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COMPOSITE MATERIALS FILLED WITH LIQUID SUBSTANCES AND THEIR ROLE IN MACHINE ENGINEERING

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Abstract: The article presents general information about composite materials filled with liquid substances used in machine engineering.
Keywords: Machine engineering, automotive engineering, liquid substances, paints and varnishes, composite materials, corrosion, polymer materials.

Introduction: In machine engineering and automotive engineering, as well as in daily life, composite materials filled with liquid substances, i.e., paints and varnishes, hold an irreplaceable role. Paint and varnish materials not only enhance the aesthetics and uniqueness of machines, appliances, and household items, but also serve as a protective means against the negative effects of the environment, corrosion, and wear. Since the base of paint and varnish materials is composed of polymers, and polymers are components of composite materials, the study of composite materials includes the following aspects:

- General information about composite materials;
- Methods of creating composite materials and their classification;
- Polymer-based composite materials;
- Composite materials filled with liquid substances, i.e., paints and varnishes, and others.

Composite materials are complex bodies consisting of a mixture of soft and hard phases that ensure integrity and strength, and composite materials filled with liquid substances are among them.

Methods: In this study, we consider the methods of creating composite materials and focus on the following points: Modern composite materials are complex multi-phase construction materials, created by selecting the ratio of components (constituents) based on volume. In composite materials, each phase has its own boundary. The component that ensures the integrity of the composite material is called the matrix (Figure 1). Other components, such as reinforcement (2) or fillers, may be placed within this matrix according to a specific geometric pattern or not. A special thin layer between the matrix and the additives defines the separation surface (3). Composite materials are classified based on the type of matrix or reinforcement and additives, microstructure features, and the method of material production.

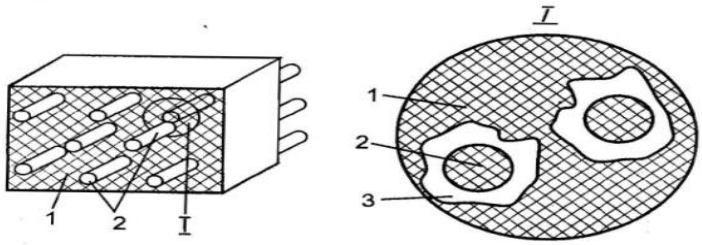

Figure 1: Structure of composite materials

Depending on the type of matrix material, composite materials can be classified as:

- Metal-based;
- Inorganic (inorganic polymers, minerals, carbon, ceramics);
- Multi-matrix composite materials.

The binder material's function is not only to give the product a specific geometric shape but also to ensure the uniform distribution of stresses and form certain mechanical properties, while also protecting the reinforcement or fillers from the external environment. The properties of the binder determine important features of the composite material, such as its resistance to heat and corrosion, ability to store electricity and heat, and reprocessability. The properties of composite materials change depending on the type of reinforcement and additives, their placement in the matrix, and their geometric dimensions. Additives, such as reinforcement elements, are primarily added to improve mechanical properties. This can increase strength, rigidity, and plasticity, while also affecting density, electrical properties, heat conductivity, and other features in specific directions or localized areas. The most important feature of composite materials is their resistance to deformation.

Due to the significant impact of additives (fillers) on the properties of composite materials, these materials are often named according to their fillers (graphite plastics, glass fiber composites, organoplastics, etc.). Composite materials also vary in terms of macrostructure. The fillers in the matrix may be arranged in a disorderly manner, but efforts are currently underway to achieve an ordered arrangement. When fillers and reinforcements of different sizes participate together, they have a higher likelihood of being arranged in an orderly fashion.

The properties of composite materials are isotropic when the characteristics are uniform in all directions. In this case, the additives are randomly arranged in powder form. If the properties of the materials differ in various directions, the composite is considered anisotropic, and in these materials, reinforcements such as fibers, plates, fabrics, or nets are placed in a certain direction. In light of the widespread use of polymer-based liquid-filled composite materials, particularly paints and varnishes, in machine-building enterprises in our country, we find it necessary to focus attention on these materials in the study.

Results: The current composite materials, with their comparative strength, corrosion resistance, and controllable magnetic and electrical properties, often exceed the characteristics of conventional steel and cast iron construction materials. Therefore, an analytical table of the main properties of nitrocellulose-based paints and enamels was created (Tables 1). Composite materials maintain their properties at temperatures of 200-400°C.

Table 1:

Analytical table of the main properties of nitrocellulose-based paints and varnishes

Material name	Viscosity according to VZ-4	Dry Residue	Drying Time at 18-23°C (min)
Nitrocellulose-basedvarnishes NC-221	100	24	120
Nitrocellulose-basedvarnishes NC-222	30	22	60
Nitrocellulose-basedvarnishes NC-223	125	33	60
Nitrocellulose-basedvarnishes NC-244	80	35	120
Nitrocellulose-basedvarnishes NC 243	100	26	60
Nitrocellulose-basedvarnishes NC 228	160	23	120
Nitrocellulose-basedvarnishes NC 224	100	25	90

Such materials have great potential for future use in automotive, shipbuilding, and aerospace industries. Composite materials are also distinguished by their ability to dampen or reduce mechanical vibrations in technology. Many manufacturing enterprises are now producing products from composite materials, which is accompanied by the technology for obtaining these materials. Paint and varnish composite materials are multi-component substances that are applied to the surface of products in liquid form and, upon drying, adhere with adhesive forces, forming a coating. The dried layer is called the protective paint and varnish coating.

Paint and varnish materials protect metals from corrosion, wood and fabrics from rotting and moisture absorption, while also serving as decorative coatings. In some cases, coatings possess special properties, such as electrical insulation, heat protection, light resistance, and others. Protective coatings significantly extend the operational lifespan of machines, metal structures, and equipment.

Conclusion: Investigating paints and varnish materials, which protect various types of vehicles in our country from the negative effects of the environment, corrosion, and wear, while ensuring their aesthetics, is essential in meeting modern demands.

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