ENCLOSURE (B) 19

STUDIES ON LUBRICATING OILS FOR THE MARINE AND AERO TORPEDO ENGINES

by

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LIST OF TABLES AND ILLUSTRATIONS

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SUMMARY

The objective of this project was to obtain an excellent lubricating oil for marine and aero topedo engines and the summary of results are shown as follows:

1. The conditions of lubrication in the marine torpedo engine resemble those in the aircraft engine and the following lubricating oil was prepared from Oha crude oil by solvent extraction and observed to be an excellent oil in practical tests:

Density (25/4)	0.8804
Flash point (°C)	222
Viscosity in S.U.S at 100°F.	1042.7
at 210°F.	92.3
Viscosity index	99
Acid value	none
Saponification	0.45
Conradson's carbon(%)	0.55
Pour point (oC)	-14

A mixture of 80% of imported aero engine oil #100 and 20% of imported aero engine oil #80 has almost the same properties as the above mentioned oil and this mixture was actually used.

2. The lubricating oil for aero torpedo engine is used at lower temperature than that for the marine torpedo engine and it is necessary to have a much lower pour point. A synthetic oil was prepared from a fraction of shale crude oil boiling from 200° to 300°C by the polymerization method and it was found satisfactory in service. Its properties are as follows:

Density (15/4)	0.8950
Flash point (°C)	225
Viscosity in S.U.S. at 210°F	93
Viscosity index	92
Saponification value	2.8
Conradson's carbon(%)	0.35
Pour point (°C)	-32
Corrosion test	OK

This oil, however, was unsuitable for use in the coldest zone and it was used mainly near the main islands of Japan or in the tropical zone.

3. For the coldest zone, a synthetic oil was prepared by polymerizing fraction boiling from 100°C to 230°C of the cracked distillate of paraffine wax and adding 1.5% of aluminium oleate to the product of polymerization.

It was found satisfactory in practical tests. This oil was observed to be suitable for use not only in the coldest zone, but also in the tropical zone. Its properties are as follows:

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Density (15/4)	0.8700
Flash point (°C)	230
Viscosity in S.U.S. 210°F	96
Viscosity index	112
Saponification value	2.8
Conradson's carbon(%)	0.08
Pour point (°C)	-46

I. INTRODUCTION

A. History of Project

For the marine torpedo engine, a steam cylinder oil had been used in summer and a mixture of 75% of steam cylinder oil and 25% of rape oil in winter. The formation of sludge in the engine was comparatively large in using these oils and it was necessary to decrease it.

The conditions of lubrication in the torpedo engine resembles that in the aero engine, and an oil prepared by the same method for aero engine oil should be suitable for the torpedo engine. Thus, studies were carried on in regard to the preparation of the marine torpedo engine oil by the solvent extraction of Oha crude oil from 1938 and finished 1940 with successful results in 1943.

B. Key Research Personnel:

Chem. Eng. Capt., Dr. I. KAGEHIRA
Chem. Eng. Lt. Comdr. N. IIMUR
Chem Eng. Lt. Comdr. E. KOSUGI

II. DETAILED DESCRIPTION

A. Marine torpedo engine oil

1. Procedure of Preparation: Marine torpedo engine oil was prepared from 50% topped residue of the Oha crude oil by the following solvent extraction method: the residual oil was deasphalted by 5 volumes of liquid propane at 45°C, and the deasphalted oil was extracted at 45°C by 6 volumes of phanol and the raffinate was dewaxed at (-) 20°C by 5 volumes of a mixture of 35% acetone and 65% benzene. The dewaxed oil was topped to have a desirable viscosity followed by treating with 10% acid clay. These procedures are given in Figure 1(B)19.

2. Results: Properties of a marine torpedo engine oil prepared by the above mentioned procedure are shown below:

Density (25/4)	0.8801
Flash point (°C)	222
Viscosity in S.U.S at 100°F	1042.7
at 210°F	92.3
Viscosity index	99
Acid value	none
Saponification value	0.45
Conradson's carbon(%)	0.55
Pour point (°C)	-14

This oil was subjected to practical tests at the Kure Naval Arsenal and found to be an excellent oil for the marine torpedo engine.

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But its production was not enough to supply the demand, and a mixture of an aero engine oil #100 and an aero engine oil #80, imported from U.S.A., in a ratio of 80 to 20 by volume was actually used, since this mixture had the same properties of the former oil.

R The Aero Torpedo Engine Oil

1. Preparation from Shale Oil

a. Procedure of Preparation. An aero torpedo engine oil was prepared from Shale oil obtained at Fushun, South Manchuria, by the following method: a gas oil fraction boiling 200° to 300°C was treated with 5 volumes of 10% caustic soda solution, 2% of 50° Be sulphuric acid, 2% of 66° Be sulphuric acid, 50% of 10% caustic soda solution and a small amount of acid clay. The refined oil obtained was fractionated by a steam distillation and a fraction boiling from 200°C to 300°C was polymerized at 80°C - 100°C in the presence of 10% of aluminium chloride. The polymer was dechlorinated at 200°C by 5% of a mixture of two parts of acid clay and one part of calcium oxide and topped off lighter fractions in a vacuum distillation. Finally 1.5% of aluminium oleate was added to the above residual oil to prevent the oil washing out by sea water in the aero torpedo engine at the end of its running on trial shots. The steps in the manufacturing procedure are shown in the Figure 2(B)19.

b. Results. The properties of an aero torpedo engine oil prepared from shale gas are as follows:

Density (15/4)	0.8950
Flash point (°C)	225
Viscosity in S.U.S. at 210°F	93
Viscosity index	92
Saponification value	2.8
Conradson's carbon(%)	0.35
Pour point (°C)	-32
Corrosion test	OK

This oil was usbjected to practical tests at the Naval Aeronautical Arsenal, YOKOSUKA, and found suitable for aero torpedo engines used near the main island of Japan or in the tropical zone, but unsatisfactory for use in the coldest zone. This oil was prepared and supplied to the Japanese Navy from FUSHUN in Manchuria.

2. Preparation from Paraffin Wax. Since aero torpedo engine oil from shale gas oil was found unsatisfactory for use in the coldest zone, its preparation from paraffin wax was studied.

a. Procedure of Preparation. (Refer to Plate 1(B)19) A fraction boiling from 100°C to 230°C of cracked distillate of paraffin wax was polymerized in the presence of 3% of $AlCl_3$ at 100°C for 10 hrs. and the polymerized product was dechlorinated at 200°C by 5% of a mixture of two parts acid clay and one part calcium oxide.

The dechlorinated oil was distilled in vacuum of 5mm Hg and its residual oil was treated with 5% of acid clay. Finally the clay treated oil was compounded with 1.5% of aluminium oleate. The procedure of preparation is shown in the Figure 3(B)19.

b. Results. The properties of an aero torpedo engine oil prepared from the cracked paraffin are as follows:

Density (15/4)	0.8700
Flash point (°C)	230
Viscosity in S.U.S at 210°F	96
Viscosity Index	112
Saponification value	2.8
Conradson's carbon(%)	0.08
Pour point (°C)	-46
Corrosion test	OK

(Contained 1.5% aluminium oleate.

This oil was subjected to practical tests at the Naval Aeronautical Arsenal, Yokosuka and found superior for use in the coldest zone and also for the tropical zone. Since then, 1943, this synthetic oil has been used for this service.

III. CONCLUSIONS

Marine or aero torpedo engine oils of superior properties were manufactured from Oha crude oil by the solvent extraction method and from shale gas oil or cracked distillate of paraffin wax by the polymerization method, and all of these products were used in this service. From the service performance of these products, it was concluded that marine torpedo engine oil should be a well-refined mineral oil and that the aero torpedo engine oil should be prepared from olefin-hydrocarbons in order to possess very low pour point.

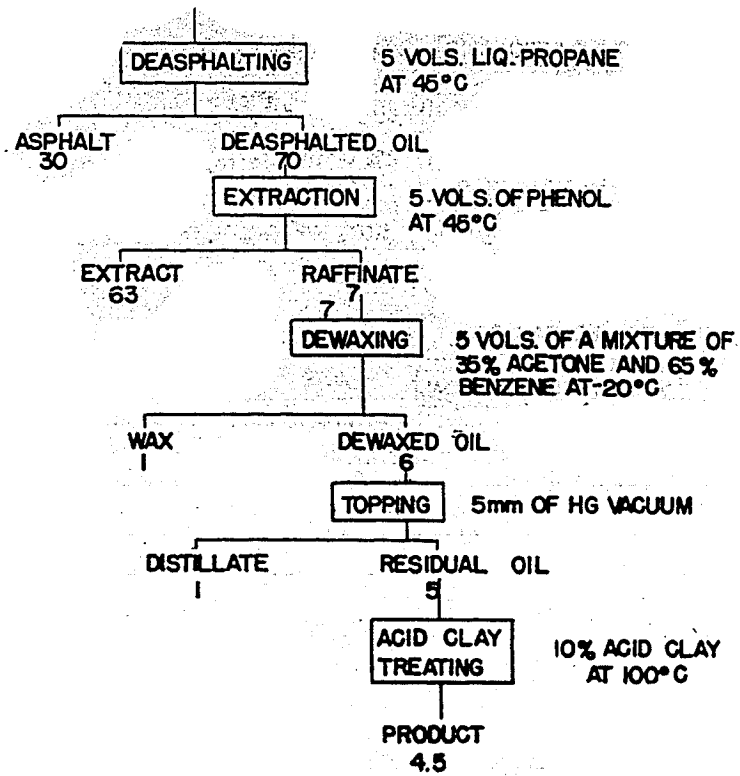

Figure 1(B)19
PREPARATION OF A MARINE TORPEDO ENGINE OIL BY SOLVENT EXTRACTION

ENCLOSURE (B)19

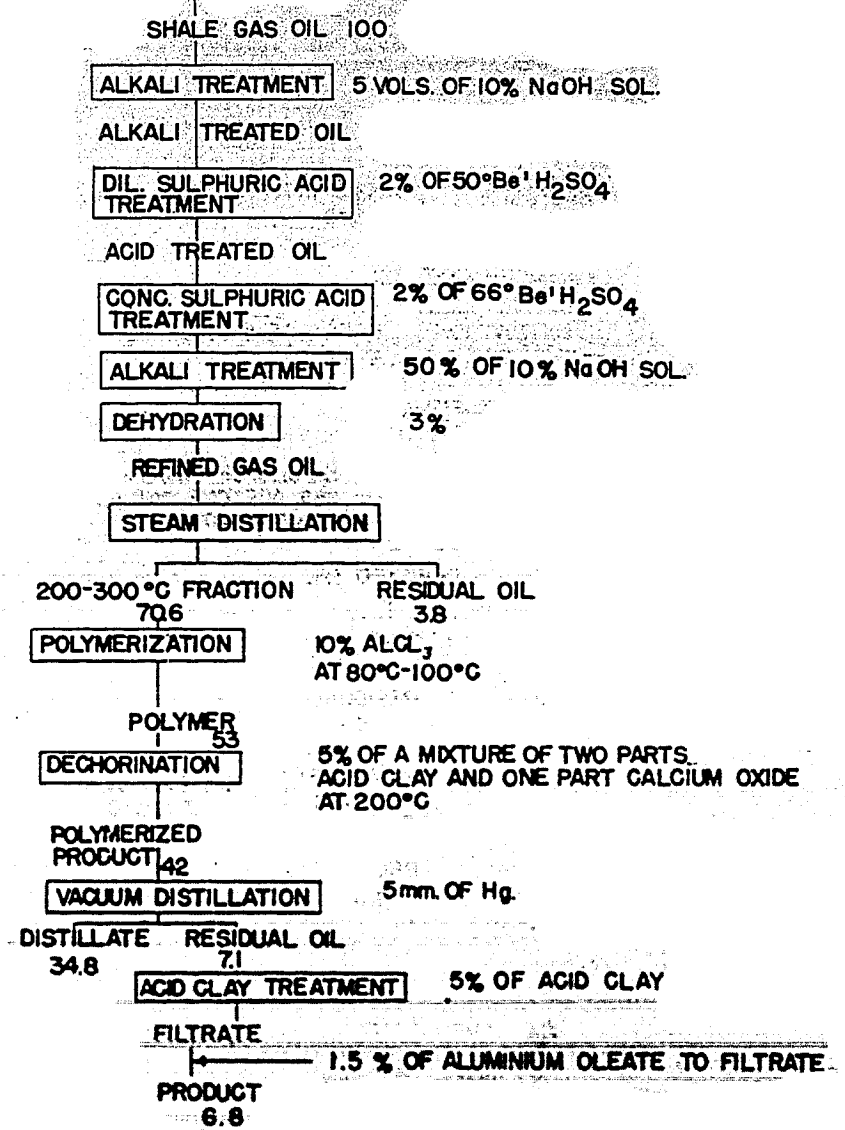

Figure 2(F)19

PREPARATION OF AN AERO TORPEDO ENGINE OIL FROM SHALE GAS OIL

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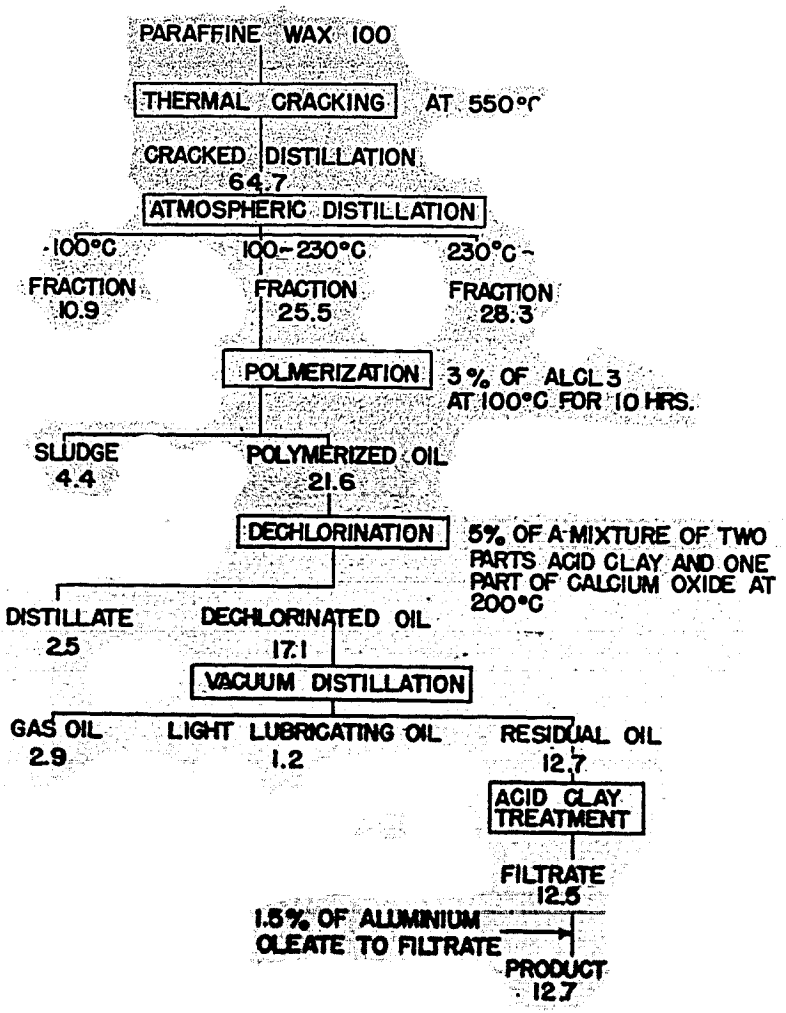

Figure 3(B)19
PROCEDURE OF PREPARING AN
AERO TORPEDO ENGINE OIL FROM PARAFFIN WAX

ENCLOSURE (B)19

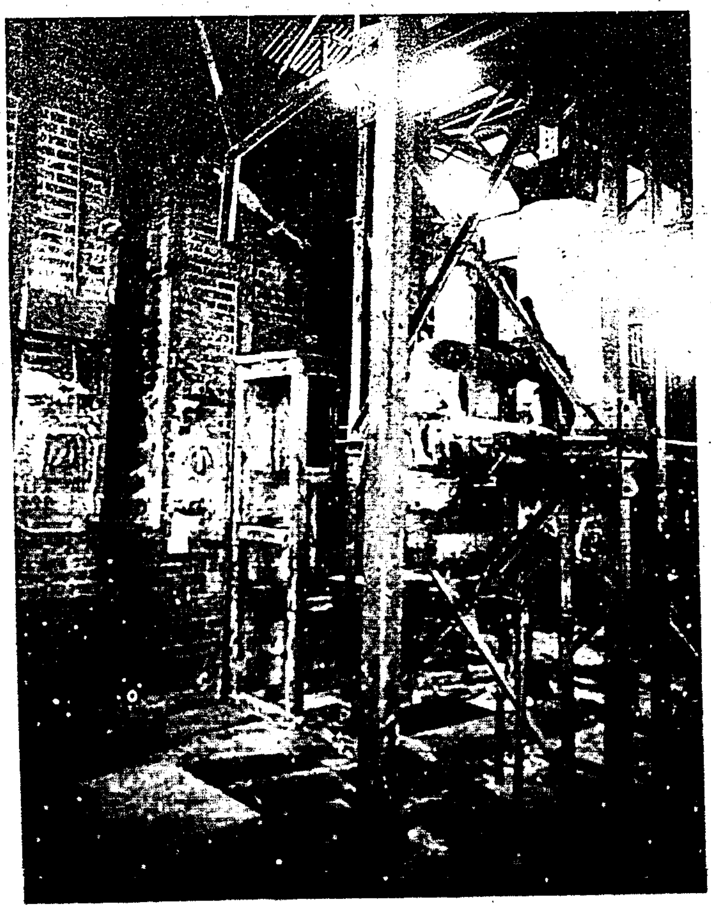

Figure [illegible]

[illegible] PARAFFIN [illegible] THERMAL CRACKING FURNACE

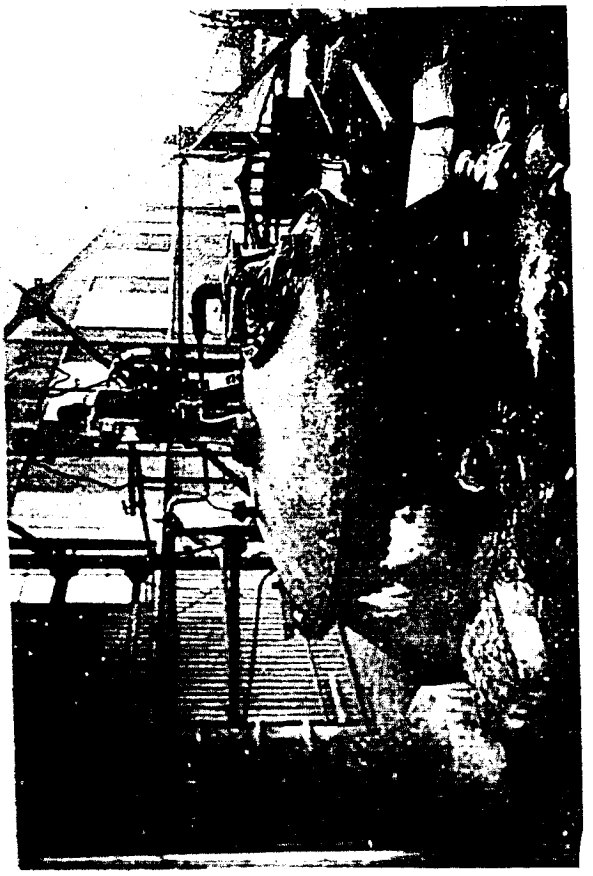

Figure 5(B)19
DECHLORINATION KETTLE

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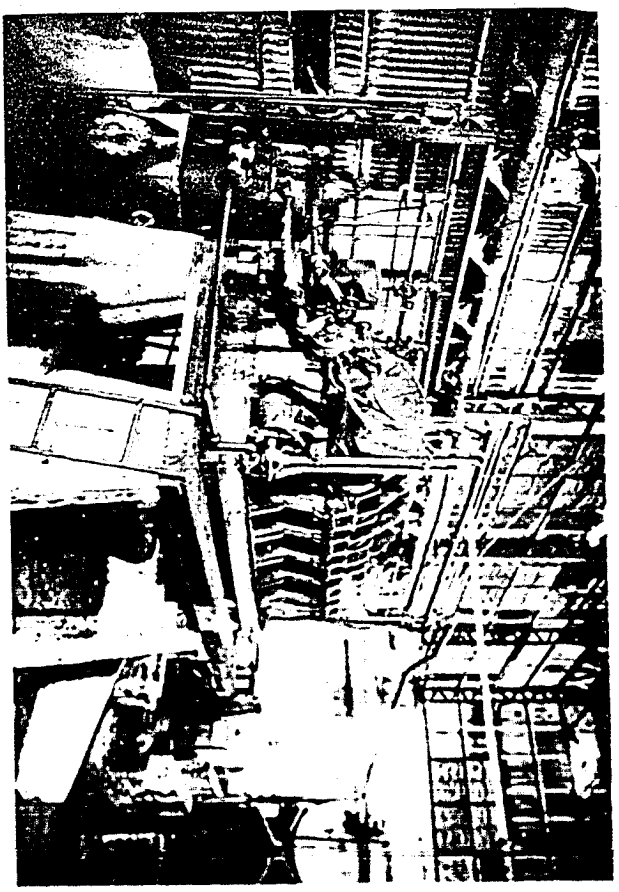

Figure (B)29
GAS AERATION UNIT FOR LUBRICANTS

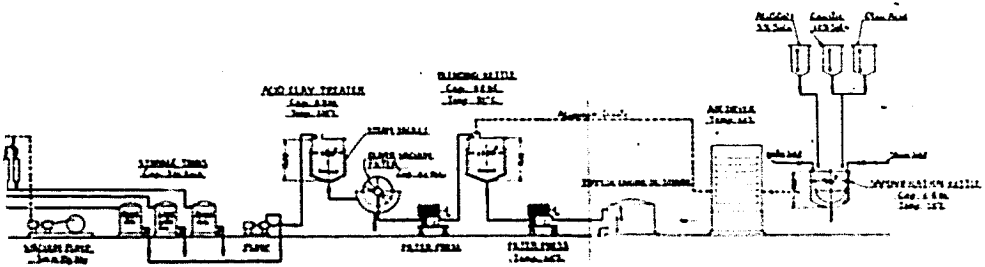

PLATE I (B) (i)

FLOW SHEET OF PILOT PLANT OF TORPEDO ENGINE LUB OIL

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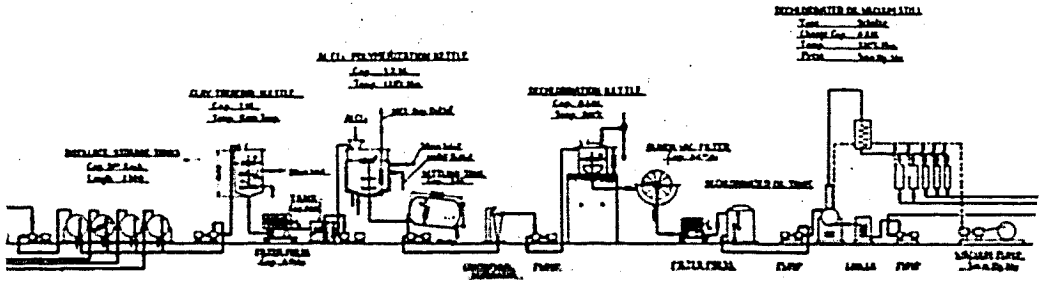

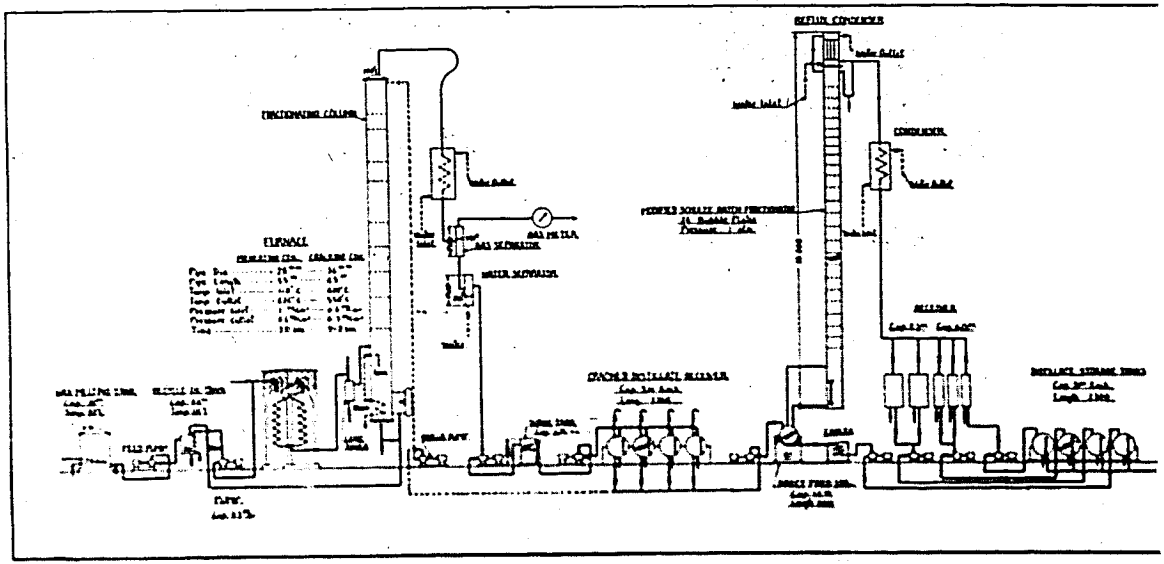
REFLUX CONDENSER
FRACTIONATING COLUMN
CONDENSER
FURNACE
GAS METER
GAS SCRUBBER
WATER SCRUBBER
GAS HOLDER
FEED PUMP