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INVESTIGATION OF PERFORMANCE CHARACTERISTICS OF MINERAL HYDRAULIC OILS CONTAINING MEDIUM ALKALINE CALCIUM-ALKYL SALICYLATE IN COMBINATION WITH ANTI-WEAR ADDITIVES

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ABSTRACT

The current stage of economic development in the developed countries of the world is characterized by high rates of development of high technology industries, among which an important place in the oil refining industry is given to high quality lubricating oils. Hydraulic oils for industrial equipment make up a significant part of the total production of industrial oils. In recent years, due to the modernization of the designs of hydraulic systems and the re-equipment of enterprises, the requirements for the quality of oils have increased significantly.

To ensure competitiveness in the domestic and foreign markets of hydraulic oils, as well as to reduce dependence on foreign additive manufacturers, it is necessary to carry out systematic work to organize the production of highly efficient additive packages[1].To achieve this goal, it is necessary to establish the relationship between the structure of the alkyl radical in the composition of commercial di-alkyl-di-thiophosphate (ZDDP) additives and the key performance properties of hydraulic oils.

Keywords: mineral hydraulic oils, anti-wear additives, investigation of the performance properties of mineral hydraulic oils, alkaline calcium alkyl salicylate hydraulic oils.

Introduction

To develop the composition of the additive package, the most common among researcher method of mixing commercial additives of various functional effects was used. The authors of [3] argue that in order to create high-level hydrolytically stable hydraulic oils, it is necessary to use free-ash di-alkyl-di-thiophosphate additives, and therefore we studied both additives containing zinc – di-alkyl-di-thiophosphates, selected based on the results of research (ZDDP IV, ZDDP V) and free-ash amine salt of di-alkyl-di-thiophosphoric acid (VNIINP-715). Samples of oils based on SN-350 (II group according to API) with the content of these additives in the amount of 0.4% mass, oil with 0.2% mass of medium alkaline calcium alkyl salicylate, as well as oils with combinations of these additives in the same content had been produced. The samples were prepared by mixing with a mechanical stirrer at a temperature of 60–70ºC. This study noted that zinc additives have a particularly strong effect on copper, as evidenced by the significant amount of dissolved copper in the oil. The authors also note the negative impact of metal sulfonates on the filterability of hydraulic oils. The conducted studies (Table 1) indeed showed a high level of oil filterability with free-ash anti-wear additive (Kf = 1.0), but at the same time a significant lag in anti-wear properties, both autonomously (di = 0.43 mm) and in a mixture with calcium alkyl

salicylate (di = 0.48 mm). In addition, the assessment of hydrolytic stability showed a significant increase in the acidity of water after testing the oil with free-ash additive VNIINP-715.

An unsatisfactory level of oil filterability with calcium alkyl salicylate can be noted. Interestingly, Detersol-140 additive showed good results in terms of hydrolytic stability (copper weight change was -0041 mg/cm^2, total acidity of water was 0 mg KOH/g), but, obviously, unsatisfactory anti-wear properties (di = 0.61 mm). The level of filterability of oils with the introduction of calcium alkyl salicylate in combination with all the studied anti-wear additives is significantly reduced. The oil with ZDDP V + Detersol-140 composition has the minimum filterability coefficient (1.61), and the maximum filterability coefficient (2.5) is set in the ZDDP IV + Detersol-140 composition.

The anti-wear properties of oils with MDP decrease, the smallest change in the level of lubricating properties noted in the combination of ZDDP V + Detersol-140, where the decrease in the wear scar diameter was 0.2 mm.

Table 1. Results of a study of the performance properties of hydraulic oils containing medium alkaline calcium alkyl salicylate in combination with anti-wear additives.

Name of additive/composition	Content in oil, % mass	Hydrolytic stability				Filterability, sec, Kf	Wear spot diameter, mm
		Corrosion of copper, ball	Change in acid number, mg KOH/g	total acidity of water, mg KOH	Change in weight of copper, mg/cm^2		
Detersol-140	0.2	2a	0.130	0	-0.04	60/130 2.17	0.61
VNIINP-715	0.4	4a	0.090	4.490	-0.26	62/62 1.00	0.43
ZDDP V	0.4	4a	-0.160	0.670	-0.98	55.3/61.9 1.12	0.31
ZDDP IV	0.4	4a	-0.140	1.320	-0.21	87/148 1.70	0.33
ZDDP V Detersol-140	0.4 0.2	4a	0.010	0.112	-0.31	59.0/95.2 1.61	0.33
ZDDP IV Detersol-140	0.4 0.2	4a	-0.107	0.561	-0.29	76/194 2.50	0.41
VNIINP-715 Detersol-140	0.4 0.2	4a	-0.036	1.960	-0.35	63/113.4 1.80	0.48

Calcium alkyl salicylate, introduced together with zinc di-alkyl-di-thiophosphate with 2-ethylhexyl radicals (ZDDP V), has an interesting effect on hydrolytic stability (Chart 1). This combination provides a reduction in the electrochemical corrosion of copper, which resulted in a change in its weight (0.31 and 0.98 mg/cm2), while the water after the test has a slight acidity. This is due to the adsorption of molecules of the surfactant additive on the metal and the formation of a double electric layer, as well as the neutralization of acids by an excess amount of calcium carbonate/hydroxide, which leads to a significant slowdown in copper corrosion and indicates the inhibitory effect of the additive.

According to the data which is given [5] the study of the sizes of additive micelles individually, as well as their combinations, makes it possible to choose the composition that will provide a synergistic increase in performance properties. For experimental confirmation of literature data, the sizes of micelles of additives ZDDP V and Detersol-140 were measured separately, as well as in a 1:1 combination (Figure 1). Based on the data obtained, it can be seen

that when the studied additives are mixed, the size distribution of micelles is narrow, monodisperse, and the deviation from additivity can be taken as an indirect indicator of a synergistic combination (Chart 2).

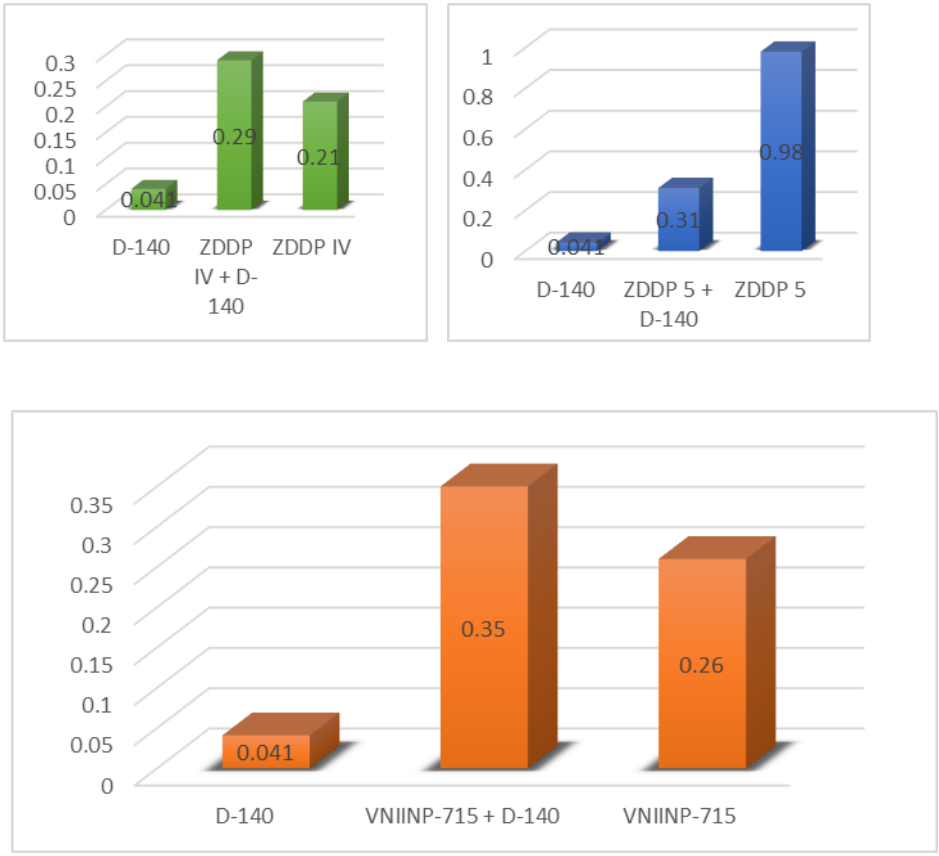

Chart 1. Influence of calcium alkyl salicylate introduced together with anti-wear additives on the hydrolytic stability of oils.

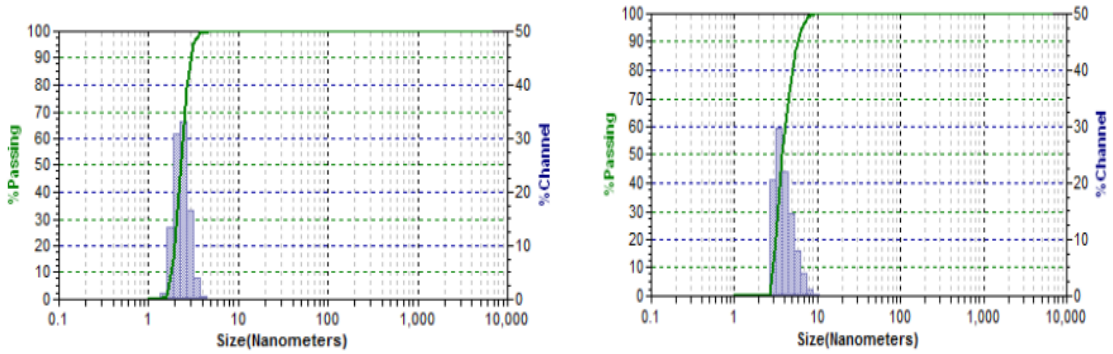

Figure 1. a) ZDDP V (2.31 nm); b) 1:1 mixture (3.79 nm); c) Detersol-140 (4.22 nm)

Distribution of micelles according to the size of additives ZDDP V and Detersol-140 separately and as well as in a 1:1 combination.

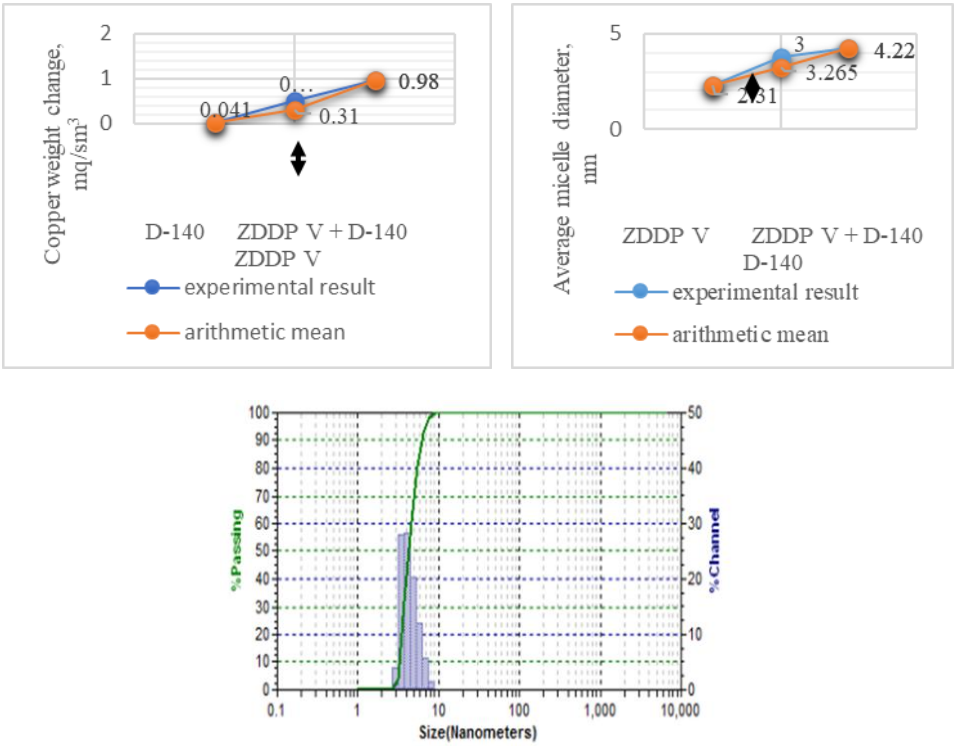

Chart 2. The effect of a combination of additives ZDDP V and Detersol-140

Results of research

1. Given the established fact, as well as positive results for other performance indicators, this combination of additives was chosen for further research to create a formulation for a package of additives for hydraulic oils of the HLP level.
2. To create an effective and storage-stable package of additives from various ash dispersants, antioxidants and other additives, a careful selection of additives compatible with each other is necessary.
3. It is necessary to provide for the introduction of antioxidants to them and to conduct studies of antioxidant properties.

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TƏRKİBİ ORTA QƏLƏVI KALSIUM-ALKIL SALISILAT OLAN MİNERAL HİDRAVLİK YAĞLARIN AŞINMAYA QARŞI ƏLAVƏLƏRİ İLƏ BİRLİKDƏ İŞTİSMAR XÜSUSİYYƏTLƏRİNİN TƏDQİQİ

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Xülasə: Təqdim olunan məqalədə HLP səviyyəli hidravlik yağlar üçün əlavələr paketinin hazırlanmasında formula yaratmaq üçün aparılmış tədqiqatların nəticələri verilmişdir. Aparılmış tədqiqatlarda müxtəlif kül dispersantlarından, antioksidantlardan və digər əlavələrdən effektiv və saxlanmağa davamlı əlavələr paketi yaratmaq üçün bir-biri ilə uyğun gələn əlavələrin diqqətlə seçilməsi metodikası hazırlanmışdır

Açar sözlər: mineral hidravlik yağlar, aşınmaya qarşı əlavələr, mineral hidravlik yağların istismar xüsusiyyətlərinin tədqiqi, qələvi kalsium alkil salisilat hidravlik yağlar.

ИССЛЕДОВАНИЕ ЭКСПЛУАТАЦИОННЫХ ХАРАКТЕРИСТИК МИНЕРАЛЬНЫХ ГИДРАВЛИЧЕСКИХ МАСЕЛ, СОДЕРЖАЩИХ СРЕДНЕЩЕЛОЧНЫЙ КАЛЬЦИЙ-АЛКИЛСАЛИЦИЛАТ В СОЧЕТАНИИ С ПРОТИВОИЗНОСНЫМИ ПРИСАДКАМИ

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Аннотация: В представленной статье представлены результаты исследований, проведенных по созданию формулы для разработки пакета присадок для гидравлических масел марки HLP. В ходе проведенных исследований была разработана методика тщательного подбора совместимых присадок для создания эффективного и стабильного при хранении пакета присадок из различных зольных диспергаторов, антиоксидантов и других добавок.

Ключевые слова: минеральные гидравлические масла, противоизносные присадки, исследование эксплуатационных свойств минеральных гидравлических масел, щелочные кальций-алкилсалицилатные гидравлические масла.