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Improvement of Tribological Properties for Lubricants By Adding Graphene Concentrate

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ABSTRACT: This work is improving the performance properties of greases additives graphene concentrate. It has been established that the addition of 1% graphene concentrate to the lubricant Solidol J contributes to an increase in its anti-wear properties by more than 30 percent. With the enrichment of commercial grease Lithol-24 with graphene concentrate, a decrease in the diameter of the spot of wear of the balls was determined at the plate size from 0.36 mm to 0.30 mm. As a result of testing lubricants in rolling bearings, a decrease in the heating temperature of bearings operating on lubricants enriched with graphene concentrate was found in comparison with commercial lubricants.

Keywords: grease, anti-wear properties, wear spot diameter, tests stand, bearing, temperature, friction surface.

1. INTRODUCTION

Anti-wear properties of greases used in friction units of machinery are the most important and determining in the general set of performance characteristics of greases [1,3]. In machinery, greases Solidol J and Lithol-24 are most commonly used, which are capable of operating in significant temperature ranges under high loads, while increasing the anti-wear properties of greases by introducing special additives and additives can significantly increase the service life of both the grease and the friction assembly [2, 4, 5]. To solve the problems of increasing the anti-wear properties of lubricants, an additive composition has been developed, consisting of surfactants, graphenes and base oil. The composition is prepared on a specially designed mechanical activator. As a result of effective exposure, graphene concentrate is obtained, which in the next stage is mixed with lubricant in a homogenizing device [6].

Figure 1 General view of the four-ball friction machine (KT-2)

The effectiveness of graphene concentrate to increase anti-wear properties was determined on the basis of the analysis of changes in the diameter of the spot of wear of balls on the KT-2 friction machine (Figure 1).

2. MATERIALS AND METHODS

The evaluation of the tribological properties of greases with graphene concentrate additives was carried out under the operating conditions of rolling bearings on a special stand (Figure 2).

The tests were carried out in the mode of comparison of the operation of bearings on commercial lubricants Solidol J, Lithol-24 and experimental lubricants with the composition of graphene concentrate 1% by volume.

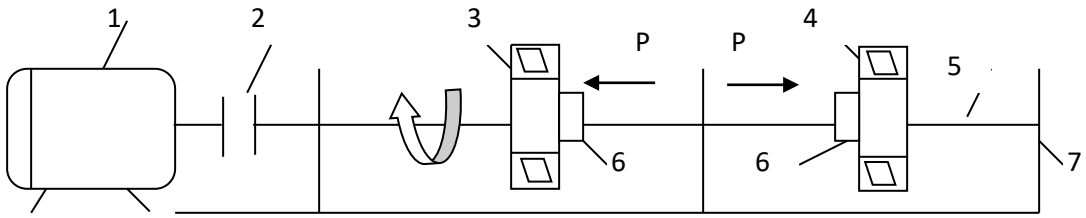


Figure 2 1. - electric motor, 2 - coupling, 3.4 - tapered rolling bearings, 5 - shaft, 6 - load adjusting nuts, 7 - housing.

As a result of bench tests, it was established that, depending on the bearing operating time on the lubricant Solidol J under a load of 150 N, the heating temperature of the sleeve increased evenly, (Figure 3).

When testing Solidol J with the addition of graphene concentrate, the heating temperature of the bearing was significantly lower and did not exceed 40ºC as compared with commercial lubricant, where the heating temperature increased to 56 ºC by 180 minutes of operating time.

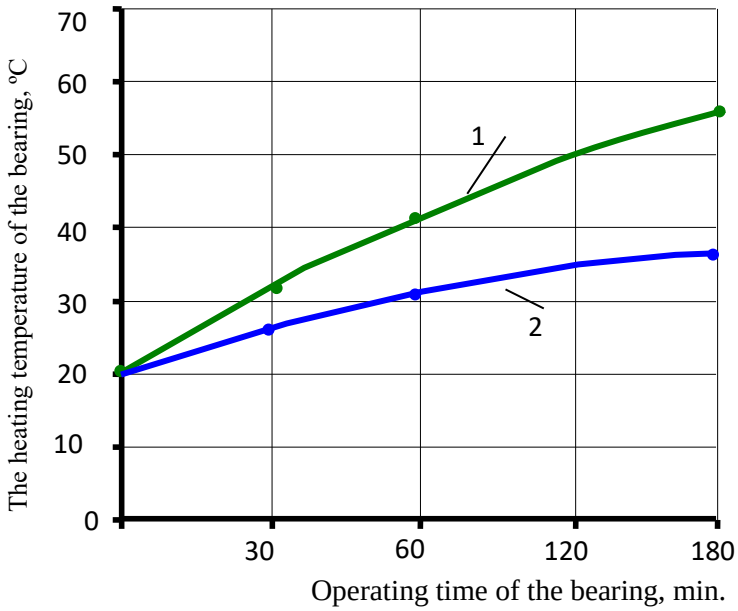


Figure 3.- The dependence of changes in the heating temperature of the bearing on the operating time, 1 - Commodity grease Solidol J; 2 - Solidol J with the addition of graphene concentrate.

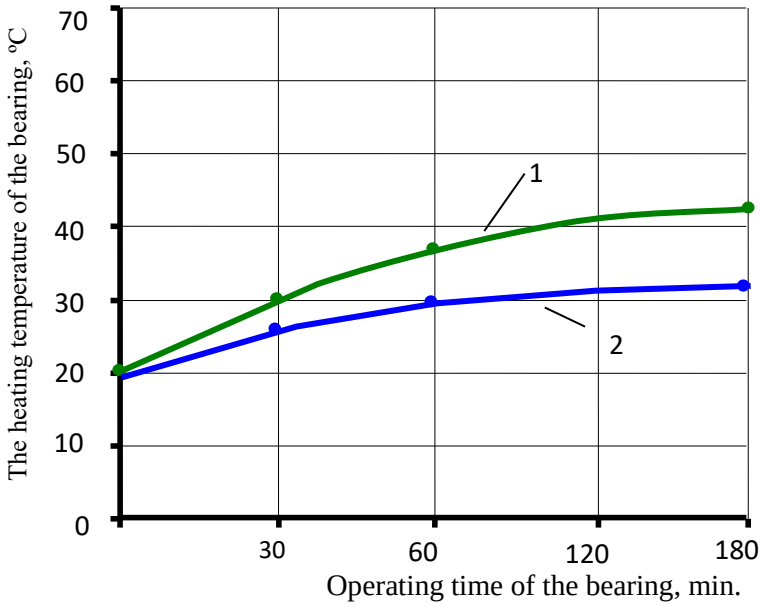
In accordance with the objectives of the research, the process of "splashing" the lubricant or reducing its mass in the bearing was analyzed before and after 180 minutes of work, Table 1.

Table 1. Results of weighing bearings

Indicators	**Time of the experiment, min**		
	0	**60**	**180**
weight of the Bearing, g			
- with commodity grease Solidol J	45,681	40,334	30,181
- with experimental grease Solidol J with the addition of graphene concentrate.	45,596	42,439	37,165

It should be noted that during the operation of the bearings, both in the first and in the second case there was a loss of lubricant mass. However, when operating a lubricant with graphene concentrate, losses were 15% less than on lubricant. Solidol J.

In the process of testing lubricants Lithol-24 with graphene concentrate obtained similar data, (Figure 4), Table 2.



1 - Commodity grease Lithol-24; 2 - Lithol -24 with the addition of graphene concentrate.

Figure 4- The dependence of the temperature of the bearing on the operating time.

Table 2. Results of weighing bearings

Indicators	**Time of the experiment, min**		
	0	**60**	**120**
Weight of the Bearing, g			
- With commodity grease Lithol-24	45,836	42,381	37,564
- With experimental grease Lithol-24 with the addition of graphene concentrate.	45,785	43,291	41, 514

Estimating the obtained dependences and values, it was established that greases with graphene concentrates had higher operational characteristics.

In the stages of research, analysis of iron content in lubricants was carried out, table 3.

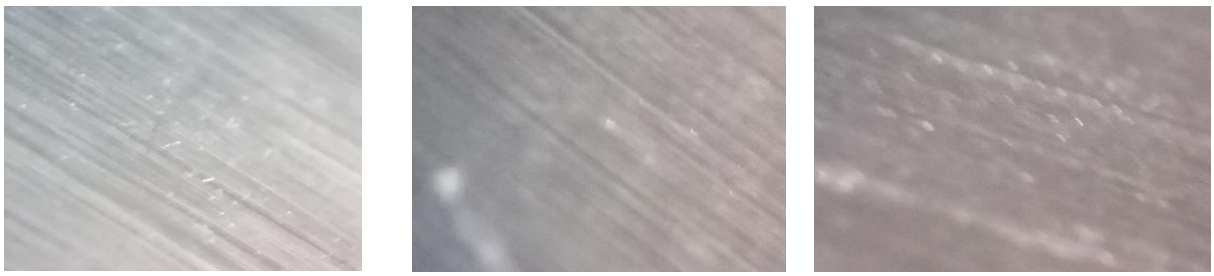
Table 3. The results of the determination of iron content in greases

Investigated lubricant	**Iron content in the lubricant. g/kg**
Solidol J	0,0018
Solidol J with 1 % of graphene concentrate	0,0009
Lithol-24	0,0011
Lithol-24 with 1 % of graphene concentrate	0,0004

Analyzing the data of table 3, it was found that the grease with graphene concentrate had better tribological characteristics in comparison with commercial Solidol J. The introduction of Lithol-24 graphene concentrate into the commercial lubricant reduces the iron content in the lubricant by 2.7 times.

Before the beginning of the experiment, the working surfaces of the bearing shells were examined under a microscope and microphotography of the surfaces was carried out. Similar actions were carried out after the completion of the tests. In (figure 5) a and b presents photomicrographs of the friction surfaces of the bearing cage.

a)



The original surface of the bearing

The friction surface after the operating time 120 min. (commercial Solidol J)

The friction surface after the operating time 120 min. (Solidol J with 1 % of graphene

b)

The original surface of the bearing

The friction surface after the operating time 120 min. (commercial Lithol-24)

The friction surface after the operating time 120 min. (Lithol-24 with 1 % of graphene concentrate)

Figure 5. – Photomicrographs of the surfaces of friction bearings To led = 80 times.

3. RESULTS AND DISCUSSION

Considering the photomicrographs of the friction surfaces, it can be concluded that the introduction of graphene concentrate on the product allows the lubricant to reduce the wear of the friction surfaces. A light grey film is formed on the surface.

In general, according to the results of research, it can be concluded that the introduction of graphene concentrate in commercial lubricants contributes to their operational properties.

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CONFLICTS OF INTEREST

The authors declare no conflict of interest

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