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UTILITY TESTS OF AVIATION GASOLINE OUTSIDE SPECIFICATIONS

by

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LIST OF TABLES AND ILLUSTRATIONS

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SUMMARY

Aviation gasoline No. 1 and No. 2 prepared by the First Naval Fuel Depot as wartime gasoline standards were acknowledged useful as well as the standard gasoline of the same octane number from the results of the bench and flight tests on various engines made in the First Naval Technical Depot.

In connection with engine starting, No. 1 gasoline was somewhat unsatisfactory at atmospheric temperatures below 10°C and No. 2 gasoline was entirely unsatisfactory at atmospheric temperatures below 20°C. Especially in winter, at atmospheric temperatures near 0°C, engines could not be started. It was, therefore, necessary to use the normal standard gasoline for starting. The sufficient amount for each engine was 5 liters. In connection with distribution of fuel to each cylinder, No. 1 gasoline was somewhat unsatisfactory in comparison with ordinary standard gasoline, and No. 2 gasoline was also unsatisfactory, but were sufficient for practical use.

Acceleration with these fuels was satisfactory for all engines. In connection with dilution of lubricant oil, No. 1 gasoline showed more dilution than ordinary gasoline, i.e., 0.8 - 1.0% of oil weight, and No. 2 gasoline showed a very large degree of dilution reaching to 1.2 - 1.4%. Careful attention, therefore, was required to use the gasoline without trouble.

I. INTRODUCTION

(A) History of Project

In the middle of 1943, the quantity of aviation gasoline in Japan became short, and an attempt was made to modify the ordinary aviation gasoline specification by the First Naval Fuel Depot. Bench and flight tests on various engines, using two types of samples, were carried out by the First Naval Technical Depot.

Satisfactory results were obtained in the middle of 1944, and immediate steps were taken to establish a specification for a standard wartime aviation gasoline.

(B) Key Research Personnel Working on Project

Mech. Eng. Capt. T. KONDO the First Naval Technical Depot

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II. DETAILED DESCRIPTION

(A) Description of Test Apparatus

Engines: Homare 20 type, Kasei 20 type, Sakae 30 type, Atsuta 30 type

Airplanes: Shiden (fighter with Homare 20 type engine)
Raiden (fighter with Kasei 20 type engine)
Zero type fighter (with Sakae 30 type engine)
Suisei (diving bomber with Atsuta 30 type engine)

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(B) Test Procedures and Experimental Results

Two types of modified aviation fuel prepared by the First Naval Fuel Depot and sent to the First Naval Technical Depot had the following properties.

Table I (B)25

PROPERTIES OF MODIFIED AVIATION FUELS

	Wartime	Modification	
	No. 1 Gasoline	No. 2 Gasoline	Ordinary Standard
First drop	60 °C max	70 °C max	60 °C max
10 % pt	90 °C max	90 °C max	80 °C max
50 % pt	115 °C max	125 °C max	105 °C max
90 % pt	160 °C max	180 °C max	150 °C max
97 % pt	170 °C max	200 °C max	170 °C max
Sum of 10, 50 & 90%	260 °C min	260 °C min	260 °C min
Leaded	0.15% max	0.15% max	0.1% max
Vapour Pressure	0.6kg/cm^2	0.6kg/cm^2	0.53kg/cm^2
Octane No.	91	87	91 & 87
Specific gravity	0.73 - 0.74	0.74 - 0.76	0.725

These fuels were examined in several engines connected to Froud dynamometers. Investigations were made with maximum allowable boost pressures and minimum economical consumptions.

The following data were obtained using maximum boost pressure. See Table II (B)25.

Table II (B)25

AV - GAS ENGINE TESTS USING MAXIMUM BOOST PRESSURE

Engines Type	By Modification* No. 1 (oct. No. 91) (mm/Hg)	By Modification** No. 2 (oct. No. 87) (mm/Hg)	Remarks
Homare 20	(1st speed) +500 (2nd speed) +350	(1st speed) + 150 (2nd speed) + 50	Over +125mm/Hg with supplementary fuel
Kasei 20	(1st speed) +450 (1st speed) +300	(1st speed) + 450 (2nd speed) + 300	Over + 160mm/Hg with supplementary fuel
Sakae 30	(1st speed) +300 (2nd speed) +200	(1st speed) +150 (2nd speed) +50	
Atsuta 30	(1st speed) +325 (2nd speed) +250	(1st speed) +150 (2nd speed) +100	

*Ordinary standard (oct. No. 91) same as modification No. 1 (oct. No. 91)
**Ordinary standard (oct. No. 87) same as modification No. 2 (oct. No. 87)

It was shown by these data that the two types of modified gasoline gave the same results as the ordinary standard gasoline. Following data were obtained on minimum economical consumption.

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Table III (B)25

MINIMUM ECONOMICAL CONSUMPTIONS
AT 2000 RPM BOOST PRESSURE
(200 mm/Hg)

	gr/hp-hr		
Engine Type	By modification No. 1 (oct. No. 91)	By modification No. 2 (oct No. 87)	Ordinary Standard (oct. No.91&87)
Homare 20	210	220	205
Kasei 20	215	225	210
Sakae 30	210	220	205
Atsuta 30	220	225	215

It was evident from these data that with minimum economical consumption, the No. 1 and No. 2 gasoline showed a somewhat larger amount of consumption in gm/hp-hr than when ordinary standard fuel was used. The specific gravities, however, of these modified fuels were somewhat higher that the ordinary standard fuel as shown in the previous table; these had the same economical consumptions in liter/hp-hr. These performances were confirmed by flight tests of various airplanes, that is, Shiden, Raiden, Zero type fighter, and Suisei.

Starting and acceleration with these fuels were investigated during these flight tests. No particular test method was utilized in connection with the investigation; the flight tests began in October 1944 and were continued until May, 1945. Starting and acceleration at atmospheric temperature was examined. From these results, acceleration with No. 1 and No. 2 gasoline was satisfactory with the ordinary acceleration mechanisms in all atmospheric temperatures, but starting ability with No. 1 gasoline was unsatisfactory at atmospheric temperatures below 10°C, that is, winter daytime or very cold autumn mornings. Under these conditions engines could not be started easily.

The starting ability of No. 2 gasoline was not satisfactory at atmospheric temperatures below 20°C, that is , autumn daytime; and, in winter, when the temperature was below about 10°C, engines could not be started easily.

To avoid this, ordinary standard gasoline was used to help starting, and it was found afterwards that 5 liters for one airplane was enough. Engines with solid fuel injection systems, such as Kasei 20 type and Atsuta 30 type had no such starting troubles.

Lubricating oil dilutions by these fuels were also examined during these flight tests, and the 40 liters Zero-fighter lubricating oil tanks after 30 hours operation were investigated. Two or three liters of new oil was added after every few hours flight, and the entire oil was exchanged with new oil after 30 - 40 hours operation. Properties of the oil samples are as follows (from memory): (See Table IV (B)25)

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Table IV (B)25

PROPERTIES OF OIL SAMPLES

	No. 1 Gasoline	No. 2 Gasoline	Ordinary Standard Gasoline
Viscosity	118(S") Saybolt	110(S") Saybolt	Over 120(S") Sayoolt
Ignition pt	95 °C	85 °C	over 80 °C
Dilution degree (weight)	0.8 - 1.0 %	1.2 - 1.4 %	0.4 - 0.6 %

From these data, the degree of oil dilution with gasoline No. 1 was somewhat larger that that of ordinary standard gasoline, and with gasoline No. 2 the dilution was very large and careful attention was required to use these gasolines without causing bearing trouble.

III. CONCLUSIONS

These flight tests were started in October 1943 and satisfactory results were obtained at the end of May 1944, at which time the naval specification of aviation gasoline was changed to the wartime specification.