ENCLOSURE (B) 9

ENGINE TEST METHODS FOR DIESEL FUEL AT OFUNA

by

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LIST OF TABLES AND ILLUSTRATIONS

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I. INTRODUCTION

An engine test plant for testing diesel fuel was installed at the First Naval Fuel Depot in 1942, together with the engine test plant for aviation fuel and lube oil.

The chemical properties and the cetane value of diesel fuel itself were examined by the 4th section of the Experimental Department. The samples were examined by actual engine test by the 2nd section of the same Department, and their suitability for practical diesel engine use was determined.

One type of engine test was made in a mono-cylinder testing engine, another in a full sized engine. If required, tests were made under actual running conditions on ships or automobiles.

Work on substitutes for diesel fuel was also carried out because the supply for this fuel became very scarce. See report "Engine Test of Substituted Fuel for Diesel and Boiler", (Enclosure (B)6, (B)7, (B)8, and (B)14) including tests of copra and copra oil, then creosote oil and soya-bean oil.

II. DETAILED DESCRIPTION OF APPARATUS

A. Mono-cylinder Engine Test

The C.F.R. engine test is the same as in U.S., and it will not be mentioned in this paper.

Several mono-cylinder engines were installed in this depot as shown in the following list.

Niigata Diesel engine
Okiko diesel engine
Ikegai semi-diesel engine
} for prime movers of generators

No. 31 type diesel engine--main engine for hydroplane carriers.

1. The Froude type electric dynamometer was used to measure the bhp delivered.

2. The RPM or total revolutions during the test was measured with tachometers and revolution counters.

3. The tachometers were checked with stop-watches.

4. A supply fuel tank was placed on a balance.

5. The Maihak indicator was used for low speed engines, and the Farnboros indicator for high speed engines to draw diagrams and to measure the maximum pressure, mean effective pressure, etc., and to determine the conditions of compression, combustion, expansion, exhaust and suction stroke.

The Okill pressure indicator was also used but not often.

6. The Orsat method was usually used to analyze the exhaust gas.

7. The inlet and outlet temperatures of lube oil and cooling water and also the temperatures of certain parts of the engine were measured with mercury thermometers, thermocouples, and occassional-

ly measured by "Thermo-color". "Thermo-color" is a temperature indicating paint used in about six temperature ranges from 300°C to 1000°C. It indicates temperature with an accuracy of about ±10°C, and was used on such engine parts as nozzles and cylinder heads.

8. Pressure of the injected fuel, blast air, lube oil, etc., were measured with pressure gauges.

9. A five degree Lingerman chart was used to measure the color of smoke.

10. A triangular notch weir type flow meter was used to measure the rate of cooling water.

Each part of the engine is carefully inspected and then reassembled before operation. The clearance is adjusted and the engine is started by hand if small, and by compressed air if large. This test operation is continued for about an hour. Then a preliminary run is carried out until the entire engine and lube oil reach their proper working temperatures.

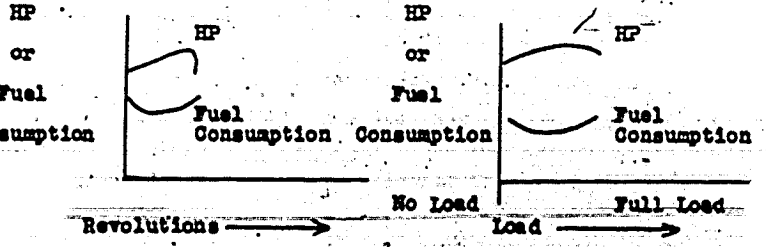
The functions of various accessories are checked during this stage to determine whether the engine has reached a normal running condition or not.

After everything is set in order, a test data sheet (cf. attached paper) is arranged and a recording trial is made. The men are then stationed in their respective positions, and the engine test is started carefully.

Tests of various loads are made, such as overload, full load, 8/10 load, 6/10 load, 4/10 load, 2/10 load, and minimum load.

An officer or an assistant engineer directs the test, one assistant handles the controls, and two or three men record the data by the director's signal.

All columns in the test sheet are filled, and from these data the characteristic curves are traced, and the thermal efficiency, etc., calculated.



After the engine test is over, the engine is dismantled and conditions of the principal parts of the engine, such as frictional surfaces (valves, bearings, piston rings, etc.), nozzles, fuel, and lube oil filters, are examined.

Contamination, wearing, and decrease of tension of piston rings; carbon deposits on piston caps, nozzle valve tips, cylinder caps; scratches on cylinder walls, piston sides and fuel pump plunger; leakage of fuel pipe flanges and corrosion of engine materials are also carefully investigated.

The combustion conditions in the cylinder are also examined from the indicator diagram obtained with a string-type indicator or a balanced pressure Farnsboro-type indicator.

B. Full Sized Engine Test

If the amount of oil sample prepared by the Research Department is small, or not suitable for long-run tests, they are tested in mono-cylinder engines. But in the case of decisive tests, such as determining the applicability for actual use, full size engines are used, and when possible, they are tested with engines aboard ships or vehicles under practical conditions.

Only few full-sized engines are installed in this depot, and most of the tests were usually carried out in the Yokosuka Naval Yard.

III. PROGRESS OF RESEARCH WORK

Investigation on the performance tests of high cetane diesel fuel for high speed diesel engines was planned, and a "61st" type high speed single cylinder diesel engine was installed but experiments were postponed owing to the shortage of gasoline which was made by cracking diesel fuel. As a result, a substitute fuel for diesel oil used in middle speed diesel engines was investigated. (See Enclosures (B)6 and (B)7.) Copra oil, soya-bean oil, creosote oil were next examined but no satisfactory results were obtained.

Figure 1(B)9
CLOSE UP VIEW OF NO. 31 TYPE
MONO-CYLINDER DIESEL ENGINE

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Table I(B)9
TEST ENGINES FOR DIESEL FUELS AND LUBRICATING OILS*

Name of Engine	Type of Engine	No. of Engine	Principal Dimensions			
			Bore	Stroke	rpm	shp
No. 31 Diesel Engine*	2 cycle solid-injection vertical single cylinder	1	420	600	420	360
Okiko Diesel** Engine	4 cycle air-injection vertical single cylinder	1	220	300	450	25
Junkers Diesel Engine	2 cycle solid-injection vertical single cylinder opposed piston type	1	65	900	1200	10
Niigata Diesel Engine (high speed)	4 cycle solid-injection vertical single cylinder	1	100	140	1800	10
Kaimuin Type Semi-Diesel Engine	2 cycle hot bulb type vertical 2 cylinder full scale engine	1	305	343	335	75
No. 61 Diesel Engine	2 cycle solid-injection vertical single cylinder	1	140	180	1600	62
Isuzu Diesel Engine	4 cycle solid-injection 6 cylinder, single row vertical	1	110	150	1600	100
Niigata Diesel Engine (low speed)	4 cycle solid-injection vertical single cylinder	1	220	300	450	25

*Principal accessories are listed on next page.

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No. 31 Diesel Engine: One turbo-blower (3200 rpm, 190 hp, 185 m^3/min)
One water brake (500 to 1000 rpm, max. hp 600 Froude type)
Marine engine was set in August 1942. Removed from Yokosuka Naval Dockyard.

Okiko Diesel Engine: One electric dynamometer (450 rpm, 25 hp)
One air compressor (100 kg/cm^2, 15 hp)
Generator engine - made by Osaka Machine Works Co. Ltd. Removed from Tokuyama Naval Fuel Depot.

Junkers Diesel Engine: Opposed piston type - made by Junkers Co Ltd. (Japan agent Mitsubishi)
Removed from Tokuyama Naval Fuel Depot without accessories

Niigata Diesel Engine (high speed): One electric dynamometer (2200 rpm, 10 hp)
Generator engine - removed from Tokuyama Naval Fuel Depot

Kaimuin Type Semi-Diesel Engine:
Marine engine - made by Taguchi Machine Works

No. 61 Diesel Engine:
Aircraft engine - removed from Yokosuka Naval Dockyard.

Isuzu Diesel Engine:
Automobile engine - made by Diesel Automobile Co. Ltd., Tsurumi Factory. Removed from Yokosuka Naval Dockyard in July 1945.

Niigata Diesel Engine (low speed): Electric dynamometer (450 rpm, 30 hp)
Generator engine - made by Niigata Machine Works Co. Ltd.
Removed from Tokuyama Naval Fuel Depot.

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Table II(B)9
BOILERS FOR TESTING FUELS*

Name of Boiler	Type of Engine	No.	Dimension		
			Heating Surface	Working Pressure	No. of Burner
Kan-pon Boiler (Main)	Ro-go type with air-preheater oil burnt 3 drum water tube	1	308.6	19	5
Kan-pon Boiler (Minor)	Ro-go type oil burnt 3 drum water tube	1	66	14	1
Cylindrical Boiler	Fire-tubes type single ended coal burnt	1	62.7	7	

* Notes on Boilers

Kan-pon Boiler (Main): One blower
Two feed pumps
Two fuel oil pumps

Kan-pon Boiler (Minor): One blower
One feed pump
One fuel pump
Formerly used for auxiliary boiler for A-class cruiser.

Cylindrical Boiler: Donkey boiler