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MISCELLANEOUS TARGETS

JAPANESE FUELS AND LUBRICANTS - ARTICLE 10
MISCELLANEOUS OIL TECHNOLOGY
AND REFINING INSTALLATIONS

U.S. NAVAL TECHNICAL MISSION TO JAPAN

U. S. NAVAL TECHNICAL MISSION TO JAPAN
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From: Chief, Naval Technical Mission to Japan.
To : Chief of Naval Operations.
Subject: Target Report - Japanese Fuels and Lubricants, Article 10 -
Miscellaneous Oil Technology and Refining Installations.
Reference: (a) "Intelligence Targets Japan" (DNI) of 4 Sept. 1945.

1. Subject report, covering miscellaneous oil technology and oil refining installations in Japan outlined by Targets X-09, X-10, and X-38(N) of Fascicle X-1 of reference (a), is submitted herewith.

2. The investigation of the target and the target report were accomplished by Comdr. G. L. Neely, USNR, Lt. Comdr. C. S. Goddin, USNR, Lieut. W. H. Millet, USNR, and Ens. E. R. Dalbey, USNR, interpreter and translator.



C. G. GRIMES
Captain, USN

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SUMMARY

MISCELLANEOUS TARGETS

JAPANESE FUELS AND LUBRICANTS - ARTICLE 10 OIL TECHNOLOGY AND REFINING INSTALLATIONS

This report includes certain miscellaneous data pertaining to petroleum refining installations and technology obtained by the Petroleum Section of the U. S. Naval Technical Mission to Japan.

The refining industry in Japan was based largely on imports of foreign crudes principally from the United States, and the refining techniques utilized were chiefly drawn from American practice.

An expensive industry was developed for the manufacture of refining equipment and the newer refineries were essentially 100% Japanese-made. The quality and appearance of such equipment as pressure vessels, tanks, pumps, and heat exchangers compared favorably with that produced in America.

The Japanese refining technology differed from American mainly with regard to processes utilized for the production of aviation gasoline. The manufacture of iso-octane by alkylation and polymerization was very limited due to inadequate supplies of C_4 hydrocarbons. Emphasis was put on the hydrocracking of kerosene and gas oils, with strenuous efforts being made to develop a fixed-bed catalytic cracking process. Several plants were put into operation by late 1943, using Japanese acid clay as a catalyst. The fluid-catalyst technique was unknown to Japan.

With regard to manufacture of oil from shale, a plant for refining crude wax shipped from the shale works at FUSHUN, was visited at TOKUYAMA, but no evidence of the existence of any shale mining or retorting operations in Japan was discovered.

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LIST OF ENCLOSURES

- (A) List of Documents in Japanese Pertaining to Research on Miscellaneous Oil Technology at the First Naval Fuel Depot, OFUNA, forwarded through ATIS to the Washington Document Center Page 11
- (B) Detailed Reports of Research on Miscellaneous Oil Technology at the First Naval Fuel Depot, OFUNA
- (B)1 "Studies on Acid Clay" by Chem. Eng. Comdr. H. FUJIMOTO Page 15
- (B)2 "Entrainment and Plate Efficiency on Bubble-Cap Rectifying Columns" by Chem. Eng. Lieut. T. YCKOYAMA ... Page 21
- (C) "Development of Catalytic Cracking in Japan" by N. NAKAHARA, President of Toa Nenryo K. K. Page 33
- (D) "The Petroleum Industry in Japan" by J. AOKI and G. NARA of the Shun Nomura Office Page 43
- (E) "Nippon Oil Co., Kudamatsu Plant" - Report by NavTechJap Page 59
- (F) "The Third Naval Fuel Depot, Tokuyama Refinery" Report by NavTechJap Page 67
- (G) "The Nippon Seiro K. K., Tokuyama Plant" - Report by NavTechJap Page 81

REFERENCES

Location of Target:

First Naval Fuel Depot, OFUNA
Third Naval Fuel Depot, TOKUYAMA
Nippon Seiro K. K., TOKUYAMA
Nippon Oil Co., KUDAMATSU

Japanese Personnel Interviewed:

H. FUJIMOTO: Chemical Engineering Commander, Japanese Navy, head of the cracking, dry distillation and pine root oil sections at the First Naval Fuel Depot, OFUNA.

T. YOKOYAMA: Chemical Engineering Lieutenant, Japanese Navy, at the First Naval Fuel Depot, OFUNA.

N. NAKAHARA: President of the Toa Nenryo K. K. (closely associated with development of catalytic cracking in Japan. Visited United States in 1939 in attempt to purchase Houdry Patents).

S. NOMURA: President of the Tatsumi Engineering Company and a leading importer of crude oil into Japan.

NISHINO: Vice-Superintendent of the Nippon Oil Company Refinery at KUDAMATSU.

I. WATANABE: Rear Admiral, Japanese Navy, Director of the Third Naval Fuel Depot, TOKUYAMA.

M. TAMURA: General Manager of the Nippon Seiro Plant at TOKUYAMA

~~In addition to the key personnel listed above, a number of~~
technical assistants were interviewed and are listed in the Enclosures contained in this report.

INTRODUCTION

In the course of gathering information on fuel and lubricant developments in Japan, several petroleum refining installations were inspected and certain miscellaneous data pertaining to oil refining technology were secured by the Petroleum Section of the U. S. Naval Technical Mission to Japan. No attempt was made to completely survey conventional refining installations or to obtain statistical information on imports, production, inventories etc., since such aspects were being thoroughly studied by other agencies, especially the U. S. Strategic Bombing Survey and the U. S. Army Intelligence Branches.

In view of the foregoing, the following comments refer only to refining features or refinery data thought to be of special interest and not discussed in the other fuel and lubricant reports prepared by NavTechJap.

Two crude oil refineries, the Nippon Oil Co. refinery at KUDAMATSU and the Japanese Navy refinery at TOKUYAMA, were inspected and are described in Enclosures (E) and (F). An inspection was also made of the Nippon Seiro Co. at TOKUYAMA, which manufactured paraffin wax from crude shale wax shipped from the shale retorting installations at FUSHUN (Enclosure (G)). Of interest are two papers prepared at the request of the Petroleum Section; one reviewing the development of catalytic cracking in Japan by N. NAKAHARA, President of the Toa Nenryo Co., and the other surveying the development of the civilian petroleum industry in Japan, prepared by the Shun Nomura Office, (Enclosures (C) and (D)). Certain miscellaneous reports and a list of documents obtained from the First Naval Fuel Depot, OYUDA, are also presented, Enclosures (A) and (B).

THE REPORT

Prior to the war, Japan's domestic consumption of petroleum amounted to about 20,000,000 barrels per year. Domestic production of crude oil was only about 2,500,000 barrels per year maximum, (including Formosa), and synthetic oil manufacture, including shale oil from Manchuria, amounted to about 850,000 barrels per year. Consequently, about 84% of the nation's peacetime requirement had to be met by importation of foreign crudes, especially from America. The petroleum refining industry in Japan was built largely on the basis of processing imported crudes, and the technology utilized was chiefly based on American distillation, cracking, and treating processes. The total refining capacity in the four main islands of Japan has been estimated at 35-40,000,000 barrels per year.

In anticipation of the war, Japan purchased crude and refined products in excess of requirements, and it has been reported that more than 80,000,000 barrels were in storage prior to Pearl Harbor. Tremendous storage installations were constructed for this purpose. For example, the bulk storage capacity of the Third Naval Fuel Depot at TOKUYAMA was some 2,000,000 barrels; the Sasebo Navy Yard, 4,000,000 barrels; and the Kure Navy Yard, 1,000,000 barrels, all mostly underground.

After the outbreak of the war, imports practically stopped until oil from BORNEO and SUMATRA became available in 1942. By the end of 1943, the submarine and air blockade caused imports of these East Indies oils to drop rapidly. By the beginning of 1945, most refineries in Japan were shut down due to lack of crude. This is illustrated by the following data obtained from the 1500kl/day Navy Refinery at TOKUYAMA, and the 800kl/day Nippon Oil Co. Refinery at KUDAMATSU.

CRUDE RUN - KILOLITERS PER YEAR

YEAR	TOKUYAMA		KUDAMATSU		
	EAST INDIES	CALIF.	EAST INDIES	CALIF.	MEXICO. & MISC.
1942	0	550,000	16,300	22,200	28,800
1943	290,000	260,000	84,500	130	600
1944	240,000	226,000	69,600	0	0
1945	12,000	0	18,100	0	0

Further data on various aspects of the civilian petroleum industry in Japan are included in Enclosure (D), prepared by the staff of the Shun Nomura Office in TOKYO.

Both the Japanese Navy and Army operated refineries in the Japanese Empire. The Navy had three refineries, a 17,000 bbl/day plant at YOKKAICHI (The Second Naval Fuel Depot), a 9500 bbl/day unit at TOKUYAMA (The Third Naval Fuel Depot), and a small unit at TAKAO Formosa (The Sixth Naval Fuel Depot). The Army initiated an active fuel and research program only shortly before the war and constructed several refineries, the largest of which was begun in 1940 at I-AKUTI.

Both the Yokkaichi and Tokuyama refineries were very similar with respect to the processes and types of equipment utilized. The refinery at TOKUYAMA was the older of the two, the first pipe-still in Japan having been installed there

in 1920. This refinery was visited and is described in Enclosure (F). This refinery was staffed by Naval petroleum specialists and was one of the most modern and best equipped refineries in Japan, comparing favorably to the best American practice. It was equipped to carry on crude distillation, thermal cracking, iso-octane manufacture by hydrogenation of butene polymers, hydrogenation of cracked gasoline, hydrocracking of kerosene, synthesis of methanol, solvent refining of lube oils, and the manufacture of greases and tetra-ethyl lead. Near the close of the war preparations were being made for the processing of crude pine root oil for the manufacture of aviation gasoline.

One of the impressive features about the newer refining and synthetic oil plants visited in Japan was the fact that the actual equipment, including furnaces, towers, tanks, piping, pumps, heat exchangers, instruments, etc., was almost completely manufactured in Japan, and further, this equipment appeared to be of high quality.

Japanese refineries differed from modern American plants primarily in the methods employed for manufacturing aviation gasoline. The most successful processes from the standpoint of the amount of aviation gasoline actually produced appear to have been high pressure hydrogenation of cracked gasoline and hydrocracking of kerosene or gas oil. Strenuous efforts were made to develop a fixed-bed catalytic cracking process after negotiations to purchase rights to the Houdry and U.O.P. catalytic cracking processes failed due to the Moral Embargo in 1939. An interesting review of the development of the catalytic cracking process in Japan, prepared by Mr. N. NAKAHARA, President of Toa Henryo Co., is given in Enclosure (G).

The fluid catalyst technique was not applied in Japan, and no indication of research studies or application of this principal to any process was evidenced at any of the several petroleum activities visited by the Petroleum Section of NavTechJap. Catalytic cracking as developed in Japan was a simple process utilizing activated Japanese acid clays as catalyst and adiabatic type reactors (with the exception of the Toa Henryo Co., which used steam under pressure as a heat-removing medium). The Japanese Navy installed two 2000 bbl/day catalytic cracking units at the Yokkaichi Refinery, one of which was completed and produced 10,000kl. of aviation gasoline in 1944. Supplies of gas and oil charging stock were exhausted and the second unit completed in 1945 was never operated. These units had automatic valves and operated on a cycle of 10 minutes cracking and 20 minutes regeneration.

Japanese acid clay is worthy of special note because of the wide variety of its application in oil refining. It was used as a catalyst for catalytic cracking (Enclosure (B)1), catalytic reforming (article 4 of this series, "The Pine Root Oil Program in Japan", Index No. X-38(N)-4 Enclosures (B)-3 and (B)-4), catalytic dehydration of alcohols (article 2 of this series, "Aviation Gasoline Research by the Japanese Navy, Index No. X-38(N)-2, Enclosure (B)-10), and in the treating of gasolines and lube oils (Enclosure (D)).

The Japanese Navy employed an acid clay from the Takeda Acid Clay Co., produced near KOMATSU City, Ishikawa District, for the catalytic cracking unit at YOKKAICHI. This clay was said to be at least as effective as U.O.P. Synthetic. A typical analysis of this clay, after treatment by boiling three hours with 2N. sulphuric acid, follows:

Ignition Loss.....	8.5%
Al ₂ O ₃	24.5
SiO ₂	60.1
Fe ₂ O ₃	3.6
CaO.....	0.7
MgO.....	2.6

Total 100.5%

The more active Japanese clays were said to be equivalent to American "Filtrol" type.

A visit was made to the Nippon Seiro K. K., Tokuyama plant, which had been reported as processing shale oil, and it was found that this plant was established in 1929 by the South Manchurian Railway Co. to produce several grades of refined paraffin wax from crude pressed wax obtained from the shale oil installations at FUSHUN, Manchuria, (Enclosure (G)). Imports of the crude pressed wax had been cut off in the middle of 1945, and no information was available to the plant personnel of the status of Fushun operations. A copy of a Japanese book entitled "Shale Oil", written by Mr. Koki ISHIBASHI of the Research Department of the Fushun Coal Manufacturing Co. of the South Manchurian Railway Co. and published in 1940, was obtained and forwarded through ATIS to the Washington Document Center (refer to ATIS Number 4602, Document Number ND26-0031). This book contains some description of the shale mining, retorting and refining operations at FUSHUN. It was stated by executives of the Nippon Seiro K. K. that no shale mining or retorting industry, other than that at FUSHUN, existed in the Japanese Empire.

Enclosure (A) lists the titles of Japanese reports pertaining to miscellaneous investigations on petroleum and other subjects at the First Naval Fuel Depot, OFUNA, which were forwarded through ATIS to the Washington Document Center.