ENCLOSURE (A)

SUMMARY OF AVIATION GASOLINE RESEARCH AT THE FIRST NAVAL FUEL DEPOT, OFUNA

by

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INTRODUCTION

During the war, the urgent demand for large quantities of aviation fuel of superior quality compelled investigation of the possibilities of producing it from all sources, both foreign and domestic. Since the resources of natural high octane crudes in Japan were very poor, synthesis of aviation gasoline was planned.

In 1942, high quality crude oil became available from the East Indies, but unfortunately imports did not last as long as desired.

Research on synthesis of fuels was, therefore, again emphasized and the use of pine root oil and alcohols was investigated. Progress in the investigations of aviation gasoline by the Japanese Navy is summarized as follows:

SUMMARY OF RESEARCH

During the period up to 1940 efforts were made primarily to improve the quality of aviation gasoline. Since 1935, aviation gasoline had been obtained by distillation of crude oil and thermal cracking of naphtha or light oils.

However, it became necessary to improve the octane value of these fuels.

The techniques acquired in the studies on coal liquefaction were applied, and soon the commercial production of aviation gasoline by hydrocracking of natural oils was achieved. (In 1938, 92 octane fuel was made by hydrocracking at TOKUYAMA.) Later, however, it was found that 92 octane rating gasoline could not be obtained by hydrocracking crude oil from North Sumatra over Mo-Ni-catalyst. Therefore, studies for improving hydrogenation catalyst were made, but it was not possible to produce 92 octane rating gasoline from this crude, although a number of experiments were made. (Encl. (B)16, Parts 1-6, Encl. (B)9).

In 1939, research on catalytic cracking of naphtha and light oil was started, studying several types of catalysts. It was found that active acid clay served to give 91 octane rating gasoline, and a commercial plant was constructed at YOKKAICHI in 1942. This type plant required less construction materials than a hydrogenation plant, as is indicated below:

Table I(A)
STEEL REQUIRED FOR PLANT CONSTRUCTION

Plant	Steel Required (Tons/Kl AvGas/yr)	
	Ordinary	Special
Hydrogenation Process	0.3	60
Catalytic Cracking Process	1.17	6

In 1936, 100 octane gasoline was required. In this connection, studies were made on synthesis of high octane components from waste gas in the cracking process of petroleum, and the next year, a study of polymerization of butylenes using H_3PO_4 catalyst was started. Shortly afterwards a commercial plant was constructed at TOKUYAMA. Due to a deficiency of butylenes in Japan, an investigation was made on the synthesis of isobutylene from acetylene. Although the acetylene process was started on a commercial scale at KONAN, North Korea, difficulties due to corrosive action and short duration of catalyst activity were encountered with the phosphoric acid catalyst used for conversion of n-butylene to iso-butylene. (Encl. (B)2, (B)10, (B)11, (B)13, (B)14, (B)15).

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After discovering that aluminum silicate was usable instead of H_3PO_4, this catalyst was used in the iso-octane plant in Formosa.

~~Another source of butylene was butanes in refinery gas (Encl. (B)1).~~

In addition to isooctane, preparation of other high octane blending compounds such as isohexane and isododecane was studied, but these compounds were not used in practice. (Encl. (B)4, Parts I, II, (B)12).

Preparation of high octane isoparaffines by H_2SO_4 alkylation of isobutane was investigated in 1939, and a commercial plant was constructed at YOKKAICHI in 1942. (Encl. (B)8). To supply isobutane for this process, the isomerization of n-butane and Fischer condensate oil or wax was studied. (Encl. (B)6, (B)3). The production of isobutane by these methods was accomplished only on a pilot plant scale.

Antidetonants for aviation gasoline were also investigated with regard to the problems of high octane fuels. Some selenium, oxygen compounds and the substitutes of ethylene-dibromide also were studied, but these compounds were not used on commercial scale. (Encl. (B)27, (B)30, (B)31).

During the war, 91 octane aviation gasoline was required. This demand was partly met in 1941, by adding 0.15% tetra ethyl lead to the gasoline from California crude oil. The stability of tetra ethyl lead was studied in 1940. (Encl. (B)28).

In trying to solve this problem studies were made on adding isooctane or small amounts of aniline to Sumatra naphtha and on the influence of moisture on octane value. (Encl. (B)29, (B)32). The scheme of adding aniline was not used in practise.

The isomerization of gasoline in the presence of $AlCl_3$ was also tried, but in vain. (Encl. (B)5, (B)7).

The synthesis of gasoline by the catalytic cracking or hydrogenation of the dry-distilled product from natural rubber was studied on semi-commercial plant scale and also the dry-distillation or high pressure hydrocracking of Soya-bean oil. (Encl. (B)17, (B)18, (B)19).

From 1943 onwards efforts were made primarily to increase the supply of aviation fuel and standard fuel. (Encl. (B)20). One device used for this purpose was to modify the quality of gasoline as indicated by the following table: (Encl. (B)23, (B)24, Part I(B)25, (B)26).

Table II(A)
SPECIFICATIONS FOR 91 OCTANE FUEL

		1939	1940	1944	1945
Octane Rating	(C.F.R.)	92 min.	91 min.	91 min.	91 min.
Distillation	10 %	80° max.	80° max.	80° max.	90° max.
	50 %	105° max.	105° max.	115° max.	125° max.
	90 %	150° max.	150° max.	160° max.	180° max.
	97 %	170° max.	170° max.	170° max.	200° max.

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Another plan was the manufacture and use of alcohols, first in blends and finally in the pure state.

After September 1944 intense efforts were made to solve the aviation fuel supply problem by using pine root oil as a source. The catalytic cracking of the light oil and hydrocracking of the middle oil were investigated, and production of 91 to 95 octane rating fuel was starting at the end of the war.

A description of engine test methods employed for testing aviation fuel at OFUNA is given in Encl. (B)33. A low temperature-low pressure laboratory to study fuel and lubricant behaviour under high altitude conditions was also under construction at the close of the war. (Encl. (B)34).

Some research was also done at OFUNA on gasoline resistant paints. (Encl. (B)21).