PHYSICOCHEMICAL AND OPERATIONAL PROPERTIES OF ENGINE OIL ADDITIVES

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Annotation: *In recent years, market requirements for oil color have increased, and light oils are in great demand [2, 3]. This means that the color requirements for "dark" additives (which have always been phenolates) automatically increase. Therefore, the discrepancy between the color index and the modern requirements for newly created additives is not a rare phenomenon. In this regard, it was decided to assess not only the efficiency of purification and colloidal stability, but also the color of the developed phenolyte additives of various alkalinity, in comparison with foreign analogues - the additive Oloa-219 (Chevron Oronite, USA) and the additive WFY007-1, produced by WanFY Chemical (China) [4].*

Keywords: *naphthalene, additives, sulfur, phenate, viscosity, sulfonate, engine, density, oxidation, dithiophosphate additives, synthetic sulfonate additive, alkaline, engine oils.*

Purpose of the study. To date, there is no universal method for assessing the behavior of oil at high temperatures, so it is customary to test oil by several (laboratory and bench) methods.

Objects and methods of research. To assess the properties of the studied additives, samples of group "D" - M-10DM oil were prepared, in which the studied additives replaced a commercial sulfur-containing phenate additive. In addition, samples of M-10DM oil were studied with the use of various commercial sulfonate additives to search for the most successful compositions. Taking into account that the other components of the oil were unchanged, the main attention was paid to the assessment of the effectiveness of the studied detergents, which was expressed in determining the high-temperature properties of the tested oil samples with new additives. The evaluation of the high-temperature properties of the oil is one of the most important characteristics of engine oils. When the oil works in the engine, oil oxidizes both in the volume and on the surface of heated parts, as a result, varnish and carbon deposits form on the surface of the parts.

At the first stage, the fundamental possibility of using fuels and lubricants in the technical sphere is determined, taking into account the general design features of the latter; on the second – the influence of fuels and lubricants on the reliability of equipment itself; on the third – the influence of fuels and lubricants on the running characteristics of machines and mechanisms, and on the fourth – the frequency of maintenance of equipment during its operation on the given fuels and lubricants [3].

Results of the study and discussion. Evaluation of the motor properties of the tested samples was determined in accordance with GOST 23175-78. The results are shown in Table 1.

Table 1. Assessment of the motor properties of oil samples M-10DM on the Folder apparatus according to GOST 23175-78

Sample № 30°C)	Mass fraction of poration,%	Mass fraction of the king fraction,%	Mass fraction of ish,%
1	41,3	57,2	1,5
2	49,7	49,5	0,8
3	45,1	53,1	1,8
4	42,1	56,3	1,6
Sample № 40°C)	**Mass fraction of poration,%**	**Mass fraction of the king fraction,%**	**Mass fraction of ish,%**
1	58,0	39,3	2,7
2	57,4	40,7	1,9
3	55,2	41,7	3,1
4	54,5	43,0	2,5

With an increase in the test temperature, the mass fraction of volatility and the amount of varnish on the test cups for the test samples increase. For sample M-10DM prepared with the use of sulfur-containing additive K-36, the critical temperature of lacquering (the temperature at which the amount of lacquer exceeds 3 wt%) is 240°C, for the rest of the samples under study, the critical temperature of lacquering is higher.

The results of tests of the studied samples M-10DM on the installation PZV-R are shown in Table 2. The method is an addition to GOST 5726-53 "Method for determining the detergent properties", includes changes in the design of the PZV installation in accordance with TU (technical requirements) 38 401102-75 "Motor oils. The method for assessing the detergent properties of oils on the PZV-R installation" and differs from the above methods in the specially selected test mode for oils of group D.

Table 2. Test results for PZV-R

Sample №	The name of cators	Unit of surement	Test hod	Result
M-10DM ple №1	Detergent perties	point	Group "D" hod	3,5
M-10DM ple №2				3,5

M-10DM ple №3				3,5
M-10DM ple №4				3,5

In accordance with TU 38 401102-75, the detergent properties of M-10 DM oil are evaluated by points, i.e. all tested samples pass the PZV-R test for compliance with oils of group "D". The test report on the PZV-R installation is given in Appendix 2 in 3 ± 0.5

Table 3 shows the test results of M-10DM oils on the IKM-40 K installation (in comparison with the commercial oil).

Table 3. Test results of M-10DM oils on the IKM-40K installation according to TU 38.401.405

№	The name of cators	Standard technical umentation	Sample	Sample	Sample	Sample	Comme oil
1	Viscosity ige,%	Not more	35,6	37,2	41,4	39,8	43,3
2	Weight loss of s, mg	Not more	18,4	20,3	21,2	19,3	23
3	Piston amination, t	-	3,6	3,2	3,8	3,7	3,9

The test results shown in Table 3 indicate that samples 1-4 meet the requirements of TU 38.401.405 in terms of "Viscosity change,%" and "Loss of liners weight, mg". According to the indicator "piston contamination, evaluation" the tested samples are superior to the reference sample - commercial oil M-10DM.

The tribological properties of the commercial oil M-10DM and the prototype with the involvement of the PDJ-3 additive were studied in accordance with GOST 9490-75, the results are shown in Table 4.

Table 4. Results of testing oil M-10DM according to GOST 9490-75

Defined indicators	Commercial oil	M-10DM on PDj-3
$D_{И\text{, мм}}$	0,34	0,33
Рк, Н(кгс)	150	162
Рс, Н(кгс)	168	181
Из, кгс(Н)	48	50,2

Compared to commercial oil, the prototype M-10DM has an increased critical load (162 N, for commercial oil – 150 N), welding load (181 N for the prototype, 168 N for commercial oil), the Iz and DI values are close for the commercial and a prototype of M-10DM oil, which indicates an increased bearing capacity and ultimate load capacity of M-

10DM oil with the involvement of an experimental additive PDj-3 in comparison with commercial oil M-10DM.

As a result of tests by standard laboratory, bench, and qualification methods of the studied samples of M-10DM oil using the developed additives PDj-2, PDj-3, as well as with the additive K-36 (reference sample), the following results were obtained.

When preparing the composition of M-10DM oil with additives PDJ-2, PDJ-3 and K-36, it is preferable to use synthetic highly alkaline sulfonates as a sulfonate additive, rather than an oil additive LPC, since the amount of sediment determined in accordance with GOST 11063 in the case of using synthetic sulfonates is reduced.

All tested samples meet the requirements of GOST 8581 for oils of group "D".

When testing prototypes of M-10DM oils, samples prepared using additives PDJ-2 and PDJ-3 (Samples 1, 2, 4) are not inferior, and in some cases exceed the results of a comparison sample - oil M-10DM with the involvement of sulfur-containing additive K -36 (Sample No. 3). For example, the critical temperature of lacquering, determined according to GOST 23175, for sample No. 3 is 240 ° C, for samples 1,2,4 it exceeds the temperature of 240 ° C. When testing samples on the IKM-40K installation according to TU 38.401.405, according to all determined parameters, samples 1,2,4 exceed the values of sample 3. Compared with the commercial oil M-10DM (with the additive K-36 in its composition), the prototype M-10DM with the involvement of the PDJ-3 additive showed improved tribological characteristics.

Conclusions. Laboratory and stand test methods of oils have shown the possibility of replacing a sulfur-containing phenate additive with environmentally friendly sulfur-free additives based on alkyl phenols in existing Group “D” oils. Considering that the developed additives meet the requirements of Mid- and Low SAPS oils, their application in these oils is promising.

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