Constructional metal-filled polymer composites


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INTRODUCTION

In recent times, metal-filled polymer composites (MPCs) have become known as a new group of construction materials optimally combining strength, the ability to conduct electricity and heat and other properties of metals with the high level of chemical stability, the shock-absorbing effect and the convenience of use featured by polymers.

The ease of processing and the wide range of properties of MPCs together with the different production processes available for the materials and products made from them present developers with extensive potential in comparison with metals, alloys, solid polymer composites (PCs) and other materials. The functional capacity of MPCs is determined by the adhesion of the polymer to the metal, and depends on the physical and chemical properties of polymer and metal, and the availability of fillers and production process stabilisers.

Products made from metal-filled polymers are produced using virtually all the known methods of polymer processing (injection moulding, extrusion, pressing, bonding, etc.). The selection of MPC shaping method is governed by the configuration and purpose of the part, the nature of the material employed and the relevant technical and economic demands. In terms of their functional qualities, parts and units made from MPCs are the equal of cast steel stampings, castings and pressed metal shapes, and better than them in terms of shock absorption, avoidance of friction and corrosion resistance. MPCs can be used as construction materials because of their successful combination of unique properties: a high strength to weight ratio, long service life and resistance to corrosive environments, ease of use and maintenance, rigidity, and also their low heat conductance in comparison with metals.

MPCs have such a wide range of application because, with correct selection of the initial components, processes and methods of production (thermal processing and curing conditions, orientation of reinforcement), it is possible to obtain a construction material that represents a combination of a set of “non-polar” physico-mechanical properties (for example, good strength and deformation characteristic alongside good shock-absorbing characteristics), while at the same time creating a reliable, light, efficient and inexpensive structure.

For the foreseeable future, the basic engineering process will continue to be metalworking by cutting, and in the vast majority of instances finishing operations will be carried out using drills, milling cutters, shears, grinding stones and so on. This will guarantee large volumes of metal swarf, which we would propose to use as an effective metal filler for thermoreactive resins. With the right processing, swarf can be a valuable secondary raw material. In one hour, a modern metal-working machine can produce about 1 m³ of swarf. The amount of swarf that can be produced in a year (some 9 mln t) is comparable with the current annual production of rolled ferrous metals. Furthermore, swarf may be conditioned and briquetted to make it handier than ordinary scrap metal.

EXPERIMENTAL

Experimental studies have been performed on epoxy composites. The matrix components used were epoxy resin (ED-20) and the curing agent diethylenetriamine (DETA). The fillers used were discontinuous cast iron swarf, discontinuous bronze swarf and chunky steel swarf (Figure 1).
An evaluation of the physico-mechanical properties of the metal-polymer composites was made from the measured values – the dynamic elasticity modulus, the bending strength and the compression strength. The results of the experimental studies are shown in Figures 2-4.

It may be seen from the graphs presented in the figures that cast iron swarf was the most effective filler for the production of polymer composites for use in construction.

CONCLUSIONS

The introduction of progressive methods of producing metal-filled polymer composites in the construction and engineering industries will enable metalworking waste to be effectively recycled, and will help to cut costs by reducing the level of materials consumption in the manufacturing process.