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Research Article

INVESTIGATION OF THE OPERATIONAL PROPERTIES OF TRANSMISSION OILS USED IN VEHICLES

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ABSTRACT

This article explores ways to improve the performance of transmission oils. The operating conditions of the gears are characterized by high loads in the contact zone of the teeth, relatively high speeds of mutual movement of rubbing surfaces, and significant temperatures in the contact zone. The antiwear properties of oils should protect transmission parts from wear and the undesirable phenomenon of galling and abrasion of gear drives. In complex sulfur-chlorine additives, sulfide films prevent scuffing, while chloride films, due to their elasticity, reduce wear and energy consumption to overcome frictional forces.

KEYWORDS

Gear oil, gear drives, additives, wear, friction, physical and chemical properties, viscosity.

INTRODUCTION

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Transmission oil is the lifeblood of a transmission. It plays an extremely important role in its durability and performance. The operating conditions of the gears are characterized by high loads in the contact zone of the teeth, relatively high speeds of mutual movement of the rubbing surfaces and significant temperatures in the contact zone.

Transmission oil must provide reliable lubrication not only of the gear teeth themselves, but also of the plain bearings. The quality of the lubricating oil plays an important role in preventing surface scuffing. To protect the rubbing surfaces from destruction, the binding energy of the additive molecules with the metal must provide such a shear strength of the boundary film so that it is less than the shear strength of the underlying metal layers. If this condition is not met, then plastic deformation is possible. The additives should form films of reduced shear resistance on the metal surface and thereby prevent plastic deformation of the metal.

RESEARCH METHODOLOGY

This article proposes ways to improve the performance properties of transmission oils used for agricultural machinery. The operating conditions of the gears are characterized by high loads in the contact zone of the teeth, relatively high speeds of mutual movement of rubbing surfaces and significant temperatures in the contact zone.

Energy losses in the transmission account for up to 20% of the total power consumption of the vehicle. If 25% of the so-called net engine power goes to the transmission without taking into account losses, then in the general system of transmission units due to its own losses in the units, this power transmitted to the drive wheels is already reduced to 12%.

During the operation of gears, bearings and other transmission units, an increase in oil temperature is observed due to friction and mixing. This temperature can reach 150 °C, and under extreme conditions and in units of heavy multi-axle machines and up to 200 °C.

The oil temperature in the transmission units varies widely. When the unit starts working after a long stop, it is equal to the ambient temperature. In steady-state operation, the oil temperature depends on the amount of energy consumed by friction in the unit and on the intensity of heat removal to the environment.The operating temperature increases with an increase in the speed of the gears, and at the same frequency - with an increase in the viscosity of the oil.

Transmission oils should, on the one hand, maintain high viscosity at operating temperatures so that the film does not collapse and the gaps are normally sealed, and on the other hand, do not become too viscous so that at the beginning of the mechanism, cold oil in the unit would not interfere with the free rotation of the gears.

Wear during jamming is the result of the combined action of mechanical wear with molecular forces. In this case, there is a deep tearing of the material, a local connection (setting) of two solids, the transfer of metal from one friction surface to another and the impact of the resulting irregularities on the conjugate surface.

In conditions of boundary lubrication, when lubricated parts experience enormous pressures, which increases the risk of rapid wear and so-called scuffing, it is necessary to add special additives to the oils that increase their lubricity. This is especially important for transmission and similar oils intended for the lubrication of various gear, hypoid and worm gears,

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where pressures develop up to 30000kg/cm2. Additives that contribute to the creation of a strong boundary layer are called anti-wear and extreme pressure.

To form a polishing film on a metal, chemically active substances such as phosphorus, sulfur, chlorine, etc. are required. However, there are no such components in transmission oils. They are introduced with additives that have polishing properties. As a result of the chemical interaction of these substances with the metal surface, new products are formed, characterized by a lower melting point and an increase in plasticity. For example, sulfur forms metal sulfides. The melting point of iron sulfide is 350 ° C lower than that of iron, and iron phosphide is 515 ° C lower. The flow of the alloy at the points of contact produces a chemical polishing of the surface, as a result of which the specific pressure and temperature decrease.

Sulfide and chloride films have lower melting points compared to metals, therefore, in the contact zone of parts, they easily pass into a molten state. The presence of a melt of sulfides or chlorides in the gap between the parts reduces the coefficient of friction, and the spreading of the melt between the surfaces leads to an expansion of the contact zone of the parts. Substances containing sulfur, chlorine, phosphorus in one combination or another are currently used as polishing additives - all of them are capable of producing compounds with more favorable antifriction properties with metals.

Under conditions of increased loads and temperatures, sulfur-containing compounds: disulfides, polysulfides compounds interact with the metal. On the rubbing surfaces, a film of iron sulfide is formed, which has a lower melting point than the base. As the temperature rises, this film melts and serves as an additional lubricant to prevent wear and tear.

The combination of propping and polishing is especially effective when the effect of chemical polishing agents and polar substances with long chains is simultaneously manifested. This circumstance is a consequence of the formation of an adsorbed film of polar substances on a chemically polished surface.

The adsorption layer, getting into the microcracks of a solid, quickly spreads deep into the crack and has a significant wedging effect on the walls, which contributes to the destruction of the surface layers.

The best extreme pressure properties are possessed by bromine compounds, however, they are in short supply, therefore, the compounds of the more accessible element chlorine are practically used. During the decomposition of chloride compounds, free chlorine or hydrogen chloride is liberated, which form chlorides with the metal. The advantages of chlorides include plasticity at elevated temperatures.

From substances containing both sulfur and chlorine in the molecule, we chose the additive LZ-309 (Sulfur 1.7%, chlorine 2.7%, phosphorus 1%). Testing several dozen of these compounds as oil additives has shown that they are very effective for gear oils used for agricultural machinery. We studied samples of industrial oils, and samples with additives LZ-309:

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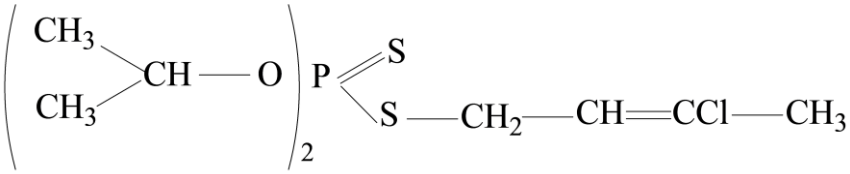

In complex sulfur-chlorine additives, sulfide films prevent scuffing, while chloride films, due to their elasticity, reduce wear and energy consumption to overcome friction.

RESULTS

As the object of the study was chosen: transmission oil TSp-14, TAp-15, and additive LZ-309 (3-6%). To carry out the experiments, oils TSp-14, TAp-15 with an additive LZ-309 (3-6%) were analyzed for physical and chemical indicators in accordance with the requirements and standards of GOST 10541.The results of testing gear oils with an additive are shown in Table 1

Table 1.

Transmission Oil Test Results with LZ-309 additive

Quality indicators	TAp-15				TSp-14			
	LZ-309 additive content,%							
	3	4	5	6	3	4	5	6
Viscosity, mm^2 / s at t=100°C	15	16	17	18	14	16	15	17
Antiwear properties,%	20	25	35	45	19	22	33	42

CONCLUSIONS

According to the results of laboratory studies, when the additive was introduced into TSp-14, TAp-15 oils, the physicochemical indicators gave positive results in comparison with base oils.

From the results of the analysis, we selected the content of additives LZ-309 5%, which shows the optimal value of viscosity and flashpoint. With a further increase in the concentration of LZ-309, the viscosity increased significantly, which can lead to increased friction losses. The higher the viscosity, the

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better the anti-wear properties and the greater the load the rubbing parts can withstand.

Further, the physicochemical properties of the TAp-15 and TSp-14 transmission oils with 5 % LZ-309 additive were determined.

In the future, these oils can be admitted to the next stage - to operational tests on special equipment.

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