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Ways to Improve the Operational Properties of Hydraulic Oils for Agricultural Machinery

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Abstract: The article discusses ways to improve the operational properties of hydraulic oils for agricultural machinery. The results of laboratory studies of hydraulic oils with an additive based on zinc dithiophosphate ZD-40 and recommendations for their use are presented. During agricultural work, tractor engines due to congestion and oxidation of carbon, the content of carbine, carbide and asphalt products increases by 1.2%. In addition, analytical relationships were obtained representing the movement of a mixture of acetone and used motor oil in viscosity states and the process of evaporation of the solvent from the oil during processing. The speed of motor oil on a cone-shaped surface is substantiated based on its effect on refining, and the dependence of the quality of refined oil on the temperature of the mixture and the availability of the evaporation process is justified.

Key words: hydraulic systems, hydraulic oils, physicochemical properties, additives, zinc dithiophosphate, studies, flash point, alkaline number, flash point.

Introduction

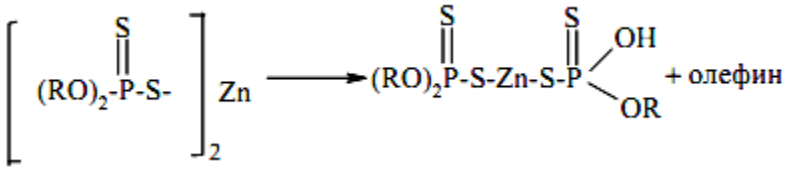
In recent years, hydraulic drives have been greatly improved. Along with the modernization of hydraulic drives, the requirements for hydraulic oils are being tightened: they must have a wide range of operating temperatures, maintain their performance for as long as possible, and comply with strict environmental standards. Improving hydraulic drives entails a change in the composition and quality of hydraulic oils. During the operation of the pump in the hydraulic system, the oil is heated and intensively mixed with air. This leads to oxidation of the oil, to an increase in the viscosity of the oil and the accumulation of oxidation products in it, to an increase in the cost of energy for driving the hydraulic system. The quality of hydraulic oils significantly affects the reliability of agricultural machinery. According to research, 70% of hydraulic system failures occur due to the condition of the oil. Of these: 40% are directly related to the performance of the oil, 60% are related to the purity of the oil.

Research analysis.

This article proposes methods for improving the operational properties of hydraulic oils used for agricultural machinery. Hydraulic oils with additives in the form of metal dialkyldithiophosphates, ashless (amine) salts or dithiophosphoric esters can provide reduced wear of hydraulic elements.

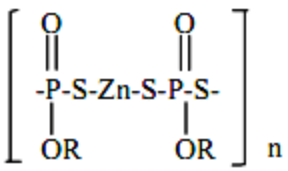
We studied samples of industrial oils I-40, I-20, and samples with the addition of zinc dithiophosphate additives ZD-40 (40- means: 15% zinc, 15% sulfur, 10% phosphorus).

The mechanism of action of zinc dithiophosphate is associated with their thermal decomposition and the formation of a polymer film on the friction surface. The decomposition of dithiophosphate can take place according to the mechanism:



The antiwear effect of such compounds occurs due to the adsorption of the metal surface with the formation of sufficiently strong compounds with the metal. In the presence of oxygen, the reactivity of sulfur compounds with respect to the metal decreases, but an increase in antiwear properties is observed.

Upon further transformations, a polymer product is formed that is formed on the surface of the metal:



At high temperatures in the zinc-sulfur-air system, the main reactions are between the solid phase and the environment. In the course of further decomposition, O-S-S alkyl trithiophosphate is formed, the interaction of which with decomposition products leads to the formation of disulfide. The effectiveness of extreme pressure is due to the formation of zinc disulfide.

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As an object of study, we selected: base oil I-20 (40%) + I-40 (60%) - with different contents (0.2 ÷ 1.2%) of the additive ZD-40, which strongly affects antiwear and extreme pressure properties of oils.
Table 1 summarizes the changes in the physicochemical parameters of the tested oil, depending on the percentage concentration of ZD-40.

Table 1.
Change in physico-chemical characteristics of the tested oil depending on the concentration of ZD-40

№	Quality indicators	ZD-40 contents					
		0.2%	0.4%	0.6%	0.8%	1.0%	1.2%
1	Viscosity, mm^2 /s at t = 40^0C	38.2	41.4	46	50	52	54
2	Flash point, °C	215	220	224	224	226	226
3	Alkaline number, mg KOH / g, not less	3.5	3.6	4.1	4.3	4.4	4.5

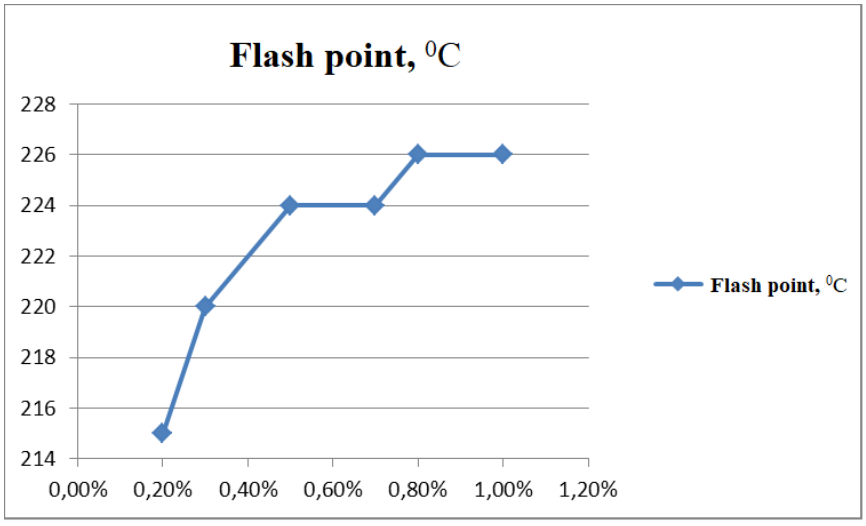
Research Results

From the results of the analysis, we selected the content of additives ZD-40 0.5%, which shows the optimal value of viscosity and flash point. With a further increase in the concentration of ZD-40, the viscosity increases significantly, which can lead to increased friction losses. With increasing viscosity, the thickness and resistance to mechanical stresses of the oil layer between the rubbing surfaces increase. Then, the physicochemical properties of oils with a 0.5% additive ZD-40 were determined.
For the experiments, hydraulic oil was subjected to analysis according to physico-chemical parameters in accordance with the requirements and standards of GOST 10541 (Table 2).

Laboratory Results

Table 2.

№	Name of indicator	Results	Oil MG-46	Norm according to GOST
		I –20 (40%) + I–40 (60%) + 0.5% ZD-40		
1	Viscosity, mm^2/s at t =40^0C	46	48	41,4-50,6
2	Density at 20^0C, g / cm^3	0,891	0,890	41.4-50.6
3	Flash point, ^{0}C	220	190	no more than 0,905
4	Pour point, ^{0}C	-33	-40	-30 to-42
5	Water content, no more	-	traces	traces
6	The content of the fur. impurities,%	0,008	0,011	no more than 0.015
7	Acid number, mg KOH per 1 g of oil, not less than	0,03	1,07	0,03



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Conclusions.

The results of laboratory studies showed that the addition of ZD-40 to the base oil gave an improved result compared to the oils used for the MG-46 agricultural machinery. Due to the harsh operating conditions, oils for hydromechanical transmissions must have appropriate viscosity and antiwear properties. From the comparison results it is clear that the operational properties of the obtained sample of hydraulic oil far exceed the domestic MG-46 and meets the standards according to GOST. This is the effectiveness of the possible use of the new sample we have received. In the future, these oils can be admitted to the next stage - to operational tests on special equipment.

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