

## ENCLOSURE (B) 25

ENGINE TESTS OF COMPOUNDED  
AIR CRAFT ENGINE LUBRICATING OIL,  
RELATIVE TO THE INFLUENCE  
OF TRICRESYL PHOSPHITE AND  
TRICRESYL PHOSPHATE AS ADDITION AGENTS

by

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SUMMARY

As the horsepower of the engine of an aeroplane is increased, the bearing loads and temperature are raised. So the film strength or oiliness of the engine lubricant must be improved and added protection from oxidation must be provided for.

From chemical and physical tests, made in America and England, tricresyl phosphate had been found effective for oiliness improvement and tricresyl phosphite for protection against oxidation. Therefore these two compounds (T. C. Pi. 0.2%, T. C. Pa. 0.2% by wt.) were added to K-120-K (the oil used in Japanese Naval Air Fleet), and sent to Nakashima, Mitsubishi, and Aichi factories to test their effect in full scale aircraft engines for long operating periods. Their tests were supervised by men of The First Naval Technical Department. In these tests, this compounded oil foamed excessively. It was thought that the tricresyl phosphite caused the foaming.

I. INTRODUCTIONA. History of Project

At the First Naval Fuel Depot, the addition agents were made by Chem. Eng. Lt. Comdr. WAKANA and Chem Eng. Lt. Comdr. HIRATA. Chem. Eng. Lt. FUJIMOTO blended this agent in K-120-K oil, and sent to The First Naval Technical Depot at YOKOSUKA for testing. This Depot at YOKOSUKA, in turn, sent it to Mitsubishi, Nakashima, and Aichi.

B. Key Research Personnel on Project

Chem. Eng. Lt. Comdr., A. WAKANA  
 Chem. Eng. Lt. Comdr., M. HIRATA  
 Chem. Eng. Lt. Comdr., P. MAKAYAMA  
 Chem. Eng. Lt., T. FUJIMOTO  
 Chem. Eng. Lt., N. KUTAKE

II. TESTINGA. Blending of Sample

Tricresyl phosphite ..... 0.2%  
 Tricresyl phosphate ..... 0.2%  
 Blending Temperature ..... 120°C  
 Blending Period ..... 6 hr

The acid value of the compounded oil was a little lower than the base oil when stirred under the same conditions.

B. Tests Engine Used

Bomare	III	Nakashima (Ogikubo)	16-cylinder air-cooled
Kasei	IV	Mitsubishi (Nagoya)	14-cylinder air-cooled
Atsuta	IVO	Aichi (Nagoya)	12-cylinder water-cooled

C. Duration of Engine Tests

Each test was about 80 hours, using regular 91 O.N. gasoline as fuel.

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These tests were made in connection with duration tests of Non-Chrome Carbon Steel crankshafts in all three engines and the test of oil was secondary.

D. Engine Test Method

1. The operating condition was at full power.
2. When the testing was completed, the engine was opened and examined, particularly the bearing surfaces, and other engine parts, on which sludge stuck such as on cylinders, superchargers, and connecting rods.
3. The chemical properties of the used oil were obtained and compared with those of the base oil.
4. The piston rings were weighed and cylinders examined after testing.

E. Summary of Data

Exact data cannot be remembered by the author but the findings it is believed, were as follows:

1. The operating condition was at full rated power.
2. The amount of sludge which stuck to the engine surfaces was smaller than that of the base oil.
3. The wearing surfaces were generally good.
4. In the case of the Homare engine the amount of foam in the oil tank was much more than with the base oil.
5. The used compounded oil was equal to or somewhat superior to the base oil when tested in the same way.

III. CONCLUSIONS

The effect of the addition agents on the engine was slight, and considered of little practical value. This experiment was completed in July, 1945, so the production of the addition agent was not in time to be of such practical use. Nevertheless, these compounds were used in the Sakae engine in Zero-Fighter during July and August, 1945. This was done in view of connecting rod (Copper-lead) bearing failures attributable to increased engine speed. About 50% of these engines showed bearing failure.

This report was obtained by the author in June, 1945 at Kasabara airfield located in KYUSHU. The author did not, however, see any of these bearings which had failed. There is no information regarding practical results obtained with this compounded oil during July and August.