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MODELING THE STRUCTURE OF A CONTINUOUS FIBER FILLER IN THE POLYMER BINDER

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Among the continuous production technology of composites based on thermoplastic polymers of the least energy-intensive pultrusion technology to provide granular molded materials and unidirectional prepregs, as well as - in the dual-impregnated (one-step) process - profile, winding, and other products. However, in real-time to the present experimental and commercial embodiments of this technology impregnation is carried out at a low speed, wherein the fibrous fillers are used relatively low molding density and specially selected low viscosity polymer melts. Technological bases of high performance pultrusion process of continuous impregnation of fibrous fillers highly viscous melts of thermoplastic polymers of large-scale industrial production developed enough. Meaning rheology optimization process mixtures composites increases sharply when using polymeric binders. This increase is primarily the increase in the technical and economic losses due to sub-optimal decision-making, due to high demands for reliability and durability of polymer composites [1].

The basis of almost all manufacturing processes of composite materials is the process of impregnating the material is treated with a solution. Steklorovinga impregnation with the resin and hardener with the high viscosity of the impregnating composition is one of the most difficult processes implemented by impregnation. Therefore many technologies have been invented by impregnation until vacuum infiltration, which provides a relatively high speed and the rate of complete impregnation. However, despite the high degree of proven technology impregnating reinforcing articles viscous compound in the impregnating product structure can be air bubbles [2]. Heterogeneity in the form of inclusion of air bubbles in the impregnated fabric structure gives the monolithic composite material and affects the performance [3]. But if the objective is to further improve the impregnation process, then this must first obtain information about the structure of the thread in the fabric and impregnating the distribution of pore sizes in it. Such data can be obtained by experimental methods, but it is very complex and requires expensive equipment. Therefore, a different approach has been chosen, the essence of which is in the preliminary modeling of the structure of the material [4]. This allows to study the structure at the level of fiber and develop new solutions for the improvement of the impregnation process.

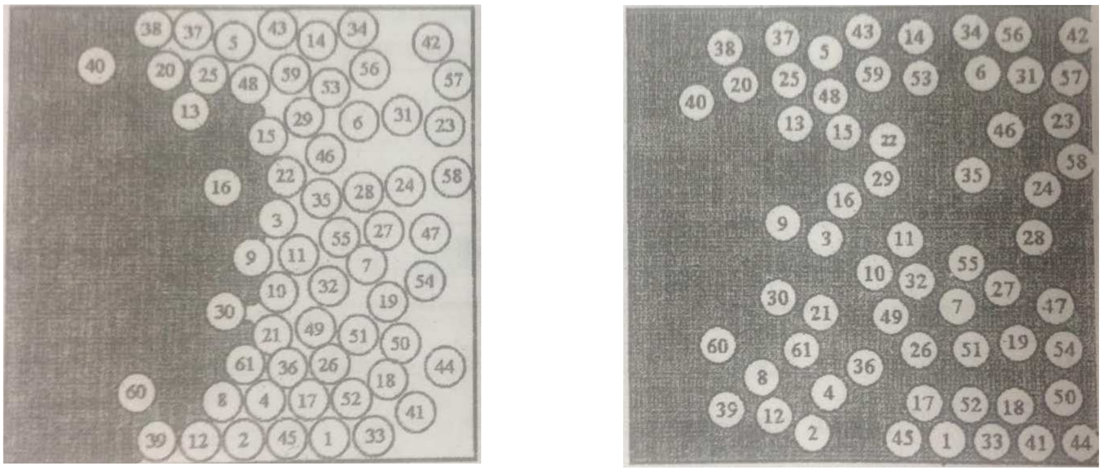
Currently, there are many options for systems modeling the structure of materials. However, they are quite complex, extensive and versatile, which makes them quite expensive. When working with such systems modeling the user has no control over the course of their work. With this in mind, and given the lack of need for a high degree of pattern versatility was advanced modeling method, in which the main pattern is a geometric aspect of structure reinforcing filaments. The model was constructed for thread-level interfiber interstices. [5] Using the principle of the densest packing of continuous fiber reinforcement in a polymer binder should determine which packages can most likely be realized in a plane. To answer this question it is necessary to determine the most probable conditions of relative position and orientation of the fibrous filler, the presence and number of contacts between them. By analogy with the plane problem with the spatial arrangement of continuous fiber reinforcement of the same size for the most dense packing without a strictly mathematical basis, taking hexagonal packing, which is characterized by the contacts 12 have a continuous fiber reinforcement. However, it is the most dense packing is rare. The most loose packing of continuous fiber reinforcement in their spatial arrangement will be such, which has a 4-pin. This packaging is relatively static stability is unlikely. Therefore, in this case the number of pins can be changed from 4 to 12.

Taking the hypothesis that the cross-sectional areas of the flat continuous fibrous filler have similar distribution characteristics interfiber space. In all the cross-sectional plane of the filler fibers in the form of displaying contours of the cross sections located at a distance from each other in a rectangular shape. The area of all rectangular area minus the total area of the cross sections of the fibers, provides a snapshot of inter-fiber spaces.

Using this data, one can go to the model of the interfiber pore spaces fiber filler to assess the distribution of interfiber pore size. An example of the construction of such a model is given in [5]. With the construction of the model inter-fiber pore space, taking into account the random deviations section outlines the fibers in the plane in a computer model of the structure of the regular fiberfill starting positions were determined geometrical parameters of the structure expressed in terms of a single strand of fiber radius and obtained the distribution function interfiber pore size flat fiberfill.

The impregnation is one of the most important processes in the technology of fiber composites with a polymer matrix. In the works devoted to the theory of fiber impregnation systems, the polymer is regarded as a Newtonian fluid, without taking into account factors such as the non-linearity of the viscous properties of the polymer compositions, the geometry of the pore space of the fiber, the fiber tension during impregnation. Comparing the values of permeability coefficients calculated on the basis of simplified models with experimental data indicates the imperfection of applied podhodov.V number of works marked by a percolation nature of the flow through the porous polymeric binder system, but special studies of this mechanism have not been conducted. In particular, no cases were considered percolation Newtonian fluids through deformable fiber systems.

To reduce the thickness of the impregnated layer and create the necessary pressure to impregnate most commonly used devices with cylindrical deflecting elements – pins and rollers. Numerous patents and experimental data indicate the need for such devices. At the same time, structural and technological parameters are calculated on the simplified models that do not have the accuracy needed for an objective assessment of the potential of different types of devices and optimization of impregnation. It is found that the original arrangement of cylindrical elements simulating fibers do not significantly affect the permeability, if these elements are not movable. This shows the influence of the model structure of the seal on the permeability coefficient. The higher the mobility of the elements, the higher density and lower permeability model. Using a computer model is established that the increase of the viscosity of the binder on the order increases the duration of the impregnation layer is almost two orders of magnitude. The increase of the degree course in law binding also reduces the permeability of the fibrous layer. The duration of the impregnation layer decreases with increasing pressure, but this increases the packing density of the fibers and reduces the effective permeability coefficients. In the stochastic arrangement of the fibers under the influence of binder formed structure is very different from the original. In particular, forming the "tongues" observed in experiments with larger patterns and strongly compacted region (Fig.). At low fiber tension pressure bonding occurs almost complete "locking" of the layer. With an increase in the fiber tension increases permeability of the fibrous layer, the fabric structure is a more homogeneous. At a tension close to the breaking load for the fibers, the rate of impregnation even somewhat higher than in the case of fixed fibers.



a *b*

The model structure is stretched layer in the initial stage (*a*) and after impregnation (*b*)

Impregnation of the continuous fiber reinforcement with the resin and hardener with the high viscosity of the impregnating composition is one of the most difficult processes implemented by impregnation. Therefore, for the continuous impregnation of a fibrous filler in the manufacture of composites use a special vacuum technology that provides a relatively high speed and completeness impregnation [1].

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