

ENCLOSURE (B) 17

**STUDIES ON THE MANUFACTURE
OF AVIATION GASOLINE
FROM SOYA-BEAN OIL**

by

**CHEM. ENG. LIEUT.
N. SAKOTA**

Research Period: 1944-1945

**Prepared for and Reviewed with Author by the
U.S. Naval Technical Mission to Japan**

Dec. 1945

ENCLOSURE (B)17

LIST OF TABLES
AND ILLUSTRATIONS

Table I(B)17 Data on Thermal Cracking in Autoclave Page 285

Table II(B)17 Properties of Composite Product Sample Page 287

Figure 1(B)17 Typical Autoclave Time - Temperature - Pressure
Relationship (Run No. 68) Page 287

Figure 2(B)17 Typical Material Balance Page 288

ENCLOSURE (B)17

SUMMARY

Aviation gasoline was obtained from soya-bean oil by thermal cracking in an autoclave. Gasoline was produced in about 20% yield with an octane value of 88.9 with 0.15% lead.

I. INTRODUCTIONA. History of Project

In Japan, research on the preparation of gasoline from soya-bean oil by heating with Japanese acid clay had been previously carried on but aviation gasoline was not successfully prepared. The present research was undertaken to investigate preparation of aviation gasoline by thermal cracking of soya-bean oil under high pressure. It was hoped that isomerization would occur during thermal cracking under these conditions.

These studies began in October 1944 and were continued until the present time.

B. Key Research Personnel Working on Project

Chem. Eng. Commander H. FUJIMOTO.
Chem. Eng. Lieutenant N. SAKOTA.

II. DETAILED DESCRIPTIONA. Test Apparatus

The apparatus used in the experiment was a horizontal, 10 liter rotating autoclave.

B. Test Procedure

400 grams of the oil, with properties shown below, were heated in the autoclave at 470°C for 30 minutes. The pressure was indicated on a manometer attached to the apparatus. The chemical changes taking place during the reaction are indicated by Figure 1(B)17. The gasoline fraction boiling below 170°C was washed with 10% H₂SO₄, then 5% NaOH, rectified, dried with anhydrous Na₂SO₄, and the physical and chemical properties determined.

Properties of Charged Oil

| | |
|-------------------------------|--------|
| D ₁₅ ¹⁵ | 0.925 |
| N ₂₀ | 1.4751 |
| D | |
| Acid Value | 1.45 |
| Saponification Value | 188.5 |
| Iodine Value | 138.0 |

C. Experimental Results

Data on thermal, cracking runs in the autoclave are given in Table I(B)17. A material balance is given by Figure 2(B)17. The total gasoline from all runs has the chemical and physical properties shown in Table II(B)17.

ENCLOSURE (B)17

III. CONCLUSION

Soya-bean oil, heated to 450°C, was cracked to liquid and gaseous substances. A gasoline fraction was isolated in 20% yield. The octane number of this gasoline was 88.9 (leaded 0.15%) and about 40% of the fraction was composed of aromatic hydrocarbons. The cracking of soya-bean oil is a possible source of supply for aviation gasoline blending stock.

The high octane of the gasoline was due to the presence of 40% aromatics formed by the aromatization of paraffins during the reaction.

This process was not used on a commercial scale. Engine performance data on the gasoline were not obtained.

ENCLOSURE (B) 17

Table I(B)17

DATA ON THERMAL CRACKING IN AUTOCLAVE

| Test Number | | 62 | 63 | 64 | 65 | 66 |
|-----------------------------------|----------------------------------|------|------|------|------|------|
| Max. Press. (kg/cm ²) | | 45 | 48 | 45 | 45 | 45 |
| End. Press. (kg/cm ²) | | 15 | 15 | 16 | 15 | 15 |
| Yields (Wt%) | Oil | 43.0 | 37.5 | 45.0 | 38.3 | 38.3 |
| | Water | 2.7 | 5.0 | 4.5 | | |
| | Carbon | 7.5 | 5.4 | 6.3 | 4.5 | 4.0 |
| Analysis of evolved gas (%) | CO ₂ | 12.0 | 12.5 | 11.6 | 12.2 | 14.5 |
| | O ₂ | 0.2 | 0.1 | 0.3 | 0.6 | 0.5 |
| | C _n H _{2n} | 4.1 | 4.0 | 4.5 | 3.4 | 4.2 |
| | CO | 8.8 | 9.7 | 10.0 | 13.8 | 6.1 |
| | H ₂ | 23.4 | 22.5 | 19.5 | 17.5 | 21.4 |
| | C _n H _{2n-2} | 36.1 | 28.7 | 39.5 | 36.3 | 40.2 |

ENCLOSURE (B)17

Table II(B)17

PROPERTIES OF COMPOSITE PRODUCT SAMPLE

| | | Product Oil | Gasoline |
|---|------------------|-------------|----------|
| Spec. Gravity 15/4 | | 0.8770 | 0.7831 |
| Acid Value | | 16 | 0 |
| Saponification Value | | 21 | 0 |
| Iodine Value | | | 54 |
| Distillation | init. pt. °C | 68 | 53 |
| | 10% | 85.5 | 75 |
| | 20 | 106 | 84 |
| | 30 | 126 | 92.5 |
| | 40 | 146.5 | 101.5 |
| | 50 | 173 | 110 |
| | 60 | 210 | 120 |
| | 70 | 251 | 130 |
| | 80 | 317 | 141 |
| | 90 | 382.5 | 156.5 |
| | 95 | | 172 |
| | | Dry pt. °C | 387 |
| Composition | Unsat. H.C.% | | 6.8 |
| | Aromatic H.C.% | | 42.0 |
| | Naphthenic H.C.% | | 35.3 |
| | Paraffinic H.C.% | | 15.1 |
| Octane Value with 0.15% lead | | | 88.9 |
| Yield of Aviation Gasoline wt% of product oil | | | 46.5 |

ENCLOSURE (B) 17

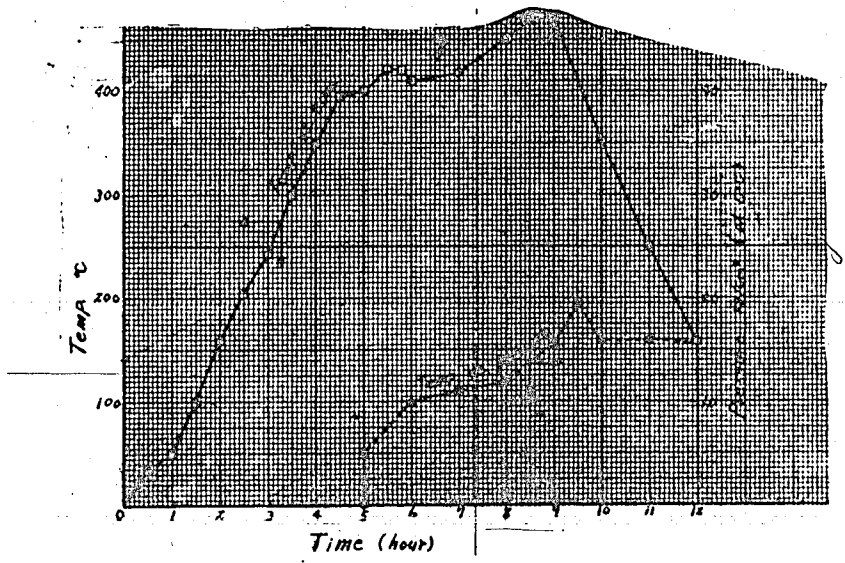


Figure 1(B)17
TYPICAL AUTOCLAVE TIME-TEMPERATURE-PRESSURE RELATIONSHIP (FOR NO. 68)

ENCLOSURE (B) 17

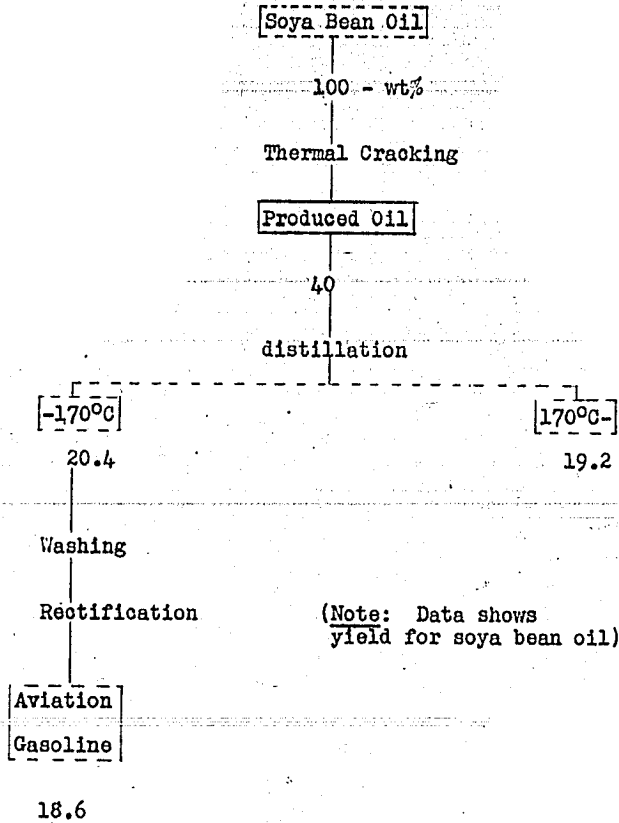


Figure 2(F) 17
TYPICAL MATERIAL BALANCE