

II. INFORMATION OF POSSIBLE TECHNICAL VALUE

REFINING OF GAS-PHASE GASOLINE

(Item 6, frames 13-14)

After the resumption of operation of gas-phase chamber 54a it was interesting to determine whether, when fresh catalyst is used, a sulfuric acid refining treatment is necessary. For this purpose several gasoline samples were refined in the usual manner and investigated. In addition, the samples were put in diffuse light and exposed eight hours to the radiation of a quartz lamp.

The following samples were used for the tests, with and without addition of inhibitor:

- (1) Gasoline after caustic washing, Unit 83.
- (2) Gasoline after caustic washing, Unit 83, redistilled to 338 F.
- (3) Gasoline after caustic washing, Unit 83, refined with 2 volume per cent acid (concentration 73) and redistilled.

The attached table gives a summary of the results. The gasoline that was washed only with caustic and that which was washed with caustic and redistilled gave satisfactory bomb tests. The gasoline refined by sulfuric acid was stable only after the addition of an inhibitor in the usual manner. Thus the results agree with those of earlier investigations.

The result of exposure to the quartz lamp is interesting. After only 8 hours, the gasoline taken after caustic washing (P 301 structure 83) was distinctly yellow and gave a precipitate. The similar sample redistilled to 338 F showed, after the same treatment, a distinct yellow color. In contrast, the sample refined by sulfuric acid remained colorless, clear, and free from precipitate after the same treatment with ultraviolet light. If one may compare the results of this light treatment with the deterioration occurring in natural aging, the more stable stock is the gasoline washed with sulfuric acid.

REFINING EXPERIMENTS ON P. 301 AFTER THE WASHING WITH CAUSTIC

DECEMBER 27, 1943

<u>Treatment</u>	Cut Point, F	Inhibitor Z V I added, %	Bomb Test		Appearance After 8 Hours Exposure to a Quartz Lamp
			TEL, cc/gal	Cum. Pb, mg	
Original	-	none	none	4.5	0.0 yellow (sediment)
" + 4.5 cc TEL/gal	-	none	4.5	17.0	31.3
" + 4.5 cc TEL/gal	-	0.01%	4.5	19.5	9.9 yellow (sediment)
Redistilled to 338 F. }	338	none	4.5	22.9	8.5 yellow
4.5 cc TEL/gal added	"	0.01%	4.5	11.5	11.0 yellow
Treated with 2 vol % acid, redistilled to	338	none	4.5	85.1	94.1 water-white
338 F, 4.5 cc TEL/gal added	"	0.01%	4.5	15.0	12.2 water-white, clear

Bottrop, Jan. 22, 1944

REFINING EXPERIMENTS ON HIGH-CUT GAS-PHASE GASOLINE  
(Item 6, frames 15-17)

In order to explore possible methods for increasing yield of gasoline, experiments were recently undertaken to improve the lead stability (4.5 cc TEL per gallon) and the storage stability of higher-cut gas-phase gasolines. Particularly, the limit was determined to which one may cut gasoline without obtaining products that give poor storage stability tests.

The following group of experiments give an insight into the possibilities of obtaining higher-cut stable gasolines. Accordingly, one can obtain a useful gasoline with an ASTM end point of around 356 F by the addition of phenolic inhibitor BJ5, previously used in our experiments. For end-points above 356 F, on the other hand, the storage tests of samples treated with BJ5 become increasingly less satisfactory with increase in end point. There exists, then, a certain possibility, at yet higher cutting, of obtaining a useful gasoline if one uses certain fractions of our newly developed inhibitors (see phenolic inhibitor A<sup>50</sup>, basic inhibitor P30; see also the report of April 17, 1941). The experiments show, for example, that an amine inhibitor fraction gives satisfactory results, even with the highest-cut gasoline fraction. In general, the addition of these nitrogenous inhibitors effects practically complete freedom from lead deposits.

For normally cut gasoline (end point, ASTM, 333 F) there results, by a single washing with caustic, without redistillation, an acceptable storage test; the light stability of these samples, however, after several days, leaves much to be desired. Gasoline washed once with caustic, not redistilled, and having an ASTM end point of 333 F gives acceptable storage tests; the light stability after several days, however, is not very satisfactory.

TABLE I

Experiment No.	Product and Manner of Refining	End Point, ASTM, F	Inhibitor	%	Bomb Tests on Samples Containing 4.5 cc TEL/gal		
					Induction Period, min	Gum, mg/100 cc	Pb Deposit mg/200 cc
945	P. 301 refined with NaOH and 2% conc. H <sub>2</sub> SO <sub>4</sub> and redistilled	333	None	-	155	81.3	107.1
"	ditto	"	BJ5	0.01	>240	10.2	8.0
953	"	"	BJ5	0.01		10.4	8.6
"	"	"	A°50, 401-410 F	"	>240	6.7	8.3
"	"	"	P30, 453-457 F	"	>240	1.2	None
"	"	"	m-Xylenol	"	>240	3.4	None
946	"	347	None	-	158	81.3	77.7
"	"	"	BJ5	0.01	>240	12.2	9.0
956	"	"	None	-	153	76.5	83.1
"	"	"	BJ5	0.01	>240	13.6	11.2
"	"	"	A°50, 401-410 F	"	>240	11.8	11.3
"	"	"	P30, 453-457 F	"	>240	2.8	1.5
947	"	356	None	-	145	104.1	87.4
"	"	"	BJ5	0.01	>240	11.9	10.8
954	"	358	None	-	142	124.9	84.4
"	"	"	BJ5	0.01	>240	14.2	8.6
"	"	"			>240	13.4	10.0
"	"	"	A°50, 401-410 F	"	>240	9.1	11.1
"	"	"	P30, 453-457 F	"	>240	1.8	None
"	"	"	m-Xylenol	"	>240	3.5	None

TABLE II

Experiment No.	Product and Manner of Refining	End Point, ASTM, F	Inhibitor,	%	Bomb Tests on Samples Containing 4.5 cc TEL/gal		
					Induction Period, min	Gum, mg/100 cc*	Pb Deposit, mg/200 cc
955	P 301 refined with NaOH and 2% conc. H <sub>2</sub> SO <sub>4</sub> and redistilled	363	None	-	171	84.8	76.0
"	ditto	"	BJ5	0.01	160	26.6	13.4
"	"	"	A*50, 401-410 F	"	>240	14.9	12.5
"	"	"	P30, 453-457 F	"	>240	2.5	None
"	"	"	m-Xylenol	"	>240	4.9	None
957	"	381	None	-	120	247.4	89.7
"	"	"	BJ5	0.01	122	33.5	17.9
"	"	"	A*50, 401-410 F	"	152	21.3	11.0
"	"	"	P30, 453-457 F	"	240	4.7	None
437	P 301 only washed with NaOH, not redistilled	-	None	-		20.9	19.2
"	ditto		BJ5	0.01	>240	9.9	11.0

\*Residue from evaporation of 100 cc of gasoline.

Bottrop-Boy, May 6, 1941

CHLORINE BALANCE FOR SUMP-PHASE CHAMBERS 52 AND 108

FOR MAY 1944  
(Item 7, frame 1)

(Chlorine in mud neglected)

Fresh charge + rinse oil		15,110.245 tons	
Cl in fresh charge + rinse oil		0.090%	
Cl in fresh charge + rinse oil	(A)		13.599 tons
Total material from liquid separator		12,936.603 tons	
Cl in total material from liquid separator		0.029%	
Cl in total material from liquid separator	(B)		3.752 tons
Water from liquid separator		1,879.108 tons	
Cl in water from liquid separator		0.0003%	
Cl in water from liquid separator	(C)		0.006 ton
Cl to be neutralized	A - (B + C)		9.841 tons
Soda theoretically required		14.699 tons	
Soda added		<u>11.587</u>	
Soda deficiency		3.112	

In May 1944, 3.112 tons less than the amount of soda theoretically required was added. This amount is equivalent to 2.082 tons Cl. Thus 78.8 per cent of the theoretically required amount was added. If the Cl in the mud removed were taken into account, the soda deficiency value would be considerably less.

Bottrop, July 10, 1944

PRODUCT BALANCE FOR SUMP-PHASE CHAMBERS 52 AND 108

FOR JUNE 1944  
(Item 8, frame 1)

Operating hours : 720  
 Total charge rate : 35.47 t/h; (33.5 P<sub>4</sub>/20.0 P<sub>5</sub> + P<sub>6</sub> + P<sub>15</sub>/4.5 P<sub>18</sub>/42.0 P<sub>7</sub>)  
 Fresh charge : 20.56 t/h; (57.9 P<sub>4</sub>/34.4 P<sub>5</sub> + P<sub>6</sub> + P<sub>15</sub>/7.7 P<sub>18</sub>)  
 Slurry from Units 18 and 19 : 20.56 t/h; (57.9 P<sub>4</sub>/34.4 P<sub>5</sub> + P<sub>6</sub> + P<sub>15</sub>/7.7 P<sub>18</sub>)

Ratio of material from liquid separator to product: 1.343 to 1.000

For 1 ton of fresh charge were needed 1.725 tons total charge and 0.0721 tons H<sub>2</sub>  
 (316,000 cu ft fresh gas)

From 2,363.6 lb newly introduced product + H<sub>2</sub> were obtained:

Products:	lb	% of new charge + H <sub>2</sub>	
<u>(1) Material from liquid separator (gas-free)</u>	1763.06	74.600	
Gasoline Unit 82	249.78		10.580
Middle Oil Unit 82	696.43		29.410
Fuel Oil Unit 82	817.25		34.590
Mud to be removed	228.40		9.670
Reaction water (pure)	100.94		4.275
Salts in charge water + reaction water	20.55		0.867
NH <sub>3</sub>	9.11		0.384
H <sub>2</sub> S	5.69		0.241
CO <sub>2</sub>	4.45		0.188
Phenols	1.28		0.054
<u>Gases:</u>			
<u>(2) Free H<sub>2</sub> in released gases</u>	15.62		0.660
free H <sub>2</sub> in E.G. 4	5.49		0.232
free H <sub>2</sub> in E.G. 21 + 23 + 31 + 33	9.68		0.410
free H <sub>2</sub> in E.G. 22 + 26	0.42		0.018
<u>(2) Hydrocarbons (C = 2.292)</u>	214.37		9.077
C1	32.72		1.384
C2	48.82		2.058
C3	60.42		2.559
C4 (normal)	51.99		2.200
C4 (iso)	7.59		0.321
C5	12.83		0.544
CO <sub>2</sub>	0.57		0.024
H <sub>2</sub> S	5.64		0.238
NH <sub>3</sub>	2.41		0.101
	<u>2351.56</u>		<u>99.512</u>



- (1) The high accumulation of middle oil is a result of the addition of P18.
- (2) The analyses of May, 1944, were used in the calculations, since the stock analyses of June, 1944, were destroyed on July 21, 1944, by the air raid.

Bottrop, Aug. 5, 1944

CHANGES IN PRODUCTION AND IN BALANCES FOR

INCREASED GASOLINE PRODUCTION  
(Item 9, frames 1-7)  
(Marked "Secret")

Production figures and costs are given for a method of operation intended to increase gasoline yields from hydrogenation.

Dr. Urban, of the Scholven hydrogenation plant, estimated that 63,000 cubic feet of hydrogen is required for the production of 1 ton of middle oil from coal and that 96,000 cubic feet is required for the production of 1 ton of gasoline.

At the Poelitz hydrogenation plant, in which pitch is also treated, it is estimated that 42,000 to 48,000 cubic feet of hydrogen is consumed in the production of 1 ton of middle oil.

The following values were used at Ruhroel:

<u>Year</u>	<u>H<sub>2</sub> Consumption per Ton Fuel Oil + Gasoline, cu ft</u>	<u>Ratio of Fuel Oil to Gasoline</u>
1941	45,000	74:26
1942	44,200	75:25
Jan.-Aug. 1943	47,700	69:31

The following hydrogen consumptions were estimated from the data above:

H <sub>2</sub> consumption per ton fuel oil from raw material	26,000 cu ft
" " " " middle oil from fuel oil	22,000 " "
" " " " gasoline from middle oil	<u>32,000</u> " "
H <sub>2</sub> consumption per ton gasoline from raw material	80,000 cu ft

Bottrop  
Nov. 18, 1943

CONDITIONS IN SUMP-PHASE HYDROGENATION SYSTEMIN WHICH GAS HYDRATES FORMED  
(Item 10, frames 4-7 and 43-44)

The following refer to Figure 1:

Pressure, suction side of circulating pumps	495 atm
, pressure " " " "	520 " "
, where gas hydrates formed	498 " "
Water added, before regenerators I and II, each	4 B/hr
, after liquid separator	4 " "
Material from liquid separator, water free	7 tons/hr
Temperature of liquid separator	68 F
No. of chambers	1
Exit gas from chamber	635,000 cu ft/hr
Temperature, suction side	77 F
, pressure side	82 F
, before gas cooler	329 F
, after gas cooler	68 F
, where gas hydrates formed	68 to 77 F
Amount of fresh gas	212,000 cu ft/hr
Amount of wash oil	63 B/hr
Inlet temperature of wash oil	95 F

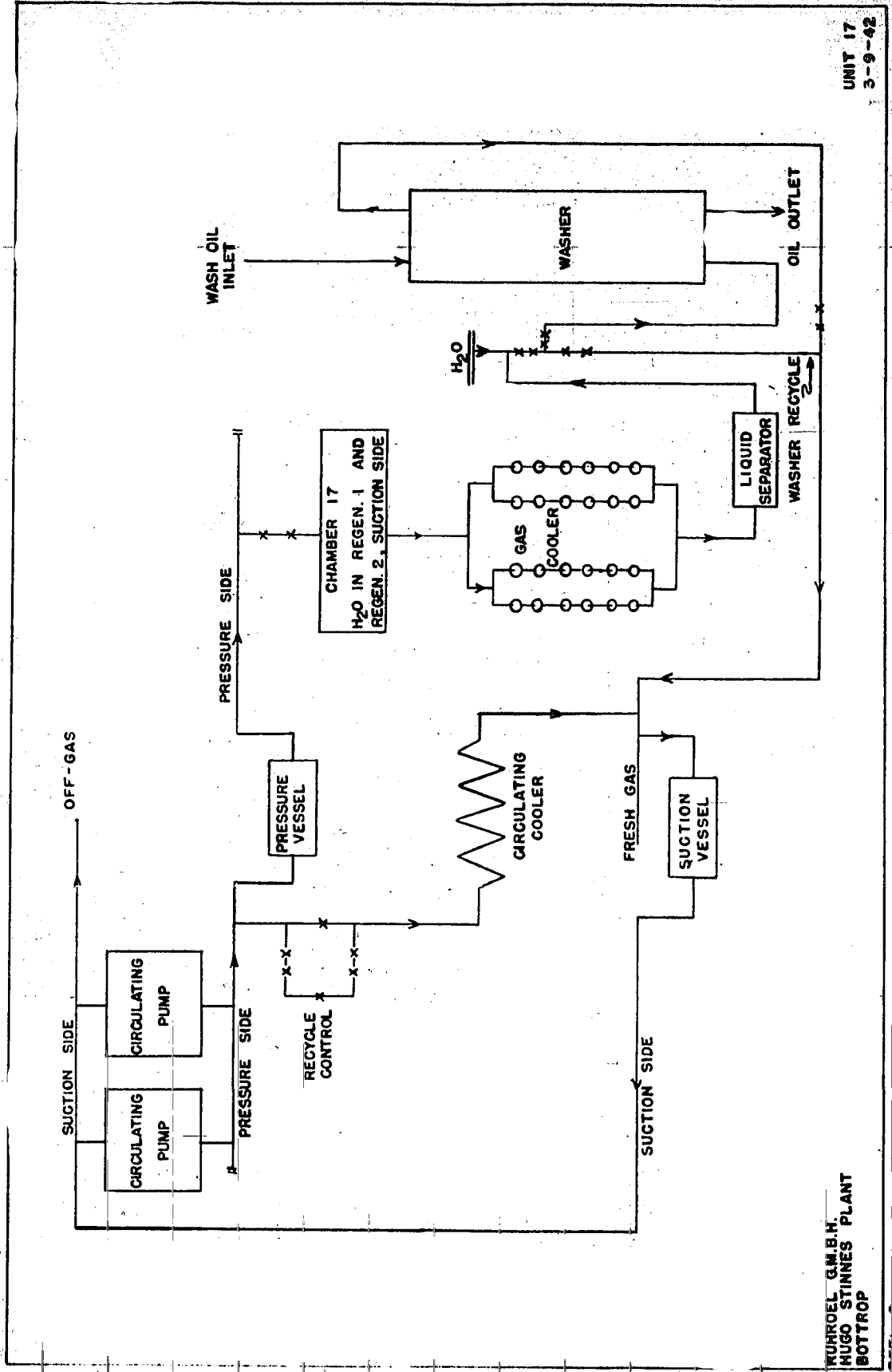
## Composition of Circulating Gas, %

	<u>Suction Side of</u> <u>Circulating Pumps</u>	<u>Pressure Side of</u> <u>Circulating Pumps</u>	<u>After Oil</u> <u>Wash</u>	<u>After Addn</u> <u>of Fresh Gas</u>	<u>Where Gas Hydrates</u> <u>Were Found</u>
CO <sub>2</sub>	0.02	0.02	0.00	0.02	0.00
H <sub>2</sub> S	0.04	0.04	0.04	0.04	0.04
NH <sub>3</sub>	0.03	0.03	0.03	0.03	0.03
O <sub>2</sub>	0.00	0.00	0.00	0.00	0.00
CO	0.80	0.80	0.70	0.80	0.70
H <sub>2</sub>	73.21	73.21	63.93	73.21	63.93
HC's	19.50	19.50	27.70	19.50	27.70
N <sub>2</sub>	6.40	6.40	8.30	6.40	8.30
C No.	1.36	1.36	1.36	1.36	1.36

## Composition of Fresh Gas, %

CO <sub>2</sub>	0.07
H <sub>2</sub>	98.13
CO	0.10
N <sub>2</sub>	1.70

Translator's note: The r's in Fig. 1 indicate points at which water was added and places in which gas hydrates were found. In the original drawing, the former were evidently red, and the latter green.



WUMROEL G.M.B.H.  
 HUGO STINNES PLANT  
 BOTTROP

REEL 9  
 ITEM 10  
 FRAME 8

FIG. 1 FLOW SHEET FOR SUMP-PHASE HYDROGENATION AT 700 ATM.  
 (AT THE BEGINNING OF PLANT OPERATION, DECEMBER, 1937)

LIQUID HYDROCARBONS OTHER THAN PROPANE AND BUTANEIN THE EXPANSION GAS FROM THE EXTRACTION UNIT

(Item 13, frames 4-5)

<u>Sampling point:</u>	<u>Unit 24 Outlet Tank J</u>
<u>Time:</u>	May 31, 1942 8:45 AM-5:40 PM
<u>Amount of gas:</u>	87.95 cu ft (59 F/735 mm)
<u>Amount of gasoline:</u>	0.5034 lb or 0.00571 lb/cu ft (59 F/735 mm)
<u>Amount of water:</u>	0.0717 lb or 0.000816 lb/cu ft

If the above values are corrected for the gasoline and water vapor in the gas, the following values are obtained:

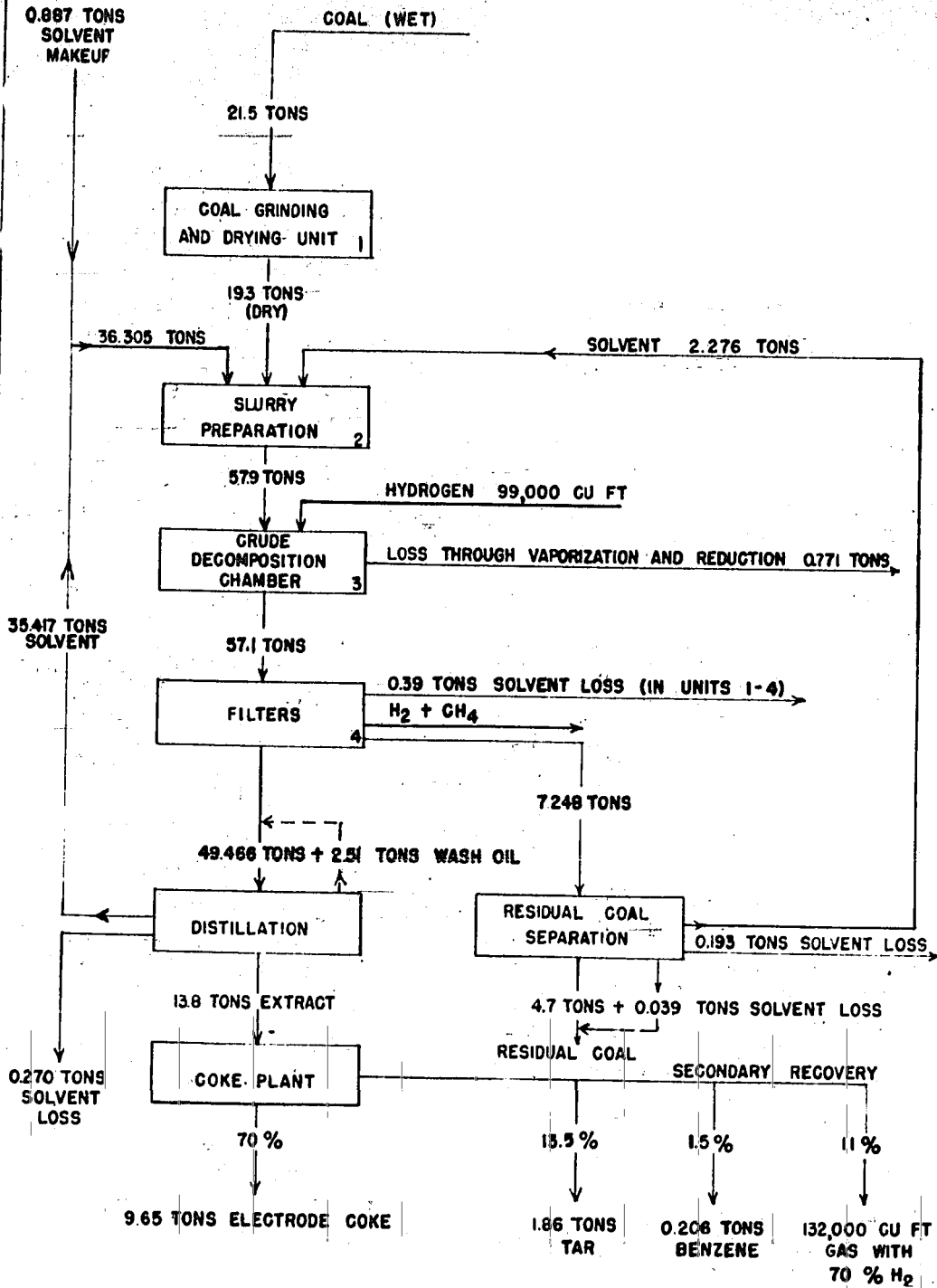
Gasoline:	0.00548 lb/cu ft
Water:	0.000784 lb/cu ft

Examination of Gasoline:

Density at 59 F	0.744
<u>Distillation (ASTM)</u>	
IBP	119 F
5 Vol. %	147
15 "	161
25 "	168
35 "	173
45 "	181
55 "	189
65 "	198
75 "	209
85 "	230
95 "	270
End Point	293 (98.0%)
Residue	1.4 vol %
Loss	0.6 vol %
10 Vol. %	155 F
90 "	241 F
Vol % distilled at 212 F	77.5
Phenols	0.11%
Pyridines	0.14%
<u>Aromatic Content</u>	
According to aniline point method	25 wt %
Aniline Point	+86.6 F
Molecular Weight	95.0

Ruhrcoel G.m.b.H.  
Main Laboratory  
June 4, 1942

PHILLIPS PETROLEUM COMPANY  
RESEARCH DEPARTMENT REPORT 502-45



UNIT NO. 0

8-4-41

FIG. 2 FLOW SHEET FOR PRODUCTION OF 110,000 TONS/YEAR EXTRACT = 77,000 TONS/YEAR ELECTRODE COKE, 13.8 TONS/HOUR EXTRACT = 9.65 TONS/HOUR ELECTRODE COKE

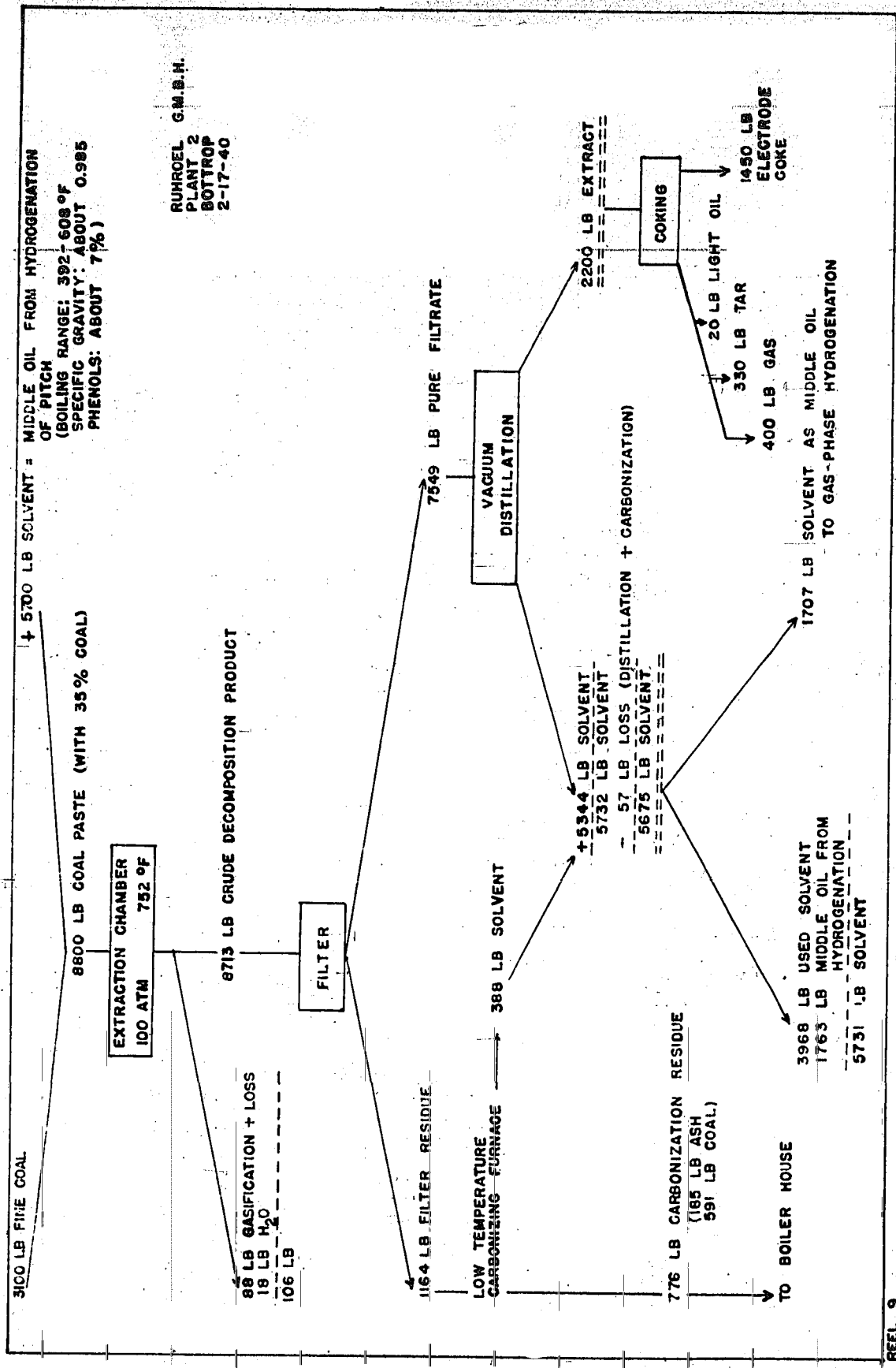


FIG. 3 PROCESS FOR RECOVERY OF EXTRACT (2200 LB STABLE EXTRACT FROM COAL)

REGENERATION OF EXTRACTION SOLVENT IN THE GAS PHASE AT 700 ATMOSPHERESSUPPLEMENT TO THE REPORT OF MARCH 31, 1942

(Item 14, frames 42-44)

In completion of our investigations carried out in the technical experimental plant at the beginning of this year, we again resumed the experiments on the regeneration of used extraction solvent. It was sought to prove whether the regeneration, which could be carried out in our first experiments at 300 atm. without loss, could also be carried out at the operating pressure of Ruhroel (about 700 atm) without too much cracking, reduction of the phenols, or hydrogenation beyond the tetralin stage. The first experiments were carried out with a 15 per cent solution of naphthalene in pitch middle oil (P 102). The following were recognized as the most favorable reaction conditions:

Catalyst:	58II
Pressure:	700 atm
Temperature:	13 mv
Charge rate:	62.4 lb/cu ft/hr
Product:Gas	1:3000

Under these reaction conditions, used solvent (P 64), which served for a separate extraction, was regenerated.

The table shows the change, which the initial oil has undergone, in the regeneration, with regard to its analysis, as well as its stability to decomposition. The regenerated solvent was examined and used for extraction as soon as it came out of the furnace. The determinations of the degree of decomposition and of filtering time were carried out by selective extraction. Although these experiments, which were carried out in the 60-cc furnace, are to be regarded only as preliminary orientation experiments, which would have to be supplemented by exact balance experiments in 5- to 10-liter furnaces, one can conclude that also at 700 atm., as at 300 atm., a regeneration of spent solvent is possible by careful hydrogenation, principally in the gas phase.

It is also intended to carry out these experiments at 500 atm.



	<u>Solvent before the Regeneration</u>	<u>Solvent after the Regeneration</u>
Density at 59 F	1.009	0.992
<u>Engler Distillation</u>		
IBP, F		378
392 F, vol %	1.0	1.5
End Point, F	590	595
Phenol, wt %	4.2	4.1
Cloud Point, F	19	7
Solution Point, F	34	28
<u>Ultimate Analysis, wt %</u>		
C	89.8	89.6
H	7.9	8.7

Substantially no loss occurred in the regeneration.

Ruhrloel G.m.b.H.  
Main Laboratory, Bottrop  
Nov. 24, 1942

REGENERATION OF EXTRACTION SOLVENT  
(Item 14, frames 45-48)

Exploratory experiments on regeneration of extraction solvent by controlled hydrogenation were conducted. It was desired to hydrogenate naphthalene and its homologues to tetralin and its homologues. At the same time, it was desired to avoid reduction of phenols and pyridines and destructive hydrogenation.

The experiments were conducted by the use of a 60-cc furnace at a hydrogen pressure of 300 atm. In the first experiments, attempts were made to hydrogenate a 20 per cent solution of naphthalene in pitch middle oil without obtaining an increase in aniline point, i.e., without formation of products more highly hydrogenated than tetralin. I. G. catalyst 58II was used. The charge rate was 62.4 pounds per cubic foot of catalyst per hour. The product-to-gas ratio was 1:3000.

The results are given in the following table:

	<u>Solvent before Regeneration</u>	<u>Solvent after Regeneration</u>
D <sub>4</sub> <sup>15</sup>	1.002	0.979
Engler Distillation		
IHP, F	396	324
Vol % distilled at 392 F	-	3.5
EP, F	604	604
Aniline Point, F	-13	-13
Phenol, wt %	5.6	5.0
Pyridine, wt %	4.7	4.4
Cloud Point, F	48	34
Naphthalene, wt %	18	8
C, wt %	90.0	89.9
H, wt %	7.7	8.7

Although only slightly more than 50 per cent of the naphthalene was hydrogenated, the regeneration was considered satisfactory. Substantially no loss occurred. Disadvantageous results were phenol hydrogenation and the formation of 3 to 4 per cent of comparatively low-boiling products.

Ruhroel, G.m.b.H.  
Main Laboratory  
Bottrop  
March 31, 1947

DETERMINATION OF IRON CARBONYL IN FISCHER-TROPSCH GASES  
(Item 15, frame 54)

For absorption in ammoniacal perhydrol solution, 10 to 50 liters of the gas to be examined is passed through three wash bottles, which are provided with fritted discs and which contain a mixture of 200 cc of redistilled methyl alcohol, 20 cc of ammonium hydroxide (sp gr, 0.91) and 10 cc of perhydrol. The contents of the wash bottles are transferred to a flask. The bottles are rinsed several times with hydrochloric acid (1:4); 100 cc of water and 2 grams of solid sodium chloride are added, and the solution is boiled for about 5 minutes. After prolonged standing, the iron hydroxide is filtered off and washed thoroughly. The precipitate is dissolved from the filter in 10 cc of 10 per cent hydrochloric acid, and the solution is diluted to the mark in a 100-cc volumetric flask.

The iron is determined colorimetrically. For this purpose, 1 cc of hydrochloric acid (sp gr, 1.19) and 2 to 3 cc of a 10 per cent solution of ammonium thiocyanate are added to an aliquot part of the iron solution in a suitable glass cylinder, and the color intensity of the solution is compared with that of a solution of iron thiocyanate of known iron content.

The iron carbonyl content is reported as grams of iron per cubic meter (STP).

**SUMMARY OF EXPERIMENTAL RESULTS OF GAS-PHASE HYDROGENATION  
OF MATERIAL FROM LIQUID SEPARATOR (P 100) AT 500-600 ATMOSPHERES  
(PRELIMINARY EXPERIMENTS IN THE COMBINATION CHAMBER)  
(Item 19, frame 3)**

Analysis of Material from Liquid Separator: 5-8% to 392 F; 65% to 680 F; about 2% phenol; 2.5% pyridine; aniline point, below -4 F  
Total Reaction Product

Catalyst	Experimental Conditions			Dura- tion, days	Increase in		Gasoline Aniline		Diesel Oil Aniline		Fuel Oil Vis- cosity		
	Temp, mv	lb/cu hr	Charge, Gas		Aniline Point, F	Residue Decompn, vol %	Pyri- dine Reductn	Point, F	Point, F	D <sub>15</sub>	Point, H <sub>2</sub> , wt %	D <sub>15</sub>	at 68 F, SUS
None	23.5	62	Fresh	<-13	12	>80	<-13	+68	0.810	12.5	0.942	11.5	In the Diesel Oil
5059 (tungsten sulfide)	22.5	62	"	+91.4	70	>80	<-13	-5.8	0.865	10.9	No Diesel Oil	1.056	8.2
6434 (tungsten sulfide)	22.5	62	"	<-13	26	<50	<-13	-14.8	0.850	10.9	No Diesel Oil	1.015	8.7
on activated Terrana)	22.5	<62	Recycle	+3.2	70	<50	<-4	-5	0.843	11.8	No Diesel Oil	1.038	8.8
6434,	22.5	62	Fresh	<-4	41	About 50	<-4	-8.6	0.840	11.5	0.970	9.4	1.070
after-treated	22.5	62	Recycle	<-4	50	>80	<-4	+95	0.800	13.5	0.930	+95	12.3
	22.5	<62	Fresh	+113	80	>90	+113	+62.6	0.814	12.7	0.973	+60.8	10.8
5811	22.5	93	"	+59	60	>90	+59	+69.8	0.814	13.1	0.987	+62.6	11.0
Al(OH) <sub>3</sub>	22.5	93	Recycle	+86	75	>90	+86	<-4	0.845	10.9	No Diesel Oil	1.050	7.4
+ CrO <sub>3</sub>	24.5	62	Fresh	<-4	32	<50	<-4	<-4	0.857	10.5	No Diesel Oil	1.027	8.3
A-Coal with Iodine	22.5	62	"	<-4	65	<50	<-4	<-4	0.857	10.5	No Diesel Oil	1.010	9.0
Coke	22.5	62	Recycle	<-4	60	<50	<-4	<-4	0.886	10.7	No Diesel Oil	1.067	7.5
Coke with	24.5	62	Recycle	<-4	38	<50	<-4	<-4	0.858	10.7	0.975	<-4	8.7
Ammonium Molybdate	22.5	62	Fresh & Recycle	<-4	55	<50	<-4	<-4	0.859	10.6	0.985	<-4	8.8
Coke with CrO <sub>3</sub>	22.5	62	Recycle	<-4	41	<50	<-4	<-4	0.855	10.7	No Diesel Oil	1.052	9.10
Brown Oxide (Fe <sub>2</sub> O <sub>3</sub> + 10% CrO <sub>3</sub> )	22.5	62	"	<-4	32	<50	<-4	<-4	0.855	10.7	0.981	<-4	8.9
Molybdenite (MoS <sub>2</sub> )	22.5	62	"	<-4	67	<50	<-4	<-4	0.889	9.9	0.992	<-4	8.4
Wolframite (WO <sub>3</sub> )	22.5	62	"	<-4	38	<50	<-4	<-4	0.887	9.9	0.994	<-4	8.0
	22.5	62	"	<-4	33	<50	<-4	<-4	0.887	9.9	0.994	<-4	8.0

Further experiments were conducted with a Munich fuller's earth, with terrana extra, and with 6719 (Ludwigshafen). The catalyst disintegrated after a few hours.  
(a) Gasoline in reaction product minus gasoline in material from liquid trap, based on gasoline-free material from liquid trap.  
(b) Volume per cent of portion boiling above 680 F converted to middle oil boiling below 680 F.  
(c) Weight per cent of the reduced phenol (or pyridine) based on phenol or pyridine in the feed.  
(d) Catalyst pills disintegrated.  
(e) Catalyst stable.  
(f) Hi split out.

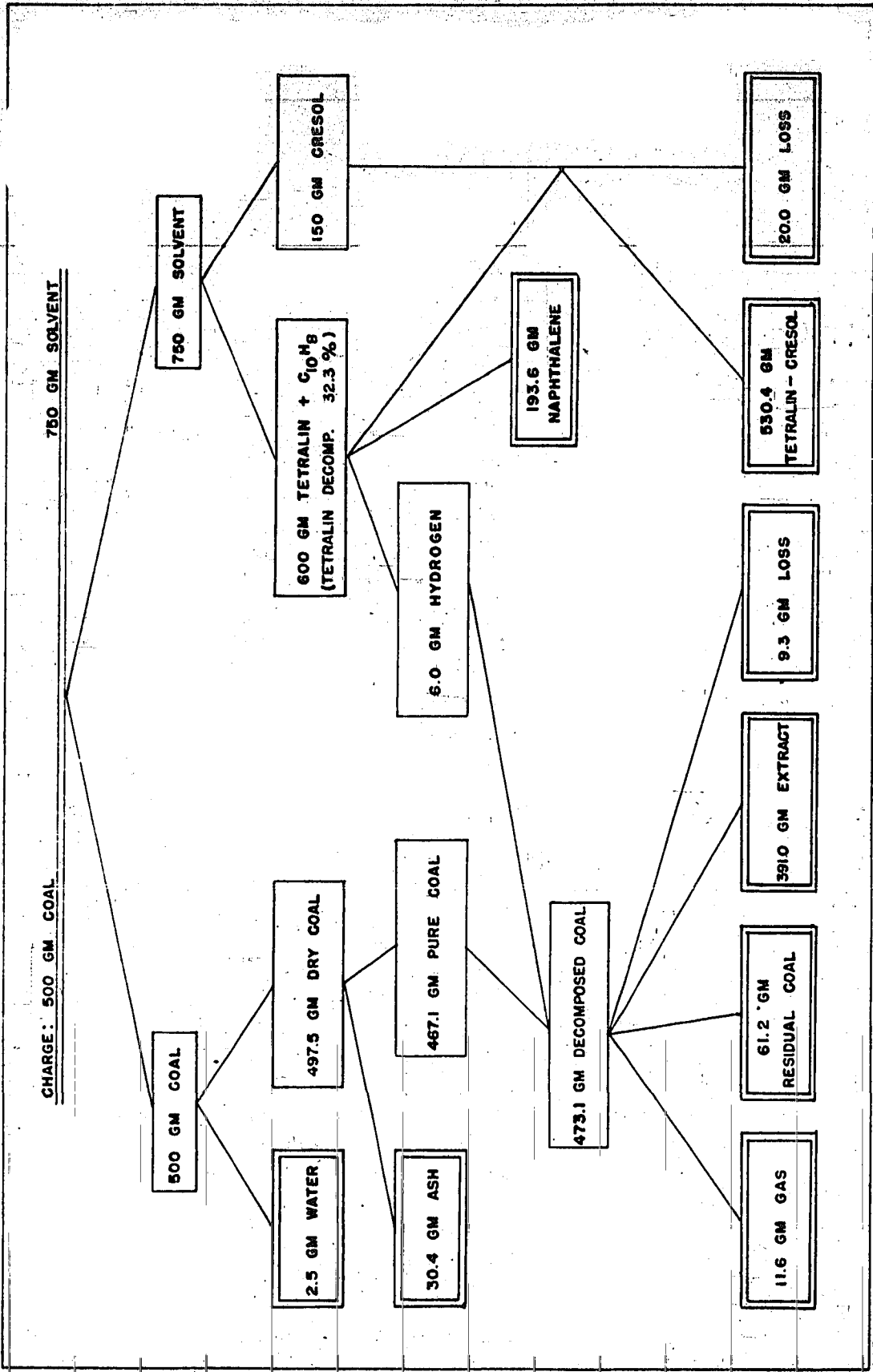


FIG. 4 BALANCE SHEET FOR COAL EXTRACTION AT 752 F FOR 2 HOURS