ENCLOSURE (B) 26

ENGINE TEST WITH PROPOSED LUBRICANT OIL ADDITION AGENTS

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LIST OF TABLES AND ILLUSTRATIONS

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SUMMARY

In Japan there was a sufficient supply of aeroplane engine lubricants until about 1943. This supply consisted principally of Texaco Oil No. 120. However, in 1943 it became necessary for the Japanese Navy to use "K-120-K". This oil was prepared in Japan from Philipps Osage crude treated in the Duo-Sol plant at TOKUYAMA. This product, however, was not quite equal to Texaco No. 120 in quality. With increase in power output, it was necessary to have oil at least as good as Texaco No. 120, and to meet this requirement, tricresyl phosphite (T.C.Pi) & tricresyl phosphate (T.C.Pa) were tested by the First Naval Fuel Depot to examine their utility in full scale engines. These addition agents were found beneficial in regard to sludge formation and for frictional surfaces, particularly master rod bearing and piston rings.

I. INTRODUCTION

This K-120-K oil in which these addition agents were blended in the ratio of 0.2% by wt of each compound at the First Naval Fuel Depot, was sent to the Mitsubishi, Nakajima, and Aichi Companies, and tested.

All these tests were undertaken in connection with endurance tests of substitute materials for connecting rod & shaft manufacture. Therefore, these oil tests were only secondary in importance.

II. DETAILED DESCRIPTION

A. Test Engines and Performance Data

HOMARE II-I Type (Nakajima Co.)

Engine Data

No. of cyl.	18
Dia. of cyl.	1200mm (about)
Wt. of cyl.	800kg (about)
Bore x Stroke	130 x 150
Stroke Vol.	36 lit (about)
Compression ratio	7
Fuel	91 O.N. gasoline
Oil	K-120-K
Cooling	air cooled

Performance Data

Horsepower (hp)		Condition	
Max.	[illegible]00	3000 R.P.M.	300mm
Rated	1900	3000 R.P.M.	350mm 2000m
Rated	1700	3000 R.P.M.	350mm 6000m

[illegible]I-V Type (Mitsubishi Co.)

Engine Data

No. of cyl.	14
Dia. of cyl.	1300mm (about)
Wt. of cyl.	800kg (about)

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Bore x Stroke	150 x 170
Stroke Vol.	42 lit (about)
Compression Ratio	6.5
Fuel	87 O.N. gasoline
Oil	K-120-K
Cooling	air cooled

Performance Data

Horsepower		Condition	
Max.	1850	2600 R.P.M.,	450mm
Rated	1700	2500 R.P.M.,	300mm 2000m
Rated	1550	2500 R.P.M.,	300mm 6000m

MISUTA II-O Type (Aichi Co.)

Engine Data

[illegible]	12
[illegible]	650kg (about)
[illegible]	150 x 170
[illegible]	34 lit
[illegible]	87 O.N. gasoline
[illegible]	K-120-K
[illegible]	inverted 60° V
[illegible]	water-cooled

Performance Data

		Condition	
Max.	1200	2500 R.P.M.,	300mm
Rated	1000	2400 R.P.M.,	150mm 1500m
Rated	970	2400 R.P.M.,	150mm 4500m

B. Test Procedure

The test period was about 60 hours in each engine and under the following conditions:

	Duration of Operation
max. power [illegible]	20h (5m + 5m) X 180 times
rated power [illegible] step	20h (6h X 2 times)
25d step	10h (5h X 2 times)
high oil temp.* operation (10° higher than ordinary operation)	10h {(30 min X 10 1st step) (30 min X 10 2nd step)}

C. Determination Method

After testing was completed, the engine was opened and the surface condition of the inner parts were examined.

1. Examination of dirt on the surfaces of the inner parts of engine, crankcase and reduction gear box.

* Usual oil inlet temp.: <75°C

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2. Examination of the frictional surfaces of crankshaft, main bearing, connecting rod, piston side, cylinder and piston ring.

3. Examination of sludge on crank pin and super charger shafts.

4. Examination of carbon on piston and cylinder.

5. Examination of wear of piston side, crankpin, crankshaft, bearing metal, etc.

6. Examination of oil after use (viscosity, dilution, Conradson's test).

The sample was collected every 10 hours, during the engine test.

D. Summary of Data

General results of these tests were as follows:

1. Dirt on inner parts of engine was less than that when base oil was used alone.

2. Frictional surface conditions were better.

3. Adherent sludge on all inner parts of the engine was less than that when base oil was used alone.

4. Adherent carbon in piston and cylinder was less than when base oil was used alone.

5. Sticking of piston rings which was due to the addition agents was not recognized at all and operation conditions were very good.

6. Corrosion of bearing surfaces was not generally recognized.

7. Wear in piston, crankpin, main bearing, analysis of used oil and analysis of adherent sludge on supercharger shaft are shown in Table I(B)26. (Data are from memory.)

III. CONCLUSIONS

These addition agents were concluded to be effective by these tests, and seem to have given satisfactory service in the following planes:

Aeroplane	Engine
Zero-Fighter	Sakae II O
SAIUN	Homare II O
GINGA	Homare II O
RAIDEN	Kasei II O
SIDEN	Homare

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Table I(B)26
ENGINE WEAR AND ANALYSIS OF USED OIL

	Base Oil	
	(K - 12 - K)	Addition agent (T.C.Pi 0.2, T.C.Pa 0.2)
Viscosity (210°F) Seybolt second	(110-130)*	(115-125)*
Conradson's Test (carbon)(%)	(1.0-2.0)*	(0.8-1.5)*
Dilution (%)	<1.0*	<1.0*
Degree of wear mean value	100%	80%
Inorganic material of adherent sludge (%)	70-80	50-65

* Show the range of variation of the oil used during operation.