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by

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MODIFIED METHOD OF EVALUATING THE PROPERTIES OF ANTICORROSIVE LUBRICATING AND HYDRAULIC OILS

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Summary

We have described a method of evaluating the properties of anticorrosive lubricating and hydraulic oils. This method is a modification method normalized according to PN-63/C-04082, ASTM D 665-54 and IP 135/61 and enables the attainment of identical results with results of normalized methods, requiring 1/4 the usual amount of oil for the investigations.

A method for the evaluation of properties of anticorrosive lubricating and hydraulic oils was developed. This method is a modification of the standardized method of evaluating the properties of anticorrosive lubricating oils according to PN-63/C-04082 (equivalent with ASTM D 665-54 and IP-135/61 standards), enabling the establishment of designations from small volumes of oil.

The purposefulness of developing this type of method justified the necessity of analyzing small amounts of oil taken from test benches and machines during the process of long-continuing tests. In many instances, during investigation of oil behavior under operational conditions, it appears to be unavoidable: we need to use small quantities of oils for this kind of investigation, and the

behavior in the tank or in the machine system of an amount of evaluated oil must change as little as possible, with the simultaneous necessity of making laboratory tests of considerable (and sometimes great frequency) amounts of oil. The standardized method requires a 300 milliliter sample of oil for establishing a single designation of anticorrosive properties. In this case it is necessary to make at least two uniform designations. With the practical limitation of the amount of the oil sample taken from the system of up to a volume of 0.5l or at most 1 liter of oil, the possibility of completing the series of other indispensable physicochemical investigations is considerably reduced or does not exist.

1. The Investigations

The principle of establishing designations, in comparison with the standard method, underwent no change. We visually evaluated corrosion changes, originating on the surface of a steel bolt, at an elevated temperature, submerged in an aqueous-oil emulsion, produced by intensive agitation of the analyzed oil with distilled water, or with an aqueous solution of inorganic salts, imitating sea-water.

Table 1. Compilation of evaluations of the degree of corrosion according to the standard method.

Degree of corrosion	Changes on the surface of a bolt
Lack of corrosion	lack of corrosion traces in the form of spots and pits
Traces of corrosion	no more than 6 dark pits and spots with a diameter not greater than 1 mm each
Moderate corrosion	spots and dulling occupy no more than 5% of the surface
Intense corrosion	spots, dulling and oxide spots take up no more than 5% of the surface

Aiming to reduce the amount of tested oil, efforts were first made to maintain the ratio of active surface/corroding steel bolt to the volume of analyzed oil, equal to the ratio resulting from conditions of standard-method investigations: on 27 cm^2 of active surface of the metal bolt 300 ml of test oil were used, or 300:27 = 11. During further initial investigations the volume of investigated oil was reduced

to 80 ml. For that volume we chose the sizes: of the metal bolt, drainage vessel, mixer and other elements. It was established, however, that it is necessary to reduce the ratio of the oil volume to the magnitude of the corroding surface. The main reason was too small a surface of the corroding bolt. Its size made it impossible to obtain repeated results. The corrosion spots on the surface of the bolt were difficult to evaluate and it was difficult to rate the degree of corrosion in accordance with the manner adopted in the standard method, Table 1. The ratio of oil volume to the corroding surface finally typified on the basis of experiments was 5:80 ml of analyzed oil per 15.6 cm^2. This was expressed in measurements of individual elements of the unit for measuring anticorrosion properties of oils. Investigations pertaining to a possible weight evaluation of a gain in the mass of the bolts by the corrosion test gave no positive results.

Table 2. Comparing results of corrosion tests by the standard and modified method.

No.	Oils	Corrosion in an inorganic salt solution								Corrosion in distilled							
		modified method				standard method				modified method				standard method			
		time in hours				time in hours				time in hours				time in hours			
		1	6	12	24	1	6	12	24	1	6	12	24	1	6	12	24
1	Oil A	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
2	[illegible] oil I	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
3	[illegible] oil II	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
4	[illegible] oil III	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
5	[illegible] oil	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
6	[illegible] oil	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
7	[illegible] oil I	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
8	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
9	[illegible] oil III	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
10	[illegible] oil IV	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

KEY: 7 – intense; 8 – lacking; 9 – moderate; 10 – traces.

When selecting oils for corrosion tests by the modified method we were guided by the possibility of obtaining a different corrosion intensity. Classification of this intensification was made of the basis of results of corrosion investigations by the standard method. More typical oils investigated were, both with and without refining additives. Results of investigating corrosion by the standard and modified method are compiled in Table 2.

Assembly for Investigating Corrosion

The assembly consisted of the following: Glass vials with a volume of 100 ml, Fig. 1. Vial covers made from polymethacrylane,

Fig. 2. Bolts of steel construction, [illegible], Fig. 1a, with dimensions of ø 8 mm, length 57 mm [illegible] for a threaded bolt). Fig. 3b shows a plate of the holder with dimensions according to requirements of standard [illegible] with modified dimensions. A polymethacrylate bolt holder was not used; the bolts were made uniformly from steel rod. The plug which allowed the bolt to be suspended from the bottom of the vial was a small bar made of artificial material [illegible] type mixer made of stainless steel, Fig. 4, with dimensions [illegible] 40 mm, was driven electrically at a rate of 1000 ± 50 rpm's. Mercury thermometers with a measuring range of 40-200°C and an elementary graduation of 1°C were used. A 4-place glycerin bath (row-type), [illegible] thermoregulator assuring maintenance of temperature with an accuracy of ±1°C, equipped with an electric mixer (about 3000 rpm's) was used to equilibrate the temperature of the fluid in the bath. Parts of the unit according to the standard and modified method are shown in Fig. 5.

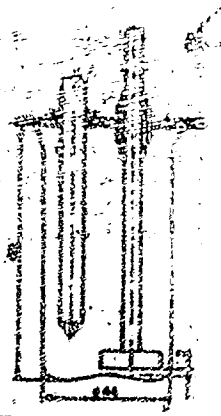

Fig. 1. Vessel for examining corrosion by the modified method.

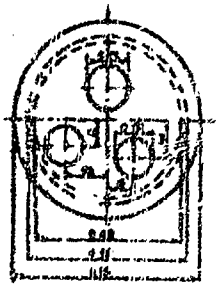

Fig. 2. Cover of vessel for examining corrosion by the modified method.

Fig. 3a. Dimensions of a bolt submitted to corrosion testing by the modified method.

Fig. 3b. Photo of bolts for studying corrosion by the standard method and modified method (smaller bolt).

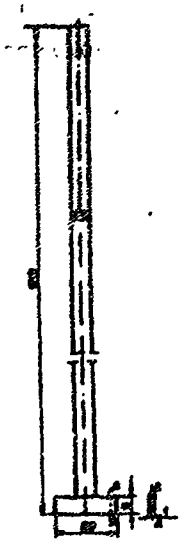

Fig. 4. Small mixer for investigating corrosion by the modified method.

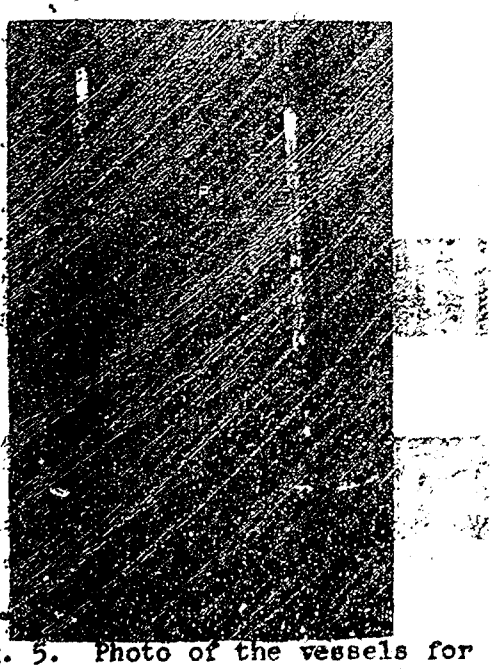

Fig. 5. Photo of the vessels for examining corrosion by the standard (larger vessel) and modified (smaller vessel) method.

Establishment of the Designation

Grinding of the steel bolt was realized manually with the aid of sandpaper of average grit [1], until the traces were removed both on the cylindrical and conical surface of the bolt. Then the bolt was smoothened with medium-grit sandpaper (No. 5), so that, when observing with the naked eye, a scratch originating from grinding could not be seen on the surface of the bolt. The bolt was wiped with a flannel cloth and filtration blotting-paper. Special efforts were made to complete final grinding of the bolt immedia[illegible]y prior to establishing the designation. The bolt can be use[illegible]ntil its diameter is reduced to 7 mm.

Two samples of 80 ml of oil each were uniformly analyzed. Following the requirements for the standardized method, after the oil samples were heated to a required temperature of 60° ± 1°C, previously prepared bolts were placed in them and they were thermostated for 30 min. Then, depending upon the arrangements for the given sample, 8 ml of inorganic salt solution or 8 ml of distilled water were poured in. The solutions were added with the mixers stopped through

the openings in the lid, which served to maintain the thermometer in place. The same procedure was then followed as in the standard method. The corrosion of the bolts was checked after 1, 6, 12 and 24 hours,* in accordance with the requirements of the standard method.

Tests requiring examinations of over 6 hours were made in stages of 6 hours per day. In these cases the steel bolts were taken out of the oil and placed on an ordinary desiccator, suspending them on stands made from aluminum wire. The beakers with oil and water were left in the bath. The intervals were not longer than 16 hours. When further designation was started the bath and oils were brought up to the desired temperature and after dispersing the salt or distilled water solution in the oil the bolts were inserted in the standard way. After completing the examination the bolts were taken out and flushed off with extraction benzine and the degree of corrosion was evaluated in accordance with requirements of the above-mentioned standard, represented in Table 1.

2. Results of Investigations

Results of examinations of properties of anticorrosion representatives of certain oil groups are compiled in Table 2. In all the analyzed oils an identity was established in the corrosion results obtained with the aid of the compared methods. The identity pertains to the degree of corrosion intensity as well as on the time of corrosion appearance. The developed modified method of evaluating anticorrosive properties gives identical results with the ones obtained by the standard method according to PN-63/C-04082.

The method permits measurements of anticorrosion properties of lubricating and hydraulic oils using about 1/4 the normal amount of test oil in comparison with the amount required for the standard method. Besides the dimensions of the vessels for studying corrosion and the amounts of liquid used, the designation conditions are the same as in the standard method.

*In case of appearance of corrosion after short time periods in the test, it is advisable to check the corrosion of bolts at intermediate time periods, e.g., 1/2, 2, 3 hours.

References

1. Polish Standard PN-63/C-04082, USA Standard ASTM D 665-54, English Standard IP-135/61.

2. Wiślicki, Bogdan. Zmodyfikowana metoda badania właściwości korozyjnych olejów smarowych i hydraulicznych (Modified Method of Checking the Properties of Corrosive Lubricating and Hydraulic Oils), Report of the Aviation Inst. No. 19/DM-3/67, Warsaw.

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13. ABSTRACT

The ASTM D 665-54 method is modified to expose 8 x 57 mm steel pins, surface area 15.6 cm(superscript 2), to 80 cc oil in a polymethacrylate-covered 100 cc cell agitated by a 1 x 6 x 20 mm 2-blade 1000 rpm flat turbine or various periods of time. [AP9022003]

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