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DETERMINATION OF THE WEAR VALUE OF ULTRAHIGH MOLECULAR WEIGHT POLYETHYLENE DEPENDING ON ADDITIVES

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Introduction. In recent years, there has been increased interest in new synthetic polymers that have a number of unique properties. Among these polymers, the most interesting is ultra-high molecular weight polyethylene (UHMWPE) due to the presence of a whole complex of valuable properties.

UHMWPE includes polyethylene (PE) having a molecular weight of more than $1.5 \cdot 10^6$. Products obtained from UHMWPE are characterized by a low coefficient of friction, as well as high wear resistance. In addition, they have high resistance to aggressive environments, as well as increased frost resistance.

UHMWPE is used where conventional PE grades and many other polymers cannot withstand harsh operating conditions. UHMWPE can act as a substitute for other, more expensive materials, such as steel, bronze, polyamides, fluoroplastics, and can become the only material suitable for the purpose.

The main methods for producing UHMWPE are: sintering, pressing, gel-forming, REM-extrusion, as well as spraying on the surface of products using electrostatic method and hot-flame spraying. [1]

Sintering is the heating process when UHMWPE powder compressed to a different degree changes into a monolithic or porous body.

The process of obtaining blanks (products) by sintering consists of two operations:

1) pressing the powder in a mold without heating;

2) sintering of the obtained blanks (products) in the free state when heated.

The sintering method can be used to produce blanks (products) weighing from tens of grams to several tens of kilograms.

If it is necessary to obtain a porous product with a density of 600 kg/m^3, it is advisable to maintain a specific pressure of about 8 MPa, and if it is necessary to produce a monolithic product with a density of 930 kg/m^3, then the specific pressure should be increased to 85-90 MPa. [2]

Task formulation: to determine the degree of wear of UHMWPE depending on the additive and determine the most effective modification.

Results and discussion. The following types of samples were used to determine wear depending on the UHMWPE modification:

- Sample #1: UHMWPE without additives;
- Sample #2: UHMWPE + 70% Fe/B_4C;
- Sample #3: UHMWPE + 70% W/B_4C.

All samples are made by sintering and represent a cylinder with a diameter of 10 mm. As a counterbody, a disk Ø 70 x 6 mm from hardened steel ШХ - 15 was chosen.

Tribological tests were carried out on a universal friction machine MODEL: MMW-1A of a vertical type with computer control. This model allows you to keep the load force constant with a deviation of ± 2 N. The relative error in measuring the friction force did not exceed ± 2% in the liquid lubrication mode.

Before conducting the study in order to reduce the surface roughness and, as a result, to improve the accuracy of the data obtained, the samples were subjected to grinding on emery paper with P600 grit.

All samples were tested under the same friction mode, with the following parameters: loading force: 471 N; specific load: 2 MPa; sliding speed: 0.1 m/s; distance traveled by samples: 1000 m.

Samples without modifiers were also tested at a speed of 0.5 m/s and 1 m/s, but during the tests, the friction force exceeded the maximum recorded by the friction machine. At a speed of 0.5 m/s, the friction force reached a critical value after 300 s, while at a speed of 1 m/s it occurred within the first 10 seconds. This is due to the fact that the samples were tested in the absence of a lubricant. Therefore, samples with modifiers were not tested at these speeds.

During the tests, the values of the friction force and the friction coefficient with a frequency of once every 1 s were recorded in real time with the ability to save to a file. The obtained data were accumulated in a graphical and textual form and, after approximation, were analyzed.

A weighting method was used to estimate the amount of wear. The samples were weighed on RADWAG AS 60/220/C/2/N scales, which allow measuring the weight with an accuracy to 10 micrograms. This method

consists of determining the difference between the weight of the samples before the test and after. Subsequently, the mass wear was converted to absolute wear . The density of samples without modifiers was assumed to be 0.94 g/cm^3, and with modifiers 0.95 g/cm^3.

The histogram (fig.1) shows a comparison of the absolute wear of the samples in µm. Moreover, the wear of the first and second samples differs slightly, which can be due to the error of converting mass wear to absolute. It can be said that the Fe/B_4C additive does not affect the wear of UHMWPE. The wear of the third sample is 10 times less than the wear of the first two samples. This indicates that the effectiveness of the W/B_4C additive is quite high. The high wear resistance of the third sample indicates that this composition is applicable to the manufacture of parts that work in heavily loaded nodes. For example, rollers, gears, support bushings, grease-free bearings, guides, and more. [3]

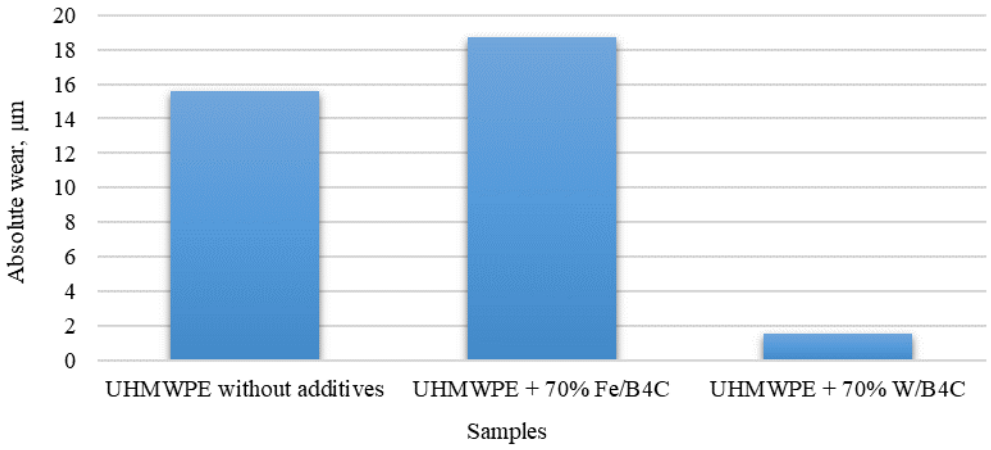

Figure 1. – Histogram of friction surface wear

Conclusion. Testing of samples with various additives showed that the lowest degree of wear is observed in the sample No. 3 containing the additive W/B_4C. The use of this additive can significantly reduce wear compared to the samples without additives, while the additive Fe/B_4C does not give a positive effect.

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