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A LABORATORY STUDY OF ANTICORROSIVE EFFECT
OF LUBRICANT ADDITIVES

by

A. M. Kuliyeu, V. B. Liksha, and
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LUBRICANT ADDITIVES

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ABSTRACT: >The anticorrosive action on Pb of alkylphenolic, sulfonated, and antioxidant additives used in various concns. in Baku and Eastern U.S.S.R. oils was studied during oxidn. of the oils at 150° for 25 hrs. The corrosion decreased with an increase of alkylphenol additive (BFK and AZNII-7) concn. The sulfonated oil additive, SB-3 (Ba salt of sulfonic acids of sulfurized diesel oil), had an anticorrosive action for 15 hrs.; but, after 20-25 hrs., the corrosion was 10-12% higher than that in an oil without additive. The antioxidant additive, DF-11 (Zn dialkyl dithiophosphate) and the antiwear additive LZ-23K (ethylene diisopropylxanthate) in small amts., (0.5-1.2%) strongly decreased the corrosion. English Translation: 5 pages.

A LABORATORY STUDY OF ANTICORROSIVE EFFECT OF
LUBRICANT ADDITIVES

A. M. Kuliyeu, V. B. Liksha, and
F. G. Suleymanova

The wide development and organization of the industrial production of different types of additives to motor oils in recent years and the increase in the scientific research into synthesizing additives require the thorough and unilateral investigation of their effect on oil for a correct scientific selection of their compositions and the corresponding concentration for different oils.

One very important requirement presented to additives is the reduction of the corrosive properties of an oil oxidized at the relatively high temperatures of a working motor with respect to the alloys used in bushings.

Basic oils, which have low stability in the operating conditions of a motor under the effect of high temperatures and contact with atmospheric oxygen, oxidize different metals and their compounds with the formation of various soluble and insoluble oxidation products, including organic acids.

Depending upon the quality of the motor fuels and oils used, the thermostress of the motors and their operating conditions, the oxidation rate and the character of the oxidation products formed change. Acids that are different in character do not change the corrosive properties of motor oils to an identical degree, which in turn causes different corrosive wear of the motor parts.

One of the most effective methods of combating corrosive wear is the use of anticorrosive additives in lubricants.

We studied the effect of different additives on the anticorrosive properties of motor oils obtained from different crude oils.

To investigate the corrosive properties of basic oils and oils

with additives we developed a new method that allows continuous monitoring of the process of lead corrosion in oils and studying the dynamics of corrosion for any interval of time of the test. This creates favorable conditions for a thorough study of this phenomenon.

A series of oil samples was oxidized with accurate and uniform air feed for 25 hours at 150°C. We investigated the anticorrosive effectiveness of alkylphenolic, sulfonated and antioxidant additives in various concentrations in Baku and Eastern USSR Oils.

Reduction of the Corrosion Rate of Lead by BFK Additive in Basic Oils During a 25 hr Test at 150°C

Additive concentrations	Degree of reduction of the lead corrosion rate, %							
	Oils from Baku Crudes					Oils from Eastern Crudes		
	D-11	AS-10	AK-10	SU	AS-6	AS-11	AS-9.5	AS-6
0.7% BFK	16.5	25.4	26.2	11.8	5.1	—	—	—
2% BFK	33.3	—	—	—	—	—	—	—
3% BFK	41.6	—	—	—	—	—	—	—
5% BFK	47.9	44.6	51.2	—	—	27.5	—	27.6
6% BFK	50.0	—	—	—	33.4	—	22.0	—
8% BFK	54.1	52.1	54.8	—	—	—	30.0	—
10% BFK	—	62.7	59.5	51.4	48.4	32.5	54.0	64.6
15% BFK	64.5	68.7	—	73.7	76.9	60.0	64.0	—

The table shows the degree of reduction (in %) of the lead corrosion rate depending upon the concentration of BFK additive, which is a product of condensation of alkylphenols with formaldehyde formed by barium hydrate.

From an analysis of the introduced data it is evident that the BFK additive reduces the corrosive properties of oils from Baku and Eastern Crudes, and the corrosive properties of these lubricants decrease with an increase in the additive concentration. Furthermore, BFK has a somewhat better anticorrosive effect in Baku oils than Eastern oils.

Introducing 4 and 8% of the alkylphenol additive AzNII-7 (barium dialkylsulfide phenolate) into SU machine oil (Baku) reduces the corrosion of lead after 5 hours of testing by 79.2 and 96.1%, after 10 hours, by 56.7 and 94.6%, after 15 hours, by 47.8 and 84.8% and after 25 hours, by 44.6 and 81.6%.

From this it follows that as a result of the intensive oxidation of a mixture of oil and additive, under the effect of high temperatures and contact with atmospheric oxygen there is a gradual destruction of the protective film formed by the AxNII-7 additive on the lead surface. The effectiveness of the anticorrosive

action of the oil with the AzNII-7 additive increases with an increase in the additive concentration; this is also supported by the results of testing Avtol AS-6 (Baku) with the AzNII-7 additive (Fig. 1). When 2% of this additive was added to the oil after 5 hours of testing the corrosion of lead was reduced by a 66.7%, after 10 hours, by 41.6%, after 15 hours, by 36.6%, and after 25 hours, at 33%.

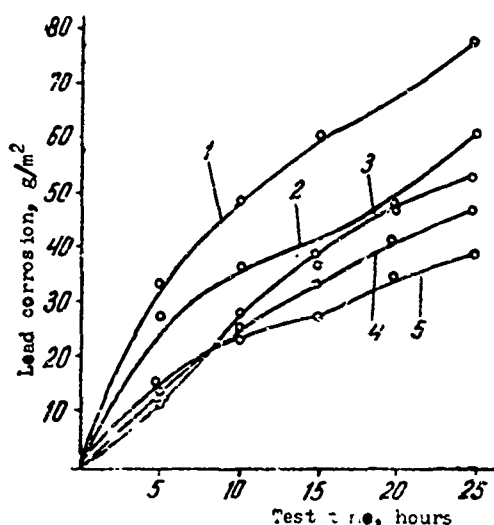


Fig. 1. Dependence of lead corrosion upon the test time at 150°C with an air feed of 30 cm³/min: 1) AS-6 oil; 2) AS-6 + 1% AzNII-7; 3) AS-6 + 2% AzNII-7; 4) AS-6 + 3% AzNII-7; 5) AS-6 + 4% AzNII-7.

SB-3 increases the acid number, due to which the corrosion resistance of oils deteriorates [1, 2], and we can also assume that the additive partially disperses the protective film formed on the lead.

However, mixing 3% of the sulfinated additive SB-3 with 1.2% of the antioxidant additive DF-11 (zinc dialkyldithiophosphate) in Avtol AS-9.5 (Eastern crude) significantly reduced the corrosion of lead (by 100% in the induction period after 5 hours, by 87% after 10 hours and by 52% after 25 hours).

A similar combined application of the alkylphenolic additives AzNII-7 with the sulfinated additive SB-3 in a 1:1 ratio (additive AzNII-8) also effectively reduces the corrosion of lead.

Figure 2 shows the dependence of lead corrosion upon test time in Avtol AS-6 (Baku) with different concentrations of the AzNII-8 additive. When 2, 4, 5 and 10% of this additive is added to the oil the corrosion of lead after 25 hours is reduced by 29.5, 51.3, 60.2 and 69.2%.

During analogous 25-hour test of D-11 and DS-11 diesel oils from Baku and Eastern Crudes with 0.7, 1.5, 4 and 9% of the foreign additive Monto 613, the anticorrosive effectiveness of this additive was 29.1 and 30%, 37.5 and 42.5%, 45.7 and 50%, 52.1 and 65%.

Investigations of the anticorrosive action of the sulfinated additive SB-3 (a barium salt of sulfo acids from sulfinated diesel oil) showed that introducing this additive into Avtols from Eastern crudes reduces the corrosion of lead in the initial test period (by 60-70% after 5 hours and by 30% after 10 hours), but after 20-25 hours the corrosion of lead in oil with this additive was 10-12% greater than without the additive.

This is explained by the fact that during a prolonged oxidation in oils the additive

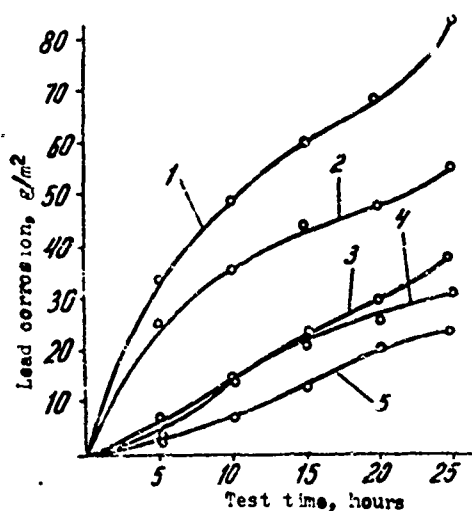


Fig. 2. Dependences of lead corrosion upon test time at 150°C with an air feed of 30 cm³/min: 1) AS-6 oil; 2) AS-6 + 2% AzNII-8; 3) AS-6 + 4% AzNII-8; 4) AS-6 + 5% AzNII-8; 5) AS-6 + 10% AzNII-8.

When 2 and 4% of this additive is added to Avtol AS-6 from Eastern crudes the corrosive properties of the oil during the same test period was reduced by 20 and 35.3%. When 8% of AzNII-8 was added to the same lubricant lead corrosion was practically absent after 5 hours (the induction period), and after a 25-hour test the anticorrosive effectiveness of this additive was 73.8%.

An investigation of the anticorrosive action of the antioxidant additive DF-11 and the antiwear additive LZ-23K (ethylene diisopropylxanthate) added to basic oils revealed their high anticorrosive properties. At a 1.2% concentration of the DF-11 additive in SU machine oil and D-11 diesel oil (Baku), and also in Avtol AS-9.5 (Eastern crude), lead corrosion was reduced by 69.7, 85.4 and 84%.

When 0.5% of the LZ-23K additive is added to Avtols AK-10 (Baku) and AS-9.5 (Eastern), lead corrosion is reduced by 48.8 and 70%.

Thus, the developed method allows us to continuously study the dynamics of the change in lead corrosion over time, and an analysis of the obtained test results allows a more accurate study of the effectiveness of the anticorrosive action of additives and the gradual destruction of protective films formed on the lead surface.

The introduction of antioxidant additives or the combined application of alkylphenolic and sulfinated additives produces an induction period during which the corrosion of lead is not observed, or it is insignificant.

All this allows us to make the correct selection of additives with higher anticorrosive properties for subsequent stand testing in motors.

Conclusions

These investigations of the anticorrosive action of additives in lubricants by the proposed method allowed us to fix the limits of the effectiveness of alkylphenolic, antioxidant and sulfinated additives.

These tests showed that alkylphenolic additives (BFK and AzNII-7) gradually reduced the corrosion of lead as their concentration is increased.

The antioxidant additive DF-11 and the antiwear additive LZ-23K (~1% concentration) have high anticorrosive properties and sharply reduce the corrosion of lead.

We have confirmed that in mixtures with certain basic oils the sulfinated additive SB-3 somewhat increases their corrosive properties during prolonged oxidation.

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