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OPTIMIZATION OF THE COMPOSITION OF DISPERSION-FILLED POLYMER COATING

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Introductions. In the friction units of various machines and mechanisms, polymeric materials are now increasingly widely used [1-3]. The main direction of improving the quality of polymeric materials and coatings from them is modification by introducing dispersed fillers. However, their disadvantage is the relatively high cost of the filler, the use of expensive equipment for obtaining reinforced polymeric materials, and the relatively high price of the reinforced materials themselves.

Aim. Study of the influence of dispersed filler on the wear resistance under sliding friction conditions of coatings based on polymer powder paint with an epoxy base (P-EP-219) obtained by gas-flame spraying.

Materials and methods. As the main material, a relatively cheap powdery (particle size 80-150 microns) poretardantlymer P–EP–219, which is used to protect the internal surfaces of refrigeration chambers, was used; as a dispersed filler, A-glass powder obtained from production waste in an amount of 5–30% with a particle size of 50–100 microns. Previous studies have shown that the addition of crushed A–glass to P–EP–219 powder reduces the percentage of wear of the coating sprayed by the gas-flame method, compared to P–EP–219 powder without filler.

The simplicity of the spraying method and the relatively low cost of the starting powders make it necessary to investigate the effect of the filler on the tribotechnical characteristics of the coating.

To determine the optimal parameters of the coating spraying mode and the

A-glass content, the Box-Wilson mathematical planning of experiments method was used [4]. The optimization parameter was taken as the percentage of coating wear, which was determined by mass loss. The tests were carried out on a friction machine SMC-2 according to the shaft-partial liner scheme at a sliding speed of 0.5 m/sec and a load of 10 MPa, which corresponds to the standard method for assessing the tribotechnical properties of polymer-based materials. A roller made of steel 45 was used as a counterbody. A composite dispersion-strengthened coating 1 mm thick was applied to the partial liner by the gas-flame spraying method (combustible mixture-propane-butane-air). The factors that were varied were denoted by: X1-coefficient β (ratio of volumetric air consumption to volumetric propane-butane consumption); X2 - powder consumption, kg/h; X3 - glass content, %. These factors have the greatest impact on the quality and properties of sprayed coatings.

The resulting regression equation has the form:

$$Y = 0{,}0646 - 0{,}0041 \cdot X1 - 0{,}0101 \cdot X2 - 0{,}0184 \cdot X3 - 0{,}0014 \cdot X1 \cdot X2 + 0{,}0054 \cdot X1 \cdot X3 + 0{,}0039 \cdot X2 \cdot X3 + 0{,}0101 \cdot X1 \cdot X2 \cdot X3.$$

The above equation made it possible to optimize the powder composition and spraying mode.

Results and discussion. Calculations of the dependence of coating wear on gas consumption and the percentage of wear on powder consumption at different glass contents showed that the wear resistance of the coating increases with an increase in the A-glass content in the powder. However, an increase in A-glass in the powder for spraying over 10-15% leads to the fact that the coating becomes brittle and rough, and at the same time, the adhesion strength of the coating to the base decreases. To clarify the optimal composition of the coating, experimental studies of its wear resistance were conducted as indicated above. Wear was determined by mass loss. The tests were carried out without lubrication and under conditions of limited lubrication with MC-10 grease (30 drops per minute).

It has been established that under conditions of sliding friction, without lubricant, and under conditions of limited lubrication, the introduction of A-glass in the amount of 5-20% into the P-EP-219 powder leads to an increase in tribotechnical characteristics. This is explained by the fact that in the dispersion-strengthened coating, the actual contact area is much smaller and is determined by the number and area of A-glass particles that perceive the load, and the polymer, which is in the high-pressure zone, provides insignificant shear resistance. In addition, A-glass powder improves the conditions for heat removal from the friction zone and minimizes the adhesive component of the friction force. Such features can be justified by a decrease in the plastic and damping properties of the coating, which leads to a decrease in the area of actual contact of the tribopair. With a further increase in the A-glass content in the spraying mixture to 30%, the friction coefficient does not decrease, and the wear percentage increases slightly (compared to a coating with 20% A-glass). This can be explained by the fact that with an increase in the filler percentage, the plasticity of the coating decreases.

The positive effect of A-glass additives in the powder mixture for spraying on the wear resistance of the resulting coating is also observed in friction conditions with limited lubrication with MC-10 grease, but the trend of changes in the friction coefficient and the percentage of wear remains the same as in sliding friction conditions without lubricant.

Compared to cast bronze of the BRO-10 brand, volume-filled glass-polymer gas-flame coatings are characterized by a friction coefficient that is 1.6 times lower and almost an order of magnitude higher wear resistance, with less damage to the counterbody.

In order to study the mechanical properties of sprayed coatings, studies were conducted on the influence of the composition of the dispersion-strengthened polymer coating on the adhesion strength to the base. In this case, samples of VSt-3sp steel measuring 60x25x0.5 mm with coatings sprayed with powders with different A-glass contents (5 - 30%) were used. The samples were bent around a rod with a diameter of 2 mm. The dependence of the bending angle at which the samples fracture occurs on the A-glass content was revealed: with an increase in the powder for spraying the dispersed filler, the fracture angle of the coatings decreases, which indicates a decrease in the strength of the coating.

The angle of failure of coatings with an A-glass content of more than 10% becomes less than 60 degrees. The percentage of wear with an increase in the filler from 10 to 30% approaches a stable one. With an A-glass content of 10 ± 3%, the coating has sufficient adhesion strength to the base in combination with high wear resistance and friction coefficient.

Conclusions. The use of A-glass as a dispersed filler in P-EP-219 powder increases the wear resistance of gas-flame coatings and reduces their strength characteristics. The optimal content of A-glass is 10 ± 3%. The obtained results allow us to recommend the optimal composition of the dispersion-filled polymer gas-flame coating based on P-EP-219 for testing in production conditions.

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