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LUBRICANTS & BEARINGS.

COUNCIL FOR SCIENTIFIC & INDUSTRIAL RESEARCH.
(Australia)

SERIAL NO. A.57.

LUBRICANTS & FRICTION: REPORT NO.17.

OIL AND FUEL FROM A JAPANESE TORPEDO.

August 26th, 1942.

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The lubricating oil and the fuel from one of the Japanese torpedoes recovered from Sydney Harbour was submitted by the Navy for examination and report. Only small samples were available.

Fuel.

The fuel was pale yellow in colour and slightly cloudy, due possibly to contamination by salt water. The odour resembled that of kerosene. The specific gravity was 0.800 at $\frac{60^{\circ}\text{F}}{60^{\circ}\text{F}}$. The fractionation data is as follows:

Received at 150°C	9%	Initial boiling point	138°C
" " 175 "	65.5%	10% received at	151 "
" " 200 "	89.5%	20% " "	155 "
" " 225 "	96%	30% " "	158.5°C
		40% " "	163°C
		50% " "	167 "
		60% " "	171 "
		70% " "	177.5°C
		80% " "	186°C
		90% " "	201 "
		Final boiling point	236.5°C
		Residue	1.6%
		Loss	0.4%
		Room temperature	14.5°C
		Barometric pressure	769 mm

This approximates to the properties of mineral turpentine or power kerosene. In view of the high boiling point of the final fraction, it would seem probable that an atomiser was used in the engine.

Lubricating Oil.

The sample supplied was a dark viscous oil with a definite vegetable odour, and was contaminated with a small amount of sand and sea water. The bottom of the container was covered with a gelatinous, sludge-like sediment, which may be due to the presence of the water. The results of the tests are as follows:-

Original Oil

Specific gravity at $\frac{60^{\circ}\text{F}}{60^{\circ}\text{F}}$.937
Viscosity (kinematic) at 100°F	154.6 c.s.
" " " 210°F	14.55 c.s.
Viscosity index	101
Diluent	< 0.5%
Acid Value	0.36 mg. KOH per g. of oil
Ash	mainly iron (with a trace of sodium and calcium)
Nitrogen	some present (possibly nitrogen base present)
Sulphur	0.5% (possibly low due to presence of nitrogen)

Saponifiable Matter - about 40%

Colour	dark
Iodine number (Hanus)	90
Neutralisation value	158 mg. KOH per g. of oil
Nitrogen	absent
Sulphur	absent
Refractive index at 60°	1.4507
Separation of solid matter on standing.	

Unsaponifiable matter < 60%

Colour	very dark
Specific gravity at $\frac{60^{\circ}\text{F}}{60^{\circ}\text{F}}$.940
Nitrogen	present
Sulphur	present
Viscosity	high

The calculated specific gravity of the fatty oil is .933.

It will be seen that the original oil is a mixture of approximately 60% mineral oil of specific gravity .940 and 40% fatty oil. The specific gravity of the original oil was .937; this gives a calculated specific gravity of .933 for the fatty oil. This figure may be somewhat high due to the presence of water.

The mineral oil, when extracted, was dark, heavy and extremely viscous resembling a low grade naphthenic type of Californian oil. The presence of sulphur in the mineral oil is probably due to poor refining (up to 2% of sulphur may be found in low grade oils).

On examining the results for the saponifiable matter, given in the table, it is evident that the fatty acids obtained from rapeseed oil possess many of these properties. The iodine number and neutralisation value are somewhat lower, and the refractive index higher, than the corresponding values for the fatty acids from rapeseed oil. This shows that some polymerisation of the fatty oil has occurred. From this, and also from the fact that the mineral oil is dark in colour, we may conclude that the original oil was used or slightly blown. The latter is unlikely since blowing greatly increases the acid value (the acid value of blown rapeseed oil may rise up to 16), specific gravity and viscosity, and lowers the iodine number, after a relatively short period of treatment.

It seemed possible that treated castor oil may have been the fatty oil used. Pure and blown castor oil must be excluded because of their high specific gravity and refractive index, and because they can only carry up to 10% of mineral oil. The fatty acids obtained from treated castor oil also have slightly different properties from those listed. Moreover on cooling they do not show any separation of solid matter, and are usually colourless or very pale yellow. The fatty acids from the original oil show separation of solid matter

and are dark in colour.

Although the viscosity index of the mineral oil extracted is probably very low, the high value for the fatty oil will compensate for this, thus accounting for the good viscosity index of the original oil. The presence of an ash (mostly iron) indicates that the oil has been used.

Summary.

The fuel supplied is mineral turpentine or power kerosene with a boiling range of 138-237°C.

The oil is probably a mixture of approximately 60% low grade mineral oil with 40% rapeseed oil. It appears to have good fluid lubrication properties as may be seen from its high viscosity index associated with its high specific gravity.

Boundary Lubricating Properties.

Measurements of the boundary lubricating properties of the oil were made by Dr. Tabor and Mr. Peart. The boundary lubricating properties at room temperature are only fair. The lubricating properties, however, do not deteriorate appreciably with rising temperatures up to 200°C. The oil appears to be reasonably stable to oxidation.

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