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THE ESTIMATION OF LUBRICATING ABILITY BY MEANS OF ENGINE TESTS.

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SYNOPSIS:

The results of wear measurements on a B.M.W.132 oil test engine are illustrated graphically; the oils in question are thus graded according to their lubricating ability. These test results warrant further research in this direction, and in contrast to the observations of other institutions, they show the possibility of investigating the lubricating ability of oils by means of engine tests.

CONTENTS:

I - INTRODUCTION:

One of the most important properties of internal combustion engine oils is sufficient lubricating ability. So far, all attempts to determine this property quantitatively have failed, and although countless test machines and apparatus have been built to this end, no mutually comparable results have been obtained. A study of the literature on this subject leads to the realisation that the difficulty in finding a faultless test method for lubricating ability is based on the number of factors affecting even the simplest lubrication process. If the results of tests on test apparatus of comparatively simple design can be so widely interpreted, it is not surprising that the results of engine tests carried out by many scientists are at present quite contradictory.

D.V.L. continuously makes engine tests on oils, with a uniformity of working conditions unequalled by other research institutes. It therefore seemed reasonable to apply these tests to the measurement of lubricating ability, as the results could be adapted to establish the missing relationship between practice and the test machine.

In these tests it was assumed that the wear occurring by boundary lubrication in the engine can be taken as a measure of the lubricating ability. This report gives the significant results of wear tests on cylinder and piston rings of a single-cylinder oil test engine.

II - TEST PROCEDURE:

A large number of test runs was carried out, applying known methods[1]) in the air-cooled B.M.W.132, to test the stability of oils, i.e., tendency to deposit formation. In these tests the engine parts in question were measured and weighed before and after each run, in order to determine the wear. These parts comprise cylinder, piston and piston-rings (Marquardt piston rings) of the type fitted in the B.M.W.132 aero-engine, series N. The working conditions correspond to the data contained in the above mentioned reports[1]).

Intava 87 was used as fuel for the test runs on oils Nos.1 and 3; for all the other runs VT 702 + 0.12% Pb was used.

Oils Nos.1 to 3 are commercial aero-engine oils, Nos.4 to 8 synthetic oils or mixtures of these with mineral oils, No.5 being the same as No.4, with the addition of an oxidation inhibitor. No.9 is a commercial compounded aero-engine oil.

III - Test results and their evaluation.

According to the specifications of recent test methods, the endurance of the oils was tested in the engines at various standard temperatures. The method stipulates that the engine is run until a power drop occurs, which at very high temperatures easily leads to seizure. In order to avoid complicating the evaluation by including those runs with considerably heavier wear, the graphs include only runs at reference temperatures (sparking plug ring) of 260° to 275°C. This limitation to a comparatively narrow temperature range was also necessary because, whenever possible, the effect of different viscosities due to different oil film temperatures must be excluded; in fact, according to its definition, the lubricating ability is a property which produces different friction coefficients in oils of equal viscosity. For these reasons, in the evaluation of test results the different viscosity at equal temperature was also taken into account. Table I shows that in the temperature range in question these differences are only slight; moreover, oil No.9, with the lowest viscosity at 150°C. and a comparatively poor viscosity temperature characteristic, (viscosity pole height) produced less wear than No.8, which had a better pole height and at 150°C. reached its maximum viscosity, though its wear preventing action was smaller. It can therefore be assumed that the test results actually indicate the different lubricating ability of the oils in question.

The test method used provides for different running times, according to the reference temperature and the type of oil. Apart from Figure I, which covers the total wear of the top piston ring for different running times, the wear per hour was plotted in terms of the running time (Figures 2 to 6). The wear values when plotted give a field of variation which appears to follow a hyperbolic curve. This must be taken into account when analysing the results, because it is not only the absolute value of the wear per hour that counts, but the corresponding running time must also be considered. The grading of these areas of variation gives a classification of the oils. A tabulation of these gradings shows that they agree comparatively well (Figure 7). This chart also contains the classification of the oils in question, according to their resistance to piston ring-sticking. It shows that oil No.8, which is highly resistant to ring-sticking, has no wear-preventing properties, whilst fatty oil No.9 has an exceptional lubricating ability but only a moderate resistance to ring-sticking.

IV - SUMMARY:

Together with tests of engine oils regarding their resistance to deposit formation, wear tests were carried out on a B.M.W.132 oil test engine. These gave a certain grading of the oils, and constitute a yardstick for the evaluation of their lubricating ability. A comparison with a classification based on the resistance of the oils to deposit formation shows that the best oils according to one classification are not necessarily rated high when the other property is considered.

As the main object of these tests was the investigation of deposit formation, their results are influenced by the length of the running times. Obviously this influence can be excluded in engine tests, which are only meant to measure the wear, and are thus used to investigate the lubricating ability.

Owing to their importance, these results were published before the monographs which are to follow, which deal with the tests in detail, as well as with the works of other research institutes.

Figure 1 - Wear of first piston ring in terms of running time.

Figure 2 - Hourly wear of rings 1, 2, 3, and 4 in terms of running time.

Figure 3 - Hourly wear of first ring.

Figure 4 - Hourly wear of rings 2, 3 and 4.

Figure 5 - Hourly wear of bottom scraper ring.

Figure 6 - Hourly cylinder wear.

Figure 7 - Grading of oils according to wear and running time.
Grading based on :-
- Wear of first ring
- Wear of 2nd, 3rd and 4th ring
- Wear of scraper
- Wear of cylinder
- Running time up to piston seizure.

TABLE I.

Oil No.	Symbol	Visc.at 150°C. in °E.	Viscosity Pole Height	Indication of the fields of variation
1	Rotring	1.5	2.03	
2	Rotring D	1.5	1.95	
3	Stanavo 100	1.5	1.68	
4	M.70	1.6	1.73	
5	M.71	1.6	1.73	
6	M.8	1.6	1.93	
7	M.9	1.6	2.15	
8	M.10	1.7	1.97	
9	Aero Shell Medium	1.4	2.12	