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IMPACT OF VARIOUS INOCULANTS ON THE MECHANICAL PROPERTIES OF POLYMER

Recent development of technology puts forward new and most strict requirements for the physical and mechanical properties of polymer composites (PCM). As long as polymers are widely used in special purpose products, it causes the urgency of a problem. The main task is to create new polymeric nanocomposites with high physical-mechanical and tribotechnical properties. One of the promising methods of structural inoculation is the introduction of diverse fillers, (disperse, fibers, ultradisperse and nanoscale) into the polymer matrix [1].

Fibers or particles embedded in the matrix of another material are the best example of modern-day composite materials, which are mostly structural. In matrix-based structural composites, the matrix serves two paramount purposes, namely, binding to reinforcement phases at a certain location and deforming to distribute stresses among the constituent reinforcement materials under applied force. Solids that accommodate stress to incorporate other constituents provide strong bonds for the reinforcing phase and they are potential matrix materials [2].

The introduction of fillers into polymers leads to the appearance of a wide range of interactions (from weak physical to chemical) arising at the polymer-filler interface. The character of these interactions largely depends on the surface chemistry of fillers. The balance of different types of interactions occurring at interface significantly affects mechanical, physical and chemical, including thermal properties of polymers and filled system as a whole. Obviously, the surface chemistry of dispersed fillers is one of the most significant factors influencing the nature of interaction at the polymer-filler interface and, consequently, the properties of the polymer. The surface chemistry of the filler and its composition are particularly important in terms of their influence on the thermal properties of the polymer and the filled polymer system [3].

The structure of filled composites is formed by combining polymer and filler. Also it depends on the phenomena occurring in the contact between the substance that binds and filler. Formation of a polymeric composite material as a complex system is a kinetic process accompanied by transition from one state to another caused by multiple changes (transformations) of spatial and temporal structures. As a result of interphase interaction between the filler and the polymer there is formation of an inoculated polymer layer on the surface of the filler. Properties of this layer significantly differ from the properties of the polymer inside the volume and determine the properties of the polymer composite as a whole [4].

The influence of the amount of filler on the mechanical properties of polymers has been widely studied. In general, the modulus of elasticity will gradually increase with increasing filling, while elongation at tensile strength should decrease. In most situations, the tensile strength increases, but this characteristic depends on many factors, such as the efficiency of interaction between pigment and binder [5].

In general cases, solid inorganic and organic fillers are used, which are divided into three groups: powder (dispersed), fibrous and sheet. Additionally, sometimes there are volumetric fillers, which include volumetric fabrics and framing systems: natural wood or systems obtained by foaming or sintering of ceramic, metal or polymeric powders [6].

Dispersed fillers are the most common. The dispersed filler content varies in the range from few percent to 70-80%. At higher filler concentrations, its particles begin to contact with each other, which leads to a step change in the composite's properties. They should be well combined with the polymer or dispersed in it, well wetted by the solution or polymer melt, not prone to agglomeration, have a homogeneous particle size and low moisture content.

The most widely used disperse fillers are mineral, organic and metallic.

Mineral (chalk, kaolin, feldspar) fillers are used primarily to reduce shrinkage, residual tension and tendency to break, and to increase strength characteristics. They also impart rigidity and fire resistance.

One of the most common organic fillers is wood flour, which is made of soft wood (mainly pine and Canadian fir) or hardwood (ash? or maple) where the presence of wood resin is undesirable. Wood flour is combined with mineral fillers. It is characterized by low abrasion, increases elasticity module at bending and significantly increases plasticity.

Organic disperse fillers are also carbon materials, including soot, carbon black and graphite, which are frequently used. Soot and carbon black act as light stabilizers and give the material electrically conductive properties by facilitating the flow of static electrical discharge. Graphite reduces the friction coefficient and has good thermal and electrical conductivity.

Metallic powders have little effect on durability but allow to change thermal and electric conductivity, heat capacity, magnetic characteristics, electric properties in a wide range, and also protect materials from electronic and penetrating radiation, change their density, flammability and etc. Copper, aluminum, iron, bronze, tin, silver, lead, zinc are most commonly used as disperse fillers [7].

Conclusions: The study of changing components ratio of polymer matrix is a promising and urgent research task for polymer composite materials which are widely used in aircraft construction. Adding inoculant to polymer matrix will allow to obtain new materials with high mechanical properties.

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