# WAYS TO IMPROVE THE PERFORMANCE OF HYDRAULIC OILS FOR AGRICULTURAL MACHINERY

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***ABSTRACT***

Ways to improve operational properties of hydraulic oils for agricultural machinery discusses in the present article. The article proposes methods for improving operational properties of hydraulic oils used for agricultural machinery. Hydraulic oils containing 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 MG-30, and samples with the addition of zinc dialkylthiophosphate additives DC-40. The antiwear effect of such compounds occurs due to their adsorption by a metal surface and formation of sufficiently strong compounds with the metal. In the presence of oxygen, the reactivity of sulfur compounds with respect to metals decreases, but an increase in the antiwear properties of the compounds is observed mainly under moderate friction conditions.

The results of laboratory studies of MG-30 hydraulic oils with the additive based on zinc dialkylthiophosphate DC-40 and recommendations for their use are presented.

**Key words:** hydraulic system, hydraulic oil, physicochemical property, additive, zinc dialkylthiophosphate, flash point, alkaline number.

## 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.

Modern agricultural machinery is inconceivable without all kinds of hydraulic systems that serve to drive most actuators. At the same time, there is a tendency to increase the power of hydraulic systems, the speed of their work while the designers strive to reduce the weight and size of the hydraulic systems themselves. This leads to a constant increase in the level of requirements for the quality of hydraulic oils.

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 the 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 energy consumption for driving the hydraulic system. A prerequisite for continuous operation of the oil is the reliable protection of the units against dust and moisture. The presence of road dust in the oil leads to a decrease in the antiwear properties of the oil, which cannot be compensated for by the most effective additives.The quality of hydraulic oils significantly affects the reliability of agricultural machinery.

According to studies, 70% of hydraulic 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.

Today, hydraulic oils must fully comply with the requirements of manufacturers, as well as stringent environmental standards. Only those hydraulic oils that have the following set of characteristics can meet new standards: high viscosity index, high antioxidant potential, thermal and chemical stability, which increases the life of the fluid in the system, corrosion protection, increased wear resistance of hydraulic parts and compatibility with hydraulic materials. The introduction of additives into their composition contributes to the improvement of the operational and physicochemical properties of hydraulic oils.

## *MATERIALS AND METHODS*

This article proposes methods for improving the operational properties of hydraulic oils used for agricultural machinery.

The quality of work and the temperature range of operation of hydraulic systems are affected by such a property of hydraulic fluids as viscosity. Select a hydraulic oil with a specific viscosity value for a specific type of pump. Pump manufacturers indicate viscosity limits acceptable for their product: maximum, minimum, optimal[1].

Maximum viscosity is the highest value at which a pump can pump oil. It also depends on the length of the pipeline, its diameter, pump power. Increased viscosity makes it difficult to move pump parts, interferes with the operation of hydraulic systems at low temperatures.

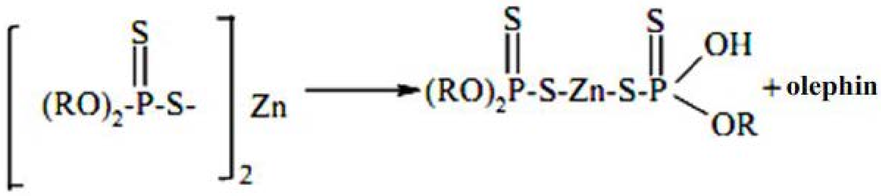
The minimum viscosity is the value at which the hydraulic system works quite reliably. If the viscosity falls below this threshold, leaks occur in the pump and valves, and this leads to a drop in power, worsening of lubrication conditions, accelerated wear of the rubbing elements of the hydraulic system.

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 MG-30, and samples with the addition of zinc dialkylthiophosphate additives DC-40 (40- means: 10% zinc, 20% sulfur, 10% phosphorus) representing the formula:$(RO)_2P(S)S–Zn–S(S)P(OR)_2$. Hydrocarbon radicals of such additives contain from three to eight ten carbon atoms. The characteristic properties of phosphorus-containing additives is their ability to reduce surface wear at moderate loads, and to ensure high smoothness of the friction surfaces. The presence of a phosphorus atom in the composition of zinc dialkylthiophosphate increases the antiwear properties of lubricants. The antioxidant properties of zinc dialkylthiophosphate are determined by the presence of thionic sulfur atoms in their molecule.

The peculiarity of zinc dialkyldithiophosphates is that these compounds, as well as the products of their thermal transformations, interact with the products of oxidation of hydrocarbons, which leads to the formation of new substances with antioxidant properties.

The mechanism of action of zinc dialkylthiophosphate is associated with their thermal decomposition and the formation of a polymer pellicle on the friction surface and interrupt the oxidation chain processes. They are able to convert active radicals into inactive compounds. The decomposition of dialkylthiophosphate can take place according to the mechanism[2]:



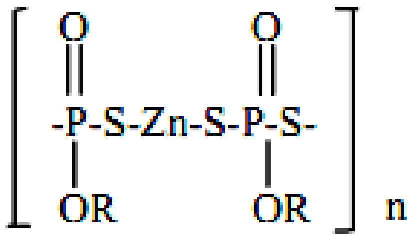
Antioxidant and chemical stability provide resistance to oxidation of the liquid under the influence of temperature. During the operation of the hydraulic system nodes, an increase in oil temperature due to friction and mixing is observed. At elevated temperatures, the oxidation of oils and the formation of insoluble compounds that precipitate. In addition, oil oxidation causes a change in other physicochemical and operational properties (increase in viscosity, acidity, deterioration of antiwear properties, etc.) The rate and depth of oil oxidation, in addition to temperature, depend on the duration of oxidation, the catalytic effect of the metal, and the concentration of oxygen in air.

At an increased working temperature of the oil, oxidation processes accelerate, and the amount of deposits increases. In this case, the heat sink from the parts deteriorates and their working conditions are tightened. An intensive decrease in the antiwear, extreme pressure and antioxidant properties of the oil occurs.

The oxidation of the oil leads to a change in its viscosity, and the products formed during this process form precipitation and varnish on the surface of the hydraulic system.

Zinc dialkyldithiophosphates initially interact with peroxide radicals, and the resulting sulfides and disulfides already decompose hydroperoxides.

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



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 the antiwear properties of the compounds is observed mainly under moderate friction conditions. In the initial stage of oxidation, zinc dialkyldithiophosphates inhibit the process due to the deactivation of the formed radicals, and in the deep stages due to the decomposition of hydroperoxides.

If even a small amount of water (0.05-0.1%) enters the hydraulic oil, it accelerates its oxidation, causes hydrolysis of unstable oil elements, and leads to the formation of sludge clogging the filter and equipment gaps. For example, when about 5% of water gets into the oil, the load of oil welding is reduced by at least 2 times. As a result, the hydraulic system is disrupted.

Studies have shown that with the introduction of zinc dialkyldithiophosphates, the oxidation reaction is delayed from the beginning of the oxidation process to the deepest stages of its development.

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.

## *RESULTS AND DISCUSSION*

As the object of study were selected: base oil MG-30 - with different contents (0.2; 0.4; 0.6; 0.8; 1.0; 1.2; 1.4%) of additives DC-40, which greatly affects the antiwear and antioxidant properties of oils.

Table 1 shows the changes in the physicochemical parameters of the tested oil depending on the percentage concentration of DC-40.

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

| No | Quality indicators | Content of DC -40 | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 0,2% | 0,4% | 0,6% | 0,8% | 1,0% | 1,2% | 1,4% |
| 1 | Viscosityat t=40°C,mm$^2$/s | 38,2 | 41,4 | 42 | 44 | 50 | 54 | 56 |
| 2 | Flash point,°C | 215 | 220 | 224 | 224 | 226 | 226 | 228 |
| 3 | Alkalinenumber, mg, not less than | 3,5 | 3,6 | 4,4 | 4,8 | 5,2 | 5,5 | 5,9 |

From the results of the analysis, we selected the content of additives DC-40 0.8%, which shows the optimal viscosity and flash point.

With a further increase in the concentration of DC-40, the viscosity increases significantly, which can lead to increased friction losses, and the necessary efforts to drive the system increase.

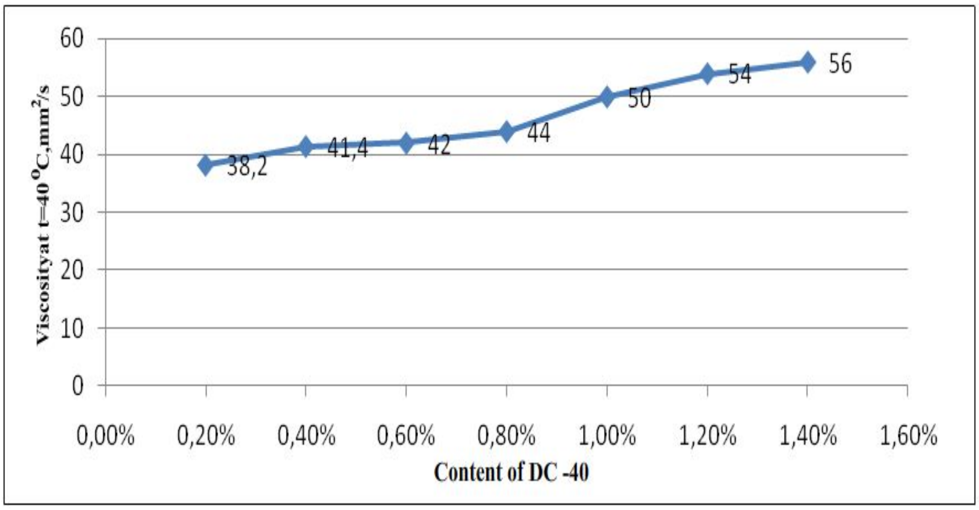



Fig.1.Viscosity change chart

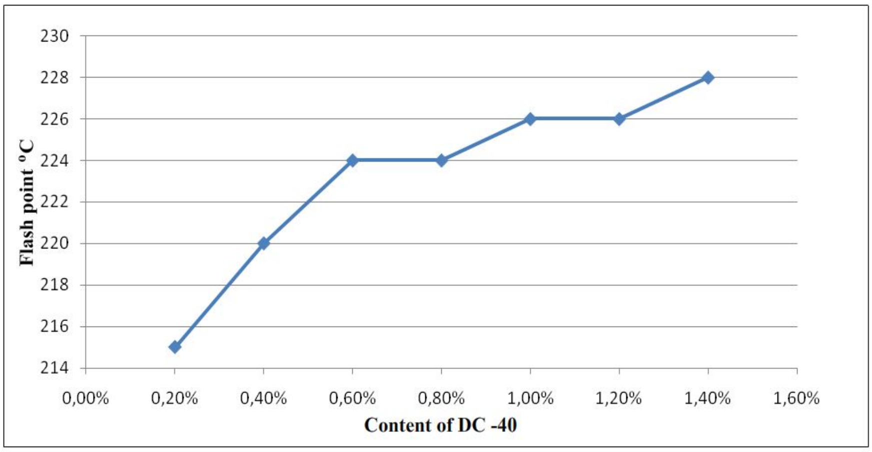



Fig. 2. Flash point temperature change chart

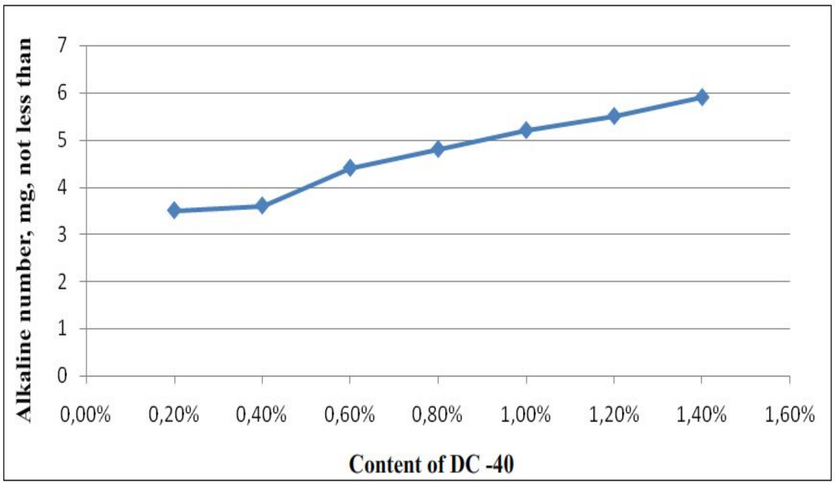



Fig. 3. Alkaline number change chart

Then, the physicochemical properties of MG-30 oils with 0.8% additive DC-40 were determined.

For the experiments, hydraulic oil was subjected to analysis according to physicochemical parameters in accordance with the requirements and standards of GOST 10541 (Table 2).

Table 2 - Laboratory Results

| No. | Name of indicator | Resultsexperience MG-30 + 0.8% DC-40 | Normaccording to GOST | Methodtrials |
|---|---|---|---|---|
| 1 | Viscosity at t=40°C, *$mm^2/s$* | 44 | 41,4-50,6 | GOST 33 |
| 2 | Density at 20°C, *$g/sm^3$* | 0,898 | no more than 0,905 | GOST 3900 |
| 3 | Flash point, °C | 228 | 224 | GOST 4333 |
| 4 | Pour point, °C | -33 | From-30 to -42 | GOST 20287 |
| 5 | Water content, not more than | - | traces | GOST 2477 |
| 6 | Content fur. impurities,% | 0,008 | no more than 0,015 | GOST 6370 |
| 7 | Alkaline number, mg KOH per 1 g of oil, not less than | 4,8 | 3,0 | GOST 11362 |

The results of laboratory studies showed some improvement in the operational properties of hydraulic oils. In the future, these oils can be admitted to the next stage - to operational tests on special equipment.

## *CONCLUSION*

The results of laboratory studies showed that the addition of DC-40 to the base oil gave an improved result compared to the oils used for the MG-30 agricultural machinery.

Due to the harsh operating conditions, oils for hydromechanical gears must have appropriate viscosity and antiwear properties.

From the comparison results it is seen that the operational properties of the obtained sample of hydraulic oil far exceed the domestic MG-30 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.

## *REFERENCES*

1 Danilov V.F., Litvinenko.A.N., AxsanovM.M., Temirbayev R.M. *Masla, smazki i speczialny`e zhidkosti* [Oils, greases and specialty fluids]. Elabuga, Izdatelstvo filiala K(P)FU, 2013. 180p.

2 Maharramov A.M., Akhmedova R.A., Akhmedova N.F. *Nefteximiya i neftepererabotka* [Petrochemicals and oil refining]. Baku, University Universities, 2009. 645p.

3 Kirichenko N.B. *Avtomobil`ny`e ekspluataczionу`e materialy`* [Automotive maintenance materials]. Moscow, Centre "Academy", 2003. 108p.