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STUDY OF THE THERMOPHYSICAL PROPERTIES OF POLYMER MICRO- AND NANOCOMPOSITES OBTAINED BY DIFFERENT METHODS

The results of experimental studies of the thermophysical characteristics of polymer micro- and nanocomposite materials based on polypropylene filled with carbon nanotubes or aluminum particles are presented. The data of a comparative analysis of the influence of the methods for producing the considered composites on the concentration dependences of heat conductivity and temperature dependences of specific heat in a wide range of changes in the mass fraction of fillers are presented.

The work carried out experimental studies to establish patterns of influence of the methods for producing polymer micro- and nanocomposites used in the manufacture of heat-exchange equipment on their thermophysical characteristics. The studies were carried out for composite materials based on polypropylene filled with carbon nanotubes (CNTs) or aluminum particles, under the conditions of varying the mass fraction of fillers ω from 0.3 to 10% using two methods for the preparation of composites - method A, based on a dry mixture of components, and method B, based on their mixing in a polymer melt. A description of the producing methods of these fillers and determination of their characteristics is given in [1, p.13; 2, p. 488].

A comparative analysis of the influence of the considered methods on the heat-conducting properties of materials upon receipt of polymer composites is carried out. It was shown that using method *B*, polymer micro- and nanocomposites can be obtained with significantly higher heat conductivity λ than method *A*. It was found that for the composites under consideration, two jumps are observed in the curves of the dependence of the heat conductivity coefficient on the mass fraction

of the filler. The first of them corresponds to the formation of percolation clusters from filler particles, which are unique heat-conducting channels, the second to the formation of a percolation network, which is a highly heat-conducting medium. It is shown that the positions of the indicated jumps, the so-called percolation thresholds, vary depending on the method of producing the composite. In this case, the percolation thresholds for method *B* are shifted to the region of lower filler concentrations. The results of the studies also showed that the application of method *B* provides a more uniform distribution of the filler in the polymer matrix. This, in turn, leads to a greater efficiency in the formation of continuous percolation clusters and percolation networks from filler particles, which are responsible for increasing the heat conductivity of materials.

On the basis of experimental studies, regularities in the change in the specific heat capacity c_p of the considered composites from temperature were established using various methods for their producing in a wide range of changes in the mass fraction of fillers. It was shown that the values of c_p for composites obtained by method *B* are lower in the studied region for all values of ω. Moreover, the values of c_p corresponding to different methods for producing composites noticeably differ only in the region of melting of the polymer matrix. These differences turn out to be more significant for composites filled with CNTs and increase with rising mass fraction of filler.

References

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