*
Polyurethanes Expo '96. Conference Proceedings.
Las Vegas, Nv., 20th-23rd Oct.1996, p.179-89. 43C6
**LOW DENSITY ALL WATER-BLOWN RIGID FOAM FOR POUR-IN-PLACE APPLICATIONS**
Kaplan W A; Neill P L; Staudte L C; Brink C J
Stepan Co.
(SPI,Polyurethane Div.)

The dimensional stability of low density, water blown rigid PU foams for pour-in-place thermal insulation applications was improved by the use of a phthalic anhydride based polyester polyol containing a dispersed cell opening agent. The foam systems obtained allowed some of the carbon dioxide to be released through the cell windows immediately after filling of the cavity, and to be rapidly replaced by air. Studies were made of the flowability, density, open cell content, dimensional stability, mechanical properties, thermal conductivity and adhesion (particularly to flame treated PE) of these foams. These properties were examined in comparison with those of HCFC-141b blown foams. 21 refs.

USA

*Accession no.643053*

*Item 173*
Polyurethanes Expo '96. Conference Proceedings.
Las Vegas, Nv., 20th-23rd Oct.1996, p.170-3. 43C6
**HFC-245FA AS A BLOWING AGENT FOR WATER HEATER FOAM INSULATION**
McGee I E; Dobransky M A; Ingold K A
Bayer Corp.
(SPI,Polyurethane Div.)

HFC-245fa was evaluated as a blowing agent in hand mixed and machine processed PU foams for use as insulation for water heaters. The density, cell structure, compression strength, dimensional stability and thermal conductivity of the foams compared favourably with those of HCFC-141b blown systems. The results of 24 hour simulated use tests in water heaters were nearly equivalent. 2 refs.

USA

*Accession no.643051*

*Item 174*
Polyurethanes Expo '96. Conference Proceedings.
Las Vegas, Nv., 20th-23rd Oct.1996, p.164-8. 43C6
**TWO YEARS OF INDUSTRIAL EXPERIENCE WITH LIQUID CARBON DIOXIDE BLOWN SLABSTOCK FOAMS**
Taverna M; Meloth H; Griffiths T
Cannon Group; CarDio BV
(SPI,Polyurethane Div.)

The CarDio process developed by Cannon Group for the manufacture of flexible slabstock PU foams using liquid carbon dioxide as blowing agent is examined. The density, cell structure and mechanical properties of the foams are compared with those of CFC-11 and methylene chloride blown systems. The economics of the process and the availability of licences and computer aided formulation software are also discussed.

LEGGETT & PLATT; TG CELLSOFT LTD.
BELGIUM; EUROPEAN COMMUNITY; EUROPEAN UNION; ITALY; USA; WESTERN EUROPE

*Accession no.643050*

*Item 175*
Polyurethanes Expo '96. Conference Proceedings.
Las Vegas, Nv., 20th-23rd Oct.1996, p.144-9. 43C6
**OPTIMIZATION OF LIQUID CARBON DIOXIDE BLOWN FLEXIBLE SLABSTOCK FOAM BY SILICONE SURFACTANTS**
Burkhart G; Zellmer V; Borgogelli R
Goldschmidt Th.,AG; Goldschmidt Chemical Corp.
(SPI,Polyurethane Div.)

Laboratory methods used by Goldschmidt to develop silicone surfactants for flexible slabstock PU foams produced using liquid carbon dioxide as blowing agent are described. Based on these evaluations, an experimental universal surfactant (EP-H-100) was developed and its effects on froth stability, cell structure and flammability performance were studied.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; USA; WESTERN EUROPE

*Accession no.643047*

*Item 176*
Polyurethanes Expo '96. Conference Proceedings.
Las Vegas, Nv., 20th-23rd Oct.1996, p.136-43. 43C6
**APPLICATION OF THE CO-2 PROCESS TO THE MAJOR METHODS OF CONTINUOUS FLEXIBLE SLABSTOCK PRODUCTION**
Blackwell J B; Buckley G; Blackwell S W
Beamech Group Ltd.
(SPI,Polyurethane Div.)

The principles of the CO-2 continuous foaming technology (Beamech Group) using liquid carbon dioxide blowing agent are described, and its application to the Maxfoam/Varimax, Vertifoam and continuous inclined conveyor processes for the manufacture of flexible slabstock PU foams is examined. 10 refs.

VERTIFOAM INTERNATIONAL LTD.
EUROPEAN COMMUNITY; EUROPEAN UNION; UK; USA; WESTERN EUROPE

*Accession no.643046*

*Item 177*
Polyurethanes Expo '96. Conference Proceedings.
Las Vegas, Nv., 20th-23rd Oct.1996, p.98-104. 43C6
**AFFORDABLE METHOD FOR CHARGING AND MEASURING GASES IN POLYURETHANE STARTING FORMULATIONS**
Lehnert A B

Gusmer-Admiral Inc.
(SPI,Polyurethane Div.)

The theory of nucleation is discussed, and details are given of a method and apparatus developed by Gusmer-Admiral for measuring concentrations of gases in starting formulations for PU foam production. The technique is capable of measuring the quantity of soluble blowing agent present in the resin system. The data are shown on an operator interface as the percentage of blowing agent present. 5 refs.

USA

*Accession no.643042*

*Item 178*
Polyurethanes Expo '96. Conference Proceedings.
Las Vegas, Nv., 20th-23rd Oct.1996, p.57-61. 43C6
**IMPROVED LOW THERMAL CONDUCTIVITY FINE CELL HCFC-141B APPLIANCE FOAM**
Venegas M H; Doerge H P
Bayer Corp.
(SPI,Polyurethane Div.)

The development of fine cell HCFC-141b blown polymeric MDI based PU foams for thermal insulation of freezers and refrigerators is described. The effects of water level, density and gel time on thermal conductivity were studied, and these variables were used as optimisation criteria for the production of foams having reduced thermal conductivity. The demould characteristics, cell size, density, thermal conductivity, machine reactivity, dimensional stability, compression strength and reverse heat leakage of the improved foams were investigated in comparison with a commercial HCFC-141b blown system. 2 refs.

USA

*Accession no.643035*

*Item 179*
Polyurethanes Expo '96. Conference Proceedings.
Las Vegas, Nv., 20th-23rd Oct.1996, p.48-52. 43C6
**REVIEW OF RECENT PROGRESS IN THE PROCESS DEVELOPMENT OF APPLIANCE INSULATION POLYURETHANE FOAM SYSTEMS**
Dean G H; Parenti V; Birch A J; Clavel P
Dow Europe SA
(SPI,Polyurethane Div.)

Results are presented of studies of the processing and properties of pentane blown PU foams, formulated with Voratec polyols (Dow Chemical), for use as thermal insulation in refrigerators. Reduced fill weights could be achieved by optimisation of the density distribution of the moulded foam, which could be related to the rise rate profile. The effects of mixing energy were quantified, and in most cases the best results were achieved when energies were high. Mould temperatures could significantly affect the flow and properties of the foam. Higher temperatures could show improvements, but only in combination with correct overpack percentages. The flow properties of a system could be improved, even at the expense of lambda value, while maintaining good energy consumption values. 5 refs.

DOW CHEMICAL CO.
SWITZERLAND; USA; WESTERN EUROPE

*Accession no.643033*

*Item 180*
Polyurethanes Expo '96. Conference Proceedings.
Las Vegas, Nv., 20th-23rd Oct.1996, p.29-34. 43C6
**USE OF SILICONE SURFACTANTS TO OPTIMIZE CYCLOPENTANE BLOWN APPLIANCE FOAM**
Fis J; Schumacher D W
OSi Specialties SA; Witco Corp.,OSi Specialties Group
(SPI,Polyurethane Div.)

Statistically designed experiments were used to identify silicone copolymer surfactants offering improved performance in cyclopentane blown rigid PU foams for use as thermal insulation in refrigerators. Structural models generated from the experimental design were used to design candidate surfactant structures for machine evaluations in a commercial appliance foam system. Surfactants giving optimised thermal conductivity, flowability, density distribution and compression strength were identified. 6 refs.

SWITZERLAND; USA; WESTERN EUROPE

*Accession no.643030*

*Item 181*
Polyurethanes Expo '96. Conference Proceedings.
Las Vegas, Nv., 20th-23rd Oct.1996, p.24-8. 43C6
**LOW K-FACTOR AND LOW DENSITY HCFC-141B APPLIANCE FOAM**
Doerge H P
Bayer Corp.
(SPI,Polyurethane Div.)

Low density PU foams for use as thermal insulation in refrigerators were produced using HCFC-141b as blowing agent, and their properties were compared with those of other HCFC-141b blown foams. The low density foams offered similar performance to a standard commercial appliance foam at an 8% lower density. Properties such as thermal conductivity, compression strength, short-term dimensional stability and long-term creep behaviour showed little differences. Compared to a commercial low density system, the new systems showed improved k-factor and compression strength at the same density. Both the initial and aged k-factors were improved by at least 3%. 3 refs.

USA

*Accession no.643029*

*Item 182*
Polyurethanes Expo '96. Conference Proceedings. Las Vegas, Nv., 20th-23rd Oct.1996, p.18-23. 43C6
**EVOLUTION OF HYDROCARBON BLOWN FORMULATIONS FOR DOMESTIC APPLIANCES APPLICATION**
Wacker W; Cappella A; Hoffmann W
Bosch-Siemens Hausgerate GmbH; ICI Polyurethanes (SPI,Polyurethane Div.)

Isopentane/pentane mixtures were used as blowing agents for PU foams for application as thermal insulation in refrigerators. Effects on foam density, compression strength, dimensional stability and thermal conductivity were investigated. Thermal conductivity was significantly reduced through the use of an isocyanate containing dispersed carbon black. 6 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; ITALY; USA; WESTERN EUROPE

*Accession no.643028*

*Item 183*
Patent Number: US 5563180 A 19961008
**CATALYST FOR POLYISOCYANURATE FOAMS MADE WITH ALTERNATIVE BLOWING AGENTS**
Skowronski M J; Trout K G
Celotex Corp.

Rigid, closed cell polyisocyanurate foams are prepared by reacting together a polyisocyanate and a polyester polyol or a mixture of a polyester polyol and at least one other isocyanate-reactive compound in the presence of: (a) a hydrogen-containing blowing agent or a mixture of a hydrogen-containing blowing and at least one co-blowing agent and (b) a catalyst mixture comprising (i) a carboxylate salt of an alkali metal or an alkaline earth metal or mixtures thereof, (ii) a quaternary ammonium carboxylate salt, and (iii) optionally a tertiary amine, where the mole ratio of carboxylate metal salt:tertiary amine is a value greater than about 2:1, and the total moles of quaternary ammonium carboxylate salt are less than the combined moles of the carboxylate metal salt and the tertiary amine.

USA

*Accession no.637250*

*Item 184*
Patent Number: US 5561171 A 19961001
**CATALYSTS WHICH STABILISE HYDROHALOCARBON BLOWING AGENT IN POLYISOCYANURATE FOAM FORMULATIONS DURING POLYMERISATION**
Demmin T R; Parker R C; Eibeck R E; Knopeck G M; Ruszaj D M
AlliedSignal Inc.

Disclosed are compositions comprising polyisocyanate, polyol, hydrohalocarbon blowing agent, surfactant and catalyst for polymerisation of the polyisocyanate and polyol. The catalyst is capable of decreasing the amount of decomposition of the blowing agent to haloalkenes during polymerisation of the polyisocyanate and polyol.

USA

*Accession no.637043*

*Item 185*
Patent Number: US 5552447 A 19960903
**RIGID CLOSED CELL POLYISOCYANATE BASED FOAMS FOR USE AS POSITIVE FLOTATION MATERIALS IN WATERCRAFT**
Green T J
BASF Corp.

A rigid closed cell polyisocyanate based foam is disclosed, for use as a positive flotation material for watercraft which meets the US Coast Guard immersion test (CGD 75-168, 33 C.F.R. No. 183.114). As a blowing agent for this foam, a mixture of 1,1,1,2-tetrafluoroethane (R-134a) as a frothing agent and water is used, where the amount of water is less than 2.5 wt.% based on the weight of the formulated polyol composition. Also, the polyols in the polyol composition are initiated by at least one amine; and the polyol composition contains a delayed action tertiary amine catalyst. The foams have excellent dimensional stability.

USA

*Accession no.633334*

*Item 186*
***Cellular Polymers***
16, No.2, 1997, p.110-49
**THERMAL CONDUCTIVITY OF ISOCYANATE-BASED RIGID CELLULAR PLASTICS: A TECHNIQUE FOR PREDICTING THE 25 YEAR VALUES**
Ball G W
British Rigid Urethane Foam Manufacturers' Assn.

The factors determining thermal conductivity of isocyanate-based rigid cellular plastics are reviewed. Research data are presented which were obtained from a programme conducted at Salford University, to establish the basis of a method based on an accelerated procedure for determination of thermal conductivity of these products which can be assumed to apply, without taking into account production variation, to a product over its 50-year life. The paper also discusses the merits of various other procedures claiming to produce 'realistic aged thermal conductivity values'.Evidence is provided that the product s made with these new blowing agents have similar thermal conductivities and similar thermal conductivity ageing characteristics to their CFC blown counterparts. 66 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; UK; WESTERN EUROPE

*Accession no.632134*

*Item 187*
Patent Number: US 5539006 A 19960723
**RIGID FOAMS WITH IMPROVED INSULATION AND PHYSICAL PROPERTIES**
Doerge H P; Ball E E; Schilling S L; Squiller E P
Bayer Corp.

Rigid PU foams having good demould and insulation properties are produced by reacting an organic polyisocyanate with a sucrose-based polyether polyol in the presence of a catalyst and a blowing agent, such as a hydrogen-containing chlorofluorocarbon, hydrogen-containing fluorocarbon or mixture thereof.

USA

*Accession no.629510*

*Item 188*
Patent Number: US 5532283 A 19960702
**AZEOTROPIC COMPOSITIONS OF 1,1,1,4,4,4-HEXAFLUOROBUTANE AND 2-METHYL BUTANE AND THE USE THEREOF IN THE PRODUCTION OF FOAMS**
Werner J; Kane S A; Boonstra E F; Doerge H P
Bayer Corp.

Azeotropic compositions made up of from about 64-80% by weight of 1,1,1,4,4,4-hexafluorobutane and from about 20-36% by weight of 2-methyl butane have been found to be particularly useful as blowing agents for the production of polyurethane foams.

USA

*Accession no.628412*

*Item 189*
Patent Number: US 5164419 A 19921117
**BLOWING AGENT AND PROCESS FOR PREPARING POLYURETHANE FOAM**
Bartlett P L; Creazzo J A
DuPont de Nemours E.I.,& Co.Inc.

The use of 1,1-difluoroethane (HFC-152a) with a minimum amount of water, preferably in the absence of water, as the blowing agent is disclosed as an efficient route to a rigid, closed-cell PU or polyisocyanurate foam with improved cell structure and excellent insulation properties.

USA

*Accession no.625051*

*Item 190*
Patent Number: US 5496869 A 19960305
**METHODS AND COMPOSITIONS FOR PREPARING RIGID FOAMS WITH NON-CHLOROFLUOROCARBON BLOWING AGENTS**
Williams S; Kaplan W; Neill P; Chapa G
Stepan Co.

Disclosed are methods and compositions for preparing rigid foams by contacting a polyisocyanate with a polyol mixture comprising (a) from about 40-95 wt.% of a polyester or polyether polyol; (b) a catalytic amount of a catalyst system comprising a primary catalyst and an amino acid salt catalyst derived from sarcosine; and (c) a non-chlorofluorocarbon blowing agent.

USA

*Accession no.621980*

*Item 191*
***Journal of Cellular Plastics***
32, No.6, Nov/Dec.1996, p.601-16
**COMPRESSION CREEP AND LONG TERM DIMENSIONAL STABILITY IN APPLIANCE RIGID FOAM**
Yourd R A
Bayer Corp.

Dimensional stability has always been a critical issue for appliance rigid PU foam. There are three factors which play an important role in dimensional stability. First is the condensation of the blowing agent which results in a loss of cell pressure and a shrinkage force on the foam. Blowing agents with higher boiling points condense sooner and generate a larger decrease in cell gas pressure than blowing agents with lower boiling points. Blowing agents that are gases do not condense at all, and their change in cell gas pressure on cooling is minimal. The second factor affecting dimensional stability is ageing or the diffusion of carbon dioxide out of the cells of the foam. Carbon dioxide diffuses out of the cells faster than other blowing agents, resulting in an additional loss of cell pressure. Carbon dioxide, generated from water in the formulation, generally comprises a relatively small portion of the cell gases and, therefore, its effect on dimensional stability in appliance rigid foams is less important. However, in formulations high in water, water's contribution to dimensional instability can be more pronounced. The third factor affecting dimensional stability of the foam is the effect of the blowing agent on the mechanical properties of the foam. 14 refs.

USA

*Accession no.617451*

*Item 192*
Patent Number: US 5506275 A 19960409
**1,1,1,2-TETRAFLUOROETHANE AS A BLOWING AGENT IN INTEGRAL SKIN POLYURETHANE SHOE SOLES**
Valoppi V L
BASF Corp.

The above compound (HFC-134a) may be used alone or in combination with water, as a blowing agent, in flexible integral skin foam, which exhibits physical properties, such as resistance to abrasion and cracking on flex,

comparable to conventional chlorinated fluorocarbon blown foams.

USA

*Accession no.610354*

*Item 193*

Patent Number: WO 9518176 A1 19950706

**FOAMABLE COMPOSITION CONTAINING UNSATURATED PERFLUORINATED BLOWING AGENT**

Dams R J; Flynn R M; Focquet K; Gasper A J; Owens J G

Minnesota Mining & Mfg.Co.

Foamable compositions comprise (a) at least one normally liquid, unsaturated perfluorinated blowing agent compound selected from the group consisting of perfluoroolefin compounds, e.g. perfluoro(4-methylpent-2-ene), perfluoroaromatic compounds, e.g. hexafluorobenzene, and perfluorocycloolefin compounds, e.g. perfluorocyclohexene, the perfluoroolefin compounds optionally containing one or more catenary heteroatoms; and (b) at least one foamable polymer or the precursors of at least one foamable polymer. The compositions are useful in preparing polymeric, e.g. polyurethane, foams.

USA

*Accession no.609690*

*Item 194*

Utech 96. Conference Proceedings.
Hague, 26th-28th March 1996, Paper 38, pp.8. 43C6

**CHARACTERISTICS OF SURFACTANTS FOR USE WITH NEW PROCESSES USING CARBON DIOXIDE AS AN AUXILIARY BLOWING AGENT**

McVey S B; Hilker B L; Lawler L F

Osi Specialities Inc.

(Crain Communications Ltd.; Rapra Technology Ltd.)

The mechanical and chemical differences between conventional and carbon dioxide based foaming processes for polyurethanes indicate that the role of the silicone surfactant is process dependent. The effect of surfactant additives on surface tension, emulsification, froth/bubble formation and stability and foam stability characteristics are studied in order to optimise the systems which use carbon dioxide as an auxiliary blowing agent. In the carbon dioxide blown foams, surfactants with a low froth density and moderate froth stability gave foams with acceptable cell size and uniformity. Surface tension information has not yet been correlated with carbon dioxide blown foams. 6 refs.

USA

*Accession no.609248*

*Item 195*

Utech 96. Conference Proceedings.
Hague, 26th-28th March 1996, Paper 32, pp.6. 43C6

**COMPARISON OF THE VPF AND LIQUID CARBON DIOXIDE FOAMING PROCESSES**

Blackwell J B; Bickley G; Blackwell S W

Beamech Group Ltd.

(Crain Communications Ltd.; Rapra Technology Ltd.)

The systems which have been developed for environmentally friendly continuous flexible PU slabstock foam manufacture are outlined. These include variable pressure foaming (VPF), liquid carbon dioxide addition into the mixing head, rapid cooling processes and alternative blowing agent technologies (methylene chloride or acetone). A comparison of VPF and one of the systems for liquid carbon dioxide addition into the mixing head (the Beamech CO-2 process) was carried out. On the basis of results obtained for the production range of grades, the economics of production, process improvements and environmental comparisons, the authors concluded that the VPF foaming process showed advantages over the use of liquid carbon dioxide. 12 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; UK; WESTERN EUROPE

*Accession no.609242*

*Item 196*

Utech 96. Conference Proceedings.
Hague, 26th-28th March 1996, Paper 31, pp.6. 43C6

**BLOWING FLEXIBLE SLABSTOCK WITH LIQUID CARBONIC ACID: PROGRESS WITH TECHNOLOGY**

Eiben R G

Bayer AG

(Crain Communications Ltd.; Rapra Technology Ltd.)

The use of carbonic acid as an environmentally friendly and economical auxiliary blowing agent for flexible PU slabstock foam manufacture is discussed, with reference to Hennecke's NovaFlex liquid carbon dioxide system. The use of this system enables low density foam grade to be produced and it decreases hardness and improves resilience, while maintaining the same density. The PU blocks show an even cell size distribution throughout the whole cross section. The NovaFlex system is outlined. It can be adapted to the customer's needs and existing machine layout.

HENNECKE GMBH

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

*Accession no.609241*

*Item 197*

Utech 96. Conference Proceedings.
Hague, 26th-28th March 1996, Paper 30, pp.8. 43C6

**TWO YEARS OF INDUSTRIAL EXPERIENCE WITH LIQUID CARBON DIOXIDE-BLOWN SLABSTOCK FOAMS**

Taverna M; Meloth H; Griffiths T

Cannon Group; CarDio BV

(Crain Communications Ltd.; Rapra Technology Ltd.)

The results are presented of two years of industrial use of CarDio, the Cannon Group's technology for using liquid carbon dioxide as blowing agent in the manufacture of flexible slabstock PU foams. The physical properties of CarDio blown foams are compared with those of methylene chloride- and CFC-11-blown foams. CarDio foams show a combination of good physical properties and easy processability. Several foam producers in Europe and in the USA are using the technology to produce environmentally safe foam at a competitive price.

EUROPE-GENERAL; EUROPEAN COMMUNITY; EUROPEAN UNION; ITALY; NETHERLANDS; USA; WESTERN EUROPE

*Accession no.609240*

*Item 198*
Utech 96. Conference Proceedings.
Hague, 26th-28th March 1996, Paper 11, pp.6. 43C6
**LIQUID CARBON DIOXIDE BLOWN FOAM FOR AUTOMOTIVE FLEXIBLE MOULDING**
Noakes C W; Casagrande G
Dow Europe SA; Dow Italia SpA
(Crain Communications Ltd.; Rapra Technology Ltd.)

Experiments were carried out using Cannon's CannOxide liquid carbon dioxide process with TDI and MDI based high resilience moulded polyurethane foams. These foams were compared with conventional water blown foams at the same density and at the same density and hardness. The use of liquid carbon dioxide injection for both TDI and MDI based foams resulted in weight reductions of 12-18%. The addition of SPECFLEX NC 650 copolymer polyol was necessary to obtain the same foam hardness as the reference foams, but other physical properties were largely unchanged, even at reduced densities. The physical properties of the foams were better than those of water blown foams of similar density. The advantages of liquid carbon dioxide injection for foam production were discussed with reference to automotive seating and furniture applications. 8 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; ITALY; SWITZERLAND; WESTERN EUROPE

*Accession no.609221*

*Item 199*
Utech 96. Conference Proceedings.
Hague, 26th-28th March 1996, Paper p, pp.10. 43C6
**NEW POLYOLS FOR IMPROVED AUTOMOTIVE SEATING DURABILITY PERFORMANCE**
Brasington R; Kinkelaar M R; Cavender K D
ARCO Chemical Products Europe; ARCO Chemical Co.
(Crain Communications Ltd.; Rapra Technology Ltd.)

The durability of cold moulded TDI-based high resilience foam was tested. From test blocks representative of a current technology polyol system, the first generation experimental polyol system (EP1) and the second generation experimental system (EP2) were tested at densities of 60 and 40 kg/cu.m. Results were also obtained from commercial MDI seat cushion foams. The results showed that the new experimental polyol systems showed an improvement in durability compared with current cold moulded foam, even under high humidity conditions. Machine made EP1 foams compared favourably with MDI production foams in terms of both durability and sensitivity to change in temperature. Dynamic modulus and hysteresis changes with time were significantly less pronounced with EO1 foam than with MDI foams. Height and load losses were smaller with the new TDI foam and fatigue also had a much smaller effect on vibrational transmissivity compared with MDI production foam. It was shown that the new TDI foams performed as well, or better, at reduced density than systems currently used in the industry. 9 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; FRANCE; USA; WESTERN EUROPE

*Accession no.609219*

*Item 200*
Utech 96. Conference Proceedings.
Hague, 26th-28th March 1996, Paper 8, pp.8. 43C6
**LOW-DENSITY, HIGH-RESILIENCE FOAMS FOR AUTOMOTIVE SEATING BASED ON TDI**
Pique S
Dow Europe SA
(Crain Communications Ltd.; Rapra Technology Ltd.)

TDI-based high resilience moulding is the main moulding technology used in North America for the production of flexible PU parts for automotive seating, but in Europe and Japan, the hot moulding and MDI-based cold moulding processes predominate. Possible reasons for this are discussed. The development of specifically designed polyols and copolymer polyols, combined with formulation optimisation for specific application requirements, allows foam manufacturers to meet the specifications of most original equipment manufacturers at densities between 30-45 kg/cu.m. 3 refs.

FIAT AUTO SPA; RENAULT SA; TOYOTA MOTOR CORP.; VOLKSWAGEN AG; DAIMLER-BENZ AG; FORD MOTOR CO.; PEUGEOT SA; GENERAL MOTORS CORP.; OPEL AG

EUROPE-GENERAL; JAPAN; NORTH AMERICA; SWITZERLAND; WESTERN EUROPE

*Accession no.609218*

*Item 201*
Utech 96. Conference Proceedings.
Hague, 26th-28th March 1996, Paper 71, pp.6. 43C6
**INNOVATIVE PANEL MANUFACTURING SYSTEM FOR A "REEFER" FACTORY**
Taverna M; Spanio G
Cannon Group
(Crain Communications Ltd.; Rapra Technology Ltd.)

Recent developments in the manufacturing technologies used to produce the various available configurations of

rigid faced panels are discussed, with special reference to the automated manufacture of large panels for insulated containers. The panels are sandwich structures in which a core of PU foam is lined with two facings of protective materials. By changing the foam and the type of facings, panels can be produced for thermal insulation (for which thermal properties are important) and for construction (for which mechanical properties are more important). The use of different blowing agents to expand the foam and fill the panels is discussed, together with the costs.

MAERSK CONTAINER INDUSTRI AS

EUROPEAN COMMUNITY; EUROPEAN UNION; ITALY; WESTERN EUROPE

*Accession no.609010*

*Item 202*

Utech 96. Conference Proceedings.
Hague, 26th-28th March 1996, Paper 70, pp.6. 43C6

**STATE OF THE ART OF PIPE INSULATION**

Schlenter B E
Shell Louvain-la-Neuve
(Crain Communications Ltd.; Rapra Technology Ltd.)

The production techniques for pipes which are pre-insulated with PU foam are described and discussed. The systems must fulfil several requirements, including excellent flow properties, excellent adhesion to the inner steel pipe and outer HDPE pipe, low thermal conductivity of the foam and a good heat resistance of the pipe system. The use of fully water blown foam systems, dual blown HCFC systems (using water and a blowing agent such as HCFC-141b) and dual blown pentane systems (using water with pentane isomer as the physical blowing agent) is discussed.

BELGIUM; EUROPEAN COMMUNITY; EUROPEAN UNION; WESTERN EUROPE

*Accession no.609009*

*Item 203*

Utech 96. Conference Proceedings.
Hague, 26th-28th March 1996, Paper 68, pp.6. 43C6

**DEVELOPMENT OF CFC-FREE POLYURETHANE MODIFIED ISOCYANURATE FOAMS WITH IMPROVED PROCESSABILITY FOR CONTINUOUS LAMINATION**

Bonapersona V; Javarone C
ICI Polyurethanes
(Crain Communications Ltd.; Rapra Technology Ltd.)

CFC-free polyurethane-modified isocyanurate foam systems and the use of polyester polyols can meet the processability requirements of the European insulation laminate producers. HCFC-141b blown and hydrocarbon blown formulations have been developed. These systems can maximise foam fire resistance or reduce the need for expensive flame retardants. 6 refs.

EUROPE-GENERAL; EUROPEAN COMMUNITY; EUROPEAN UNION; ITALY; USA; WESTERN EUROPE

*Accession no.609007*

*Item 204*

Utech 96. Conference Proceedings.
Hague, 26th-28th March 1996, Paper 67, pp.4. 43C6

**IMPACT OF THE CFC-ISSUE ON RIGID POLYURETHANE FOAM FOR CONSTRUCTION APPLICATIONS**

Van den Bosch R
Dow Benelux NV
(Crain Communications Ltd.; Rapra Technology Ltd.)

The impact on construction applications of replacing CFCs as blowing agents for rigid PU foam is discussed with reference to the thermal efficiency, dimensional stability, combustion modification and cost of rigid PU foam insulation products. 4 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; NETHERLANDS; WESTERN EUROPE

*Accession no.609006*

*Item 205*

Utech 96. Conference Proceedings.
Hague, 26th-28th March 1996, Paper 60, pp.10. 43C6

**NOVEL DEVELOPMENTS USING PURE ISO-PENTANE BLOWING AGENT IN APPLIANCE MANUFACTURE**

Parenti V; Burch A J; Dean G H; Clavel P
Dow Europe SA
(Crain Communications Ltd.; Rapra Technology Ltd.)

Cyclopentane has become well established in Europe as a blowing agent for rigid PU foams for the insulation of refrigeration appliances. Developments are described which have resulted in a system blown entirely by isopentane, giving enhanced insulation performance, flowability and demould properties. Improvements in the polyol formulation have made it possible to maintain blend stability in the machine tank. The performance of isopentane blown systems is compared with CFC-11 50% reduced, cyclopentane and iso-/n-pentane blown reference materials. The results for the processing properties, thermal insulation performance and long-term dimensional stability of the foams confirm the theoretical prediction that isopentane used as a sole blowing agent gives the best overall results. 7 refs.

SWITZERLAND; WESTERN EUROPE

*Accession no.609000*

*Item 206*

Utech 96. Conference Proceedings.
Hague, 26th-28th March 1996, Paper 57, pp.8. 43C6

**NEW SILICONE SURFACTANTS FOR RIGID POLYURETHANE FOAM**

Frey J H; Grimminger J; Stevens R E
Air Products & Chemicals Inc.
(Crain Communications Ltd.; Rapra Technology Ltd.)

The heat of hydration technique is described. This is a new technique for evaluating silicone surfactant polarity in order to select appropriate surfactant structures for new

rigid PU foam formulations for specific applications. Two new silicone surfactants have been developed for non-CFC blowing agents for rigid PU foam. Dabco DC5604 surfactant has been designed to provide an optimal balance of thermal and mechanical properties for HCFC-141b/water co-blown and all-water blown rigid PU systems. An experimental surfactant, XF-J2557, was developed to provide better emulsification, finer cell structure and improved flame retardancy for n-pentane blown rigid PU foam lamination formulations. 12 refs.

USA

*Accession no.608997*

*Item 207*

Utech 96. Conference Proceedings.
Hague, 26th-28th March 1996, Paper 56, pp.6. 43C6

**INCREASING THE SOLUBILITY OF PENTANE IN RIGID FOAM SYSTEMS**

Chittolini C
Ediltec Srl
(Crain Communications Ltd.; Rapra Technology Ltd.)

For ecological reasons, PU rigid foams used for insulation in appliances, refrigeration industry panels and continuous laminating panels are now produced using pentane as a blowing agent rather than CFC-11 or HCFC-141b. However, the low solubility of pentane and the low stabilty of emulsions of pentane and polyols have caused processing problems. This paper describes how homogeneous solutions of the pentane/polyol components can be obtained using Kytane 20 A.S. (a proprietary blend of alkanolamides) which is soluble in pentane and in a wide range of polyols used for rigid foams. Kytane 20 A.S. acts as a vehicle to introduce more pentane into the polyol component, resulting in easy processing and good foam characteristics. 4 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; ITALY; WESTERN EUROPE

*Accession no.608996*

*Item 208*

Utech 96. Conference Proceedings.
Hague, 26th-28th March 1996, Paper 55, pp.14. 43C6

**HFC-245FA: A NONFLAMMABLE, LIQUID BLOWING AGENT FOR RIGID POLYURETHANE FOAMS**

Williams D J; Parker R C; Bogdan M C
Allied-Signal Inc.
(Crain Communications Ltd.; Rapra Technology Ltd.)

HFC-245fa (1,1,1,3,3-pentafluoropropane) is a potential long-term replacement blowing agent for HCFC-141b in rigid PU foams used for thermal insulation. This liquid HFC has a low order of acute toxicity, is environmentally acceptable and is stable in the presence of common foam raw materials and materials of construction. HFC-245fa has produced foams with excellent processability, physical properties equal to or better than those of HCFC-141b blown foams, good thermal conductivity values and good ageing properties. 3 refs.

USA

*Accession no.608995*

*Item 209*

***Journal of Cellular Plastics***
32, No.2, March/April 1996, p.159-71

**DETERMINATION OF THE BLOWING AGENT DISTRIBUTION IN RIGID POLYURETHANE FOAM**

Svanstrom M; Ramnas O
Chalmers University of Technology

The amount and distribution of blowing agent in rigid PU foam were determined by several methods. A method involving solvent extraction with subsequent gas chromatographic analysis was developed and found to be advantageous for CFC-blown foam, together with a combustion method in which the chloride ions formed were determined by titration. The solvent extraction method was also successfully applied to blowing agents in CFC-free foams. Three methods involving heating and weight loss determination were evaluated. They were easy to use, but corrections for thermal decomposition of the polymer were required. About half the total amount of CFC-11 in the studied PU foams from district heating pipes was found to be dissolved in the polymer matrix. 15 refs.

SCANDINAVIA; SWEDEN; WESTERN EUROPE

*Accession no.600790*

*Item 210*

***Rubber World***
214, No.3, June 1996, p.45

**PU SLABSTOCK MACHINE**

Foam One Systems from Edge-Sweets are capable of manufacturing round blocks 5ft in diameter and rectangular blocks 8x7ft. Foam One is capable of manufacturing the full range of flexible PU foams without the use of auxiliary blowing agents. A laboratory development machine for Foam One is also available. This unit can be used without licence for the development and investigation of the variable pressure foaming process. This abstract includes all the information contained in the original article.

EDGE-SWEETS CO.
USA

*Accession no.598544*

*Item 211*

Utech '92. Conference proceedings.
Hague, 31st March-2nd April 1992, p.286-9. 43C6

**DEVELOPMENT OF CFC-FREE INTEGRAL SKIN FOAM FOR STEERING WHEELS**

Hobby R T; Heather M; Christfreund A; Dobinson D P

UTA Clifford; ICI Polyurethanes
(Crain Communications Ltd.)

The elimination of CFC- II in the manufacture of integral skin foam (ISF) remains a challenge for the polyurethanes industry. The use of HFA-22, which has significantly lower ozone depletion potential, is a step in the right direction but is not the ultimate solution. HFA-123, pentane and water blowing have been evaluated as potential alternatives. But each change in the chemical system results in the need for other modifications. Integration of all these into the manufacturing process places severe pressure on the steering wheel producer, working inside increasingly stringent time constraints. UTA Clifford and ICI Polyurethanes have recognised that further development of water-blowing technology is the preferred way forward, and that the fastest route to solve these pressing problems is through close partnership. So, a joint development programme has been undertaken, using statistical design of experiment techniques. This has proved to he a powerful approach, significantly reducing development time and providing an optimum solution. Confirmation has been obtained during a pre-production trial at UTA-Clifford, when a wide range of steering wheels was successfully produced. The optimised system is fully acceptable when used in combination with an in-mould coating; UTA Clifford will commercialise the technology in 1992.

BELGIUM; EUROPEAN COMMUNITY; EUROPEAN UNION; UK; WESTERN EUROPE

*Accession no.594679*

*Item 212*
Utech '92. Conference proceedings.
Hague, 31st March-2nd April 1992, p.272-6. 43C6
**VERSATILE AND COMPREHENSIVE APPROACH TO CFC-FREE POLYURETHANE HOT MOULDING**
Pique S
Polyol International BV
(Crain Communications Ltd.)

One of the most interesting features of PU hot moulding is the possible production of a wide variety of foam grades, ranging from very soft, low density foams for automotive rear backrests, to high load-bearing, high density foams for front seats, of various sizes, thickness and complexity. The manufacture of such a broad range of products traditionally requires, apart from the use of copolymer polyols for the hard grades, levels of auxiliary blowing agents like CFC-II, of up to 18 pph polyol for softer grades. The ways in which it is possible to virtually eliminate CFC-II from hot moulded foam production, while retaining the versatility of the process, are discussed. This is achievable, when replacing CFC by additional water blowing, by optimising the main PU intermediates and combining them with new types of specifically designed additives. Parallel to the use of a copolymer polyol specifically designed for hot-moulded foams, the performance achievable with a series of experimental polyol additives for CFC-elimination (as well as improved base polyols and isocyanates) are presented. It is shown how CFC-replacement is possible throughout the full density/hardness range covered by hot moulding today, and how the variety of solutions developed in our laboratories can respond to foam manufacturers' needs and production requirements.12 refs.

SWITZERLAND; WESTERN EUROPE

*Accession no.594676*

*Item 213*
Utech '92. Conference proceedings.
Hague, 31st March-2nd April 1992, p.252-5. 43C6
**MODIFIED TDI FOR NON-CFC FLEXIBLE FOAM WITH RECYCLABILITY**
Parrron J C
Rhone-Poulenc SA
(Crain Communications Ltd.)

The current high resilience moulded foams present a good level of properties. However the suppression of CFCs leads to higher densities and harder foams. The replacement of CFCs by HCFCs still seems uncertain and the adjunction of melamine to meet the combustion challenge reinforces the above mentioned effects. Thus, it is necessary to modify the foam components in order to realise the expansion with only water, in presence of melamine. Rhone-Poulenc proposes a modified TDI that allows to obtain, with standard polyols and without any CFC, low density foams with good softness. The addition of' melamine is then possible to comply with combustibility tests such as BS 5852 - CRIB 5 - Part 2. One more argument is, that, if the potential recyclability of the foam is considered, hydroglycolysis of such a foam gives only one amine: TDA, easily separable and recyclable in phosgenation process. 4 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; FRANCE; WESTERN EUROPE

*Accession no.594672*

*Item 214*
Utech '92. Conference proceedings.
Hague, 31st March-2nd April 1992, p.201-7. 43C6
**PRODUCTION OF CFC-FREE, LOW DENSITY COLD CURE MOULDED FOAMS**
Wehman C
Shell Research SA
(Crain Communications Ltd.)

A variety of routes is examined to achieve CFC elimination from flexible PU foam. The most promising from an environmental point of view are those based on all water-blown systems. These rely fully on the water-isocyanate reaction for the foam expansion, and the extra foam hardness due to an increase in polyurea is compensated for by a modification of the polymer. Two ways to approach this are by the use of specially designed

 

polyols or by the addition of foam softening agents such as CARAPOR 2001. The soft polyols have only a limited effect and can cause deterioration of some foam properties, especially compression set. The use of a softening additive has been proved to be very effective in slabstock and hot cure moulding but has been found to be of very limited use in cold cure moulding. In order to allow all water blown low density low hardness cold cure moulded foam to be produced another approach has been adopted. In this approach the optimum composition and concentration of the main components of a cold cure moulding formulation are established with regard to their contribution to lowering the hardness and density of the foam. Subsequently a catalyst system has been developed which gives both good processing and optimum values for the other foam properties. 14 refs.

BELGIUM; EUROPEAN COMMUNITY; EUROPEAN UNION; WESTERN EUROPE

*Accession no.594661*

*Item 215*
Utech '92. Conference proceedings.
Hague, 31st March-2nd April 1992, p.194-7. 43C6
**TECHNICAL ADVANCEMENTS IN THE ELIMINATION OF BLOWING AGENTS IN FLEXIBLE SLABSTOCK SYSTEMS**
Brumner K; Schrock A K
Dow Chemical Europe; Dow Chemical Co.
(Crain Communications Ltd.)

The international phase out of chlorofluorocarbons (CFCs) has made it almost impossible for flexible PU foam manufacturers to produce the variety of foam grades previously offered. Methylene chloride and hydrochlorofluorocarbons (HCFCs) as alternative blowing agents are regarded as only a short term solution by the industry, and suffer from economical as well as ecological pressure. The results of a new technology allowing the production of virtually all density and firmness grades of flexible foam without the use of volatile solvents as auxiliary blowing agents (ABA) are presented. Dow has developed a new polyol technology allowing the production of foams over a wide range of hardness levels in densities of 21 kg/m3 up to about 50 kg/m3 without added ABAs. Furthermore, this technology, in combination with a new additive, also allows the production of foams with densities as low as 18 kg/m3 at various hardness levels. The foam stability, processing latitude, and foam physical properties remain very good over the whole application range. This unique technology enables the foam manufacturer to produce a wide range of conventional foam grades with only one polyol and without the need of ABXS. Low density grades can also be produced at high hardness in combination with the novel additive and polymer polyols. 3 refs.

SWITZERLAND; USA; WESTERN EUROPE

*Accession no.594659*

*Item 216*
Utech '92. Conference proceedings.
Hague, 31st March-2nd April 1992, p.191-3. 43C6
**COMFORT CUSHIONING FROM ICI'S MDI-BASED FLEXIBLE SLABSTOCK TECHNOLOGY**
Casey M; Mueller L; Parfondry A; Elliot A
ICI Polyurethanes
(Crain Communications Ltd.)

Suppliers of flexible PU slabstock have been striving to satisfy the needs of the furniture and bedding markets and the manufacturers who supply them since the early 1950s. Major steps have been taken through the years to satisfy the various performance requirements. To date, the technology and end products have been built around the TDI molecule. The flexible slabstock industry has seen in the last 5 years an onslaught of environmental pressures which has challenged the industry to search for new technologies - some of these challenges include the elimination of CFCs, with alternative blowing methods such as methylene chloride still under close scrutiny. In Europe the desire to reach harmonisation of fire safety standards is currently posing a new set of demands on the industry to safeguard its reputation and dominance especially opposite the Furniture market. ICI specialises in MDI-based technologies and in the light of the environmental demands facing the flexible foam industry, ICI has made significant investment into the development of the Waterlily Comfort Cushioning range of MDI-based flexible PU slabstock foams which meet many of the quality, safety and environmental demands of the furniture and bedding industries.

USA

*Accession no.594658*

*Item 217*
Utech '92. Conference proceedings.
Hague, 31st March-2nd April 1992, p.182-7. 43C6
**CFC-FREE HIGH RESILIENCE SLABSTOCK FOAM BASED ON COPOLYMER POLYOLS**
Knaub P
Polyol International BV
(Crain Communications Ltd.)

Responding to the wider concern expressed in the world over the use of chlorofluorocarbons, Polyol International has undertaken a programme of research and development in its laboratory in Meyrin, Switzerland, aimed at eliminating chlorofluorocarbons in high resilience slabstock foams based on its copolymer polyols. The approach selected is to use carbon dioxide, obtained by the reaction of water and isocyanate as sole blowing agent. This environmentally friendly approach was preferred as it involves a minimum of changes in the production conditions and avoids the installation of expensive gas extraction and recycling systems, needed when using currently accepted blowing agents like methylene chloride. Due to current regulation activities in some

countries, certain blowing agents are not accepted for use in slabstock foam.

SWITZERLAND; WESTERN EUROPE

*Accession no.594656*

*Item 218*
Utech '92. Conference proceedings.
Hague, 31st March-2nd April 1992, p.42-5. 43C6
**RECENT ADVANCES IN ALL-MDI-BASED CFC-FREE FLEXIBLE FOAMS**
Murry D; Sparrow D; Tan A
ICI Polyurethanes
(Crain Communications Ltd.)

ICI Polyurethanes has put significant effort into reducing density, so increasing competitiveness, of all-MDI-based foams. This new generation of PU systems not only makes it possible to produce low density flexible foams in large and increasingly complex moulds, but also demonstrates improved physical properties, exceeding the stringent requirements of the industry. CFC-free combustion modified high resilience (CMHR) foams have now also been developed for the furniture industry capable of' meeting even the most stringent large scale ignition tests. One area of concentrated effort has been the development of vibration damping foams. While these foams have been developed to meet low resilience requirements, they still maintain all the benefits of traditional MDI cold-cure systems. The fast inherent reactivity of all-MDI-based cream foams not only allows for more rapid cure and thus shorter cycle times, but has also made it possible to develop systems containing low levels of catalysts leading to excellent fogging performance in automotive applications. The new systems, suitable for both conventional and foam-in-fabric applications, have been designed with recycling in mind. These key aspects are documented with specific examples, and the advantages of ICI Polyurethanes' latest generation of all-MDI-based foams are highlighted.

BELGIUM; EUROPEAN COMMUNITY; EUROPEAN UNION; WESTERN EUROPE

*Accession no.594627*

*Item 219*
Patent Number: US 5464882 A 19951107
**METHOD FOR INHIBITING THE DEGRADATION OF HYDROCHLOROFLUOROCARBONS UTILISED AS FOAMING AGENTS IN THE PREPARATION OF FOAMED POLYURETHANES AND POLYISOCYANURATES**
Basile G; Musso E; Tonelli C; Girolomoni S
Ausimont SpA

Degradation by dehydrohalogenation of blowing agents, such as mixtures of 123 and 123A, is inhibited by addition of a stabiliser, such as a nitromethane, nitroethane or 1-nitropropane, to the reaction medium prior to the start of reaction.

EUROPEAN COMMUNITY; EUROPEAN UNION; ITALY; WESTERN EUROPE

*Accession no.594065*

*Item 220*
Patent Number: US 5464879 A 19951107
**1,1,1,2-TETRAFLUOROETHANE AS A BLOWING AGENT IN INTEGRAL SKIN POLYURETHANE SHOE SOLES**
Valoppi V L
BASF Corp.

The above blowing agent may be used alone or in combination with water in flexible integral-skin foams exhibiting physical characteristics, such as resistance to abrasion and cracking on flex comparable to conventional chlorinated fluorocarbon blown foams.

USA

*Accession no.594062*

*Item 221*
Polyurethanes '95. Conference Proceedings.
Chicago, Il., 26th-29th Sept.1995, p.514-9. 43C6
**NEW SOLUTIONS FOR THE IMMEDIATE EXTRACTION OF N-PENTANE FROM INTEGRAL SKIN PU FOAM PIECES, AND WHICH SORT OF POSSIBLE SOLUTIONS SHOULD PLANTS UTILISING PENTANE HAVE**
Mersiadis G; Mariani V; Riva P
IFTA Canada Inc.; Impianti OMS SpA
(SPI,Polyurethane Div.)

A vacuum degassing appliance developed by Impianti OMS for the removal of residual pentane blowing agent from integral skin PU foam mouldings is described, and results are presented of gas chromatography studies undertaken to verify its efficiency. Machinery and safety systems produced by the Company for PU foam moulding using pentane as blowing agent are also examined.

CANADA; EUROPEAN COMMUNITY; EUROPEAN UNION; ITALY; USA; WESTERN EUROPE

*Accession no.592120*

*Item 222*
Polyurethanes '95. Conference Proceedings.
Chicago, Il., 26th-29th Sept.1995, p.501-5. 43C6
**FOR THE INSULATION OF DOMESTIC REFRIGERATORS, THE USE OF C-PENTANE HAS BECOME ALMOST AN INDUSTRY STANDARD: ITS USE, HOWEVER, DOES REQUIRE DEDICATED MACHINERY**
Mariani V; Mersiadis G
Impianti OMS SpA; IFTA Canada Inc.
(SPI,Polyurethane Div.)

The advantages of pentane as a blowing agent for PU foams for use as thermal insulation in refrigerators are

 

reviewed, and safety measures made necessary by the flammability and explosivity of this blowing agent are discussed. Processing machinery and safety systems developed by Impianti OMS are described.

CANADA; EUROPEAN COMMUNITY; EUROPEAN UNION; ITALY; USA; WESTERN EUROPE

*Accession no.592118*

*Item 223*
Polyurethanes '95. Conference Proceedings.
Chicago, Il., 26th-29th Sept.1995, p.491-6. 43C6
**LIQUID CARBON DIOXIDE BLOWN SLABSTOCK FOAMS: INDUSTRIAL RESULTS**
Fiorentini C; Taverna M; Griffiths T; Collins B
Cannon Afros Srl; Cannon Group; Cannon Viking; Cannon USA
(SPI,Polyurethane Div.)

The CarDio process developed by Cannon for the production of PU slabstock foams using liquid carbon dioxide as blowing agent is described. Experience of the use of the process in industry is reported, and technical, economic and environmental advantages are examined. Details are also given of the FoamKit computer aided formulation software developed for the process by TG Cellsoft.

MAPLES; NORDITALIA RESINE; VEENENDAAL; CARPENTER E.R.,CO.INC.; TG CELLSOFT LTD.
EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; ITALY; UK; USA; WESTERN EUROPE

*Accession no.592116*

*Item 224*
Polyurethanes '95. Conference Proceedings.
Chicago, Il., 26th-29th Sept.1995, p.484-8. 43C6
**PROCESSING SOLUTIONS FOR PENTANE BLOWN POLYURETHANE FOAMS IN THE REFRIGERATION SECTOR: A TECHNICAL MARKET UPDATE**
Taverna M; Corradi P; Biondich B
Cannon Group; Cannon Afros Srl; Cannon USA
(SPI,Polyurethane Div.)

The acceptance of cyclopentane as a blowing agent for PU foam insulation for refrigerators is examined on a regional basis, and advances in processing safety and foam performance are reviewed. Processing machinery developed by Cannon for PU foaming with cyclopentane is described.

EUROPEAN COMMUNITY; EUROPEAN UNION; ITALY; USA; WESTERN EUROPE; WORLD

*Accession no.592114*

*Item 225*
Polyurethanes '95. Conference Proceedings.
Chicago, Il., 26th-29th Sept.1995, p.481-3. 43C6
**PATENTED PENTANE PROCESS TECHNOLOGY: KEY TO US CYCLOPENTANE BLOWN REFRIGERATOR PRODUCTION**
Hanne D R; Hudson E; Pieper K H
Bayer Corp.; Hennecke Machinery; Frigidaire Co.; Maschinenfabrik Hennecke GmbH
(SPI,Polyurethane Div.)

The Cyclo-Flex and Lin-Flex systems developed by Hennecke for the foaming of refrigerator cabinets with pentane blown PU foam are described. A number of safety features designed to overcome potential hazards in the use of pentane are examined.

BAYER AG
EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; USA; WESTERN EUROPE

*Accession no.592113*

*Item 226*
Polyurethanes '95. Conference Proceedings.
Chicago, Il., 26th-29th Sept.1995, p.464-70. 43C6
**REDUCTION OF THERMAL CONDUCTIVITY IN HYDROCARBON BLOWN RIGID POLYURETHANE FOAMS**
Rotermund U; Knorr G; Seifert H; Wiegmann W
BASF Schwarzheide GmbH; Elastogran GmbH
(SPI,Polyurethane Div.)

Rigid PU foams with thermal conductivities comparable with those of 50% reduced CFC-11 blown foams were produced using an aromatic polyol and cyclopentane (CP) or its mixtures with other hydrocarbons as blowing agents. The formulations produced finer cells and increased the amount of material in the cell struts, and the ratio between CP and carbon dioxide concentration in the gas composition was increased. Certain mixtures of CP with other hydrocarbons or hydrofluorocarbons increased the blowing effect, thus reducing the density and thermal conductivity of the foams. These effects were explained by thermal conductivity measurements on gas mixtures. Good long-term dimensional stability was achieved due to the lower solubility of CP in the PU matrix compared with HCFC-141b and CFC-11. 14 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; USA; WESTERN EUROPE

*Accession no.592110*

*Item 227*
Polyurethanes '95. Conference Proceedings.
Chicago, Il., 26th-29th Sept.1995, p.459-63. 43C6
**ADVANCES IN FOAM ADHESION TO REFRIGERATOR LINERS AND OTHER SUBSTRATES**
Nichols J B; Bonekamp J; Miller R C
Dow Chemical Co.
(SPI,Polyurethane Div.)

A study was made of the effects of foam formulation and process conditions and liner composition on the adhesion of HCFC-141b blown rigid PU foam thermal insulation to refrigerator liner protective layers made of ABS, high-impact PS (HIPS), PE and blends of HIPS and PE

containing a compatibiliser and adhesion promoter. A tensile test was used to quantify the level of adhesion before and after thermal cycling, and the Brett mould was used for laboratory simulations of foam adhesion within a refrigerator. Loss of adhesion was shown to occur after samples were repeatedly thermally cycled from a cold to a hot environment for several days. Levels of adhesion were found to vary in different parts of a refrigerator cabinet, but these variations could be minimised by the use of an adhesion promoter in the liner protective layer. 7 refs.

USA

*Accession no.592109*

*Item 228*

Polyurethanes '95. Conference Proceedings.
Chicago, Il., 26th-29th Sept.1995, p.454-8. 43C6

**INTRODUCTION OF HCFC-22/141B APPLIANCE FOAM TECHNOLOGY IN NORTH AMERICA**

Gurecki J R; Wheeler I A
ICI Polyurethanes
(SPI,Polyurethane Div.)

PU foams for use in thermal insulation for refrigerators and freezers were produced using mixtures of HCFC-141b and HCFC-22 as blowing agents. The effects of the condensation temperature and blowing efficiency of the blowing agents on flow, thermal conductivity, dimensional stability and freeze crack resistance were investigated, and the energy consumption of built-up freezer cabinets was examined. The inclusion of HCFC-22 was shown to give foams with improved low temperature dimensional stability at lower densities than could be achieved at the same level of blowing when using HCFC-141b alone. Foams with lower freeze stable densities were produced without loss of k-factor or energy consumption rating of freezers. 4 refs.

USA

*Accession no.592108*

*Item 229*

Polyurethanes '95. Conference Proceedings.
Chicago, Il., 26th-29th Sept.1995, p.448-53. 43C6

**ISO-/N-PENTANE BLOWN RIGID POLYURETHANE FOAM FOR APPLIANCES: A REALISTIC AND ECONOMICALLY ATTRACTIVE ALTERNATIVE TO CYCLOPENTANE**

Birch A J; Parenti V; van Duin K J; Smits G F; Clavel P
Dow Europe SA; Dow Benelux NV
(SPI,Polyurethane Div.)

Mixtures of isopentane and n-pentane were used as blowing agents for rigid PU foams for use as thermal insulation in refrigerators. The density, compression strength, dimensional stability, thermal conductivity and demould expansion characteristics of the foams were examined in comparison with foams blown with cyclopentane and a 50% reduced CFC-11 system. The compatibility of the blowing agents with high-impact PS and ABS refrigerator liners was also investigated. 9 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; NETHERLANDS; SWITZERLAND; USA; WESTERN EUROPE

*Accession no.592107*

*Item 230*

Polyurethanes '95. Conference Proceedings.
Chicago, Il., 26th-29th Sept.1995, p.436-42. 43C6

**IMPROVED AGEING CARBON DIOXIDE BLOWN FOAM FOR REFRIGERATORS/ FREEZERS**

Grunbauer H J M; Cikut L; Haworth G J; Beerwart A
Dow Benelux NV; Dow Chemical Co.; Maytag Corp.
(SPI,Polyurethane Div.)

An industrial trial was undertaken to evaluate the ageing and energy consumption performance of a new, slow ageing carbon dioxide blown PU foam for thermal insulation in refrigerators and freezers. The impact on energy consumption and ageing of a PETG barrier film laminated on the liner sheet and plastics encapsulated powder vacuum panels was also assessed. Foams produced at 2.31 pcf minimum fill density showed a lower k-factor and 10-fold retarded ageing effect compared to conventional carbon dioxide blown foams. In comparison with HCFC-141b blown foams, initial energy consumption was 15-20% higher without vacuum panels but nearly 10% lower with them. Ageing effects over a one year measurement period were virtually negligible for the new foam, which was attributed to the combined action of the barrier liner and the slow ageing foam. 6 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; NETHERLANDS; USA; WESTERN EUROPE

*Accession no.592105*

*Item 231*

Polyurethanes '95. Conference Proceedings.
Chicago, Il., 26th-29th Sept.1995, p.406-12. 43C6

**NEW ALL WATER BLOWN MDI BASED FLEXIBLE MOULDED FOAM SYSTEM**

Obata M; Utsumi H; Ohkubo K; Ueno K; Sakai S
Mitsui Toatsu Chemicals Inc.
(SPI,Polyurethane Div.)

The structure and properties of water blown flexible PU foams based on modified MDI and new polyol formulations are described. The relationship between mechanical properties and degree of crosslinking and morphology, as influenced by the MDI, and soft segment mobility as influenced by the polyol is examined. The advantages of these foams in automotive seat cushion applications are discussed. 11 refs.

JAPAN; USA

*Accession no.592100*

*Item 232*
Polyurethanes '95. Conference Proceedings.
Chicago, Il., 26th-29th Sept.1995, p.310-3. 43C6
**REDUCTION OF POLYURETHANE FOAM THERMAL CONDUCTIVITY BY IN-SITU CARBON DIOXIDE REMOVAL**
Ferrero-Heredia M A; Day J; Ward W J
GE Corporate R & D
(SPI,Polyurethane Div.)

Particulate sodium hydroxide was used as a sorbent for the in-situ removal of carbon dioxide from PU foams blown with a mixture of carbon dioxide and R-141b. Removal of carbon dioxide from foam blown with a mixture of 14% carbon dioxide and 86% R-141b resulted in a 9% reduction in thermal conductivity under refrigerator conditions. 1 ref.

USA

*Accession no.588967*

*Item 233*
Polyurethanes '95. Conference Proceedings.
Chicago, Il., 26th-29th Sept.1995, p.296-302. 43C6
**OPTIMISED SILICONE SURFACTANTS FOR HCFC AND PENTANE BLOWN POLYISOCYANURATE AND POLYURETHANE RIGID FOAMS**
Burkhart G; Klincke M; Willoughby K L
Goldschmidt Th.,AG; Goldschmidt Chemical Corp.
(SPI,Polyurethane Div.)

The development by Goldschmidt of new silicone surfactants for rigid PU and polyisocyanurate foams blown with HCFC-141b and pentane is described. For pentane blown systems, Tegostab B 8469 was developed with particular attention being paid to its emulsification characteristics. A combination of a silicone surfactant and a polyether co-surfactant was investigated for HCFC-141b blown polyisocyanurate foam. The compounded surfactant, Tegostab B 8458, showed advantages in k-factor, compression strength and horizontal flow properties. This product was also stable in isocyanate preblends. 1 ref.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; USA; WESTERN EUROPE

*Accession no.588965*

*Item 234*
Polyurethanes '95. Conference Proceedings.
Chicago, Il., 26th-29th Sept.1995, p.292-5. 43C6
**DEVELOPMENT OF CYCLOPENTANE BLOWN FOAM SYSTEM FOR APPLIANCES USE**
Matsumoto S; Hayashi O; Kita M; Fujino H
Mitsui Toatsu Chemicals Inc.
(SPI,Polyurethane Div.)

Rigid PU foams for thermal insulation were produced using cyclopentane as blowing agent. Factors involved in reducing thermal conductivity were investigated, and it was shown that polyether polyols with low blowing agent solubility gave low thermal conductivity and that the thermal conductivity decreased with increasing viscosity of the resin pre-mix, provided the pre-mix and the isocyanate could be mixed almost uniformly. Through the selection of polyols and formulation parameters, foams were obtained with thermal conductivities almost equal to those of foams blown with reduced CFC-11 or HCFC-141b. 6 refs.

JAPAN; USA

*Accession no.588964*

*Item 235*
Polyurethanes '95. Conference Proceedings.
Chicago, Il., 26th-29th Sept.1995, p.196-203. 43C6
**CFC REPLACEMENT: TECHNICAL APPLICATIONS FOR MICROPOROUS MATERIALS**
Treuling U; Horn P
BASF AG
(SPI,Polyurethane Div.)

Integral skin PU foams blown with carbon dioxide were produced in a process in which the water-isocyanate reaction was controlled by encapsulating the water in a reservoir (molecular sieve) made of a microporous material. The release of the blowing agent and the subsequent initiation of foam formation were thermally induced during the processing of the components. Of the microporous materials tested, zeolites, silica gels and activated carbon showed the best properties. Applications of this technology are described, with particular reference to the manufacture of steering wheels with integrated air bags. 5 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; USA; WESTERN EUROPE

*Accession no.588950*

*Item 236*
Polyurethanes '95. Conference Proceedings.
Chicago, Il., 26th-29th Sept.1995, p.186-93. 43C6
**DEVELOPMENT AND APPLICATION OF NEW INVESTIGATIVE TOOLS TO FORMULATION DESIGN IN RIGID FACED CONSTRUCTION FOAMS**
Vreys M G C
Dow Benelux NV
(SPI,Polyurethane Div.)

The performance of PU foam formulations was simulated under laboratory conditions for the production of high thickness rigid faced double band laminated sandwich panels. Parameters examined included the build-up of polymer green strength, the impact of the exotherm and polymer Tg, controlled post-expansion, measurement of viscosity build in the polymer, tailored rise rate profiles and foam structural analysis. These studies led to the development of a polyol formulation suitable for the

preparation of a carbon dioxide/HCFC-141b blown PU foam which met DIN-4102 B2 flammability requirements and gave good quality panels at all thicknesses. 1 ref.

EUROPEAN COMMUNITY; EUROPEAN UNION; NETHERLANDS; USA; WESTERN EUROPE

*Accession no.588949*

*Item 237*
Polyurethanes '95. Conference Proceedings.
Chicago, Il., 26th-29th Sept.1995, p.175-81. 43C6
**ALL CARBON DIOXIDE BLOWN CARBODIIMIDE MODIFIED POLYISOCYANURATE FOAM FOR METAL-FACED SANDWICH PANEL**
Matsumoto M; Yoshida N; Nakamura S; Morimoto K
Daido Steel Sheet Corp.; Nisshinbo Industries Inc.
(SPI,Polyurethane Div.)

Sandwich panels consisting of metal facings filled with carbodiimide modified polyisocyanurate foam were produced by a continuous process in which carbon dioxide generated by the water-isocyanate reaction and the carbodiimide reaction was used as the sole means of foam expansion. Chain extenders based on bisphenol-A were used to obtain improved dimensional stability without affecting other properties. The effects of the carbodiimide reaction and chain extenders on friability, dimensional stability, foam/metal adhesion, compression strength and thermal conductivity were investigated. 6 refs.

JAPAN; USA

*Accession no.588947*

*Item 238*
Polyurethanes '95. Conference Proceedings.
Chicago, Il., 26th-29th Sept.1995, p.170-4. 43C6
**SEMI-CONTINUOUS OPEN CELL POLYURETHANE RIGID FOAM**
Iwakiri S; Sato S; Kambara Y; Matsushita S
Nippon Polyurethane Industry Co.Ltd.
(SPI,Polyurethane Div.)

Rigid PU foams were produced using CFC-11, a 50% reduced CFC-11 system, HCFC-141b and water as blowing agents. Free rise foams were produced in an open mould and packed foams in a closed mould. The relationship between dimensional stability, overpack ratio and closed cell ratio of the packed foams was investigated. The closed cell ratio of water blown semi-continuous open cell foams increased with overpack ratio, but was under 70% even at 120% overpack ratio, and so these foams showed good dimensional stability at every overpack ratio. Water blown foams with over 70% closed cell ratio had good dimensional stability only at high overpack ratios, which led to high moulding pressures. 9 refs.

JAPAN; USA

*Accession no.588946*

*Item 239*
Polyurethanes '95. Conference Proceedings.
Chicago, Il., 26th-29th Sept.1995, p.163-9. 43C6
**DEVELOPMENT OF A CLASS 1 ASTM E-84 CARBON DIOXIDE BLOWN POUR-IN-PLACE SYSTEM**
Stewart R D; Lynch J J
ICI Polyurethanes Group
(SPI,Polyurethane Div.)

The performance of carbon dioxide, isopentane and HFC-134a blowing agents in fire rated discontinuous pour-in-place PU and polyisocyanurate foam systems was investigated in comparison with HCFC-141b. Studies were made of foam properties including flammability, thermal conductivity, compression strength, dimensional stability and adhesion. The flammability characteristics of carbon dioxide blown foams were considerably improved by going to a higher isocyanate index and using a modified polyester polyol. Polyisocyanurate foams were produced which obtained an ASTM E-84 Class 1 fire rating and gave the best overall balance of dimensional stability, fire performance and cost. 5 refs.

USA

*Accession no.588945*

*Item 240*
Polyurethanes '95. Conference Proceedings.
Chicago, Il., 26th-29th Sept.1995, p.156-62. 43C6
**IMPROVED HYDROCARBON BLOWN FOAMS FOR NORTH AMERICA**
Nicola W J; Weber H U
Bayer Corp.; Bayer AG
(SPI,Polyurethane Div.)

Results are presented of studies undertaken to develop improved hydrocarbon blown polyisocyanurate foams using n-pentane and cyclopentane as blowing agents. The foams were evaluated for hydrocarbon emissions, compression strength, dimensional stability, flammability, thermal conductivity and adhesion to glass fibre facers. 2 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; USA; WESTERN EUROPE

*Accession no.588944*

*Item 241*
Polyurethanes '95. Conference Proceedings.
Chicago, Il., 26th-29th Sept.1995, p.70-3. 43C6
**HIGH QUALITY FLEXIBLE SLABSTOCK FOAM USING LIQUID CARBON DIOXIDE AS AN AUXILIARY BLOWING AGENT**
Eiben R G; Sulzbach H M; Ferrand J T; Radovich D A
Bayer AG; Maschinenfabrik Hennecke GmbH; Bayer Corp.; Hennecke Machinery
(SPI,Polyurethane Div.)

Processes and equipment are described for the manufacture of flexible slabstock PU foams blown with

liquid carbon dioxide using the NovaFlex technology developed by Bayer and Hennecke. The density and mechanical properties of the foams are examined. 2 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; USA; WESTERN EUROPE

*Accession no.588931*

*Item 242*

Polyurethanes '95. Conference Proceedings. Chicago, Il., 26th-29th Sept.1995, p.47-50. 43C6

**100% CARBON DIOXIDE BLOWN CLASS 1 FLAME RATED POLYURETHANE FOAM**

Mirasol S M; Bhattacharjee D; Williams S J

Dow Chemical Co.

(SPI,Polyurethane Div.)

The development and testing of carbon dioxide blown, flame retardant PU foams are described. Foams with a class 1 flame rating were obtained by the use of aromatic polyols and a phosphate flame retardant. The foams had densities of around 2.4 pcf, showed good compression strength and dimensional stability, and could be processed without any modification of existing equipment. 7 refs.

USA

*Accession no.588927*

*Item 243*

Polyurethanes '95. Conference Proceedings. Chicago, Il., 26th-29th Sept.1995, p.34-8. 43C6

**METHOD FOR THE DETERMINATION OF CELL GAS CONTENT IN POLYURETHANE FOAMS**

Bogdan M C; Orlowski D F; Bennington J L; Welch J L

AlliedSignal Inc.

(SPI,Polyurethane Div.)

A gas chromatographic technique is described for determining the composition of cell gases in PU foams. The method is shown to be applicable to foams produced with the full range of blowing agents.

USA

*Accession no.588925*

*Item 244*

Polyurethanes '95. Conference Proceedings. Chicago, Il., 26th-29th Sept.1995, p.11-20. 43C6

**TECHNIQUES TO ASSESS THE VARIOUS FACTORS AFFECTING THE LONG-TERM DIMENSIONAL STABILITY OF RIGID POLYURETHANE FOAM**

Singh S N; Lynch J J; Daems D

ICI Polyurethanes

(SPI,Polyurethane Div.)

Factors controlling the dimensional stability of foams are examined, and details are given of a test method developed by ICI Polyurethanes for predicting the long-term dimensional stability of rigid PU foams produced with CFC replacement blowing agents. The test focuses on accelerating the normal diffusion processes which typically take place over a period of months or years. Results for the long-term ageing of boards and refrigerator/freezer cabinets are compared with the predictions of the new test method. 17 refs.

BELGIUM; EUROPEAN COMMUNITY; EUROPEAN UNION; USA; WESTERN EUROPE

*Accession no.588922*

*Item 245*

Patent Number: EP 700953 A2 19960313

**THERMAL INSULATING FOAMED MATERIAL AND METHOD FOR MANUFACTURING THE SAME**

Inagaki F; Hashida T; Suzuki M; Kishimoto Y; Ueno T

Matsushita Electric Industrial Co.Ltd.

A PU foam is made using a blowing agent, such as an iodofluorohydrocarbon, perfluoroalkene or hydrogen-containing fluoromorpholine derivative. The blowing agents have a low thermal conductivity and a short life in air and thus are environmentally friendly. The iodofluorohydrocarbon, in particular, can give incombustibility and self-extinguishing properties to conventional inflammable substances, such as cyclopentane.

JAPAN

*Accession no.587891*

*Item 246*

Patent Number: US 5451615 A 19950919

**PROCESS FOR PREPARING POLYURETHANE FOAM IN THE PRESENCE OF A HYDROCARBON BLOWING AGENT**

Birch A J

Dow Chemical Co.

A polyisocyanate is reacted with a polyol composition comprising a fatty oil having a fatty acid content, especially a hydroxyl-substituted fatty acid, which enhances the miscibility of the hydrocarbon blowing agent. A preferred fatty oil is castor oil comprising, as principle constituent, the hydroxyl-substituted fatty acid, ricinoleic acid. Enhanced storage stability of the polyol composition containing hydrocarbon blowing agent in amounts required for production of low density foam is achieved.

USA

*Accession no.586854*

*Item 247*

Patent Number: US 5444101 A 19950822

**PROCESS FOR RIGID POLYURETHANE FOAMS**

De Vos R; Biesmans G

Imperial Chemical Industries PLC

Rigid PU or urethane-modified polyisocyanurate foam is prepared in the presence of a blowing agent mixture comprising cyclopentane and a certain amount of other organic compounds, as co-blowing agents. The saturated vapour pressure of the co-blowing agents in bar at Tuse(v.p.) complies with a specified equation.

EUROPEAN COMMUNITY; EUROPEAN UNION; UK; WESTERN EUROPE

*Accession no.585201*

*Item 248*
Cellular Polymers III. Conference proceedings.
Coventry, 27th-28th April 1995, paper 21. 6124
**CARDIO PROCESS: INDUSTRIAL PRODUCTION EXPERIENCES**
Fiorentini C; Taverna M; Collins B; Griffiths T
Cannon Afros; Cannon Communications Inc.; Cannon USA Inc.; Cannon Viking
(Rapra Technology Ltd.)

As environmental pressure increases worldwide, it is becoming necessary for formers to eliminate chlorinated solvents or any type of auxiliary blowing agents from their production. In some countries, these solvents have already been banned. The impact on the flexible foam industries would be to increase foam prices and to eliminate certain soft grades. The Cannon Group has developed a new process for introducing liquid CO2 into slabstock polyols, and successfully produce low density foams on modified slabstock equipment. 11 refs.

USA

*Accession no.583896*

*Item 249*
Cellular Polymers III. Conference proceedings.
Coventry, 27th-28th April 1995, paper 16. 6124
**SOLUBILITY AND NUCLEATION PHENOMENA IN RIGID PU FOAM EXPANSION BY LOW BOILING BLOWING AGENTS: MODELLING APPROACH**
Gruenbauer H J M
Dow Benelux NV
(Rapra Technology Ltd.)

Solubility and nucleation behaviour of low-boiling blowing agents (LBBA) in polyols for rigid foams are modelled by using classical thermodynamics in combination with solubility parameter theory to account for intermolecular interactions. Model predictions agree satisfactorily with experimental solubility and frothing behaviour of HFC-134a. For one-component polyol system, quantitative agreement between measured solubilities and solubility parameter predictions is sufficient to allow for reliable assessment of trends. Model calculations are been carried out for HCFC-22, HCFC-142b, HFC134a, HFC-152a and C1-C4 alkanes using a typical rigid polyol as a standard reference. These calculations confirm that, at current foam densities, total replacement of CFC-11 with any of the LBBAs considered is unlikely due to intrinsic limitations. Co-blowing with other blowing agents, such as CO2, make the isocyanate-H2O reaction a viable option. 11 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; NETHERLANDS; WESTERN EUROPE

*Accession no.583891*

*Item 250*
Antec '95. Vol.II. Conference Proceedings.
Boston, Ma., 7th-11th May 1995, p.2194-6. 012
**INTERACTIONS BETWEEN HCFC-141B BLOWN FOAM AND PLASTICS REFRIGERATOR LINERS**
Dave R S; Drenzek P J; Hilton G B; Moran B D; Nardi D P; Wong R P
Monsanto Co.
(SPE)

Theoretical and experimental models were developed to analyse the mechanics of the formation of indentations (dimples) on the surface of plastics refrigerator liners due to vapours trapped in voids in HCFC-141b blown PU foams. The models showed that reducing void diameter and increasing liner thickness would have the greatest effect in minimising deflection of the liner, while increasing the modulus would give only a slight improvement. It was also shown that the temperature sensitivity of the blowing agent played a key role in the process. 3 refs.

USA

*Accession no.571306*

*Item 251*
***Cellular Polymers***
13, No.4, 1994, p.277-91
**EFFECT OF PHOSPHO-HALOGENATED POLYETHER POLYOL(IXOL B 251) ON FIRE BEHAVIOUR OF RIGID POLYURETHANE FOAMS BLOWN WITH VARIOUS AGENTS**
Modesti M; Simioni F
Padova,Universita

Substitution of CFC-11 with blowing agents with low environmental impact in the manufacture of PU thermal insulation materials results in changes in several properties of the materials. The increased flammability of material based on Ixol B 251 with flammable blowing agents (HCFC-141b, 2-chloropropane and n-pentane) can be reduced by modifying the formulation, e.g. by increasing the amount of flame retardants. The results of oxygen index testing are compared with data obtained from ISO 3582, DIN 4102-B2 and UNI 9177 tests and are shown to be well correlated. The initial thermal conductivity of the various foams is strongly related to the thermal conductivity of the gas phase and increases with the new blowing agents, in the case of n-pentane reaching values which are about 20% higher than that of foams blown with CFC-11. 11 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; ITALY; WESTERN EUROPE

*Accession no.525998*

*Item 252*
Patent Number: US 5300534 A 19940405
**PRODUCTION OF PLASTIC FOAMS, PREFERABLY RIGID FOAMS CONTAINING URETHANE GROUPS OR URETHANE AND ISOCYANURATE GROUPS, AND BLOWING AGENT-CONTAINING EMULSIONS FOR THIS PURPOSE**
Volkert O; Meynard C A
BASF AG

An organic and/or modified organic polyisocyanate is reacted with at least one relatively high molec.wt. compound containing at least two reactive hydrogen atoms and, if desired, a low molec.wt. chain extender and/or crosslinking agent in the presence of a blowing agent, a catalyst and, if desired, assistants and/or additives. The blowing agent is at least one vinyl fluoroalkane or a mixture thereof with at least one different physical and/or chemical blowing agent. Emulsions containing at least one vinyl fluoroalkane and at least one of the starting components are used to produce the foam.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

*Accession no.520000*

*Item 253*
Utech '94: Groundwork for Growth. Conference proceedings.
Hague, 22nd-24th March 1994, paper 61, pp.8. 43C6
**BLOWING EFFICIENCY ENHANCEMENT HELPS REPLACE CHLOROFLUOROCARBONS AND HYDROFLUOROCARBONS IN MDI-BASED FLEXIBLE POLYURETHANE FOAMS**
House D W; Scott R V
UOP Inc.
Edited by: Reed D; Lee C A
(Crain Communications Ltd.; Rapra Technology Ltd.)

Unilink 4200, i.e. 4,4'-bis-(sec-butylamino) diphenylmethane, is an additive that reacts in a urethane foam formulation to increase both the level of urea groups present and the hard segment content. Unilink 4200 has been shown to significantly reduce foam density in certain MDI-based flexible polyurethane foams and thus can be used to replace auxiliary blowing agents. The term blowing efficiency enhancer has been coined to describe the way Unilink 4200 acts to reduce foam density. Data shows how use of Unilink 4200 decreases the need for auxiliary blowing agents. The synergistic effects between Unilink 4200 and additives such as diethanolamine and Ortegol 310 are shown. 6 refs.

USA

*Accession no.518988*

*Item 254*
Utech '94: Groundwork for Growth. Conference proceedings.
Hague, 22nd-24th March 1994, paper 54, pp.8. 43C6
**1,1,2-TRIFLUOROETHANE (HFC-143). A NEW ZERO OZONE DEPLETION POTENTIAL BLOWING AGENT FOR RIGID POLYURETHANE FOAMS**
Barthelemy P P; Leroy A; Zipfel L; Krucke W
Solvay SA; Solvay Fluor & Derivate GmbH
Edited by: Reed D; Lee C A
(Crain Communications Ltd.; Rapra Technology Ltd.)

Data is presented to support the argument that HFC-143 is the best candidate as a zero ozone depletion blowing agent for rigid PU foams. Solubility in various commercial polyols is compared with that of HCFC-22. Although HFC-143 is a gas with a boiling point of 5C, it retains many advantages of a liquid blowing agent and can be processed with a conventional low pressure dispensing machine. Density, dimensional stability, closed cell content and thermal conductivity data are given for foams prepared from preblended systems containing HFC-143. Only acute toxicity data are available and this shows a No Observable Effect Level above 10000 ppm. Flammability data are given for mixtures of HFC-143, HFC-134a and air. 4 refs.

BELGIUM; EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

*Accession no.518981*

*Item 255*
Utech '94: Groundwork for Growth. Conference proceedings.
Hague, 22nd-24th March 1994, paper 41, pp.4. 43C6
**EXPANDING THE USE OF CFC-FREE HIGH RESILIENCE FOAM TECHNOLOGY**
de Roeck H
Arco Chemical Europe Inc.
Edited by: Reed D; Lee C A
(Crain Communications Ltd.; Rapra Technology Ltd.)

Ultracel technology offers a wide range of high resilience and combustion modified high resilience foams, without auxiliary blowing agents, between 21 and 65 kg/cu.m and between 25 and 65 kg/cu.m, respectively. The technology uses two high performance polyols, i.e. Ultracel polyol 2000 and Arcol polyol HS 100. Ultracel polyol 2000 offers the best processability and foam stability of all TDI-based technologies. It allows a wide formulating latitude (broad range of diethanolamine, tin catalyst and TDI index). Arcol polyol HS 100, although being a non-reactive polyol, complements Ultracel polyol 2000 most efficiently by providing additional loadbearing properties, offering the widest possible hardness range of all TDI-based technologies. Three types of foam are highlighted in this paper. In high resilience foam, the quality of the auxiliary blowing agent-free, 21 kg/cu.m density, soft foam (40N at 40 ILD) is even superior compared to foams blown with auxiliary blowing agents with regard to comfort and dynamic fatigue. The 50-65 kg/cu.m density, soft foams offer high quality as well as high support, and are

characterised by a very pleasant feel. Data on formulations, foam properties and foaming conditions are shown. 2 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; FRANCE; WESTERN EUROPE

*Accession no.518968*

*Item 256*
Utech '94: Groundwork for Growth. Conference proceedings.
Hague, 22nd-24th March 1994, paper 39, pp.6. 43C6
**NEW BLOWING SYSTEM FOR CONVENTIONAL AND HIGH RESILIENCE SLABSTOCK AND HOT-MOULDED FLEXIBLE FOAMS**
Stefani D; Sam F O
Enichem Polimeri Research Centre
Edited by: Reed D; Lee C A
(Crain Communications Ltd.; Rapra Technology Ltd.)

Use of the PU POL 9912 family of polyether polyols does away with halogenated and toxic blowing agents. The systems can be used for the production of conventional and high resilience slabstock foams and for hot moulding technology. A wide range of hardnesses was obtained, ranging from very soft to medium firm foams. Properties of foams blown with water, with water plus CFC-11, and with water plus liquid carbon dioxide are tabulated. 3 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; ITALY; WESTERN EUROPE

*Accession no.518966*

*Item 257*
Utech '94: Groundwork for Growth. Conference proceedings.
Hague, 22nd-24th March 1994, paper 37, pp.5. 43C6
**MDI SLABSTOCK FOAMS IN LUXURY BEDDING. A PERFECT MATCH**
Mispreuve H A; Knaub P A M
Dow Europe SA
Edited by: Reed D; Lee C A
(Crain Communications Ltd.; Rapra Technology Ltd.)

The Dow Chemical Company has developed MDI-based slabstock foams designed to meet the most severe requirements of the luxury bedding market segment. The all-water blown technology is based on a new range of raw materials that include Voralux HP 700 polyol series and Isonate M100 isocyanate series. This paper describes the features of this technology in terms of processability, physical properties, feel, flame retardancy and dynamic fatigue. 4 refs.

SWITZERLAND; WESTERN EUROPE

*Accession no.518964*

*Item 258*
Utech '94: Groundwork for Growth. Conference proceedings.
Hague, 22nd-24th March 1994, paper 36, pp.10. 43C6
**RECENT DEVELOPMENTS IN MDI BASED FLEXIBLE SLABSTOCK**
Parfondry A; Cassidy E
ICI,Polyurethanes Group
Edited by: Reed D; Lee C A
(Crain Communications Ltd.; Rapra Technology Ltd.)

Waterlily comfort cushioning based on MDI was developed by ICI for flexible slabstock application. This new technology is appreciated for its adaptability to specific cushioning or padding requirements. The properties of this new family of materials are discussed and compared with those of conventional materials, with special emphasis on comfort, static creep and durability as expressed by dynamic fatigue and recovery. The robust processing characteristics of the technology are described and an example of experimental design to optimise consistency in production is presented and discussed. The Taguchi technique was used to vary formulation and process parameters to assess their effect on foam quality. Other attractive features such as homogeneity and rapid cure profile for just-in-time delivery are also presented. Uses in mattresses and furniture cushioning are suggested. 5 refs.

BELGIUM; EUROPEAN COMMUNITY; EUROPEAN UNION; WESTERN EUROPE

*Accession no.518963*

*Item 259*
Utech '94: Groundwork for Growth. Conference proceedings.
Hague, 22nd-24th March 1994, paper 30, pp.9. 43C6
**REFRIGERATORS WITH ONLY CARBON DIOXIDE BLOWN FOAM INSULATION**
Cecchini C; Cellarosi B; Brocci M
EniChem
Edited by: Reed D; Lee C A
(Crain Communications Ltd.; Rapra Technology Ltd.)

The development of carbon dioxide-blown PU foam formulations offering adequate processability and demoulding time, good physicomechanical characteristics and low surface friability is summarised. Tests with real refrigerators showed an increase in energy consumption of only 6% after 3 years, despite the fact that laboratory tests showed a 6% increase in lambda value after only 20 days. This clearly different behaviour of a real appliance unit with respect to an unfaced foam could lead to the reconsideration of the ageing problem of these foams and make their use for refrigerator applications more realistic.

EUROPEAN COMMUNITY; EUROPEAN UNION; ITALY; WESTERN EUROPE

*Accession no.518957*

*Item 260*
Utech '94: Groundwork for Growth. Conference proceedings.

Hague, 22nd-24th March 1994, paper 26, pp.6. 43C6
**EFFECTS OF HYDROCARBONS IN PU FOAM FOR REFRIGERATED APPLIANCES**
Birch A J; Fanichet X; Smits G F; Schindler P
Dow Europe SA
Edited by: Reed D; Lee C A
(Crain Communications Ltd.; Rapra Technology Ltd.)

Cyclopentane has over the past year gained significant backing as the blowing agent, for rigid PU foam, favoured by the appliance manufacturers of Europe. This paper examines some of the processing and property phenomena exhibited by polyurethane foams blown with cyclopentane. Included is an examination of the effects of condensation of cyclopentane within the cells of the foam, and the implications this has on the compressive strength, dimensional stability and lambda values. Also included is a comparison of the commercially available grades of cyclopentane. No significant differences were found between these grades in terms of processing and final material properties. A formulated polyol designed for use with a blend of iso- and n-pentane is compared with both cyclopentane and CFC-11 reduced technologies. While lambda values for such a blend are inherently poor at a mean temperature of 24C, those measured at 0C showed a difference of only 1.5% compared to cyclopentane. 1 ref.

SWITZERLAND; WESTERN EUROPE

*Accession no.518953*

*Item 261*
Utech '94: Groundwork for Growth. Conference proceedings.
Hague, 22nd-24th March 1994, paper 25, pp.6. 43C6
**CYCLOPENTANE-BASED POLYURETHANE RIGID FOAM FOR APPLIANCES. AN ENVIRONMENTALLY SAFE INSULATION**
Thompson-Colon J A; Detrich K W; Eisen N; Lamberts W M
Bayer AG
Edited by: Reed D; Lee C A
(Crain Communications Ltd.; Rapra Technology Ltd.)

Processing, flammability, thermal conductivity, creep and dimensional stability data are given to show that cyclopentane is a good blowing agent for refrigerator and freezer insulation. 7 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

*Accession no.518952*

*Item 262*
Utech '94: Groundwork for Growth. Conference proceedings.
Hague, 22nd-24th March 1994, paper 24, pp.7. 43C6
**CYCLOPENTANE BLOWN POLYURETHANE RIGID FOAM FOR APPLIANCES**
Adams S; Volkert O; Wiegmann W
BASF AG
Edited by: Reed D; Lee C A
(Crain Communications Ltd.; Rapra Technology Ltd.)

Foam density, thermal conductivity, ageing and compression strength data are presented to show that cyclopentane is the best halogen-free blowing agent for appliance insulation. Safety recommendations to avoid fires and explosions are given in detail. 4 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

*Accession no.518951*

*Item 263*
Utech '94: Groundwork for Growth. Conference proceedings.
Hague, 22nd-24th March 1994, paper 19, pp.8. 43C6
**DIMENSIONALLY STABLE, CARBON DIOXIDE-BLOWN, FINE CELLED RIGID FOAMS BY CONTROLLED CELL OPENING**
Smits G F
Dow Benelux NV
Edited by: Reed D; Lee C A
(Crain Communications Ltd.; Rapra Technology Ltd.)

A combination of modelling techniques and experimental data are used to evaluate what effects can be expected from changes in cell size and/or density on the polymer distribution in foams and consequently on foam physical properties like compressive strength, initial thermal conductivity and thermal conductivity ageing. A special emphasis is put on the properties which can be obtained for open-celled foams, provided the cell opening occurs in a controlled way and does not change the material distribution with respect to the corresponding closed cell foam. 6 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; NETHERLANDS; WESTERN EUROPE

*Accession no.518947*

*Item 264*
Utech '94: Groundwork for Growth. Conference proceedings.
Hague, 22nd-24th March 1994, paper 17, pp.8. 43C6
**ROUTES TO MORE ENVIRONMENTALLY FRIENDLY RIGID POLYURETHANE FOAMS**
Thijs S
Shell Research SA
Edited by: Reed D; Lee C A
(Crain Communications Ltd.; Rapra Technology Ltd.)

Progress in the use of n-pentane and cyclopentane as CFC-replacement blowing agents is described, including the customising of polyols for use in pentane-blown foams. Density, dimensional stability, flammability, cell gas composition, ageing and thermal insulation data are given for pentane-blown foams. 14 refs.

BELGIUM; EUROPEAN COMMUNITY; EUROPEAN UNION; WESTERN EUROPE

*Accession no.518945*

*Item 265*
Utech '94: Groundwork for Growth. Conference proceedings.
Hague, 22nd-24th March 1994, paper 13, pp.6. 43C6
**ADDITIVES FOR LOW DENSITY MDI FOAMS**
Savoca A C; Kimock M J; Listemann M L; Wressell A L
Air Products & Chemicals Inc.
Edited by: Reed D; Lee C A
(Crain Communications Ltd.; Rapra Technology Ltd.)

Conversion, rise, density and mechanical property data are given for MDI foams containing a new tertiary amine catalyst (XF-J1002) and a new surfactant (XF-I2585). The tertiary amine improves blowing efficiency and system flowability at higher water levels. An additional benefit of this catalyst is reduced amine emission from the finished foam. Amine emission data obtained by gas chromatography are shown. 4 refs.

USA

*Accession no.518941*

*Item 266*
Utech '94: Groundwork for Growth. Conference proceedings.
Hague, 22nd-24th March 1994, paper 7, pp.6. 43C6
**ADVANCES IN POLYURETHANE FOR USE IN ACOUSTIC APPLICATIONS FOR THE AUTOMOTIVE SECTOR**
Cunningham A; Duggan N
ICI,Polyurethanes Group
Edited by: Reed D; Lee C A
(Crain Communications Ltd.; Rapra Technology Ltd.)

A summary is given of the performance of ICI's latest range of acoustic foams with respect to airborne noise attenuation. These foams were specially designed to provide not only low densities with excellent flow and demould times, but also the design flexibility to select the most appropriate intrinsic foam acoustic performance for the specific application under consideration. Details are given of the test equipment. 7 refs.

BELGIUM; EUROPEAN COMMUNITY; EUROPEAN UNION; WESTERN EUROPE

*Accession no.518935*

*Item 267*
Patent Number: US 5286758 A 19940215
**USE OF FORMATE SALTS AS AUXILIARY AGENTS FOR LOW DENSITY RIGID FOAMS**
Christman D L; Reichel C J
BASF Corp.

It has been found that in addition to acting as an auxiliary blowing agent, various salts of formic acid may be used to tailor the reactivity characteristics of rigid PU foam formulations. Salts of particular interest are: ammonium formate, sodium formate and potassium formate. By varying the amounts and combinations of these salts, characteristics of a formulation's reactivity such as cream type, gel time, rise time and tack-free time, may be manipulated.

USA

*Accession no.510909*

*Item 268*
Polyurethanes World Congress 1993. Conference Proceedings.
Vancouver, B.C., 10th-13th Oct.1993, p.625-30. 43C6
**EFFECT OF TERTIARY AMINE CATALYST SYSTEMS FOR LOWER DENSITY RIGID FOAM WITH HCFC-141B**
Harada S; Isayama Y; Kitagawa H; Morii M; Fukushima T
Kao Corp.
(SPI,Polyurethane Div.; SPI Canada Inc.; European Isocyanate Producers Assn.)

Results are shown for the use of Kaolizer KLP-200K for HCFC-141b blown rigid foam. The system using Kaolizer KLP-200K results in lower density foam and reduced HCFC-141b consumption compared with that using conventional catalysts. It is also an effective catalyst for cyclopentane blown rigid foam. Formulation and property (including density, compressive strength and thermal conductivity) data are shown. 2 refs.

JAPAN

*Accession no.502817*

*Item 269*
Polyurethanes World Congress 1993. Conference Proceedings.
Vancouver, B.C., 10th-13th Oct.1993, p.609-18. 43C6
**SILICONE SURFACTANTS FOR PENTANE BLOWN RIGID FOAM**
Grimminger J; Muha K
Air Products & Chemicals; PURA GmbH & Co.
(SPI,Polyurethane Div.; SPI Canada Inc.; European Isocyanate Producers Assn.)

A variety of silicone surfactants (dimethylsiloxane copolymers with long polyether side chains) were evaluated for the ability to emulsify and stabilise pentane in polyol premixes (including flame retardants). Considerable data on foam properties (closed cell content, thermal conductivity, ageing, mechanical properties, pentane content, pentane loss, flammability) are shown. Two surfactants, DABCO DC193 and experimental surfactant XF-H25-73 were excellent. 6 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

*Accession no.502815*

*Item 270*
Polyurethanes World Congress 1993. Conference Proceedings.

Vancouver, B.C., 10th-13th Oct.1993, p.532-8. 43C6
**EFFECTIVE DIFFUSION COEFFICIENTS OF CARBON DIOXIDE AND HCFC-22 IN POLYURETHANE AND POLYISOCYANURATE FOAMS**
Bhattacharjee D; Booth J R
Dow Chemical Co.
(SPI,Polyurethane Div.; SPI Canada Inc.; European Isocyanate Producers Assn.)

Thin slice accelerated desorption using a gravimetric methodology was successfully extended to determine effective diffusion coefficients of HCFC-22 and carbon dioxide in polyurethane, polyurethane modified polyisocyanurate and polyurea modified polyurethane foam structures. They included appliance foam and boardstock foam. A modification of the sorption equation was developed to describe the special case of two component simultaneous desorption from a uniformly heterogeneous continuum. 8 refs.

USA

*Accession no.502804*

*Item 271*
Polyurethanes World Congress 1993. Conference Proceedings.
Vancouver, B.C., 10th-13th Oct.1993, p.473-483. 43C6
**KEY ASPECTS OF NOVEL CATALYST SYSTEMS IN ALL-WATER BLOWN INTEGRAL SKIN FOAMS. RELATED CATALYTIC ACTIVITIES IN THE ISOCYANATE REACTION**
Okuzono S; Kisaka H; Tamano Y; Lowe D W
TOSOH Corp.; TOSOH USA Inc.
(SPI,Polyurethane Div.; SPI Canada Inc.; European Isocyanate Producers Assn.)

Catalytic activity of various amine and tin catalysts are summarised. Relationships amongst catalytic activity, viscosity rise, foaming behaviour, foam properties, cure and skin formation were elucidated. In all-water blown integral skin foam, the newly developed tertiary amine catalyst F22 provided the best skin formation. It was important to balance the gelling and blowing activity by applying a co-catalyst to F22. 14 refs.

JAPAN; USA

*Accession no.502797*

*Item 272*
Polyurethanes World Congress 1993. Conference Proceedings.
Vancouver, B.C., 10th-13th Oct.1993, p.456-64. 43C6
**ZERO OZONE DEPLETION POTENTIAL BLOWING AGENTS FOR POLYURETHANE FOAMS**
Creazzo J A; Hammel H S; Schindler P; Cicalo K J
Du Pont Chemicals; Du Pont de Nemours International SA; Dow Europe SA
(SPI,Polyurethane Div.; SPI Canada Inc.; European Isocyanate Producers Assn.)

A summary is given of basic data developed to support commercial process conversion from CFC-11 to HFC-134a (Formacel Z-4). Topics include a comparison of the physical properties, results of vapour pressure and solubility studies with different polyols, effects of different surfactants on HFC-134a solubility, confirmation of product stability in foaming applications, B-side system viscosity effects, and materials-of-construction compatibility data (resistance of various rubbers and plastics to HFC-134a and HFC-152a). The paper summarises experience developed in modifying equipment to handle higher b-side mixing and storage pressure, and discusses effects of process settings on foam quality. Some joint ventures between blowing agent suppliers and insulation, e.g. refrigerators, and non-insulation. e.g. footwear, manufacturers are described.

SWITZERLAND; USA; WESTERN EUROPE

*Accession no.502795*

*Item 273*
Polyurethanes World Congress 1993. Conference Proceedings.
Vancouver, B.C., 10th-13th Oct.1993, p.451-5. 43C6
**DEVELOPMENT AND OPTIMISATION OF AN HCFC-141B POLYURETHANE FOAM SYSTEM FOR THE RESIDENTIAL DOOR MARKET**
Grbac J; Wheeler I; Gurecki J
ICI Polyurethanes Group
(SPI,Polyurethane Div.; SPI Canada Inc.; European Isocyanate Producers Assn.)

Comparison of products blown by HCFC-141b with those blown by CFC-11 shows that achievement of foam densities meeting industry requirements together with the required physical properties (including k-factor, dimensional stability, compressive strength and friability) is possible. Flow properties,both vertical and horizontal, were also examined. Flammability and heat of combustion data are tabulated.

CANADA; USA

*Accession no.502794*

*Item 274*
Polyurethanes World Congress 1993. Conference Proceedings.
Vancouver, B.C., 10th-13th Oct.1993, p.439-44. 43C6
**LOW PERMEABILITY POLYOLS FOR RIGID FOAM APPLICATIONS**
Moore D R; Kaplan W A; Tabor R L
Dow Chemical Co.
(SPI,Polyurethane Div.; SPI Canada Inc.; European Isocyanate Producers Assn.)

Data are presented on several new polyols which are designed to prevent thermal conductivity ageing of water blown PU foams by improving carbon dioxide retention

and air exclusion. Formulation, dynamic mechanical and thermal conductivity reduction data are shown. 7 refs.

USA

*Accession no.502792*

*Item 275*
Polyurethanes World Congress 1993. Conference Proceedings.
Vancouver, B.C., 10th-13th Oct.1993, p.425-32. 43C6

**NEW POLYURETHANE ENERGY MANAGEMENT FOAMS FOR IMPROVED AUTO INTERIOR SAFETY**

Naik B G
ICI Polyurethanes Group
(SPI,Polyurethane Div.; SPI Canada Inc.; European Isocyanate Producers Assn.)

ICI Polyurethanes has developed a portfolio of new energy management PU foam systems which are CFC-free, water-blown, and low density. These products range from rigid to semi-rigid to viscoelastic foams. Each type of foam offers unique properties for various automotive interior applications. Rigid foams absorb energy primarily through a non-recoverable, physical crushing of the foam cells. On the other hand, semi-rigid and viscoelastic foams provide a viscous dissipation of energy with a slow shape recovery. This paper describes the development, static/dynamic impact properties, and processing of these new PU energy management foams.

USA

*Accession no.502790*

*Item 276*
Polyurethanes World Congress 1993. Conference Proceedings.
Vancouver, B.C., 10th-13th Oct.1993, p.405-10. 43C6

**WATER-BLOWN RIGID FOAMS**

Christman D L; Reichel C J
BASF Corp.
(SPI,Polyurethane Div.; SPI Canada Inc.; European Isocyanate Producers Assn.)

BASF has uncovered a family of additives which act as cell openers when added to resin formulations. Using standard rigid foam polyols, they have prepared foams with densities as low as 0.90 pcf which show less than 5% dimensional changes when kept at 158F and 100% relative humidity for 28 days. The measured closed cell content can be as low as 3-5% although foams in the 1.1-1.4 pcf density range were found to be dimensionally stable at closed cell contents as high as 88%.

USA

*Accession no.502787*

*Item 277*
Polyurethanes World Congress 1993. Conference Proceedings.
Vancouver, B.C., 10th-13th Oct.1993, p.383-5. 43C6

**ZERO OZONE DEPLETION POTENTIAL RIGID INSULATION FOAMS PREPARED WITH HYDROFLUOROALKANES**

Yu-Hallada L C; Reichel C J
BASF Corp.
(SPI,Polyurethane Div.; SPI Canada Inc.; European Isocyanate Producers Assn.)

HFA's (hydrofluoroalkanes or partially fluorinated alkanes) make fine, closed cell foams. HFA-blown rigid foams at 2.0 pcf density or lower have low initial k-factors (0.13 Btu in/h sq.ft. F). Aged k-factors are excellent. HFA's have zero ozone depletion potential and relatively low halogen global warming potential. Data on foams from HFA combinations are given.

USA

*Accession no.502784*

*Item 278*
Polyurethanes World Congress 1993. Conference Proceedings.
Vancouver, B.C., 10th-13th Oct.1993, p.379-82. 43C6

**HCFC-141B BLOWN POLYURETHANE FOAM PANELS MEET FACTORY MUTUAL 4880 APPROVAL**

Brown S A
Polythane Systems Inc.
(SPI,Polyurethane Div.; SPI Canada Inc.; European Isocyanate Producers Assn.)

PSI H10-20, a PU foam system blown with HCFC-141b, is commercially available for both continuous and discontinuous metal panel production. This system is the first HCFC-141b blown PU foam system to meet the criteria for ASTM E-84 Class 1 flammability and FMRC's 4880 approval standard. The physical and thermal properties of this HCFC-141b blown foam are comparable to those obtained with a CFC-11 foam. This paper presents physical property data, including k-factor studies, from metal panels produced using the PSI H10-20 system and compares them with CFC-11 blown systems. 3 refs.

USA

*Accession no.502783*

*Item 279*
Polyurethanes World Congress 1993. Conference Proceedings.
Vancouver, B.C., 10th-13th Oct.1993, p.373-6

**DEVELOPMENT OF A LOW HCFC-141B CLASS 1 POLYURETHANE FOAM SYSTEM FOR METAL PANELS**

Dobransky M A; Treffinger E
Miles Inc.; Bally Engineered Structures Inc.
(SPI,Polyurethane Div.; SPI Canada Inc.; European Isocyanate Producers Assn.)

Reduction of ozone depletion potential during manufacture of insulated metal panels for walk-in cold

storage is described. First CFC-11 was reduced by co-blowing the foam with carbon dioxide formed from the reaction of water and isocyanate. Then the CFC-11 was replaced by HCFC-141b. Thermal insulation performance had to be maintained as well as freeze stability, foam-to-metal adhesion (torque test) and density limits. 6 refs.

USA

*Accession no.502782*

*Item 280*
Polyurethanes World Congress 1993. Conference Proceedings.
Vancouver, B.C., 10th-13th Oct.1993, p.361-7. 43C6
**INNOVATIVE SILICONE SURFACTANT TECHNOLOGY FOR HFC-134A AND CYCLOPENTANE BLOWN RIGID POLYURETHANE FOAMS**
Burkhart G; Klincke M
Goldschmidt Chemical Corp.
(SPI,Polyurethane Div.; SPI Canada Inc.; European Isocyanate Producers Assn.)

Data is presented which shows the superior performance of newly developed silicone surfactants for formulations blown with cyclopentane and HFC-134a. Special attention had to be given to the emulsification properties of the silicone surfactants without sacrificing nucleation efficiency and stabilisation of the foam during the expansion. 2 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

*Accession no.502780*

*Item 281*
Polyurethanes World Congress 1993. Conference Proceedings.
Vancouver, B.C., 10th-13th Oct.1993, p.354-60. 43C6
**EMPLOYMENT OF ZERO OZONE DEPLETION POTENTIAL BLOWING AGENTS FOR POLYURETHANE RIGID FOAMS FOR THERMAL INSULATION**
Cecchini C; Cancellier V; Cellarosi B
EniChem Polimeri SpA
(SPI,Polyurethane Div.; SPI Canada Inc.; European Isocyanate Producers Assn.)

Results given for development work on the use of HFC-134a blown foams for the refrigeration industry. Good material distribution and mechanical characteristics were obtained, and in particular a thermal conductivity value of 21 mW/mK. The possibility of using this agent for continuous panel production was also investigated. Physico-mechanical characteristics and insulation properties (including ageing) are given for carbon dioxide (water blown) foams. 4 refs.

EUROPEAN COMMUNITY; ITALY; WESTERN EUROPE

*Accession no.502779*

*Item 282*
Polyurethanes World Congress 1993. Conference Proceedings.
Vancouver, B.C., 10th-13th Oct.1993, p.311-6. 43C6
**HYPERLITE LOW AND HIGH DENSITY MOULDED FOAM MEETING EUROPEAN AUTOMOTIVE STANDARDS**
Hill R A; Brasington R; Hanak P; Mahy M
Arco Chemical Europe Inc.
(SPI,Polyurethane Div.; SPI Canada Inc.; European Isocyanate Producers Assn.)

Correlation between foam properties and the Hyperlite polyols used is explained. Special attention is paid to compression sets, particularly wet and humid, dynamic fatigue and FMVSS 302 requirements. The Hyperlite polyols and polymer polyols are of a highly reactive nature that allows rapid demould whilst maintaining good processing characteristics such as flow and open foams. Hyperlite foams are cold cure TDI based foams and are very comparable to hot foam and high resilience slabstock formulating technology. They contribute to the recyclability of flexible polyurethanes by reducing the chemical diversity while maintaining their wide scope in applications and properties. Emphasis is placed on foams for car seats and seat backs. 4 refs.

EUROPEAN COMMUNITY; FRANCE; WESTERN EUROPE

*Accession no.502772*

*Item 283*
Polyurethanes World Congress 1993. Conference Proceedings.
Vancouver, B.C., 10th-13th Oct.1993, p.305-10. 43C6
**NOVEL APPROACH TO THE PRODUCTION OF LOW DENSITY, CFC-FREE FLEXIBLE POLYURETHANE FOAMS**
Sam F O; Stefani D; Lunardon G F
ECP Enichem Polimeri Srl
(SPI,Polyurethane Div.; SPI Canada Inc.; European Isocyanate Producers Assn.)

A novel chemical intermediate has been identified by EniChem which can be employed in a flexible PU foam formulation for slabstock, significantly contributing to the reduction of foam density to as low as 16.5 kg/cu.m, without thermal degradation hazards. Excellent compression set values are shown too. The substance is a new, non-toxic, non-halogenated organic compound, specially designed to obtain foams with excellent physical characteristics. Another significant feature of the intermediate is its application in the Hot Moulding technology leading to a net density reduction of 5-6 kg/cu.m without any modification of water level and maintaining all the superior physico-mechanical performances of TDI-based moulded foams. Details of the machinery used in trials are given together with formulation and property data. 3 refs.

EUROPEAN COMMUNITY; ITALY; WESTERN EUROPE

*Accession no.502771*

*Item 284*
Polyurethanes World Congress 1993. Conference Proceedings.
Vancouver, B.C., 10th-13th Oct.1993, p.297-304. 43C6
**NEW HIGH RESILIENCE SLABSTOCK TECHNOLOGIES BASED ON HIGH PERFORMANCE POLYOLS**
Mispreuve H; Knaub P
Dow Europe SA; Polyol International BV
(SPI,Polyurethane Div.; SPI Canada Inc.; European Isocyanate Producers Assn.)

New high performance polyols are made by a process based on a proprietary catalyst technology that makes it possible to produce polyols with reduced side products and high equivalent weights up to 5000. The benefits that these high performance polyols can give to TDI- and MDI-based water blown HR slabstock foams are explained. Benefits are in softness, comfort factor, reduced discolouration, touch and feel. 15 refs.
SWITZERLAND; WESTERN EUROPE
*Accession no.502770*

*Item 285*
Polyurethanes World Congress 1993. Conference Proceedings.
Vancouver, B.C., 10th-13th Oct.1993, p.279-87. 43C6
**UNDERSTANDING THE FUNDAMENTALS OF FORCED COOLING IN THE PRODUCTION OF BLOWING AGENT FREE FLEXIBLE SLABSTOCK POLYURETHANE FOAMS**
McAfee C D; Wiltz E P; Skorpenske R G; Ridgway D H; McClusky J V
Dow Chemical Co.
(SPI,Polyurethane Div.; SPI Canada Inc.; European Isocyanate Producers Assn.)

Results of forced cooling experiments on water blown PU foam on the Varimax half scale pilot line are presented, with emphasis on avoiding discolouration and degradation. As well as optimising procedures, some formulation improvements were discovered, i.e. novel polyols, modifiers and catalysts. 9 refs.
USA
*Accession no.502768*

*Item 286*
Polyurethanes World Congress 1993. Conference Proceedings.
Vancouver, B.C., 10th-13th Oct.1993, p.270-8. 43C6
**THE RAPID CURE PROCESS. INDUSTRIAL EXPERIENCE, ENGINEERING AND FORMULATION PRINCIPLES**
Stone H; Reinink E; LIchvar S; Carlson W; Sikorsky C
PMC Inc.,General Foam Div.
(SPI,Polyurethane Div.; SPI Canada Inc.; European Isocyanate Producers Assn.)

The Rapid Cure process for cooling flexible foam by rapidly blowing air through it was developed in order to allow safe production of low density, high water flexible foam formulations without use of any auxiliary blowing agents. This process, adapted to existing Maxfoam equipment, has been in full scale continuous use for more than a year. This report covers some of the engineering principles and formulations and covers further equipment modifications. Adaptation of the process to accommodate existing plant layout are discussed. Formulating for optimum quality is also dealt with by means of ample data. Accelerated ageing tests including heat stability, static fatigue and flex fatigue performance for a variety of foam grades are presented. 4 refs.
USA
*Accession no.502767*

*Item 287*
Polyurethanes World Congress 1993. Conference Proceedings.
Vancouver, B.C., 10th-13th Oct.1993, p.176-83. 43C6
**CANNON ENVIRO-CURE EQUIPMENT APPLIED TO THE VERTIFOAM AND MAXFOAM PROCESSES**
Collins B; Fawley C
Cannon USA; Cannon Viking
(SPI,Polyurethane Div.; SPI Canada Inc.; European Isocyanate Producers Assn.)

A process developed by Crain Industries (Enviro-Cure) can produce a full range of density and hardness (low and high) flexible PU foams without using any auxiliary blowing agents. Water is used as a total blowing system since it generates carbon dioxide from the foam reaction. Flexible slabstock foam is made typically by either the Maxfoam or Vertifoam process. Enviro-Cure can be adapted to both of these foam manufacturing processes, and can be supplied as an addition to existing equipment or supplied as a full turnkey project including foaming equipment. The layout of the Enviro-Cure equipment will depend on the space available and process type. This paper deals with the equipment necessary to produce CFC-free and alternative blowing agent-free foams based on the Enviro-Cure process. Equipment is explained by photographs and processes by graphs or tables. Details are given of environmental legislation that can be satisfied by the technology.
EUROPEAN COMMUNITY; UK; USA; WESTERN EUROPE
*Accession no.502755*

*Item 288*
Polyurethanes World Congress 1993. Conference Proceedings.
Vancouver, B.C., 10th-13th Oct.1993, p.161-5. 43C6
**PROCESSING EFFECTS ON HCFC-141B APPLIANCE FOAM INSULATION**
Mann D J; Mautino V M

 

Miles Inc.
(SPI,Polyurethane Div.; SPI Canada Inc.; European Isocyanate Producers Assn.)

A systematic evaluation is given of the effects of processing conditions on the physical properties of a conventional-density, PMDI-based, HCFC-141b blown foam system. The physical properties of primary interest included k-factor, flowability, and the % overpacking required to produce low temperature dimensional stability. The processing parameters that were varied included chemical temperature, index, mould temperature, and pour pressure. The results presented in this paper were generated using the data obtained from sixteen experiments. These experiments were designed to produce statistically valid information from a minimum number of experiments. The magnitude of individual effects, as well as the synergetic interactions, were evaluated. 2 refs.
USA

*Accession no.502752*

*Item 289*
Polyurethanes World Congress 1993. Conference Proceedings.
Vancouver, B.C., 10th-13th Oct.1993, p.154-60. 43C6
**BLOWING AGENT EMISSION CALCULATIONS FOR A REFRIGERATOR**
Shankland I R
Allied-Signal Inc.
(SPI,Polyurethane Div.; SPI Canada Inc.; European Isocyanate Producers Assn.)

An outline is given of a model which can estimate the concentration of blowing agents emitted from the foam insulation into the cavity of a domestic refrigerator. The concentration of blowing agent inside the refrigerator decays asymptotically with time and depends on the diffusion coefficient and initial concentration of blowing agent in the foam, the number and surface area of holes through the plastic liner, whether or not the foam is adhered to the plastic liner, and the air exchange rate for the refrigerator. The model calculations (for HCFC-141b) indicate that, under normal operating conditions, the blowing agent concentration inside the refrigerator is very low, typically parts per billion by volume. 10 refs.
USA

*Accession no.502751*

*Item 290*
Polyurethanes World Congress 1993. Conference Proceedings.
Vancouver, B.C., 10th-13th Oct.1993, p.66-73. 43C6
**NOVEL TECHNOLOGY FOR THE MANUFACTURE OF ALL-WATER-BLOWN FLEXIBLE SLABSTOCK FOAM**
Skorpenske R G; Solis R; Moy S A; Wiltz E P; McAfee C D; Brunner K; Doerges C
Dow Chemical Co.; Dow Europe SA; Polyol International BV
(SPI,Polyurethane Div.; SPI Canada Inc.; European Isocyanate Producers Assn.)

Hysteresis, stress at break, dynamic mechanical property and IR spectra data are compared for foams blown by conventional blowing agents and by first generation reduced blowing agent technology. Polyol XUS 153.02 was used. Formulation and property data are also given for second generation water-blown foams that contain the modifiers XU-15617, Celltrek HD 300 and Celltrek 301 in addition to the above polyol. The additives reduce tin catalyst requirements and improve bun surface cure. 5 refs.
SWITZERLAND; USA; WESTERN EUROPE

*Accession no.502739*

*Item 291*
Polyurethanes World Congress 1993. Conference Proceedings.
Vancouver, B.C., 10th-13th Oct.1993, p.40-5. 43C6
**SECOND GENERATION CARBON DIOXIDE BLOWN SYSTEMS**
Stewart R D
ICI Polyurethanes Group
(SPI,Polyurethane Div.; SPI Canada Inc.; European Isocyanate Producers Assn.)

Carbon dioxide blown systems were evaluated and compared with typical CFC-11 blown systems for rigid pour-in-place applications such as appliances, insulated water heaters, and vending machines. Small scale laboratory tests were designed to quantify performance parameters such as foaming pressure, adhesion (peel test), and flow. These tests aided in the development of specific carbon dioxide blown systems with improved performance versus current carbon dioxide based technology. Machine processing was conducted on appliance units comparing fill weights and processing characteristics. Energy efficiency testing and physical property comparisons are reported. 2 refs.
USA

*Accession no.502735*

*Item 292*
Polyurethanes World Congress 1993. Conference Proceedings.
Vancouver, B.C., 10th-13th Oct.1993, p.33-9. 43C6
**HYDROCARBONS PROVIDE ZERO OZONE DEPLETION POTENTIAL AND ZERO GLOBAL WARMING POTENTIAL INSULATION FOR HOUSEHOLD REFRIGERATION**
Ballhaus H; Hahn H
Liebherr Hausgerate GmbH
(SPI,Polyurethane Div.; SPI Canada Inc.; European Isocyanate Producers Assn.)

Results of processing experiments on refrigerator foams blown by pentane are presented. Safety aspects are

emphasised. No perfluoroalkanes were necessary to obtain a pentane-blown insulation as as effective as the current CFC-blown. Pentane could be blended into polyol as a premix, without igniting the factory, if the machinery were properly modified. Further handling of that premix was much less hazardous than originally expected. During the moment of the injection cycle, when the foam filled approximately three-quarters of the mould, the gas content was sufficient for ignition. Therefore strong air suction must be applied to the vent of the moulding form. Pentane levels of less than 0.1% within 5-inch could be easily achieved. The flammability of pentane-blown foams was not significantly higher than that of F-11 blown foam. Equipment is illustrated. Safety and monitoring protocols are given.

EUROPEAN COMMUNITY; GERMANY; WESTERN EUROPE

*Accession no.502734*

*Item 293*

Polyurethanes World Congress 1993. Conference Proceedings.
Vancouver, B.C., 10th-13th Oct.1993, p.10-3. 43C6

**HFC-356, A ZERO OZONE DEPLETION POTENTIAL BLOWING AGENT CANDIDATE FOR NORTH AMERICAN APPLIANCE FOAM FORMULATIONS**

Ball E E; Lamberts W M
Miles Inc.; Bayer AG
(SPI,Polyurethane Div.; SPI Canada Inc.; European Isocyanate Producers Assn.)

Properties of 1,1,1,4,4,4-hexafluorobutane (HFC-356) are tabulated alongside those of CFC-11. Its potential as a blowing agent for PU foam insulation for refrigerators and freezers is discussed. Data are shown to compare foam properties and processability of formulations containg HFC-356, CFC-11 and HCFC-141b. 6 refs

EUROPEAN COMMUNITY; GERMANY; USA; WESTERN EUROPE

*Accession no.502730*

*Item 294*

Polyurethanes '92. Conference Proceedings.
New Orleans, La., 21st-24th Oct.1992, p.493-5. 43C6

**WATERLILY RANGE OF QUALITY COMFORT MATERIALS FROM ICI'S MDI-BASED FLEXIBLE SLABSTOCK TECHNOLOGY**

Casey M; Muller L; Elliot A; Parfondry A
ICI,Polyurethanes Group
(SPI,Polyurethane Div.)

ICI has developed a technology package for 100% water-blown MDI-based slabstock foams. Considerable investment in the project has included a production scale foaming unit with an output of 700 lb/min. Deterioration of physical properties, normally associated with MDI formulations at low densities, have been overcome with the design of novel chemical intermediates, which has also required new formulation development and some equipment modification. The technology package allows a wide range of hardness/density combinations from a small number of raw material components, and produces foams with remarkable stability and fast cure times. This speed, and MDI's low vapour pressure, lead to much-improved working environments. In general, the new foams give a good balance of comfort properties with an excellent latex-like feel. Data is shown comparing their performance with that of existing high resilience foams.

BELGIUM; EUROPEAN COMMUNITY; WESTERN EUROPE

*Accession no.499006*

*Item 295*

Polyurethanes '92. Conference Proceedings.
New Orleans, La., 21st-24th Oct.1992, p.487-92. 43C6

**CFC-FREE, LOW DENSITY, SOFT FLEXIBLE SLABSTOCK FOAMS**

Mayer O
Arco Chemical Europe Inc.
(SPI,Polyurethane Div.)

Arcol DP 1135 is a new modified polyether polyol which has eliminated the need for CFC-11 or other auxiliary blowing agent in the production of soft standard foam grades above 18 kg/cu.m density. Formulations and foam property data are given which show how Arcol DP 1135 can be used as base polyol for producing low density, soft foams, processable by conventional water-blown technology. Very small amounts of Arcol 3420 improved the physical properties. 1 ref.

EUROPEAN COMMUNITY; FRANCE; WESTERN EUROPE

*Accession no.499005*

*Item 296*

Polyurethanes '92. Conference Proceedings.
New Orleans, La., 21st-24th Oct.1992, p.481-6. 43C6

**MDI SLABSTOCK FOAMS. A NEW FRONTIER**

Mispreuve H; Elwell R; Sewell R; Thoen J
Dow Europe SA; Dow Benelux BV
(SPI,Polyurethane Div.)

Physical properties data are shown for all-MDI CFC-free high resilience furniture and bedding foam as well as low resilience foam for packaging. 5 refs.

EUROPEAN COMMUNITY; NETHERLANDS; SWITZERLAND; WESTERN EUROPE

*Accession no.499004*

*Item 297*

Polyurethanes '92. Conference Proceedings.
New Orleans, La., 21st-24th Oct.1992, p.468-72. 43C6

**POUR BEHIND VINYL SRIM FOR DOOR PANEL APPLICATIONS**

Ho D
BASF Corp.
(SPI,Polyurethane Div.)

 

A unique moulding process and a polyurethane system are described that enable production of light weight, strong, yet functional door panels for the automotive industry. Ease of processing, design freedom, quick demould time and one step production operation all contribute toward low cost interior trim panels. This pour behind vinyl PU system is a cost effective method to produce a high quality, low density door panel in less than one minute. The system uses water as blowing agent. Numerous variables involved in the preparation of door panels using this one step technique were evaluated. They included investigation of substrates, adhesion, flowability, moulding pressure, heat resistance, equipment used, fire retardant properties, and water absorption. The low density, pour behind vinyl system with densities as low as 8 lb/cu. foot and fibreglass contents as low as 15% in the system, achieved the physical properties necessary to exceed today's automotive industry specifications. Cost data are included. The PU system adhered excellently to the vinyl skin without an adhesive. 9 refs.

USA

*Accession no.499002*

*Item 298*
Polyurethanes '92. Conference Proceedings.
New Orleans, La., 21st-24th Oct.1992, p.455-8. 43C6
**DEVELOPMENT OF CFC-FREE INTEGRAL SKIN FOAM FOR STEERING WHEELS**
Amato T A; Cassidy E F; Christfreund A; Dobinson D; Randall D
ICI,Polyurethanes Group
(SPI,Polyurethane Div.)

Results of a joint project by ICI and UTA-Clifford to produce a steering wheel by water-blown integral skin foam technology are presented. Wheels can be produced on a variety of machines at a similar demould time to CFC-blown systems and with a lower weight than CFC-blown systems. The system is available commercially. 3 refs.

BELGIUM; EUROPEAN COMMUNITY; UK; WESTERN EUROPE

*Accession no.498999*

*Item 299*
Polyurethanes '92. Conference Proceedings.
New Orleans, La., 21st-24th Oct.1992, p.449-54. 43C6
**ALL WATER BLOWN INTEGRAL SKIN FOAM**
Wada H; Hasegawa N; Fukuda H; Takeyasu H
Asahi Glass Co.Ltd.
(SPI,Polyurethane Div.)

Use of a novel high purity, narrow MWD polyol (PREMINOL) enables production of water blown integral skin foam which has a tight, highly durable, voidless skin. Curing time is the same as with CFC-11 blowing agent. Conventional manufacturing systems can be used. Process data and surface images are given for foams produced from formulations with and without CFC-11. 4 refs.

JAPAN

*Accession no.498998*

*Item 300*
Polyurethanes '92. Conference Proceedings.
New Orleans, La., 21st-24th Oct.1992, p.438-48. 43C6
**POLYURETHANE ENERGY ABSORBING FOAMS FOR AUTOMOTIVE APPLICATIONS**
Rossio R C; Vecchio M; Abramczyk J
BASF Corp.; Ford Motor Co.
(SPI,Polyurethane Div.)

Theory and general data on the effects of impact on energy absorbing materials, including PU foam, is presented. Details are given of new water-blown PU foams (Elastoflex EA) that meets the safety criteria for vehicle interiors and exteriors. They are unique in their ability to efficiently absorb energy during an impact, rather than transferring this potential energy to the occupant, which could increase the probability of injury. These low density foams can be moulded efficiently into a variety of shapes using existing PU processing equipment, e.g. a Puromat 80 high pressure foam machine.

USA

*Accession no.498997*

*Item 301*
Polyurethanes '92. Conference Proceedings.
New Orleans, La., 21st-24th Oct.1992, p.431-5. 43C6
**INNOVATIVE SURFACTANT TECHNOLOGY FOR ALTERNATIVELY BLOWN POLYISOCYANURATE FOAM INSULATION**
Willoughby K; Hennington R M
Goldschmidt Chemical Corp.
(SPI,Polyurethane Div.)

The advantages of the silicone surfactant Tegostab B 84PI are demonstrated by processing and finished foam data on polyisocyanurate insulation material blown by CFC-11, water, water/HCFC-141B and HCFC-141b. Properties compared are flowability, density, closed cell content, friability, facer adhesion, blowing agent retention, dimensional stability, humidity resistance, and thermal transmission.

USA

*Accession no.498996*

*Item 302*
Polyurethanes '92. Conference Proceedings.
New Orleans, La., 21st-24th Oct.1992, p.422-30. 43C6
**EFFECTS OF HUMIDITY AND ELEVATED TEMPERATURE ON THE DENSITY AND THERMAL CONDUCTIVITY OF A RIGID POLYISOCYANURATE FOAM**
Zarr R R; Nguyen T

US,National Inst.of Standards & Technology
(SPI,Polyurethane Div.)

Measurements of apparent thermal conductivity are presented for specimens of rigid polyisocyanurate foam cut from a commercial insulation product and aged in air at 60C and different humidities. Specimens were cut from boards blown with trichlorofluoromethane. Measurements were conducted for a period of 357 days at approximately 50-day intervals. Ageing curves of specimen mass, volume, density, and thermal conductivity for rigid polyisocyanurate foam are presented and implications of changes in these properties are discussed. Loss of blowing agent was measured by FTIR. Surface changes were studied by SEM. 27 refs.

USA

*Accession no.498995*

*Item 303*
Polyurethanes '92. Conference Proceedings.
New Orleans, La., 21st-24th Oct.1992, p.410-21. 43C6
**NOVEL SPRAY FOAM POLYOLS WITH IMPROVED PERFORMANCE**
Yamato L T; Schiff D E; Bhattacharjee D; Galbreath D E; McAdams H P; Dressel D
Dow Chemical Co.; IPI Inc.; Foam Enterprises
(SPI,Polyurethane Div.)

Polyols for CFC-free spray foams, i.e. blown by water or by HCFC-141, were investigated. Two polyols which led to an acceptable overall b-side viscosity and produce foams with good dimensional stability and with low friability were developed for carbon dioxide blown rigid PU spray foam formulations. The polyols also have potential utility in other rigid polyurethane and polyurethane modified polyisocyanurate foam applications. Results of ASTM tests for density, k-factor, friability, % closed cells, compressive strength, dimensional stability, heat and smoke release, and peel adhesion (to steel), are tabulated together with some processing information (cream time, gel time and tack free time). 6 refs.

USA

*Accession no.498994*

*Item 304*
Polyurethanes '92. Conference Proceedings.
New Orleans, La., 21st-24th Oct.1992, p.396-9. 43C6
**FORMACEL S STABILITY IN RIGID POLYURETHANE FOAM PREMIX**
Hammel H S; Bartlett P L; Creazzo J A
du Pont Chemicals
(SPI,Polyurethane Div.)

The degradation of HCFC-22 (Formacel S) in the presence of various polyols, catalysts and stabilisers was studied. Amine catalysts caused most degradation. Overall the studies showed that degradation of HCFC-22 can occur in the B-side mixtures. The rate of degradation was slow. In the worst case the loss of HCFC-22 was about 1% per month. Degradation products were not of concern from a toxicity standpoint. A preliminary study of HFC-134a (Formacel Z-4) and HFC-152a (Formacel Z-2) indicated that there was no degradation of those compounds in the B-sides. 4 refs.

USA

*Accession no.498992*

*Item 305*
Polyurethanes '92. Conference Proceedings.
New Orleans, La., 21st-24th Oct.1992, p.390-5. 43C6
**CARBON DIOXIDE BLOWN DIMENSIONALLY STABLE RIGID POLYURETHANE FOAM FOR ENTRY DOOR APPLICATIONS**
Mirasol S; Bhattacharjee D; Moreno O
Dow Chemical Co.
(SPI,Polyurethane Div.)

A novel technology involving a new polyol was developed. It provided foams with excellent adhesion to different substrates, e.g. plastic liner materials as well as steel facers, while maintaining excellent dimensional stability at low density under a variety of temperature and humidity conditions. The foams contained finer and more uniform cells than those blown with CFC-11. The technology successfully produced steel entry doors on conventional equipment. 3 refs.

USA

*Accession no.498991*

*Item 306*
Polyurethanes '92. Conference Proceedings.
New Orleans, La., 21st-24th Oct.1992, p.384-9. 43C6
**POLYURETHANE FOAM SYSTEMS FOR CLASS 1 METAL PANELS**
Lynch J J; Gerber D; Stewart R D
ICI Polyurethanes
(SPI,Polyurethane Div.)

The important performance criteria for fire rated metal panels are discussed. Pitfalls encountered while changing the blowing agent are pointed out and specifically tailored PU foam systems incorporating HCFC-141b and HCFC-22 are revealed. They are capable of obtaining Class 1 fire ratings with no sacrifice of processing characteristics, physical properties and thermal conductivity. 5 refs.

USA

*Accession no.498990*

*Item 307*
Polyurethanes '92. Conference Proceedings.
New Orleans, La., 21st-24th Oct.1992, p.348-58. 43C6
**THANCAT DA LINE. HIGHLY EFFECTIVE CATALYSTS FOR ALL-WATER-BLOWN HR FOAM**

Diblitz K; Diblitz C
Condea Chemie GmbH
(SPI,Polyurethane Div.)

Two azanorbornane catalysts (Thancat DA 301 and Thancat DA 401) are evaluated by data showing cure time, start time, rise time, density, shrinkage and cream time of the reaction mixture as well as density, open-cell content, shrinkage and mechanical property data for the foams. Special attention is paid to flowability and fogging. 7 refs.

EUROPEAN COMMUNITY; GERMANY; WESTERN EUROPE

*Accession no.498986*

*Item 308*

Polyurethanes '92. Conference Proceedings.
New Orleans, La., 21st-24th Oct.1992, p.341-7. 43C6

**TEXACAT CATALYSTS IN WATER-BLOWN RIGID FOAM**

Dedeaux D W; Rister E L; Zimmerman R L; Kohoutek F C
Texaco Chemical Co.
(SPI,Polyurethane Div.)

Effects are shown for over 15 tertiary amine catalysts (15 Texacat grades) on reaction profiles and foam properties at varying degrees of water-blowing in a rigid pour polyurethane foam system. This paper examines the intrinsic gelling character of these catalysts, and screens catalyst performance on the bases of flow, k-factor, closed-cell content, and compressive strength of the resultant foams. The superior flow character of a proprietary catalyst for all water-blown rigid foam is demonstrated. The effect of isocyanate index and choice of co-blowing agents is discussed. Several volatile organic compounds, including isopentane and HCFC-141b, were screened as co-blowing agents. Texacat ZR-70 was the most effective in terms of flow and cure. Texacat ZF-10 and Texacat ZF-22 were good choices in all-water blown rigid systems.

USA

*Accession no.498985*

*Item 309*

Polyurethanes '92. Conference Proceedings.
New Orleans, La., 21st-24th Oct.1992, p.183-6. 43C6

**IMPROVED RIGID INSULATING POLYURETHANE FOAMS PREPARED WITH HCFCS AND PERFLUOROALKANES**

Yu-Hallada L C; McLellan K P; Wierzbicki R J; Reichel C J
BASF Corp.
(SPI,Polyurethane Div.)

The potential of perfluoropentane and perfluorohexane as blowing agents was investigated. Their insolubility in polyols and polyisocyanates meant that they had to be dispersed as emulsions. They produced foams with very fine cells and low k-factors. However, they had low efficiency at blowing and so they were mixed with HCFC-22 and HCFC-141b. Addition of perfluoroalkanes to co-blown systems of HCFC and water gave significant improvement in thermal insulating properties. Foams blown by perfluoroalkanes showed only slight changes in k-factor through ageing. the ozone depletion potentials of the perfluoroalkanes was zero, but their global warming potential was about 5. 2 refs.

EUROPEAN COMMUNITY; GERMANY; WESTERN EUROPE

*Accession no.498967*

*Item 310*

Polyurethanes '92. Conference Proceedings.
New Orleans, La., 21st-24th Oct.1992, p.177-82. 43C6

**MICRO-FINE CELLULAR TECHNOLOGY FOR THE APPLIANCE INDUSTRY**

de Vos R; Rosbotham D; Deschaght J
ICI,Polyurethanes Group
(SPI,Polyurethane Div.)

Development work by ICI with low boiling blowing agents, i.e. blends of HCFC-22 with HCFC-142b, is described. The need to comply with regulations on CFCs as well as the consumption of energy by appliances is emphasised. New technology involving the use of insoluble material as nucleating agent produced micro-fine celled foam and overcame frothing caused by low boiling blowing agents. Initial and aged thermal conductivity data are given for various formulations. 2 refs.

BELGIUM; EUROPEAN COMMUNITY; WESTERN EUROPE

*Accession no.498966*

*Item 311*

Polyurethanes '92. Conference Proceedings.
New Orleans, La., 21st-24th Oct.1992, p.172-6. 43C6

**RAPID TECHNOLOGY EVALUATION TO HCFC-22/142B BLOWING AGENT FOR REFRIGERATOR INSULATION FOAM**

Fanichet X; Kuhn E; Schindler P
Dow Europe SA
(SPI,Polyurethane Div.)

The above blowing agents are presented as less toxic alternatives to HCFC-123 and HCFC-141b. Foam formulations are presented which achieve similar processing and foam properties as 50% R-11 blown foam systems. Excellent initial and aged foam k-factors were obtained. The effect of these low boiling blowing agents on plastic liner materials, the different possibilities of blowing agent addition and the influence of machine parameters were investigated as well. Trials at major European appliance manufacturers showed superior insulation performance of the entire cabinets with respect to k-factor.

SWITZERLAND; WESTERN EUROPE

*Accession no.498965*

*Item 312*
Polyurethanes '92. Conference Proceedings.
New Orleans, La., 21st-24th Oct.1992, p.165-171.
43C6
**LOWER DENSITY HCFC BLOWN APPLIANCE FOAMS**
Doerge H P
Miles Inc.
(SPI,Polyurethane Div.)

New low k-factor HCFC blown foams are described. They have lower k-factors and densities than previously reported microcell HCFC blown foams. In addition, formulation and property data are presented for new HCFC blown foams having similar thermal conductivities and densities to production CFC-11 blown foams. Processing characteristics, physical properties and demoulding effects are shown to be equivalent or better than conventional CFC-11 blown production foams. Blowing agents mentioned are HCFC-141b and HCFC-123. 2 refs.

USA

*Accession no.498964*

*Item 313*
Polyurethanes '92. Conference Proceedings.
New Orleans, La., 21st-24th Oct.1992, p.158-64. 43C6
**OPEN CELL ISOCYANURATE FOAMS. A NOVEL ROUTE TO HIGH PERFORMANCE THERMAL INSULATION PANELS**
Ashida K; Kashiwame J
Detroit,Mercy University; Asahi Glass Co.Ltd.
(SPI,Polyurethane Div.)

Open cell isocyanurate foam and its use as a core material for vacuum insulation panels are discussed. When open cell foams are used as core materials for insulation panels kept under vacuum, the total heat loss through the panel consists only of the contributions from conductivity through the solid and the radiation loss. The preparation, processing, properties and applications of open cell rigid isocyanurate foams are described. They were blown by a blend of methylene chloride and pentane. The resulting foams had open cell contents of about 50-95% depending upon the reaction conditions employed at densities of 30-50 kg/cu.m. When pour-in-place foams were further exposed to vacuum after foaming, the resulting foams had an increased open cell content. This open cell foam technology suggests a variety of potential applications, not only for household refrigerators and deep freezers, but also for cryogenic liquid tank insulation, e.g. liquid hydrogen, liquid oxygen, liquid nitrogen, and liquified natural gas. 13 refs.

JAPAN; USA

*Accession no.498963*

*Item 314*
Polyurethanes '92. Conference Proceedings.
New Orleans, La., 21st-24th Oct.1992, p.141-8. 43C6
**SPECIALLY DESIGNED SURFACTANTS AND ALTERNATIVE TECHNIQUES FOR PROCESSING OF CRC-FREE RIGID FOAMS**
Klincke M; Burkhart G
Goldschmidt Th.,AG
(SPI,Polyurethane Div.)

It is shown that the phaseout of CFCs has made it necessary to reexamine the chemical structure of the silicone surfactants for each newly developed rigid PU foam system in order to achieve optimum performance. An unconventional way of blowing rigid PU foams is reported making use of the inherent tendency of the isocyanate group to react with itself and to form carbodiimide and carbon dioxide. This approach makes it possible to reduce the amount of auxiliary blowing agent and/or water in a formulation significantly without sacrificing the physical foam properties. The effect of nucleation aids (melamine and aerosil) on the cell structure and likewise on the Lamda-value of rigid PU foam is presented. 2 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

*Accession no.498961*

*Item 315*
Polyurethanes '92. Conference Proceedings.
New Orleans, La., 21st-24th Oct.1992, p.102-11. 43C6
**PROCESSING-PROPERTIES RELATIONSHIPS FOR POLYURETHANE SPRAY FOAMS WITH HCFC BLOWING AGENTS**
Strauss E L; Bziik J W
Martin Marietta Astronautics Group; Martin Marietta Manned Space Systems
(SPI,Polyurethane Div.)

Two PU spray foams, SS-1228 and SS-1229, were selected for process development since they ranked highest in meeting mandatory thermal protection requirements for the National Launch System. A statistical design of experiment was employed to evaluate the spray process variables of foam component temperature and pressure, room and substrate temperature, relative humidity, overlap time, and spray gun. Specimens cut from test panels were tested for density, compression strength, tension strength (-423F to +200F), open cell content and friability weight loss. Bond strengths between successive layers were measured. SS-1228 with HCFC-141b was selected as the primary spray foam candidate. SS-1229 was penalised on account of adverse toxicity information on its blowing agent HCFC-123. 5 refs.

USA

*Accession no.498956*

*Item 316*
Polyurethanes '92. Conference Proceedings.
New Orleans, La., 21st-24th Oct.1992, p.36-41. 43C6

**FINE-CELLED CFC-FREE RIGID FOAM. NEW MACHINERY WITH LOW BOILING BLOWING AGENTS**
Grunbauer H J M; Broos J A F; Thoen J A; Smits G F
Dow Benelux NV; Admiral Equipment Co.
(SPI,Polyurethane Div.)

Newly developed high pressure dispensing and nucleating equipment is described. It was designed for making fine cell foams using soluble low-boiling blowing agents (LBBA) and sparingly soluble nucleating gases, e.g. nitrogen and noble gases. The underlying concepts for handling, processing and metering LBBAs are developed from a systematic investigation of LBBA solubilities in polyols, using modelling as well as experimental measurements. In addition to the usual dispensing function, the equipment incorporates facilities for LBBA loading and for quantitative determination of dissolved and dispersed gaseous LBBA. The commercial viability of these features, under conditions simulating global industrial practice, is exemplified by presenting properties of fine-cell foams produced by using HFC-134a and HCFC-22/142b blends, in combination with tailor-made polyols, isocyanates and formulation additives. 8 refs.

EUROPEAN COMMUNITY; NETHERLANDS; USA; WESTERN EUROPE

*Accession no.498947*

*Item 317*
Polyurethanes '92. Conference Proceedings.
New Orleans, La., 21st-24th Oct.1992, p.23-25. 43C6
**HYDROFLUOROCARBONS AND HYDROFLUOROCARBON ETHERS AS BLOWING AGENTS FOR RIGID INSULATING URETHANE FOAMS**
Fishback T L; Reichel C J
BASF Corp.
(SPI,Polyurethane Div.)

Density, compression strength, thermal conductivity (initial and after heat ageing), friability, dimensional stability, abrasion resistance, tear strength, hardness, tensile and fatigue property data are shown for rigid PU and isocyanurate foams blown with HFC-E245 (difluoromethyl-1,1,1-trifluoroethylether), HFC-E356 (methyl-1,1,1,2,3,3-hexafluoropropyl ether) and HFC-245ca (1,1,2,2,3-pentafluoropropane). They were found to be good blowing agents and co-blowing agents (with water) for existing rigid foam formulations, including integral skin foams. 4 refs.

USA

*Accession no.498944*

*Item 318*
Polyurethanes '92. Conference Proceedings.
New Orleans, La., 21st-24th Oct.1992, p.12-16. 43C6
**K-FACTOR IMPROVEMENT VIA PERFLUORINATED HYDROCARBONS**
Londrigan M E; Snider S C; Trout K G
Center for Applied Engineering Inc.
(SPI,Polyurethane Div.)

The effects of mixing perfluorinated hydrocarbons (Fluorinert FC-72, Fluorinert FC-84, Fluorinert FC-70, Fluorinert L-11722 and Performance Fluid 5050) with conventional CFC blowing agents or HCFC replacements on the thermal conductivity and density of PU or polyisocyanurate foams were investigated. The handbatch foams were derived from phthalic ester polyols and polymeric MDI (with and without carbon black). 3 refs.

USA

*Accession no.498942*

*Item 319*
Polyurethanes '92. Conference Proceedings.
New Orleans, La., 21st-24th Oct.1992, p.2-11. 43C6
**BLOWING AGENTS. THE NEXT GENERATION**
Decaire B R; Pham H T; Richard R G; Shankland I R
Allied Signal Inc.
(SPI,Polyurethane Div.)

Properties of some liquid blowing agents and some lower boiling, so-called gaseous blowing agents are tabulated and discussed. These properties include thermal conductivity, toxicity, flammability, atmospheric life, volatility, and solubility in polyols. The substances considered are HFC-152a, HFC-134a, HFC-125, HFC-32, HFC-143A, HCFC-22, HCFC-142b, HCFC-141b, and HFC-356. Data are given too for a large number of hydrofluoropropane isomers. 12 refs.

USA

*Accession no.498941*

*Item 320*
Polyurethanes '92. Conference Proceedings.
New Orleans, La., 21st-24th Oct.1992, p.688-92. 43C6
**ALL-WATER-BLOWN POLYURETHANE INTEGRAL SKINS TO REPLACE CURRENT CFC-BLOWN SYSTEMS**
Madaj E J; Jasenak J R
Miles Inc.
(SPI,Polyurethane Div.)

It is shown by means of property data (density, hardness, TS, EB, tear strength, abrasion resistance, compression set) that water-blown integral skin systems are a viable alternative to CFC-containing polyurethanes.

USA

*Accession no.498870*

*Item 321*
Polyurethanes '92. Conference Proceedings.
New Orleans, La., 21st-24th Oct.1992, p.668-71. 43C6
**FROM CHLOROFLUOROCARBON TO CHEMICAL BLOWING AGENT. A VIABLE ALTERNATIVE**

Bradford L; Franklin R; Williams B
Akzo Chemicals Inc.
(SPI,Polyurethane Div.)

Use of dialkyl dicarbonates, particularly E-90018T, as blowing agents is explained. Limitations, i.e. rate of reaction, decomposition pathways to give either one or two moles of carbon dioxide, and problems of alcohol release, are pointed out. Brief formulation and property data are shown for PU foams. Comparison is made with other gas-yielding agents. 4 refs.

USA

*Accession no.498867*

*Item 322*
Polyurethanes '92. Conference Proceedings.
New Orleans, La., 21st-24th Oct.1992, p.660-7. 43C6
**MANUFACTURING FLEXIBLE SLABSTOCK FOAMS WITH TECHNOLOGY THAT ALLOWS THE REDUCTION OR ELIMINATION OF AUXILIARY BLOWING AGENTS**
Hicks J S; Skorpenske R G; McAfee C D; Wiltz E P; Brunner K
Dow Chemical Co.; Dow Europe SA
(SPI,Polyurethane Div.)

A summary is presented of the significant contributions made to the global flexible slabstock industry via the successful commercialisation of Dow technology. Emphasis is placed on meeting environmental and occupational health legislation in Europe and USA. Advantages of Celltrek 3000 polyol and Celltrek HD300 additive are emphasised. 7 refs.

DOW CHEMICAL CO.; DOW EUROPE SA
SWITZERLAND; USA; WESTERN EUROPE

*Accession no.498866*

*Item 323*
Polyurethanes '92. Conference Proceedings.
New Orleans, La., 21st-24th Oct.1992, p.650-9. 43C6
**COMPRESSION SET MECHANISMS IN FLEXIBLE POLYURETHANE FOAM**
Skorpenske R G; Solis R; Kuklies R A; Schrock A K; Turner R B
Dow Chemical USA
(SPI,Polyurethane Div.)

Model foams which varied in urea content (water level), soft segment connectivity (TDI index), and urethane content (phenyl isocyanate capped polyol) were characterised analytically and evaluated for their response to variations in temperature, moisture and mechanical stress. The effect of foam cell structure on compression set was also studied. It is concluded that that resistance to temperature induced polymer transitions under strain, the hydrogen bonded network, soft segment elasticity driven recovery, and the covalent network, can be used to describe the phenomenon of compression set on a molecular level. Moisture was also found to significantly reduce the energy required to induce compression set by plasticising the urea hard domain. Relevance to the trend towards water-blown foams is indicated. 7 refs.

USA

*Accession no.498865*

*Item 324*
CFCs and the Polyurethane Industry : Volume 4.
Basel, Technomic, 1992, p.419-566. 43C6
**1991 UNEP FLEXIBLE AND RIGID FOAMS TECHNICAL OPTIONS REPORT**
United Nations Environment Programme 1991
Edited by: Lichtenberg F W
(SPI,Polyurethane Div.)

This report reviews the use of CFCs in flexible and rigid foam and outlines the available technical options that can be implemented by each foam market segment in order to eliminate CFC usage. Updates on the progress of each market sector in reducing CFC consumption since 1986 are given. A perspective is also given on CFC use patterns in developing countries.

USA

*Accession no.498006*

*Item 325*
***Journal of Cellular Plastics***
29, No.5, Sept/Oct.1993, p.413-4
**CFC USE VIRTUALLY ELIMINATED BY FLEXIBLE POLYURETHANE FOAM PRODUCERS**

The Polyurethane Foam Association, the organisation of flexible PU foam manufacturers, has announced that at the end of 1992, its members has achieved a 99.88% reduction in the use of CFC-11 since 1986. Association members and industry suppliers have been successful in developing alternative production technologies that have helped the rapid phase-out of CFCs in the flexible foam industry. This abstract includes all the information contained in the original article.

POLYURETHANE FOAM ASSN.
USA

*Accession no.494084*

*Item 326*
Polyurethanes World Congress 1991: The Voice of Advancement. Conference Proceedings.
Nice, 24th-26th Sept.1991, p.752-9. 43C6
**FROTH AND POUR-IN-PLACE FOAM SYSTEMS BASED ON CFC ALTERNATIVES**
Dwyer F J; Parker R C; Thrun K M; Zwolinski L M
Allied-Signal Inc.
(SPI,Polyurethane Div.; European Isocyanate Producers Assn.)

The use of two alternative HCFC-type candidates, chlorodifluoromethane (HCFC-22) and 1,1-dichloro-1-

fluoroethane (HCFC-141b), as substitutes for CFC-12 and CFC-11 in the production of rigid PU foam insulation for residential and commercial refrigeration is demonstrated. The physical, chemical and environmental properties of these products and their performance in these applications are described.

USA

*Accession no.485301*

*Item 327*
Polyurethanes World Congress 1991: The Voice of Advancement. Conference Proceedings.
Nice, 24th-26th Sept.1991, p.740-4. 43C6
**PUR FOAMS PREPARED WITH EMULSIFIED PERFLUOROALKANES AS BLOWING AGENTS**
Volkert O
BASF AG
(SPI,Polyurethane Div.; European Isocyanate Producers Assn.)

The results are reported of a study of the use of perfluoroalkanes as blowing agents in rigid PU foams. A procedure for dispersing these blowing agents in polyols as emulsions whose fine drops are easily vaporised is described along with trials aimed at minimising the amount of perfluoroalkanes in the foams. The most suitable perfluoroalkanes are shown to be perfluoropentane, perfluorohexane and perfluoroheptane, giving rise to foams with particularly fine cells and low thermal conductivity.

EUROPEAN COMMUNITY; GERMANY; WESTERN EUROPE

*Accession no.485300*

*Item 328*
Polyurethanes World Congress 1991: The Voice of Advancement. Conference Proceedings.
Nice, 24th-26th Sept.1991, p.412-27. 43C6
**MATHEMATICAL MODELLING TECHNIQUES TO PREDICT IMPORTANT ASPECT OF K-FACTOR AGEING OF CFC-11 FREE RIGID INSULATION**
Smits G F; Thoen J A
Dow Benelux NV
(SPI,Polyurethane Div.; European Isocyanate Producers Assn.)

A complete overview is presented of the scope and limitations of two alternative approaches to the use of CFC as blowing agents for rigid PU foams, based on the results of extensive computational analysis and simulation. The approaches involve the partial or total replacement of CFC-11 by carbon dioxide and the use of less ozone depleting HCFCs to replace CFC-11. Critical chemical, physical and compositional parameters that regulate both initial and aged thermal conductivity and dimensional stability are quantified and theory, mathematics and simulation tuned to experimental data. 18 refs.

EUROPEAN COMMUNITY; NETHERLANDS; WESTERN EUROPE

*Accession no.485286*

*Item 329*
Polyurethanes World Congress 1991: The Voice of Advancement. Conference Proceedings.
Nice, 24th-26th Sept.1991, p.243-9. 43C6
**CFC-FREE PU PIPE INSULATION FOAMS FOR USE IN DISTRICT HEATING SYSTEMS**
Broennum T
Shell Belgium
(SPI,Polyurethane Div.; European Isocyanate Producers Assn.)

The effect of the total replacement of CFC-11 on the processing and physical properties of PU pipe insulation foams containing polyols developed specifically to overcome the problems encountered when increased water levels are used in the formulation, was investigated. Blowing agents employed were carbon dioxide, via the water/isocyanate reaction, and dual blown systems based on carbon dioxide and HCFCs, such as 142b. 2 refs.

BELGIUM; EUROPEAN COMMUNITY; WESTERN EUROPE

*Accession no.485273*

*Item 330*
Polyurethanes World Congress 1991: The Voice of Advancement. Conference Proceedings.
Nice, 24th-26th Sept.1991, p.169-71. 43C6
**INFLUENCE OF GASSING, ESPECIALLY WITH CO2, ON THE MACHINABILITY AND MOULDED PART PROPERTIES OF PU FOAM SYSTEMS**
Jung L
Elastogran Polyurethane GmbH
(SPI,Polyurethane Div.; European Isocyanate Producers Assn.)

A gassing concept for gases with a high solubility is described and its application to the gassing of isocyanate components with carbon dioxide is demonstrated. Three examples are presented, namely the gassing of a flexible foam system for automotive seat cushions, the gassing of a flexible foam system for the backfoaming of automobile carpeting and the gassing of a semi-rigid system for dashboards.

EUROPEAN COMMUNITY; GERMANY; WESTERN EUROPE

*Accession no.485265*

*Item 331*
Polyurethanes World Congress 1991: The Voice of Advancement. Conference Proceedings.
Nice, 24th-26th Sept.1991, p.160-3. 43C6
**METERING OF FLAMMABLE BLOWING AGENTS**
Lerch B P; Taubenmann P
BASF AG; Elastogran Polyurethane GmbH

(SPI,Polyurethane Div.; European Isocyanate Producers Assn.)

Two distinct processes of using pentane as a blowing agent in the production of PU foam are described. The processes involve direct pentane metering into the mix head according to the nozzle-within-a-nozzle process and the metering of pentane into the polyol stage of the process, which is protected from flammability and explosion hazards.

EUROPEAN COMMUNITY; GERMANY; WESTERN EUROPE

*Accession no.484595*

*Item 332*
Polyurethanes World Congress 1991: The Voice of Advancement. Conference Proceedings.
Nice, 24th-26th Sept.1991, p.66-8. 43C6
**EXPERIENCES AND RESULTS OF CFC-FREE PU FOAMS IN BUILDING INDUSTRY**
Ihanamaki A
Lohja Corp.
(SPI,Polyurethane Div.; European Isocyanate Producers Assn.)

Experiences by Lohja Corp. when developing CFC-free PU foams are outlined and the results of tests carried out on PU foam formulations containing HFA-22 as a replacement for CFC-11 are briefly reported. 2 refs.

FINLAND; SCANDINAVIA; WESTERN EUROPE

*Accession no.484574*

*Item 333*
Polyurethanes World Congress 1991: The Voice of Advancement. Conference Proceedings.
Nice, 24th-26th Sept.1991, p.63-5. 43C6
**NEW CFC-FREE TECHNOLOGY FOR THE PRODUCTION OF PUR INSULATION PANELS**
Wallaeys B; de Schryver P; Cop P
Recticel NV
(SPI,Polyurethane Div.; European Isocyanate Producers Assn.)

The properties (physical, environmental and toxicological) and use of 2-chloropropane as a replacement for CFC-11 in rigid PU foam boards are described. The technology is known as LBL-2.

BELGIUM; EUROPEAN COMMUNITY; WESTERN EUROPE

*Accession no.484573*

*Item 334*
Polyurethanes World Congress 1991: The Voice of Advancement. Conference Proceedings.
Nice, 24th-26th Sept.1991, p.60-2. 43C6
**CFC-FREE PU-SANDWICH ELEMENT DBL PRODUCTION FOR SCANDINAVIAN MARKETS**
Ojala R
Urepol Oy
(SPI,Polyurethane Div.; European Isocyanate Producers Assn.)

A report is presented on preliminary trials on CFC-free PU foams and on HFA-22/water blown PU foams. Lambda values at 10C versus time, mechanical properties and costs for foams blown with HFA-22/CO2, CO2 and CFC-11 are reported.

FINLAND; SCANDINAVIA; WESTERN EUROPE

*Accession no.484572*

*Item 335*
***Journal of Cellular Plastics***
29, No.3, May/June 1993, p.222-45
**MINIMISATION OF HCFC-141B DECOMPOSITION IN RIGID POLYISOCYANURATE FOAMS**
Bodnar T W; Dewhurst J E; Koch J J; Demmin T R; Eibeck R E; Parker C
Air Products & Chemicals Inc.; Allied-Signal Inc.

Results are presented of an investigation of the effects of a number of formulation variables on the dehydrochlorination of HCFC-141b blowing agent during the formation of rigid polyisocyanurate foams to produce chlorofluoroethylene, HCFC-1131a. The change in HCFC-1131a content in foam cells with time, studied by ageing foam samples at three temps., 70, 130 and 200F, is also considered. 5 refs.

USA

*Accession no.478699*

*Item 336*
***Journal of Cellular Plastics***
29, No.2, March/April 1993, p.144-58
**REPLACING CFC-11 WITH HCFC-22 IN POLYURETHANE FOAM**
Creazzo J A; Hammel H S
Du Pont de Nemours E.I.,& Co.Inc.

Basic data obtained for the use of HCFC-22 as a blowing agent in PU and polyisocyanurate systems are presented, including data on physical properties, compatibility with materials of construction, solubility/compatibility in polyols, effect on B-side viscosities, stability in B-side systems and in foams, and foam insulation value. Results of foam trials in which HCFC-22 was used to replace CFC-11 are discussed, covering processability of the foam systems, foam properties and performance of the HCFC-22 foams in the final products. (Polyurethanes World Congress, SPI/ISOPA, Nice, France, Sept.1991)

USA

*Accession no.477696*

*Item 337*
***Journal of Cellular Plastics***
29, No.2, March/April 1993, p.132-43
**CHLORODIFLUOROMETHANE AS THE PRIMARY BLOWING AGENT FOR RIGID URETHANE FOAMS USING CONVENTIONAL**

 

**LOW AND HIGH PRESSURE FOAM MIXING EQUIPMENT**
Krueger D C; Reichel C J
BASF Corp.

The suitability of chlorodifluoromethane(R-22) as a replacement for CFC-11 as a blowing agent for rigid PU foams was investigated. It was shown that low density R-22 blown foams could be made using conventional PU foam equipment. The resulting foams had good physical properties and were easy to process. Their dimensional stability was very good at low and high temps., with foam densities above 1.5 pcf, and they exhibited improved k-factors compared with all-water blown foam formulations. Foams co-blown with HCFC-22/water had improved blowing efficiency and reduced minimum fill weights. Foam densities down to 1.5 pcf could be moulded in place. 6 refs. (Polyurethanes World Congress, SPI/ISOPA, Nice, France, Sept.1991)

USA

*Accession no.477695*

*Item 338*
***Journal of Cellular Plastics***
29, No.2, March/April 1993, p.114-31
**BLOWING AGENT EMISSIONS FROM INSULATION FOAMS**
Shankland I R
Allied-Signal Inc.

An outline is presented of a mathematical model that can be used to estimate the concentration of blowing agent, emitted from polyisocyanurate foam insulation, which may be present in a house. The basic assumption of the model is that the blowing agent emission process is a diffusion process. Other assumptions on which the model is based are also discussed. Estimates of concentrations of CFC-11 and HCFC-14b in the house are given. The sensitivity of the calculations to the input parameters is also discussed. 9 refs. (Polyurethanes World Congress, SPI/ISOPA, Nice, France, Sept.1991)

USA

*Accession no.477694*

*Item 339*
***Urethanes Technology***
9,No.6,Dec.1992/Jan.1993,p.12
**HCFCS TO GO BY 2030**

The United Nations Environment Programme has tightened the Montreal Protocol, bringing forward all the deadlines for the elimination of substances which damage the ozone layer, including CFCs and HCFCs used in making PU foams. In addition the industrialised countries have pledged an extra 500m US dollars to the present 500m US dollars to help developing countries adapt to the regulations in the 1994-6 period. Brief details are given of the deadline dates for various materials.

EUROPEAN COMMUNITY; UK; WESTERN EUROPE

*Accession no.466117*

*Item 340*
***Cellular Polymers***
11,No.5,1992,p.357-77
**PRODUCTION OF CFC-FREE, LOW DENSITY COLD CURE MOULDED FOAMS**
Wehman C
Shell Research SA

The development of cold cure moulding formulations for a wide range of PU foam density and hardness, based on Caradol 28-3 polymer polyol for hardness enhancement, water as the only blowing agent, glycerol and Caradate 45, is described. It is shown that the desired foam appearance and processing can be obtained by using an optimised combination of amines and a tin catalyst. One of the amine catalysts could be specifically included to improve skin cure. It is demonstrated that easy demoulding and good crush resistance can be achieved by using a balanced combination of the above catalysts and a cell-opener. 14 refs.

SHELL CHEMICAL CO.

BELGIUM; EUROPEAN COMMUNITY; WESTERN EUROPE

*Accession no.464838*

*Item 341*
***Urethanes Technology***
9,No.5,Oct/Nov.1992,p.22-4
**3M MATERIALS GIVE MICROCELLULAR FOAMS; BETTER THERMAL INSULATION FOLLOWS**
Focquet K
3M Belgium NV

Development work at 3M is reported to have demonstrated that the addition of certain fluorine-based compounds to rigid foam formulations can lower the foam's thermal conductivity. These compounds produce a microcellular morphology in the foam that results in greatly improved insulation efficiency. Significant improvements in lambda values that can be achieved, as well as energy consumption data and physical properties, with unique fluorine compounds not yet fully commercialised by 3M are described. 6 refs.

BELGIUM; EUROPEAN COMMUNITY; WESTERN EUROPE

*Accession no.464635*

*Item 342*
***Journal of Cellular Plastics***
28,No.2,March/April 1992,p.115-29
**IMPROVEMENTS IN HCFC MICROCELL APPLIANCE FOAM**
Doerge H P
MILES INC.

A report is presented on the development of improved lower density microcellular HCFC-blown PU foams having demoulding characteristics and insulation properties equivalent to or better than those of commercial CFC-11-blown foams. Various factors, including polyol

selection, are related to improvements in strength properties and demoulding characteristics. The use of a small amount of water, about 0.2% based on the total foam formulation, is shown to produce foams having the lowest thermal conductivities. 4 refs. (SPI/ISOPA Polyurethanes World Congress,Nice,France,Sept.1991)

USA

*Accession no.457255*

*Item 343*
***Journal of Cellular Plastics***
28,No.2,March/April 1992,p.100-14
**POLYURETHANE RIGID FOAM SYSTEMS FOR METAL-FACED SANDWICH PANELS FOR THE 1990S**
Jeffs G M F;Rosbotham I D;Mathys B;Frigo R
ICI POLYURETHANES GROUP

Rigid PU foams for metal-faced sandwich panels are discussed with emphasis on reduced CFC foams, CFC-free systems (carbon dioxide-blown, HCFC-123- and HCFC-141b-blown, HCFC-22-blown and pentane-blown) and parameters affecting peel adhesion. 2 refs. (SPI/ISOPA Polyurethanes World Congress, Nice, France, Sept.1991)

BELGIUM; EUROPEAN COMMUNITY; ITALY; WESTERN EUROPE

*Accession no.457254*

*Item 344*
***Cellular Polymers***
11,No.3,1992,p.201-23
**HCFC BLOWN RIGID POLYURETHANE FOAMS AND REFRIGERATOR LINER MATERIALS: SEARCH FOR COMPATIBLE SYSTEMS**
Potter K G;Tweedale C R
ICI,POLYURETHANES GROUP; MONSANTO EUROPE SA

The current status of developments towards the reduction and eventual elimination of CFC-11 from rigid PU foam systems used for the insulation of domestic refrigerators and freezers is discussed. The problems of liner/alternative blowing agent interactions are examined. The main parameters covered include thermal conductivity, its ageing, carbon dioxide permeability and adhesion between the PU foam and the plastics liner. The physical attack of the liners is considered and new liner materials and combinations which are compatible with HCFC blown foams are identified. 3 refs.

BELGIUM; EUROPEAN COMMUNITY; WESTERN EUROPE

*Accession no.457206*

*Item 345*
***Journal of Cellular Plastics***
28,No.1,Jan/Feb.1992,p.48-65
**REPLACEMENT OF CHLOROFLUOROCARBONS IN ALL MDI AUTOMOTIVE SEATING FOAMS**
Thoen J;Elwall R;Sewell R;Broos R;Pellacani L;Pedroni L;Bergianti G
DOW BENELUX NV; DOW ITALIA SPA

Details are given of the use of recently developed Dow methylene diisocyanate technology in meeting the necessary requirements for eliminating the use of chlorofluorocarbons as blowing agents in the PU foam industry. 11 refs.

EUROPEAN COMMUNITY; ITALY; NETHERLANDS; WESTERN EUROPE

*Accession no.453006*

*Item 346*
***Rubber World***
205,No.6,March 1992,p.17-21
**CFC-FREE POLYETHER PU SYSTEMS FOR FOOTWEAR APPLICATIONS**
Phanopoulos;Limerkens H;Stilling H;Randall D
ICI POLYURETHANES GROUP

This article discusses some of the work being carried out by ICI to remove CFCs from polyether PU footwear systems. It is shown that two new families of polyether based PU systems for shoe soling applications have been developed, which both eliminate the need for CFCs. The two families provide either an integral skin type moulding as is achieved by CFCs, or have improved innate mechanical properties to such levels that they do not require the integral skin and which overcome problems such as afterblow. 1 ref.

USA

*Accession no.448250*

*Item 347*
***Journal of Testing & Evaluation***
20,No.1,Jan.1992,p.33-42
**HYDROCHLOROFLUOROCARBON (HCFC) BLOWING AGENTS FOR FOAM INSULATION OF LAUNCH VEHICLE CRYOGENIC PROPELLANT TANKS**
Strauss E L;Bzik J W
MARTIN MARIETTA CORP.; MARTIN MARIETTA MANNED SPACE SYSTEMS

The results are reported of an initial screening study carried out on two polyurethane spray-on foam insulations using several HCFC compounds (HCFC-141b, HCFC-123 and blends thereof), as blowing agents. Tests were performed to measure bond and flatwise tension strengths at different temps., compression at ambient temp. and substrate strain compatibility at liquid helium temp. The foams were also characterised for density, closed-cell content, oxygen index and ablation under radiant heating. 12 refs.

USA

*Accession no.447032*

*Item 348*
***Urethanes Technology***
8,No.3,June/July 1991,p.11
**FOAMERS SLASH CFC USE**
Moore M

Environmental issues facing the US Polyurethane Foam Association's (PFA's) members are discussed. These include reduction of CFC use. Members reduced their use of CFC-11 by more than 90% between 1986 and 1990, but there are problems in eliminating it altogether. The PFA's and the Halogenated Solvents Industry Alliance's (HSIA's) campaign to fight workplace limits on methylene chloride in North Carolina is discussed, as is the PFA's role in potential regulations arising from the new UC Clean Air Act, and in state and local regulations on furniture flammability.

HALOGENATED SOLVENTS INDUSTRY ALLIANCE; POLYURETHANE FOAM ASSN.; US,ENVIRONMENTAL PROTECTION AGENCY
USA

*Accession no.444958*

*Item 349*
Polyurethanes 90.Conference Proceedings.
Orlando,Fl.,30th Sept-3rd Oct.1990,p.260-65. 43C6
**NOVEL POLYISOCYANURATE FOAMS FOR ROOFING AND SHEATHING**
Knis S A;Ference D M;Kennedy E E;Bhattacharjee D;Dai S-H
DOW CHEMICAL CO.
(SPI,Polyurethane Div.)

Non-traditional chemical routes to carbon dioxide co-blowing of polyisocyanurate foam for roofing and sheathing insulation are discussed. Results of processability, physical and flammability characteristics of panels made from non-HCFC routes to CFC-11 reduction are described. Formulations having an isocyanate index of 250 using polyester polyols and containing no additive halogen or phosphorus flame retardant were employed. Two alternative methods to the isocyanate-water reaction for generating carbon dioxide are reported. 2 refs.

USA

*Accession no.432575*

*Item 350*
Polyurethanes 90.Conference Proceedings.
Orlando,Fl.,30th Sept-3rd Oct.1990,p.247-59. 43C6
**TECHNICAL VIABILITY OF ALTERNATIVE BLOWING AGENTS IN POLYISOCYANURATE ROOF INSULATION. PART III. IN SITU THERMAL AGEING AND PERFORMANCE IN DIFFERENT ROOF SYSTEMS**
Christian J E;Courville G E;Linkons R L;Wendt R L;Graves R S;Smith T
OAK RIDGE NATIONAL LABORATORY; US,NATIONAL ROOFING CONTRACTORS ASSOCIATION
(SPI,Polyurethane Div.)

A progress report is presented on the field thermal performance measurements on experimental polyisocyanurate laminate boardstock foams blown with blends of CFC-11, HCFC-123 and HCFC-141b. The field data are used to derive an empirical model for predicting effective diffusion coefficients for the air components into the foam cells. Comparisons were made with diffusion coefficients developed from steady state laboratory measurements. Relative ageing performance of test specimens of HCFC-141b under a black and under a white membrane are reported. 5 refs.

USA

*Accession no.432574*

*Item 351*
Polyurethanes 90.Conference Proceedings.
Orlando,Fl.,30th Sept-3rd Oct.1990,p.564-70. 43C6
**DEVELOPMENT OF REDUCED CFC REFRIGERATOR FOAM INSULATION**
Chapa G;Haworth G J
ADMIRAL CO.; DOW CHEMICAL CO.
(SPI,Polyurethane Div.)

A matrix sensitivity study of CFC-11 and water for a commercial polyol used with MDI-based foams is reported where up to 50% CFC reduction was evaluated and the results are reported, including K-factors, free rise density and energy performances in refrigerators.

USA

*Accession no.432555*

*Item 352*
Polyurethanes 90.Conference Proceedings.
Orlando,Fl.,30th Sept-3rd Oct.1990,p.580-83. 43C6
**NOVEL RIGID POLYURETHANE FOAM SYSTEMS IN SUPPORT OF CFC REDUCTION/ ELIMINATION AND ENERGY CONSERVATION STANDARDS**
Jeffs G M F;Rosbotham I D;Thomas A K
ICI POLYURETHANES GROUP
(SPI,Polyurethane Div.)

A family of rigid PU foams has been developed to reduce or eliminate CFC-11 usage as a blowing agent in refrigerator insulation. Either HCFC-123 or HCFC-141b replaces the CFC-11 and similar thermal conductivities are observed. 4 refs.

USA

*Accession no.432544*

*Item 353*
Polyurethanes 90.Conference Proceedings.
Orlando,Fl.,30th Sept-3rd Oct.1990,p.234-38. 43C6
**TECHNICAL VIABILITY OF ALTERNATIVE**

**BLOWING AGENTS IN POLYISOCYANURATE ROOF INSULATION. PART I. PROCESSING AND PHYSICAL PROPERTIES**
Blaupied R H;Knis S A
ATLAS ROOFING CORP.; DOW CHEMICAL CO.
(SPI,Polyurethane Div.)

The use of alternatives to CFC-11 is described, particularly their thermal properties and ageing behaviour under laboratory and accelerated ageing conditions. Results are compared to and correlated with results from predictions of long term ageing of CFC blown foams. Blends of HCFC-141b and HCFC-123 were used.

USA

*Accession no.432540*

*Item 354*
Polyurethanes 90.Conference Proceedings.
Orlando,Fl.,30th Sept-3rd Oct.1990,p.197-200. 43C6
**INTEGRAL SKIN AND SHOE SOLES - ALTERNATIVE BLOWING METHODS**
Hass J D;Reichel C J;Cole E W;Krueger D C;Markovs R A
BASF AG; BASF CORP.
(SPI,Polyurethane Div.)

The replacement of chlorofluorocarbon R-11 as a blowing agent for integral skin foams by chlorofluorocarbon R-22 (HCFC-22) is described. Results of its solubility in various polyols, its vapour pressure in resin systems and the storage stability integral skin resins is reported. 2 refs.

EUROPEAN COMMUNITY; USA; WEST GERMANY; WESTERN EUROPE

*Accession no.432522*

*Item 355*
Polyurethanes 90.Conference Proceedings.
Orlando,Fl.,30th Sept-3rd Oct.1990,p.500-3. 43C6
**LOW DENSITY FLEXIBLE FOAM WITHOUT THE USE OF CFCS OR METHYLENE CHLORIDE**
Wujcik S E;Christman D L;Reichel C J
BASF CORP.
(SPI,Polyurethane Div.)

The use of HCFC R-22 as an interim auxiliary blowing agent replacement for CFC in PU foams is investigated. Foams were prepared with densities of less than 1.2 pcf. Solubility in four typical slab polyols and vapour pressures of solution were measured. Several methods to prepare solutions of R-22 in slab polyols were developed. Master batches can be prepared by sparging the R-22 gas into the liquid. Alternatively, the R-22 can be added as a gas or liquid into a recycle loop. 4 refs.

USA

*Accession no.432209*

*Item 356*
Polyurethanes 90.Conference Proceedings.
Orlando,Fl.,30th Sept-3rd Oct.1990,p.540-46. 43C6
**MEASUREMENTS OF DIFFUSION COEFFICIENTS OF ALTERNATIVE BLOWING AGENTS IN CLOSED CELL FOAM INSULATION**
Page M C;Glicksman L R
MASSACHUSETTS INSTITUTE OF TECHNOLOGY
(SPI,Polyurethane Div.)

The diffusion coefficient of air constituents and blowing agents in closed cell foam insulation was measured to study the effects of CFC-11, HCFC-123 and HCFC-141b, on ageing rates. Tests using a transient, constant volume sorption method were run. Results extrapolated to room temperature indicate that the alternative blowing agents will not significantly increase ageing. Measurements of sample foam geometry and density were used to determine mass distribution. The results were used in a model to compare solid polymer permeability. Higher solid polymer permeability with carbon dioxide and a higher amount of solid polymer in the cell walls was found in foams made with alternative blowing agents. 7 refs.

USA

*Accession no.432191*

*Item 357*
***Cellular Polymers***
9,No.4,1990,p.253-77
**PROGRESS IN THE REDUCTION AND ELIMINATION OF THE USE OF CFCS IN RIGID POLYURETHANE FOAM**
Jeffs G M F;Sparrow D J
ICI POLYURETHANES GROUP

A review is presented of progress towards the reduction or replacement of CFCs. Complete blowing with carbon dioxide has several drawbacks but requires further consideration. The development of a wider range of air-impermeable facing materials to eliminate rapid lambda value ageing is seen as a key technical requirement. HCFCs are seen increasingly as the most viable alternatives but they await completion of toxicological testing. Short term solutions are being developed for some markets. Pie charts indicate industry sector share of the foam market, led by construction uses. Properties of various systems are tabulated. 11 refs.

BELGIUM; EUROPEAN COMMUNITY; WESTERN EUROPE

*Accession no.425555*

*Item 358*
Utech 90.Conference Proceedings.
The Hague,3rd-5th April 1990,p.52-5. 43C6
**NEW TECHNOLOGIES TO OVERCOME THE CFC PROBLEMS FOR INTEGRAL SKIN FOAMS PRODUCTION**
Andreola P;Valcarenghi A
MONTEDIPE SPA
(Crain Communications Ltd.)

Research by Enimont on methods of substituting or eliminating CFC in integral skin PU foam production is described. Particular attention is paid to the use of HFA 123 and 141b (with known technology), to the use of HFA 22 (with new technology for introducing it preferentially in the polyol blend) and to the use of carbon dioxide from the water-isocyanate reaction in the production of parts with high surface/volume ratio. Alternative technologies for obtaining parts with an elastic skin and a carbon dioxide-expanded low density foam core are described, including rotational moulding and coating. 2 refs.

ENIMONT

EUROPEAN COMMUNITY; ITALY; WESTERN EUROPE

*Accession no.417635*

*Item 359*

Utech 90.Conference Proceedings.
The Hague,3rd-5th April 1990,p.43-7. 43C6

**RECENT PROGRESS IN THE REDUCTION OF CFCS IN RIGID POLYURETHANE FOAM FOR THERMAL INSULATION**

Aten W C;Cope B;Zuta R B
SHELL CHEMICALS RESEARCH CENTRE
(Crain Communications Ltd.)

The reduction of CFC usage by increasing the amount of water used in the blowing process is discussed and the development of suitable polyols for such systems is described. Applications of reduced-CFC systems in the fields of continuous laminating and district heating pipe insulation are considered. The possibility of achieving total replacement of CFCs is examined. 4 refs.

BELGIUM; EUROPEAN COMMUNITY; WESTERN EUROPE

*Accession no.417633*

*Item 360*

Utech 90.Conference Proceedings.
The Hague,3rd-5th April 1990,p.31-8. 43C6

**PROGRESS IN THE REDUCTION AND ELIMINATION OF THE USE OF CFCS IN RIGID POLYURETHANE FOAM**

Jeffs G M F;Sparrow D J
ICI POLYURETHANES INTERNATIONAL
(Crain Communications Ltd.)

Topics discussed include the benefits of rigid PU foam, control of the availability of CFC 11, ICI Polyurethanes' approach to the challenge, technology based on reduced levels of CFC 11, monitoring of insulation efficiency, and technology for the elimination of CFC 11. 11 refs.

BELGIUM; EUROPEAN COMMUNITY; WESTERN EUROPE

*Accession no.417627*

*Item 361*

Polyurethanes World Congress 1987: 50 years of Polyurethanes.Conference Proceedings.
Aachen,29th Sept-2nd Oct.1987,p.59-66. 43C6

**DU PONT PROGRAMME ON FLUOROCARBON ALTERNATIVE BLOWING AGENTS FOR POLYURETHANE FOAMS**

Dishart K T;Creazzo J A;Ascough M R
DU PONT CANADA INC.; DU PONT DE NEMOURS E.I.,& CO.INC.
(SPI,Polyurethane Div.;Fachverband Schaumkunststoffe eV)

Criteria for identifying and selecting candidate alternative compounds to CFCs for the Du Pont programme are described in detail with emphasis on blowing agent applications for PU foams. The two candidate CFC-11 substitutes, the hydrochlorofluorocarbons HCFC-123 and HCFC-141b, which have survived the criteria screening process to date are presented and their limitations and uncertainties relative to their future acceptance in the marketplace are discussed. 9 refs.

CANADA; USA

*Accession no.402209*

*Item 362*

Patent Number: US 5407596 A 19950418

**POLYOLS FOR THE PRODUCTION OF FOAMS WITH HCFC BLOWING AGENTS**

Mafoti R; Keegan R E; Schilling S L
Miles Inc.

Sucrose-based polyether polyols which do not promote degradation of HCFC blowing agents are produced by blocking at least 10% of the polyol's hydroxyl groups with a compound represented by a given formula. These polyether polyols are particularly useful in the production of polyurethane foams.

USA

*Accession no.567610*

*Item 363*

Utech Asia '95. Conference Proceedings.
Suntec City, 23rd-25th May 1995, paper 39. 43C6

**TOTALLY WATER-BLOWN INTEGRAL SKIN FOAM**

Chung Y S; Park J B; Sakai M; Inoue H
Kumho Mitsui Toatsu Inc.; Mitsui Toatsu Chemicals Inc.
(Crain Communications Ltd.)

Generally, PU integral skin consisting of core and skin layer is now produced by using such blowing agents as CFCs and HCFCs. However, for environmental reasons, the development of an all-water blown integral skin foam system has become urgent. Conventional water-blown systems have resulted in various problems. The effect of several kinds of polyols, isocyanate and curing agents on all water and CFC-blown systems are compared to solve these problems, and an improved all-water blown system with a suitable balance of gelling and blowing reactions is found. An all water-blown PU integral skin foam system

for automotive steering wheels meeting the performance criteria of CFC or HCFC systems is introduced. 3 refs.

JAPAN; KOREA

*Accession no.564873*

*Item 364*
Utech Asia '95. Conference Proceedings.
Suntec City, 23rd-25th May 1995, paper 34. 43C6
**PERFORMANCE OF OLEOCHEMICAL BASED POLYESTER POLYOLS IN POLYURETHANES**
van der Wouden M
Unichema International
(Crain Communications Ltd.)

It is reported that oleochemical-based polyester polyols are increasingly being used in both rigid foam and elastomers. Pentane blowing technology for rigid PU foams has become more important. Oleochemical-based polyester polyols are especially showing good performance. Compatibility of the PU system with the blowing agent, flame resistance and insulation properties are considerably improving. Most of the residual blowing agent is retained within the foam cells. As pentane is an inflammable liquid, further formulation modifications are required to maintain the flame resistance of the foams. Aspects covered include rigid foam applications, insulation properties, flame resistance, hydrolysis resistance and mechanical properties. 2 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; NETHERLANDS; WESTERN EUROPE

*Accession no.564868*

*Item 365*
Utech Asia '95. Conference Proceedings.
Suntec City, 23rd-25th May 1995, paper 32. 43C6
**RECENT ADVANCES IN ANCILLARY MATERIALS FOR RECENT RIGID FOAMS**
Burkhart G; Klincke M
Goldschmidt Th.,AG
(Crain Communications Ltd.)

In recent years, the PU industry focused most of the research and product development efforts on environmental issues. The need to replace CFC blowing agents in rigid PU foam has especially proved to be critical, and many attempts have been made to achieve this final goal. Recent developments in silicone surfactants for the appliance and boardstock industries are described - choice depends strongly on blowing agent used as well as the specific requirement of the individual system. A new cell opening technology for rigid PU foam by means of an additive approach is discussed. This technology is important particularly when carbon dioxide is used as blowing agent, as these foams tend to shrink if the densities are too low and the cells are closed.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

*Accession no.564866*

*Item 366*
Utech Asia '95. Conference Proceedings.
Suntec City, 23rd-25th May 1995, paper 31. 43C6
**NEW SURFACTANTS FOR RIGID FOAM MADE USING ALTERNATIVE BLOWING AGENTS**
Smoyer B a; Schumacher D W; Chong S M; Fis J
OSi Specialties Inc.; OSi Specialties Singapore Pte.Ltd.; OSi Specialties SA
(Crain Communications Ltd.)

Data are presented demonstrating the impact of the surfactant in optimisation of formulations employing alternative blowing agents presently being utilised in the preparation of rigid PU foam. It demonstrates surfactant performance in HCFC-141b, reduced HCFC-141b, reduced CFC-11 and cyclopentane formulations. 4 refs.

SINGAPORE; SWITZERLAND; USA; WESTERN EUROPE

*Accession no.564865*

*Item 367*
Utech Asia '95. Conference Proceedings.
Suntec City, 23rd-25th May 1995, paper 29. 43C6
**RECENT PROGRESS IN RIGID FOAMS FOR CONTAINER INSULATION**
Park J N; Lee S H; Nakamura F
HD Polyurethane Co.
(Crain Communications Ltd.)

World production of refrigerated containers reached 70,000 TEU in 1994. As in other PU industries, refrigerated container manufacturers have actively implemented a CFC-phaseout programme. A promising vision of CFC elimination in refrigerated containers is presented. Reduced CFC-11 system, a precious industry solution, and HCFC-141b, now being implemented in the industry, show well-balanced performance in all aspects. These two options still offer the best cost performance except for environmental concerns being more enhanced globally. Emphasis is placed on a cyclopentane system which also satisfies all performance requirements and is ready to be applied if the safety issue at the manufacturing site is fully assured. All water-blown systems can not satisfy current requirements for refrigerated containers. Further development is necessary to achieve this ideal solution for the future.

KOREA

*Accession no.564863*

*Item 368*
Utech Asia '95. Conference Proceedings.
Suntec City, 23rd-25th May 1995, paper 27. 43C6
**PENTANE PROCESS TECHNOLOGY - NOT ONLY FOR THE APPLIANCE INDUSTRY?**
Brueninghaus V; Pieper K H
Maschinenfabrik Hennecke GmbH
(Crain Communications Ltd.)

Other industries are making use of the experience gained by the refrigerator appliance industry in cyclopentane

blowing agent technology. Pipes are today being insulated with PU foams systems free of CFC. The use of cyclopentane-blown foams in this particular application are described. 2 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

*Accession no.564861*

*Item 369*
Utech Asia '95. Conference Proceedings.
Suntec City, 23rd-25th May 1995, paper 25. 43C6
**PREDICTION OF LONG-TERM PERFORMANCE OF CYCLOPENTANE BLOWN FOAM THROUGH A STUDY OF MECHANICAL-PHYSICAL PROPERTIES**
Martinella L; Caprioli G; Cappella A; Stein R
Whirlpool Europe; ICI Polyurethanes
(Crain Communications Ltd.)

Whirlpool has been producing refrigerators and freezers with insulation foam based on cyclopentane for two years. The cabinet quality obtained has been of consistently high standard, without aesthetic defects. In order to implement the new technology quickly, while still being able to predict and confirm suitable long-term properties, it has been necessary to develop a series of test procedures. These link formulation, processing and structural parameters, particularly those relating to dimensional stability. The foam properties considered are mechanical parameters, changes in cell gas composition and pressure, and PU matrix attack by cyclopentane's plasticising effect. 4 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; ITALY; SINGAPORE; WESTERN EUROPE

*Accession no.564859*

*Item 370*
Utech Asia '95. Conference Proceedings.
Suntec City, 23rd-25th May 1995, paper 24. 43C6
**HCFC-141B BLOWN APPLIANCE SYSTEM DEVELOPMENT FOR A JAPANESE OEM IN THAILAND**
Hamada S; Kawabata H; Pusanaas Y; Nishimoto Y
Dow Chemical Japan Ltd.; Pacific Plastic Thailand Ltd.; Mitsubishi Electric Ltd.
(Crain Communications Ltd.)

The appliance industries in South Asia are showing significantly higher growth annually than in any other regions in the world. Dow has been working closely with the appliance industry in Thailand to support them to eliminate CFC from their rigid insulation foams for refrigerators through Pacific Plastic Thailand. The work done specifically to develop the HCFC 141b-blown foam system suitable for Kang Yong Electric to eliminate CFC 11 from its rigid PU insulation foams is described. 3 refs.

KANY YONG ELECTRIC PUBLIC CO.
JAPAN; THAILAND

*Accession no.564858*

*Item 371*
Utech Asia '95. Conference Proceedings.
Suntec City, 23rd-25th May 1995, paper 22. 43C6
**HYDROCARBON-BLOWN RIGID PU FOAM FOR THE JAPANESE REFRIGERATOR INDUSTRY**
Heilig G; Ikebe M; Matsumoto T
Sumitomo Bayer Urethane Co.Ltd.
(Crain Communications Ltd.)

The Japanese refrigerator industry is in the state of transition from CFC-blown rigid PU foam insulation to alternative solutions. Currently, HCFC-blown foam is mainly applied throughout the industry. At the beginning of 1994, the first manufacturer started to use cyclopentane-blown foam. Sumitomo Bayer Urethane has taken over the technical leadership of this development. The formulations and properties of hydrocarbon-blown rigid PU foam for the Japanese refrigerator market are detailed and efforts towards achieving low thermal conductivity values are described. 12 refs.

JAPAN

*Accession no.564856*

*Item 372*
Utech Asia '95. Conference Proceedings.
Suntec City, 23rd-25th May 1995, paper 15. 43C6
**CFC ELIMINATION FROM MOULDED LOW DENSITY FLEXIBLE FOAM**
Wehman C; Cenens J
Shell Research SA
(Crain Communications Ltd.)

From an environmental point of view, the best way to eliminate CFC from flexible moulded PU foam is using water as the sole blowing agent. In doing so, the foam densities can be maintained but increased foam hardness due to an increase of polyurea in the polymer occurs as an undesirable side effect. An important part of Shell's research efforts in this field has been devoted to reducing the foam hardness to the values obtained for CFC-blown foams. The results are described for both cold cure and hot cure moulding.

BELGIUM; EUROPEAN COMMUNITY; EUROPEAN UNION; WESTERN EUROPE

*Accession no.564849*

*Item 373*
Utech Asia '95. Conference Proceedings.
Suntec City, 23rd-25th May 1995, paper 12. 43C6
**FOAM HARDNESS CONTROL IN TDI-BASED FOAMS**
Vandichel J C; Shears J
Shell Research SA
(Crain Communications Ltd.)

The elimination of auxiliary blowing agents has been a major issue in the PU foam industry. The introduction of this new technology has necessitated the development

of novel routes to TDI-based soft flexible foams. In addition, the demand for foams with enhanced load-bearing properties has increased. Various techniques have been developed to modify the physical properties of slabstock foams. Increased hardness can be obtained by raising the crosslink density in the polymer matrix of foams based on a standard polyol, through the addition of CARADOL MD145-01, a high functionality polyol. CARAPOR 2001 is a product resulting from the study of polymer morphology. This additive effectively reduces foam hardness through changes to the polyurea species in the foam. Various techniques to control hardness in TDI-based slabstock are described. They include the use of CARADOL for increased foam hardness, or Shell additives and additive polyols for soft foams. 8 refs.

BELGIUM; EUROPEAN COMMUNITY; EUROPEAN UNION; WESTERN EUROPE

*Accession no.564846*

*Item 374*
Utech Asia '95. Conference Proceedings.
Suntec City, 23rd-25th May 1995, paper 11. 43C6
**ADDITIVES FOR DIFFICULT-TO-PROCESS LOW DENSITY METHYLENE CHLORIDE BLOWN FLEXIBLE FOAMS**
Boo K H
OSi Specialities A-P
(Crain Communications Ltd.)

Geolite technology was introduced in 1990 for the production of low density and/or soft polyether PU foams using reduced auxiliary blowing agents. Subsequent development work and industrial trials have demonstrated the unique capabilities of Geolite to provide stability during the foaming process, particularly difficult-to-process low density formulations which use methylene chloride as a blowing agent. The ways in which Geolite helps in solving problems on production lines with the proper selection of other additives are described. Reduction of density and IFD gradients, as well as improved foam yield, are also demonstrated. A new amine catalyst offering greatly improved reactivity in methylene chloride-blown foams is also discussed.

HONG KONG

*Accession no.564845*

*Item 375*
Utech Asia '95. Conference Proceedings.
Suntec City, 23rd-25th May 1995, paper 4. 43C6
**LIQUID CARBON DIOXIDE-BLOWN SLABSTOCK FOAMS**
Fiorentini C; Taverna M; Griffiths A; Fawley C
Afros SpA; RNA SpA; Cannon Viking Ltd.
(Crain Communications Ltd.)

Research carried out by Cannon is claimed to have provided a proven solution for the elimination of CFCs and auxiliary blowing agents from foam formulations while generating a new method for producing slabstock foams: as cost is currently very important, foamers have an option for producing an environmentally safe foam at very competitive prices.

EUROPEAN COMMUNITY; EUROPEAN UNION; ITALY; UK; WESTERN EUROPE

*Accession no.564838*

*Item 376*
Utech Asia '95. Conference Proceedings.
Suntec City, 23rd-25th May 1995, paper 3. 43C6
**EQUIPMENT FOR THE VARIABLE PRESSURE FOAMING PROCESS**
Blackwell J B
Beamech Group Ltd.
(Crain Communications Ltd.)

The operation of PU foam machinery at high altitudes has shown that lower foam densities can be produced from formulations made at sea level. The variable pressure foam process is patented worldwide, and has been in full commercial operation since 1991. It is claimed to enable the widest range of foams to be made, commercially, economically and safely and to give the potential for Best Available Control Technology. 6 refs.

PREFOAM AG

EUROPEAN COMMUNITY; EUROPEAN UNION; UK; WESTERN EUROPE

*Accession no.564837*

*Item 377*
Cellular Polymers II. Conference proceedings.
Edinburgh, 23-25th March 1993, paper 20. 6124
**WATERLILY COMFORT CUSHIONING: MDI SLABSTOCK TECHNOLOGY FROM ICI**
Parfondry A; Casey M; Muller L
ICI Polyurethanes
(Rapra Technology Ltd.)

The flexible slabstock industry is continuing to be under pressure due to a number of environmental pressures. The use of CFCs will soon be banned worldwide, and other blowing agents are also under scrutiny. Flammability standards are constantly tightening and recycling is another important factor to be taken into consideration. ICI Polyurethanes has developed a new technology package for 100% water blown MDI-based flexible slabstock PU foams. The development of two new chemical intermediates has allowed the elimination of the normal deterioration of physical properties traditionally occurring in MDI foams at low densities. Aspects covered include the product range, environmental improvement, and product properties.

BELGIUM; EUROPEAN COMMUNITY; EUROPEAN UNION; WESTERN EUROPE

*Accession no.562732*

*Item 378*
Cellular Polymers II. Conference proceedings.
Edinburgh, 23-25th March 1993, paper 12. 6124
**ZERO ODP RIGID FOAM TECHNOLOGY**
Rosbotham I D; De Vos R
ICI Polyurethanes
(Rapra Technology Ltd.)

One of the most challenging environmental problems today is the depletion of the ozone layer by fully halogenated materials. Amongst such materials are the CFC blowing agents used in the PU foam making process. The replacement programme for CFCs is a two-stage process, the first being via HCFCs, which is already in progress. The second stage introduces HFCs, or more generally, materials exhibiting a zero ozone depletion potential (ODP). The performance of the various ODP options is described, compared to CFCs currently available, when used as PU foam blowing agents. These include carbon dioxide, pentane isomers, hexafluorobutane and HFC 124a. Also described is a novel technology developed by ICI Polyurethanes to improve the level of insulation performance of foam blown by these zero ODP materials. 3 refs.

BELGIUM; EUROPEAN COMMUNITY; EUROPEAN UNION; WESTERN EUROPE

*Accession no.562724*

*Item 379*
Cellular Polymers II. Conference proceedings.
Edinburgh, 23-25th March 1993, paper 9. 6124
**CORRELATED VIEW OF REACTION KINETICS AND STRUCTURE DEVELOPMENT DURING THE REACTIVE PROCESSING OF WATER BLOWN, FLEXIBLE POLYURETHANE FOAM**
Elwell M J; Ryan A J
UMIST; Dow Benelux NV
(Rapra Technology Ltd.)

The formation of urethane, soluble urea and hydrogen bonded urea species during the fast bulk copolymerisation which forms flexible PU foam is studied using the adiabatic reactor method and forced-adiabatic, time-resolved FT-IR spectroscopy. The evolution of time-bonded urea is analysed emphasising the onset of microphase separation of urea hard segment sequences and their subsequent growth into hydrogen bonded urea hard segment domains. FT-IR spectroscopy indicates that the microphase separation transition occurred at a critical conversion of isocyanate functional groups. The results also indicate that the microphase separation process appears to occur via a nucleation and growth mechanism. 25 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; NETHERLANDS; UK; WESTERN EUROPE

*Accession no.562722*

*Item 380*
Patent Number: US 5397810 A 19950314
**POLYOL, POLYURETHANE RESIN AND UTILISATION THEREOF**
Ozaki S; Izukawa T; Kawakami H; Masuda T; Kimura M; Nozawa T; Hashiba M
Mitsui Toatsu Chemicals Inc.

A novel polyol is obtained by using a specified polyhydric alcohol, polyoxyalkylene polyol, aliphatic amine and/or alkanolamine as a raw material and adding an organic polycarboxylic acid or its anhydride and an alkylene oxide. Also described is a polyurethane resin prepared from the above polyol and an organic polyisocyanate; a rigid polyurethane foam prepared by using a hydrochlorofluorocarbon or hydrofluorocarbon foaming agent which is of low hazard; and a composite using the foam. Properties of the foam obtained are equivalent to those obtained using conventional chlorofluorocarbons. Consequently, the rigid polyurethane foam is very useful for insulation materials and structural insulation materials.

JAPAN

*Accession no.561185*

*Item 381*
Patent Number: US 5387618 A 19950207
**PROCESS FOR PREPARING A POLYURETHANE FOAM IN THE PRESENCE OF A HYDROCARBON BLOWING AGENT**
Smits G F
Dow Chemical Co.

Polyisocyanate-based foams, particularly polyurethane or polyurethanepolyisocyanurate foam, prepared in the presence of a certain blowing agent, are described. The blowing agent consists of (a) from 5-80 mol % of a C5-C6 alicyclic alkane or mixtures thereof; and (b) from 95-20 mol % of a mixture of isopentane and n-pentane present in a mole ratio of from about 80:20 to about 20:80.

USA

*Accession no.558070*

*Item 382*
***Journal of Cellular Plastics***
31, No.4, July/Aug.1995, p.313-29
**EVALUATION OF HFC 245CA AND HFC 236EA AS FOAM BLOWING AGENTS**
Sharpe J; MacArthur D; Liu M; Kollie T; Graves R; Hendriks R
Martin Marietta Manned Space Systems; Oak Ridge National Laboratory; US,Environmental Protection Agency

Results are presented of a cooperative effort to evaluate HFC-245ca and HFC-236ea as blowing agents for rigid PU insulation foams, and to perform limited accelerated ageing evaluations of hand poured samples, comparing them with CFC-11. 4 Refs.

USA

*Accession no.555870*

*Item 383*
Polyurethanes '94. Conference proceedings.
Boston, Ma., 9th-12th Oct.1994, p.625-30. 43C6
**ALL-WATER BLOWN INTEGRAL SKIN FOAM FOR AUTOMOTIVE STEERING WHEELS**
Ueda H; Sakai M; Inoue H; Koga N
Mitsui Toatsu Chemicals Inc.
(SPI,Polyurethane Div.)

PU integral skin foam has been used for automotive steering wheels due to its high quality, good surface properties, excellent physical properties and high productivity. The effects of several kinds of polyols, isocyanates and catalysts on all water and CFC blown systems are compared, and an improved all water-blown system having suitable balance between gelling and blowing reactions is developed. It is found to be useful to measure the pressure and dielectric constant during the foaming process in the mould, in order to evaluate the curing behaviour exhibited by different formulations. 3 refs.

JAPAN; KOREA

*Accession no.555657*

*Item 384*
Polyurethanes '94. Conference proceedings.
Boston, Ma., 9th-12th Oct.1994, p.599-608. 43C6
**STUDY OF THE EFFECT OF POLYOL AND ISOCYANATE VISCOSITIES UPON THE PROCESSING AND PROPERTIES OF RIGID POLYISOCYANURATE FOAMS BLOWN WITH HCFC-141B**
Schiff D E; Koehler C E; Parsley K D; Bhattacharjee D
Dow Chemical Co.
(SPI,Polyurethane Div.)

The mandated change from CFC-11 to HCFC-141b as a blowing agent for polyisocyanurate insulation foams has required producers of these foams to make numerous formulation changes. The changes have been warranted due to the differing physical properties of HCFC-141b versus CFC-11. These differences include higher boiling point, high latent heat of vapourisation, increased polymer solubility and decreased viscosity of the polyol and isocyanate blends which contain HCFC-141b compared to CFC-11. These differences have led to concerns with the ultimate physical properties of polyisocyanurate foams blown with HCFC-141b as compared to those with CFC-11 blown foams. In particular, the increased solubility of HCFC-141b in the foam's polymer matrix has led to a reduction in compressive strength and problems with dimensional stability. Emphasis is placed on Dow Chemical's efforts at improving foam processing and dimensional stability of these foams with the use of high functional, low equivalent weight polyols and increased viscosity and higher functionality polymeric MDI. 4 refs.

USA

*Accession no.555654*

*Item 385*
Polyurethanes '94. Conference proceedings.
Boston, Ma., 9th-12th Oct.1994, p.591-8. 43C6
**ALL WATER-BLOWN RIGID URETHANE FOAM**
Sato H; Aoyagi M; Min K H; Takeyasu H
Asahi Glass Co.Ltd.
(SPI,Polyurethane Div.)

As CFCs are scheduled to be phased out by the end of 1995, alternative blowing agents for rigid PU foams have been developed promptly. Water is one of the ultimate blowing agents as all water-blown foams are free from ozone depletion potential, global warming potential and safety problems. However, these materials present problems including high thermal conductivity, high surface friability and gradual deformation at room temperature. Development work carried out by Asahi Glass using the company's new polyamine derived polyols is described. 6 refs.

JAPAN

*Accession no.555653*

*Item 386*
Polyurethanes '94. Conference proceedings.
Boston, Ma., 9th-12th Oct.1994, p.578-90. 43C6
**INTERACTION BETWEEN CATALYST CHOICE AND PHYSICAL PROPERTIES OF NON-CFC BLOWN POLYISOCYANURATE FOAMS**
Rister E L; Grigsby R A
Huntsman Corp.
(SPI,Polyurethane Div.)

A number of components are required to prepare PU and PU-modified polyisocyanurate rigid foams. Initial tests with HCFCs and other alternative blowing agents reveal small and sometimes predictable differences from rigid foams blown with CFC-11. A combination of laboratory tests including flow moulds, ultrasonic rate of rise and commercial production are employed to develop optimum catalyst packages for HCFC and other organic blowing agents. A statistical design experiment is used to show the relationship between water and catalyst level to the physical properties such as k-factor, cold shrinkage and density. The cure of these foams is monitored on line as a function of log Ion Viscosity with the ICAM 1000 and compared to conventional ASTM D-2126-75 dimensional stability tests. The physical properties are optimised through the proper choice of catalyst or catalyst blends using established gel to blow ratios, a flow index system and in-mould pressures. The blends have proved to be extremely beneficial in improving the efficiency, cost and processing for commercial laminators. 6 refs.

USA

*Accession no.555652*

*Item 387*
Polyurethanes '94. Conference proceedings.
Boston, Ma., 9th-12th Oct.1994, p.568-77. 43C6

 

**DEVELOPMENT OF IMPROVED HIGH FUNCTIONALITY POLYMERIC MDI FOR HCFC-141B BOARDSTOCK**
Burns S B; Lynch J J; Sander M A; Singh S N
ICI Polyurethanes
(SPI,Polyurethane Div.)

The US continuous laminate boardstock industry has successfully employed new polyol, surfactant and catalyst technologies to make the transition from CFC-11 to HCFC-141b. New high functionality isocyanates are developed and evaluated using laboratory flow analysis. The aim is to improve flow and processability, thereby ensuring a uniform cell structure and superior dimensional stability. Strong correlations exist between dynamic flow analysis and actual laminator performance measures. These correlations are used to guide the evaluations, enabling selection of the best possible product. 4 refs.

USA

*Accession no.555651*

*Item 388*
Polyurethanes '94. Conference proceedings.
Boston, Ma., 9th-12th Oct.1994, p.519-22. 43C6
**EVALUATION OF HCFC-141B IN RIGID URETHANE FLAME RETARDED SYSTEMS**
Williams B; Bradford L
Akzo Chemicals Inc.
(SPI,Polyurethane Div.)

The time is rapidly approaching for CFCs to be eliminated. In the USA, this phaseout should occur by 31st December 1995. One of the primary blowing agents to replace freon 11 in the interim will be HCFC-141. Hydrochlorofluorocarbons will be only used temporarily due to their ozone depletion value. Fyrol PCF is a widely accepted flame retardant used with a number of rigid PU systems. The additive and other flame retardants are evaluated in a HCFC-141 pour-in-place formulation. There are a number of physical property tests which have been used as criteria to establish which flame retardant offers the best properties for the HCFC-141 blown systems. Some factors considered include system stability, density variation, insulation, LOI and the UL-94 test. The cone calorimeter is used as a tool to evaluate the optimum combustion performance in the test formulation. Comparison data are also explored between the cone calorimeter at different radiator heat levels. 3 refs.

USA

*Accession no.555645*

*Item 389*
Polyurethanes '94. Conference proceedings.
Boston, Ma., 9th-12th Oct.1994, p.316-23. 43C6
**CFC-FREE REFRIGERATED ISO CONTAINERS (REALITY COMPARISON BASED ON VARIOUS ALTERNATE BLOWING AGENTS)**
Graaff W; Welte R
Graaff GmbH; Bayer AG
(SPI,Polyurethane Div.)

It is shown that acceptable foam with densities between 45 and 80kg/m3 can be produced with alternative blowing agents - HCFCs, hydrocarbons or water. While ecological concern is the main reason for using alternative blowing agents, other properties are modified with that change inevitably. It is shown that these properties can be evaluated in laboratory trials and be used to modify container construction to compensate for drawbacks of some of the properties. It is shown that conflicting targets can be balanced; several small improvements in construction can be combined to make a new type of refrigerated vehicle using alternative blowing agents without losing the high insulation efficiency and without major changes in inside or outside dimensions or in the total strength of the finished container.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

*Accession no.555516*

*Item 390*
Polyurethanes '94. Conference proceedings.
Boston, Ma., 9th-12th Oct.1994, p.300-10. 43C6
**INSIGHT INTO THE CHARACTERISTICS OF A NUCLEATION CATALYST IN CFC-FREE RIGID FOAM SYSTEMS**
Yoshimura H; Tamano Y; Okuzono S
Tosoh Corp.; Tosoh USA Inc.
(SPI,Polyurethane Div.)

The establishment of CFC-free PU foam systems, aimed at total CFC elimination by 1995, is of paramount importance in present day PU foam technology. In all cases of alternative blown systems there exists differences in foaming behaviour as well as inferior foam properties compared to traditional CFC-11 blown systems. Especially in HCFC-141b and cyclopentane blown systems, the following are of major concern: thermal conductivity, dimensional stability and foam density. It is very difficult to improve these three factors simultaneously. Their improvement is discussed from a standpoint of amine catalysts; also special newly-developed nucleation catalyst systems are introduced for cyclopentane and HCFC-141b blown systems. 11 refs.

JAPAN; USA

*Accession no.555514*

*Item 391*
Polyurethanes '94. Conference proceedings.
Boston, Ma., 9th-12th Oct.1994, p.239-45. 43C6
**EVALUATION OF NEW ULTRASOFT LOW DENSITY FOAMS IN FIBRE BATTING APPLICATIONS**
Hager S L; Duffy R D
ARCO Chemical Co.
(SPI,Polyurethane Div.)

Polyester fibre batting and PU foam are used widely as cushioning and filling materials in the construction of furniture, mattresses and home accessories. In 1993, ARCO Chemical introduced a new foam formulating technology, Softcel foam, that allows the production of ultrasoft low density PU foam having cushioning characteristics closer to that of fibre while maintaining the durability and other performance characteristics of foam. The formulating, manufacture and performance characteristics of this foam, as well as its performance in end-use articles, are reviewed. Comparisons are made between finished articles manufactured with foam and fibre batting. Emphasis is placed on new commercial foam grades and applications, and on new growth opportunities for ultrasoft PU foam.

USA

*Accession no.555505*

*Item 392*
Polyurethanes '94. Conference proceedings.
Boston, Ma., 9th-12th Oct.1994, p.207-13. 43C6
**ADVANCES IN CATALYSIS FOR ALL-WATER BLOWN FLEXIBLE SLABSTOCK FOAMS**
Bodnar T W; Nichols J D; Wiese K D
Air Products & Chemicals Inc.
(SPI,Polyurethane Div.)

Recent changes in the status of traditional blowing agents have left many producers of flexible PU foam searching for new technology. One method currently gaining popular support is the concept of forced cooling. To overcome the obstacles presented by this process, Air Products & Chemicals has developed a new curing agent, Dabco H1075. A second approach to eliminating the use of alternative blowing agents has been the development of a variety of foam softeners and/or modifiers enabling the use of water as sole blowing agent to produce most foam grades. The performance of the company's two new catalysts are outlined. 12 refs.

USA

*Accession no.555501*

*Item 393*
Polyurethanes '94. Conference proceedings.
Boston, Ma., 9th-12th Oct.1994, p.194-9. 43C6
**OPEN-CELLED POLYURETHANE FOAM-BASED VACUUM PANEL TECHNOLOGY: A FULLY POLYURETHANE-BASED COMPOSITE TECHNOLOGY FOR VACUUM INSULATED APPLIANCES**
de Vos R; Rosbotham D; Deschaght J
ICI Polyurethanes
(SPI,Polyurethane Div.)

Vacuum-based insulation technology results, when introduced into appliances, in a substantial reduction in energy consumption of these appliances. ICI has developed systems based on both carbon dioxide and physical blowing agents. The status of both technologies is reported, firstly representing a complete assessment of the technical requirements for open-celled foam. Additionally, requirements for the encapsulation film material are discussed. Secondly, specific design criteria for the encapsulation foam are presented in terms of flow performance, pressure and temperature build-up and adhesion to several liners. Finally, a model allowing the prediction of the performance of such composite technology is introduced.

BELGIUM; EUROPEAN COMMUNITY; EUROPEAN UNION; WESTERN EUROPE

*Accession no.555499*

*Item 394*
Polyurethanes '94. Conference proceedings.
Boston, Ma., 9th-12th Oct.1994, p.189-93. 43C6
**CYCLOPENTANE-BLOWN RIGID POLYURETHANE INSULATION FOAM TECHNOLOGY FOR THE FUTURE**
Yu-Hallada L C
BASF Corp.
(SPI,Polyurethane Div.)

Concern over the depletion of the ozone layer by CFCs has led to legislation banning their use for the production of rigid insulation-critical PU foams by 1996. The industry must find alternatives to CFCs and HCFCs which preferably have zero ozone depletion potential. The search has been narrowed down to the investigation of hydrofluoroalkanes and hydrocarbons. 3 refs.

USA

*Accession no.555498*

*Item 395*
Polyurethanes '94. Conference proceedings.
Boston, Ma., 9th-12th Oct.1994, p.169-81. 43C6
**PERFORMANCE OF CARBON BLACK-CONTAINING POLYURETHANE FOAM IN DOMESTIC REFRIGERATORS**
Pisipati J S; Godbey J A
Miles Inc.; Center for Applied Engineering Inc.
(SPI,Polyurethane Div.)

The North American appliance industry has been challenged to meet stringent federal standards for energy consumption using CFC alternatives, which generally increase thermal conductivity of a foam. After a period of evaluating several options, the industry has, for the most part, settled on hydrochlorofluorocarbon, HCFC-141b, as a substitute for CFC-11. Preliminary evaluation of carbon black-containing foams based on HCFC-141b have shown that the materials processed well in cabinets and have no effect on linear appearance. A designed process study is conducted to understand flow behaviour and maximise foam performance in cabinets. The work is also extended to cyclopentane systems. Hanmix studies show that

improvements of 7-9% in k-factors can be obtained in foams containing carbon black. This work demonstrates the versatility of using carbon black with different blowing agents. 6 refs.

USA

*Accession no.555496*

*Item 396*

Polyurethanes '94. Conference proceedings.
Boston, Ma., 9th-12th Oct.1994, p.163-8. 43C6

**CYCLOPENTANE BLOWN FOAM SYSTEMS FOR DOMESTIC APPLIANCES APPLICATION**

Bazzo W; Cappella A; Talbot S
ICI Italia SpA; ICI Polyurethanes
(SPI,Polyurethane Div.)

During the last twelve months, all major European appliance manufacturers have chosen the cyclopentane option as blowing agent for PU insulation, as the optimum solution for the replacement of CFCs. The reason for this choice is due to several factors which outweigh the disadvantage of cyclopentane flammability and the related safety problems. The results of studies conducted by ICI Polyurethanes on cyclopentane foam are presented. Also addressed are the further developments being carried out with leading appliance manufacturers towards the improvement of key requirements, such as thermal conductivity, foam morphology and mechanical properties. 9 refs.

BELGIUM; EUROPEAN COMMUNITY; EUROPEAN UNION; ITALY; WESTERN EUROPE

*Accession no.555495*

*Item 397*

Polyurethanes '94. Conference proceedings.
Boston, Ma., 9th-12th Oct.1994, p.150-5. 43C6

**WATER BLOWN URETHANE INSULATION FOR USE IN CRYOGENIC ENVIRONMENTS**

Blevins E; Sharpe J
Martin Marietta Manned Space Systems
(SPI,Polyurethane Div.)

Thermal Protection Systems (TPS) of NASA's Space Shuttle External Tank include PU and polyisocyanurate modified PU foam insulations. These insulations, currently foamed with CFC-11 blowing agent, serve to maintain cryogenic propellant quality, maintain the external tank structural temperature limits, and minimise the formation of ice and frost that could potentially damage the ceramic insulation on the space shuttle orbiter. Due to environmental concerns, the PU insulation industry and the External Tank Project are faced with replacing CFC-11. The development criteria, statistical experimental approach and resultant foam properties are described. 7 refs.

USA

*Accession no.555493*

*Item 398*

Polyurethanes '94. Conference proceedings.
Boston, Ma., 9th-12th Oct.1994, p.141-9. 43C6

**REDUCED DENSITY CARBON DIOXIDE BLOWN FOAM BASED ON A NOVEL POLYOL TECHNOLOGY**

Nichols J B; Bhattacharjee D; Moreno O; Mirasol S; Tabor R
Dow Chemical Co.
(SPI,Polyurethane Div.)

In view of increasing pressure to use environmentally acceptable, non-flammable blowing agents with zero ozone depletion potential in the manufacture of rigid PU foams, there is greater interest in 100% carbon dioxide blown technology. Emphasis is placed on the design of experiments to yield a foam with good processability and excellent dimensional stability in a variety of conditions, while maintaining the in-place density usually obtained with CFC-11/HCFC-141b blown systems. The key to success is the development of a novel polyol that leads to dimensionally stable foams at higher levels of water. The commercial viability of this technology is demonstrated by producing actual parts without any equipment modifications. 4 refs.

USA

*Accession no.555492*

*Item 399*

Polyurethanes '94. Conference proceedings.
Boston, Ma., 9th-12th Oct.1994, p.123-33. 43C6

**ZERO ODP, ZERO GWP, HALOGEN-FREE AND LOW K-FACTOR AZEOTROPES AS BLOWING AGENTS FOR ISOCYANATE-BASED FOAMS**

Ashida K; Morimoto K; Yufu A
Detroit,University; Nisshinbo Industries Inc.
(SPI,Polyurethane Div.)

Due to the ozone depletion potential problem of CFCs and HCFCs, a number of alternative physical blowing agents for isocyanate-based foams are being investigated. Azeotropic blowing agents are described. Emphasis is placed on halogen-free binary or ternary azeotropes consisting of C5-C7 aliphatic hydrocarbons, C2-C4 carboxylic esters, C3-C4 ketones, and C4 ethers. 33 refs.

JAPAN; USA

*Accession no.555490*

*Item 400*

Polyurethanes '94. Conference proceedings.
Boston, Ma., 9th-12th Oct.1994, p.115-22. 43C6

**STATUS REPORT ON THE DEVELOPMENT OF A LIQUID HFC BLOWING AGENT**

Knopeck G M; Parker R C; Richard R G; Shankland I R
AlliedSignal Inc.
(SPI,Polyurethane Div.)

CFC blowing agents have been eliminated from virtually all PU foam applications and replaced, in many cases, with

more environmentally acceptable HCFCs. In many applications, the preference has been to convert from one liquid blowing agent to another. The environmental, toxicological and performance characteristics of a primary liquid HFC blowing agent candidate are discussed. Aspects covered include environmental properties, toxicity testing, laboratory foam evaluation involving both PU and polyisocyanurate, plastics compatibility, blowing agent stability, foam premix stability and decomposition. 5 refs.

USA

*Accession no.555489*

*Item 401*
Polyurethanes '94. Conference proceedings.
Boston, Ma., 9th-12th Oct.1994, p.110-4. 43C6
**NEW FOAM BLOWING AGENTS CONTAINING FLUOROIODOCARBONS**
Nimitz J
Ikon Corp.
(SPI,Polyurethane Div.)

Details are given of a new group of high performance foam blowing agents that are non-flammable and appear to be non-toxic and environmentally safe. These agents contain fluoroiodocarbons (FICs), either neat or in blends. The physical, thermodynamic, toxicological and environmental properties of FIC-based foam blowing agents, as well as availability and cost, are described. 5 refs.

USA

*Accession no.555488*

*Item 402*
Polyurethanes '94. Conference proceedings.
Boston, Ma., 9th-12th Oct.1994, p.36-40. 43C6
**NEW WATER-BLOWN POLYURETHANE SYSTEMS FOR USE IN FOOTWEAR**
Madaj E J; Walter K E
Miles Inc.
(SPI,Polyurethane Div.)

Chlorofluorocarbons have, for years, been used as blowing agents in PU integral skin systems such as those used in footwear applications. Due to environmental reasons, their replacement is necessary; two new technologies are now available. It is demonstrated that water-blown PU soling systems are effective replacements; not only can water-blown systems achieve excellent physical properties, they can also offer advantages over both the earlier systems and those using hydrochlorofluorocarbons as blowing agents. Details of recent work in the area of water-blown footwear systems carried out by Miles are given. 6 refs.

USA

*Accession no.555479*

*Item 403*
Polyurethanes '94. Conference proceedings.
Boston, Ma., 9th-12th Oct.1994, p.24-30. 43C6
**USE OF PENTANE-BLOWN IN RIGID FOAM AND INTEGRAL SKIN PRODUCTION PLANTS**
Mariani V; Allgaier P J
Impianti OMS SpA
(SPI,Polyurethane Div.)

Pentane isomers have already been used as blowing agents for integral skin PU foams, for the rigid foams in household domestic refrigerator insulation and for the core of sandwich panels with flexible or metal substrata. Problems have arisen from their use due to their very low flash point values, and the low thermal conductivity of N-pentane produced foam. An emulsifying system improving thermal conductivity and the characteristics of foams obtained with pentane are described.

EUROPEAN COMMUNITY; EUROPEAN UNION; ITALY; WESTERN EUROPE

*Accession no.555477*

*Item 404*
Polyurethanes '94. Conference proceedings.
Boston, Ma., 9th-12th Oct.1994, p.12-6. 43C6
**LATEST MANUFACTURING SOLUTIONS FOR SLABSTOCK FOAMS**
Fiorentini C; Taverna M; Griffith T; Collins B
Cannon Afros srl; Cannon Communication; TG Cellsoft Ltd.; Cannon USA Inc.
(SPI,Polyurethane Div.)

As environmental pressure increases worldwide, it is becoming necessary for foamers to eliminate chlorinated products such as CFCs, methylene chloride, 1.1.1 trichloroethane or any type of volatile organic compounds from their production. Cannon has developed and patented a proprietary method for the addition of liquid carbon dioxide to flexible foam formulations for slabstock. Details of the CarDio process, which is claimed to enable foamers to continue the production of their existing foam grades at a lower chemical cost, are presented. 7 refs.

CYPRUS; EUROPEAN COMMUNITY; EUROPEAN UNION; ITALY; USA; WESTERN EUROPE

*Accession no.555475*

*Item 405*
***Journal of Cellular Plastics***
30, No.6, Nov./Dec.1994, p.539-53
**USE OF ALTERNATIVE BLOWING AGENTS IN POLYURETHANE FOAMS - A COMPARISON BETWEEN EXPERIMENTAL AND PREDICTED AGEING**
Biesmans G; De Vos R; Rosbotham I D
ICI Polyurethanes

An improved model and the associated characterisation techniques for prediction of the long-term thermal conductivity of rigid PU foams are presented. The comparison of an 'experimental data set' with a

'calculated data set' shows the accuracy and reliability of the method. The calculated data set is generated via determination of fundamental foam physical properties and an ageing calculation model. The two most important factors are the effective diffusion constant and the initial cell gas composition. The effect of temp. on both the effective diffusion constants and gas content is determined. Finally, the foam structure is described in terms of cell size, polymer distribution over struts and windows and foam void volume. The predictions from the model are compared with laboratory ageing results and field exposure data for foams based on alternative blowing agents. 13 refs.

BELGIUM; EUROPEAN COMMUNITY; EUROPEAN UNION; WESTERN EUROPE

*Accession no.538301*

*Item 406*
***Journal of Cellular Plastics***
30, No.6, Nov./Dec.1994, p.509-21
**PENTANE-BLOWN POLYURETHANE RIGID FOAMS FOR CONSTRUCTION**
Heilig G; Wiedermann R E
Sumitomo Bayer Urethane Co.Ltd.; Bayer AG

The properties of pentane, including n-pentane, isopentane and cyclopentane, are discussed and the development of pentane-blown PU systems is described. The insulation properties and fire performance of pentane-blown PU foams are considered, with reference to applications in the construction industry. 11 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; JAPAN; WESTERN EUROPE

*Accession no.538300*

*Item 407*
***Journal of Cellular Plastics***
30, No.6, Nov./Dec.1994, p.494-508
**DIMENSIONALLY STABLE ALL CARBON DIOXIDE BLOWN FOAM AT 1.60 PCF DENSITY**
Moore S E
Dow Chemical Co.

The development of a closed cell rigid PU foam that contains no CFC-11, hydrochlorofluorocarbon or volatile organic compounds as blowing agents for expansion of the foam is described. The preparation of the all carbon dioxide blown foam is discussed. The foam is shown to maintain acceptable shrinkage characteristics (less than 4% volume change) and can be made at a 1.60 lb/cu ft density. The friability of the foam can be adjusted by a proper balance between high and low functionality polyol content. Numerous laboratory evaluations and commercial scale operations show the diversity and uniqueness of these types of foams in the PU industry. 16 refs.

USA

*Accession no.538299*

*Item 408*
Patent Number: WO 9414882 A1 19940707
French
**MIXTURES USEFUL FOR PREPARING A CELLULAR POLYMERIC MATERIAL**
Franklin J; Barthelemy P; Vanlautem N; Leroy A
Solvay SA

1,1,2-Trifluoroethane is used as a physical blowing agent for preparing cellular polymeric materials, in particular PS or polyurethane foams.

BELGIUM; EUROPEAN COMMUNITY; EUROPEAN UNION; WESTERN EUROPE

*Accession no.536684*

*Item 409*
***Cellular Polymers***
13, No.5, 1994, p.361-70
**LATEST MANUFACTURING SOLUTIONS FOR SLABSTOCK FOAMS**
Fiorentini C; Taverna M; Griffiths T
Cannon Afros SRL; Cannon Communication; Cannon Viking

Cannon has developed and patented CarDio, a proprietary method for the addition of liquid carbon dioxide to flexible foam formulations for slabstock. The process enables foamers to continue producing their existing foam grades at a lower chemical cost, due to the significant price differential between CFCs, auxiliary blowing agents and carbon dioxide. Its peculiar foaming method can dramatically reduce the size of the foaming plants, thereby deriving the advantages of reduced floor space and plant volume.

EUROPEAN COMMUNITY; EUROPEAN UNION; ITALY; WESTERN EUROPE

*Accession no.535073*

*Item 410*
***Cellular Polymers***
13, No.4, 1994, p.277-91
**EFFECT OF PHOSPHO-HALOGENATED POLYETHER POLYOL(IXOL B 251) ON FIRE BEHAVIOUR OF RIGID POLYURETHANE FOAMS BLOWN WITH VARIOUS AGENTS**
Modesti M; Simioni F
Padova,Universita

Substitution of CFC-11 with blowing agents with low environmental impact in the manufacture of PU thermal insulation materials results in changes in several properties of the materials. The increased flammability of material based on Ixol B 251 with flammable blowing agents (HCFC-141b, 2-chloropropane and n-pentane) can be reduced by modifying the formulation, e.g. by increasing the amount of flame retardants. The results of oxygen index testing are compared with data obtained from ISO 3582, DIN 4102-B2 and UNI 9177 tests and are shown to be well correlated. The initial thermal conductivity of

the various foams is strongly related to the thermal conductivity of the gas phase and increases with the new blowing agents, in the case of n-pentane reaching values which are about 20% higher than that of foams blown with CFC-11. 11 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; ITALY; WESTERN EUROPE

*Accession no.525998*

*Item 411*

Patent Number: US 5300534 A 19940405

**PRODUCTION OF PLASTIC FOAMS, PREFERABLY RIGID FOAMS CONTAINING URETHANE GROUPS OR URETHANE AND ISOCYANURATE GROUPS, AND BLOWING AGENT-CONTAINING EMULSIONS FOR THIS PURPOSE**

Volkert O; Meynard C A

BASF AG

An organic and/or modified organic polyisocyanate is reacted with at least one relatively high molec.wt. compound containing at least two reactive hydrogen atoms and, if desired, a low molec.wt. chain extender and/or crosslinking agent in the presence of a blowing agent, a catalyst and, if desired, assistants and/or additives. The blowing agent is at least one vinyl fluoroalkane or a mixture thereof with at least one different physical and/or chemical blowing agent. Emulsions containing at least one vinyl fluoroalkane and at least one of the starting components are used to produce the foam.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

*Accession no.520000*

*Item 412*

Utech '94: Groundwork for Growth. Conference proceedings.

Hague, 22nd-24th March 1994, paper 61, pp.8. 43C6

**BLOWING EFFICIENCY ENHANCEMENT HELPS REPLACE CHLOROFLUOROCARBONS AND HYDROFLUOROCARBONS IN MDI-BASED FLEXIBLE POLYURETHANE FOAMS**

House D W; Scott R V

UOP Inc.

Edited by: Reed D; Lee C A

(Crain Communications Ltd.; Rapra Technology Ltd.)

Unilink 4200, i.e. 4,4'-bis-(sec-butylamino)diphenylmethane, is an additive that reacts in a urethane foam formulation to increase both the level of urea groups present and the hard segment content. Unilink 4200 has been shown to significantly reduce foam density in certain MDI-based flexible polyurethane foams and thus can be used to replace auxiliary blowing agents. The term blowing efficiency enhancer has been coined to describe the way Unilink 4200 acts to reduce foam density. Data shows how use of Unilink 4200 decreases the need for auxiliary blowing agents. The synergistic effects between Unilink 4200 and additives such as diethanolamine and Ortegol 310 are shown. 6 refs.

USA

*Accession no.518988*

*Item 413*

Utech '94: Groundwork for Growth. Conference proceedings.

Hague, 22nd-24th March 1994, paper 54, pp.8. 43C6

**1,1,2-TRIFLUOROETHANE (HFC-143). A NEW ZERO OZONE DEPLETION POTENTIAL BLOWING AGENT FOR RIGID POLYURETHANE FOAMS**

Barthelemy P P; Leroy A; Zipfel L; Krucke W

Solvay SA; Solvay Fluor & Derivate GmbH

Edited by: Reed D; Lee C A

(Crain Communications Ltd.; Rapra Technology Ltd.)

Data is presented to support the argument that HFC-143 is the best candidate as a zero ozone depletion blowing agent for rigid PU foams. Solubility in various commercial polyols is compared with that of HCFC-22. Although HFC-143 is a gas with a boiling point of 5C, it retains many advantages of a liquid blowing agent and can be processed with a conventional low pressure dispensing machine. Density, dimensional stability, closed cell content and thermal conductivity data are given for foams prepared from preblended systems containing HFC-143. Only acute toxicity data are available and this shows a No Observable Effect Level above 10000 ppm. Flammability data are given for mixtures of HFC-143, HFC-134a and air. 4 refs.

BELGIUM; EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

*Accession no.518981*

*Item 414*

Utech '94: Groundwork for Growth. Conference proceedings.

Hague, 22nd-24th March 1994, paper 41, pp.4. 43C6

**EXPANDING THE USE OF CFC-FREE HIGH RESILIENCE FOAM TECHNOLOGY**

de Roeck H

Arco Chemical Europe Inc.

Edited by: Reed D; Lee C A

(Crain Communications Ltd.; Rapra Technology Ltd.)

Ultracel technology offers a wide range of high resilience and combustion modified high resilience foams, without auxiliary blowing agents, between 21 and 65 kg/cu.m and between 25 and 65 kg/cu.m, respectively. The technology uses two high performance polyols, i.e. Ultracel polyol 2000 and Arcol polyol HS 100. Ultracel polyol 2000 offers the best processability and foam stability of all TDI-based technologies. It allows a wide formulating latitude (broad range of diethanolamine, tin catalyst and TDI index). Arcol polyol HS 100, although being a non-reactive

polyol, complements Ultracel polyol 2000 most efficiently by providing additional loadbearing properties, offering the widest possible hardness range of all TDI-based technologies. Three types of foam are highlighted in this paper. In high resilience foam, the quality of the auxiliary blowing agent-free, 21 kg/cu.m density, soft foam (40N at 40 ILD) is even superior compared to foams blown with auxiliary blowing agents with regard to comfort and dynamic fatigue. The 50-65 kg/cu.m density, soft foams offer high quality as well as high support, and are characterised by a very pleasant feel. Data on formulations, foam properties and foaming conditions are shown. 2 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; FRANCE; WESTERN EUROPE

*Accession no.518968*

*Item 415*

Utech '94: Groundwork for Growth. Conference proceedings.
Hague, 22nd-24th March 1994, paper 39, pp.6. 43C6

**NEW BLOWING SYSTEM FOR CONVENTIONAL AND HIGH RESILIENCE SLABSTOCK AND HOT-MOULDED FLEXIBLE FOAMS**

Stefani D; Sam F O
Enichem Polimeri Research Centre
Edited by: Reed D; Lee C A
(Crain Communications Ltd.; Rapra Technology Ltd.)

Use of the PU POL 9912 family of polyether polyols does away with halogenated and toxic blowing agents. The systems can be used for the production of conventional and high resilience slabstock foams and for hot moulding technology. A wide range of hardnesses was obtained, ranging from very soft to medium firm foams. Properties of foams blown with water, with water plus CFC-11, and with water plus liquid carbon dioxide are tabulated. 3 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; ITALY; WESTERN EUROPE

*Accession no.518966*

*Item 416*

Utech '94: Groundwork for Growth. Conference proceedings.
Hague, 22nd-24th March 1994, paper 37, pp.5. 43C6

**MDI SLABSTOCK FOAMS IN LUXURY BEDDING. A PERFECT MATCH**

Mispreuve H A; Knaub P A M
Dow Europe SA
Edited by: Reed D; Lee C A
(Crain Communications Ltd.; Rapra Technology Ltd.)

The Dow Chemical Company has developed MDI-based slabstock foams designed to meet the most severe requirements of the luxury bedding market segment. The all-water blown technology is based on a new range of raw materials that include Voralux HP 700 polyol series and Isonate M100 isocyanate series. This paper describes the features of this technology in terms of processability, physical properties, feel, flame retardancy and dynamic fatigue. 4 refs.

SWITZERLAND; WESTERN EUROPE

*Accession no.518964*

*Item 417*

Utech '94: Groundwork for Growth. Conference proceedings.
Hague, 22nd-24th March 1994, paper 36, pp.10. 43C6

**RECENT DEVELOPMENTS IN MDI BASED FLEXIBLE SLABSTOCK**

Parfondry A; Cassidy E
ICI,Polyurethanes Group
Edited by: Reed D; Lee C A
(Crain Communications Ltd.; Rapra Technology Ltd.)

Waterlily comfort cushioning based on MDI was developed by ICI for flexible slabstock application. This new technology is appreciated for its adaptability to specific cushioning or padding requirements. The properties of this new family of materials are discussed and compared with those of conventional materials, with special emphasis on comfort, static creep and durability as expressed by dynamic fatigue and recovery. The robust processing characteristics of the technology are described and an example of experimental design to optimise consistency in production is presented and discussed. The Taguchi technique was used to vary formulation and process parameters to assess their effect on foam quality. Other attractive features such as homogeneity and rapid cure profile for just-in-time delivery are also presented. Uses in mattresses and furniture cushioning are suggested. 5 refs.

BELGIUM; EUROPEAN COMMUNITY; EUROPEAN UNION; WESTERN EUROPE

*Accession no.518963*

*Item 418*

Utech '94: Groundwork for Growth. Conference proceedings.
Hague, 22nd-24th March 1994, paper 30, pp.9. 43C6

**REFRIGERATORS WITH ONLY CARBON DIOXIDE BLOWN FOAM INSULATION**

Cecchini C; Cellarosi B; Brocci M
EniChem
Edited by: Reed D; Lee C A
(Crain Communications Ltd.; Rapra Technology Ltd.)

The development of carbon dioxide-blown PU foam formulations offering adequate processability and demoulding time, good physicomechanical characteristics and low surface friability is summarised. Tests with real refrigerators showed an increase in energy consumption of only 6% after 3 years, despite the fact that laboratory tests showed a 6% increase in lambda value after only 20 days. This clearly different behaviour of a real appliance unit with respect to an unfaced foam could lead to the

reconsideration of the ageing problem of these foams and make their use for refrigerator applications more realistic.

EUROPEAN COMMUNITY; EUROPEAN UNION; ITALY; WESTERN EUROPE

*Accession no.518957*

*Item 419*
Utech '94: Groundwork for Growth. Conference proceedings.
Hague, 22nd-24th March 1994, paper 26, pp.6. 43C6
**EFFECTS OF HYDROCARBONS IN PU FOAM FOR REFRIGERATED APPLIANCES**
Birch A J; Fanichet X; Smits G F; Schindler P
Dow Europe SA
Edited by: Reed D; Lee C A
(Crain Communications Ltd.; Rapra Technology Ltd.)

Cyclopentane has over the past year gained significant backing as the blowing agent, for rigid PU foam, favoured by the appliance manufacturers of Europe. This paper examines some of the processing and property phenomena exhibited by polyurethane foams blown with cyclopentane. Included is an examination of the effects of condensation of cyclopentane within the cells of the foam, and the implications this has on the compressive strength, dimensional stability and lambda values. Also included is a comparison of the commercially available grades of cyclopentane. No significant differences were found between these grades in terms of processing and final material properties. A formulated polyol designed for use with a blend of iso- and n-pentane is compared with both cyclopentane and CFC-11 reduced technologies. While lambda values for such a blend are inherently poor at a mean temperature of 24C, those measured at 0C showed a difference of only 1.5% compared to cyclopentane. 1 ref.

SWITZERLAND; WESTERN EUROPE

*Accession no.518953*

*Item 420*
Utech '94: Groundwork for Growth. Conference proceedings.
Hague, 22nd-24th March 1994, paper 25, pp.6. 43C6
**CYCLOPENTANE-BASED POLYURETHANE RIGID FOAM FOR APPLIANCES. AN ENVIRONMENTALLY SAFE INSULATION**
Thompson-Colon J A; Detrich K W; Eisen N; Lamberts W M
Bayer AG
Edited by: Reed D; Lee C A
(Crain Communications Ltd.; Rapra Technology Ltd.)

Processing, flammability, thermal conductivity, creep and dimensional stability data are given to show that cyclopentane is a good blowing agent for refrigerator and freezer insulation. 7 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

*Accession no.518952*

*Item 421*
Utech '94: Groundwork for Growth. Conference proceedings.
Hague, 22nd-24th March 1994, paper 24, pp.7. 43C6
**CYCLOPENTANE BLOWN POLYURETHANE RIGID FOAM FOR APPLIANCES**
Adams S; Volkert O; Wiegmann W
BASF AG
Edited by: Reed D; Lee C A
(Crain Communications Ltd.; Rapra Technology Ltd.)

Foam density, thermal conductivity, ageing and compression strength data are presented to show that cyclopentane is the best halogen-free blowing agent for appliance insulation. Safety recommendations to avoid fires and explosions are given in detail. 4 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

*Accession no.518951*

*Item 422*
Utech '94: Groundwork for Growth. Conference proceedings.
Hague, 22nd-24th March 1994, paper 19, pp.8. 43C6
**DIMENSIONALLY STABLE, CARBON DIOXIDE-BLOWN, FINE CELLED RIGID FOAMS BY CONTROLLED CELL OPENING**
Smits G F
Dow Benelux NV
Edited by: Reed D; Lee C A
(Crain Communications Ltd.; Rapra Technology Ltd.)

A combination of modelling techniques and experimental data are used to evaluate what effects can be expected from changes in cell size and/or density on the polymer distribution in foams and consequently on foam physical properties like compressive strength, initial thermal conductivity and thermal conductivity ageing. A special emphasis is put on the properties which can be obtained for open-celled foams, provided the cell opening occurs in a controlled way and does not change the material distribution with respect to the corresponding closed cell foam. 6 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; NETHERLANDS; WESTERN EUROPE

*Accession no.518947*

*Item 423*
Utech '94: Groundwork for Growth. Conference proceedings.
Hague, 22nd-24th March 1994, paper 17, pp.8. 43C6
**ROUTES TO MORE ENVIRONMENTALLY FRIENDLY RIGID POLYURETHANE FOAMS**
Thijs S
Shell Research SA
Edited by: Reed D; Lee C A
(Crain Communications Ltd.; Rapra Technology Ltd.)

Progress in the use of n-pentane and cyclopentane as CFC-replacement blowing agents is described, including the

customising of polyols for use in pentane-blown foams. Density, dimensional stability, flammability, cell gas composition, ageing and thermal insulation data are given for pentane-blown foams. 14 refs.

BELGIUM; EUROPEAN COMMUNITY; EUROPEAN UNION; WESTERN EUROPE

*Accession no.518945*

*Item 424*

Utech '94: Groundwork for Growth. Conference proceedings.
Hague, 22nd-24th March 1994, paper 13, pp.6. 43C6

**ADDITIVES FOR LOW DENSITY MDI FOAMS**

Savoca A C; Kimock M J; Listemann M L; Wressell A L
Air Products & Chemicals Inc.
Edited by: Reed D; Lee C A
(Crain Communications Ltd.; Rapra Technology Ltd.)

Conversion, rise, density and mechanical property data are given for MDI foams containing a new tertiary amine catalyst (XF-J1002) and a new surfactant (XF-I2585). The tertiary amine improves blowing efficiency and system flowability at higher water levels. An additional benefit of this catalyst is reduced amine emission from the finished foam. Amine emission data obtained by gas chromatography are shown. 4 refs.

USA

*Accession no.518941*

*Item 425*

Utech '94: Groundwork for Growth. Conference proceedings.
Hague, 22nd-24th March 1994, paper 7, pp.6. 43C6

**ADVANCES IN POLYURETHANE FOR USE IN ACOUSTIC APPLICATIONS FOR THE AUTOMOTIVE SECTOR**

Cunningham A; Duggan N
ICI,Polyurethanes Group
Edited by: Reed D; Lee C A
(Crain Communications Ltd.; Rapra Technology Ltd.)

A summary is given of the performance of ICI's latest range of acoustic foams with respect to airborne noise attenuation. These foams were specially designed to provide not only low densities with excellent flow and demould times, but also the design flexibility to select the most appropriate intrinsic foam acoustic performance for the specific application under consideration. Details are given of the test equipment. 7 refs.

BELGIUM; EUROPEAN COMMUNITY; EUROPEAN UNION; WESTERN EUROPE

*Accession no.518935*

*Item 426*

Patent Number: US 5286758 A 19940215

**USE OF FORMATE SALTS AS AUXILIARY AGENTS FOR LOW DENSITY RIGID FOAMS**

Christman D L; Reichel C J
BASF Corp.

It has been found that in addition to acting as an auxiliary blowing agent, various salts of formic acid may be used to tailor the reactivity characteristics of rigid PU foam formulations. Salts of particular interest are: ammonium formate, sodium formate and potassium formate. By varying the amounts and combinations of these salts, characteristics of a formulation's reactivity such as cream type, gel time, rise time and tack-free time, may be manipulated.

USA

*Accession no.510909*

*Item 427*

Polyurethanes World Congress 1993. Conference Proceedings.
Vancouver, B.C., 10th-13th Oct.1993, p.625-30. 43C6

**EFFECT OF TERTIARY AMINE CATALYST SYSTEMS FOR LOWER DENSITY RIGID FOAM WITH HCFC-141B**

Harada S; Isayama Y; Kitagawa H; Morii M; Fukushima T
Kao Corp.
(SPI,Polyurethane Div.; SPI Canada Inc.; European Isocyanate Producers Assn.)

Results are shown for the use of Kaolizer KLP-200K for HCFC-141b blown rigid foam. The system using Kaolizer KLP-200K results in lower density foam and reduced HCFC-141b consumption compared with that using conventional catalysts. It is also an effective catalyst for cyclopentane blown rigid foam. Formulation and property (including density, compressive strength and thermal conductivity) data are shown. 2 refs.

JAPAN

*Accession no.502817*

*Item 428*

Polyurethanes World Congress 1993. Conference Proceedings.
Vancouver, B.C., 10th-13th Oct.1993, p.609-18. 43C6

**SILICONE SURFACTANTS FOR PENTANE BLOWN RIGID FOAM**

Grimminger J; Muha K
Air Products & Chemicals; PURA GmbH & Co.
(SPI,Polyurethane Div.; SPI Canada Inc.; European Isocyanate Producers Assn.)

A variety of silicone surfactants (dimethylsiloxane copolymers with long polyether side chains) were evaluated for the ability to emulsify and stabilise pentane in polyol premixes (including flame retardants). Considerable data on foam properties (closed cell content, thermal conductivity, ageing, mechanical properties, pentane content, pentane loss, flammability) are shown. Two surfactants, DABCO DC193 and experimental surfactant XF-H25-73 were excellent. 6 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

*Accession no.502815*

*Item 429*
Polyurethanes World Congress 1993. Conference Proceedings.
Vancouver, B.C., 10th-13th Oct.1993, p.532-8. 43C6
**EFFECTIVE DIFFUSION COEFFICIENTS OF CARBON DIOXIDE AND HCFC-22 IN POLYURETHANE AND POLYISOCYANURATE FOAMS**
Bhattacharjee D; Booth J R
Dow Chemical Co.
(SPI,Polyurethane Div.; SPI Canada Inc.; European Isocyanate Producers Assn.)

Thin slice accelerated desorption using a gravimetric methodology was successfully extended to determine effective diffusion coefficients of HCFC-22 and carbon dioxide in polyurethane, polyurethane modified polyisocyanurate and polyurea modified polyurethane foam structures. They included appliance foam and boardstock foam. A modification of the sorption equation was developed to describe the special case of two component simultaneous desorption from a uniformly heterogeneous continuum. 8 refs.

USA

*Accession no.502804*

*Item 430*
Polyurethanes World Congress 1993. Conference Proceedings.
Vancouver, B.C., 10th-13th Oct.1993, p.473-483. 43C6
**KEY ASPECTS OF NOVEL CATALYST SYSTEMS IN ALL-WATER BLOWN INTEGRAL SKIN FOAMS. RELATED CATALYTIC ACTIVITIES IN THE ISOCYANATE REACTION**
Okuzono S; Kisaka H; Tamano Y; Lowe D W
TOSOH Corp.; TOSOH USA Inc.
(SPI,Polyurethane Div.; SPI Canada Inc.; European Isocyanate Producers Assn.)

Catalytic activity of various amine and tin catalysts are summarised. Relationships amongst catalytic activity, viscosity rise, foaming behaviour, foam properties, cure and skin formation were elucidated. In all-water blown integral skin foam, the newly developed tertiary amine catalyst F22 provided the best skin formation. It was important to balance the gelling and blowing activity by applying a co-catalyst to F22. 14 refs.

JAPAN; USA

*Accession no.502797*

*Item 431*
Polyurethanes World Congress 1993. Conference Proceedings.
Vancouver, B.C., 10th-13th Oct.1993, p.456-64. 43C6
**ZERO OZONE DEPLETION POTENTIAL BLOWING AGENTS FOR POLYURETHANE FOAMS**
Creazzo J A; Hammel H S; Schindler P; Cicalo K J
Du Pont Chemicals; Du Pont de Nemours International SA; Dow Europe SA
(SPI,Polyurethane Div.; SPI Canada Inc.; European Isocyanate Producers Assn.)

A summary is given of basic data developed to support commercial process conversion from CFC-11 to HFC-134a (Formacel Z-4). Topics include a comparison of the physical properties, results of vapour pressure and solubility studies with different polyols, effects of different surfactants on HFC-134a solubility, confirmation of product stability in foaming applications, B-side system viscosity effects, and materials-of-construction compatibility data (resistance of various rubbers and plastics to HFC-134a and HFC-152a). The paper summarises experience developed in modifying equipment to handle higher b-side mixing and storage pressure, and discusses effects of process settings on foam quality. Some joint ventures between blowing agent suppliers and insulation, e.g. refrigerators, and non-insulation. e.g. footwear, manufacturers are described.

SWITZERLAND; USA; WESTERN EUROPE

*Accession no.502795*

*Item 432*
Polyurethanes World Congress 1993. Conference Proceedings.
Vancouver, B.C., 10th-13th Oct.1993, p.451-5. 43C6
**DEVELOPMENT AND OPTIMISATION OF AN HCFC-141B POLYURETHANE FOAM SYSTEM FOR THE RESIDENTIAL DOOR MARKET**
Grbac J; Wheeler I; Gurecki J
ICI Polyurethanes Group
(SPI,Polyurethane Div.; SPI Canada Inc.; European Isocyanate Producers Assn.)

Comparison of products blown by HCFC-141b with those blown by CFC-11 shows that achievement of foam densities meeting industry requirements together with the required physical properties (including k-factor, dimensional stability, compressive strength and friability) is possible. Flow properties,both vertical and horizontal, were also examined. Flammability and heat of combustion data are tabulated.

CANADA; USA

*Accession no.502794*

*Item 433*
Polyurethanes World Congress 1993. Conference Proceedings.
Vancouver, B.C., 10th-13th Oct.1993, p.439-44. 43C6
**LOW PERMEABILITY POLYOLS FOR RIGID FOAM APPLICATIONS**
Moore D R; Kaplan W A; Tabor R L
Dow Chemical Co.

(SPI,Polyurethane Div.; SPI Canada Inc.; European Isocyanate Producers Assn.)

Data are presented on several new polyols which are designed to prevent thermal conductivity ageing of water blown PU foams by improving carbon dioxide retention and air exclusion. Formulation, dynamic mechanical and thermal conductivity reduction data are shown. 7 refs.

USA

*Accession no.502792*

*Item 434*
Polyurethanes World Congress 1993. Conference Proceedings.
Vancouver, B.C., 10th-13th Oct.1993, p.425-32. 43C6
**NEW POLYURETHANE ENERGY MANAGEMENT FOAMS FOR IMPROVED AUTO INTERIOR SAFETY**
Naik B G
ICI Polyurethanes Group
(SPI,Polyurethane Div.; SPI Canada Inc.; European Isocyanate Producers Assn.)

ICI Polyurethanes has developed a portfolio of new energy management PU foam systems which are CFC-free, water-blown, and low density. These products range from rigid to semi-rigid to viscoelastic foams. Each type of foam offers unique properties for various automotive interior applications. Rigid foams absorb energy primarily through a non-recoverable, physical crushing of the foam cells. On the other hand, semi-rigid and viscoelastic foams provide a viscous dissipation of energy with a slow shape recovery. This paper describes the development, static/dynamic impact properties, and processing of these new PU energy management foams.

USA

*Accession no.502790*

*Item 435*
Polyurethanes World Congress 1993. Conference Proceedings.
Vancouver, B.C., 10th-13th Oct.1993, p.405-10. 43C6
**WATER-BLOWN RIGID FOAMS**
Christman D L; Reichel C J
BASF Corp.
(SPI,Polyurethane Div.; SPI Canada Inc.; European Isocyanate Producers Assn.)

BASF has uncovered a family of additives which act as cell openers when added to resin formulations. Using standard rigid foam polyols, they have prepared foams with densities as low as 0.90 pcf which show less than 5% dimensional changes when kept at 158F and 100% relative humidity for 28 days. The measured closed cell content can be as low as 3-5% although foams in the 1.1-1.4 pcf density range were found to be dimensionally stable at closed cell contents as high as 88%.

USA

*Accession no.502787*

*Item 436*
Polyurethanes World Congress 1993. Conference Proceedings.
Vancouver, B.C., 10th-13th Oct.1993, p.383-5. 43C6
**ZERO OZONE DEPLETION POTENTIAL RIGID INSULATION FOAMS PREPARED WITH HYDROFLUOROALKANES**
Yu-Hallada L C; Reichel C J
BASF Corp.
(SPI,Polyurethane Div.; SPI Canada Inc.; European Isocyanate Producers Assn.)

HFA's (hydrofluoroalkanes or partially fluorinated alkanes) make fine, closed cell foams. HFA-blown rigid foams at 2.0 pcf density or lower have low initial k-factors (0.13 Btu in/h sq.ft. F). Aged k-factors are excellent. HFA's have zero ozone depletion potential and relatively low halogen global warming potential. Data on foams from HFA combinations are given.

USA

*Accession no.502784*

*Item 437*
Polyurethanes World Congress 1993. Conference Proceedings.
Vancouver, B.C., 10th-13th Oct.1993, p.379-82. 43C6
**HCFC-141B BLOWN POLYURETHANE FOAM PANELS MEET FACTORY MUTUAL 4880 APPROVAL**
Brown S A
Polythane Systems Inc.
(SPI,Polyurethane Div.; SPI Canada Inc.; European Isocyanate Producers Assn.)

PSI H10-20, a PU foam system blown with HCFC-141b, is commercially available for both continuous and discontinuous metal panel production. This system is the first HCFC-141b blown PU foam system to meet the criteria for ASTM E-84 Class 1 flammability and FMRC's 4880 approval standard. The physical and thermal properties of this HCFC-141b blown foam are comparable to those obtained with a CFC-11 foam. This paper presents physical property data, including k-factor studies, from metal panels produced using the PSI H10-20 system and compares them with CFC-11 blown systems. 3 refs.

USA

*Accession no.502783*

*Item 438*
Polyurethanes World Congress 1993. Conference Proceedings.
Vancouver, B.C., 10th-13th Oct.1993, p.373-6
**DEVELOPMENT OF A LOW HCFC-141B CLASS 1 POLYURETHANE FOAM SYSTEM FOR METAL PANELS**
Dobransky M A; Treffinger E
Miles Inc.; Bally Engineered Structures Inc.
(SPI,Polyurethane Div.; SPI Canada Inc.; European Isocyanate Producers Assn.)

Reduction of ozone depletion potential during manufacture of insulated metal panels for walk-in cold storage is described. First CFC-11 was reduced by co-blowing the foam with carbon dioxide formed from the reaction of water and isocyanate. Then the CFC-11 was replaced by HCFC-141b. Thermal insulation performance had to be maintained as well as freeze stability, foam-to-metal adhesion (torque test) and density limits. 6 refs.

USA

*Accession no.502782*

*Item 439*
Polyurethanes World Congress 1993. Conference Proceedings.
Vancouver, B.C., 10th-13th Oct.1993, p.361-7. 43C6
**INNOVATIVE SILICONE SURFACTANT TECHNOLOGY FOR HFC-134A AND CYCLOPENTANE BLOWN RIGID POLYURETHANE FOAMS**
Burkhart G; Klincke M
Goldschmidt Chemical Corp.
(SPI,Polyurethane Div.; SPI Canada Inc.; European Isocyanate Producers Assn.)

Data is presented which shows the superior performance of newly developed silicone surfactants for formulations blown with cyclopentane and HFC-134a. Special attention had to be given to the emulsification properties of the silicone surfactants without sacrificing nucleation efficiency and stabilisation of the foam during the expansion. 2 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

*Accession no.502780*

*Item 440*
Polyurethanes World Congress 1993. Conference Proceedings.
Vancouver, B.C., 10th-13th Oct.1993, p.354-60. 43C6
**EMPLOYMENT OF ZERO OZONE DEPLETION POTENTIAL BLOWING AGENTS FOR POLYURETHANE RIGID FOAMS FOR THERMAL INSULATION**
Cecchini C; Cancellier V; Cellarosi B
EniChem Polimeri SpA
(SPI,Polyurethane Div.; SPI Canada Inc.; European Isocyanate Producers Assn.)

Results given for development work on the use of HFC-134a blown foams for the refrigeration industry. Good material distribution and mechanical characteristics were obtained, and in particular a thermal conductivity value of 21 mW/mK. The possibility of using this agent for continuous panel production was also investigated. Physico-mechanical characteristics and insulation properties (including ageing) are given for carbon dioxide (water blown) foams. 4 refs.

EUROPEAN COMMUNITY; ITALY; WESTERN EUROPE

*Accession no.502779*

*Item 441*
Polyurethanes World Congress 1993. Conference Proceedings.
Vancouver, B.C., 10th-13th Oct.1993, p.311-6. 43C6
**HYPERLITE LOW AND HIGH DENSITY MOULDED FOAM MEETING EUROPEAN AUTOMOTIVE STANDARDS**
Hill R A; Brasington R; Hanak P; Mahy M
Arco Chemical Europe Inc.
(SPI,Polyurethane Div.; SPI Canada Inc.; European Isocyanate Producers Assn.)

Correlation between foam properties and the Hyperlite polyols used is explained. Special attention is paid to compression sets, particularly wet and humid, dynamic fatigue and FMVSS 302 requirements. The Hyperlite polyols and polymer polyols are of a highly reactive nature that allows rapid demould whilst maintaining good processing characteristics such as flow and open foams. Hyperlite foams are cold cure TDI based foams and are very comparable to hot foam and high resilience slabstock formulating technology. They contribute to the recyclability of flexible polyurethanes by reducing the chemical diversity while maintaining their wide scope in applications and properties. Emphasis is placed on foams for car seats and seat backs. 4 refs.

EUROPEAN COMMUNITY; FRANCE; WESTERN EUROPE

*Accession no.502772*

*Item 442*
Polyurethanes World Congress 1993. Conference Proceedings.
Vancouver, B.C., 10th-13th Oct.1993, p.305-10. 43C6
**NOVEL APPROACH TO THE PRODUCTION OF LOW DENSITY, CFC-FREE FLEXIBLE POLYURETHANE FOAMS**
Sam F O; Stefani D; Lunardon G F
ECP Enichem Polimeri Srl
(SPI,Polyurethane Div.; SPI Canada Inc.; European Isocyanate Producers Assn.)

A novel chemical intermediate has been identified by EniChem which can be employed in a flexible PU foam formulation for slabstock, significantly contributing to the reduction of foam density to as low as 16.5 kg/cu.m, without thermal degradation hazards. Excellent compression set values are shown too. The substance is a new, non-toxic, non-halogenated organic compound, specially designed to obtain foams with excellent physical characteristics. Another significant feature of the intermediate is its application in the Hot Moulding technology leading to a net density reduction of 5-6 kg/cu.m without any modification of water level and maintaining all the superior physico-mechanical performances of TDI-based moulded foams. Details of the machinery used in trials are given together with formulation and property data. 3 refs.

EUROPEAN COMMUNITY; ITALY; WESTERN EUROPE

*Accession no.502771*

*Item 443*
Polyurethanes World Congress 1993. Conference Proceedings.
Vancouver, B.C., 10th-13th Oct.1993, p.297-304. 43C6
**NEW HIGH RESILIENCE SLABSTOCK TECHNOLOGIES BASED ON HIGH PERFORMANCE POLYOLS**
Mispreuve H; Knaub P
Dow Europe SA; Polyol International BV
(SPI,Polyurethane Div.; SPI Canada Inc.; European Isocyanate Producers Assn.)

New high performance polyols are made by a process based on a proprietary catalyst technology that makes it possible to produce polyols with reduced side products and high equivalent weights up to 5000. The benefits that these high performance polyols can give to TDI- and MDI-based water blown HR slabstock foams are explained. Benefits are in softness, comfort factor, reduced discolouration, touch and feel. 15 refs.

SWITZERLAND; WESTERN EUROPE

*Accession no.502770*

*Item 444*
Polyurethanes World Congress 1993. Conference Proceedings.
Vancouver, B.C., 10th-13th Oct.1993, p.279-87. 43C6
**UNDERSTANDING THE FUNDAMENTALS OF FORCED COOLING IN THE PRODUCTION OF BLOWING AGENT FREE FLEXIBLE SLABSTOCK POLYURETHANE FOAMS**
McAfee C D; Wiltz E P; Skorpenske R G; Ridgway D H; McClusky J V
Dow Chemical Co.
(SPI,Polyurethane Div.; SPI Canada Inc.; European Isocyanate Producers Assn.)

Results of forced cooling experiments on water blown PU foam on the Varimax half scale pilot line are presented, with emphasis on avoiding discolouration and degradation. As well as optimising procedures, some formulation improvements were discovered, i.e. novel polyols, modifiers and catalysts. 9 refs.

USA

*Accession no.502768*

*Item 445*
Polyurethanes World Congress 1993. Conference Proceedings.
Vancouver, B.C., 10th-13th Oct.1993, p.270-8. 43C6
**THE RAPID CURE PROCESS. INDUSTRIAL EXPERIENCE, ENGINEERING AND FORMULATION PRINCIPLES**
Stone H; Reinink E; LIchvar S; Carlson W; Sikorsky C
PMC Inc.,General Foam Div.
(SPI,Polyurethane Div.; SPI Canada Inc.; European Isocyanate Producers Assn.)

The Rapid Cure process for cooling flexible foam by rapidly blowing air through it was developed in order to allow safe production of low density, high water flexible foam formulations without use of any auxiliary blowing agents. This process, adapted to existing Maxfoam equipment, has been in full scale continuous use for more than a year. This report covers some of the engineering principles and formulations and covers further equipment modifications. Adaptation of the process to accommodate existing plant layout are discussed. Formulating for optimum quality is also dealt with by means of ample data. Accelerated ageing tests including heat stability, static fatigue and flex fatigue performance for a variety of foam grades are presented. 4 refs.

USA

*Accession no.502767*

*Item 446*
Polyurethanes World Congress 1993. Conference Proceedings.
Vancouver, B.C., 10th-13th Oct.1993, p.176-83. 43C6
**CANNON ENVIRO-CURE EQUIPMENT APPLIED TO THE VERTIFOAM AND MAXFOAM PROCESSES**
Collins B; Fawley C
Cannon USA; Cannon Viking
(SPI,Polyurethane Div.; SPI Canada Inc.; European Isocyanate Producers Assn.)

A process developed by Crain Industries (Enviro-Cure) can produce a full range of density and hardness (low and high) flexible PU foams without using any auxiliary blowing agents. Water is used as a total blowing system since it generates carbon dioxide from the foam reaction. Flexible slabstock foam is made typically by either the Maxfoam or Vertifoam process. Enviro-Cure can be adapted to both of these foam manufacturing processes, and can be supplied as an addition to existing equipment or supplied as a full turnkey project including foaming equipment. The layout of the Enviro-Cure equipment will depend on the space available and process type. This paper deals with the equipment necessary to produce CFC-free and alternative blowing agent-free foams based on the Enviro-Cure process. Equipment is explained by photographs and processes by graphs or tables. Details are given of environmental legislation that can be satisfied by the technology.

EUROPEAN COMMUNITY; UK; USA; WESTERN EUROPE

*Accession no.502755*

*Item 447*
Polyurethanes World Congress 1993. Conference Proceedings.
Vancouver, B.C., 10th-13th Oct.1993, p.161-5. 43C6
**PROCESSING EFFECTS ON HCFC-141B APPLIANCE FOAM INSULATION**
Mann D J; Mautino V M
Miles Inc.
(SPI,Polyurethane Div.; SPI Canada Inc.; European Isocyanate Producers Assn.)

A systematic evaluation is given of the effects of processing conditions on the physical properties of a conventional-density, PMDI-based, HCFC-141b blown foam system. The physical properties of primary interest included k-factor, flowability, and the % overpacking required to produce low temperature dimensional stability. The processing parameters that were varied included chemical temperature, index, mould temperature, and pour pressure. The results presented in this paper were generated using the data obtained from sixteen experiments. These experiments were designed to produce statistically valid information from a minimum number of experiments. The magnitude of individual effects, as well as the synergetic interactions, were evaluated. 2 refs.

USA

*Accession no.502752*

*Item 448*

Polyurethanes World Congress 1993. Conference Proceedings.

Vancouver, B.C., 10th-13th Oct.1993, p.154-60. 43C6

**BLOWING AGENT EMISSION CALCULATIONS FOR A REFRIGERATOR**

Shankland I R

Allied-Signal Inc.

(SPI,Polyurethane Div.; SPI Canada Inc.; European Isocyanate Producers Assn.)

An outline is given of a model which can estimate the concentration of blowing agents emitted from the foam insulation into the cavity of a domestic refrigerator. The concentration of blowing agent inside the refrigerator decays asymptotically with time and depends on the diffusion coefficient and initial concentration of blowing agent in the foam, the number and surface area of holes through the plastic liner, whether or not the foam is adhered to the plastic liner, and the air exchange rate for the refrigerator. The model calculations (for HCFC-141b) indicate that, under normal operating conditions, the blowing agent concentration inside the refrigerator is very low, typically parts per billion by volume. 10 refs.

USA

*Accession no.502751*

*Item 449*

Polyurethanes World Congress 1993. Conference Proceedings.

Vancouver, B.C., 10th-13th Oct.1993, p.66-73. 43C6

**NOVEL TECHNOLOGY FOR THE MANUFACTURE OF ALL-WATER-BLOWN FLEXIBLE SLABSTOCK FOAM**

Skorpenske R G; Solis R; Moy S A; Wiltz E P; McAfee C D; Brunner K; Doerges C

Dow Chemical Co.; Dow Europe SA; Polyol International BV

(SPI,Polyurethane Div.; SPI Canada Inc.; European Isocyanate Producers Assn.)

Hysteresis, stress at break, dynamic mechanical property and IR spectra data are compared for foams blown by conventional blowing agents and by first generation reduced blowing agent technology. Polyol XUS 153.02 was used. Formulation and property data are also given for second generation water-blown foams that contain the modifiers XU-15617, Celltrek HD 300 and Celltrek 301 in addition to the above polyol. The additives reduce tin catalyst requirements and improve bun surface cure. 5 refs.

SWITZERLAND; USA; WESTERN EUROPE

*Accession no.502739*

*Item 450*

Polyurethanes World Congress 1993. Conference Proceedings.

Vancouver, B.C., 10th-13th Oct.1993, p.40-5. 43C6

**SECOND GENERATION CARBON DIOXIDE BLOWN SYSTEMS**

Stewart R D

ICI Polyurethanes Group

(SPI,Polyurethane Div.; SPI Canada Inc.; European Isocyanate Producers Assn.)

Carbon dioxide blown systems were evaluated and compared with typical CFC-11 blown systems for rigid pour-in-place applications such as appliances, insulated water heaters, and vending machines. Small scale laboratory tests were designed to quantify performance parameters such as foaming pressure, adhesion (peel test), and flow. These tests aided in the development of specific carbon dioxide blown systems with improved performance versus current carbon dioxide based technology. Machine processing was conducted on appliance units comparing fill weights and processing characteristics. Energy efficiency testing and physical property comparisons are reported. 2 refs.

USA

*Accession no.502735*

*Item 451*

Polyurethanes World Congress 1993. Conference Proceedings.

Vancouver, B.C., 10th-13th Oct.1993, p.33-9. 43C6

**HYDROCARBONS PROVIDE ZERO OZONE DEPLETION POTENTIAL AND ZERO GLOBAL WARMING POTENTIAL INSULATION FOR HOUSEHOLD REFRIGERATION**

Ballhaus H; Hahn H

Liebherr Hausgerate GmbH

(SPI,Polyurethane Div.; SPI Canada Inc.; European Isocyanate Producers Assn.)

Results of processing experiments on refrigerator foams blown by pentane are presented. Safety aspects are emphasised. No perfluoroalkanes were necessary to obtain a pentane-blown insulation as as effective as the current CFC-blown. Pentane could be blended into polyol as a

premix, without igniting the factory, if the machinery were properly modified. Further handling of that premix was much less hazardous than originally expected. During the moment of the injection cycle, when the foam filled approximately three-quarters of the mould, the gas content was sufficient for ignition. Therefore strong air suction must be applied to the vent of the moulding form. Pentane levels of less than 0.1% within 5-inch could be easily achieved. The flammability of pentane-blown foams was not significantly higher than that of F-11 blown foam. Equipment is illustrated. Safety and monitoring protocols are given.

EUROPEAN COMMUNITY; GERMANY; WESTERN EUROPE

*Accession no.502734*

*Item 452*

Polyurethanes World Congress 1993. Conference Proceedings.
Vancouver, B.C., 10th-13th Oct.1993, p.10-3. 43C6

**HFC-356, A ZERO OZONE DEPLETION POTENTIAL BLOWING AGENT CANDIDATE FOR NORTH AMERICAN APPLIANCE FOAM FORMULATIONS**

Ball E E; Lamberts W M
Miles Inc.; Bayer AG
(SPI,Polyurethane Div.; SPI Canada Inc.; European Isocyanate Producers Assn.)

Properties of 1,1,1,4,4,4-hexafluorobutane (HFC-356) are tabulated alongside those of CFC-11. Its potential as a blowing agent for PU foam insulation for refrigerators and freezers is discussed. Data are shown to compare foam properties and processability of formulations containg HFC-356, CFC-11 and HCFC-141b. 6 refs

EUROPEAN COMMUNITY; GERMANY; USA; WESTERN EUROPE

*Accession no.502730*

*Item 453*

Polyurethanes '92. Conference Proceedings.
New Orleans, La., 21st-24th Oct.1992, p.493-5. 43C6

**WATERLILY RANGE OF QUALITY COMFORT MATERIALS FROM ICI'S MDI-BASED FLEXIBLE SLABSTOCK TECHNOLOGY**

Casey M; Muller L; Elliot A; Parfondry A
ICI,Polyurethanes Group
(SPI,Polyurethane Div.)

ICI has developed a technology package for 100% water-blown MDI-based slabstock foams. Considerable investment in the project has included a production scale foaming unit with an output of 700 lb/min. Deterioration of physical properties, normally associated with MDI formulations at low densities, have been overcome with the design of novel chemical intermediates, which has also required new formulation development and some equipment modification. The technology package allows a wide range of hardness/density combinations from a small number of raw material components, and produces foams with remarkable stability and fast cure times. This speed, and MDI's low vapour pressure, lead to much-improved working environments. In general, the new foams give a good balance of comfort properties with an excellent latex-like feel. Data is shown comparing their performance with that of existing high resilience foams.

BELGIUM; EUROPEAN COMMUNITY; WESTERN EUROPE

*Accession no.499006*

*Item 454*

Polyurethanes '92. Conference Proceedings.
New Orleans, La., 21st-24th Oct.1992, p.487-92. 43C6

**CFC-FREE, LOW DENSITY, SOFT FLEXIBLE SLABSTOCK FOAMS**

Mayer O
Arco Chemical Europe Inc.
(SPI,Polyurethane Div.)

Arcol DP 1135 is a new modified polyether polyol which has eliminated the need for CFC-11 or other auxiliary blowing agent in the production of soft standard foam grades above 18 kg/cu.m density. Formulations and foam property data are given which show how Arcol DP 1135 can be used as base polyol for producing low density, soft foams, processable by conventional water-blown technology. Very small amounts of Arcol 3420 improved the physical properties. 1 ref.

EUROPEAN COMMUNITY; FRANCE; WESTERN EUROPE

*Accession no.499005*

*Item 455*

Polyurethanes '92. Conference Proceedings.
New Orleans, La., 21st-24th Oct.1992, p.481-6. 43C6

**MDI SLABSTOCK FOAMS. A NEW FRONTIER**

Mispreuve H; Elwell R; Sewell R; Thoen J
Dow Europe SA; Dow Benelux BV
(SPI,Polyurethane Div.)

Physical properties data are shown for all-MDI CFC-free high resilience furniture and bedding foam as well as low resilience foam for packaging. 5 refs.

EUROPEAN COMMUNITY; NETHERLANDS; SWITZERLAND; WESTERN EUROPE

*Accession no.499004*

*Item 456*

Polyurethanes '92. Conference Proceedings.
New Orleans, La., 21st-24th Oct.1992, p.468-72. 43C6

**POUR BEHIND VINYL SRIM FOR DOOR PANEL APPLICATIONS**

Ho D
BASF Corp.
(SPI,Polyurethane Div.)

A unique moulding process and a polyurethane system are described that enable production of light weight, strong, yet functional door panels for the automotive

industry. Ease of processing, design freedom, quick demould time and one step production operation all contribute toward low cost interior trim panels. This pour behind vinyl PU system is a cost effective method to produce a high quality, low density door panel in less than one minute. The system uses water as blowing agent. Numerous variables involved in the preparation of door panels using this one step technique were evaluated. They included investigation of substrates, adhesion, flowability, moulding pressure, heat resistance, equipment used, fire retardant properties, and water absorption. The low density, pour behind vinyl system with densities as low as 8 lb/cu. foot and fibreglass contents as low as 15% in the system, achieved the physical properties necessary to exceed today's automotive industry specifications. Cost data are included. The PU system adhered excellently to the vinyl skin without an adhesive. 9 refs.

USA

*Accession no.499002*

*Item 457*

Polyurethanes '92. Conference Proceedings.
New Orleans, La., 21st-24th Oct.1992, p.455-8. 43C6

**DEVELOPMENT OF CFC-FREE INTEGRAL SKIN FOAM FOR STEERING WHEELS**

Amato T A; Cassidy E F; Christfreund A; Dobinson D; Randall D
ICI,Polyurethanes Group
(SPI,Polyurethane Div.)

Results of a joint project by ICI and UTA-Clifford to produce a steering wheel by water-blown integral skin foam technology are presented. Wheels can be produced on a variety of machines at a similar demould time to CFC-blown systems and with a lower weight than CFC-blown systems. The system is available commercially. 3 refs.

BELGIUM; EUROPEAN COMMUNITY; UK; WESTERN EUROPE

*Accession no.498999*

*Item 458*

Polyurethanes '92. Conference Proceedings.
New Orleans, La., 21st-24th Oct.1992, p.449-54. 43C6

**ALL WATER BLOWN INTEGRAL SKIN FOAM**

Wada H; Hasegawa N; Fukuda H; Takeyasu H
Asahi Glass Co.Ltd.
(SPI,Polyurethane Div.)

Use of a novel high purity, narrow MWD polyol (PREMINOL) enables production of water blown integral skin foam which has a tight, highly durable, voidless skin. Curing time is the same as with CFC-11 blowing agent. Conventional manufacturing systems can be used. Process data and surface images are given for foams produced from formulations with and without CFC-11. 4 refs.

JAPAN

*Accession no.498998*

*Item 459*

Polyurethanes '92. Conference Proceedings.
New Orleans, La., 21st-24th Oct.1992, p.438-48. 43C6

**POLYURETHANE ENERGY ABSORBING FOAMS FOR AUTOMOTIVE APPLICATIONS**

Rossio R C; Vecchio M; Abramczyk J
BASF Corp.; Ford Motor Co.
(SPI,Polyurethane Div.)

Theory and general data on the effects of impact on energy absorbing materials, including PU foam, is presented. Details are given of new water-blown PU foams (Elastoflex EA) that meets the safety criteria for vehicle interiors and exteriors. They are unique in their ability to efficiently absorb energy during an impact, rather than transferring this potential energy to the occupant, which could increase the probability of injury. These low density foams can be moulded efficiently into a variety of shapes using existing PU processing equipment, e.g. a Puromat 80 high pressure foam machine.

USA

*Accession no.498997*

*Item 460*

*Polyurethanes '92. Conference Proceedings.*
New Orleans, La., 21st-24th Oct.1992, p.431-5. 43C6

**INNOVATIVE SURFACTANT TECHNOLOGY FOR ALTERNATIVELY BLOWN POLYISOCYANURATE FOAM INSULATION**

Willoughby K; Hennington R M
Goldschmidt Chemical Corp.
(SPI,Polyurethane Div.)

The advantages of the silicone surfactant Tegostab B 84PI are demonstrated by processing and finished foam data on polyisocyanurate insulation material blown by CFC-11, water, water/HCFC-141B and HCFC-141b. Properties compared are flowability, density, closed cell content, friability, facer adhesion, blowing agent retention, dimensional stability, humidity resistance, and thermal transmission.

USA

*Accession no.498996*

*Item 461*

Polyurethanes '92. Conference Proceedings.
New Orleans, La., 21st-24th Oct.1992, p.422-30. 43C6

**EFFECTS OF HUMIDITY AND ELEVATED TEMPERATURE ON THE DENSITY AND THERMAL CONDUCTIVITY OF A RIGID POLYISOCYANURATE FOAM**

Zarr R R; Nguyen T
US,National Inst.of Standards & Technology
(SPI,Polyurethane Div.)

Measurements of apparent thermal conductivity are presented for specimens of rigid polyisocyanurate foam cut from a commercial insulation product and aged in air at 60C

and different humidities. Specimens were cut from boards blown with trichlorofluoromethane. Measurements were conducted for a period of 357 days at approximately 50-day intervals. Ageing curves of specimen mass, volume, density, and thermal conductivity for rigid polyisocyanurate foam are presented and implications of changes in these properties are discussed. Loss of blowing agent was measured by FTIR. Surface changes were studied by SEM. 27 refs.

USA

*Accession no.498995*

*Item 462*

Polyurethanes '92. Conference Proceedings.
New Orleans, La., 21st-24th Oct.1992, p.410-21. 43C6

**NOVEL SPRAY FOAM POLYOLS WITH IMPROVED PERFORMANCE**

Yamato L T; Schiff D E; Bhattacharjee D; Galbreath D E; McAdams H P; Dressel D
Dow Chemical Co.; IPI Inc.; Foam Enterprises
(SPI,Polyurethane Div.)

Polyols for CFC-free spray foams, i.e. blown by water or by HCFC-141, were investigated. Two polyols which led to an acceptable overall b-side viscosity and produce foams with good dimensional stability and with low friability were developed for carbon dioxide blown rigid PU spray foam formulations. The polyols also have potential utility in other rigid polyurethane and polyurethane modified polyisocyanurate foam applications. Results of ASTM tests for density, k-factor, friability, % closed cells, compressive strength, dimensional stability, heat and smoke release, and peel adhesion (to steel), are tabulated together with some processing information (cream time, gel time and tack free time). 6 refs.

USA

*Accession no.498994*

*Item 463*

Polyurethanes '92. Conference Proceedings.
New Orleans, La., 21st-24th Oct.1992, p.396-9. 43C6

**FORMACEL S STABILITY IN RIGID POLYURETHANE FOAM PREMIX**

Hammel H S; Bartlett P L; Creazzo J A
du Pont Chemicals
(SPI,Polyurethane Div.)

The degradation of HCFC-22 (Formacel S) in the presence of various polyols, catalysts and stabilisers was studied. Amine catalysts caused most degradation. Overall the studies showed that degradation of HCFC-22 can occur in the B-side mixtures. The rate of degradation was slow. In the worst case the loss of HCFC-22 was about 1% per month. Degradation products were not of concern from a toxicity standpoint. A preliminary study of HFC-134a (Formacel Z-4) and HFC-152a (Formacel Z-2) indicated that there was no degradation of those compounds in the B-sides. 4 refs.

USA

*Accession no.498992*

*Item 464*

Polyurethanes '92. Conference Proceedings.
New Orleans, La., 21st-24th Oct.1992, p.390-5. 43C6

**CARBON DIOXIDE BLOWN DIMENSIONALLY STABLE RIGID POLYURETHANE FOAM FOR ENTRY DOOR APPLICATIONS**

Mirasol S; Bhattacharjee D; Moreno O
Dow Chemical Co.
(SPI,Polyurethane Div.)

A novel technology involving a new polyol was developed. It provided foams with excellent adhesion to different substrates, e.g. plastic liner materials as well as steel facers, while maintaining excellent dimensional stability at low density under a variety of temperature and humidity conditions. The foams contained finer and more uniform cells than those blown with CFC-11. The technology successfully produced steel entry doors on conventional equipment. 3 refs.

USA

*Accession no.498991*

*Item 465*

Polyurethanes '92. Conference Proceedings.
New Orleans, La., 21st-24th Oct.1992, p.384-9. 43C6

**POLYURETHANE FOAM SYSTEMS FOR CLASS 1 METAL PANELS**

Lynch J J; Gerber D; Stewart R D
ICI Polyurethanes
(SPI,Polyurethane Div.)

The important performance criteria for fire rated metal panels are discussed. Pitfalls encountered while changing the blowing agent are pointed out and specifically tailored PU foam systems incorporating HCFC-141b and HCFC-22 are revealed. They are capable of obtaining Class 1 fire ratings with no sacrifice of processing characteristics, physical properties and thermal conductivity. 5 refs.

USA

*Accession no.498990*

*Item 466*

Polyurethanes '92. Conference Proceedings.
New Orleans, La., 21st-24th Oct.1992, p.348-58. 43C6

**THANCAT DA LINE. HIGHLY EFFECTIVE CATALYSTS FOR ALL-WATER-BLOWN HR FOAM**

Diblitz K; Diblitz C
Condea Chemie GmbH
(SPI,Polyurethane Div.)

Two azanorbornane catalysts (Thancat DA 301 and Thancat DA 401) are evaluated by data showing cure time, start time, rise time, density, shrinkage and cream time of the reaction mixture as well as density, open-cell content, shrinkage and mechanical property data for the foams. Special attention is paid to flowability and fogging. 7 refs.

EUROPEAN COMMUNITY; GERMANY; WESTERN EUROPE

*Accession no.498986*

*Item 467*
Polyurethanes '92. Conference Proceedings.
New Orleans, La., 21st-24th Oct.1992, p.341-7. 43C6
**TEXACAT CATALYSTS IN WATER-BLOWN RIGID FOAM**
Dedeaux D W; Rister E L; Zimmerman R L; Kohoutek F C
Texaco Chemical Co.
(SPI,Polyurethane Div.)

Effects are shown for over 15 tertiary amine catalysts (15 Texacat grades) on reaction profiles and foam properties at varying degrees of water-blowing in a rigid pour polyurethane foam system. This paper examines the intrinsic gelling character of these catalysts, and screens catalyst performance on the bases of flow, k-factor, closed-cell content, and compressive strength of the resultant foams. The superior flow character of a proprietary catalyst for all water-blown rigid foam is demonstrated. The effect of isocyanate index and choice of co-blowing agents is discussed. Several volatile organic compounds, including isopentane and HCFC-141b, were screened as co-blowing agents. Texacat ZR-70 was the most effective in terms of flow and cure. Texacat ZF-10 and Texacat ZF-22 were good choices in all-water blown rigid systems.
USA
*Accession no.498985*

*Item 468*
Polyurethanes '92. Conference Proceedings.
New Orleans, La., 21st-24th Oct.1992, p.183-6. 43C6
**IMPROVED RIGID INSULATING POLYURETHANE FOAMS PREPARED WITH HCFCS AND PERFLUOROALKANES**
Yu-Hallada L C; McLellan K P; Wierzbicki R J; Reichel C J
BASF Corp.
(SPI,Polyurethane Div.)

The potential of perfluoropentane and perfluorohexane as blowing agents was investigated. Their insolubility in polyols and polyisocyanates meant that they had to be dispersed as emulsions. They produced foams with very fine cells and low k-factors. However, they had low efficiency at blowing and so they were mixed with HCFC-22 and HCFC-141b. Addition of perfluoroalkanes to co-blown systems of HCFC and water gave significant improvement in thermal insulating properties. Foams blown by perfluoroalkanes showed only slight changes in k-factor through ageing. the ozone depletion potentials of the perfluoroalkanes was zero, but their global warming potential was about 5. 2 refs.
EUROPEAN COMMUNITY; GERMANY; WESTERN EUROPE
*Accession no.498967*

*Item 469*
Polyurethanes '92. Conference Proceedings.
New Orleans, La., 21st-24th Oct.1992, p.177-82. 43C6
**MICRO-FINE CELLULAR TECHNOLOGY FOR THE APPLIANCE INDUSTRY**
de Vos R; Rosbotham D; Deschaght J
ICI,Polyurethanes Group
(SPI,Polyurethane Div.)

Development work by ICI with low boiling blowing agents, i.e. blends of HCFC-22 with HCFC-142b, is described. The need to comply with regulations on CFCs as well as the consumption of energy by appliances is emphasised. New technology involving the use of insoluble material as nucleating agent produced micro-fine celled foam and overcame frothing caused by low boiling blowing agents. Initial and aged thermal conductivity data are given for various formulations. 2 refs.
BELGIUM; EUROPEAN COMMUNITY; WESTERN EUROPE
*Accession no.498966*

*Item 470*
Polyurethanes '92. Conference Proceedings.
New Orleans, La., 21st-24th Oct.1992, p.172-6. 43C6
**RAPID TECHNOLOGY EVALUATION TO HCFC-22/142B BLOWING AGENT FOR REFRIGERATOR INSULATION FOAM**
Fanichet X; Kuhn E; Schindler P
Dow Europe SA
(SPI,Polyurethane Div.)

The above blowing agents are presented as less toxic alternatives to HCFC-123 and HCFC-141b. Foam formulations are presented which achieve similar processing and foam properties as 50% R-11 blown foam systems. Excellent initial and aged foam k-factors were obtained. The effect of these low boiling blowing agents on plastic liner materials, the different possibilities of blowing agent addition and the influence of machine parameters were investigated as well. Trials at major European appliance manufacturers showed superior insulation performance of the entire cabinets with respect to k-factor.
SWITZERLAND; WESTERN EUROPE
*Accession no.498965*

*Item 471*
Polyurethanes '92. Conference Proceedings.
New Orleans, La., 21st-24th Oct.1992, p.165-171. 43C6
**LOWER DENSITY HCFC BLOWN APPLIANCE FOAMS**
Doerge H P
Miles Inc.
(SPI,Polyurethane Div.)

New low k-factor HCFC blown foams are described. They have lower k-factors and densities than previously reported microcell HCFC blown foams. In addition, formulation and property data are presented for new HCFC blown foams having similar thermal conductivities

and densities to production CFC-11 blown foams. Processing characteristics, physical properties and demoulding effects are shown to be equivalent or better than conventional CFC-11 blown production foams. Blowing agents mentioned are HCFC-141b and HCFC-123. 2 refs.

USA

*Accession no.498964*

*Item 472*
Polyurethanes '92. Conference Proceedings.
New Orleans, La., 21st-24th Oct.1992, p.158-64. 43C6
**OPEN CELL ISOCYANURATE FOAMS. A NOVEL ROUTE TO HIGH PERFORMANCE THERMAL INSULATION PANELS**
Ashida K; Kashiwame J
Detroit,Mercy University; Asahi Glass Co.Ltd.
(SPI,Polyurethane Div.)

Open cell isocyanurate foam and its use as a core material for vacuum insulation panels are discussed. When open cell foams are used as core materials for insulation panels kept under vacuum, the total heat loss through the panel consists only of the contributions from conductivity through the solid and the radiation loss. The preparation, processing, properties and applications of open cell rigid isocyanurate foams are described. They were blown by a blend of methylene chloride and pentane. The resulting foams had open cell contents of about 50-95% depending upon the reaction conditions employed at densities of 30-50 kg/cu.m. When pour-in-place foams were further exposed to vacuum after foaming, the resulting foams had an increased open cell content. This open cell foam technology suggests a variety of potential applications, not only for household refrigerators and deep freezers, but also for cryogenic liquid tank insulation, e.g. liquid hydrogen, liquid oxygen, liquid nitrogen, and liquified natural gas. 13 refs.

JAPAN; USA

*Accession no.498963*

*Item 473*
Polyurethanes '92. Conference Proceedings.
New Orleans, La., 21st-24th Oct.1992, p.141-8. 43C6
**SPECIALLY DESIGNED SURFACTANTS AND ALTERNATIVE TECHNIQUES FOR PROCESSING OF CRC-FREE RIGID FOAMS**
Klincke M; Burkhart G
Goldschmidt Th.,AG
(SPI,Polyurethane Div.)

It is shown that the phaseout of CFCs has made it necessary to reexamine the chemical structure of the silicone surfactants for each newly developed rigid PU foam system in order to achieve optimum performance. An unconventional way of blowing rigid PU foams is reported making use of the inherent tendency of the isocyanate group to react with itself and to form carbodiimide and carbon dioxide. This approach makes it possible to reduce the amount of auxiliary blowing agent and/or water in a formulation significantly without sacrificing the physical foam properties. The effect of nucleation aids (melamine and aerosil) on the cell structure and likewise on the Lamda-value of rigid PU foam is presented. 2 refs.

EUROPEAN COMMUNITY; EUROPEAN UNION; GERMANY; WESTERN EUROPE

*Accession no.498961*

*Item 474*
Polyurethanes '92. Conference Proceedings.
New Orleans, La., 21st-24th Oct.1992, p.102-11. 43C6
**PROCESSING-PROPERTIES RELATIONSHIPS FOR POLYURETHANE SPRAY FOAMS WITH HCFC BLOWING AGENTS**
Strauss E L; Bziik J W
Martin Marietta Astronautics Group; Martin Marietta Manned Space Systems
(SPI,Polyurethane Div.)

Two PU spray foams, SS-1228 and SS-1229, were selected for process development since they ranked highest in meeting mandatory thermal protection requirements for the National Launch System. A statistical design of experiment was employed to evaluate the spray process variables of foam component temperature and pressure, room and substrate temperature, relative humidity, overlap time, and spray gun. Specimens cut from test panels were tested for density, compression strength, tension strength (-423F to +200F), open cell content and friability weight loss. Bond strengths between successive layers were measured. SS-1228 with HCFC-141b was selected as the primary spray foam candidate. SS-1229 was penalised on account of adverse toxicity information on its blowing agent HCFC-123. 5 refs.

USA

*Accession no.498956*

*Item 475*
Polyurethanes '92. Conference Proceedings.
New Orleans, La., 21st-24th Oct.1992, p.36-41. 43C6
**FINE-CELLED CFC-FREE RIGID FOAM. NEW MACHINERY WITH LOW BOILING BLOWING AGENTS**
Grunbauer H J M; Broos J A F; Thoen J A; Smits G F
Dow Benelux NV; Admiral Equipment Co.
(SPI,Polyurethane Div.)

Newly developed high pressure dispensing and nucleating equipment is described. It was designed for making fine cell foams using soluble low-boiling blowing agents (LBBA) and sparingly soluble nucleating gases, e.g. nitrogen and noble gases. The underlying concepts for handling, processing and metering LBBAs are developed from a systematic investigation of LBBA solubilities in polyols, using modelling as well as experimental

measurements. In addition to the usual dispensing function, the equipment incorporates facilities for LBBA loading and for quantitative determination of dissolved and dispersed gaseous LBBA. The commercial viability of these features, under conditions simulating global industrial practice, is exemplified by presenting properties of fine-cell foams produced by using HFC-134a and HCFC-22/142b blends, in combination with tailor-made polyols, isocyanates and formulation additives. 8 refs.

EUROPEAN COMMUNITY; NETHERLANDS; USA; WESTERN EUROPE

*Accession no.498947*

*Item 476*

Polyurethanes '92. Conference Proceedings.
New Orleans, La., 21st-24th Oct.1992, p.23-25. 43C6

**HYDROFLUOROCARBONS AND HYDROFLUOROCARBON ETHERS AS BLOWING AGENTS FOR RIGID INSULATING URETHANE FOAMS**

Fishback T L; Reichel C J
BASF Corp.
(SPI,Polyurethane Div.)

Density, compression strength, thermal conductivity (initial and after heat ageing), friability, dimensional stability, abrasion resistance, tear strength, hardness, tensile and fatigue property data are shown for rigid PU and isocyanurate foams blown with HFC-E245 (difluoromethyl-1,1,1-trifluoroethylether), HFC-E356 (methyl-1,1,1,2,3,3-hexafluoropropyl ether) and HFC-245ca (1,1,2,2,3-pentafluoropropane). They were found to be good blowing agents and co-blowing agents (with water) for existing rigid foam formulations, including integral skin foams. 4 refs.

USA

*Accession no.498944*

*Item 477*

Polyurethanes '92. Conference Proceedings.
New Orleans, La., 21st-24th Oct.1992, p.12-16. 43C6

**K-FACTOR IMPROVEMENT VIA PERFLUORINATED HYDROCARBONS**

Londrigan M E; Snider S C; Trout K G
Center for Applied Engineering Inc.
(SPI,Polyurethane Div.)

The effects of mixing perfluorinated hydrocarbons (Fluorinert FC-72, Fluorinert FC-84, Fluorinert FC-70, Fluorinert L-11722 and Performance Fluid 5050) with conventional CFC blowing agents or HCFC replacements on the thermal conductivity and density of PU or polyisocyanurate foams were investigated. The handbatch foams were derived from phthalic ester polyols and polymeric MDI (with and without carbon black). 3 refs.

USA

*Accession no.498942*

*Item 478*

Polyurethanes '92. Conference Proceedings.
New Orleans, La., 21st-24th Oct.1992, p.2-11. 43C6

**BLOWING AGENTS. THE NEXT GENERATION**

Decaire B R; Pham H T; Richard R G; Shankland I R
Allied Signal Inc.
(SPI,Polyurethane Div.)

Properties of some liquid blowing agents and some lower boiling, so-called gaseous blowing agents are tabulated and discussed. These properties include thermal conductivity, toxicity, flammability, atmospheric life, volatility, and solubility in polyols. The substances considered are HFC-152a, HFC-134a, HFC-125, HFC-32, HFC-143A, HCFC-22, HCFC-142b, HCFC-141b, and HFC-356. Data are given too for a large number of hydrofluoropropane isomers. 12 refs.

USA

*Accession no.498941*

*Item 479*

Polyurethanes '92. Conference Proceedings.
New Orleans, La., 21st-24th Oct.1992, p.688-92. 43C6

**ALL-WATER-BLOWN POLYURETHANE INTEGRAL SKINS TO REPLACE CURRENT CFC-BLOWN SYSTEMS**

Madaj E J; Jasenak J R
Miles Inc.
(SPI,Polyurethane Div.)

It is shown by means of property data (density, hardness, TS, EB, tear strength, abrasion resistance, compression set) that water-blown integral skin systems are a viable alternative to CFC-containing polyurethanes.

USA

*Accession no.498870*

*Item 480*

Polyurethanes '92. Conference Proceedings.
New Orleans, La., 21st-24th Oct.1992, p.668-71. 43C6

**FROM CHLOROFLUOROCARBON TO CHEMICAL BLOWING AGENT. A VIABLE ALTERNATIVE**

Bradford L; Franklin R; Williams B
Akzo Chemicals Inc.
(SPI,Polyurethane Div.)

Use of dialkyl dicarbonates, particularly E-90018T, as blowing agents is explained. Limitations, i.e. rate of reaction, decomposition pathways to give either one or two moles of carbon dioxide, and problems of alcohol release, are pointed out. Brief formulation and property data are shown for PU foams. Comparison is made with other gas-yielding agents. 4 refs.

USA

*Accession no.498867*

*Item 481*
Polyurethanes '92. Conference Proceedings.
New Orleans, La., 21st-24th Oct.1992, p.660-7. 43C6
**MANUFACTURING FLEXIBLE SLABSTOCK FOAMS WITH TECHNOLOGY THAT ALLOWS THE REDUCTION OR ELIMINATION OF AUXILIARY BLOWING AGENTS**
Hicks J S; Skorpenske R G; McAfee C D; Wiltz E P; Brunner K
Dow Chemical Co.; Dow Europe SA
(SPI,Polyurethane Div.)

A summary is presented of the significant contributions made to the global flexible slabstock industry via the successful commercialisation of Dow technology. Emphasis is placed on meeting environmental and occupational health legislation in Europe and USA. Advantages of Celltrek 3000 polyol and Celltrek HD300 additive are emphasised. 7 refs.

DOW CHEMICAL CO.; DOW EUROPE SA
SWITZERLAND; USA; WESTERN EUROPE

*Accession no.498866*

*Item 482*
Polyurethanes '92. Conference Proceedings.
New Orleans, La., 21st-24th Oct.1992, p.650-9. 43C6
**COMPRESSION SET MECHANISMS IN FLEXIBLE POLYURETHANE FOAM**
Skorpenske R G; Solis R; Kuklies R A; Schrock A K; Turner R B
Dow Chemical USA
(SPI,Polyurethane Div.)

Model foams which varied in urea content (water level), soft segment connectivity (TDI index), and urethane content (phenyl isocyanate capped polyol) were characterised analytically and evaluated for their response to variations in temperature, moisture and mechanical stress. The effect of foam cell structure on compression set was also studied. It is concluded that that resistance to temperature induced polymer transitions under strain, the hydrogen bonded network, soft segment elasticity driven recovery, and the covalent network, can be used to describe the phenomenon of compression set on a molecular level. Moisture was also found to significantly reduce the energy required to induce compression set by plasticising the urea hard domain. Relevance to the trend towards water-blown foams is indicated. 7 refs.

USA

*Accession no.498865*

*Item 483*
CFCs and the Polyurethane Industry : Volume 4.
Basel, Technomic, 1992, p.419-566. 43C6
**1991 UNEP FLEXIBLE AND RIGID FOAMS TECHNICAL OPTIONS REPORT**
United Nations Environment Programme 1991
Edited by: Lichtenberg F W
(SPI,Polyurethane Div.)

This report reviews the use of CFCs in flexible and rigid foam and outlines the available technical options that can be implemented by each foam market segment in order to eliminate CFC usage. Updates on the progress of each market sector in reducing CFC consumption since 1986 are given. A perspective is also given on CFC use patterns in developing countries.

USA

*Accession no.498006*

*Item 484*
***Journal of Cellular Plastics***
29, No.5, Sept/Oct.1993, p.413-4
**CFC USE VIRTUALLY ELIMINATED BY FLEXIBLE POLYURETHANE FOAM PRODUCERS**

The Polyurethane Foam Association, the organisation of flexible PU foam manufacturers, has announced that at the end of 1992, its members has achieved a 99.88% reduction in the use of CFC-11 since 1986. Association members and industry suppliers have been successful in developing alternative production technologies that have helped the rapid phase-out of CFCs in the flexible foam industry. This abstract includes all the information contained in the original article.

POLYURETHANE FOAM ASSN.
USA

*Accession no.494084*

*Item 485*
Polyurethanes World Congress 1991: The Voice of Advancement. Conference Proceedings.
Nice, 24th-26th Sept.1991, p.752-9. 43C6
**FROTH AND POUR-IN-PLACE FOAM SYSTEMS BASED ON CFC ALTERNATIVES**
Dwyer F J; Parker R C; Thrun K M; Zwolinski L M
Allied-Signal Inc.
(SPI,Polyurethane Div.; European Isocyanate Producers Assn.)

The use of two alternative HCFC-type candidates, chlorodifluoromethane (HCFC-22) and 1,1-dichloro-1-fluoroethane (HCFC-141b), as substitutes for CFC-12 and CFC-11 in the production of rigid PU foam insulation for residential and commercial refrigeration is demonstrated. The physical, chemical and environmental properties of these products and their performance in these applications are described.

USA

*Accession no.485301*

*Item 486*
Polyurethanes World Congress 1991: The Voice of Advancement. Conference Proceedings.
Nice, 24th-26th Sept.1991, p.740-4. 43C6

**PUR FOAMS PREPARED WITH EMULSIFIED PERFLUOROALKANES AS BLOWING AGENTS**
Volkert O
BASF AG
(SPI,Polyurethane Div.; European Isocyanate Producers Assn.)

The results are reported of a study of the use of perfluoroalkanes as blowing agents in rigid PU foams. A procedure for dispersing these blowing agents in polyols as emulsions whose fine drops are easily vaporised is described along with trials aimed at minimising the amount of perfluoroalkanes in the foams. The most suitable perfluoroalkanes are shown to be perfluoropentane, perfluorohexane and perfluoroheptane, giving rise to foams with particularly fine cells and low thermal conductivity.

EUROPEAN COMMUNITY; GERMANY; WESTERN EUROPE

*Accession no.485300*

*Item 487*
Polyurethanes World Congress 1991: The Voice of Advancement. Conference Proceedings.
Nice, 24th-26th Sept.1991, p.412-27. 43C6
**MATHEMATICAL MODELLING TECHNIQUES TO PREDICT IMPORTANT ASPECT OF K-FACTOR AGEING OF CFC-11 FREE RIGID INSULATION**
Smits G F; Thoen J A
Dow Benelux NV
(SPI,Polyurethane Div.; European Isocyanate Producers Assn.)

A complete overview is presented of the scope and limitations of two alternative approaches to the use of CFC as blowing agents for rigid PU foams, based on the results of extensive computational analysis and simulation. The approaches involve the partial or total replacement of CFC-11 by carbon dioxide and the use of less ozone depleting HCFCs to replace CFC-11. Critical chemical, physical and compositional parameters that regulate both initial and aged thermal conductivity and dimensional stability are quantified and theory, mathematics and simulation tuned to experimental data. 18 refs.

EUROPEAN COMMUNITY; NETHERLANDS; WESTERN EUROPE

*Accession no.485286*

*Item 488*
Polyurethanes World Congress 1991: The Voice of Advancement. Conference Proceedings.
Nice, 24th-26th Sept.1991, p.243-9. 43C6
**CFC-FREE PU PIPE INSULATION FOAMS FOR USE IN DISTRICT HEATING SYSTEMS**
Broennum T
Shell Belgium
(SPI,Polyurethane Div.; European Isocyanate Producers Assn.)

The effect of the total replacement of CFC-11 on the processing and physical properties of PU pipe insulation foams containing polyols developed specifically to overcome the problems encountered when increased water levels are used in the formulation, was investigated. Blowing agents employed were carbon dioxide, via the water/isocyanate reaction, and dual blown systems based on carbon dioxide and HCFCs, such as 142b. 2 refs.

BELGIUM; EUROPEAN COMMUNITY; WESTERN EUROPE

*Accession no.485273*

*Item 489*
Polyurethanes World Congress 1991: The Voice of Advancement. Conference Proceedings.
Nice, 24th-26th Sept.1991, p.169-71. 43C6
**INFLUENCE OF GASSING, ESPECIALLY WITH CO2, ON THE MACHINABILITY AND MOULDED PART PROPERTIES OF PU FOAM SYSTEMS**
Jung L
Elastogran Polyurethane GmbH
(SPI,Polyurethane Div.; European Isocyanate Producers Assn.)

A gassing concept for gases with a high solubility is described and its application to the gassing of isocyanate components with carbon dioxide is demonstrated. Three examples are presented, namely the gassing of a flexible foam system for automotive seat cushions, the gassing of a flexible foam system for the backfoaming of automobile carpeting and the gassing of a semi-rigid system for dashboards.

EUROPEAN COMMUNITY; GERMANY; WESTERN EUROPE

*Accession no.485265*

*Item 490*
Polyurethanes World Congress 1991: The Voice of Advancement. Conference Proceedings.
Nice, 24th-26th Sept.1991, p.160-3. 43C6
**METERING OF FLAMMABLE BLOWING AGENTS**
Lerch B P; Taubenmann P
BASF AG; Elastogran Polyurethane GmbH
(SPI,Polyurethane Div.; European Isocyanate Producers Assn.)

Two distinct processes of using pentane as a blowing agent in the production of PU foam are described. The processes involve direct pentane metering into the mix head according to the nozzle-within-a-nozzle process and the metering of pentane into the polyol stage of the process, which is protected from flammability and explosion hazards.

EUROPEAN COMMUNITY; GERMANY; WESTERN EUROPE

*Accession no.484595*

*Item 491*
Polyurethanes World Congress 1991: The Voice of Advancement. Conference Proceedings.

Nice, 24th-26th Sept.1991, p.66-8. 43C6
**EXPERIENCES AND RESULTS OF CFC-FREE PU FOAMS IN BUILDING INDUSTRY**
Ihanamaki A
Lohja Corp.
(SPI,Polyurethane Div.; European Isocyanate Producers Assn.)

Experiences by Lohja Corp. when developing CFC-free PU foams are outlined and the results of tests carried out on PU foam formulations containing HFA-22 as a replacement for CFC-11 are briefly reported. 2 refs.

FINLAND; SCANDINAVIA; WESTERN EUROPE

*Accession no.484574*

*Item 492*
Polyurethanes World Congress 1991: The Voice of Advancement. Conference Proceedings.
Nice, 24th-26th Sept.1991, p.63-5. 43C6
**NEW CFC-FREE TECHNOLOGY FOR THE PRODUCTION OF PUR INSULATION PANELS**
Wallaeys B; de Schryver P; Cop P
Recticel NV
(SPI,Polyurethane Div.; European Isocyanate Producers Assn.)

The properties (physical, environmental and toxicological) and use of 2-chloropropane as a replacement for CFC-11 in rigid PU foam boards are described. The technology is known as LBL-2.

BELGIUM; EUROPEAN COMMUNITY; WESTERN EUROPE

*Accession no.484573*

*Item 493*
Polyurethanes World Congress 1991: The Voice of Advancement. Conference Proceedings.
Nice, 24th-26th Sept.1991, p.60-2. 43C6
**CFC-FREE PU-SANDWICH ELEMENT DBL PRODUCTION FOR SCANDINAVIAN MARKETS**
Ojala R
Urepol Oy
(SPI,Polyurethane Div.; European Isocyanate Producers Assn.)

A report is presented on preliminary trials on CFC-free PU foams and on HFA-22/water blown PU foams. Lambda values at 10C versus time, mechanical properties and costs for foams blown with HFA-22/CO2, CO2 and CFC-11 are reported.

FINLAND; SCANDINAVIA; WESTERN EUROPE

*Accession no.484572*

*Item 494*
***Journal of Cellular Plastics***
29, No.3, May/June 1993, p.222-45
**MINIMISATION OF HCFC-141B DECOMPOSITION IN RIGID POLYISOCYANURATE FOAMS**
Bodnar T W; Dewhurst J E; Koch J J; Demmin T R; Eibeck R E; Parker C
Air Products & Chemicals Inc.; Allied-Signal Inc.

Results are presented of an investigation of the effects of a number of formulation variables on the dehydrochlorination of HCFC-141b blowing agent during the formation of rigid polyisocyanurate foams to produce chlorofluoroethylene, HCFC-1131a. The change in HCFC-1131a content in foam cells with time, studied by ageing foam samples at three temps., 70, 130 and 200F, is also considered. 5 refs.

USA

*Accession no.478699*

*Item 495*
***Journal of Cellular Plastics***
29, No.2, March/April 1993, p.144-58
**REPLACING CFC-11 WITH HCFC-22 IN POLYURETHANE FOAM**
Creazzo J A; Hammel H S
Du Pont de Nemours E.I.,& Co.Inc.

Basic data obtained for the use of HCFC-22 as a blowing agent in PU and polyisocyanurate systems are presented, including data on physical properties, compatibility with materials of construction, solubility/compatibility in polyols, effect on B-side viscosities, stability in B-side systems and in foams, and foam insulation value. Results of foam trials in which HCFC-22 was used to replace CFC-11 are discussed, covering processability of the foam systems, foam properties and performance of the HCFC-22 foams in the final products. (Polyurethanes World Congress, SPI/ISOPA, Nice, France, Sept.1991)

USA

*Accession no.477696*

*Item 496*
***Journal of Cellular Plastics***
29, No.2, March/April 1993, p.132-43
**CHLORODIFLUOROMETHANE AS THE PRIMARY BLOWING AGENT FOR RIGID URETHANE FOAMS USING CONVENTIONAL LOW AND HIGH PRESSURE FOAM MIXING EQUIPMENT**
Krueger D C; Reichel C J
BASF Corp.

The suitability of chlorodifluoromethane(R-22) as a replacement for CFC-11 as a blowing agent for rigid PU foams was investigated. It was shown that low density R-22 blown foams could be made using conventional PU foam equipment. The resulting foams had good physical properties and were easy to process. Their dimensional stability was very good at low and high temps., with foam densities above 1.5 pcf, and they exhibited improved k-factors compared with all-water blown foam formulations. Foams co-blown with HCFC-22/water had improved blowing efficiency and reduced minimum fill weights.

Foam densities down to 1.5 pcf could be moulded in place. 6 refs. (Polyurethanes World Congress, SPI/ISOPA, Nice, France, Sept.1991)

USA

*Accession no.477695*

*Item 497*

***Journal of Cellular Plastics***

29, No.2, March/April 1993, p.114-31

**BLOWING AGENT EMISSIONS FROM INSULATION FOAMS**

Shankland I R

Allied-Signal Inc.

An outline is presented of a mathematical model that can be used to estimate the concentration of blowing agent, emitted from polyisocyanurate foam insulation, which may be present in a house. The basic assumption of the model is that the blowing agent emission process is a diffusion process. Other assumptions on which the model is based are also discussed. Estimates of concentrations of CFC-11 and HCFC-14b in the house are given. The sensitivity of the calculations to the input parameters is also discussed. 9 refs. (Polyurethanes World Congress, SPI/ISOPA, Nice, France, Sept.1991)

USA

*Accession no.477694*

*Item 498*

***Urethanes Technology***

9,No.6,Dec.1992/Jan.1993,p.12

**HCFCS TO GO BY 2030**

The United Nations Environment Programme has tightened the Montreal Protocol, bringing forward all the deadlines for the elimination of substances which damage the ozone layer, including CFCs and HCFCs used in making PU foams. In addition the industrialised countries have pledged an extra 500m US dollars to the present 500m US dollars to help developing countries adapt to the regulations in the 1994-6 period. Brief details are given of the deadline dates for various materials.

EUROPEAN COMMUNITY; UK; WESTERN EUROPE

*Accession no.466117*

*Item 499*

***Cellular Polymers***

11,No.5,1992,p.357-77

**PRODUCTION OF CFC-FREE, LOW DENSITY COLD CURE MOULDED FOAMS**

Wehman C

Shell Research SA

The development of cold cure moulding formulations for a wide range of PU foam density and hardness, based on Caradol 28-3 polymer polyol for hardness enhancement, water as the only blowing agent, glycerol and Caradate 45, is described. It is shown that the desired foam appearance and processing can be obtained by using an optimised combination of amines and a tin catalyst. One of the amine catalysts could be specifically included to improve skin cure. It is demonstrated that easy demoulding and good crush resistance can be achieved by using a balanced combination of the above catalysts and a cell-opener. 14 refs.

SHELL CHEMICAL CO.

BELGIUM; EUROPEAN COMMUNITY; WESTERN EUROPE

*Accession no.464838*

*Item 500*

***Urethanes Technology***

9,No.5,Oct/Nov.1992,p.22-4

**3M MATERIALS GIVE MICROCELLULAR FOAMS; BETTER THERMAL INSULATION FOLLOWS**

Focquet K

3M Belgium NV

Development work at 3M is reported to have demonstrated that the addition of certain fluorine-based compounds to rigid foam formulations can lower the foam's thermal conductivity. These compounds produce a microcellular morphology in the foam that results in greatly improved insulation efficiency. Significant improvements in lambda values that can be achieved, as well as energy consumption data and physical properties, with unique fluorine compounds not yet fully commercialised by 3M are described. 6 refs.

BELGIUM; EUROPEAN COMMUNITY; WESTERN EUROPE

*Accession no.464635*

*Item 501*

***Journal of Cellular Plastics***

28,No.2,March/April 1992,p.115-29

**IMPROVEMENTS IN HCFC MICROCELL APPLIANCE FOAM**

Doerge H P

MILES INC.

A report is presented on the development of improved lower density microcellular HCFC-blown PU foams having demoulding characteristics and insulation properties equivalent to or better than those of commercial CFC-11-blown foams. Various factors, including polyol selection, are related to improvements in strength properties and demoulding characteristics. The use of a small amount of water, about 0.2% based on the total foam formulation, is shown to produce foams having the lowest thermal conductivities. 4 refs. (SPI/ISOPA Polyurethanes World Congress,Nice,France,Sept.1991)

USA

*Accession no.457255*

*Item 502*

***Journal of Cellular Plastics***

28,No.2,March/April 1992,p.100-14

**POLYURETHANE RIGID FOAM SYSTEMS FOR METAL-FACED SANDWICH PANELS FOR THE 1990S**

Jeffs G M F;Rosbotham I D;Mathys B;Frigo R
ICI POLYURETHANES GROUP

Rigid PU foams for metal-faced sandwich panels are discussed with emphasis on reduced CFC foams, CFC-free systems (carbon dioxide-blown, HCFC-123- and HCFC-141b-blown, HCFC-22-blown and pentane-blown) and parameters affecting peel adhesion. 2 refs. (SPI/ISOPA Polyurethanes World Congress, Nice, France, Sept.1991)

BELGIUM; EUROPEAN COMMUNITY; ITALY; WESTERN EUROPE

*Accession no.457254*

*Item 503*
***Cellular Polymers***
11,No.3,1992,p.201-23

**HCFC BLOWN RIGID POLYURETHANE FOAMS AND REFRIGERATOR LINER MATERIALS: SEARCH FOR COMPATIBLE SYSTEMS**

Potter K G;Tweedale C R
ICI,POLYURETHANES GROUP; MONSANTO EUROPE SA

The current status of developments towards the reduction and eventual elimination of CFC-11 from rigid PU foam systems used for the insulation of domestic refrigerators and freezers is discussed. The problems of liner/alternative blowing agent interactions are examined. The main parameters covered include thermal conductivity, its ageing, carbon dioxide permeability and adhesion between the PU foam and the plastics liner. The physical attack of the liners is considered and new liner materials and combinations which are compatible with HCFC blown foams are identified. 3 refs.

BELGIUM; EUROPEAN COMMUNITY; WESTERN EUROPE

*Accession no.457206*

*Item 504*
***Journal of Cellular Plastics***
28,No.1,Jan/Feb.1992,p.48-65

**REPLACEMENT OF CHLOROFLUOROCARBONS IN ALL MDI AUTOMOTIVE SEATING FOAMS**

Thoen J;Elwall R;Sewell R;Broos R;Pellacani L;Pedroni L;Bergianti G
DOW BENELUX NV; DOW ITALIA SPA

Details are given of the use of recently developed Dow methylene diisocyanate technology in meeting the necessary requirements for eliminating the use of chlorofluorocarbons as blowing agents in the PU foam industry. 11 refs.

EUROPEAN COMMUNITY; ITALY; NETHERLANDS; WESTERN EUROPE

*Accession no.453006*

*Item 505*
***Rubber World***
205,No.6,March 1992,p.17-21

**CFC-FREE POLYETHER PU SYSTEMS FOR FOOTWEAR APPLICATIONS**

Phanopoulos;Limerkens H;Stilling H;Randall D
ICI POLYURETHANES GROUP

This article discusses some of the work being carried out by ICI to remove CFCs from polyether PU footwear systems. It is shown that two new families of polyether based PU systems for shoe soling applications have been developed, which both eliminate the need for CFCs. The two families provide either an integral skin type moulding as is achieved by CFCs, or have improved innate mechanical properties to such levels that they do not require the integral skin and which overcome problems such as afterblow. 1 ref.

USA

*Accession no.448250*

*Item 506*
***Journal of Testing & Evaluation***
20,No.1,Jan.1992,p.33-42

**HYDROCHLOROFLUOROCARBON (HCFC) BLOWING AGENTS FOR FOAM INSULATION OF LAUNCH VEHICLE CRYOGENIC PROPELLANT TANKS**

Strauss E L;Bzik J W
MARTIN MARIETTA CORP.; MARTIN MARIETTA MANNED SPACE SYSTEMS

The results are reported of an initial screening study carried out on two polyurethane spray-on foam insulations using several HCFC compounds (HCFC-141b, HCFC-123 and blends thereof), as blowing agents. Tests were performed to measure bond and flatwise tension strengths at different temps., compression at ambient temp. and substrate strain compatibility at liquid helium temp. The foams were also characterised for density, closed-cell content, oxygen index and ablation under radiant heating. 12 refs.

USA

*Accession no.447032*

*Item 507*
***Urethanes Technology***
8,No.3,June/July 1991,p.11

**FOAMERS SLASH CFC USE**

Moore M

Environmental issues facing the US Polyurethane Foam Association's (PFA's) members are discussed. These include reduction of CFC use. Members reduced their use of CFC-11 by more than 90% between 1986 and 1990, but there are problems in eliminating it altogether. The PFA's and the Halogenated Solvents Industry Alliance's (HSIA's) campaign to fight workplace limits on methylene chloride in North Carolina is discussed, as is the PFA's

role in potential regulations arising from the new UC Clean Air Act, and in state and local regulations on furniture flammability.

HALOGENATED SOLVENTS INDUSTRY ALLIANCE; POLYURETHANE FOAM ASSN.; US,ENVIRONMENTAL PROTECTION AGENCY
USA

*Accession no.444958*

*Item 508*
Polyurethanes 90.Conference Proceedings.
Orlando,Fl.,30th Sept-3rd Oct.1990,p.260-65. 43C6
**NOVEL POLYISOCYANURATE FOAMS FOR ROOFING AND SHEATHING**
Knis S A;Ference D M;Kennedy E E;Bhattacharjee D;Dai S-H
DOW CHEMICAL CO.
(SPI,Polyurethane Div.)

Non-traditional chemical routes to carbon dioxide co-blowing of polyisocyanurate foam for roofing and sheathing insulation are discussed. Results of processability, physical and flammability characteristics of panels made from non-HCFC routes to CFC-11 reduction are described. Formulations having an isocyanate index of 250 using polyester polyols and containing no additive halogen or phosphorus flame retardant were employed. Two alternative methods to the isocyanate-water reaction for generating carbon dioxide are reported. 2 refs.

USA

*Accession no.432575*

*Item 509*
Polyurethanes 90.Conference Proceedings.
Orlando,Fl.,30th Sept-3rd Oct.1990,p.247-59. 43C6
**TECHNICAL VIABILITY OF ALTERNATIVE BLOWING AGENTS IN POLYISOCYANURATE ROOF INSULATION. PART III. IN SITU THERMAL AGEING AND PERFORMANCE IN DIFFERENT ROOF SYSTEMS**
Christian J E;Courville G E;Linkons R L;Wendt R L;Graves R S;Smith T
OAK RIDGE NATIONAL LABORATORY; US,NATIONAL ROOFING CONTRACTORS ASSOCIATION
(SPI,Polyurethane Div.)

A progress report is presented on the field thermal performance measurements on experimental polyisocyanurate laminate boardstock foams blown with blends of CFC-11, HCFC-123 and HCFC-141b. The field data are used to derive an empirical model for predicting effective diffusion coefficients for the air components into the foam cells. Comparisons were made with diffusion coefficients developed from steady state laboratory measurements. Relative ageing performance of test specimens of HCFC-141b under a black and under a white membrane are reported. 5 refs.

USA

*Accession no.432574*

*Item 510*
Polyurethanes 90.Conference Proceedings.
Orlando,Fl.,30th Sept-3rd Oct.1990,p.564-70. 43C6
**DEVELOPMENT OF REDUCED CFC REFRIGERATOR FOAM INSULATION**
Chapa G;Haworth G J
ADMIRAL CO.; DOW CHEMICAL CO.
(SPI,Polyurethane Div.)

A matrix sensitivity study of CFC-11 and water for a commercial polyol used with MDI-based foams is reported where up to 50% CFC reduction was evaluated and the results are reported, including K-factors, free rise density and energy performances in refrigerators.

USA

*Accession no.432555*

*Item 511*
Polyurethanes 90.Conference Proceedings.
Orlando,Fl.,30th Sept-3rd Oct.1990,p.580-83. 43C6
**NOVEL RIGID POLYURETHANE FOAM SYSTEMS IN SUPPORT OF CFC REDUCTION/ ELIMINATION AND ENERGY CONSERVATION STANDARDS**
Jeffs G M F;Rosbotham I D;Thomas A K
ICI POLYURETHANES GROUP
(SPI,Polyurethane Div.)

A family of rigid PU foams has been developed to reduce or eliminate CFC-11 usage as a blowing agent in refrigerator insulation. Either HCFC-123 or HCFC-141b replaces the CFC-11 and similar thermal conductivities are observed. 4 refs.

USA

*Accession no.432544*

*Item 512*
Polyurethanes 90.Conference Proceedings.
Orlando,Fl.,30th Sept-3rd Oct.1990,p.234-38. 43C6
**TECHNICAL VIABILITY OF ALTERNATIVE BLOWING AGENTS IN POLYISOCYANURATE ROOF INSULATION. PART I. PROCESSING AND PHYSICAL PROPERTIES**
Blaupied R H;Knis S A
ATLAS ROOFING CORP.; DOW CHEMICAL CO.
(SPI,Polyurethane Div.)

The use of alternatives to CFC-11 is described, particularly their thermal properties and ageing behaviour under laboratory and accelerated ageing conditions. Results are compared to and correlated with results from predictions of long term ageing of CFC blown foams. Blends of HCFC-141b and HCFC-123 were used.

USA

*Accession no.432540*

*Item 513*
Polyurethanes 90.Conference Proceedings.
Orlando,Fl.,30th Sept-3rd Oct.1990,p.197-200. 43C6
**INTEGRAL SKIN AND SHOE SOLES - ALTERNATIVE BLOWING METHODS**
Hass J D;Reichel C J;Cole E W;Krueger D C;Markovs R A
BASF AG; BASF CORP.
(SPI,Polyurethane Div.)

The replacement of chlorofluorocarbon R-11 as a blowing agent for integral skin foams by chlorofluorocarbon R-22 (HCFC-22) is described. Results of its solubility in various polyols, its vapour pressure in resin systems and the storage stability integral skin resins is reported. 2 refs.

EUROPEAN COMMUNITY; USA; WEST GERMANY; WESTERN EUROPE

*Accession no.432522*

*Item 514*
Polyurethanes 90.Conference Proceedings.
Orlando,Fl.,30th Sept-3rd Oct.1990,p.500-3. 43C6
**LOW DENSITY FLEXIBLE FOAM WITHOUT THE USE OF CFCS OR METHYLENE CHLORIDE**
Wujcik S E;Christman D L;Reichel C J
BASF CORP.
(SPI,Polyurethane Div.)

The use of HCFC R-22 as an interim auxiliary blowing agent replacement for CFC in PU foams is investigated. Foams were prepared with densities of less than 1.2 pcf. Solubility in four typical slab polyols and vapour pressures of solution were measured. Several methods to prepare solutions of R-22 in slab polyols were developed. Master batches can be prepared by sparging the R-22 gas into the liquid. Alternatively, the R-22 can be added as a gas or liquid into a recycle loop. 4 refs.

USA

*Accession no.432209*

*Item 515*
Polyurethanes 90.Conference Proceedings.
Orlando,Fl.,30th Sept-3rd Oct.1990,p.540-46. 43C6
**MEASUREMENTS OF DIFFUSION COEFFICIENTS OF ALTERNATIVE BLOWING AGENTS IN CLOSED CELL FOAM INSULATION**
Page M C;Glicksman L R
MASSACHUSETTS INSTITUTE OF TECHNOLOGY
(SPI,Polyurethane Div.)

The diffusion coefficient of air constituents and blowing agents in closed cell foam insulation was measured to study the effects of CFC-11, HCFC-123 and HCFC-141b, on ageing rates. Tests using a transient, constant volume sorption method were run. Results extrapolated to room temperature indicate that the alternative blowing agents will not significantly increase ageing. Measurements of sample foam geometry and density were used to determine mass distribution. The results were used in a model to compare solid polymer permeability. Higher solid polymer permeability with carbon dioxide and a higher amount of solid polymer in the cell walls was found in foams made with alternative blowing agents. 7 refs.

USA

*Accession no.432191*

*Item 516*
***Cellular Polymers***
9,No.4,1990,p.253-77
**PROGRESS IN THE REDUCTION AND ELIMINATION OF THE USE OF CFCS IN RIGID POLYURETHANE FOAM**
Jeffs G M F;Sparrow D J
ICI POLYURETHANES GROUP

A review is presented of progress towards the reduction or replacement of CFCs. Complete blowing with carbon dioxide has several drawbacks but requires further consideration. The development of a wider range of air-impermeable facing materials to eliminate rapid lambda value ageing is seen as a key technical requirement. HCFCs are seen increasingly as the most viable alternatives but they await completion of toxicological testing. Short term solutions are being developed for some markets. Pie charts indicate industry sector share of the foam market, led by construction uses. Properties of various systems are tabulated. 11 refs.

BELGIUM; EUROPEAN COMMUNITY; WESTERN EUROPE

*Accession no.425555*

*Item 517*
Utech 90.Conference Proceedings.
The Hague,3rd-5th April 1990,p.52-5. 43C6
**NEW TECHNOLOGIES TO OVERCOME THE CFC PROBLEMS FOR INTEGRAL SKIN FOAMS PRODUCTION**
Andreola P;Valcarenghi A
MONTEDIPE SPA
(Crain Communications Ltd.)

Research by Enimont on methods of substituting or eliminating CFC in integral skin PU foam production is described. Particular attention is paid to the use of HFA 123 and 141b (with known technology), to the use of HFA 22 (with new technology for introducing it preferentially in the polyol blend) and to the use of carbon dioxide from the water-isocyanate reaction in the production of parts with high surface/volume ratio. Alternative technologies for obtaining parts with an elastic skin and a carbon dioxide-expanded low density foam core are described, including rotational moulding and coating. 2 refs.

ENIMONT
EUROPEAN COMMUNITY; ITALY; WESTERN EUROPE

*Accession no.417635*

*Item 518*
Utech 90.Conference Proceedings.
The Hague,3rd-5th April 1990,p.43-7. 43C6
**RECENT PROGRESS IN THE REDUCTION OF CFCS IN RIGID POLYURETHANE FOAM FOR THERMAL INSULATION**
Aten W C;Cope B;Zuta R B
SHELL CHEMICALS RESEARCH CENTRE
(Crain Communications Ltd.)

The reduction of CFC usage by increasing the amount of water used in the blowing process is discussed and the development of suitable polyols for such systems is described. Applications of reduced-CFC systems in the fields of continuous laminating and district heating pipe insulation are considered. The possibility of achieving total replacement of CFCs is examined. 4 refs.

BELGIUM; EUROPEAN COMMUNITY; WESTERN EUROPE

*Accession no.417633*

*Item 519*
Utech 90.Conference Proceedings.
The Hague,3rd-5th April 1990,p.31-8. 43C6
**PROGRESS IN THE REDUCTION AND ELIMINATION OF THE USE OF CFCS IN RIGID POLYURETHANE FOAM**
Jeffs G M F;Sparrow D J
ICI POLYURETHANES INTERNATIONAL
(Crain Communications Ltd.)

Topics discussed include the benefits of rigid PU foam, control of the availability of CFC 11, ICI Polyurethanes' approach to the challenge, technology based on reduced levels of CFC 11, monitoring of insulation efficiency, and technology for the elimination of CFC 11. 11 refs.

BELGIUM; EUROPEAN COMMUNITY; WESTERN EUROPE

*Accession no.417627*

*Item 520*
Polyurethanes World Congress 1987: 50 years of Polyurethanes.Conference Proceedings.
Aachen,29th Sept-2nd Oct.1987,p.59-66. 43C6
**DU PONT PROGRAMME ON FLUOROCARBON ALTERNATIVE BLOWING AGENTS FOR POLYURETHANE FOAMS**
Dishart K T;Creazzo J A;Ascough M R
DU PONT CANADA INC.; DU PONT DE NEMOURS E.I.,& CO.INC.
(SPI,Polyurethane Div.;Fachverband Schaumkunststoffe eV)

Criteria for identifying and selecting candidate alternative compounds to CFCs for the Du Pont programme are described in detail with emphasis on blowing agent applications for PU foams. The two candidate CFC-11 substitutes, the hydrochlorofluorocarbons HCFC-123 and HCFC-141b, which have survived the criteria screening process to date are presented and their limitations and uncertainties relative to their future acceptance in the marketplace are discussed. 9 refs.

CANADA; USA

*Accession no.402209*

 

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