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Improving the performance properties of greases

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Abstract

This research was executed at 2020, by studying the improving the performance properties of greases, Greases working in friction units of machines and mechanisms are exposed to high loads. Reduced wear on rolling and plain bearings, where lubricants work, it is provided with special anti-wear additives, where lubricants work, it is provided with special anti-wear additives added to the lubricant during its manufacture. At the same time, the presence of anti-wear additives in commercial lubricants does not always meet the harsh operating conditions. To improve the anti-wear properties of commercial lubricants, the issue of their modification with nanostructured materials is considered. It has been determined that the introduction of ultra-dispersed metal powders into the lubricant, graphenes with subsequent mechanical mixing does not lead to an increase in the anti-wear properties of commercial lubricants, but to their reduction. It has been established that the introduction of a 10% solution of carbamide in ammonium hydroxide into an additive consisting of powders of molybdenum disulfide, copper, brass, industrial oil changes its structural and dispersed composition. Subsequent introduction of this suspension in an amount of 1 ... 3% of the mass. in a commercial grease increases its anti-wear properties by 25 ... 30%. Studies have shown that repeated exposure to the grease with the addition of 10% graphenes allows obtaining a concentrate with sufficiently high anti-wear properties.

Keywords: grease, additive, structuring, dependence, anti-wear properties, concentration, composition, diameter of wear scare.

1. Introduction

As is known, during the operation in the friction units of agricultural machinery, greases are exposed to high temperature and stress [1, 2].This is especially true for lubricants operating in worn out sliding bearings, where the temperature on the metal surface can exceed 90 degrees or more. Under the influence of thermal processes in the lubricant, oxidation processes and changes in its structure begin. At high temperatures of the grease, the thickness of the lubricating film on the friction surface will change [3, 4]. Changes in the physical and chemical characteristics of greases in friction units, their tribological properties lead to a decrease in the service life of the bearings. Among the most common and used in agricultural machinery is Lithol-24 grease. Grease Lithol-24 compared with the previously widely used Grease solidol zh, has higher performance due to the action of additives and fillers included in the lubricants [5, 6]. However, under harsh operating conditions, even high quality greases are not always able to prevent increased wear. In this connection, over the past 20-30 years, the search for new highly effective additives and fillers has been carried out. It is noteworthy to study the possibility of including new nanostructured materials in the composition of greases, providing reduced wear of the friction surfaces, and in some cases even their recovery. A number of works are known related to the addition of fillers such as molybdenum disulfide, powders of copper, brass, their alloys, oxides and complex compounds of other metals added to lubricants in an amount of 1 ... 3% mass. Works aimed at improving the performance properties of lubricants by enriching them with nanostructured graphene additives are of interest [9, 10]. One common disadvantage of all additives is the complex technological process of their preparation, difficult to implement in the conditions of enterprises of the agro-industrial complex adding the additives to commercial lubricants involves the use of special equipment, ensuring uniform distribution of filler particles throughout the volume of the viscous medium of the grease is sufficient. Using industrial homogenizers, dispersers can be justified only when large volumes of processing greases, which is characteristic of tractors, combines, cars more than 200 units, in fact, in the agro-industrial complex, the fleet of machines of the bulk of agricultural enterprises does not exceed 50-60 units. Analysis of a wide variety of fillers, metal powders, nanotubes, carbon graphite compounds, etc. which shows that in real conditions the preparation of lubricants with additives is very difficult to ensure not only uniform distribution of particles throughout the lubricant volume, but also the subsequent effect, reducing wear. Particles of additives with a dispersed composition of 1 micron or less are able to aggregate in the process of lubrication in the friction unit and then act as an “abrasive material”. The aim of the research was to improve the performance properties of greases and improve the technological process of adding fillers and additives.

2. Methods and material

During the research used plastic commodity grease Lithol-24. Ultrafine powders of molybdenum disulfide metals, copper alloys, brass with phosphorus, and graphene powders were considered as fillers. Fillers were introduced into the lubricant both without preliminary treatment and after exposure to them with solvents and grinders. Stirring was carried out with mechanical stirrers under laboratory conditions. Determination of the tribological characteristics of greases was carried out on a four-ball friction machine KT-2 at temperatures of 20 ... 80 ° C. The uniformity of distribution of filler particles and the process of aggregation in the lubricant was examined under microscope called (Bioline 70). The elemental composition of lubricants in the course of the research was determined on an MGA-915 M absorption spectrometer under the conditions of the TSTU Nano center .

3. Results and Discussions

At the first stage, the efficiency of introducing and increasing the anti-wear properties of grease under the action of additives of ultra-dispersed metal powders and graphene components in laboratory conditions was considered. The addition of additives to the lubricant and their mechanical mixing leads to an increase in the diameter of the wear scar and deterioration of the anti-wear properties of the lubricant.

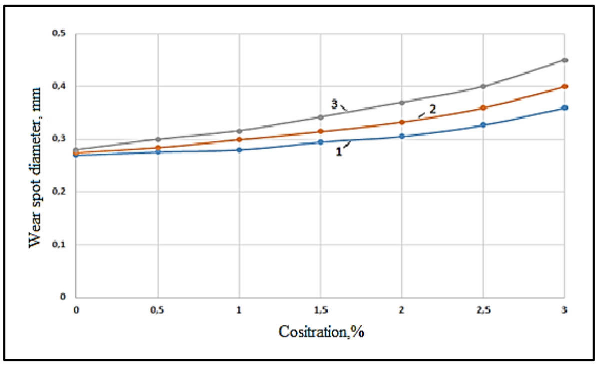

Figure 1. Dependence of changes in the anti-wear properties of Lithol-24 grease on the concentration of additives based on ultrafine powders of metals and graphenes: 1 - 1%; 2 - 2%; 3 - 3%.

This fact can be explained by the uneven distribution of powder metal particles over the volume of the lubricant and their grouping. The micrographs show samples of Lithol-24 grease after the addition of ultrafine powder of molybdenum disulfide and copper alloy, brass with phosphorus (PN), mixed with industrial oil.

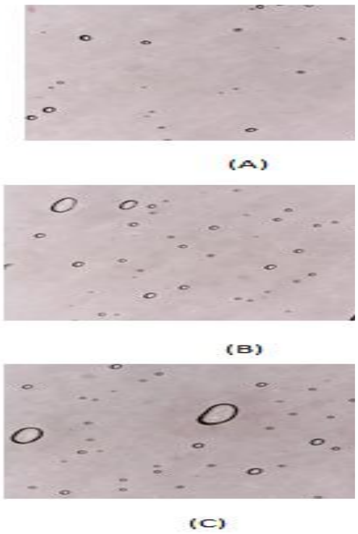

Figure 2. Micrographs of samples of Lithol-24 grease mixed with ultra-dispersed filler (UL): a) concentration of CN-1%; b) concentration of UN - 2%; c) concentration of CN - 3%.

In order to change the structural state of the additive based on metal powders, ammonium hydroxide was introduced into it in a percentage ratio of 3, 6, 10% of the mass. It was found that when introduced into an oil medium (I-20A) with a powder filler 10% ammonium hydroxide, there is a stratification of the liquid (separation of the liquid occurs). A metallic (copper) precipitate forms in the lower part, then a layer of liquid colored blue-green and a layer of yellow oil. The viscosity of the medium changes to a gel-like mobile state.

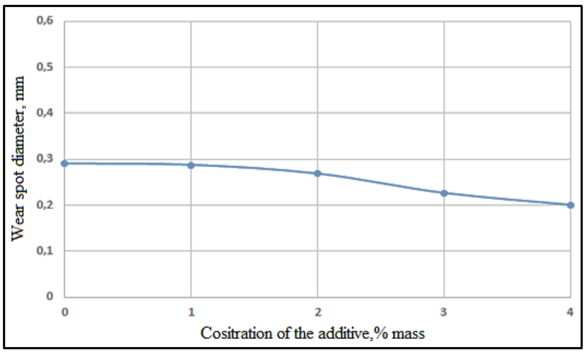

Figure 3. Dependence of the change in the anti-wear properties of the lubricant on the concentration of the structured additive.

As a result of the studies, it was found that the addition of structured ultra-dispersed metal powders to the commercial Lithol-24 after mixing with ammonium hydroxide makes it possible to increase the anti-wear properties of the grease by 25 ... 30%. As is known, the introduction of graphenes into the lubricant, with their subsequent mechanical mixing, leads to a decrease in the anti-wear properties of the commercial lubricant Lithol-24. Based on previously known approaches and works [9, 10, and 11], aimed at reducing the "negative effects" from the action of graphenes in lubricating oils, studies have been carried out on the effect of mechanical mills on the mixture. In particular, 10 g of medium-layer graphenes were added to Lithol-24 grease with a mass of 100 g. The mixture was mixed and sent to a mechanical grater mill, where, for 60 minutes, rubbing was performed. After finishing the processing, the homogeneity of the mixture and the presence of visible graphene particles were examined under a microscope. The 3-roll milled mixture (MA) was found to have a uniform structure. However, in the case of simple mechanical mixing with additives in the lubricant, graphene particles of the dispersed ranged (1-3) microns were observed. A comparative analysis of the anti-wear properties of the lubricant compositions on the friction machine showed, that mechanically activated (MA) grease after adding graphene concentrate to it (line 2) has higher performance characteristics compared to grease, enriched with medium-layer graphenes without prior exposure to them (line 1).

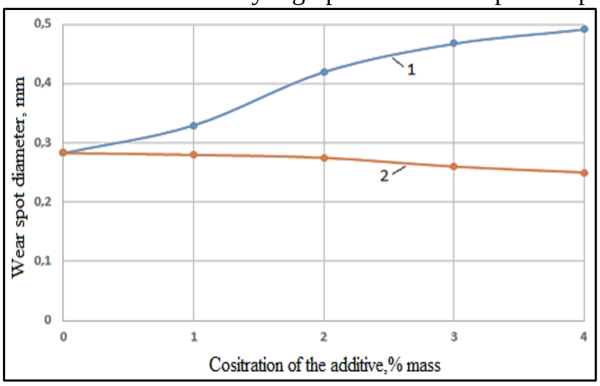

Figure 4. Dependence of the change in the anti-wear properties of Lithol-24 grease on the concentration of the graphene additive: 1 - grease with the addition of graphene and subsequent mechanical mixing; 2 - grease with the addition of graphene concentrate (preliminary grinding of graphenes with grease, followed by adding the concentrate to the grease)

It has been established that the pretreatment of graphenes makes it possible to reduce the diameter of the wear spot of the grease from 0.28 mm to 0.25 mm at a concentration of 3-4 wt%. In the absence of pre-treatment and the introduction of graphenes into the lubricant, followed by mechanical stirring, the diameter of the wear scar on the balls increases to values of 0.45-0.50 mm, taking into account that the concentrate consists of a 10 percent composition of the grease with the sameamount of graphenes and is added to the commercial grease in an amount of 1-4% of the mass. However, the assessment of the anti-wear properties of a lubricant on a friction machine has its drawbacks and does not always accurately simulate the operating conditions. The efficiency of the modified lubricants was additionally evaluated in bench conditions in tapered rolling bearings. As a result of the study, the change in the relief of the working surface of the bearing housing was estimated, its heating temperature during operation for 2 hours at a speed of 60 rpm and a load of 50 N. Before and during the tests, the iron content in the lubricant was determined every 20 minutes.

Analyzing the results obtained, it was found that the lubricant composition Lithol-24 with the addition of 3% of the mass, dissolved ultrafine metal powders with ammonium hydroxide, allows to reduce the heating temperature of the bearing by 8 ° C compared to the temperature on the surface of the bearing operating on commercial grease without additives. A similar result was obtained when a graphene concentrate was added to the lubricant. When considering the working surfaces of the bearing housings, a change in the color of the working surface was found. In the first case, when using a lubricating additive based on metal powders, the surface had a shiny yellow-copper color, in the second case, in the second case, when the graphene concentrate was added, the bearing surface changed color from steel to matte gray. As a first approximation, it was found that discoloration of the bearing tracks confirms the effect of the formation of a protective film on the friction surface. Analysis of lubricant samples for iron content in all lubricant compositions.

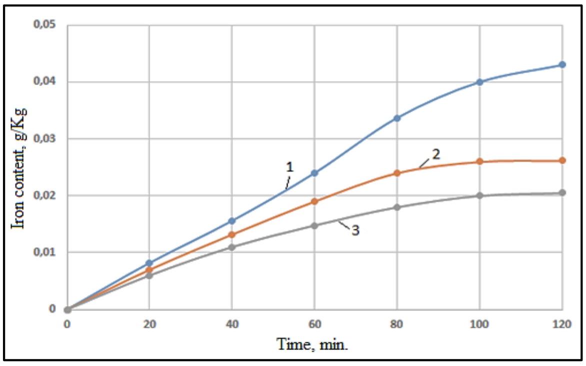

Figure 5. Change in the iron content in the grease from the time of operation in the rolling bearing: 1 - commercial grease Lithol-24; 2 - Lithol-24 grease with the addition of 3% graphene concentrate; 3 - Lithol-24 grease with the addition of a 3% solution of metal powders. As a result of the analysis of the dependence of the growth of the iron content in lubricants it was found that over a test period of 120 minutes in Lithol-24 grease, this indicator was more than 0.04 g / kg (line 1). In grease with the addition of 3% graphene concentrate, during the period of operation of the bearing under load for 100 - 120 minutes, the value of the iron content did not exceed 0.025 g / kg (line 2). And in Lithol-24 grease with the addition of a 3% solution of metal powders - 0.018-0.02 g / kg.

4. Conclusions

1. As a result of research, it was found that the introduction of additives of ultra-dispersed metal powders, «dissolved» in ammonium hydroxide, and graphene concentrate improves

the anti-wear properties of the commercial grease Lithol-24.

2. The addition of additives to the lubricant ensures the formation of a protective film on the friction surface.
3. The operational properties of a commercial lubricant can be increased, which ensures a decrease in wear of parts and, accordingly, an extension of their service life.

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