EFFECT OF GRAPHITE CONTENT ON WEAR OF THERMOSTABLE GRAPHITE-REINFORCED PLASTICS

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ABSTRACT
This article contains the examination of graphite-filled systems based on an aromatic copolyamide (poly-m-,n-phenylene isophthalamide) – phenilon C1. Used as fillers are natural colloidal graphites ELP-B, B-1 and C-1 contained at the amount of 5 to 30 mass %. The results of investigations allowed to state that the type and content of filler has a substantial effect on tribotechnical properties of graphite-reinforced plastics. It has been found that phenilon containing 15-20 mass % of graphite C-1 possesses the best tribotechnical characteristics.

Keywords: Friction, wear, carbon plastic, polyethylene, shear-resistivity

INTRODUCTION
Intensive development of various areas of technics requires the elaboration of new construction materials based on polymers possessing good physico-mechanical properties within the wide temperature range, instead of expensive nonferrous metals and alloys. Nowadays, construction materials based on thermoreactive and thermostable polymers are used in industry. However, alongside with the presence of valuable properties they have low heat resistance, which limits their broad application in industry.

The application of heat resistant aromatic polyamides as the polymer base for construction materials is of special concern. Aromatic polyamides of phenilon mark [1] are advantageous over most existing thermoplastics in heat resistance (548 K) and in stability characteristics. However, high values of the coefficient of friction without lubrication limit their application because of strong heating that leads to the seizure of a specimen and a counterbody.

SUBJECTS AND METHODS OF INVESTIGATION
During the creation of self-lubricating composites a copolyamide (poly-m-,n-phenylene isophthalamide) – phenilon C1 was used as the binder (bending (tensile) strength of 220-240 (120-140) MPa, impact resistance of 40-50 kJ/m³, heat resistance by Vicat of 548 K). Colloidal graphites ELP-B, B-1 and C-1 at the content varying from 5 to 30 mass % were chosen as fillers.

The specimen for the investigations were obtained by means of a compression pressing method in heated press moulds. Powder-like material was prior briquetted at room temperature. Briquetting pressure was chosen depending on the height of the briquette in order to reach the density about 400–450 kg/m³. To prevent the destruction, the press material was thoroughly dried prior to pressing at the temperature about 453–473 K during one hour in a drying box. Uniform heating of the compressed material along the whole volume was achieved by means of applying compound heating, which means that lateral heaters were used alongside with horizontal heating ovens.

The investigation of tribotechnical characteristics in the regime of dry friction was held at a disc machine [2] at sliding velocity of 2 m/sec, the pressure upon the specimen of 2 MPa. The friction of polymer specimen 10 mm in diameter and 8 mm in height was done against a disc from steel 45 heat-treated to the hardness of 45-58 HRC with the surface roughness of Ra=0,63. The track passed by the specimen made 10⁴ m. The wear was determined by a gravimetric method with the accuracy within 0,1 mg. The intensity of linear wear was calculated with the help of technique [3].

RESULTS AND DISCUSSION
According to the obtained data, the amount of the filler has essential effect on the wear of composite materials. The nature of graphite-reinforced plastics' dependence on the filler content in the composition is identical for all the investigated materials – that is a monotonous wear, starting from 5.5 at 5% and reaching 0.33·10⁻¹⁰ (C-1), 0.9·10⁻¹⁰ (B-1) and 1.5·10⁻¹⁰ m/m (ELP-B) at 18–20 mass % (see fig. 1). The further increase of the filler leads to insignificant increase of the material's wear. In its turn the coefficient of (see fig. 2) decreases at the increase of graph-
ite content; its values in the area of optimum make 0.019, 0.020 and 0.021 correspondingly for C-1, B-1 and ELP-B.

The mechanism of improving the tribotechnical properties of phenilon by introducing graphite into its composition is conditioned by the complex effect of graphite as a good self-lubricating material, and phenilon as a polymer binder possessing the improved physico-mechanical and tribotechnical characteristics [4].

In the process of friction, on the surface of a steel counterbody there forms a graphite film which levels the surface and has a function of a solid lubricant that prevents the wear of a counterbody and the intensive wear of a polymer specimen. The velocity of film formation, its uniformity and density depend directly on the amount of graphite in the polymer composition. This allows to explain the sharp increase of wear-resistance of the compositions containing up to 15-20 mass % of graphite. The further increase (over 20 mass %) of filler content leads to an essential decrease of strength and to the higher fragility of the composite material, due to which there occurs the increase of fatigue wear rate.

The wear-resistance of graphite-reinforced plastics is under significant effect of both the nature and the size of filler particles. Materials containing graphite with greater dispersed composition as the filler possess higher values. The basic size of colloid-graphite specimen grows in the line ELP-B, B-1 and C-1.

Generally, within the investigated regimes of friction the wear of graphite-reinforced plastics based on phenilon is insignificant, which testifies to these materials' high possibilities for exploitation. The obtained results bear good agreement with the theory of lubricating effect of carbon graphite materials [5, 6].

In order to obtain good lubricating properties of graphite we need the presence of water vapor or other gases [5]. It is known that during friction there occurs the destruction of graphite materials along cleavages and along borders as a result of crystals distortion. The borders may show abrasive wear whose values decrease in the presence of water vapor. In experimental investigations in vacuum graphite's coefficient of friction decreases from 0.8 to 0.18, and its wear decreases by about a thousand times [6].

The aromatic polyamide phenilon is significantly disposed to moisture sorption from air. In the process of friction the friction heating contributes to water vapor's desorption from the specimen's volume and to their ingress into the friction zone, which has beneficial effect on the friction of carbon graphite materials. Besides, during graphite-reinforced plastics' friction within the contact zone there occur mechanic-chemical processes accompanied by the formation of active radicals, emission of gas products that are chemisorbed and adsorbed by graphite crystals' active centres, thus creating good conditions for friction.

REFERENCES