

TABLES

TABLE 1
COMPOSITION OF FISCHER-TROPSCH REACTOR-WAXES (wt%) [4]
(Fe-based catalyst)

Carbon Number	Mobil Run CT-256-3	Mobil Run CT-256-4	Mobil Run CT-256-5
10-20	7.7	1.9	1.5
21-25	15.1	3.9	3.1
26-30	19.8	6.2	3.9
31-35	17.9	6.6	4.3
36-40	13.2	5.3	3.5
41-45	9.7	4.6	3.3
46-50	6.7	4.1	3.1
51-55	3.9	2.6	2.6
55+	6.0	64.8	74.7
Total	100.0	100.0	100.0
For C ₅₅ +			
Molar Avg. MW	460	814	976
(Avg. Carbon No.)	(33)	(58)	(70)
Weight Avg. MW	596	1135	1291
(Avg. Carbon No.)	(42)	(81)	(92)

TABLE 2
COMPOSITION OF FISCHER-TROPSCH WAXES* [5]

	Arge Wax	Air Products	Union Carbide	Mobil Wax
Avg. Carbon Number	47	23	28	51
Hydrocarbon Types, wt%				
Paraffins	88.0	89.7	90.5	64.6
Mono-Olefins (major type)	5.6	7.0	6.2	23.2
Diolefins (major type)	0.1	0.2	0.1	1.4
Monoaromatics	0.3	0.2	0.5	0.8
Oxygenates, wt% (major type aliphatic alcohols)	6.0	2.9	2.7	10.0
Branched molecules, %	2.3	44.0	13.0	31.0

* The sources of the reactor waxes were a commercial Arge fixed-bed reactor (Fe), and three pilot plants operated by Air Products and Chemicals, Inc. (Co), Union Carbide Corp. (Co), and Mobil Corp. (Fe).

TABLE 3
PHYSICAL PROPERTIES
OF F-T SLURRY BUBBLE-COLUMN MEDIUMS [1]

	FT-200 Wax ¹	Reactor-Wax Mobil Run 4	Reactor-Wax Mobil Run 5
Density (260°C), g/cm ³	0.72	0.69	0.71
Surface Tension (260°C), Dynes/cm	24.0	26.27	28.0
Viscosity (204/149°C), cP	2.2/-	4.3/6.1	8.5/17.6

¹ molecular weight 600.

TABLE 4
PHYSICAL PROPERTIES OF F-T WAXES [6]

Wax Type	Temp. (°C)	Density (kg/m ³)	Viscosity (mPa.s)
FT-300 Wax ¹	200	722	4.2
	265	681	2.7
Sasol Wax ²	200	701	2.9
	265	655	2.0
Mobil Wax ³	200	716	3.8
	265	674	2.3

¹ from Dura Commodities Co. NY, average molecular weight 750.

² reactor wax from Sasol's Arge fixed-bed reactor.

³ composite reactor wax from Mobil pilot plant slurry reactor, Runs 9, 11, and 12.

TABLE 5
 PROPERTIES OF FISCHER-TROPSCH WAXES [5]

Analysis	Commercial Arge Wax (Fe)	Union Carbide (Co)	Air Products (Co)	Mobil Wax (Fe)
API	22.3	29.9	39.0	20.4
Specific Gravity	0.9200	0.8767	0.8299	0.9317
IBP, °F	597	547	417	518
Carbon, wt%	85.2	85.3	85.2	84.4
Hydrogen, wt%	14.7	14.7	14.8	15.3
Elemental Oxygen, wt%	0.1			
Sulfur, ppm	80	<100	<100	4
Nitrogen, ppm	16	0.1	10	3
Aniline Point, °F	293	258	239	298
Melting Point, °F	220	196	156	203
Viscosity, cSt @ 250°F	7.59	3.70	2.31	12.44
Conradson Carbon, wt%	<0.1	<0.1	<0.1	<0.1
n-C ₇ insolubles, wt%	24.4	0.44	<0.1	22.6
Metals, ppm	5.9	3.5	1.7	135*

* 133 ppm iron.

TABLE 6
 THERMAL CRACKING OF REACTOR-WAX VACUUM BOTTOMS [1]
 (Sample weight 200 g, Cracking temperature 454°C)

Run No.	1	2	3	4	5
Charge Cutpoint, °C	461	461	461	461	503
Run Time, sec	162	77	162	250	250
ERT*, sec	800	400	800	1200	1200
Pressure, MPa	1.48	0.79	1.20	-	-
Liquid Product, wt%	97.65	97.95	93.25	98.55	98.45
Light Gas, NL/g	0.86	0.40	0.79	1.27	0.09
C ₄₇₊ Converted, wt%	18.0	11.2	39.9	37.4	45.6

* ERT - equivalent residence time in the thermal cracker estimated at 427°C

TABLE 7
 EFFICIENCY OF SEDIMENTATION WITH VARIOUS TYPES OF INSERT
 IN SEDIMENTATION VESSEL [14]

Time, min.	Portion of vessel cleared of solids, % height			
	No insert	Inclined tubes	Cones and spiral turnings	Bent elliptical plates
5	0.8	4	18	60
10	1.2	8	40	100
20	2.5	17	78	-
30	3.7	25	100	-
40	4.9	33	-	-
50	6.0	42	-	-
60	7.0	52	-	-

TABLE 8

MAGNETIC SEPARATION OF CATALYST FINES FROM
SLURRY BUBBLE COLUMN WAX [38]

	Treatment			
	Example 1		Example 2	
	<u>None</u>	<u>HGMS</u>	<u>None</u>	<u>HGMS</u>
<u>PPM</u>				
Iron	7600	35	15000	56
Copper	170	14	215	3
Potassium	8	15	510	21
Nitrogen	40	50	-	-
<u>Weight, %</u>				
Solids	2	0.01	3	0.04
Solids removed	-	99.5	-	98.6

FIGURES

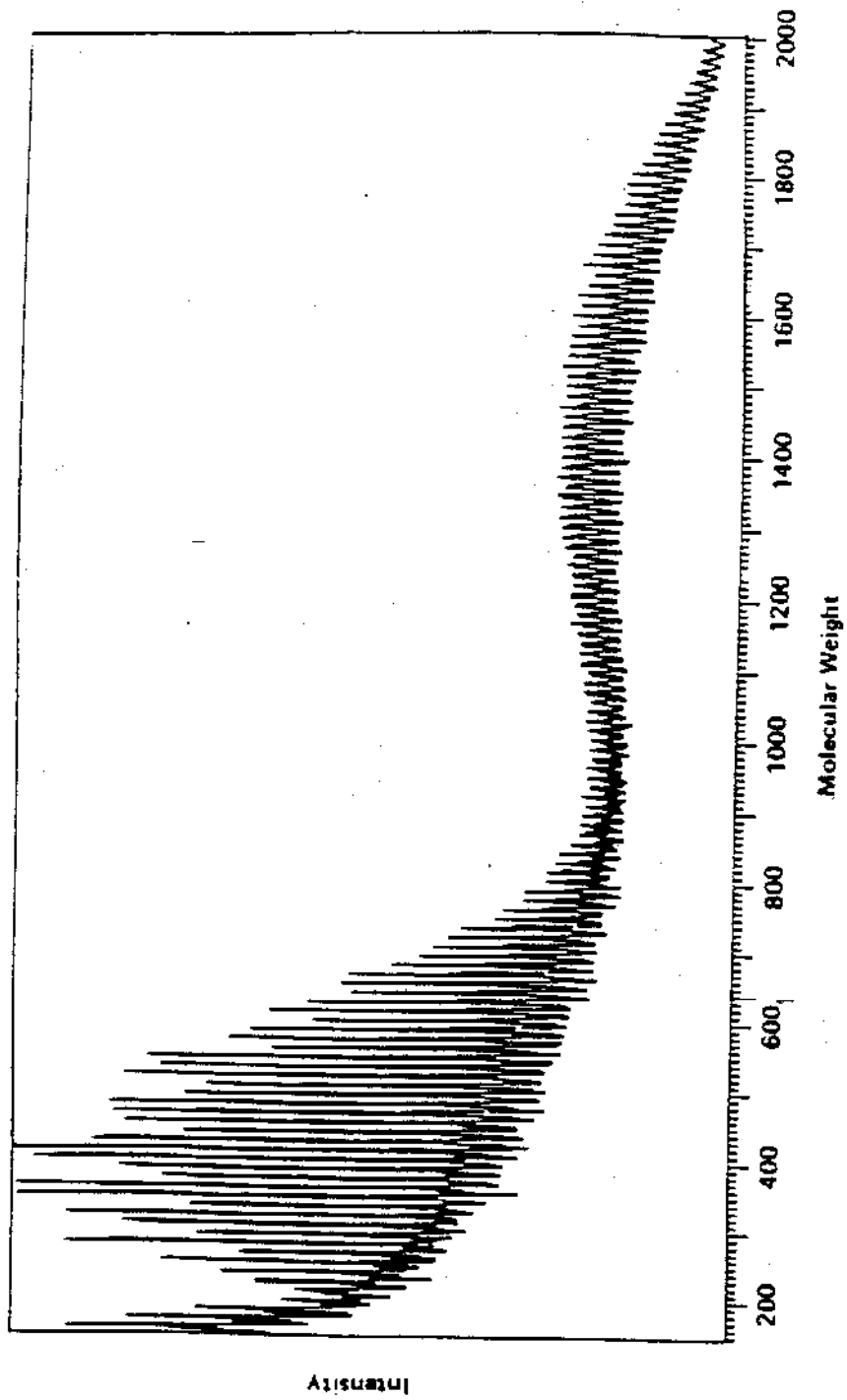


FIGURE 1. FIMS SPECTRUM OF RUN-256-4 REACTOR WAX (WIDE RANGE) [1]

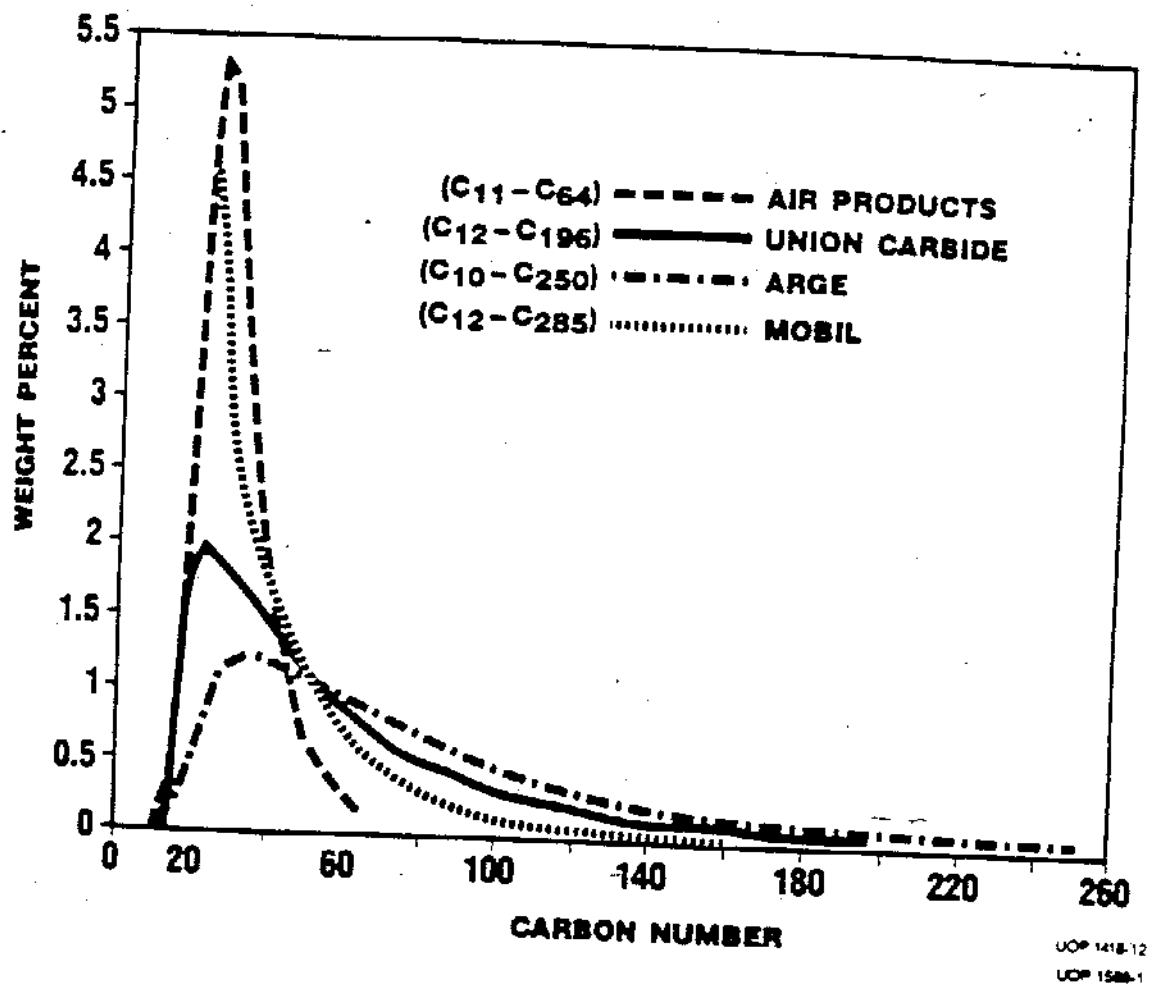


FIGURE 2. CARBON NUMBER DISTRIBUTION OF F-T WAXES [5]

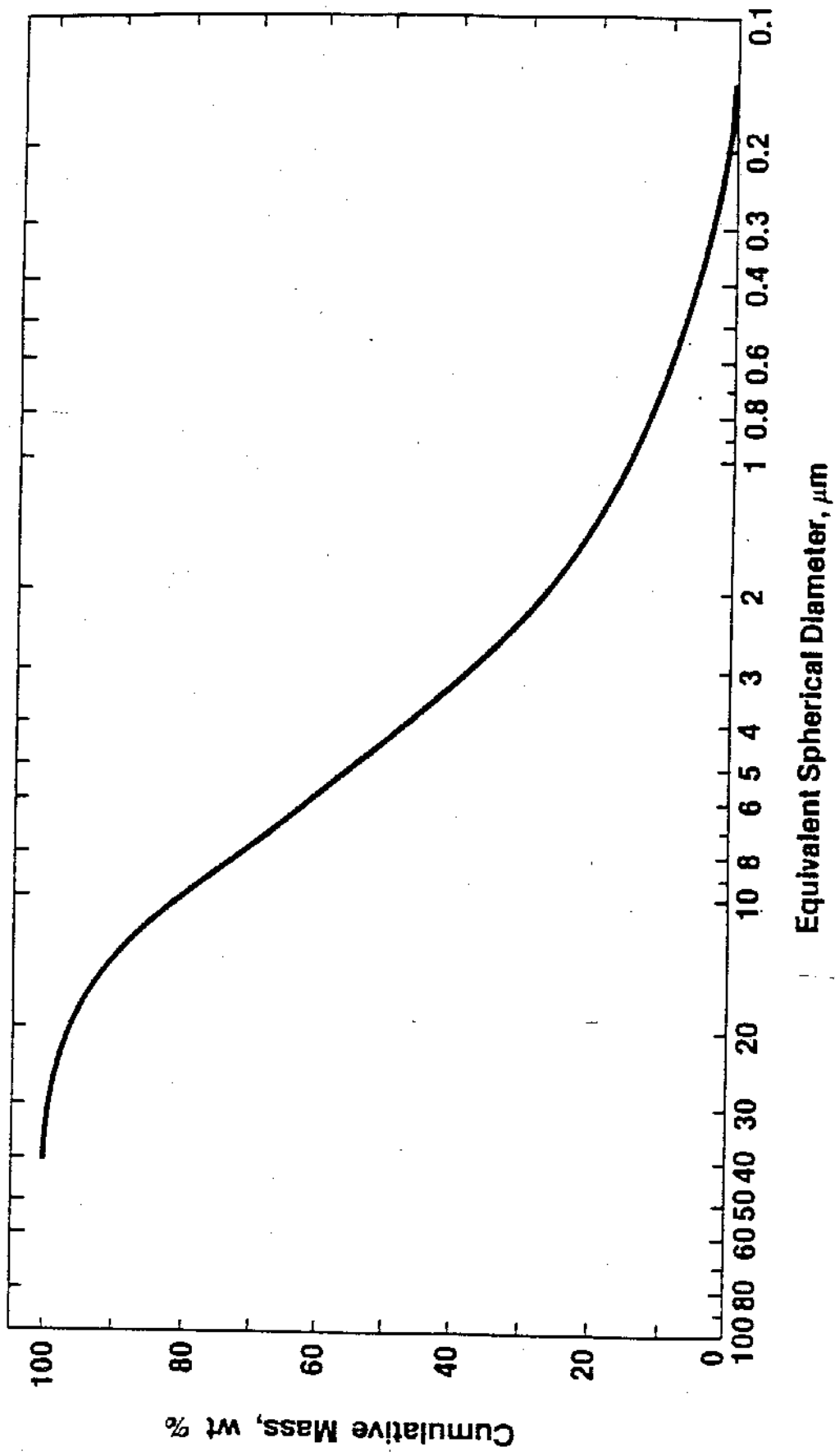


FIGURE 3. PARTICLE SIZE DISTRIBUTION OF FRESH CATALYST (Fe/Cu/K₂CO₃) [1]

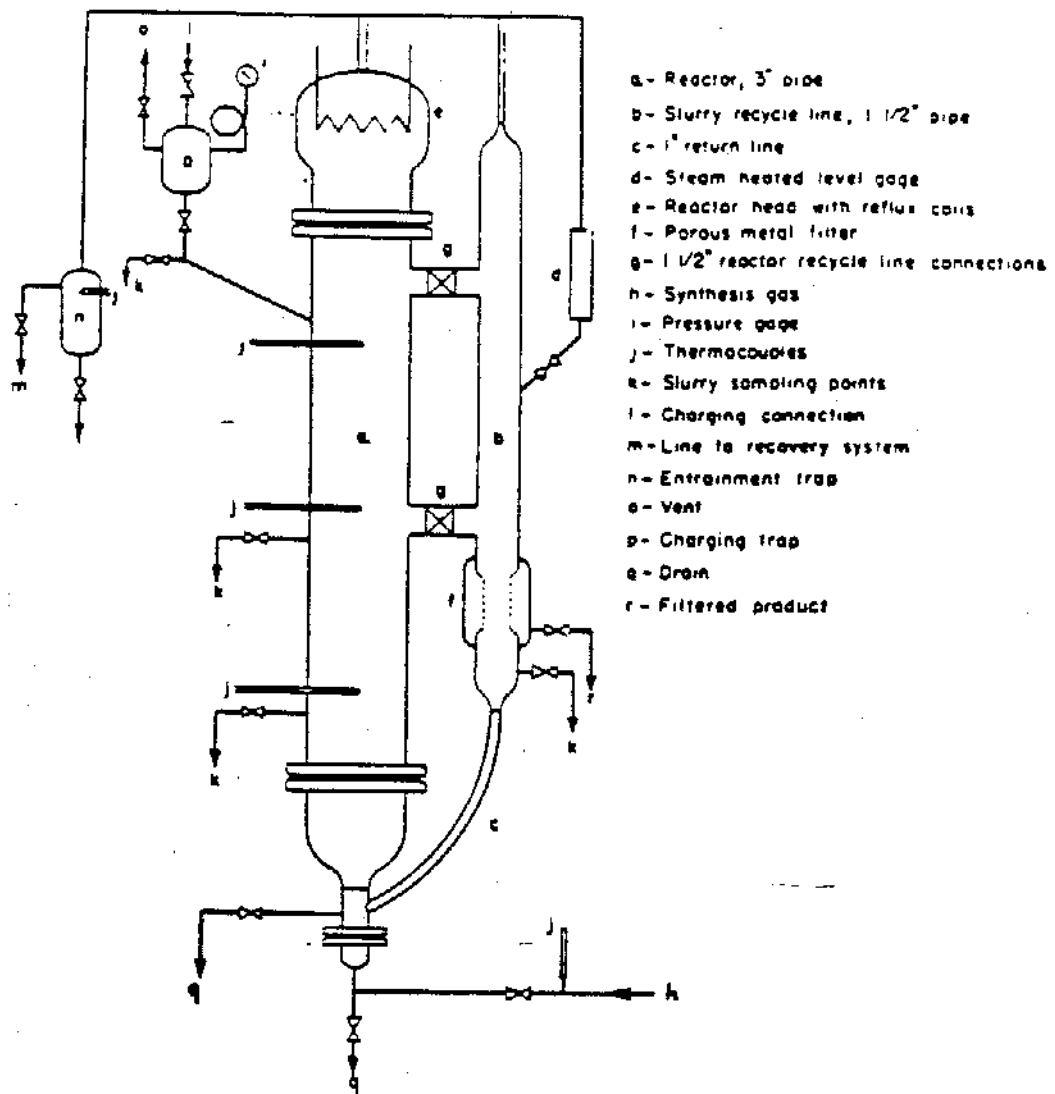


FIGURE 4. BUREAU OF MINES SLURRY REACTOR AND ACCESSORIES [24].

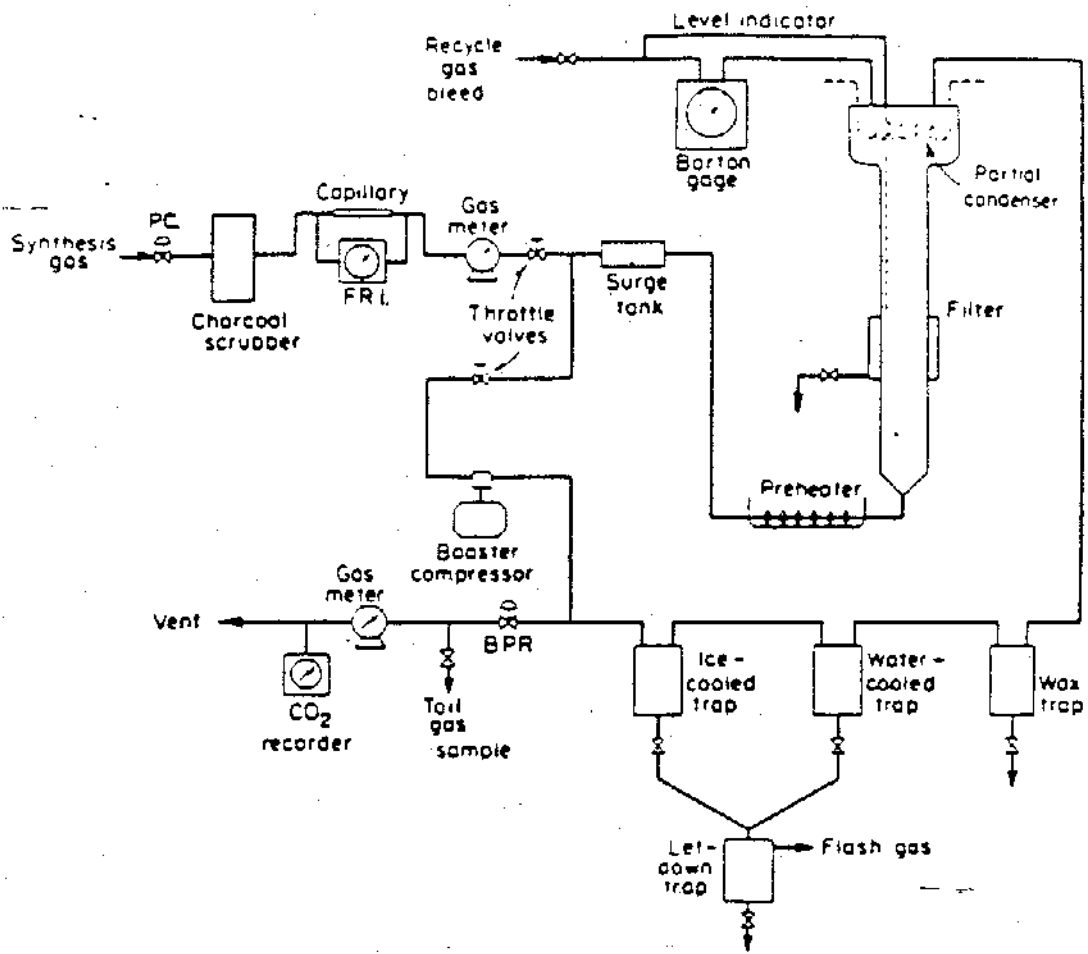


FIGURE 5. BUREAU OF MINES MODIFIED FISCHER-TROPSCH PROCESS [25].

NO.	NAME OF PART
1	17.5 IN. 1750 ATM
2	SHIMM HEATING VALVE
3	SHIELD TO ATM
4	MASS FLOW METER
5	SYNTHESIS GAS ROTAMETER
6	FLOWMETER
7	HEAT EXCHANGER
8	STEAM CHEST (COOLING SYSTEM)
9	GAS PREHEATER
10	GAS PREHEATER
11	REACTOR
12	PARTIAL CONDENSER
13	WATER COOLED CONDENSER
14	HIGH PRESSURE SEPARATOR
15	RESIDUAL GAS SCRUBBER
16	REFRIGERATED CONDENSER
17	DISSOLVED GAS CONDENSER
18	RESIDUAL GAS HEATER
19	RESIDUAL GAS ROTAMETER
20	RESIDUAL GAS ROTAMETER
21	WET GAS METER
22	GAS HOLDER
23	21" WATER SEAL
24	ROTAMETER TO VENT
25	WATER METER
26	STEAM CONDENSER (COOLING SYSTEM)
27	STEAM CONDENSER (COOLING SYSTEM)
28	DEAD WEIGHT VALVE (COOLING SYSTEM)
29	WATER HEATER (COOLING SYSTEM)
30	WATER PUMP
31	CATALYST ADDITION VESSEL
32	SLURRY MIXER
33	FILTER VESSEL
34	SEDIMENTATION VESSEL
35	WAX RECEIVER (P.C.)
36	LOW PRESSURE SEPARATOR
37	DISSOLVED GAS COOLER
38	DISSOLVED GAS HEATER
39	SIGHT GLASS (WATER PRODUCT)
40	SIGHT GLASS (OIL PRODUCT)
41	WATER RECEIVER
42	OIL RECEIVER
43	WATER PRODUCT STORAGE TANK
44	OIL PRODUCT STORAGE TANK
45	WATER PRODUCT STORAGE TANK
46	OIL PRODUCT STORAGE TANK
47	U TUBE
48	PURGING GAS CYLINDERS
49	SAFETY VALVE
50	PRESSURE LET DOWN AND FLOW CONTROL VALVE (GAS)
51	PRESSURE LET DOWN VALVE (OIL AND WATER PRODUCT)
52	PRESSURE LET DOWN VALVE (SOFT WAX PRODUCT)
53	PRESSURE LET DOWN VALVE (HARD WAX PRODUCT)
54	REDUCING VALVE

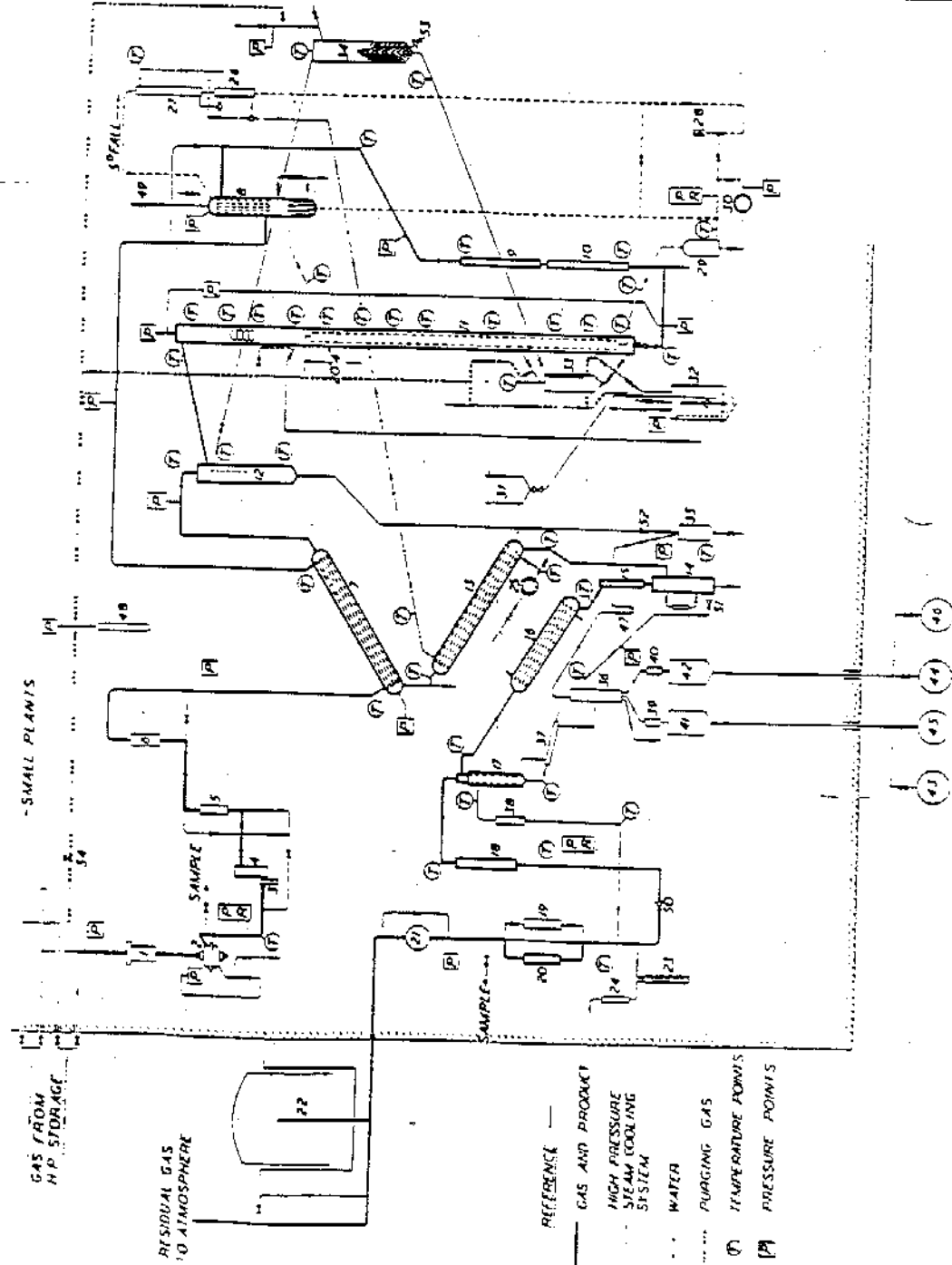


FIGURE 6. DIAGRAMMATIC ARRANGEMENT OF HYDROCARBON SYNTHESIS PLANT [14]

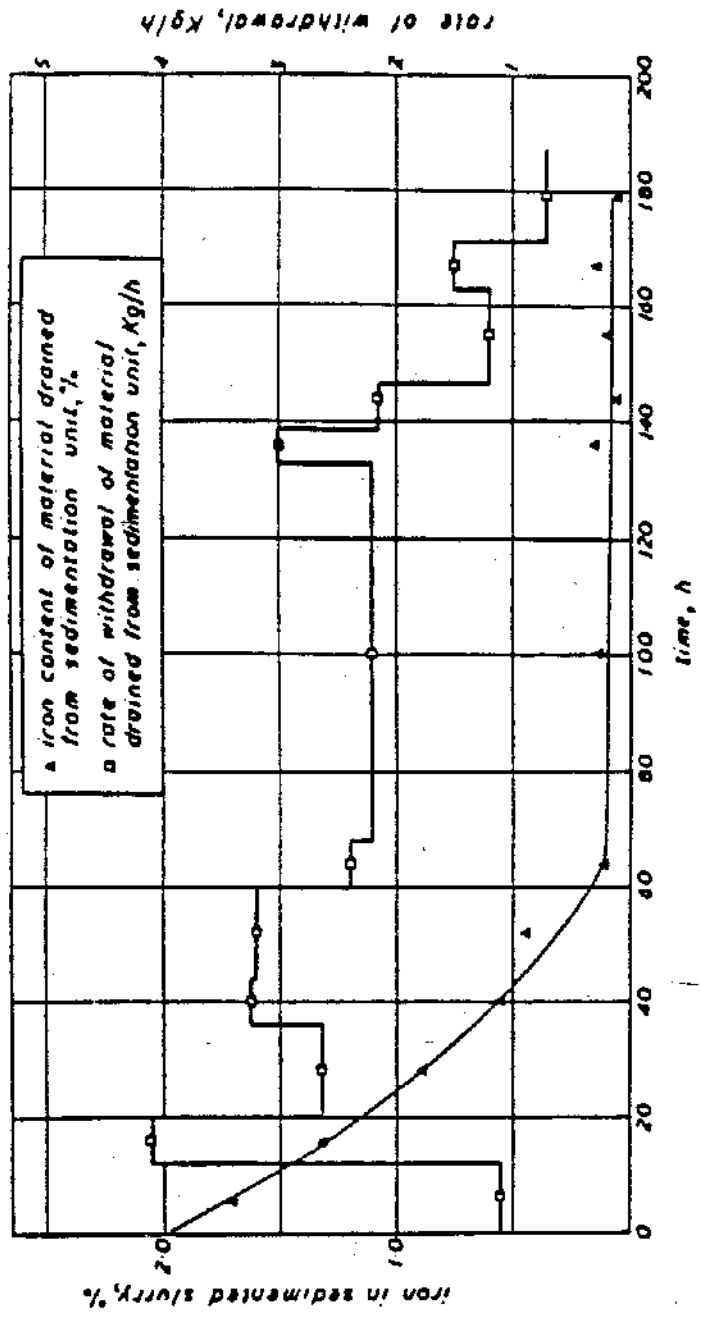


FIGURE 7. SEDIMENTATION RESULTS [14]

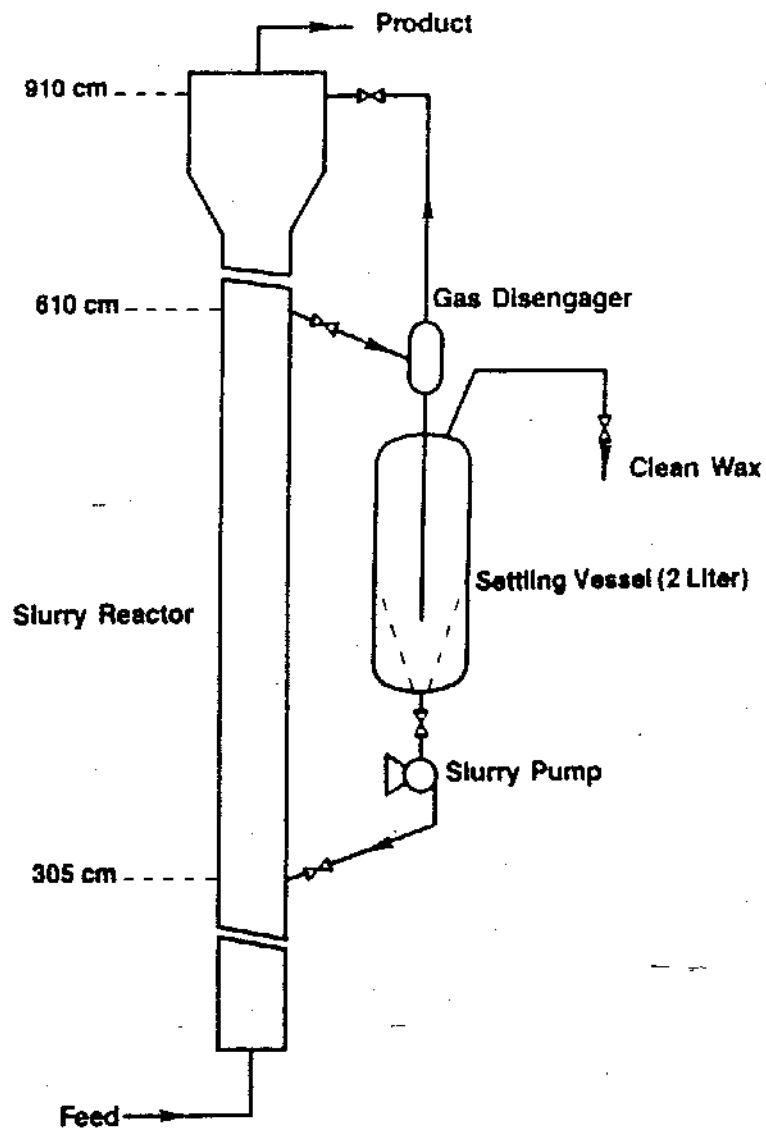
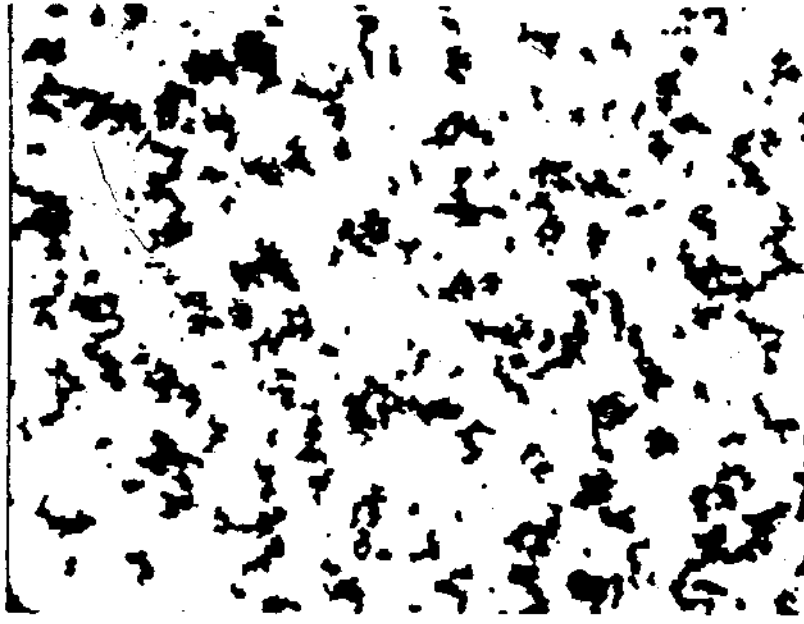


FIGURE 8. SCHEMATIC DIAGRAM OF MOBIL'S CONTINUOUS SETTLING SYSTEM FOR CATALYST/WAX SEPARATION [1]

After Settling



100 Micron

Fresh Catalyst

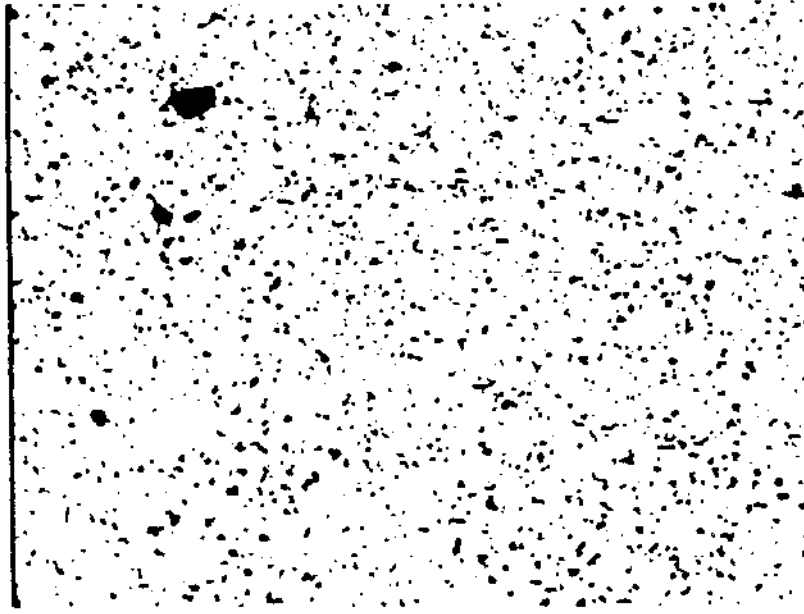


FIGURE 9. PHOTOGRAPHS OF SLURRY SAMPLES (MOBIL RUN CF-256-13) [1]

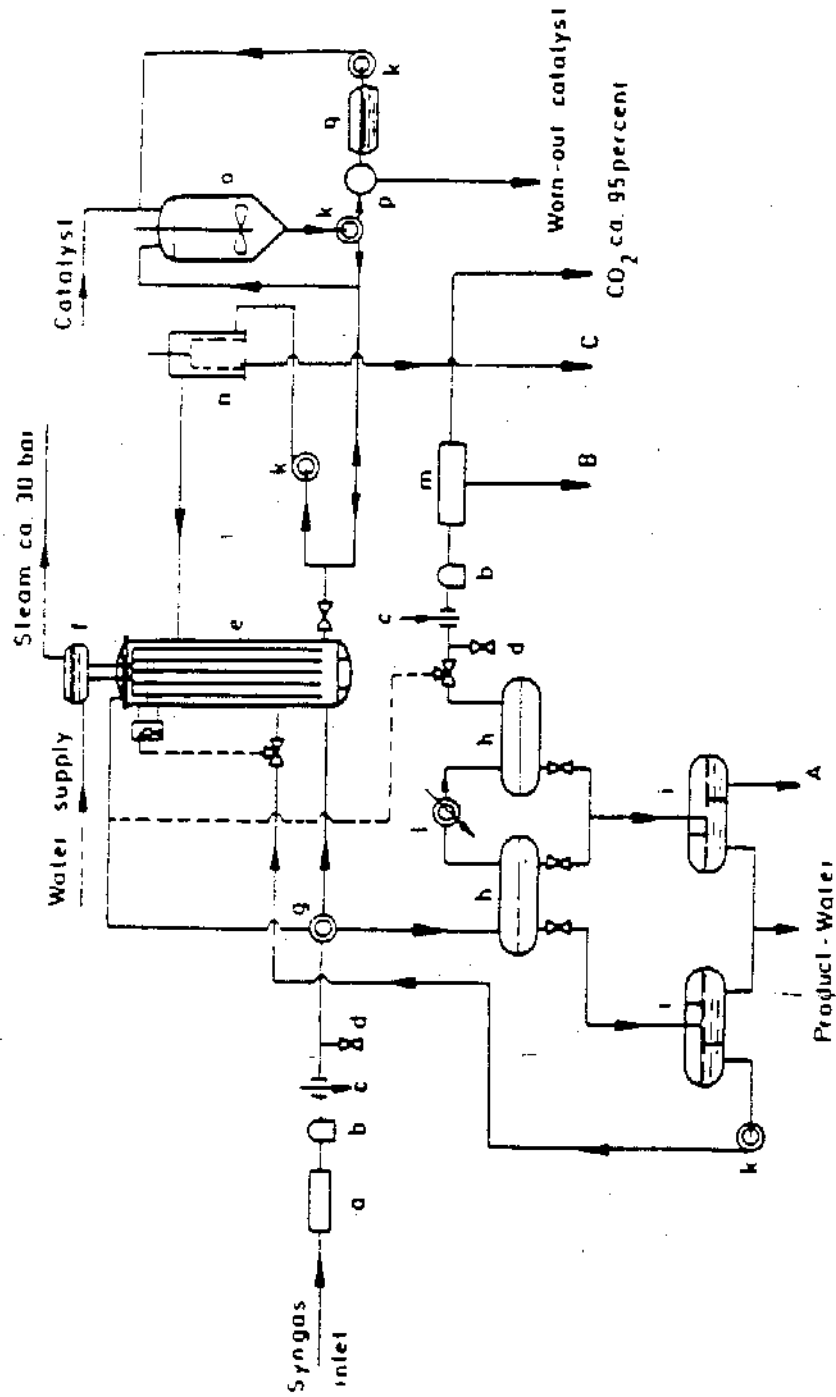


FIGURE 10. FLOW DIAGRAM OF THE RHEINPREUSSEN-KOPPERS DEMONSTRATION PLANT [12]

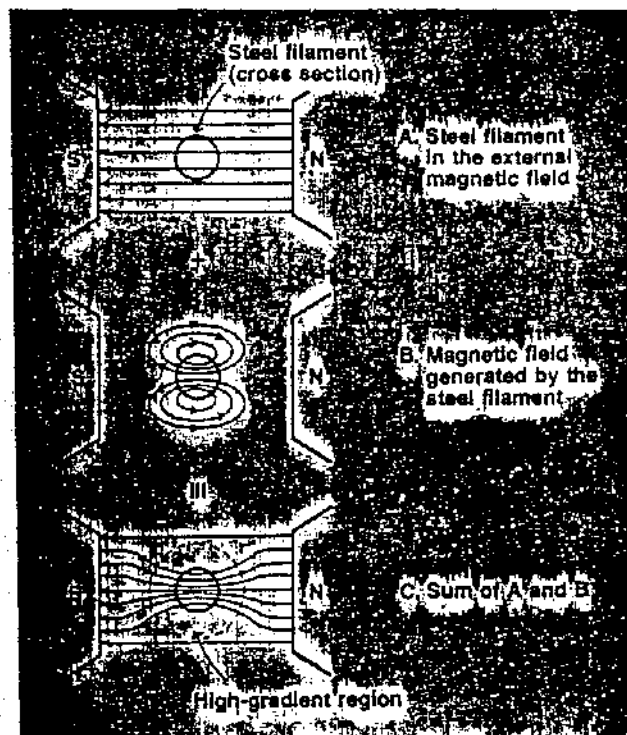


FIGURE 11. GENERATION OF HIGH MAGNETIC FIELD GRADIENT [31]

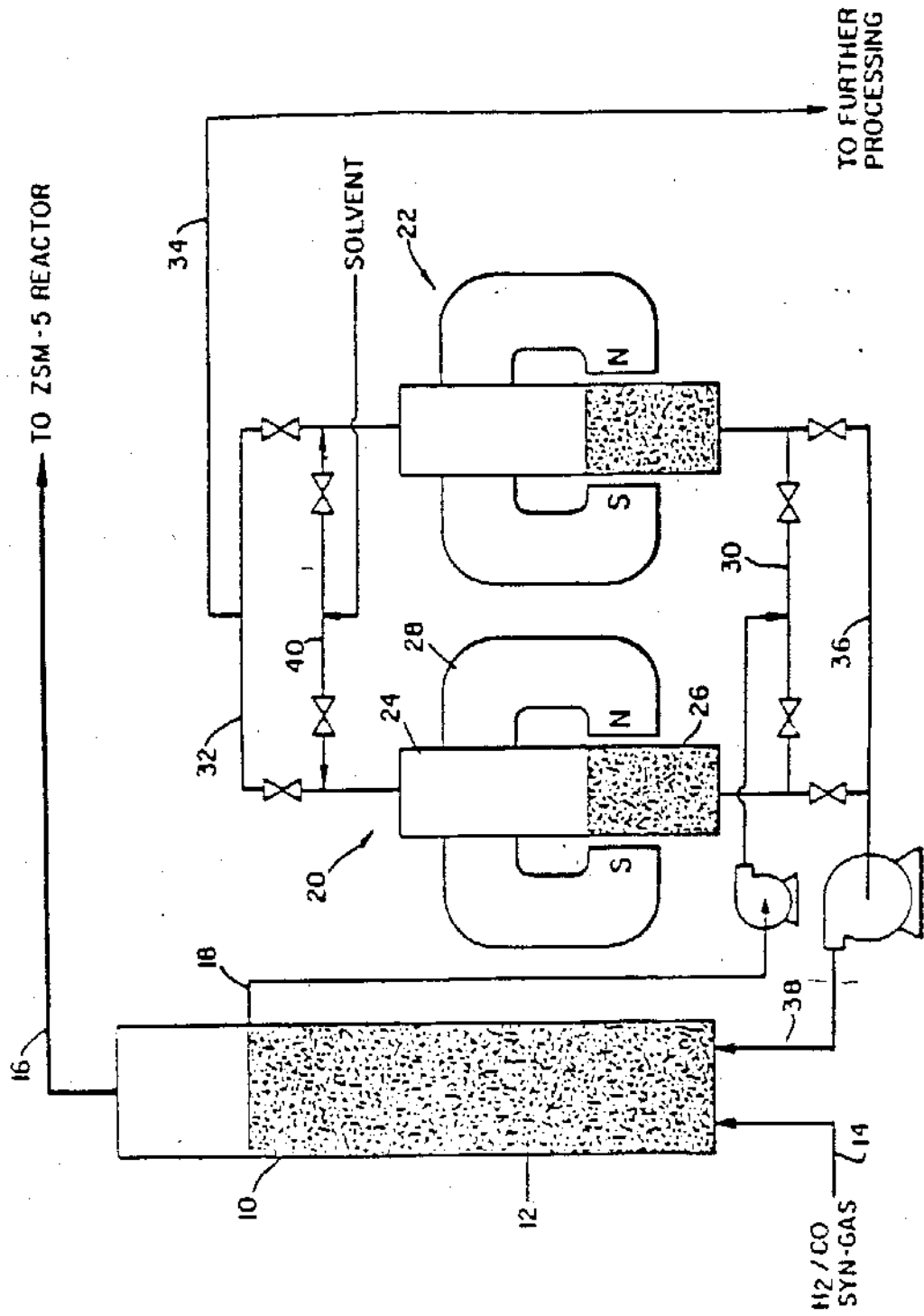


FIGURE 12. HIGH GRADIENT MAGNETIC SEPARATION OF FT CATALYST FROM SLURRY WAX [38]

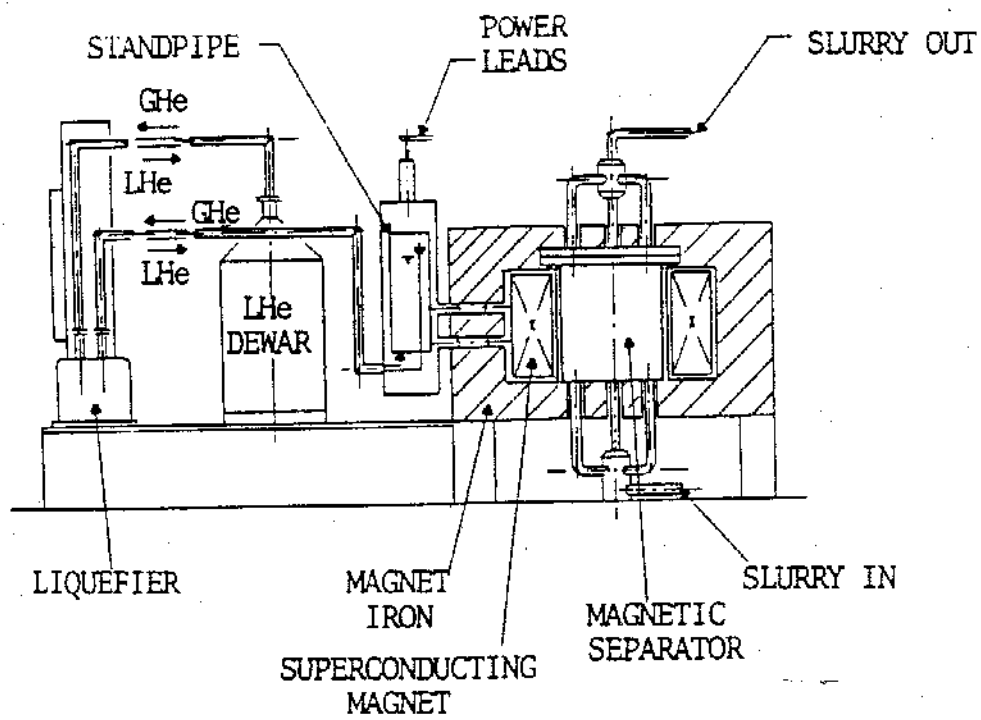


FIGURE 13. SUPERCONDUCTING MAGNETIC SEPARATOR [40].