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ITEM No. 30

FILE No. XXV-6

COPY No. ~~158~~

T.OM-8

Classification Cancelled,
by authority of
The Joint Chiefs of Staff,
by Col. E. W. Gruhn

(Same as XXVI-80)

CONFIDENTIAL

STEINKOHLEN-BERGWERK RHEINPREUSSEN
MOERS-MEERBECK

Atwell + Schroeder

CONFIDENTIAL

COMBINED INTELLIGENCE OBJECTIVES
SUB-COMMITTEE

(Same as XXVI-80) and TOM-8
except folded plan
lacking in XXVI-80

CONFIDENTIAL

STEINKOHLEN-BERGWERK RHEINPREUSSEN
MOERS-MEERBECK
(HOMBERG)

Reported By

H.V. ATWELL, USA.
W.C. SCHROEDER, USA.

On behalf of the

British Ministry of Fuel and Power
and
U.S. Technical Industrial Intelligence Committee

CIOS Target No. 30/5.05
Fuels and Lubricants

T.O.M. No. 8 report was issued May 15, 1945

COMBINED INTELLIGENCE OBJECTIVES SUB-COMMITTEE
G-2 Division, SHAEF (Rear) APO 413

CONFIDENTIAL

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PERSONNEL OF INSPECTION TEAM

W.C. SCHROEDER	U.S. Bureau of Mines
H.V. ATWELL	Petroleum Administration for War, USA.

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CIOS TARGET 30/5.05
RHEINPREUSSEN FISCHER-TROPSCH PLANT

I Target Identification

The location of the Fischer-Tropsch plant of the Steinkohlen-Bergwerk-Rheinpreussen is shown by Figure 1 page 2. It has been referred to variously as located in Homberg, Homberg-Meerbeck, Moers, and Moers-Meerbeck, of which the last is the most accurate designation. This plant is one of a chain of Rheinpreussen plants identified locally by the number of the mine shaft with which they are associated. South of Homberg, near the Rhine, is the original plant at Shafts I, II and III, and here also is the Main Office of the Company. West of this plant, about half way between Homberg and Moers is a coking plant at Shaft IV. A short distance north-east of Moers is the present target at Shaft V and considerably farther to the northwest is another coking plant at Shaft VI nearLintfort. There is an affiliated plant, Gewerkschaft Neu-Mühl, a short distance northeast of Duisberg. All Fischer Tropsch activities were confined to the Moers-Meerbeck plant.

CIOS TARGET
30/505

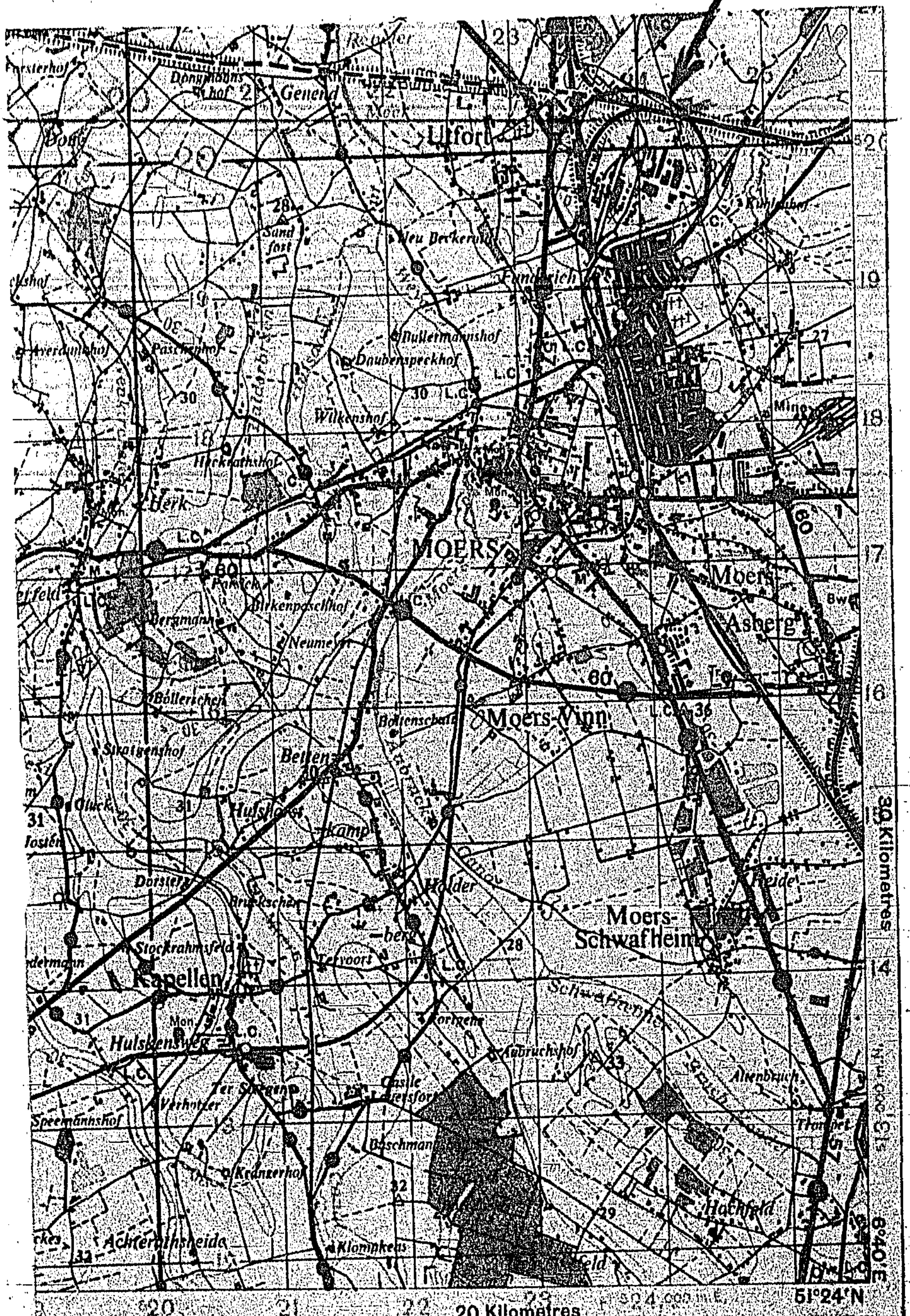


Figure 1
Map showing Target Area

II Inspection Procedure

The Moers-Meerbeck plant of Rheinpreussen was occupied by American troops on the evening of 4 March, 1945 and the CIOS party arrived on the morning of 6 March. (Captain Eyles (21 Army Group Hdqtrs.) Military leader of the party had called at the plant on the evening of 5 March.) The inspection was concluded on the morning of 9 March. The only persons found in the plant who appeared to be competent to give information about operations there were Betriebsführers, Ziegler and Hackländer, and Betriebsleitern Breitenstein and Lohman. Ziegler was a power engineer but familiar with coking operations, and furnished only a small part of the total information. Hacklander was manager of the coking plant and Breitenstein and Lohman were assistant-manager and construction foreman respectively in the Synthetic fuel plant. These three shown in Fig. 2 furnished most of the information about Fischer Tropsch operations. All information in this report, for which other sources are not specified or obvious, was obtained from the four men named.

All technical and top administrative personnel had been moved to unknown locations east of the Rhine. Apparently the most valuable records, including research reports and notebooks, had also been moved. The documents which remained, chiefly in basement store rooms, were examined as carefully as time permitted and those which looked most informative were confiscated. In some places this examination was difficult because the documents had been scattered by combat troops who were billeted in practically all of the few habitable rooms in the plant. Some documents were found in boxes partly packed with indications that the shipping of documents to safety had been hasty and was not completed.

An effort has been made to abstract, and in some cases to translate, what appear to be the most important documents, on the basis of subject matter and dates, for inclusion with the present report. A large part of the seized material has been recorded on microfilm to facilitate future examination.

A list of the seized documents is attached as Appendix A.

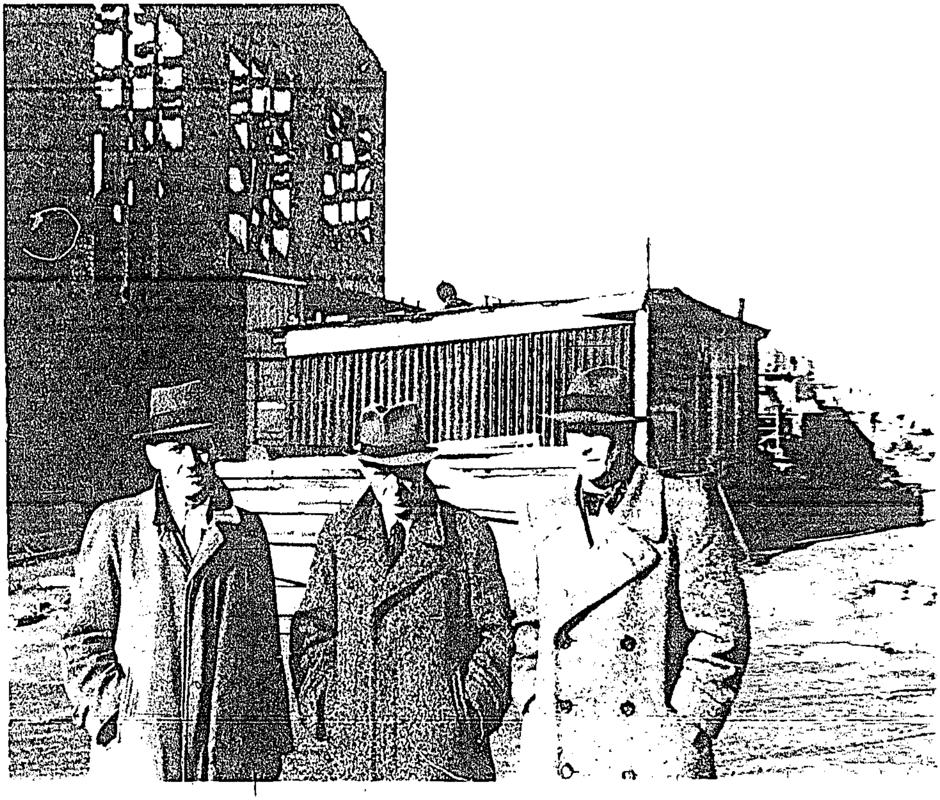


Figure [illegible]

[illegible] right, [illegible]
[illegible], Fritz [illegible].

III Plant Layout

Among the documents seized were large plot plans of the coking plant (Plan No.3) and of the synthetic fuel plant (Plan No. 6) The latter has been reproduced as Figure 3 page 6 and both have ~~been used to check the identity of the buildings~~ in the target area against the identities shown by Figure 4 which was the best previous information In table I page 8 is a list of only those buildings for which more accurate or more informative identification could be obtained from the plantplans. In general the previous identification was sufficiently accurate for the purpose at hand. However it will be noted that the laboratory building, 96, was thought to be a workshop, while the engine testing laboratory, 97, the research laboratory, 120, were unidentified. Building 121 though to be a laboratory or workshop proved to be a storehouse. These mistakes are not surprising in view of the similarity in structures of the buildings in question. Just southwest of the research laboratory, 120, was a new building for pilot plant research not shown in the DID plan. In the area just north of gasholder 95, was a large bomb shelter or "bunker", also not indicated on Fig.4. This was reported to be capable of sheltering 600 to 1000 people and appeared to have suffered no real damage from bombing.

From one of the captured plot plans of the Treibstoffwerke it is possible to determine the years in which various additions to the plant were made. It is assumed that the pilot plant research building, southwest of building 120, and the bunker were built in 1944 since they are not shown on the plan which includes 1943 construction.

In normal times the synthetic fuel plant (Treibstoffwerke) employed about 1900 men and women in the operating departments and about 25 research workers.

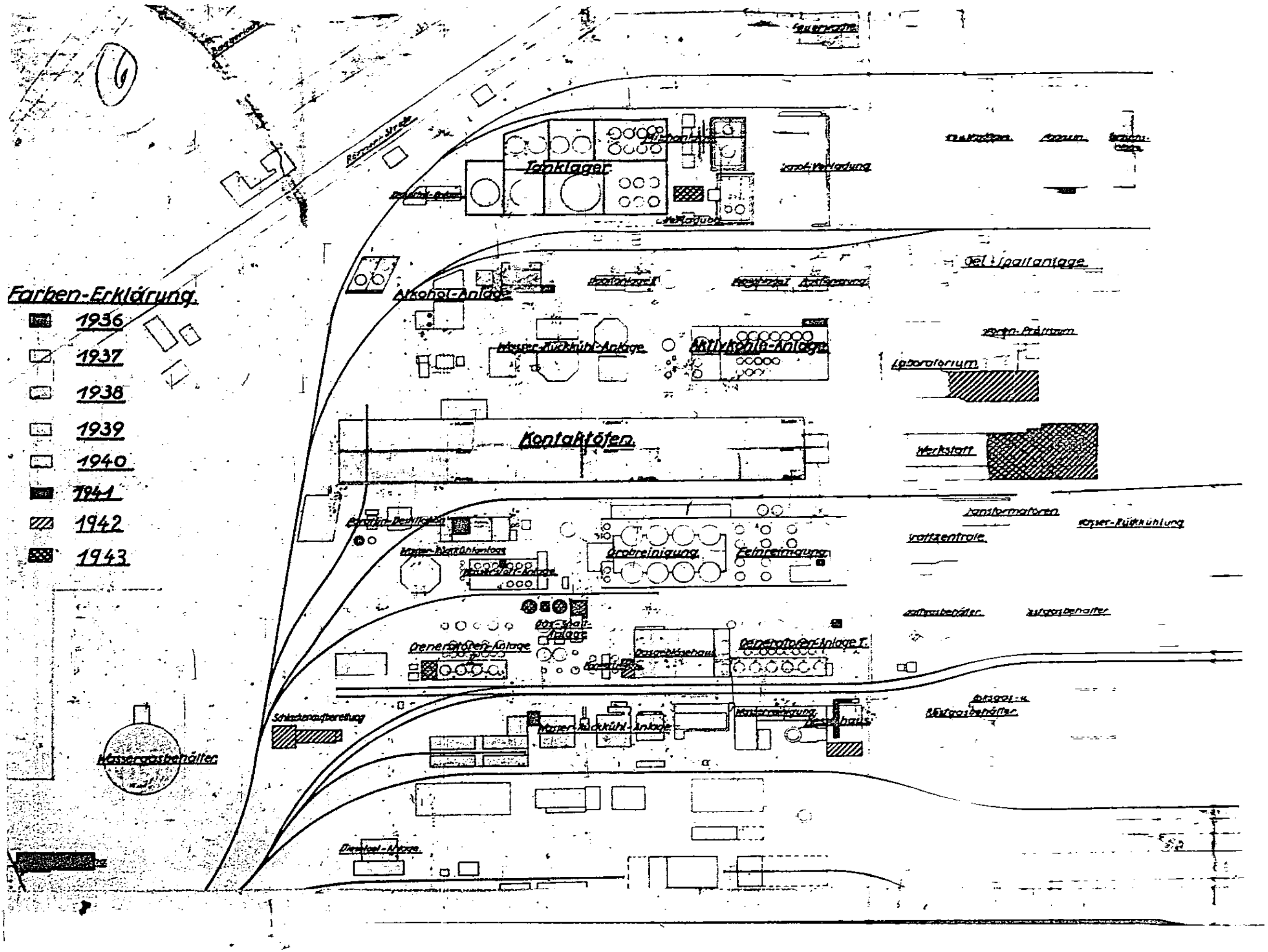


Figure 3

Plot Plan of Synthesis Plant
Rheinpreussen Moers

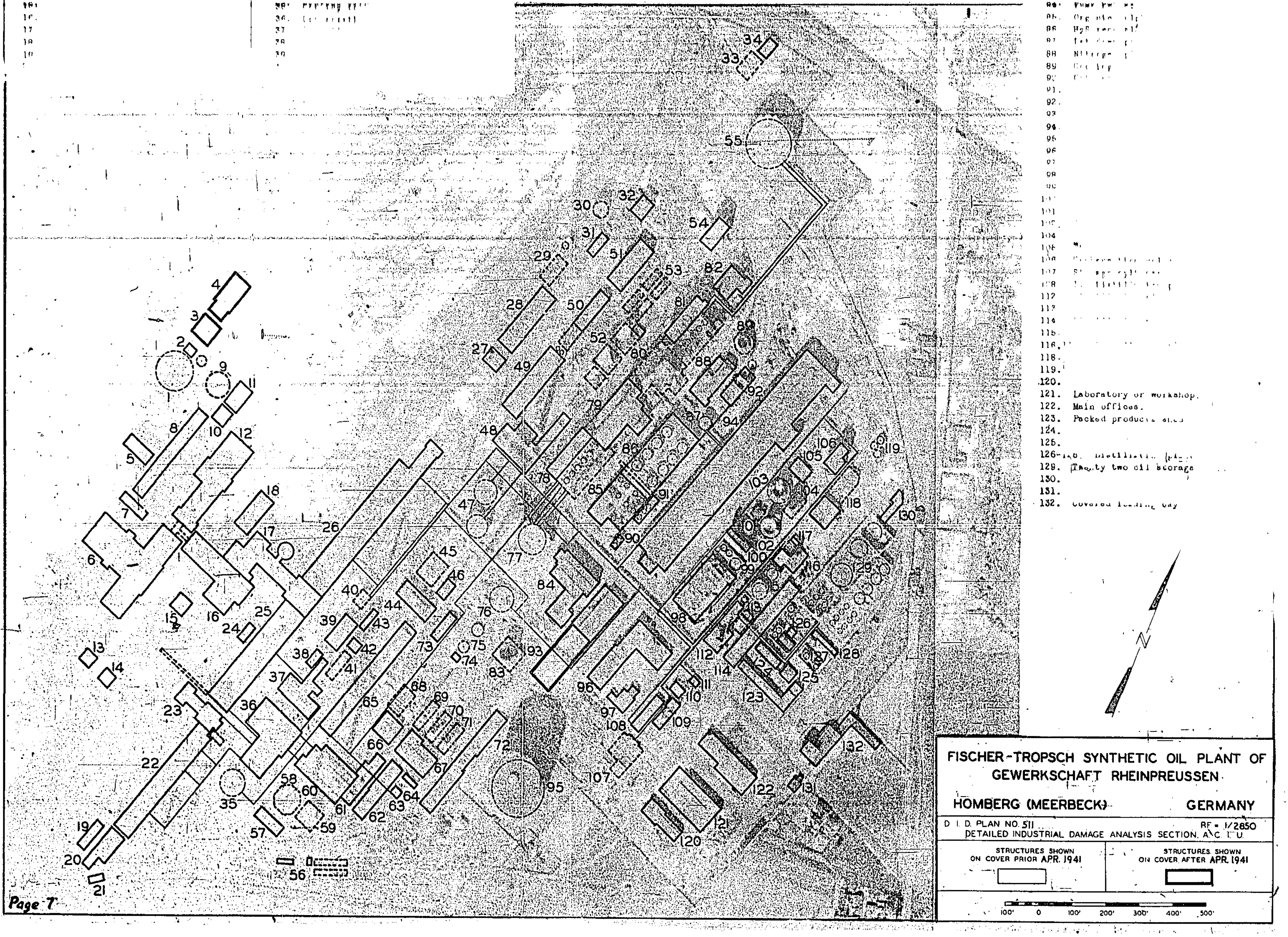
1.
2.
3.
4.
5.
6.
7.
8.
9.
10.
11.
12.
13.
14.
15.
16.
17.
18.
19.

21.
22. Modern coke ov [illegible]
23.
24.
25.
27.
28.
29.
30.
31.
32.
33.
34.
35. [illegible]
36. [illegible]
37.
38.
39.

41.
42. Distillation unit
44. Benzol fractionati
45. Storage cylinders.
46.
47. Two wet gasho
48. [illegible] house.
49.
50. Ammonium sulphate
52. Three cooling tower
53. Pitch bays.
54. Low cooling tower
55. Wet gasholder.

56. Water purifica
and pitch bays
57. Pump house.
58. Cooling tower
59. Cooling tower
60. Boiler house
61. [illegible]
62.
63.
64.
65. Ammonium sulpha
66-67. Linde plant.
68. Cylinder storage.

69-71. Cooling tow
72. [illegible]
73.
74.
75. Two [illegible]
76. Gasholder
77. Wet p[illegible]
78. Water gas pl
79. Blower house
80. Conve[illegible]
81. Water gas p
82. Pump house
83. Cooling tower
84. Pump house
85. Organic sulp
86. H_2S removal
87. [illegible]
88. Nitrogen
89. Cooling
90. [illegible]
91.
92.
93.
94.
95.
96.
97.
98.
99.
100.
101.
102.
104.
105.
106. Carbon [illegible]
107. Storage cylinders
108. [illegible]
112.
113.
114.
115.
116-117.
118.
119.
120.
121. Laboratory or workshop.
122. Main offices.
123. Packed products shed
124.
125.
126-128. Distillation plant
129. Twenty two oil storage
130.
131.
132. Covered loading bay



FISCHER-TROPSCH SYNTHETIC OIL PLANT OF
GEWERKSCHAFT RHEINPREUSSEN

HOMBERG (MEERBECK) GERMANY

D. I. D. PLAN NO. 511 RF = 1/2850
DETAILED INDUSTRIAL DAMAGE ANALYSIS SECTION, A.C.I.U.

STRUCTURES SHOWN ON COVER PRIOR APR. 1941	STRUCTURES SHOWN ON COVER AFTER APR. 1941
▭	▭

100' 0 100' 200' 300' 400' 500'

TABLE I

Correction and Amplification of Building Identities

Building Number	Identity	
	Assumed	Actual
1 - 5		Not shown on plans.
10 - 11	Unknown	Locomotive shops.
12	"	Workshops.
13	"	Gatehouse.
14	"	Lunch room.
15	"	Conveyor machinery.
17	Crushing & loading	Washing.
18	Unknown	Compressors.
23	Cooling tower	Coke conveyor.
24	Unknown	Coke breaker.
28	"	Pitch casting plant.
30	"	Impregnating oil tank.
32	"	Diesel oil refining.
33	"	Decarbonating plant.
34	"	" "
36	Condensation & tar recovery	Power house.
37	Tar stills	Boiler house.
39	Distillation unit	Pump house.
40	Unknown	Gas cooler.
41	"	" "
49	"	Distillation building.
50, 51	Ammonium Sulfate Preparation	Tank pits and Crystallizing building.
53	Pitch bays	Water settling basins.
55	Wet gas holder	Water gas holder.
56	Water purification	Water settling basins.
57	Pump house	Permutit plant.
62	Pump house	Store house.
73	Unknown	Cooling pans.
74	"	Pump house.
76	Gasholder	Holder for residue gas.
77	Wet gasholder	Holder for "cracked" gas.
84	Pump house	Central power house.
88	Nitrogen plant	Hydrogen plant.
92	Unknown	Paraffin distillation.
93	"	Machine shops.
96	Workshops	Laboratory.
97	Unknown	Engine test laboratory.

TABLE I (continued)

Building Number	Identity	
	Assumed	Actual
98	Unknown	Charcoal absorption towers.
99	"	Water scrubbers.
106	Condensation columns	Alcohol plant.
107	Storage cylinders	Oil cracking unit.
108 - 111	Distillation plant	" " "
113	Unknown	Stabilization unit.
117	Distillation plant	" "
118	Unknown	Alcohol plant.
120	"	Research laboratory.
121	Lab. or workshop	Storehouse.
123	Packed products shed	Liquefied gas. shipping.
124	Unknown	Liquefied gas storag
125	"	" " "
126	Distillation plant	Liquid fuel shipping
127	" "	Liquid fuel blending
128	" "	" " "
130	Unknwon	Lead tetraethyl blending
131	"	Gate house.
132	Covered loading bay.	Fire apparatus & garage.

IV Personnel and Organization

The general director of Rheipreussen plants was Heinrich Kost. His principal assistants are presumably those named on circular letters issued late in 1944 and early in 1945, from which Table II, page 11 has been prepared.

More detailed information regarding a number of employees of the synthetic fuel plant and laboratories were found on personnel cards which were seized for future use as desired (Document 101).

TABLE II

MANAGERIAL PERSONNEL OF RHEINPREUSSEN PLANTS

Gen. Direktor
    Kost

Herra Direktor
    Uterberg
    Küppers
    Fehlemann
    Strüven Schacht V
    Dr. Grimme "
    Dr. Kölbel "

Inspector
    Blöcher
    Bofenschen
    Wengeler

Betriebsführer
    Heuer Schacht VI
    Ley "
    Kühl "
    Schmidt "
    Schröder Neumühl
    Thielicke Schacht I/II
    Ziegler " V

Maschinenfahrsteiger
    Gelhausen
    Schaffranitz

Kokereichef
    Rohrwasser Schacht I/II

Betriebsführer
    Hackländer
    Dossman
    Richter, Neumühl
    Kirchhoff Schacht I/II
    Bergmann

Oberassistant
    Bamberger

Baumeister
    Arntzen, Neumühl
    Hilbert

Brandinspektor
    Vondran

Rechnungsführer
    Flottmann
    Schmitz

Markscheinder
    Schulte

Oberingeniews
    Dr. Kochs
    Scholler
    Körner

Dipl. Ingenieur
    Nennstiel
    Deckert
    Bruckhaus

The organisation of the Moers-Meerbeck plant was outlined by our informants as follows:

Synthetic Fuel Plant	
Managing director	Baumgartner
General plant	Breitenstein
Processing	Rumof
Alcohol plant	Dr. Haeuser
Boiler and machinery	Biermann
Power	Nute
Workshop and erection	Lohmann
Plant control	Ing.Juengling
Technical office	Herr Menger
" "	Herr Girke
Coking Plant	
Managing director	Hacklaender
Deputy	Ditzel
Plant engineer	Hold
Assistants	Witzke, Bilo, Schmalz, Koehn
Technical office	Westerlage
Laboratory	
Chief chemist	Dr.Grimme
Chemist	Dr.Schmitt
"	Dr.Wiedmann
"	Dr.Campen
"	Dr.Woellner
Engine testing Laboratory	Dr.Dahnefelser

This list of laboratory personnel is believed to be incomplete and does not include the organization of the Research Laboratory about which very little information could be obtained.

V Coking Plant

Various parts of the coking and by-product recovery plants are shown by Figures 5, 6, 7, 8 and 9. Figures 10, 11 and 12 are also from the same areas of the plant showing particularly the bomb damage.

The plant contains three batteries of coke ovens of which the two oldest were built in 1907-08 and the newest was built in 1928-29. There are 210 ovens in all. The newer ovens handle 20 tons of coal per charge, which is coked in 32 hours. The normal throughout of all ovens was 1800 tons of coal per day which yielded 1500 tons of coke per day. The coal was stated to have the following average composition.

Water	9-10%
Washed and dried coal	
Ash	6-7%
Volatile	24%
Carbon	69%
Sulfur	0.8%

The coke oven gas produced at this plant is augmented by that from ovens at adjacent Shafts IV and VI. Of the combined total, 10000 cubic meters per hour is converted to synthesis gas, about 3000 cubic meters per hour goes to surrounding towns as fuel and the balance is used in Plant V as fuel.

No further details were obtained about the coking operations or the recovery of by-products since there appeared to be nothing new or unconventional in this part of the plant.

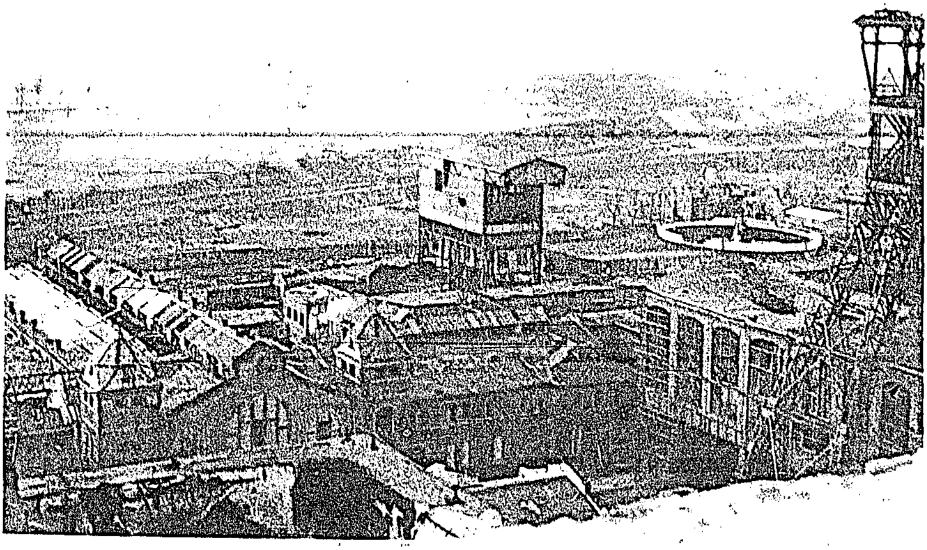


Figure 5.

Coal crusher and storehouse (6) lower left and
mine headgear (1[illegible]) lower right, looking NW from
top of coal bunker at new coke ovens (2[illegible]).

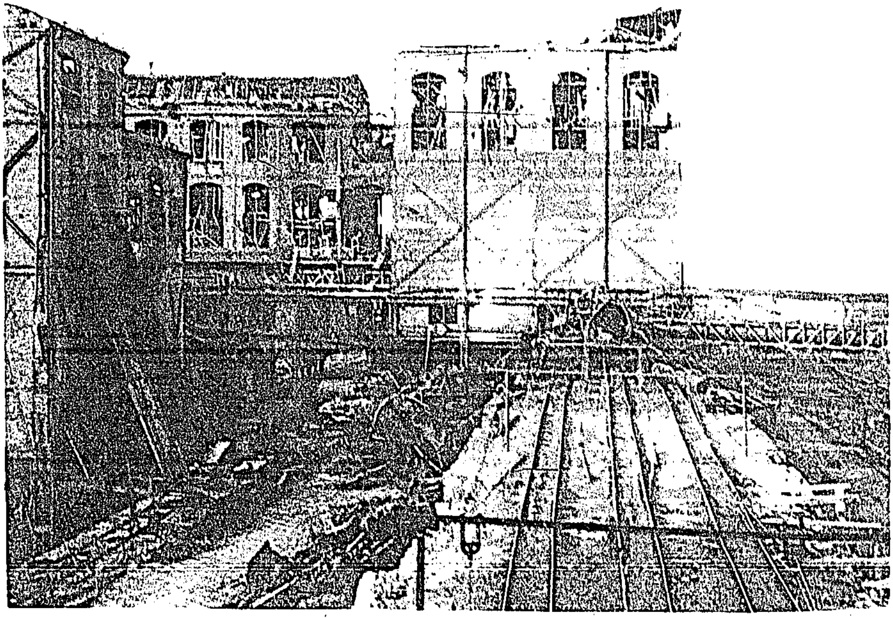


Figure 6

[illegible]
[illegible] her (extreme left).
Looking north along top of old [illegible] ovens ([illegible]5).

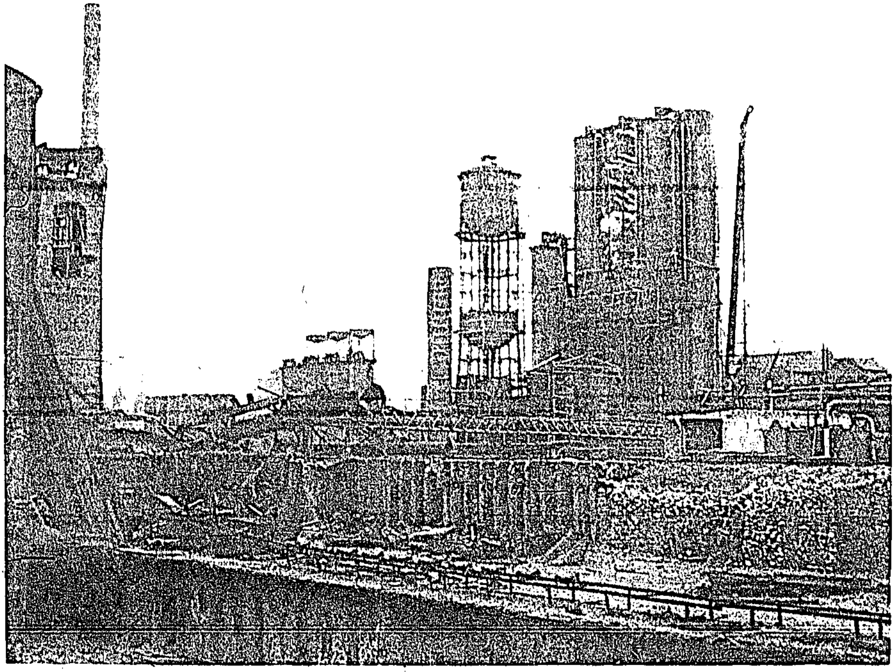


Figure 7

[illegible] with [illegible]
in background, looking NE from bridge between old
coke ovens (25) and new coke ovens (22).

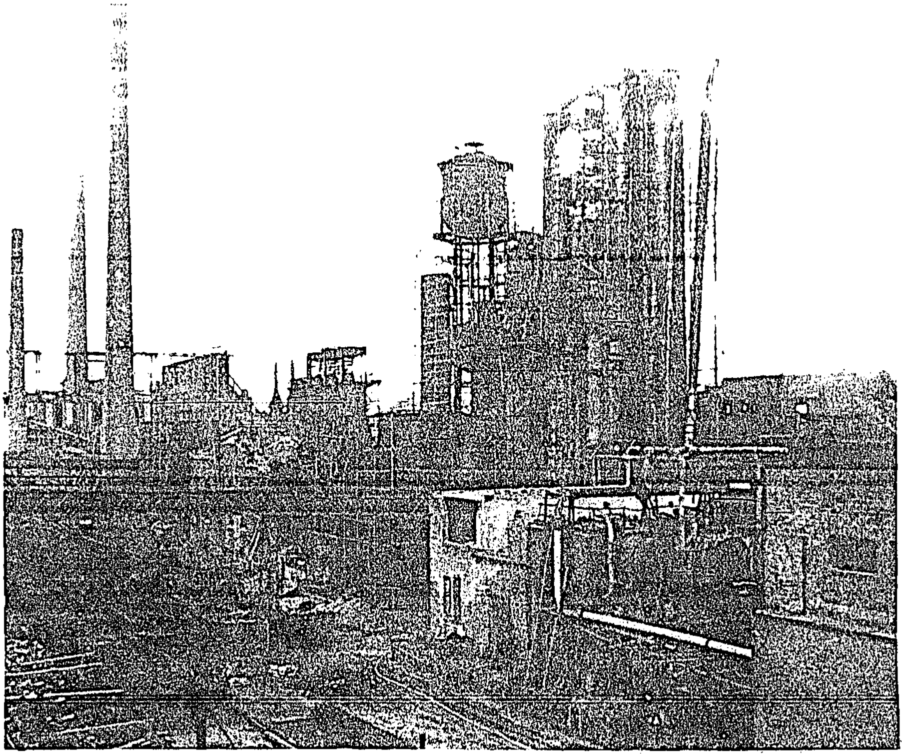


Figure 6

[illegible]
nearest stack; boiler house (48) behind main stack; gas generators (78) to right of boiler house looking SE from south end of old coke ovens (25).

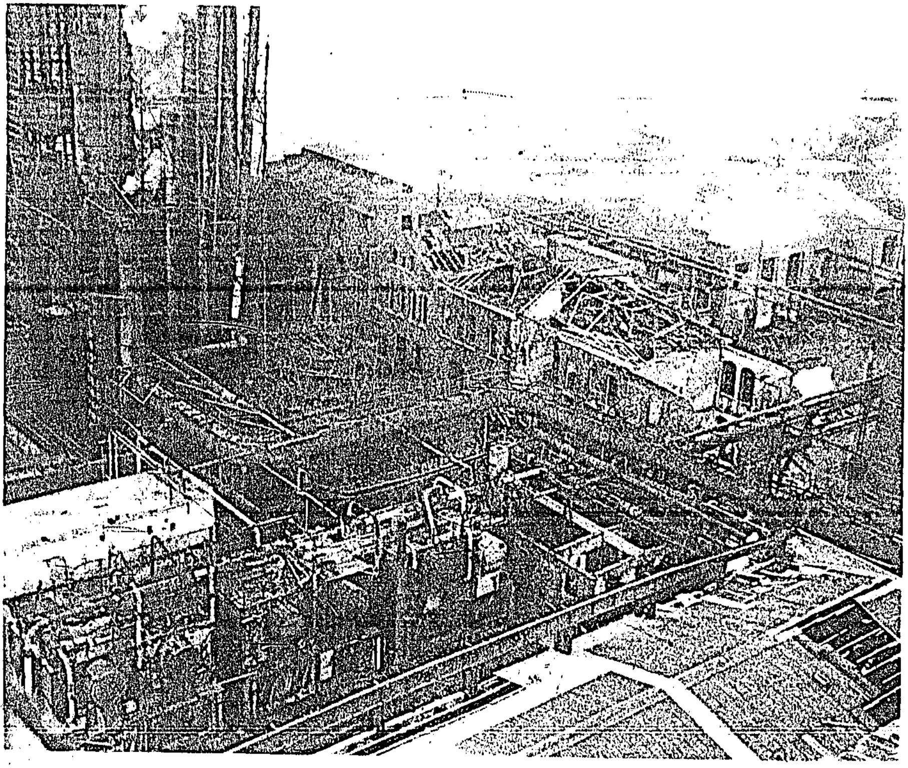


Figure 9.

Steam boilers ([illegible]) lower left, [illegible] scrubbers, upper left; ammonium sulfate plant (65, center, looking NE from north end of new coke ovens (22), continued on 00011.

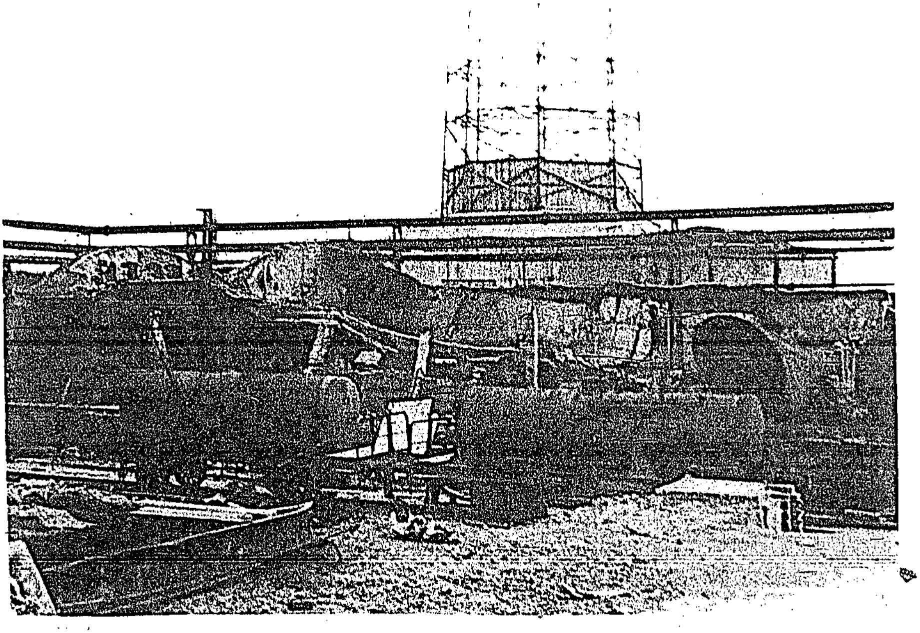


Figure 10.

Cooling tower (86) with remaining [illegible] pans (73) in foreground, looking east.

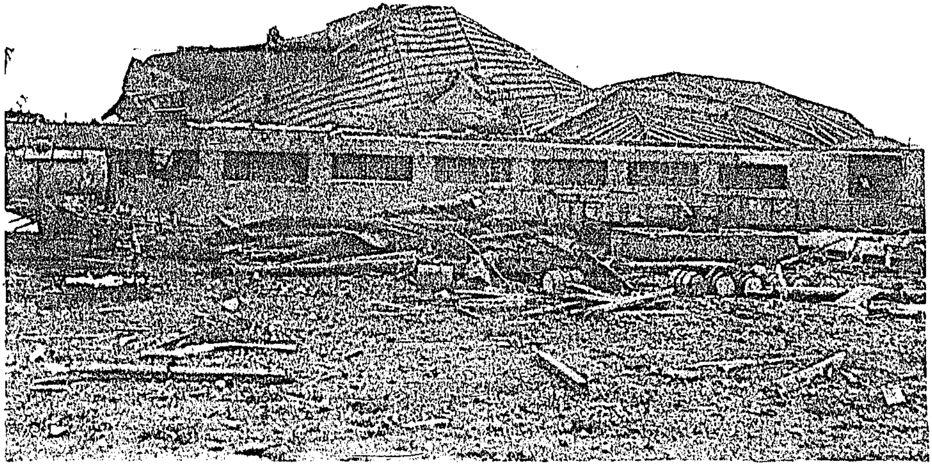


Figure 11.

[illegible]
Plant ([illegible]E) looking east.

Figure 12.

[illegible]

VI. Synthesis Plant

The general procedure involved ~~in~~ the Moers Fischer-Tropsch operations will be reviewed prior to consideration of the individual steps in greater detail.

Water gas is made from coke in eleven Koppers generators and is passed in part through a catalytic convertor unit to increase the ratio of hydrogen to carbon monoxide. Coke oven gas is "cracked" with steam non-catalytically in a battery of six Cowper stoves and is mixed with converted water gas in the proportion required to give a 2:1 ratio of hydrogen to CO. The mixed gas subjected to coarse purification (Grobreinigung) for H_2S removal by passage through iron oxide, and then is contacted with iron oxide plus sodium carbonate at elevated temperature for fine purification (Feinreinigung) to remove organic sulfur. The purified gas goes to the first stage of synthesis ovens, comprising two thirds of the total, and then to water scrubbers and charcoal absorbers for removal of condensible products (C_3 and heavier). The unabsorbed gases pass through the second stage of synthesis ovens and to a final water scrubbing and charcoal absorption. Oil condensate from the water scrubbers is fractionated to make several distillate cuts and waxy bottoms known as "gatsch". The light hydrocarbons recovered from the charcoal are stabilized to yield benzin bottoms and a C_3-C_4 fraction overhead which is liquefied under pressure and designated by the somewhat confusing term "gasol".

A. Water Gas Generation

The water gas generators are arranged in two batteries. The older battery, containing six generators was built in 1936 and a second battery of four generators was built in 1938. A fifth generator was added to the latter battery in 1943. Fairly complete drawings and descriptions of these generators were picked up (Doc 25) which indicate that they were conventional in construction and operation except for somewhat more elaborate provisions for recovering waste heat than would be used in the United States. It was stated that normally nine of the eleven units were in service and that the total coke consumption was about 900 (metric) tons per day. The operating cycle of each generator was given as 80 seconds blast, 6 seconds purge, 60 seconds up run, 50 seconds down run, and 6 seconds purge.

From the data in a seized record book (Doc. 19), Table III, page 24, has been prepared summarizing the operation of these generators as carried out in 1941 and 1942

The remains of the old battery of water gas gene~~rators is shown by Figure 13, page 25.~~

B. Water Gas Conversion.

Approximately 18% of the water gas produced was passed through a pair of catalytic convertors to increase the ratio of H_2 to CO. The average performance of these convertors is also shown in Table III. These convertors are approximately 3 meters in diameter and 6 meters high, and operated at 450-500°C. The converted gas is water washed and combined with the remainder of the water gas in holder (55).

From seized document No. 61, it appears that the convertor catalyst contained the following ingredients although its entire composition was not given:

Cr	3.7%
Mu	0.1%
P	0.1%
As	Trace

A sample stated to be fresh convertor catalyst was obtained. The results of an analysis of this sample made by the Fuel Research Station are given on page 23a.

C. Coke Oven Gas Cracking.

To further increase the synthesis gas supply and to complete the adjustment of the H_2:CO ratio to the desired 2:1, coke oven gas in the amount of about 10,000 cubic meters per hour is "cracked" with steam in a battery of three Cowper stoves. These are refractory lined chanbers approximately six meters in diameter and twenty meters high packed with refractory checker brick. No significant drawings or further details of construction were obtained. The stoves are used in rotation on a cycle comprising blast, steam purge, "crack", and steam purge. The cracking temperature was stated to be 1200°C. From seized document No. 19 the following figures were taken as representative of this cracking operation in 1941 and 1942.

Water-gas Shift Catalyst, Sample No. 6.

This sample consisted of greyish-brown, irregular-shaped pieces, approximate size range, 1/2 to 3/4 in., ~~of great hardness and mechanical strength. Bulk density:~~ 1300 g./liter.

Analysis:

	%
Moisture (by distillation with xylene	5.0
Additional moisture given off at 800°C.	13.0
$Si\ O_2$	5.1
Fe_2O_3	38.5
Cr_2O_3	5.4
Al_2O_3	2.5
$Ca\ O$	18.2
$Mg\ O$	5.2
$-CO_2$	5.0
$-SO_3$	1.9
Difference (alkalies, etc.)	0.2
	100.0

This analysis presents no unusual features. Chromium oxide is a normal promotor for the shift catalyst, and lime is a recommended addition, burnt dolomite being often used as the basis of the catalyst.

TABLE III.

OPERATION OF WATER GAS GENERATORS AND CONVERTORS.

Average composition of coke.

H_2O	8.2%
Volatile + C	82.6%
Ash	9.2%

Average Generator Operation.

Coke charged to generators		981,220 metric tons/day.
Water gas produced		1,146,070 M³/day.
Gross steam consumption	=	1870 metric tons/day.
	=	95 pounds/Mcf.
Steam generated in waste heat boiler	=	1095 metric tons/day.
	=	56 pounds/Mcf.
Net steam consumtion		39 pounds/Mcf.

Average Convertor Operation.

Water gas converted	210,900 M³/day.
% of total water gas	18.4%
Converted gas volume	260,400 M³/day.
Steam consumption (30 atm)	86 metric tons/day.
Water consumption	1 004 M³/day.
Coke oven gas cracked	251,590 M³/day
Steam to cracking stoves	250.4 metric tons/day.
Cracked gas production	389,370 M³/day.
Coke oven gas used as fuel	4,862 M³/day.
Heating value	4,455 Cal/M³.
Other gas (Rest gas) used as fuel.	122,200 M³/day.
Heating value	2,292 Cal/M³.

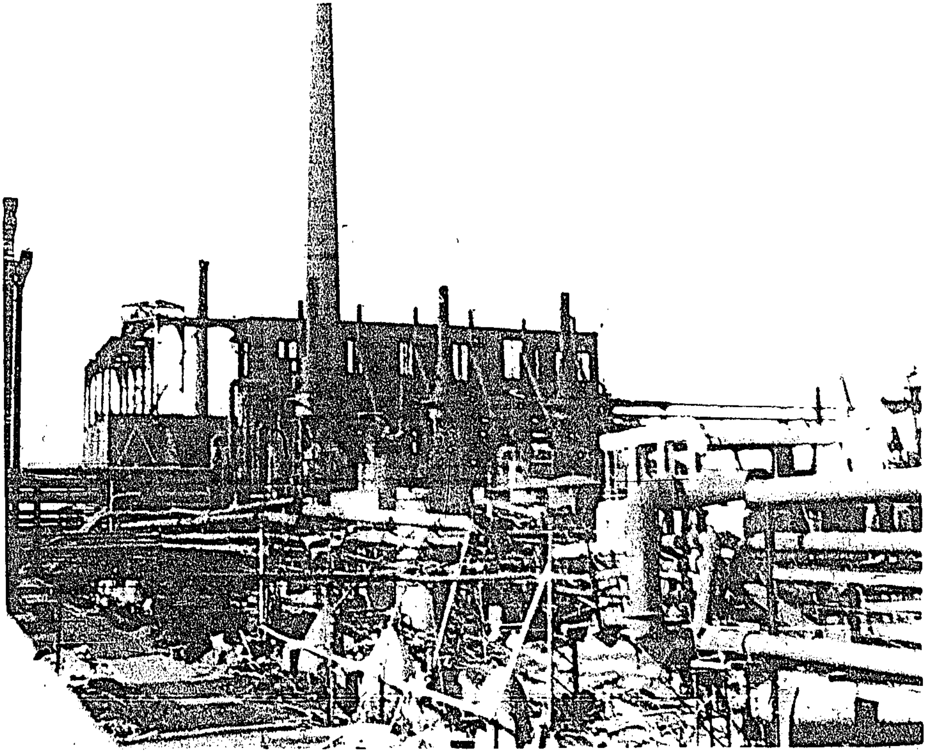


Figure 16.

[illegible]
purification plant ([illegible]5) looking up from south
of contact oven house 94.

D. Synthesis Gas Purification.

The mixture of converted water gas and cracked coke oven gas is passed at atmospheric temperature to a battery of eight "Grobreinigung" towers for removal of H_2S. Each tower is approximately 11 meters in diameter and 10 meters high, containing 800 tons of catalyst in beds about 0.3 meters deep on 18 trays spaced 1 meter apart. The catalyst is stated to be iron oxide (luxmasse) and to have a life of about 12 weeks after which it is thrown away. The gas velocity through the catalyst was stated to be 1 meter per second. Air in the amount of 1.4% of the gas treated is added to the gas ahead of the coarse purification to function as an oxidizing agent in the subsequent fine purification step.

A sample of this catalyst was obtained. Results of its analysis as reported by the Fuel Research Station are as follows:

Moisture	49.5
Loss on ignition at 475°C.	5.4%

The ignited and air dried catalyst showed the following analysis which is typical of Luxmasse:

Moisture	3.4%
SiO_2	0.8
Fe_2O_3	56.0
Al_2O_3	27.4
CAO	6.2
SO_3	1.9
CO_2	2.2
Difference	2.1
	100.0%

The fine purification (Feinreinigung) plant for removal of organic sulfur comprises a battery of five chambers filled with lump catalyst containing iron oxide plus sodium carbonate. The chambers were 4.7 meters inside diameter and about 6 meters high with brick ~~insulated walls to facilitate operation at elevated~~ temperature. The gas is preheated in a small pipe heater to reaction temperature which ranges from 180°C with a fresh catalyst to 280°C when the catalyst is nearly exhausted.

A sample said to be the fine purification catalyst was obtained and identified as CIOS Sample No.9 The result of the analysis of this sample as reported by the Fuel Research Station is as follows:

Moisture	8.0
Fe_2O_3	34.4
Na_2CO_3	23.8
SO_3	3.5
Unidentified	30.3

Miscellaneous laboratory notes (Document 61) indicate that the fine purification catalyst contains about 29% of Na_2CO_3. Apparently experiments on the regeneration of the fine purification catalyst with oxygen were conducted in 1941 from the records of which the following information was derived:

The fully spent mass showed as a typical analysis 33% Na_2SO_4, 0.3% Na_2SO_3, and 4% Na_2CO_3. This indicates that the reaction in Feinreinigung is essentially a catalytic oxidation and that O_2 in the synthesis gas is essential, as other documents and data have indicated. Spent mass that had not been regenerated showed - 16 - 30% Na_2SO_4, 0.4% Na_2SO_3, and 7 - 15% Na_2CO_3. The above analyses indicate that the original mass contained about 30% Na_2CO_3, the remainder presumably being Fe_2O_3.

The gas leaving the fine purification and going to the reactors was stated to have the following composition.

CH_4	0.5%
Other hydrocarbons	0.2
CO_2	8.0
O_2	0.1
N_2	8.0
CO	28.0
H_2	55.0

From other sources it was learned that the sulfur content is 0.4 to 0.5 gms S per 100 M^3 after normal fine purification.

E. Synthesis Catalyst

The Moers plant used a cobalt Catalyst but the persons interrogated claimed to know nothing more about its composition except that it had not changed since the plant started operations. The catalyst is obtained from Ruhrchemie at Oberhausen-Holten and is returned to them for reworking. The catalyst is received in the reduced state in steel "Kubels" as illustrated by Fig 14. Each Kubel holds approximately 3 metric tons which is sometimes a little more and sometimes a little less than required to fill a single synthesis oven. An overhead travelling crane moves and dumps these containers. Return shipments of spent catalyst are made in the same Kubels which are carried on specially built rail cars holding two Kubels each.

One Kubel filled with what was stated to be fresh synthesis catalyst was found in the northeast corner of the synthesis building. The cover was not bolted tight and some deterioration of the catalyst might have occured due to infiltration of air during several months standing. On 7 March the cover was partly removed and a small sample of catalyst taken (CIOS No.10) without any special precautions to exclude air from the Kubel. The sample did not ignite spontaneously and the sample container was sealed promptly and the cover replaced on the Kubel. On the following day the cover was again partly removed to permit a large sample can to be lowered onto the top of the catalyst in the vessel. The can was previously purged with CO_2 and a blast of CO_2 was directed into the upper part of the Kubel while the sample was being taken. It was impossible to dig deeper than about one foot below the surface of the Catalyst and at this depth, where the sample was taken, the catalyst was observed to be at a dull red temperature.

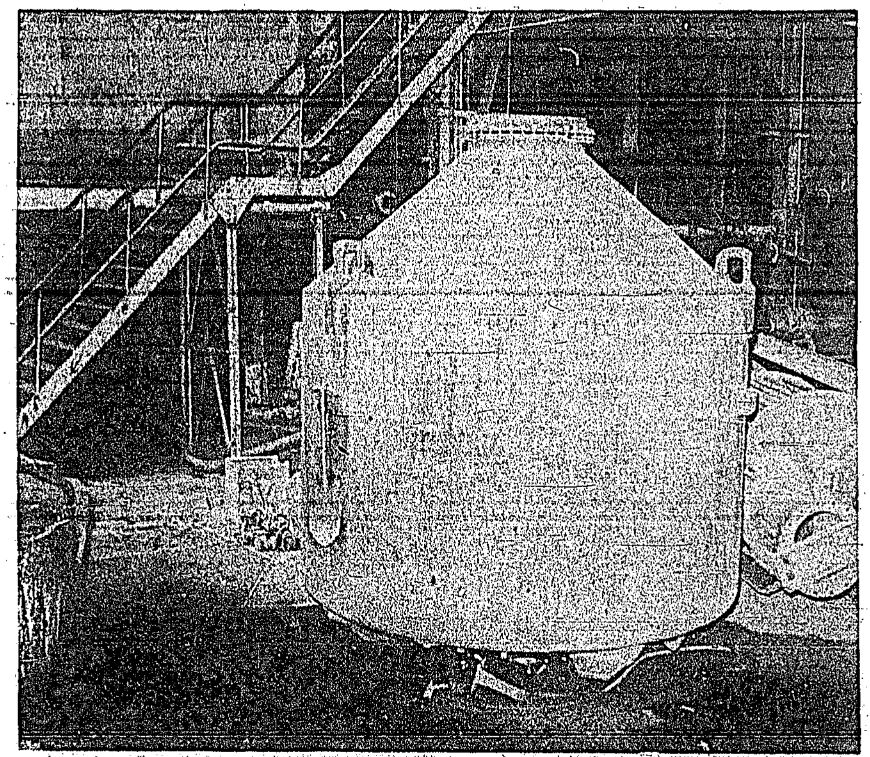


Figure 14.

"Kübel" used for shipping synthesis catalyst.

Before removing the can of catalyst from the Kubel, the cover of the can was put in place and it was sealed with adhesive tape within a few minutes thereafter. This was identified as CIOS sample Bo.2. The Fuel Research Statio analyzed sample No. 2 and tested both samples for activity with the following results:

	%			%	
Moisture	1.0		Ca 0	0.9	
Loss on ignition	4.0		Mg 0	0.9	(0.9)
Si O_2	47.9	(47.5)	Ni	0.1	
Fe_2O_3	6.5		$-SO_3$	nil	
Th O_2	1.8	(1.8)	$-CO_2$	0.2	
Al_2O_3	1.9		Unaccounted for	5.6	
Co_2O_3	29.2	(28.7)		100.0	

The material "unaccounted for" may be undetermined elements or may be due to false assumptions as to the state in which the known elements are present in the sample.

The amount of material insoluble in acid/ 52.7% gives a minimum figure for the kieselguhr content, and 100 - (Co_2O_3+ ThO_2+ MgO) gives a maximum figure.

The composition of the catalyst expressed in the usual manner would therefore appear to lie between the limits shown:

Co	ThO2	MgO	Kieselguhr
100	8.8	4.4	260 to 330

This result is in complete disagreement with information obtained by the Ruhr Party, which was that the catalyst used in all Western-German Fischer-Tropsch plants had the composition:

100 Co, 5 ThO_2, 8 MgO, 180-220 Kieselguhr

The above analytical results should therefore be regarded as tentative.

Both samples 2 and 10, as obtained, were completely inactive for synthesis at 185°C. and 195°C. After reduction with hydrogen at 400°C. in the usual manner, both catalysts showed gas volume contractions of 10% and 20% respectively when evaluated at 185°C. and 195°C.

Although it is known that catalyst was not made or reworked by Rheinpreussen, no specific information has been found on the technology of these operations as carried out by Ruhrchemie and occasionally by Brabag. Some discussion of the subject took place in connection with controversy over the cost of reworking, included in Document No. 2 which remains to be studied in detail. From Document No. 7 recording shipments of catalyst from Ruhrchemie to Rheinpreussen Table IV, page 32 has been prepared. There seemed to be no significant trend in compositiom during 1942. Comparable figures for June and December 1943 and June 1944 indicate no trend during these years unless possibly toward a slightly higher ratio of Kieselguhr to cobalt.

The total shipments of cobalt by month from July 1940 to September 1944 shown in Table V, page 33. The shipments were low in August 1942, in May, June and July 1943, January and February 1944, and June 1944 and later. There is no indication for the reason for these depressions, but it is possible that they were associated with bombings of Ruhrchemie plants or their sources of supply. The shipment to Rheinpreussen in September indicates some optimism even at that date about resuming synthesis operations at Moers.

The exact basis of calculation catalyst reworking costs is not clear from first reading of the seized account books, but it appears that Rheinpreussen's monthly payments to Ruhrchemie amounted to 3.7 to 4.2 marks per kilo of cobalt returned by Ruhrchemie.

A Rheinpreussen memorandum 27 August 1942 describes a method reported by Hoesch-Benzin for evaluating synthesis catalysts, involving measurement of hydrogen and carbon monoxide adsorption separately at normal pressure and temperatures of 50, 100, 150 and 200°C. It is stated that adsorption increases with temperature over this range and that much more hydrogen than CO is adsorbed per gram of cobalt. From these adsorption curves, it is implied that some measure of activity can be derived although just how this is done is not explained.

From the minutes of conferences of Ruhrchemie ~~Licensees, extending over the period from November~~ 1936 to July 1939 (Document 93), the following additional information about catalysts and operating conditions was derived.

Effect of ThO_2 - Mg O ratios.

No final conclusions were reached at the meetings as to the exact effect of the Mg O content. In general, the trend of opinion indicated that a ratio of 1 Th O_2 to 1.6 Mg O gave satisfactory results and about as good a catalyst containing a higher proportion of Th O_2. Further increase in Mg O content was tried but the experiments had not run long enough to determine its effect.

Sulfur Removal.

The major item of interest found in the discussion of sulfur removal concerned the effect of oxygen in the operation of the Feinreinigung. With 0.012 vol. percent O_2 the H_2S removal was very poor. With 0.177 to 0.205 volume percent oxygen, good H_2S removal was secured except at extremely high rates of gas throughput. When the O_2 content was increased to 0.802 to 0.903 volume percent, the efficiency of H_2S removal was seriously decreased. Organic sulfur removal was not very effective with 0.012 volume percent oxygen but was effective with 0.177 to 0.443 volume percent. The best results were secured with 0.177 to 0.205 vol.percent oxygen.

Miscellaneous Items.

Other matters discussed at the meetings concerned general matters of plant operation such as emptying and reloading the convertors with catalyst, removal of paraffin, removal of carbon deposits, and regeneration with hydrogen or by washing with Fischer-Tropsch product.

TABLE IV
Components of Synthesis Catalyst
Shipments from Ruhrchemie to Rheinpreussen *

Month	Kilograms shipped				Component Ratios by weight.		
1942	Cobalt	Thorium	Kieselguhr	MgO.	Th/Co	Kies./Co.	MgO/Co
Jan.	19571	995	32045	1481	0.0508	1.637	0.0756
Feb.	20922	1061	36323	1538	0.0506	1.735	0.0734
Mar.	21278	1096	36418	1644	0.0513	1.710	0.0771
Apr.	21681	1129	36060	1732	0.0519	1.658	0.0796
May	21571	1125	37343	1573	0.0521	1.728	0.0728
June	24163	1241	40994	1715	0.0513	1.691	0.0708
July	19966	1018	33729	1381	0.0509	1.688	0.0692
Aug.	13692	711	24243	1010	0.0519	1.770	0.0736
Sept.	21655	1121	37126	1605	0.0517	1.713	0.0740
Oct.	21313	1067	37141	1650	0.0500	1.741	0.0773
Nov.	11769	586	20396	867	0.0497	1.730	0.0735
Dec.	17536	888	29634	1290	0.0505	1.688	0.0734
1942 Totals & Ave.	235117	12038	401452	17486	0.0512	1.706	0.0744
June 1943	9281	467	18947	713	0.0503	2.040	0.0768
Dec. 1943	18231	928	39012	1352	0.0508	2.139	0.0740
June 1944	10853	545	19529	806	0.0502	1.799	0.0742

* Data from CIOS Document No.7.

TABLE V.

Catalyst shipments from Ruhrchemie to Rheinpreussen Expressed as kilograms of Cobalt.

	1940	1941	1942	1943	1944
Jan		22220	19571	17928	15240
Feb		20360	20922	17452	14353
Mar		22453	21278	19864	19008
Apr		21010	21681	17653	20590
May		22896	21571	24881*	19340
June		23323	24163	24356**	10853
July	20904	22819	19966	13117	3603
Aug	21117	21367	13692	16727	None reported
Sept	16894	25310	21655	16988	24258
Oct	22843	21030	21313	20510	No further Shipments
Nov	15286	22992	17536	18065	
Dec	21129	22985	17928	18231	
Total	118173	268765	241276	225772	127245

*Includes 17335 kg. from Brabag

** Includes 13567 kg. from Brabag

F. Synthesis Ovens.

The contact oven house is shown by Fig. 15, which also shows the extensive damage done to the south end of this building by bombing. ~~The ovens are arranged~~ in two parallel rows along the length of this building. The first 36 ovens, in the south end of the building, were erected in 1936: the next 12 were erected in 1937, and the last 48 were erected in 1938.

Figure 16 shows the outer ends of three ovens viewed from the ground level. Below these ovens can be seen the catalyst discharge troughs, and in the center is a portable bucket elevator for dumping spent catalyst into kubels for return to Ruhrchemie.

The synthesis ovens themselves were of the rather well-known early Ruhrchemie type, designed for low pressure operation. One of these ovens which had been removed from the battery is shown in some detail by Figures 17 and 18. For some unknown reason, the water tube leaders had been cut off from this reactor, but this leaves the spacing of the tubes more apparent.

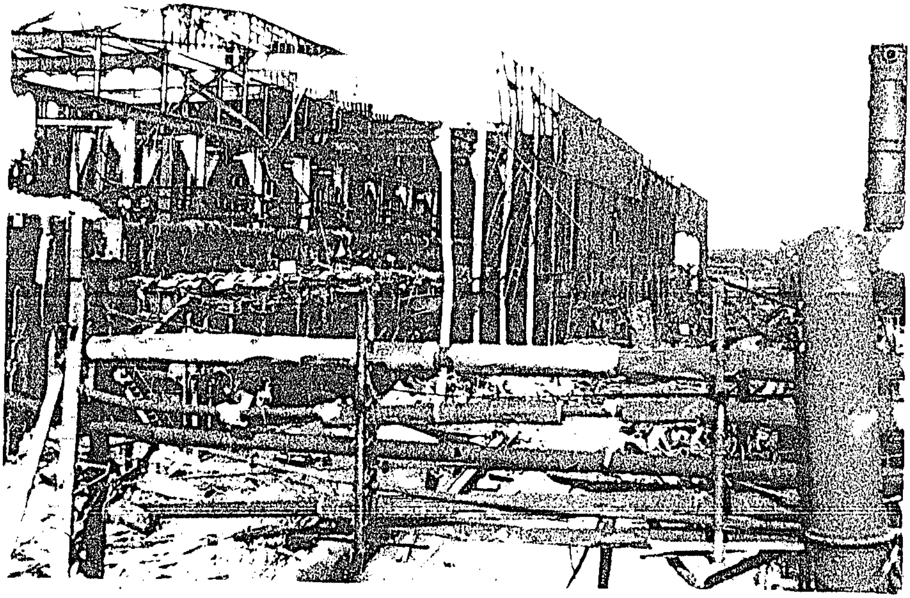
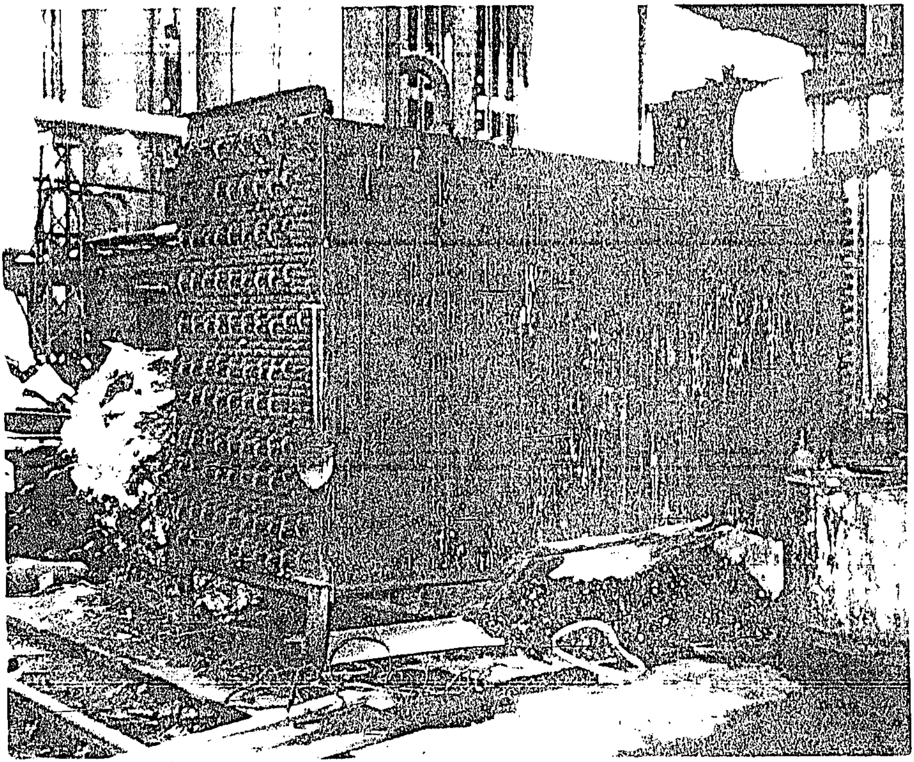


Figure 10

[illegible] wall [illegible] damage
to pillars.



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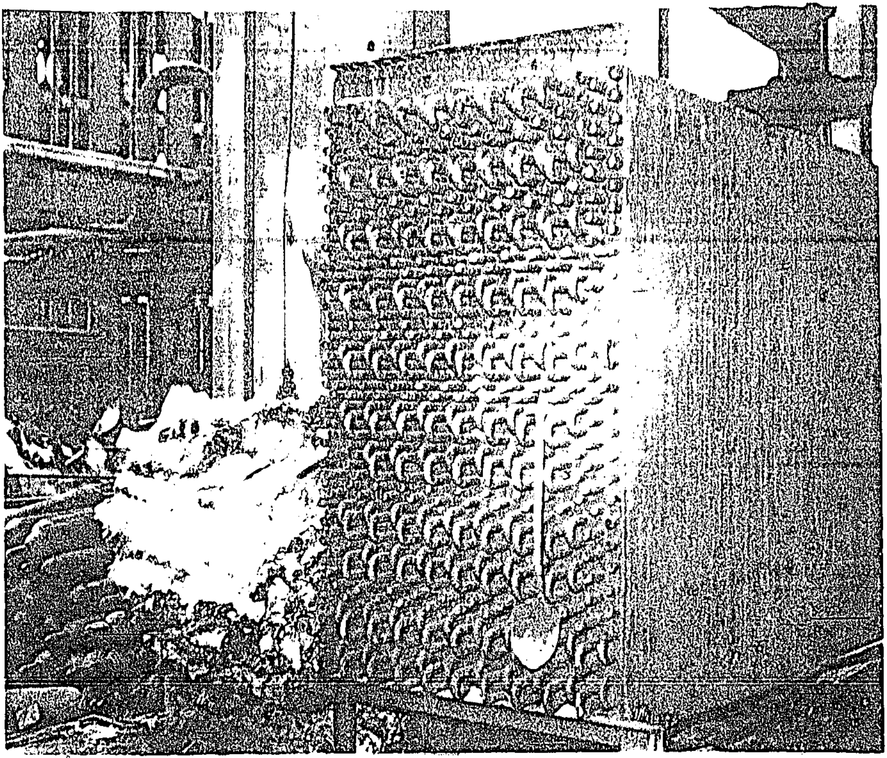

Figure 10

[illegible]

Each reactor is approximately 1.5 meters wide 2.9 meters high and 5 meters long. The horizontal water cooling tubes extend lengthwise of the reactor. There are 11 tubes in each of the 29 horizontal rows, the tubes being approximately 2.5 cm outside diameter. Horizontal headers, spaced as indicated by the cut-off ~~rows of tubes in Fig.18, are connected at both ends of~~ the reactor and their ends join vertical headers at each corner of the reactor as can be seen partially on the reactor at the left in Fig.16. The vertical headers on the same side of each reactor have a connecting line at the bottom. The vertical headers at the inner end (nearest the center of the building) of each reactor are connected to a superimposed steam drum, wherein steam pressure, and thereby reactor temperature is controlled.

The more recent units were arranged with a steam drum for each reactor as shown in Fig.19 whereas earlier units had two reactors connected to each drum as shown by Fig.20. Several units of each type are shown by Figures 21 and 22.

The edges of the transverse cooling plates can be seen in Figs 17 and 18 although the spacing is so close that the individual plates can not be distinguished. These plates are approximately 1 cm face to face. The catalyst fills the space between the plates and around the tubes.

No detail drawings or descriptive matter relating to reactor construction were found among the seized documents. It is understood that the reactors were made by Mannesmannrohren Werke, Dusseldorf.

G. Synthesis Procedure

It is customary to operate 60 ovens in the first stage and 30 in the second stage, with the remaining 6 emptying and filling or out of service for repairs or catalyst washing. Synthesis gas is supplied to the first stage of ovens direct from the fine purification step at a temperature of 150-160°C and at a rate of 1000-1200 cubic meters per hour per oven. (This stated rate is higher than indicated by captured documents.) The effluent is subjected to water scrubbing and charcoal absorption after each stage although in early operations only water scrubbing was used after the first stage. The catalyst temperature

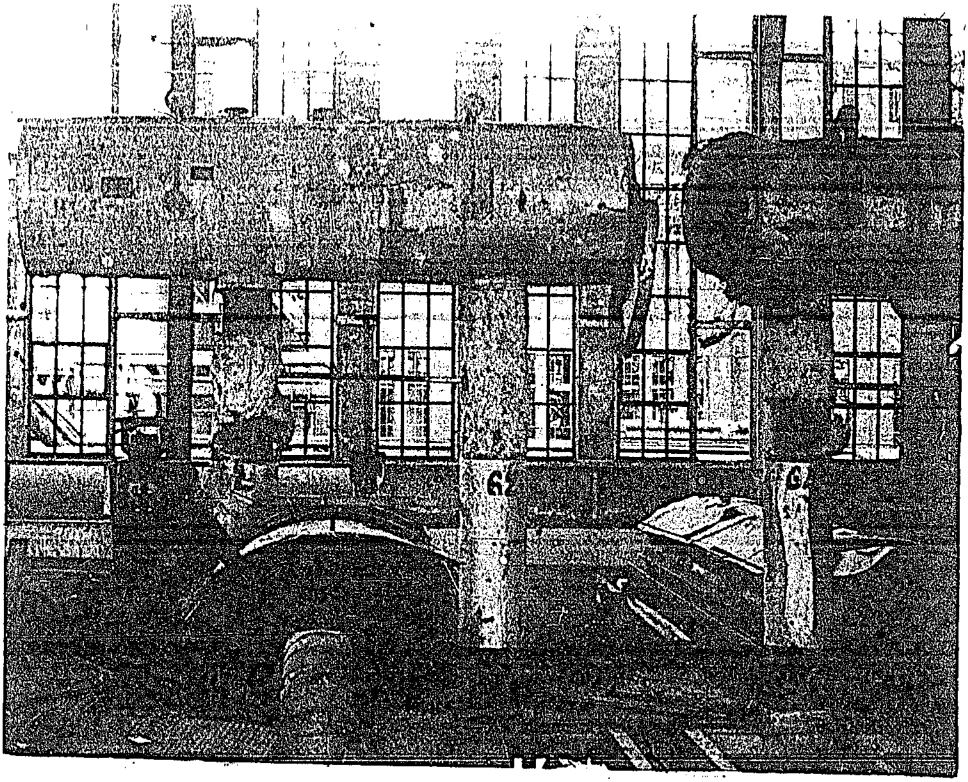

Figure 19.

Steam drum for one of newer ovens viewed
from control floor.

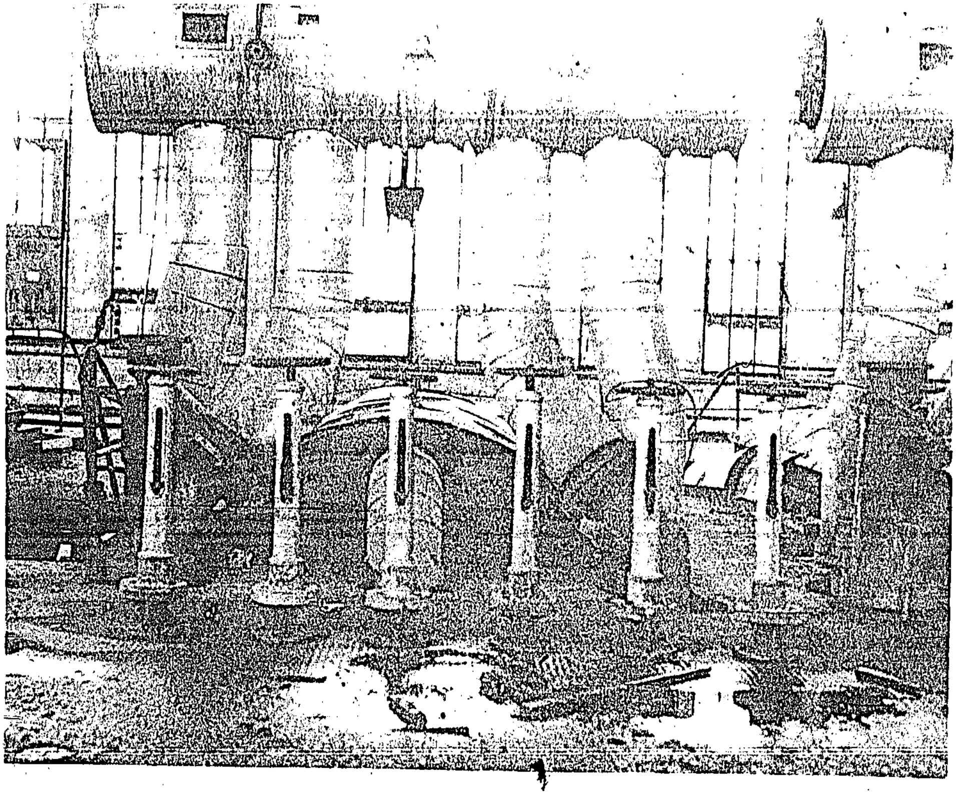

Figure 20.

Steam drum showing a part of the ovens,
viewed from control floor.

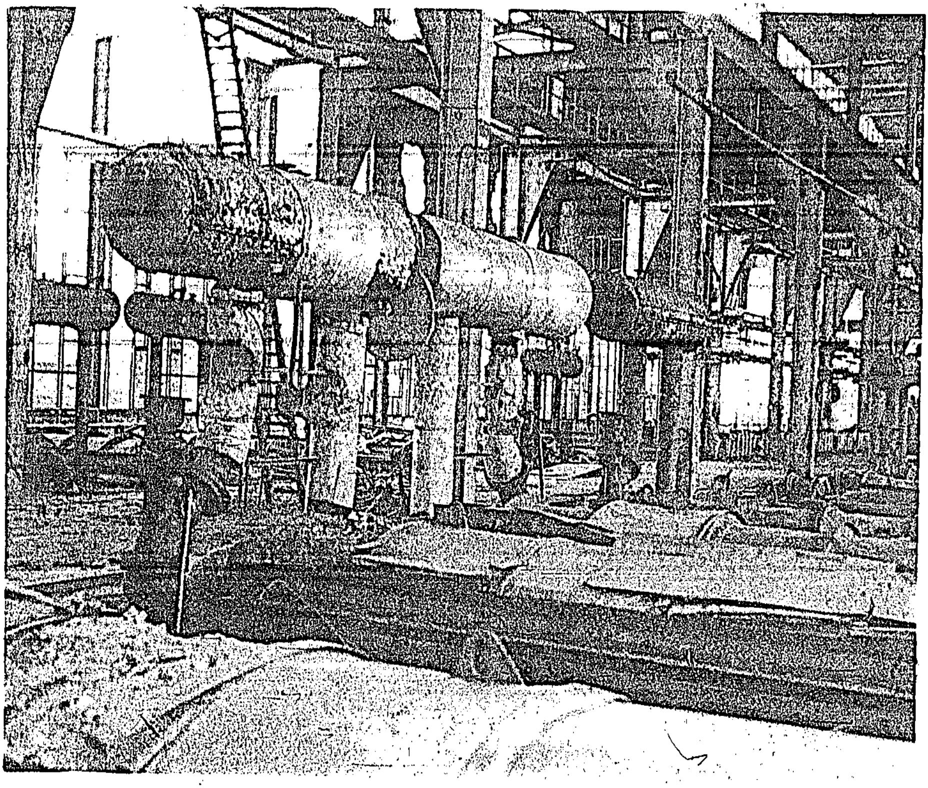

Figure 21.

[illegible]
of oven.

Figure 22.

Steam drums of older ovens viewed from control floor.

was stated to be 195 to 200°C and the pressure not over 3000 mm. of water (4.26 psi). The pressure on the cooling water is increased from 2.5 to 9.0 atm. during the life of the catalyst. This corresponds to a range of water temperature from 139°C. to 180°C. which does not seem reasonable for the stated 5°C. rise in catalyst temperature. It seems probable that the latter figure is in error, but nothing bearing on this point has yet been found in the seized records.

From a plant record book (Doc.19) and corresponding graphs, a rather detailed picture of the performance of the synthesis ovens during the last half of 1941 and the first half of 1942 can be obtained. During this period the synthesis gas charge rate averaged about 630 cu.m. per hour per oven. The charge rate was in general quite steady but on some days averaged as low as 520 M^3 per hour, and on others as high as 740 M^3 per hour. The product yield figures, for some unknown reason, showed much greater fluctuations from day to day with no apparent correlation with charge rate. The total liquid product, including "Gasol" (C_3 and C_4 hydrocarbons) averaged 150-155 grams per cubic meter, with a daily minimum of 135 gm/M^3 and a maximum of 175 gms/M^3. The yield of products heavier than the "Gasol" averaged about 135 gm/M^3 with a minimum of 112 gm/M^3 and a maximum of 155 gm/M^3.

The performance of the individual stages is also illustrated by reported date for 1941 and 1942 from which Table VI page 46 has been compiled. These data are derived from independent analyses of material to and from each stage and obvious inconsistencies suggest that analytical errors, in some cases, were considerable. For the period in question the CO-conversion in the first stage averaged about 70%, and in the second stage about 65%. The efficiency of CO utilization measured by the proportion converted to useful products (C_3 and heavier) is generally considerably lower for the second stage, probably in part because of the greater dilution of gas processed in this stage. There is no apparent explanation for certain exceptions to this relationship (18 September in particular). The original data also include hydrogen balances for these operations.

Further data on synthesis oven performance are provided by a collection of data sheets (Doc.73) for tests conducted in April, May and June 1943. The calculation procedure was as follows:

TABLE VI

Conversion in Individual Stages of Synthesis

	FIRST STAGE		SECOND STAGE		OVERALL	
	% CO	CO Conv.	%CO	CO Conv.	% CO	CO Conv.
1941	Conv.	Eff. Fac.*	Conv.	Eff. Fac	Conv.	Eff. Fa
23 July	74.7	3.33	77.9	1.49	94.5	2.76
8 Aug.	76.8	5.63	61.0	1.99	90.5	3.70
19 Aug.	70.6	4.00	64.0	2.35	89.3	3.76
28 Aug.	72.8	4.51	64.3	0.89	90.3	3.08
18 Sept	75.8	4.02	65.2	7.69	92.3	4.26
2 Oct.	74.8	4.58	61.0	1.62	90.1	3.61
21 Oct.	75.6	3.14	68.1	2.82	92.3	3.37
5 Nov.	77.7	3.95	62.9	3.80	91.7	4.50
18 Nov.	78.2	4.86	79.0	2.48	95.1	3.22
9 Dec.	74.4	5.20	68.4	2.44	91.9	4.38
29 Dec.	76.4	5.37	69.6	2.82	92.6	4.60
1942						
6 Jan.	77.1	4.35	66.7	1.70	92.4	3.74
31 Jan.	74.0	4.65	57.8	4.38	89.1	4.10
10 Feb.	75.4	6.26	60.8	1.88	90.4	4.80
25 Feb.	78.3	3.80	69.4	1.87	93.4	3.40

* CO Conversion Efficiency Factor

$$= \frac{\text{Vol CO Converted to } C_3 \text{ and heavier}}{\text{Vol CO Converted to } CO_2,\ CH_4\ \&\ C_2H_2}$$

Not calculated or designated as such in the original data.

1. Gas contraction calculated from nitrogen contents. Nitrogen was directly determined (Feinbest) and not by difference.

2. From this, carbon and hydrogen balances were calculated, and the quantities of both coming out in the liquid products + gasol thereby determined.

   Liquid products + gasol production was calculated by dividing the carbon lost from the gas by 0.845, which is evidently considered the average carbon content of these products. Similarly liquid products + gasol production was calculated by dividing the hydrogen lost from the gas by 0.297, which is evidently a factor determined by experience, since much of the hydrogen goes to water.

   In two tests of the first stage of synthesis gas contraction was 41.7% and 52.8%, respectively. On nine tests of the second stage gas contraction varied from 32.1% to 41.6% with an average of 36.1%. Three tests of both stages in series showed gas contraction of 71.0%, 72.8% and 73.2% respectively.

   The following shows results of two tests, one for the first stage and one for the second chosen so that the outlet of the first stage and the inlet of the second nearly correspond.

	First stage		Second stage	
	Inlet	Outlet	Inlet	Outlet
CO_2	8.9	21.4	21.0	34.4
C_nH_{2n}	0.0	1.6	0.3	1.1
O_2	0.0	0.1	0.0	0.0
CO	26.2	14.4	15.7	3.3
H_2	51.5	26.0	28.7	7.0
CH_4	0.7	10.0	7.6	14.9
N_2 (determined)	12.43	26.36	26.59	39.19
Gas contraction	52.8%		32.1%	
* Liquid products + gasol g/m^3 inlet gas	95.6		52.4	
* Same, based on H_2 + CO content	123.0		118.0	

* Calculated from carbon balance

Calculation shows a total yield of liquid products + gasol of about 155g/m^3 of pure synthesis gas (H_2 + CO). One of the tests made in series on both stages showed a calculated yield of 175.0 g/m^3.

The normal life of a charge of catalyst is about four months. Three or four times during this period the catalyst is dewaxed by washing for 12 to 15 hours at 160°C with synthetic benzin having a boiling range of about 140 to 180°C. Hydrogenation was originally used for this purpose, the hydrogen being made by the iron-steam reaction. It was stated that benzin washing has been used for the last two years because it is much more "effective", but it seems probable that the reason for the change was the desire to recover the high melting point wax instead of largely destroying it by hydro-cracking on the catalyst. The benzin is distilled from the extract and the residual wax, known as "Hart Paraffin" is cast in pans to make cakes for shipment.

An informal report from the Rheinpreussen laboratory dated 15 March 1938, entitled "The Removal of Paraffin from Used Catalyst" describes a series of experiments directed toward the removal of paraffin from used Fischer-Tropsch catalyst by its heating with water and solutions of NaOH, $Na_2 CO_3$ and $Na H CO_3$. The conclusions reached are as follows:-

1. By heating Fischer catalyst with a 4-5% soda solution at atmospheric pressure a satisfactory removal of paraffin can be achieved. The removal amounts to 65-75%.

2. For effecting a sufficient removal of paraffin the mixture of catalyst and solution of soda must be heated to above 100°C. The melting point of the paraffin in the catalyst is so high that a temperature of 96-98°C is inadequate.

3. Small grain sizes of the catalyst are more difficult to free of paraffin than the larger ones.

4. Silica converted to soluble form during the treatment is only slight.

5. For a clean paraffin separation 3 parts of soda solution to one part of catalyst is considered most favorable.

A report from Brabag (Ruhland) transmitted to Rheinpreussen by letter dated 21 March 1938 discusses the efficiency of hydrogenation as a means for regenerating spent Fischer-Tropsch catalyst. The author concludes that a hydrogenation step for said catalyst having a reduced activity in consequence of desposition of paraffin therein is effective in increasing the life-period of the catalyst. The recommended conditions of hydrogenation are temperatures of 200 to 225°C and a flow of hydrogen equivalent to 1000 m^3 per hour per oven. Compared with the production of catalyst ovens that have operated without hydrogenation for over 2000 hours, hydrogenation increase the production about 25%.

The following disadvantages however attend a regeneration hydrogenation:

1 The paraffin is not completely removed from the catalyst.

2 By reason of catalytic cracking a part of the paraffin in the catalyst is decomposed and

3. Paraffin (wax) of new and particularly high molecular weight are formed.

The comment in the second paragraph of page 6 is interesting. It states as follows:

> "The formation of methane during the hydrogenation of the catalyst is at present viewed as an index of progressive cracking of iso paraffins because methane is manifestly a reaction product of these iso paraffins."

Informal reports from Brabag dated 4 and 5 January, 1938 (Doc 92) discuss experimental work on the effect of impurities in synthesis gasol laboratory experiments showed some advantage for final purification with active charcoal but plant tests did not confirm this advantage, probably because of other uncontrolled factors. Active carbon gave a sulfur content of only 0.1 - 0.2 gm/100 m^3 compared with 0.4 - 0.5 gm/100 m^3 from normal fine purification.

The hydrocarbon content of the synthesis gas is ordinarily 0.1 - 0.2 gm/m^3 before fine purification and 0.5 to 1.0 gm/m^3 after fine purification indicating some synthesis reaction which is suspected of involving resin-forming hydrocarbons. The effect of such hydrocarbons in synthesis is not definitely known.

An oxygen content greater than 0.12% by volume in the synthesis gas is known to be quite detrimental to the catalyst. The air introduced for fine purification leaves 0.02% of O_2 in the synthesis gas, but its effect on the synthesis catalyst is unknown. Fresh catalysts blanketed with CO_2 may become red hot due to reaction with oxygen in the air during transfer to the ovens but this does not seem to impair catalyst activity or life.

Carbon dioxide has not been found to enter into the synthesis reaction. Its chief effect seems to be as a diluent, causing lower conversions as the CO_2 content is increased and the $CO + H_2$ content is decreased, Increasing the ratio of H_2 to CO appears to promote the hydro-cracking of oil and wax on the catalyst.

Increasing the ratio of $CO:H_2$ in synthesis gas tends to make heavier as well as more saturated products. Initial operation of a catalyst with synthesis gas relatively rich in CO seems to cause some permanent damage since abnormally short life results from subsequent operation with normal gas. Commerical fine purification does not remove all of the impurities which harm the catalyst. A spent catalyst contains bound CO_2 equivalent to 7-8% of the cobalt when calculated as carbonate.

Thiophene and other cyclics seem to be the most detrimental type of sulfur compounds. A given amount of sulfur as thiophene is much more detrimental if benzol is also present. Pure benzol or naphthalene apparent does not harm the catalyst. Acetylene up to 1% in the synthesis gas does not appear harmful.

High space velocity, once through, gives reduced percent conversion but increased unit productivity. Recycling gives a lower boiling product and a recycle ratio of 2.5 to 1 gives practically no oil heavier than benzin. Decreasing the depth of the catalyst bed had a different effect from increasing throughput to a bed of standard depth. A lower olefin content is observed with the deeper bed indicating the primary products to be olefinic, and normally undergoing more or less secondary hydrogenation, depending on the depth of bed.

As a part of the exchange of technical information between Ruhrchemie licensees it was apparent~~ly the practice to exchange copies of patent applica~~tions relating to the Fischer-Tropsch process. A number of these applications dating from 1936 to 1939 were captured (Doc 81) and brief abstracts thereof are attached as Appendix D. Probably the U.S. equivalents of some of these applications are among those seized and made public by the Alien Property Custodian.

Washing wax from the catalyst with a solvent at its boiling (or condensing) point, the subject of Brabag 182389, was apparently being practiced at Rheinpreussen. With this exception there is no evidence as to what extent, if at all, the procedures in question have been used. No applications of this [illegible] filed later than June 1939 were found.

H. Product Recovery

The condensible products from the first and second stages of synthesis were recovered in separate but essentially similar units comprising water scrubbing towers for cooling by direct contact with water and condensing the heavier oil, and batteries of charcoal absorption chambers for recovering the light benzin and C_3-C_4 hydrocarbons. Each charcoal unit consisted of seven towers, normally divided as follows:- 2 towers absorbing, 1 tower steaming, 2 towers drying and 2 towers cooling. The time cycle is as follows: absorption 40 minutes, steaming 20 minutes, drying 40 minutes, and cooling 40 minutes. The remains of some of the charcoal absorbers are shown in Fig.24 and a more general view of the absorption plant is shown by Fig.25. The charcoal was obtained from Lurgi at Frankfort. No significant data on the performance of the charcoal absorbers have yet been found.

Part of the dry gas (Rest gas) from the final charcoal absorbtion is returned to the gas cracking unit for conversion of its Methane and the balance is used as fuel. The distillate from the charcoal absorbers is stabilized to yield a light benzin bottom which is used as a blending stock for motor fuel, and a normally gaseous product overhead, consisting mainly of C_3 and C_4 hydrocarbons, which

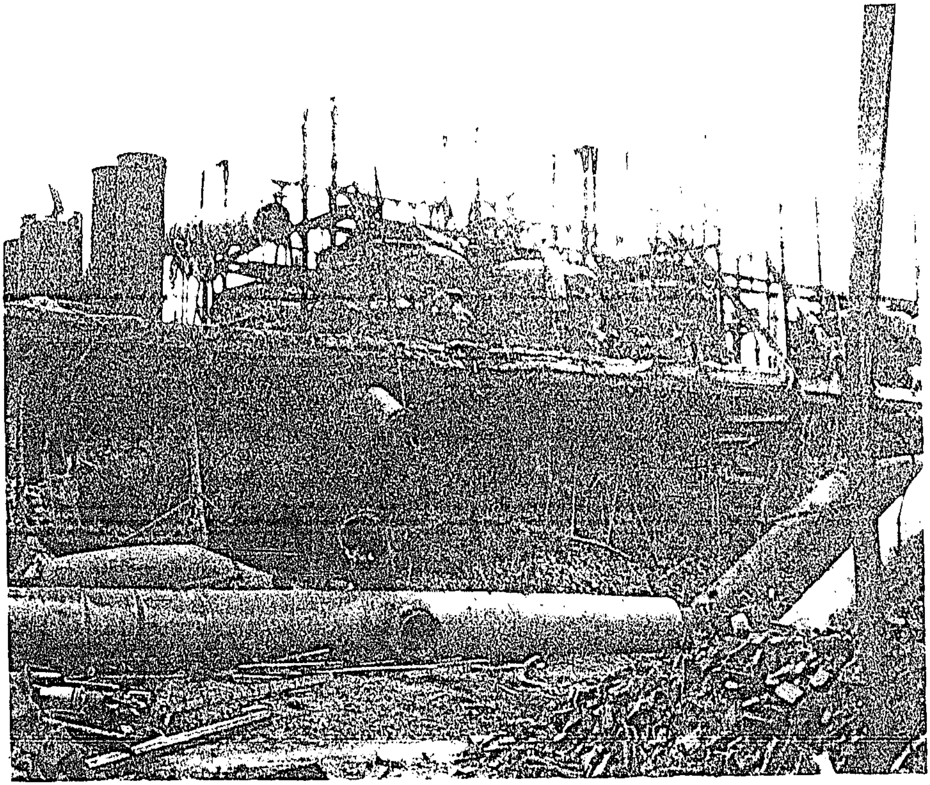

Figure [illegible]

[illegible]

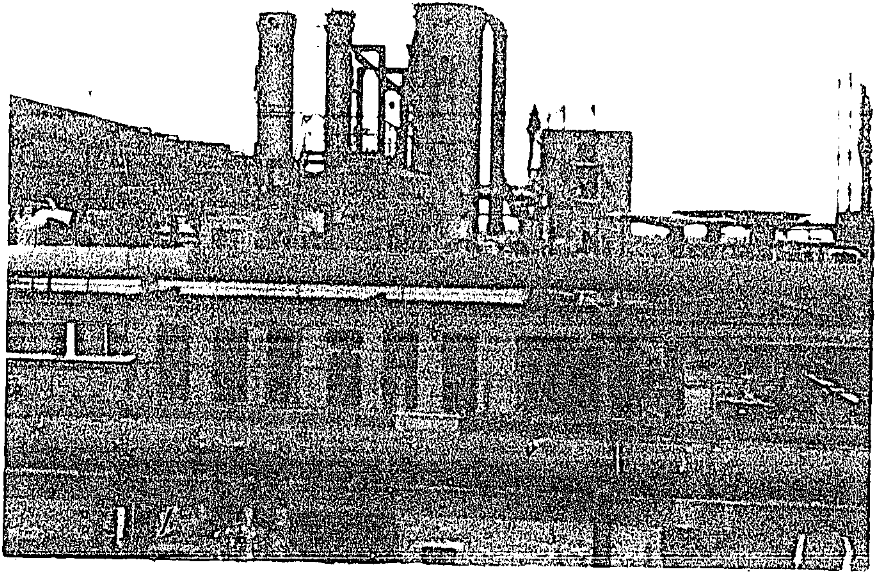

Figure [illegible].

[illegible] 58 [illegible]
[illegible] Alcohol plant 118 to right of [illegible]
water scrubbing towers.

goes to the alcohol plant for utilization of its olefin content. This overhead is normally handled as a liquid under pressure and identified as "gasol". Except for the part used for alcohol manufacture it was apparently sold mostly as motor fuel under the less confusing name of "Treibgas". A diagram was obtained showing the arrangement of the original stabilizing unit (Doc.31). ~~A second stabilizing unit was built~~ in [illegible] when the capacity of the original unit proved inadequate.

The combined oil from the water scrubbers is fractionated to yield light and heavy benzin, light kogasin, middle oil, heavy kogasin, and a waxy bottoms known as "gatsch". Practically no information could be obtained about the properties or uses of these products except by subsequent study of seized documents. The opinion was expressed that the gasoline had [illegible] [illegible] [illegible] but this was subsequently proved wrong.

An oil cracking unit had been erected in the Moers plant but was never used for the intended purpose. This was described as a Wilke unit, but subsequent study of documents indicates that it was a Carburol unit built by the Wilke Co. A complete set of drawings, including engineering calculations, for this unit was obtained (Doc.26). The fractionating equipment on this unit had been used to supplement inadequate capacity of the primary fractionating plant, but the whole unit was dismantled and moved after suffering some bomb damage. Probably the desirability of using Kogasin as Diesel fuel instead of cracking stock was a factor in this move.

VII PLANT CAPACITY

The normal output of primary liquid products was stated to be 180-200 tons per day of which about half was benzin and liquefied gas. Diesel oil and wax were indicated to be the other major products but no satisfactory information on product distribution was obtained until seized records were studied.

Table VII, page 56 has been prepared from statements submitted in connection with quarterly royalty payments to Ruhrchemie (Docs. 1 and 2) and shows annual output of principal products from 1939 through 1944. Even for the best years 1940 and 1941 the output of this plant was only a little over one third of the generally assumed capacity figure of 180,000 tonnes per year. Monthly production totals for 1942, 1943 and 1944 are shown by Table VIII, page 57. It will be seen that production fell off suddenly as a result of the severe air raid on the night of July 19-20, 1944. It is believed that all production reported subsequent to July, 1944, resulted from the working up of accumulated stocks of crude oil and perhaps recovering wax and oil from the catalyst in the remaining reactors.

The production of principal products by months for the year 1944 is shown in Table IX page 58.

Table VII

ANNUAL PRODUCTION OF PRIMARY PRODUCTS
(according to Ruhrchemie License Accounts)*

	1939**		1940		1941		1942		1943		1944	
	Tons	Wt %	Tons	Wt %	Tons	Wt %	Tons	Wt %	Tons	Wt %	Tons	Wt %
Stabilized benzin	32291.181	61.5	33277.875	48.8	33942.628	47.7	30025.489	46.3	31970.060	51.4	16362.656	51.7
Heavy benzin	2481.230	4.7	280.900	0.4	249.975	0.3	262.950	0.4	32.340	0.0+	137.950	0.5
Kogasin for mixed diesel fuel	7999.247	15.2	8740.339	12.8	8180.851	11.5	7025.886	10.8	5219.855	8.4	1764.947	5.6
Light Diesel fuel			11991.164	17.6	8213.429	11.6	8178.594	12.7	6445.310	10.4	3219.023	10.2
Liquefied gas	5420.988	10.3	6112.429	8.9	7379.136	10.4	6762.280	10.4	6094.340	9.8	3154.857	10.0
"Hart" Paraffin	736.087	1.4	1397.733	2.1	1407.568	2.0	1712.555	2.6	1679.670	2.7	1165.070	3.7
Kogasin	132.958	0.3	1800.634	2.6	6655.620	9.3	5765.480	8.9	5932.570	9.5	3381.810	10.7
Gatsch	3481.191	6.6	4660.601	6.8	5092.674	7.2	5147.670	7.9	4832.310	7.8	2414.800	7.6
	52542.882		68261.675		71121.881		64880.904		62206.455		31601.113	

* CIOS Documents Nos. 1 and 2.

** Earlier figures from this source not complete since Royalty payments did not begin until 1939. Total 1937-38 production stated elsewhere to be 35,600 tons.

TABLE VIII

MONTHLY PRODUCTION TOTAL *
ALL LIQUID PRODUCTS - METRIC TONS

	1942	1943	1944
~~Jan.~~	~~5,754,466~~	~~5,713,123~~	~~5,593,659~~
Feb.	5,460,766	5,403,285	5,296,845
Mar.	6,109,418	5,910,451	5,747,675
Apr.	6,010,346	5,800,730	5,729,077
May.	6,357,390	5,925,868	6,020,837
June.	6,171,988	5,386,936	4,956,244
July	5,117,943	5,728,477	1,520,445
Aug.	3,825,625	5,551,051	29,100**
Sept	5,473,729	5,260,693	20,410
Oct.	5,535,115	5,740,129	127,400
Nov.	5,826,542	5,455,951	13,000**
Dec.	5,884,066	5,635,008	0,000**
Totals	67,527,394	66,692,702	35,054,692

** Monthly statement missing; total estimated from other records.

* From CIOS documents 17 and 20.

Table IX

Monthly Production of Primary Products*
1944.
Metric Tons.

Month	Treibgas	Benzin	Light Diesel Fuel	Mixed Diesel Fuel**	Light Kogasin	Heavy Kogasin	Hart Paraffin	Gatsch
January	638.300	2653.312	533.470	170.000	491.650	411.247	230.200	404.200
February	680.400	2537.045	563.180	172.500	413.108	416.522	137.260	330.300
March	794.800	2705.295	537.470	244.000	365.722	364.368	143.970	353.800
April	801.300	2661.307	744.920	197.000	537.500	358.190	165.440	375.500
May	722.700	2805.479	528.600	329.500	464.390	366.598	220.000	411.300
June	689.800	2228.242	684.370	273.000	507.322	388.060	157.500	403.200
July	227.700	719.903	67.300	72.000	93.740	86.040	18.890	105.060
August	--	--	--	--	--	--	20.000	8.500
September	--	--	--	--	--	--	17.000	3.410
October	--	--	--	--	--	--	--	--
November	--	--	--	--	--	--	10.000	--
Total	4555.000	16310.583	3659.310	1458.000	2873.432	2391.025	1620.060	2395.090
% of Grand Total	12.9	46.3	10.4	4.1	8.1	6.8	4.6	6.8

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* From CIOS Documents 17 & 20.

** Kogasin Component only.

VIII QUALITY AND DISTRIBUTION OF PRODUCTS

Interrogation at the Moers plant yielded very little information regarding product quality or distribution, but seized documents were somewhat more helpful. Product quality standards for synthetic fuel plants in West Germany were apparently worked out to meet Government requirements by the Arbeitsgemeinschaft fur Hydrierung, Synthese, and Schwelung, abreviated "Arsyn", having headquarters in Berlin (NW 7 den Dorotheenstrasse 35111) and a branch office in Essen at the Krupp A.G. (Dr. - Ing Fritz Müller). Correspondence with, and reports to, this organization have yielded considerable information on product specifications and how they were met by Rheinpreussen.

The destinations of practically all shipments of stabilized benzin, Diesel fuel and Liquefied gas were apparently dictated by the "Zentralburo fur Mineralol GMBH". The address of this bureau was originally Berlin 1 Charlottenberg 9, Adolph Hitler-Platz 7/9, but on 26 August, 1943, "as a precautionary measure against catastrophe" it was changed to Dresden-Altstadt, Beustrasse 7. Although other records indicated shipments merely to "Zentralburo", one book was found (Doc 15) showing the exact destination of each carload or cylinder of such products shipped during 1944.

From the above sources most of the following information about specific products has been derived.

A. Liquefied Gas (Flussiggas; Treibgas)

Figures for prospective production of liquefied gas by all Fischer-Tropsch plants in West Germany were assembled at conferences held in August and October, 1939 (Doc 88) and are summarized in Table X page 60. Plants showing zero percent olefins presumably had polymerization units or were converting olefins to alcohols as at Rheinpreussen. The estimates contemplated setting aside 15000 tons of Treibgas per year in 1940 and 1941 for aviation engine factories but how this would be used is not stated.

The division of Rheinpreussen's primary production between alcohol manufacture and shipment for fuel in 1944 is shown by Table XI page 61.

TABLE X

ESTIMATED PRODUCTION OF LIQUEFIED GAS FOR MOTOR FUEL BY SYNTHETIC FUEL PLANTS
(Metric Tons)

	Last three Mos. 1939	Total 1940 Tons	Total 1940 % olefins	Total 1941
Scholven	13,500	54,000	0	54,000
Gelsenberg	700	20,800	0	50,000
Victor Rauxel	350	2,800	50	2,800
Rheinpreussen	1,800	5,400	50	5,400
Ruhrbenzin	1,200	6,000	50	6,000
Krupp	900	4,300	50	4,500
Essener Steinkohle	1,350	5,400	50	5,400
Hoesch	1,500	4,800	40	5,000
Rheinbraun		20,000	0	40,000
Total		123,500		170,000

TABLE XI

RHEINPREUSSEN PRODUCTION
AND DISTRIBUTION OF TREIBGAS
1944 - Metric Tons

1944 Month	Production	Distribution *	
		Zentralburo**	Alcohol Plant
Jan.	638,300	390,780	243,800
Feb.	680,400	440,132	189,000
Mar.	794,800	643,153	183,200
Apr.	801,300	591,556	187,300
May	722,700	518,029	230,900
June	689,800	462,848	216,900
July	227,700	135,438	68,300***

* Excluding small amounts used by Rheinpreussen plants

** Includes small amounts "fur Rechnung Benzol-Verband, Bochum"

*** The total stock on hand (46,122 Tons) was destroyed by the bombing of 19 July, 1944.

The principal recipients of Rheinpreussen shipments in 1944, excluding companies getting relatively small quantities in cylinders, are shown by Table XII, page 63.

B. Grund Benzin

In recent years the great demand for Diesel fuel has apparently resulted in the lowering of its initial boiling point to the extent that only one benzin was made and shipped. This is sometimes referred to as stabilized benzin and presumably takes the alternative name of "grundbenzin" from its use as a base stock for blending in motor fuels. Data on the total shipments and principal properties of this benzin as made at Moers are given in Table XIII, page 64. The principal recipients of benzin shipments from Moers in 1944 are shown in Table XIV, page 65.

Although the Moers plant had facilities for adding lead tetra-ethyl to gasoline it was stated that no lead had been available there for the last two years. Seized correspondence indicates that this may have been in accordance with agovernment ruling that lead blending should not be done with any facilities which could not be made absolutely safe against bombing.

The necessity of reducing the benzin endpoint to around 160°C to make the required quantity of Diesel fuel introduced a serious problem of avoiding excess front-and volatility which was a subject of prolonged discussion and repeated compromise.

C. Diesel Fuel

Seized documents 74 and 82 reveal that means for increasing Diesel fuel production began to be discussed seriously late in 1939 with particular consideration being given to lowering the initial boiling point to about 150°C and blending with aromatic stocks of similar boiling range from high temperature coking. It was foreseen that less gas oil would be available for cracking and the gasoline quality would be impaired accordingly. The reduction of benzin endpoint would necessitate some shifting of butanes from benzin to Treibgas which might require changes in pressure regulators etc. for use of the latter as motor fuel. The aromatic stock desired for blending was tar wash oil which would have to be replaced by heavy synthetic gas oil for benzol recovery and this introduced a number of operating problems.

Table XII

PRINCIPAL RECIPIENTS OF RHEINPREUSSEN TREIBGAS SHIPMENTS, 1944
Metric Tons

Principal Consignees	Matzerath Erkelenz	Hinkel Essen	Hilleke Essen	Benzol Verband Koblenz	Benzol Verband Frankfurt	Benzol Verband Stuttgart	Hugo Stinnes Mannheim
January:	58.250	115.400	11.500	42.060	--	--	21.150
February:	119.900	192.600	12.800	--	41.450	20.500	19.650
March:	271.700	106.000	11.200	38.800	--	--	--
April:	197.400	171.200	6.600	22.500	21.000	--	83.090
May:	94.400	114.900	14.600	46.800	20.800	--	87.600
June:	30.900	37.000	--	--	--	--	42.500

Table XIII

"Grundbenzin"
Monthly Shipments Reported to "Arsyn", 1943-1944

Month	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July
Quantity Tonnes:	2710	2451	2709	2647	2745	2558	2737	2715	2545	2794	2645	2607	2653	2537	2705	2661	2805	2218	720
Tests:																			
Sp.Gr.	0.679	0.679	0.682	0.683	0.685	0.682	0.683	0.683	0.682	0.680	0.680	0.679	0.679	0.679	0.682	0.681	0.680	0.681	0.682
% off at 75°C	41	41	40	37	39	39	37	40	40	42	42	42	42	43	40	38	40	39	39
V.P.(Atm)	0.73	0.68	0.58	0.57	0.59	0.59	0.58	0.59	0.64	0.72	0.77	0.79	0.81	0.78	W0.78 S0.60	0.58	0.70**	0.62	0.63
End B.P.°C	160	158	157	160	163	165	166	165	163	161	166	162	160	157	160	161	161	162	170
Octane No. (R.M)	60	61.5	59	55	56*	54.3*	53.0	52.4*	55*	57	58	57.2*	57.4*	56.7*	54.7*	53.5*	55.2*	54.4*	55**

* M.M. instead of R.M.

** Winter grade on orders from Arsyn

Table XIV

Principal Recipients of Grundbenzin Shipments from Rheinpreussen - 1944 -

Jan:	WIFO Ebrach 102.150	WIFO Berlin 205.700	WIFO Derben 258.200	WIFO Farge 358.100	Z.Holl. Gelsenk. 101.500	R.Mueser Bochum 184.100	NITAG Dortmund 157.450	Thyssen Duisbrg 105.300	Ruhroel Bottrop 350.300
Feb:	WIFO Ebrach 143.800	Benz.V. Stuttg. 125.000	WIFO Derben 456.100	Konstantin Bochum 110.000	Z.Holl. Gelsenk. 197.100	R.Mueser Bochum 132.500	Muller Gladb. 117.400	OLEX Regnsb. 347.400	Ruhroel Bottrop 209.700
March:	Rheinpr. Heilbr. 175.850	RAAB Karlsruhe 147.900	Gasolin Stuttg. 108.550	Konstantin Bochum 145.800	Rhenania Cologne 163.650	R.Mueser Bochum 111.500	Ebert Regensb. 801.400	--	Ruhroel Bottrop 113.300
April:	NITAG Magdeb. 583.150	NITAG Neuss 144.900	Dr.Marks Cologne 107.600	Benzol V. Eickel 365.000	Betriebsgess. Dresden 397.000	--	--	--	Ruhroel Bottrop 201.550
May:	WIFO Amstetten 407.500	RAAB Duessel. 104.100	Strohmeyer Freib'rg 122.75	Rhenania Magdeburg 199.000				OLEX Regensb. 368.100	
June:	NITAG Dortmund 166.350	Gasolin Frankfrt 108.800	Zentralbuero Vienna 356.600	D.Erdoel Pechelbronn. 697.000	WIFO Heiligenstadt 268.000	OLEX Danzig 145.000			
July:	WIFO, Derben 660.700	--	--	--	--	OLEX, Danzig 100.350			

Apparently engine tests were conducted by Bosch at Stuttgart, and by the Rheinpreussen and Ruhrchemie laboratories to prove that Fischer-Tropsch oil boiling from 150° to 320°C could be used satisfactorily with current Diesel engines and injectors. However no exhaustive or recent engine test data pertinent to this problem have been found.

In the discussions of increased Diesel fuel production there were occasional references to the need for considerable quantities of propylene to be used in some undisclosed manner for the production of a pour point depressant. Chlorine was also needed for this project but it was stated that the chlorine supply problem had been solved. No evidence has been found as to the extent to which such a pour depressant was made or used.

The basis for the final decision as to diesel fuel specifications does not appear in available records. The quality, as well as the quantity, of the two grades of fuel finally shipped by Rheinpreussen is shown in Table XV and Table XVI. The SDK is believed to be entirely Kogasin but the combination of about 76 cetane number with a solid point of about -42°C (-44°F) indicates the use of a pour depressant. The mixed diesel fuel MOK contains a coal tar oil (Waschol) the specifications of which are unknown. Shipments in 1944 averaged 45% "Waschol" and 55% Kogasin.

A flow diagram (Doc 78) indicates that the Rheinpreussen diesel oil refining process involves mixing suitable fractions and proportions of Kogasin and tar oil and treating the mixture with weak acid followed by weak alkali after which the oil is centrifuged, contacted with bleaching earth and passed through a filter press. No verbal confirmation of the details of this process was obtained.

The principal recipients of Diesel fuel shipments from Moers in 1944 are shown by Tables XVII and XVIII, pages 69 and 70.

On 13 March 1942 Arsyn notified Fischer-Tropsch plants that the Luftwaffe would require unspecified quantities of Diesel fuel meeting the following specifications.

Table XV

Synthetic Diesel Fuel (SDK)
Monthly Shipment Reports to "Arsyn"
1943 - 1944

Month:	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July
Quantity: Tonnes	506	346	396	420	510	429	601	439	487	510	836	679	533	563	538	745	529	684	67
Tests:																			
Density	0.746	0.744	0.743	0.745	0.747	0.748	0.748	0.747	0.749	0.748	0.750	0.749	0.748	0.747	0.747	0.747	0.747	0.748	0.748
Filterability	<60 -35	60 -35	<60 -40	<60 -35	<60 -20	<60 -35	<60 -25	<60 -35	<60 -35	<60 -35	<60 -35	<60 -35	<60 -35	<60 -35	<60 -35	<60 -35	<60 -35	<60 -35	<60 -35
Solid Point °C	-41	-44	-49	-45	-43	-39	-38	-41	-41	-40	-40	-41.5	-41	-41	-41	-41	-41	-40	-38
Flame Point °C	27	30	26	29	32	40	37	30	43	40	44	49	42	46	47	46	48	48	50
Cetane No.	77	77	77	76	78	76	76	76	76	78	73	73	75	75	75	75	78	78	78
Boiling Range °C	156 -252	159 -244	158 -225	162 -246	155 -236	169 -240	167 -243	160 -234	164 -252	160 -250	165 -245	164 -247	165 -240	165 -238	165 -250	165 -245	165 -247	165 -250	168 -255

TABLE XVI

Mixed Diesel Fuel (MDK)*
Monthly Shipment Reports to "Arsyn"
1943 - 1944

Month:	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July
Quantity: Tonnes	934	908	962	955	875	550	479	763	679	403	297	480	299	319	454	397	593	440	104
Tests:																			
Density	0.847	0.848	0.846	0.847	0.848	0.849	0.848	0.848	.0848	0.899	0.899	0.887	0.881	0.881	0.879	0.880	0.879	0.881	0.881
Filterability	<60	60	<60	<60	<60	<60	<60	<60	<60	<60	<60	<60	<60	<60	<60	<60	<60	<60	<60
Solid Point	-32	-34	-35	-34	-32	-32	-33	-33	-30	-26	-28	-25	-27	-29	-26	-26	-30	-29	-25
Flame Point	57	58	61	61	62	61	63	62	61	65	65	61	62	62	63	59	62	63	68
Cetane No.	55	53	55	54	54	54	54	55	57	45	45	45	48	48	48	48	50	50	50
Boiling Range	170 -285	171 -280	170 -280	171 -285	171 -288	171 -286	171 -283	171 -284	170 -284	170 -295	170 -300	170 -302	170 -295	170 -309	170 -300	170 -305	170 -300	171 -320	170 -320

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* Designation changed to "NDK" Oct. 1943 and subsequent months

TABLE XVII

PRINCIPAL RECEIPIENTS OF SYNTHETIC DIESEL FUEL SHIPMENTS FROM RHEINPREUSSEN, 1944

Main Consignees:	OLES Regensburg	Kuno Ebert Regensburg	WIFO Ebrach	Rh.Ossag Torgau	Kriegsmarine	Benzol V. Magdeburg
Tons:						
January	151.500	154.000	-	-	-	-
February	99.850	-	102.850	-	125.170	98.000
March	150.800	-	-	146.500	-	-
April	205.500	-	-	357.500	-	-
May	-	-	83.000	141.600	-	-
June	201.400	-	-	174.400	-	-
July	-	-	-	66.700	-	-

TABLE XVIII

2

Principal recipients of Mixed Diesel Fuel Shipments from Rheinpreussen, 1944

Tons

Main Consignees	Rheinpr. Cologne	Rheinpr. Duisburg	Rheinpr. Moers	DAPG Wesel	DAPG Maggen	Bezol.V. Dortmund
January:	34.200	100.500	-	-	-	-
February:	-	-	55.700	47.550	-	59.160
March:	-	67.320	77.700	-	-	51.260
April:	-	33.500	58.000	-	-	-
May:	-	122.250	71.500	-	48.400	-
June:	100.000	61.650	-	84.760	-	-
July:	-	97.500	--	-	10.000	-

TABLE XIX .

Principal Recipients of Kogasin Shipments from Rheinpreussen
1944 - Metric Tons

1944	Light Kogasin			Heavy Kogasin		
	Chemische Werke, Huls.	Rubrehemie Holton	I. G. Farben Ludwigshaven	Rheinpreussen Anlage IV	Rubrehemie Holton	I. G. Farben Ludwigshaven
January	105.036	385.550	-	345.520	53.600	11.950
February	198.130	213.860	-	268.110	131.250	17.130
March	263.840	64.970	36.760	355.860	-	8.500
April	236.840	300.660	-	340.940	-	17.250
May	251.900	212.490	-	366.370	-	-
June	155.560	316.540	35.070	307.050	64.030	16.880
July	79.940	13.800	-	86.040	-	-
	No additional stock or shipments			None	-	-
August				22.500	-	-
September				No additional stock or shipments		

Sp.Gr. at 20	Not below	0.740
Solid Print	Not over	-38°C
Flame Point	Not below	+37°C
Viscosity	Not below	1.05 E at 20°C
Neut. No.	Not over	0.4
Cetane No. (HWA)	Not below	70
Initial boiling pt.	About	160°C
End boiling pt.	Not over	360°C

Rheinpreussen replied that they could meet this requirement by blending Mittelol with heavy benzin as follows:-

	Mittelol	Schwerbenzin	1:1 Mixture
Sp.Gr.	0.752	0.742	0.7465
B.P.A.	-26.5°C	-36.0(-42.)°C	-25.0(-32.0)°C
Solid Point	-29.0°C	-44.0°C	-45.0°C
Flame Point			45.0°C
Vis /20°C			1.07°E
Cetane No.			78

It will be noted that the "SDK" Diesel fuel shipped from Moers during the last year of operations also met these specifications. Unfortunately the designations of these shipments are not indicative of the extent to which such fuel was used by the Luftwaffe.

D. Kogasin

The distribution of shipments of light and heavy kogasin from Moers during 1944 is shown by Table XIX page 71. The heavy kogasin shipped to Rheinpreussen "Anlage IV", Homberg was used for the manufacture of synthetic lubricating oils and was stated to have a boiling range of about 250-350°C. The specifications and uses of the other shipments are unknown.

Two samples of oil were taken from tank car Essen 5-8394, which was reported in captured documents to contain light kogasin. These samples were identified as C105 No.1 and C105 No.5. Sample No.1 was analysed by the Petroleum Board and No.5 by the Fuel Research Station, with results as given below:-

140	83.5 %
150	88.5
160	93.0
170	95.5
178	97.0
End point	178°C
Residue	1.7%
Loss	1.3%
Bromine No.	66
Olefin content	42%

E. Hard Paraffin and Gatsch

In 1944 "Hart Paraffin", recovered by washing of the synthesis catalyst with benzin, was shipped mainly to Norddeutsche Mineralolwerke, Stettin-Politz, but small shipments were made to other scattered plants. Monthly reports to Arsyn for 1943 characterize the Hart Paraffin as having a melting point above 65°C. Gatsch, recovered as bottoms from distillation of the synthetic crude oil, was shipped entirely to the Fettsaüre-Werke, Witten. The use made of these waxes is unknown but it seems probable that they were in part oxidized to fatty acids for the production of soaps and other derivatives. Some of the work along this line conducted at Moers is discussed later under the subject of Research Activities.

A considerable stock (12 tons) of hard paraffin was left in the Moers plant and a sample was obtained. This wax is yellow in color, has a destinctive odor and was stated to have a melting point of 80-100°C. A sample was examined by the Petroleum Board with the following results:-

Melting point (ASTM Pet.Method)	90°C
Iodine No.	3½
Saponification value	1
Ash	0.13%
Water	3.0%

Examination of another portion of the same sample by the Fuel Research Station yielded the following information.

The sample was distilled under a pressure of approximately 1mm abs. and the observed boiling points were corrected to 760mm giving the following distillation record:-

	CIOS No.1 P.B.No.45/989 Mech 573	CIOS No.5
Specific Gravity /60°F	0.7609	0.757
Color	15 Saybolt	
Odor	Typical of F.T.	
Initial BP	192°C	195
200°	3.5%	3.0
210	17 %	17.5
220	35 %	37.0
230	53 %	55.0
240	69 %	71.5
250	82 %	84.5
260	91 %	92.0
270	95 %	95.5
End point	276°C	279
Recovery	97%	98.5
Residue	2%	1.5
Unsaturates	8.0%	10-11%
Aromatics	Nil	
Unsulphonatable	92%	
Bromine No	13.8	10
An.Pt. before Sulphonation	83.0°C	
An.Pt. after Sulphonation	86.6%	
Cetane No.	86	

A sample taken from one of several drums marked "Leuchtol" in a box car awaiting shipment to Plant IV was identified as CIOS No. 4. This was tested by the Petroleum Board under their number 45/988 Mech 574 and was found to be identical with CIOS Sample No.1.

A sample was taken from tank car FS Italia Mo 551033 which was reported in captured documents to contain intermediate product. This was identified as CIOS No. 7 and was analyzed by the Fuel Research Station with the following results:-

Sp.g at 20°C	0.685
Initial boiling pt.	42°C
50°C	3.0%
60	12.5
70	25.0
80	35.0
90	44.0
100	54.0
110	63.0
120	71.0
130	78.5

Below 300°C	11.0%
300-330°C	0.3
330-350	0.7
350-375	1.2
375-400	2.1
400-425	1.9
425-450	4.9
above 450	76.9
loss	1.0
	100.0

The total wax boiling above 300°C had a molecular weight of 430 and the fraction boiling above 450°C had a molecular weight of 530. The congealing points (Method TP 76-44T) were as follows:

Total wax	80-81°C
Above 300 C	87-88°C
Above 450 C	91°C

IX ALCOHOL PLANT

The alcohol plant (Building 106) was erected in 1940. Here the olefins from the stabilizer over-head are absorbed in sulfuric acid and hydrolyzed to alcohols and some incidental polymer which is blended in motor fuel.

The C_3 and C_4 feed containing approximately 30% olefins is contacted for one hour with 58°Be. sulfuric acid by stirring in a water jacketed reaction vessel (Made by Lurgi) under 10-15 atms. pressure. Cooling water is used in the jacket during the summer months, but not during the winter. The temperature is not allowed to rise above a maximum of 45°C. Following the mixing period, the reactor contents are allowed to settle for 30 minutes.

The bottom layer from the reactor, that is the ester and acid layer, is drawn off to storage. This material is then charged to a second mixer where it is contacted with water at atmospheric pressure and temperature. This mixer operates continuously. The material flows into a separator where a polymer is taken off as the upper layer and sent to motor gasoline blending. The lower layer is then passed to a four-stage hydrolyzer of which the first three stills are shown by Fig. 26, page 78. Ester is hydrolized to alcohol by heating with open steam in the 4 stages, all maintained under a pressure of 0.2 atm absolute. The temperatures in successive stages are as follows:

1)	75-80°C	2)	80-88°C
3)	88-95°C	4)	95-104°C

The liquid from the 4th stage is 25% sulfuric acid; it is sent to the acid concentrator for concentration to 58°Be. and returned to the esterfication reactor.

The vapors from the 4 hydrolyzers consisting of a mixture of alcohol and water of 50% concentration pass through a caustic washer to storage.

The upper layer from the primary contactors is the unreacted C_3 and C_4 hydrocarbon and polymer. It is drawn into a storage vessel containing steam coils and is vaporized from the storage vessel through a caustic washer into a gas holder. The material is then compressed and charged to a re-run column where C_3 and C_4 product is made overhead for use as bottled gas (treibgas). The small amount of polymer bottoms is blended into motor gasoline. The production of alcohols from 26-28 tons per day of Fischer-Tropsch C_3-C_4 fraction is 2.0-2.1 tons per day of isopropyl alcohol, and 3.2-3.5 tons per day of a mixture of secondary and tertiary butyl alcohols.

The alcohol purification system consists of 6 bubble plate towers. The 50-50 water alcohol mixture from the hydrolysers enters the first column containing 30 plates on the 16th plate. A small amount of caustic is introduced on the 18th plate. Open steam is used for removing a small amount of polymer as an overhead product. The temperature at the top is 90°C., and at the bottom 120°C. The pressure is 0.6-0.8 atms. The bottoms from the first column enter the second column containing 36 plates on the 11th plate. Open steam is used to take overhead a water alcohol mixture containing about 75% alcohol. Water is withdrawn from the bottom of the column Pressure in the column is 1.2-1.3 atms. and the temperature at the top of the column is 110-115°C.

The overhead from the second column enters the third column containing 70 plates, which is the benzol azeotrope column, on the 55th plate. 90% benzol is refluxed to the top of the column and impure isopropyl alcohol is taken off the 10th plate as a vapor, and the impure butyl alcohol is taken off the bottom of this column. This column operates under 2.2-2.4 atms. with a top temperature of 60°C and a bottom temperature of 104°C. The impure isopropyl alcohol passes to a 30-plate column entering on the 6th or 8th plate. Pure isopropyl alcohol is taken overhead and the bottoms returned to the azeotrope column on the 10th plate. The impure butyl alcohol is fed to a 20-plate column on the third plate. Pure isobutyl alcohol is taken overhead and a heavy residue is the bottom product. The overhead from the aseotrope column is a mixture of alcohol, benzol and water, The mixture passes to a separator where a water layer is taken off and returned to the column on the 56th plate. The upper layer is then charged to a 60-plate column entering on the 20th plate. Direct steam is used for distilling overhead an alcohol-benzol mixture which is returned to the azeotrope column as reflux. Water is withdrawn as the bottom product from this column. 600 liters per month of 90% alcohol is added make-up.

Various seized records show that the alcohol plant also produced fusel oil, and "Dilenol". The latter is unidentified but may be crude higher alcohols. As derivatives of these primary products crude acetone, propyl ether and "Syrup Rheal" were also made.

"Syrup Rheal" appears to be a by product of the acetone manufacture but is not further identified. Research notes indicate that aluminium alcoholate was also being made at Moers but no information was obtained as to method or scale of manufacture or of commercial use of this product.

By a license agreement dated 15 July 1938 Rheinpreussen obtained rights to dehydrate alcohols by an unspecified process covered by German patents (Listed) of the firm E. Merck, Darmstadt. Semi-annual accountings of the royalty payments due Merck, in accordance with this licence reveal the figures quoted below for alcohol production. For recent years monthly production figures are also given.

	Butyl Alcohol Kilograms	Propyl alcohol including that converted to acetone Kilograms
First half 1940	143600	48560
Last half 1940	387770	108840
First half 1941	376346	134216
Last half 1941	496203	252794
First half 1942	524178	278543
Last half 1942	276940	187511
First half 1943	617188	505359
Last half 1943	630282	566225
First half 1944	556654	638970

The distribution of the bulk of the alcohol shipments in 1944 is shown by Table XX page 79. The identity of "Sektoll" is not established. Another unidentified product, "Dilenol", was shipped almost exclusively to Geb Overlack, Meunchen-Gladbach. One or both of these products may be amyl alcohols which are known to have been made and are not otherwise accounted for in the shipping records. Mixed butyl-propyl ether was shipped in about the same quantities entirely to Overlack at M. Gladbach. From January through June isopropyl ether was shipped exclusively to Wiegand Svehne, Oberhausen, but in quantities of only about one ton per month. In July the shipments of this ether were as follows:-

I.A.Farben. Frankfurt/M	14 Tons
Pankower Transp. Berlin/Pankow	13 Tons
Chemische Fab. Gruenau, Berlin/Gruenau	14 Tons

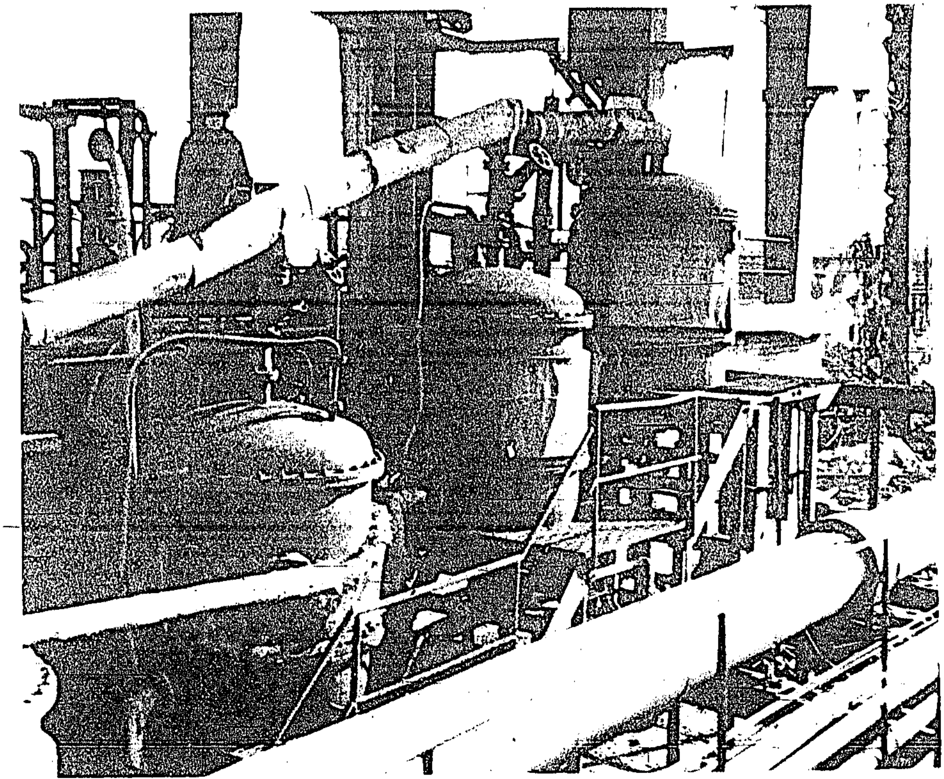

Figure [illegible]

[illegible]

Building [illegible]

TABLE XX

Alcohol Shipments by Rheinpreussen in 1944

Metric Tons

Principal Consignees	BUTYL ALCOHOL		ISO-PROPYL ALCOHOL		SEKTOL II	
	DEGUSSA Buchhausen	DEGUSSA Frkfrt/M	DEGUSSA Mainz	I-G FARBEN Frkfrt/M	PANKOWER Transport Berlin/P.	Gebrueder Overlack M/Gladbach
January:	29.050	45.650	13.300	29.000	-	-
February:	49.800	15.360	-	29.350	-	7.950
March:	48.900	45.300	29.800	15.450	-	9.600
April:	31.400	44.100	32.000	-	26.000	7.300
May:	63.000	46.400	-	-	29.540	9.946
June:	-	-	-	14.850	14.200	5.500
July	-	15.700	-	-	-	-

X LABORATORY FACILITIES

The largest laboratory building (96) had apparently been used for general testing and analytical work. Although the upper part of the building had been badly damaged by bombing, the basement was intact and was well stocked with glassware and chemicals. One private laboratory in the basement had been left as used and all documents therein were examined carefully. In the basement corridors other miscellaneous collections of documents were found and examined. However, no formal research note books or reports were discovered, and the records of greatest value had evidently been shipped away. Two carloads of boxed laboratory equipment and chemicals were found on sidings in the plant but so far as they were examined they yielded no research records.

Building 97 was the automotive engine testing laboratory but no information could be obtained about the work done there except by inspection of the remaining equipment. Two small four cylinder engines were found on test stands without dynamometers. Two dynamometer stands were in the same room without engines. There was no chassis dynamometer. In another room were three stands which probably previously accommodated CFR or IG knock test engines. There was no indication of equipment for supercharged knock testing.

Building 120 and a new building southwest of it, which does not show on the aerial map, were stated to be used for research on lubricants and fats but the informants professed to be entirely ignorant of the details of the work carried out there. The personnel had been moved to an unknown destination about a month previously and no records were found in either building. Among the chemists engaged in this work were Drs. Kölbel, Ackerman, and Langheim.

Building 120 was used for small scale research but the only pieces of apparatus which had survived the bombing were four small heavily insulated units which seemed to involve thermo syphon circulation of a liquid downward through a vertical reactor by means of a heated external return line. A view "through" this laboratory is shown in Fig. 27, page 81.

In the adjacent new building operations were obviously on a larger scale but likewise difficult to identify from the remaining apparatus. The equipment included a batch still of approximately 100 gal. capacity surmounted by a fractionating column about 1ft. in diameter and 20 ft high. There was also a rotating drum about 3x3 ft. with a scraper which might have been

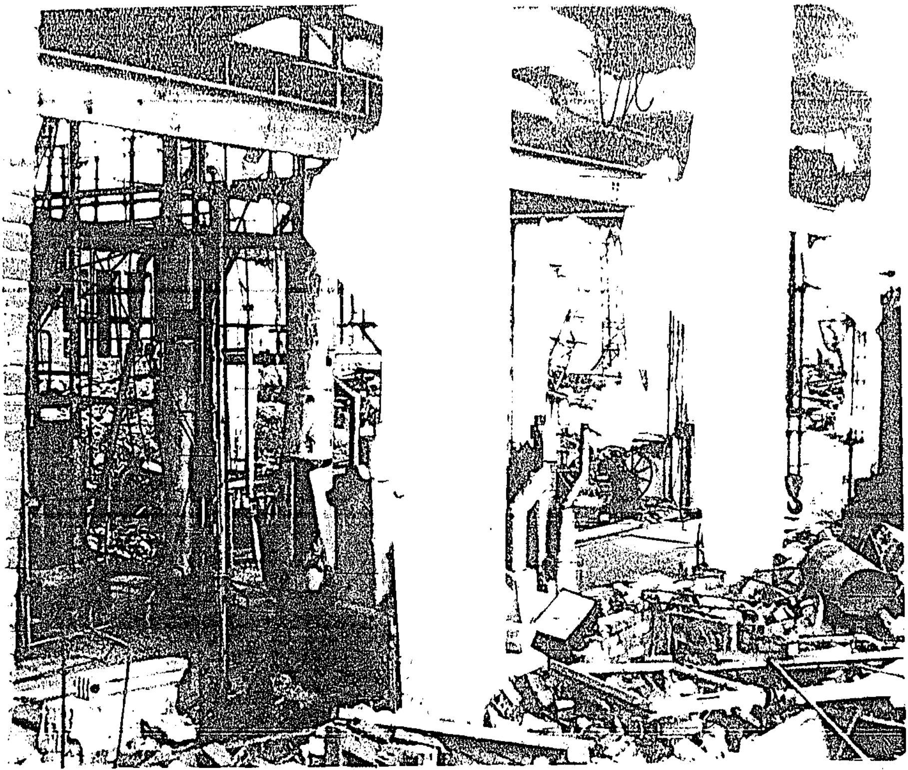

Figure 27.

[illegible]

used for converting some solid to flake form. In the same room was direct driven horizontal drum about 4x4 ft. entirely enclosed in a heavy housing and built by C.G.Haubolt, Chemnitz. Being assembled in the opposite end of the building was a piece of apparatus ~~which might have been a dryer. It comprised a vertical~~ shaft about 10 ft tall carrying two squirrel cage fans about 6 ft in diameter. Surrounding the fan and spaced about 4 ft therefrom were fin-tube heaters and a frame to enclose the whole in a metal housing. Frame work for some kind of inclined conveyor extended from the floor to the top of the unit, and around the upper part of the fan was a helical structure of angle iron.

XI RESEARCH ACTIVITIES

Although it was stated that all collected laboratory records and reports had been moved to other (unknown) plants, and no evidence to the contrary was seen, a few miscellaneous ~~documents were picked up which give some idea of the lines of~~ research being followed at the Moers plant.

A document dated 15 Jan. 1942, signed by Dr. Grimme comprises the research program as of that date. The departmental documents from which this was compiled were also obtained and indicate that all of the work outlined was in progress and many of the items represented accomplishments rather than proposed future work. The outline submitted by Laboratory No.1 has been translated in full since it was considerably condensed in Dr. Grimme's summary. Also a letter dated 27 September, 1943 from Dr. Grimme to Director Kost was found, summarizing the research accomplishments during the preceding year. Translations of this, and of the above mentioned 1942 documents, are attached as Appendix B, page 108.

A complete picture of the reported research activities can not be conveyed by any further condensation of the outlines in question, but it can be said that the following broad lines of research appear to hold a prominent place in the programs:-

1. Development of dehydrogenation catalyst, including new alumina supports.
2. Conversion of alcohols to ketones and production of resinous products from the ketones.
3. Production of aluminum alcoholates and derivatives for a variety of uses.
4. Production of acids and esters thereof from Fischer-Tropsch wax.
5. Production of glycols and derivatives thereof.
6. Fundamental studies of reactions of fatty acids with olefins.
7. Production of higher alcohols from olefins in benzin and kogasin.
8. Research on pyrotechnics and other assigned problems in connection with the war effort.

Other research and development activities were indicated by miscellaneous documents as follows:-

A letter dated 17 Jan.1945 from the Reichsamt fur Wirtschaftsausban, Berlin, discusses tests conducted at the ~~Textile Engineering School, Krefeld, and directs further tests~~ at I.G. relating to the suitability of di-aluminum-hydroxide, presumably made at Moers, for us as a "Druckverdickungsmittel" in textile dyeing.

A letter dated 15 Nov. 1944 from Märkische Seifen Industrie, Witten-Ruhr, conveys a complaint from their branch factory at Lahr/Baden regarding poor color of "Kontakt-Paraffin" (wax) furnished by Rheinpreussen-Moers.

A letter dated 23 Jan. 1945, from Chemisch-technisches Laboratorium von Hch. Norrenberg, Irmenach bei Iraben-Trarbach, inquires about experimental data on Rheinpreussen's salve base "Synalin".

Correspondence in August 1944 with Krup Treibstoffwerke Wanne-Eickel, explains that lack of manufacturing equipment at Moers makes it impossible for Rheinpreussen to furnish fatty acids to Schering A.G. Berlin, for use in insecticides.

Some correspondence and technical data on the preparation and uses of "Pantoxyl" were found, dated in 1941. This product appears to be an oxidized Fischer-Tropsh wax, useful as a thickening agent, emulsifying agent etc. Some data were also found relating to "Parestol" which appears to be a similar product.

Notes on a conference held at the Bergbauverein, 25 Nov. 1942 showed the following production of fatty acids from different Fischer Tropsch plants.

Rheinpreussen	about	4000	Kg	per	month
Krupp	"	2000	"	"	"
Rauxel	"	1800	"	"	"
Essener Steinkohle	"	3000	"	"	"
Hoesch	"	10000	"	"	"
Ruhrchemie	Unknown				

The high production at Hoesch was attributed to the use of pressure synthesis there. Methods of recovering soaps of these acids were discussed. Apparently the soaps are used mainly locally as detergents.

XII. RELOCATION OF EQUIPMENT

A number of documents were found which reveal in part, where equipment from the synthesis plant and laboratories was shipped after further operations at Moers became impractical. The most recent statement was a letter from Director Kost to the Rustungskommando, Essen, 24 Feb. 1945, which is summarized below:-

The alcohol and acetone plants are going to Dr. Hermann Hauser and Co. in Bredolar in Sauerland; the Carburol plant to Paul Cullmann and Co. in Hedersleben near Nachterstädt; the Fischer Synthesis plant to Karl Henkel and Co. in Alme in Sauerland; the research laboratories to Lüdenscheid; and the experimental plant for research on iron catalysts to Bochum-Stiepel, in the building of the Rheinpreussen mine Gibraltar-Erbstollen.

A list dated 10 Feb. 1945 indicates that the equipment from the engine testing laboratory also went to Nächterstädt. What appear to be complete lists of the Alcohol plant equipment shipped to Bredolar and the synthesis equipment shipped to Alme were obtained. A long list of laboratory apparatus packed for shipment, presumably to Ludenscheid, was also found.

A memorandum dated 22 Jan. 1945, regarding accounting for the cost of such moving indicated that some equipment was also being shipped to Hannover-Linden, Coswig, Hildesheim, Heilbronn, and Burgstall. The last named destination is apparently near Neumühle northeast of Duisberg, (Rheinpreussen Gewerkschaft Neumühle) where some research laboratory was to be set up as indicated by letters of 24 Jan. 1945 and 26 Jan. 1945.

Bills of lading for material going to Coswig indicate that this came from the Moers hydrogen plant. Similar documents identify the shipments to Hannover-Linden as relating to "Einlagerung Aegier-Norday-Lager, Arbeitsstab Geilenberg".

A detached sheet dated 28 Feb. 1945 lists laboratory equipment and personal property of several individuals, including Dr. Grimme, as prepared for shipment to "Anlage Lachs", suggestive of a coded underground plant but actually not identified. A letter dated 7 Feb. 1945 from Lurgi Wärme, Baubüro Plauen, acknowledges the receipt of contact ovens Nos. 24 and 43. There is no apparent connection between this and the Scheduled shipment of synthesis equipment to Alme. A card from Stadtwerke Chemnitz, Gaswerk III, dated 10 Feb. 1945 acknowledges the receipt of two cars, contents not specified.

Most of the seized correspondence regarding shipments to these points excluding detailed lists of goods, are translated and reproduced in Appendix C, page 120.

No information could be obtained as to the new location of personnel from Moers, but in general they probably went with the equipment of the departments with which they were formerly associated.

XIII INFORMATION REGARDING OTHER SYNTHETIC FUEL PLANTS

At a meeting of Fischer-Tropsch plant operators in October 1939 tables were prepared to show the expected output and product quality for all plants in West Germany during most of 1940 (Doc.42). ~~These estimates assumed maximum production of Diesel Fuel and gatsch,~~ with the benefit ~~of~~ various improvements and expansions of plant facilities which were in prospect when the conference was held. Some of these data are summarized in Table XXI page 88. From other records it has been found that the Rheinpreussen expectation of making 100 cetane Diesel fuel with a solid point of -25°C was never realized which suggests that some of the other estimates may be likewise optimistic. The total output estimate for Rheinpreussen proved to be quite accurate and the magnitude of the other production figures does not seem unreasonable. The productive capacity of some of these plants may have been increased subsequent to 1940.

Somewhat earlier (Doc 38) an estimate was prepared for benzin and liquefied gas production by a larger group of plants, which is summarized in Table XXII page 89.

A summary of the type and capacity of equipment in the West German Fischer-Tropsch plants was included in Doc 42 and is condensed in Table XXIII page 90.

TABLE XXI

West Germany Fischer-Tropsch Plants
Estimated Capacity and Product Quality
July - Sept. 1940
Basis Maximum Diesel Fuel and Gatsch

	Essener Steinkohle	Hoesch (Mid.Pres.)	Krupp Treibstwk (Atm.& Mid) Pres.	Rhein-preussen	Ruhr-benzin	Gewk Victor
Total Primary Products: tons/mo.	4400	2750	4450	5200	5700	2500
Benzin: tons/mo.	3650	995	2200	2900	2200	1300
End boiling point °C	165	160	175	160	145	160
Octane Number	61-62	55-56	60-61	60	58-60	62
Vapor pressure, atm.	0.65	0.78	0.60	0.78	0.70	0.65
Diesel Fuel: tons/mo.	*	1100	1650	1960	1850	900
Boiling range, °C		130-280	-	160-310	145-280	150-310
% below 200°C		55-60	40-50	40	40-50	55
Cetane number		70	85-95	100	80-85	80-90
Solid point, °C		-23.5	21	-25	-25	-35
Flame point, °C		21	35	40	21	57
Gatsch: tons/mo.	*	450	405	360	-	175
% useful for oxidation		85	100	-	-	-
Liquefied Gas; tons/mo.	700	300	250	450	500	400
Wt. % C4		75	70	50	60-70	65

* Diesel oil and gatch not to be made because of lack of distillation facilities.

TABLE XXII

Estimated Capacity of Synthetic Fuel Plants
1940 - 1941*
Metric Tons per year

	Benzin	Liquefied Gas
Gelsenberg	200,000	40,000
Scholven	200,000	40,000
Rheinpreussen	50,000	10,000
Victor	27,000	5,000
Krupp	40,000	8,000
Hoesch	45,000	8,000
Essener Steinkohle	50,000	10,000
Rheinbraun (Wesseling)	100,000	16,000
Ruhrbenzin	60,000	16,000
Total	772,000	157,000

* Capacities for 1941 were expected to be the same except for Rheinbraun (Wesseling) which was to make 20,000 Tons benzin and 40,000 tons liquefied gas.

TABLE XXIII
Equipment and Capacities
West German Fischer-Tropsch Plants
October 1939

Plant	Rheinpreussen	Essener Steinkohle	Hoesch Benzin	Krupp Treibstwk.	Ruhrbenzin	Gewerk. Victor
Synthesis Pressure	Atm.	Atm.	Middle	Atm. and "Pressure"	Atm. and "Pressure"	Atm.
Raw Material	H.t.coke & gas	H.t.coke & gas	H.t.coke	?	Coke	H.t.coke
Gas Producers	10*	10(Demag)	6 (Demag)	3	11	3(Demag) 4(Pintsch)
Output per unit M 3/hr	6000	9000				
Gas Cracking Units	1	?	?	?	?	2
Output M 3/hr	17000	-	-	-	-	20000
Ideal Gas Production M 3/hr	60000*	57500	36200	48000	63000	32600
Number of ovens	96	96	68	72A-20P	52A-72P	52
Stages	Optional	48 1 stage 48 2 stage	36 1 stage 32 optional	36 1 stage 36 optional 20 2 stage***	2 stage	41 1 stage 11 2 stage 4 optional
Benzin Separation between stages	No**	Yes	No	No	No	Yes
Oil Cracking Unit	Carburol	Carburol	Carburol	Carburol	TVP & UOP	Carburol
Capacity, tons/day	65	125	125	100	100 & 90	50-60
Gas Polymerization Unit	None	None	None	Yes	UOP	Pintsch
Capacity, tons/year	-	-	-	14000	24000	9000

* As of 1 Jan 1940. ** Subsequently changed. *** Pressure ovens.

XIV. BOMBING DAMAGE AND DEFENSE MEASURES

Bombing of the Moers plant was stated to have occured on July 20, August 21, October 25, November 2,8,20,21 in 1944 and ~~on February 28, 1945. The first attack, elsewhere referred to as~~ the attack of July 19 since it started before midnight, practically ended the production of synthetic fuels, although partial repairs permitted small scale operation for a few days theafter. After another heavy bombing on October 25, 1944 attempts to repair the synthesis plant were discontinued and instrument and accessories which could be used elsewhere were moved.

In general the bomb damage in the synthesis plant was widespread and severe. Most of the equipment for charge gas production and purification and for product recovery was completely destroyed. The south end of the contact oven house was very badly damaged but many of the ovens in the remainder of the building looked as though they could be restored to operating condition if desired.

The first serious damage to the coke ovens was caused by the bombing of 25 Oct. 1944 and raids thereafter put the two older batteries permanently out of commission by 21 Nov. 1944. The third (newest) battery of coke ovens continued operation until the bombing of 28 February 1945, four days before the plant was captured. The mine operating machinery was badly damaged by bombing on an unspecified but presumably recent date.

The abrupt drop in actual production as a result of the July 19 raid is well shown by Table IX page 58.

The realization by the plant management that production could not be maintained is evidenced by the monthly forecasts of production submitted to Arsyn from which the following estimates of total liquid products are taken.

1944	Predicted tons, total liquid
June	4800
July	5200
Aug.	4200
Sept.	1200
Oct.	2400

No later forecasts have been found.

On 28 Nov. 1944, Rheinpreussen informed Arsyn that no further production could be expected from Moers.

The monthly statement to "arsyn" for July, 1944 reports the following losses of stocks due to enemy action during that month:-

Stock	Loss in Tonnes
Crude (Synthetic)	680.3
Grund benzin	172.5
~~Kogasin in N Diesel Fuel~~	~~2.0~~
Gatsch	11.3
Liquefied Gas	39.8
Kogasin	44.0
Total	949.9 tonnes

Enemy action on 2 Nov. 1944 destroyed 14 tons of Mixed Diesel fuel, and attacks on 2 Nov. and 21 Nov. 1944 destroyed, 103 tons of benzin, which was all the benzin on hand at that time. Of the remaining stocks, 110 tons of "Rohol" were shipped to Brabag and 11.85 tons of mixed Diesel fuel were shipped to Rheinpreussen Schacht IV. This left only 15.5 tons of light Kogasin in car Essen 508394 and 33 tonnes of intermediate oil (not further identified) in cars 551033, 597876, and 505655. There also remained 12.5 tonnes of hard paraffin, presumably that in the storage bin at the North end of the contact oven house, from which a sample was taken. (See page 74 for analytical results) Samples of the oil in cars 551033 and 508394 were also taken and results of the analysis of these samples will be found in the section relating to Kogasin, page 73.

For synthetic fuel plants in general the prevention and repair of bomb damage was organized by Arsyn and considerable correspondence on this subject, dating back to May 1940, was seized (Doc 75). Of the numerous parts of the plants for which protective measures were recommended, special importance seems to have been attached to the storage facilities for lead tetraethyl, and the handling of lead was forbidden unless adequate safe guards against bomb damage were provided. The vulnerability of pipe lines, particularly for water supply, was also a matter of great concern and covered by special instructions. Brabag issued a circular letter (5-12-44) recommending wherever practical, and giving directions for the substitution of canals for pipe lines to handle water supply and drainage in hydrogenation plants, including those which were to be partly underground. Leuna described means adopted for quick emptying of pressure vessels in case of attack. Stettin-Politz described the temporary use of hydrogenation vessels for oil cracking while repairs were being made on other parts of the plant required for hydrogen production. Stettin also recommended independent utility supplies to segments of the synthesis plant (decentralization) to minimize the danger of all production being stopped by a single attack. These recommendations (1 Dec. 1944) concluded with the following significant statement: "This conversion has not yet been undertaken because of an air attack which took place immediately after the completion of the repairs necessitated for the reconstruction as outlined.----Furthermore this reconversion will require obtaining priority construction material from the Ministry of Reconstruction"

As far back as July 1, 1940, the Reich Economics Ministry ordered all fuel producing plants to reduce their stocks for the duration of the war. They were permitted to keep in stock:

Crude Oil a maximum of the amount needed for a monthly production. (Not subject to this rule were the plants in Ostmark, in the Bohemian protectorate and in the Eastern provinces).

Intermediate products a quantity not exceeding that which could be treated over a period of two months.

Finished products under no condition was any amount to be stored, but was to be shipped as soon as ready.

In May 1942, it was decided, in spite of the shortage of personnel, to create within each plant, a fire brigade, which would at all times be ready to step in in case of fire.

As air raid attacks on the Ruhr increased in intensity and the damage to synthetic oil plants became more serious, a committee met in Rauxel, in September 1944, to compare and discuss the extent of damage suffered by various synthetic oil plants. According to the Geilenberg plan, precautions and reconstruction measures, based on common experiences, would permit a much more speedy resumption of operations, and at the same time eliminate undue loss of time and waste of construction material. In order to make these experiences available to all plants, a commission, composed of 4 to 5 highly specialized technicians, was appointed. This commission, it was decided, would visit the individual plant immediately after the bombing and:

1) advise the management on measures to be taken for the necessary repairs and assist them in estimating the material and labor required;

2) Clear substitution parts for damaged units out of reserves which may be on hand in other synthetic plants.

This exchange of reserve units between the various plants, was expected to prove more efficacious and speedy than calling on the distribution center of the Geilenberg commission.

A Stosstrupp (Shocktroop) service was then created to assist individual plants in repairing damages caused by air attacks, in cases where local efforts would be inadequate. The Ruhr district Stosstrupp units were located in various cities and functioned under supervisor. They consisted of specialized units servicing:

1) Pit repairs
2) Transport installations
3) Coke oven plants
4) Power station installations
    a) furnaces
    b) machines
    c) transportation installations of every kind
5) Cooling towers
6) Steel construction
7) Electric installations
    a) high tension
    b) low tension.

Requests for services of the shocktroops were to be made to the central Ruhr committee. Debris were to be cleaned out before the arrival of the shock troops so that they could commence work immediately. All necessary repair material was to be on hand. The Stosstrupp supplied the small tools. On the other hand, the individual plants were obligated to have the balance of the machines put into working order, so that full production could be resumed, as soon as the shocktroops completed their repairs. The management of the plant was to inform the stosstrupp unit supervisor of the time the unit commenced and ended work. Furthermore the plant was to supply food and lodgings for these units

Seized records contain considerable information regarding personnel constituting the commission for the Ruhr area. Copies of the code used for reporting the location and extent of bomb damage in the various Arsyn plants were also obtained.

XV ACKNOWLEDGEMENTS

The writers are greatly indebted to Mr. C.Chilvers and associates of The Petroleum Board and to Dr. C.D.Hall and associates of The Fuel Research Station for making tests and analyses of the various samples brought back from Moers. Valuable assistance in reading and abstracting captured documents has been given by Messrs. J.H.Jones, A.R.Powell, W.W.Odell, and H.M.Weir. The cooperation of the U.S.S.B.S. in making available microfilm equipment for photographing many of the captured documents is also appreciated.

APPENDIX A

LIST OF CAPTURED DOCUMENTS AND SAMPLES

The attached list differs from the original which was prepared in the field and returned with the documents, in the following respects:

1. The titles have been amplified to give a more accurate description of the contents of each document.

2. The documents have been further classified according to subjects as indicated on the following page, and the documents pertaining to each subject have been tied in bundles for convenient future reference. The letter following each document number indicates the subject classification.

3. Many documents have been recorded on microfilm with the cooperation of USSBS. Following the title of documents which have been microfilmed the letter "C" indicates a document completely microfilmed and "P" indicates partly microfilmed.

4. On the subject classification list on the following page the "Sack Number" indicates the MIRS sack in which the subject bundle in question has been placed for storage.

SUBJECT CLASSIFICATION OF DOCUMENTS

		Sack No.
A.	Plant Production and Cost Records, Shipping and Receiving Records	1477
B.	Synthesis Gas Production and Purification	1477
C.	Synthesis Operation including Catalyst Data	1477
D.	Primary Product Recovery and Refining	1478
E.	Research, Development, and By Products	1478
F.	Personnel and Organization	1478
G.	Methods of Test and Analysis except Engine Testing	1478
H.	Engine Testing of Fuels	1478
I.	Bomb Damage	1478

APPENDIX A

LIST OF CAPTURED DOCUMENTS

Doc. No.	Class	Title	Micro films
1.	A	Correspondence and accounts in connection with royalty payments to Ruhrchemie Late 1940 through 1944. (Book and loose sheets).	C
2	A	Rurchemie lincense with correspondence and accounts regarding royalty payments 1935 to July 1940	C
3.	A	Record of daily receipts of chemicals, desulfurizing catalysts, oil stocks etc., including weights and origin of shipments Jan. 1942 thru Oct. 1943.	C
4.	A	Daily production figures, primary products only 1943.	P
5.	A	Record of daily receipts of chemicals, desulfurizing catalysts, oil stocks etc., including weights and origin of shipments Nov. 1943 thru 1944.	
6.	A	Daily production figures, primary products only 1944.	P
7.	C	Synthesis catalyst shipments from Ruhrchemie July 1940 to October 1944.	C
8.	C	Raw material requirements for synthesis catalyst preparation from 1936 to date.	C
9.	A	Record of taxable benzin production 1943-1944.	
10.	A	Record of taxable benzal production 1943-1944	
11.	B	Misc. data on gas cracking operation	
12.	E	Construction schedules for improvements and expansion of Moers plant 1942-1943.	C
13.	E	Alcohol production figures in connection with royalty payments to Merck.	
14.	A	Monthly summaries of production, shipments and stocks, including by products, 1944	P

Doc. No.	Class	Title	Micro films
15.	A	Shipping records showing car numbers, weights consignees for all products in 1944.	
16.	A	Daily reports on production, shipment, and stocks including alcohols etc. Jan-July 1944 summarized by months.	C
17.	A	Monthly cost statements including summaries of production 1943 and 1944. Summary of costs for 1942.	P
18.	C	Calculations of conversions per stage and overall for synthesis ovens, 1941 and 1942.	
19.	C	Material and energy balance for gas production and synthesis units including graphs of daily production 1941-1942.	P
20.	A	Cost and production summary for July 1944, (Now combined with 17)	P
21.	B	Miscellaneous papers on gas composition.	
22.	F	Miscellaneous documents relating to Moers personnel and organization.	
23.	A	Daily report sheets for production, shipments and stocks, most of 1944.	P
24.	B	Drawing of complete plant for synthesis gas production at Moers (1938)	
25.	B	Koppers drawings and description of proposed enlargement of Moers water gas plant (1938)	P
26.	D	Complete set of drawings with engineering calculations for all parts of Wilke oil cracking unit and clay treating unit (1939)	P
27.	C	Drawing of special rail car carrying two Kubels for synthesis catalyst.	
28.	D	Diagrams and description of Moers charcoal absorption plant (1939)	
29.	B	Description and drawings of Rheinpreussen Grobreinigung unit built by Aug. Klonne.	
30.	B	Detail drawing of masonry in Zundkammer of gas generators (1942).	

Doc. No.	Class	Title	Micro films
31.	D	Diagram of Stabilization unit #1.	
32.	B	Drawing of combustion shaft of the cowper stove for gas cracking.	
33.	B	Drawing of slag washing plant.	
34.	B	Detail drawing of masonry on gas generator (1936).	
35.	B	Detail drawing of masonry in "Zundkammer" of gas generator (1941).	
36.	B	Detail drawing of masonry on gas generator (1941).	
37.	B	Detail drawing of masonry on "Zundkammer" of Gas generator	
38.	B	Drawing of fine Purification Plant.	
39.	B	Drawing of fine Purification Plant.	
40.	B	Drawing of fine Purification Plant.	
41.	B	Detail drawing of masonry on dust separator and connecting conduits of gas generator (1941)	
42.	A	Tabulations of equipment and capacities of all "Western" Fischer Tropsch plants Oct. 1939.	P
43.	H	Notes re apparatus for controlling feed of liquefied gas to engine and determining anti-knock value.	
44.	H	Data on relation between cetane and cetene numbers.	
45.	C	Graphs of unidentified variables in operation of second stage of F.T. including $C_2 + C_3$ content of gas 1943-1944 (Cf Doc 90).	
46.	G	Procedure for taking gas samples from ovens and for low temperature fractional distillation of these samples to determine composition (1944).	
47.	C	Blank form for reporting operating conditions and production data all Fischer-Tropsch plants.	
48.	C	Data pertaining to determining condensible hydrocarbons in gas.	

Doc. No.	Class	Title	Micro films
49.	E	Apperently unpublished thesis by W.Beir on a study of the solidification characteristics of mixed waxes.	
50.	E	Miscellaneous and relatively unimportant test data for synthesis, charcoal absorption, cracking and alcohol units.	
51.	A	Detailed calculations of costs of making diesel fuel and alcohols, and reworking synthesis catalysts including pertinent information on processes and quantities 1943-1944.	P
52.	H	Misc. Notes and graphs from engine test laboratory concerning relationships between FeCO and TeL. (1939) Engine tests on fuel blends (1944)	P
53.	E.	Original laboratory notes on reactions of "Butel" with various organic acids.	
54.	H	Original notes and report on experiments for measuring vaporlocking tendency in lab. apparatus and in engines (1940)	
55.	H	I.G. report (1941) on reference fuels and accuracy of octane number determination.	C
56.	E	Miscellaneous data regarding wax oxidation in connection with "Parestol" manufacture.	P
57.	G	Miscellaneous analytical methods useful in connection with F.T. synthesis.	
58.	E	Charts representing course of oxidation of parafin wax by blowing with air.	
59.	B	Tests on Moers coal and ash therefrom (1938)	
60.	G	Collection of analytical methods applicable to Fischer-Tropsch operations and products.	P
61.	B	Misc. notes on fine purification experiments and regeneration of catalyst, also tests on shift converter catalyst.	
62.	E	Numbers and titles of patent applications filed by Rheinpreussen-Moers Sept. 1943 to Sept. 1944.	C

Doc. No.	Class	Title	Micro films
63.	E.	Laboratory subject classification for files etc.	
64.	E.	Original laboratory notes on conversion of Kogasin to lube oils with $AlCl_3$ (1934-1935)	
65.	B	Technology and Prospects of Oxygen Utilization Karwat, Brenn. Chemie 17, 141-149 (1936)	
66.	F	Diagram showing methods of converting coal and possible products therefrom (different from Doc 70)	
67.	C	Note book containing miscellaneous calculations, partly on diesel fuel blends.	
68.	B	Notes on experiments on purification of synthesis gas with bleaching earth.	
69.	B	Misc. data on effect of active charcoal adsorption ahead of fine purification.	
70.	F	Diagram showing methods of converting coal and possible products therefrom (different from Doc 66)	C
71.	C	Misc. data on synthesis oven and charcoal absorber operation.	
72.	D	Paper by Grimme on recovering light hydrocarbons by charcoal absorption presented at second Chem. Eng. Congress, Berlin 1940.	
73.	C.	Experimental data on charcoal absorption and contact oven performance 1941-1942.	
74.	A	Monthly production estimates and reports for Arsy including some product tests, and related correspondence. Oct. 1941 to date.	P
75.	I	Correspondence and documents cleared through Arsyn regarding prevention and repair of bomb damage including hydrogenation plants.	C
76.	G.	Misc. documents on nomenclature and analytical methods.	
77.	G	Miscellaneous documents on physical and chemical properties.	
78.	D	Flow diagram of Diesel fuel refining process	
79.	H	Tech. Hochachule Stuttgart report on design of engine for testing Diesel or Otto cycle engine fuels.	C

Doc. No.	Class	Title	Micro films
80.	D	Experimental data on substitution of Kogasin for wash oil in benzol recovery. Sept. 1939.	
81.	E	Copies of patent applications filed by Ruhrchemie relating to Fischer-Tropsch from Dec. 1937 to July 1939.	
82.	A	Correspondence with Arsy re production of and specifications for benzin, diesel fuel etc.	P
83.	E	Letter 22 June 1944 re use of sodium-propyl-butyl sulfate in spinning bath for synthetic fibres.	
84.	E	Miscellaneous documents relating to preparation and use of higher alcohols, fatty acids, special waxes etc.	P
85.	E	Miscellaneous correspondence and data re production and use of "Pantoxyl" oxidized wax.	P
86.	E	Private report 3 Feb. 1942 on review of the Esthonian oil shale industry.	C
87.	C	Blank operating report forms used by Brabag.	
88.	A	Actual and prospective production of liquefied gas by all Fischer Tropsch Plants 1939-1940.	C
89.	A	Misc. notes on unidentified conference re F.T. synthesis plants' equipment and capacities (July 1939)	
90.	C	Diagram of sources of C_3 and C_4 hydrocarbon in connection with F.T. synthesis (cf 45)	
91.	B	Photos and description of Pintsch apparatus for charging coke to water gas generator and arranging gas cracker with latter.	
92.	C	Informal reports from Brabag (Ruhland) Jan 1938 on influence of synthesis gas and its impurities on catalyst capacity and life.	C
93.	E	Minutes of conferences of Fischer-Tropsch plant representatives on research and operating problems Nov.1936 to July 1939.	

Doc. No.	Class	Title	Micro films
94.	F	Letter 8 July 1941 from Ruhrchemie to licensees regarding countercurrent operation of fine purification towers to increase catalyst life.	
95.	G	~~Miscellaneous documents relating to catalyst~~ composition, catalyst handling and regeneration.	P
96.	G	Minutes of conferences at Holten July-Aug. 1936 on progress of new construction (Ruhrbenzin?)	
97.	F	Miscellaneous documents relating to industrial relations, military service of personnel etc.	P
98.	F	Miscellaneous research programs and summaries including Pantoxyl etc.	P
99.	H	Data on reproducibility of octaine number determination and minutes of 1941 conferences on this subject.	P
100.	H	Fuel consumption test data for engine w 24 Engine and fuel unidentified (1940)	
101.	F	Cards from personnel files at Moers for technical employees and others who might be useful sources of information.	
102.	F	Documents relating to shipment of laboratory and plant equipment, stocks etc. to new locations 1944-1945.	P
103.	G	Chemical Testing Methods for the preparation of Fuels I Coking Industry. E. Merck, Verlag Chemie 1943.	P
104.	G	Publications of V.d. Eisenhüttenleute on Laboratory procedures for the coking industry.	P
105.	G	V.D.I. bulletin DIN 1952 (1943) on procedures for measurement of fluid flow with orifices etc.	P

PLOT PLANS AND DIAGRAMS SEPARATELY LISTED
ALL IN MIRS SACK # 1481

1. Plot plan of Synthetic Fuel Plant 1939
2. Plot plan of Coking Plant (undated).
3. Plot plan of Coking Plant (undated).
4. Plot plan of Coking Plant 1938.
5. Plot plan of Coking Plant 1938.
6. Plot plan of Synthetic Fuel plant colored to show dates of construction through 1943.
7. Flow diagram of Fischer-Tropsch process.

LIST OF SAMPLES
TAKEN FROM
RHEINPREUSSEN-MOERS PLANT

Milk can (not Jerrican) filled with benzin from tank car at Rheinpreussen. Container incorrectly named because sample was not transferred to a Jerrican at 21 Army Group Headquarters for shipment as requested. Sample taken from first tank car at Moers (Deutsche Reichsbahn - Essen - 508394) and the same as smaller sample 5. Composition uncertain. To be subjected to Engler distillation and determination of specific gravity and Bromine Addition No.

2. Milk can filled with Fischer-Tropsch catalyst. This to be sampled carefully under CO_2 for analysis and activity test and the balance sealed for future disposal.

3. One of two pieces of wax (from catalyst washing). To be subjected to vacuum fractionation and determination of of melting points.

4. Jerrican filled with illuminating oil from drums in box car at Moers (not "Benzene from second tank car"). Identity uncertain, although drum was marked "Leuchtol". To be tested like Sample 1.

5. Small can of Benzin from Rheinpreussen I. Sample taken from same tank car as Sample No. 1. Identity uncertain. To be subjected to Engler distillation, determination of specific gravity and Bromine addition No.

6. Can shift convertor catalyst Rheinpreussen. Supposed to be fresh catalyst (of unknown composition) for water-gas shift reaction. To be analysed.

7. Small can of benzin from Rheinpreussen II. Sample taken from second tank care (F.S. Italia Mo. 551033) in Moers plant. Identity uncertain, and no more sample available. To be tested like Sample 5.

8. Can rough purification catalyst for sulfur. Supposed to be "Luxmasse". To be analysed.

9. Can fine sulfur purification catalyst. Supposed to be Luxmasse plus sodium carbonate. To be analyzed.

10. Small can of Fischer-Tropsch catalyst. To be handled like Sample 2. Sample 10 came from same Kubel in Moers plant as Sample 2 but was taken with less precaution against oxidation.

CIOS TARGET 30/5108
RHEINPREUSSEN-HOMBERG.
MOERS-MEERBECK

CLASSIFICATION OF CAPTURED DOCUMENTS FOR STORAGE.

16 April, 1945

MIRS BAG	BUNDLE	DOCUMENTS
1477	A(2)	1,2,3,4,5,6,9,10,14,15,17,20,23,42,51,79, 82,88,89,16.
1477	B	11,21,24,25,29,30,32,33,34,35,36,37,38,39, 40,41,59,61,65,68,69,91,94.
1477	C	7,8,18,19,27,45,48,67,71,87,90,92,95,96,47.
1478	D	26,28,31,72,78,80.
1478	E	12,13,49,50,53,56,58,62,63,64,66,70,81,83, 84,85,86,93,98.
1478	F	22,97,101,102.
1478	G	46,57,60,76,77,103,104,105.
1478	H	43,44,52,54,79,99,100,55.
1478	I	75.
1481	Plans and Maps Nos. 1,2,3,4,5,6 and 7.	

APPENDIX B.

TRANSLATIONS OF DOCUMENTS RELATING TO RESEARCH ACTIVITIES

The following is a rough translation of a manuscript by Dr. Grimme (said to be Director of the laboratory at Moers) dated January 15, 1942.

PROGRAM OF WORK FOR THE RESEARCH LABORATORIES

Research Laboratory No. 1

1) Dehydrogenation of hydrocarbons, in particular propane and butane to propylene and butylene, also the catalysts (chromoxide - aluminium oxide) developed therefor.

2) Conversion of alcohols to ketones.

3) Work with resins - preliminary.

   (a) Manufacture of methylester of ethylacrylic acid
   (b) Betamethyl gamma keto butanol
   (c) Manufacture and purification of methylisopropenylketone and plexigum-like polymerisation products therefrom.

4) Development of the ketone resin, "Emekal", from methylethylketone and formaldehyde, also the working out of a process for a production of about 4 tons per month.

5) Manufacture of secondary butylstearate as plasticizer.

6) Manufacture of aluminium alcoholates. Experiments respecting different catalysts for the reaction of aluminium with alcohols. Application of butyl and propyl aluminium alcoholates for

   (a) Pyrotechnical purposes
   (b) Igniters for carbons
   (c) The treatment of textile fibres
   (d) For Lacquer technique and other purposes, especially the manufacture of emulsions.
   (e) Medicinal purposes (Professor Engelhardt, Tübingen and Prof. Frey, Düsseldorf).

7) Development of the carbonic acid addition products of aluminium alcoholates, in particular of the butyl compounds.

8) Development of active aluminium hydroxide and oxide from aluminium alcoholates and their technical and medical application, also the development of an experimental unit for the production of above compounds.

9) Manufacture of a new gelation medium (Rh_6) out of butyl and our C_6 to C_9 fatty acids, also the Wittener-method-fatty acids. Application of the aluminium salts of these fatty acids for the purpose of "Wa Prüf 5 1c".

12) Developed contracts of OKH, "Wa Prüf 5 lc":—

(a) Development of smoke tubes (Parchlorit 7)
(b) Development of water stable friction devices (?) or grinding compounds (?).
(c) Development of an igniter cartridge for oil (Parchlorit 7).
(d) Development of storage stable retarded devices (Parchlorit 7).
(e) Development of a membrane as a safety valve for flame throwing devices.
(f) Development of incendiary oil for filling of flame throwing devices.
(g) Development of burning tubes (Parchlorit 7).
(h) Development of a chemical time igniter (translater's concept is that this is a delayed fuse of some sort). Refer to our files W 109 820 XI/72 at "Chemischer Zeitzünder".

Research Labpratory No. 2

1) Manufacture of esters of acetic, propionic, and butyric acids with propyl, butyl and amyl alcohols.

2) Separation of olefines and paraffins through treatment with slective solvents, in particular with SO_2.

3) Manufacture of esters of phthallic acid, and other dicarbonic acids (plasticisers, thickeners and glyptals.

4) Reaction between dicarbonic acids, in particular phthalic acid and alcoholates.

5) Investigation of the oxidation products, Parestol and Pantoxyl, in a comprehensive sense. For example, resins of the type of alkyd resins, soaps, washing media, salve basis for pharmacy and cosmetic purposes from fatty acids. Application of the oxy-acids as linseed oil substitutes, hydrogenation of the oxidation products to alcohols and esters.

6) Introduction of the sulphonic acid groups and nitro groups in the paraffin hydrocarbons.

7) Oxidation of the lower paraffins to dicarboxylic acids by means of nitric acid.

8) Dicarboxylic acids from Parestol or from paraffin or through the intermediary of the phenols from coke plants.

Research Laboratory No. 3

1) Conclusion of the theoretical work on secondary octyl acetate (trichloracetic acid and benzene sulphonic acid as catalyst, H_2S formation).

~~2) Development of the production of secondary octyl acetate~~ into semi-technical operation; corrosion problem, filtration.

3) Production of esters of secondary alcohols of high and low molecular weight.

4) Tests of the additivity of fatty acids to different olefine double bonds (iso-olefines, cyclic compounds).

5) Addition of H_2CO_3 and HCN on olefines.

6) Production in the wet way of pure olefines by means of the esters of secondary monovalent and polyvalent alcohols.

7) Experiments on the composition of kogasins. Fractionation, determination of branch chains and the position of the double bond.

8) Production of fatty acid esters of secondary alcohols from the pure substances for determination of their properties.

9) Explanation of the reaction mechanism of resin formation from ketones, in particular methyl ethyl ketone and formaladehyde; principal reaction, subsidiary reactions influence of single reactions on the quality of the resin.

10) Further experiments regarding methylol compounds, in particular mono- and di- methylol acid-amides.

11) Production of tasteless triglycerol esters from synthetic fatty acids of the Fischer Tropsch synthesis and explanation of the carrier of the scratchy after taste. Esters of "Wittener" fatty acids.

Research Laboratory No. 4.

1) Purification of polymer benzin with phenolates.

2) Experiments in respect to the suitability of isopropyl alcohol as protection against freezing.

~~3) Production of ethers from alcohols and from olefines.~~

4) Production of the di-alkyl sulfates for alkylation.

5) Production of tertiary butyl alcohol.

6) ~~Polymerisation of residue gas from the alcohol plant;~~ production of products with high molecular weight.

7) Production of high molecular weight compounds from polymerisation of isobutylene.

8) Production of isobutylene by isomerisation of normal butylene.

9) Experiments on the reaction between olefines and aldehydes, especially formalin; production of glycols.

10) Chlorhydrins, olefine oxides and glycols from propylene and higher olefines -

    (a) production of hydraulic liquids from glycols.

    (b) polymerisation of olefine oxides.

    (c) conversion of olefine oxides with paraffins to alcohols

11) Removal of CO_2 and H_2S from gases with aqueous ammonia.

12) Production of fuel for powdered coal motors from carbon monoxide.

(Signed) GRIMME

Treibstoffwerk, 15 January, 1942.

Treibstoffwerk
7 January 1942

Projects carried out from 1940 to the present date and the projects under way at present.

Dehydrogenation of hydrocarbons, particularly propane and butane to propylene and butylene over Chromia-Alumina, Catalysts developed for this purpose. About 60 catalysts have been developed, of which the following in particular appear to be highly active and technically useful:-

K-33b: A mixed catalyst containing 10% Cr_2O_3 on synthetic Dawsonite.

K-57 : A mixed catalyst containing 18% Cr_2O_3 and especially simple to prepare technically, since it is obtained directly by coprecipitation of aluminum chromate solution with ammonium bicarbonate. See (patent) applications St 59796 and St 61012 IVb/129g,"Process for Preparation of Active Aluminum Oxide-and Aluminum Oxide - Chrominum Oxide Mixed Catalysts".

K-58/K-61: A mixed catalyst of high activity and exceptional mechanical strength obtained by decomposition of aluminum secondary butylate with water followed by direct adsorption of chromic acid -- see application St 59655 IVb/12m "Preparation and Use of Purest Hydroxides and Oxides of Aluminum and Magnesium", as well as addition application St 59894 "Process for Preparation of Activated Aluminum Oxide Catalysts".

2. Conversion of Ketones to Alcohols

A process has been developed for the thermal dehydrogenation of secondary alcohols, especially secondary butyl alcohol, to ketones, with the aid of a zinc catalyst (K-67) having a zinc content of 7-9%. The process has been put into use technically for the production of 30 tonnes per month of methylethylketone. In addition a process has been discovered for refining methylethylketone, which tends to turn yellow during storage, by distillation in the presence of calcium hydroxide.

3. Preliminary Work on Synthetic Resins.

Preparation of methyl ester of ethyl-acrylic acid (beta-methyl gamma-keto-butanol). Preparation and purification of methylisopropenyl ketone and its polymerization products resembling plexigum. For the decolorizing of methylisopropenylketone before its polymerization experiments have ~~been carried out which~~ proved barium hydroxide and other weak alkalis to be suitable see application St 60877 "Process for the purification of methylisopropenylketone", Furthermore, the preparation of cyclo-hexanone resin (AW-2-Resin), methylvinylketone, and others.

4 Development of the ketone resin "Emekal" from methylethylketone and formaldehyde, as well as the establishment of the process for a production of about 4 tonnes per month. Further improvement of the "Emekal" resin to an almost colorless and above all, hydrocarbon soluble resin type (for example Emekal 350) for the lacquer industry. See application St 60911, "Process for preparation of light colored, easily soluble synthetic resins".

5. Preparation of secondary butyl stearate as a plasticizer.

6. Preparation of aluminum alcoholates. Investigation of different catalysts for the reaction of aluminum with alcohols See application St 59625 IVc/120 and St 59626 IVc/120, "Process for the preparation of alcoholates of magnesium and aluminum".

Use of Aluminum Alcoholate (butyl and propyl) for:-

(a) pyrotechnic purposes (application St 59322 IVd/78d, "Use of metal-alcohol compounds for pyrotechnic purposes")
(b) carbon igniters (application St 59424 IVb/78d, "Process for improving the ignitability and combustion velocity of solid hydrocarbons").
(c) treatment of textile Fibres (application St 60815 IVc/8k, "Process for improving textile fibres").
(d) lacquer technique and other purposes, especially the preparation of emulsions and suspensions with the aid of aluminum alcoholates")
(e) medicinal purposes (Professor Engelhardt, Tübingen, as well as Professor Frey, Düsseldorf)

7. Development of the carbonic acid addition products of aluminum alcoholates, particularly of the butyl compounds (application St 59783 IVd/12$_o$, "Process for stabilization of metal alcoholates") Preparation of the material "Carbutal" or "Rh$_5$" and its use as a gelation medium for lacquers and protective coatings (application St 60358 IV/10b, "Process of thickening and solidifying liquid organic compounds") Likewise a proposal for medicinal use of carbutals (Professor Engelhardt, Tübingen; Professor Frey, Düsseldorf).

8. Development of an aluminum alcoholate plant for a production of about 30 tons per month (application St 61255 IV/12$_o$, "Process for preparation of metal alcoholates; likewise St 59783 above).

9. Preparation of active aluminum hydroxide and oxide from aluminum alcoholates and their technical and medicinal application, as well as the development of an experimental plant for production of aluminum hydroxide and oxide.

10. Working out of a process for recovering pure aluminum from waste and remelted aluminum alloys (application St 61231 IVb/12m, "Process for separation of aluminum from aluminum alloys").

11. Preparation of a new gelatinizing material (Rh$_6$) from butyl (Butal) and our C$_6$ - C$_9$ fatty acids, and also the fatty acids from the Wittener process. Use of the aluminum salts of of these fatty acids for the purpose of "Wa Prüf 5 1c".

12. Development assignments of the "OKH.,Wa Prüf 5".

1. Development of smoke tubes (Parchlorit 7)*
2. " " water resistant abrasive devices (Reibsätzen)
3. " " an igniter cartridge for oil (Parchlorit 7)*
4. " " storage stable delay devices

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* See application St 59425 IVb/78i, "Process for preparation of finely dispersed materials, of importance in pyrotechnics, from paraffin wax from the Fischer-Tropsch synthese".

4. Development of storage-stable delay devices (contd) ~~(Parchlorit 7)~~[*]

5. " " membranes as a safety valve for flame throwing devices.

6. " " incendiary oil for filling flame throwing devices, and in combination with the above

~~7. " " an aluminum alcoholate plant (see above)~~

8. " " burning tubes (Parchlorit 7)[*]

9. " " a chemical time igniter (see special application W 109820 XI/721, "Chemical time igniter").

few additional assignments are yet to be expected.

(signed)
Wiedmann

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[*] See application St 59425 IVb/781, "Process for preparation of finely dispersed materials, of importance in pyrotechnics, from paraffin wax from the Fischer-Tropsch synthese"

Treibstoffwerk
27 September 1943

To: General Manager Kost,
General Offices

Herewith I send you a review of the productivity of the scientists in the principal laboratories in the past report year.

Dr. Wiedmann

Work of Dr. W. in the past year:

(A) Aluminum alcoholates and their decomposition in the most various ways. Technically useful products, especially thickeners, plastic masses and artificial materials were produced from the aluminum alcoholates and shown to be technically useful.

(b) Aluminum hydroxide and oxide: Intensive work was done on the production of the different modifications. Preparations were in part, taken up for their production on a semi-technical scale. Their usefulness as additives, as rubber filler, as catalysts, as a carrier for serums, as polishing means, and their usefulness for medical purposes was discussed and worked on in conjunction with numberous foreign firms.

(c) Production of ketones, especially acetone was worked on further, and during the report year the technical production of acetone was built up and is being carried forward at present.

(d) A series of developed projects ~~of~~ the Armed Forces (Army and Air Force) was worked upon and, in part, finished. In all of this work, Herr. Dr. W. proved himself to be extraordinarily valuable by reason of his fertility of ideas, his application to his work, and the pleasant way with which he did the work.

In the work mentioned above, he was supported with zeal and success by his assistant Dr. Josten.

Nine patents were applied for in respect to the work above mentioned from Dr. Wiedmann's division.

Dr. Schmitt

Aside from working upon any special current problems in the realm of organic chemistry, Dr. Schmitt was busy with the synthesis of polyvalent alcohols (glycerine substitutes). The work was carried far enough in the course of the report year so that the technical planning in all particulars could be completed. In addition to this the conversion of acetone to diacetone alcohol and the conversion of the latter to glycol D was brought sufficiently to conclusion so that planning for a technical plant could be taken up.

Two patents were applied for in the above avenues of effort from Dr. Schmitt's division.

Aside from the above, Dr. Schmitt, together with Diploma Engineer Dr. Beier, oversaw the education of the apprentices.

Dr. Campen

The avenues in which Dr. Campen worked were:

(a) Dicarbonxylic acid from parestol fatty acids, etc., etc.

(b) Nitrocarbonic acids from fatty acids and their conversion into amino acids.

Both of the above named problems, which are of importance for the complete synthetic production of artificial fibres, led to results of richest significance, which were described in different patent applications.

(c) Obtaining higher alcohols from olefines of the benzine and kogasin fractions, and a new and what appears to be especially economic way to the solution of the above problem was worked out, whereby there was also obtained valuable information for the recovery of lower alcohols.

(d) Isolation of olefines from synthesis product was further worked out in the laboratory and in the technical experimental plant. Dr. C. further supervised the extension of the laboratories which can be designated as complete in this report year.

Dr. C. was, in all of the above work, in which he showed great diligence and skill, assisted by Dr. Wollner, who could be promoted on the basis of his working out of the separation of olefines from kogasin.

Three patents were applied for in Dr. C.'s division.

Dr. Häusser

Dr. H. was primarily busy with the management of the alcohol plant which experienced a very considerable increase of production, as well as improvement in economies during the report year.

Aside from this Dr. H. worked in the laboratory on the isolation of amyl alcohol from the pentane fractions, the concentration of sulphuric acid by means of submerged burners, and the separation of new kinds of subsidiary products from the alcohol ~~plant (octanesulphones).~~

Dr. H. has shown himself as a diligent plant manager, exhibiting independence. One patent came from his division.

Diploma Engineer Beier

He dedicated himself with the greatest zeal and scientific attention to all problems of the control laboratories. It should be especially noted that in spite of hindrances from sickness he carried out his work regularly.

Dr. Dannefelser

Dr. D. has conscientiously carried through his work as the division head of the test stands, including the direction of the benzin laboratory, and the control tests of final products.. Also he has given useful service in the negotiations with the service and government authorities.

(Signed) GRIMME

APPENDIX C

Documents Relating to Relocating Moers Equipment

3)
Discussions in Berlin at the GbChem and Geilenbergstab on 25.10.44.

Topic of discussion: Karburol Plant 2 Rheinpreussen and Alcohol Plant Rheinpreussen.

Present were:

Dr. Altpeter, GbChem/Berlin.

Dr. Arnold " "

Dr. Sorg " "

Dr. Pflaundler " " (A.R.P. reporter)

Dr. Gerich " " (Reporter for the locality for erecting new plants).

Dr. Romberg, Production Board.

Dir. Dr. Grimme, Rheinpreussen/Moers.

Ing. Cullmann, Rheinpreussen/Moers.

4)
Discussion at the Riebeck'schen Montanwerken Concordia Nachterstedt on 26.10.44.

Topic of discussion: Karburol Plant 2 (Jakob 9).

Present were:

Dr. Pfaff, Concordia/Nachterstedt

Dr. Gerich, GbChem/Berlin

Dr. Seifert, Wintershall A.G./Salzbergen

Obering. Weiss, DBHG/Berlin

Dr. Schmidt, Still/Recklinghausen

Obering. Breitbach, Still/Recklinghausen

Dir. Dr. Grimme, Rheinpreussen/Moers

Ing. Cullmann, Rheinpreussen/Moers

5)

Discussion and Inspection in Messinghausen and Bredelar.

Topic of discussion: Karburol Plant 1 (Jakob II and Alcohol Plant).

Present were:

Dr. Seifert, Wintershall A.G./Salzbergen

Dr. Schmidt, Still/Recklinghausen

Obering. Breitbach, Still/Recklinghausen

Obering. Weiss, DBJG/Berlin

O.T.-Stab, Building site, Messinghausen

Dir. Dr. Grimme, Rheinpreussen/Moers

Ing. Cullmann, Rheinpreussen/Moers

1) Karburol Plant (Jakob 9) Rheinpreussen.

The existing Karburol Plant Rheinpreussen is to be set up in combination with a new vaccum distillation. A few parts from the greatly damaged Viktor Rauxel Plant are to be taken to supplement the former. Provisions have been made to use as a raw product lignite distillation tar or BGR tar which is to be supplied by the Riebeck'schen Montanwerken Nachterstedt near Aschersleben. The originally intended locality of the plant in Miltisch-Roitschen near Meissen was, to begin with, changed for Frose (in the vicinity of Riebeck'schen Montanwerk), but this suggestion was turned down by the GbChem (Mr. Pfanndler) for A.R.P.-technical reasons because there is an exceptional accumulation of large-size industrial plants at the proposed locality (closed-down lignite mine). Dr. Gerich of GbChem has immediately gone in search of a new locality in the vicinity of Nachterstedt. As soon as a suitable locality has been found Dr. Gerish will advise us immediately. Special attention was called by Rheinpreussen and the firm Still to the fact that, owing to constant changes in the selection of the locality, the dismantling and assembling work has already been delayed by six weeks, as a result of which the demanded starting date (18.1.45) has been rendered doubtful.

The same conditions apply to the plants Karburol 1 and 3. In order to be able to carry out the dismantling work at an accelerated pace, however, it was agreed that until a final decision has been reached in regard to the locality the dismantled parts are to be sent for storage to the Riebeck'schen Montanwerk. Dr. Pfaff (Riebeck'sche Montanwerke) declared his willingness to make suitable premises available for that purpose. The unloadking of the trucks will be supervised by our gang leader Tombrink. 12 men have been asked for by teleprinter from the O.T. through Dr. Sorg (GbChem) for the purpose of unloading. The unloading gag is to arrive at Nachterstedt on 31.10.44.

The temporary despatch address reads:
"Steinkolenbergwerk Rheinpreussen
i.Fa. Riebeck'sche Montanwerke,
Neues Schwelwerk,
Nachterstedt-Hoym".

In regard to the trucks which have already been despatched to Miltisch Reitschen, the goods yards there have been informed telegraphically that the trucks arriving are to be passed on to the new address.

Data for Karburol Plant 2.

Trustee administration until completion: Head Engineer Weiss of the DBHG/Berlin.

Building supervision for building and power supply: DBHG/Berlin.

Building supervision for apparatus components: Firm Still/ Rechlinghausen.

Works Commissar for Construction & Erection: Dr. Kox, DBHG/Berlin.

Works Commissar for Production: ?

Responsible for the Apparatus Section: Dr. Schmidt, Still/ Recklingh.

Old locality: Rheinpreussen/Meerbeck.

New locality: Will be decided later.

Raw product to be used: Lignite distillation tar or EGR tar

Capacity: 16,000 tons per year = 2,000 tons per month = 65 tons per day = 2.7 per hour with 250 working days.

Ultimate Products:

Raw benzine	25% = 16 tons per day.
Raw Diesel fuel	25% = 16 tons per day.
Gas	12% = 8 tons per day.
Heating oil residue	36% = 23.5 tons per day.
Loss	2% = 1.5 tons per day.
	100% = 65 tons per day.

Power requirements:

Steam (10 atm.)	10 tons per hour.
Water (15°C)	300 m³ per hour.
Current (500 V)	200 Kwh.

Commencement of dismantling 17.10.44. End of dismantling: 15.11.44 in Moers.

Commencement of dismantling 1.11.44 End of dismantling: 30.11.44 in Rauxel.

Commencement of work on the building site: 1.12.44

Commencement of assembly: 15.12.44

Starting date: 28. 2.45.

Date for beginning of operation: 15. 3.45.

Provided the ultimate locality is announced immediately

Quota agent: The firm Still via DBHG/Berlin

Quota weight:
120 tons unalloyed.
22 tons alloyed.
50 tons tank.
0.5 tons NF

Condition of the old plant:

Apparatuses, scaffoldings, furnaces well preserved.

2 Tanks destroyed.
All measuring instruments and regulators damaged or in need of repair.
A few regulators are missing.
~~1 x 3000m^3 Gasometer must be newly erected.~~
The boiler plant will be procured by the Olhon

Personnel essential for assembly:

By 15.12.44.

5 E-Welders 5 A-Welders 10 Fitters 20 Assistants.

By 1.1.45.

10 E-Welders 10 A-Welders 20 Fitters 40 Assistants.

By 10.1.45

15 E-Welders 15 A-Welders 30 Fitters 60 Assistants.

Current (220 V) must be available on the building site by 15.12.44.

Traffic: Incoming: 6 trucks per day.
Outgoing: 5 trucks per day.

A.R.P.: Camouflage of the plants, bunker or galleries.

Cost of the plant: Will be decided later.

Report on the progress of dismantling (number of trucks despatched number of men employed, erection of the parts despatched, etc.) must be made very week to Head Engineer Weiss, DBHG.

Berlin-Charlottenburg 2
Knesebeckstr. 99: Tel. 31 80 21

Place where the parts to be despatched are warehoused:

Temporarily : Riebeck'sche Montanwerke Nachterstedt-Hoym

2) Karburol Plant 1 (Jakob 11). Luetzgendorf.

Contractor: Wintershall A.G.

Trustee administration until completion: DBHG/Berlin.

Building supervision for buildings and power supply: DBHG/Berlin

Building supervision for apparatus components: The firm of Still/Recklinghausen

Works Commissar for Construction & Erection: Dr. Kox, DBHG/Berlin

Works Commissar for Production: Dr. Seifert, Wintershall A.G./ Salzbergen.

Responsible for the Apparatus Section: Dr. Schmidt, Still/Recklinghausen.

Old Locality: Luetzgendorf.

New Locality: Bredelar

Despatch address for goods traffic: Bredelar, junction railway Zechitwerke.

Raw product to be used:

Mineral oil residue 60,000-75,000 tons per year = 5,000-6,250 tons per month = 240-300 tons per day = 10-12.5 tons per hour, 250 working-days.

Ultimate products:

Raw benzine	25%	= 60 - 75 tons per day.
Raw Diesel fuel	25%	= 60 - 75 tons per day.
Gas	12%	= 29 - 36 tons per day.
Heating Oil Residue	36%	= 86 -108 tons per day.
Loss	2%	= 5 - 6 tons per day.
	100%	=240 -300 tons per day.

Power requirements:

Steam (10 atm)	30 tons per hour.
Water (15°C)	600 m³/h.
Current (220V)	600 KWH

The power supply is arranged in such a manner that the power for the alcohol plant of Rheinpreussen can be supplied by the cracking plant.

New Apparatuses for Feeding the "Gasol" to the Alcohol Plant:

1 Gasometer 300 m^3
2 Compressors (from Rheinpreussen)

Dates:

Commencement of dismantling: 16.10.44. End of dismantling: 30.11.44.
Commencement of Assembly: 15.11.44
Starting date : 18.1.45

3). Alcohol Plant Rheinpreussen.

A basic agreement was mde with the Wintershall A.G. to the effect that the alcohol plant is to be erected in conjunction with the Karburol Plant 1 (Luetzgenforf). The raw product to be used (7,200 - 9,000 tons per year cracking gas with 30% Olefin content = 12% of the quantity used for the Karburol Plant) is supplied by the latter so that it is advisable to set the alcohol plant up in the immediate vicinity of the Karburol Plant. The locality coming into consideration which is about 200 m away from the cracking plant (Bredelar Sauerland) was inspected very thoroughly. The gas is fed to the alcohol plant in a compressed state (smaller pipelines) for which a small gasometer (200 m^3) and 2 compressors are required; The latter will be provided by Rheinpreussen.

The steam required of 6.5 t/h (10 atm) as well as water (200 m^3/h) and current (65 KWh, 500 V) will be take from the power production of the Karburol Plant 2 which will be constructed on a correspondingly larger scale. In addition, a transformer 500 V, 65KWA must be procured because the cracking plant operates on 220 V.

It has been possible to convince the competent authorities of the GbChem (Dr. Altpeter and Dr. Sorg) as well as the Production Board (Dr. Romberg) of the necessity for immediate decentralisation of the alcohol plant.

In spite of the greatest efforts made it has not been possible to obtain a definite decision from Herr Geilenberg or Herr Leidreiter - a decision desired by Rheinpreussen - because a discussion did not take place on that day as these gentlemen were too busy. Herr Thelen is to try to obtain from Herr Leidreiter the official permit for dismantling and if possible for the assembly of the alcohol plant.

The attention of the various service departments has repeatedly been called to the urgent necessity for the immediate dismantling of the Karburol and the alcohol plant because dismantling at a later date would be rendered doubtful owing to expected enemy action. The following points must be clarified immediately:

The fundamental permit for dismantling and/or reassembly and the provision of the corresponding number of workmen, furthermore the definite erection locality so that the individual apparatuses can be removed from the works one after the other and a bottleneck on the dismantling site avoided.

Draft for the Building Maturity Declaration.

for the decentralisation of the alcohol plant and acetone plant of the Fuel Works Rheinpreussen, Homberg/Niederrhein, to Bredelar (Sauerld).

Alcohol-Acetone Plant Rheinpreussen

Consisting of:

a) Polymerisation.
- 2 Stirring Plants.
- 2 Mixers.
- 4 Boilers
- 2 Coolers (100 m^2)
- 6 Pumps (each 3 m^3h)
- Various Small Tanks and Apparatuses.

b) Sulphuric acid regeneration.
- 2 Evaporators.
- 2 Re-evaporators.
- 1 Vacuum Condenser.
- 2 Vacuum Pumps.
- Various small apparatuses.

c) Water Extraction from Alcohol.
- 1 Column 900 Ø x 15000
- 2 " 700 Ø x 7000
- 3 " 700 Ø x 4000
- 12 Condensers totalling 150 m^2
- 10 Pumps each 3 m^3/h.
- Various small apparatuses and tanks.

d) Acetone Plant.
1 Tube Furnace
3 Blowers
1 Evaporator
1 Distillation Column
4 Pumps
Various containers

e) Tank Store.
~~6 Tanks 2000 Ø x 8500~~
11 Tanks 1600 Ø x 6000

All above plant components are undamaged and in good condition.

Quota requirements:

Machine iron	35 tons
Construction iron	40 tons
NE metals	5 tons

Costs

for construction	RM 50,000.-
for assembly	RM 80,000.-

Capacity:

To be used:	25 tons per day cracking gas (30% Olefin content) = 7.5 tons per day Olefine from the Jakob 11 plant.
Product:	7 tons per day alcohol. 1.2 tons per day acetone. 7 tons per day liquid gas (for fuel purposes) Rest: Heating gas.

Labour:

12 Men
15 Women

Operating Means:

H_2SO	5 tons per month
NaOH	5 tons per month

Operating Means:

H_2SO	5 tons per month
NaOH	5 tons per month

Power:

Water (15 $^\circ$C)	200	m^3/h
Current (500 V)	65	KWh
Steam (10 atm.)	2	t/h
Steam (2.5 ")	4.5	t/h

Fixed date suggestion:

Commencement of dismantling	1.11.44
End of dismantling	1.12.44
Commencement of construction	15.11.44
Commencement of assembly	15.12.44
End of assembly	15. 2.45

Assembly personnel required:
(not including building workers)

	15.12	1.1	15.1
A-Welders	7	10	15
E-Welders	3	5	15
Fitters	10	20	30
Assistants	20	40	60

Traffic:

Incoming:	3 tank wagons per month
Outgoing:	14 tank wagons per month 10 tank gas wagons.

4). Karburol Plant 3, Plant Bergkamen.

The plant is already dismantled partly, but the erection site is not yet known so that the dismantling work on this plant is also hindered owing to the change in the assembly site. Hoyerswerda/Lausitz is intended as the prospective locality.

5). Top Plant Taube 1 in Messinghausen.
Taube 2 in Muehlenbein.

These plants were inspected. They are two new twin plants with 3,000 tons per month raw material operating on 50% residue. The construction of the plants is very primitive (brick furnaces, small suspended roof, cooler and heat exchanges without compensation and without facility for switching off, no regulators, pumps in the open, steam supply from old locomotive boilers).

The date for starting was fixed at about 6 weeks ago, but neither of the two twin plants are ready for operation as yet. Considerable difficulties will presumably occur in the maintenance of the plant in the event of snow and severe cold.

The erection of Taube 1 in regard to A.R.P. is good, that of Taube 2 poor, as the latter is built into the centre of a circular stone quarry (crude oil tank with furnace).

Points to be clarified.

a) Karburol Plant2:

1). Fixing ultimate locality and ultimate despatch address.

2). Advising the Army Order Number by GbChem via DBHG to Still.

3). Works Commissar for Production.

b) Alcohol-Plant:

1) Permit for dismantling from Geilenberg and the provision of labor.

2). Permit for re-assembly from Geilenberg and provision of labor.

3). Definite confirmation of the projected site Bredelar.

4). Despatch address for the new site.

5). Ascertaining name of the Trustee Administrator (DBHG?)

6). Ascertaining name of the Works Commissar for Construction and Erection (DBHG?)

7). Ascertaining the name of the assembly firm (Dr. Otto?)

8). Ascertaining the name of the Werke Commissar for Production (Rheinpreussen).

Re: Storage Places

Please be advised that for purposes of efficiency, the various storage places have been given individual account numb. These are as follows:-

22030: All expenditures pertaining to shipments made to Alem, Stiepel, Mann.-Linden, Coswig, Hildesheim, Heilbronn, Bugstall. In the case of the last two cities only those expenditures which are not made for the laboratories, are to be considered.

22031: Shipping expenditures to Herdersleben abd Herdersleben Nachterstedt.

22032: Expenditures for shipments to Bredelar.

Expenditures incurred for any other shipments, such as for laboratories, experimental stations, etc, shall, as heretofore, be entered under number 2203, next to the account of the consignee.
For example:
2203/490 for Laboratories
2203/491 for motor testing labs.
2203/600 for experimental stations.

Expenditures entered in accounts no. 2203-22032 should show the purpose of the individual shipment.

To the Rustungskommando
Essen - Bredency
Am Wiesental 10

February 24, 1945

Re New Location

Replying to your letter of the 10th inst. we herewith, give you a list of the new locations of our chemical plants.

The Alcohol & Acetone Plants will be moved to Bredolar in Sauerland. All necessary machines, apparatus and pipefittings have been forwarded there. The building order for this plant has been given and is being carried out.

The Carburol Plant will be built in a larger scale in Hedersleben near Nachterstadt. The necessary machines, apparatus and pipe fittings have already arrived on the new location; the building order has been given and is being carried out.

For the Fischer Synthesis Plant we have a moving order to Alme in Sauerland. A great part of the machinery apparatus and pipe-fittings for it has arrived. A building order has not yet been given.

The Addresses to which we are moving are as follows:

Dr. Hermann Häusser & Co., Bredolar

Paul Cullmann & Co., Hedersleben

Karl Henkel & Co., Alme

The Research Laboratories have been moved to Lüdenscheid. The order has been given as well.

The Experimental Plant for Research on Iron Catalysts has been moved to Bochum-Stiepel to the building of our Mine Gibraltar-Erbstollen. Here we also intend to erect a pilot plant., The order for the pilot plant has not yet been given.

Up to now 354 railway trucks have left to the new locations.

Steinkohlen Bergwerk

"Rheinpreussen"

Die Direktion

Gez. Kost

APPENDIX D.

ABSTRACTS OF PATENT APPLICATIONS

RELATING TO THE

FISCHER TROPSCH PROCESS

Ruhrchemie Filed 20 Feb., 1939
R-104584 IVd/120

To make products of lower molecular weight and higher olefin content the hydrogenation of CO is carried out with recycling of the product gas after separation of condensibles by cooling and charcoal absorption. With a cobalt catalyst at 200-230°C, a recycle ratio of 3:1 to 10:1 is preferred. A relatively high pressure, 3-10 atm., and high temperatures 200-230°C, can be used. The resulting gas and gasoline is stated to be about 75% olefinic and 55% of the product is in the C_2-C_4 range.

Ruhrchemie Filed 28 Mar., 1939
R-104876 IVd/120

The hydrogenation of CO is carried out by passing synthesis gas into a suspension of finely divided catalyst in a suitable oil, preferably with mechanical agitation to distribute the gas, and simultaneously introducing a liquid such as water, which vaporizes under the reaction conditions to control the temperature. For example, 1270 gms of Co-ThO_2-MgO-Kieselgur catalyst containing 400 gms. Co is suspended in 15 litres of oil boiling from 240°-300°C. Synthesis gas containing 1 Co;$2H_2$ is introduced at a rate of 2.5 litres per gm Co per hour, and a pressure of 10 atm. is maintained in the reaction. The synthesis starts at 190°C and the temperature is gradually raised to 210°C as water is introduced to maintain this temperature. The contraction of synthesis gas amounts to 85% and the yield of liquid and solid hydrocarbons amounts to 172 gm/m^3. The liquid product contains 90% boiling up to 300°C and having an olefin content of 20%.

Ruhrchemie Filed 15 Apr., 1939
R-104999 IVd/120

Preparation of synthesis catalysts by precipitating from sulfate instead of nitrate solution and activating by washing with alkali carbonate or hydroxide solution. For example, a catalyst containing 100 parts Co. 10 parts Mg 0, 5 parts ThO_2 and 200 parts kieselguhr is prepared from a solution containing 40 gms/liter of Co in the form of sulfate. The precipitate obtained by addition of "soda" is washed first with water (1 liter per 25_g Co) then with n/20 (NH_4) 2 CO_3 (1 liter per 25g Co) and finally with water (1 liter per 25g Co).

R-105297 IVd/120 Filed 24 May, 1939.

Increasing production of high molecular weight hydrocarbons by using a catalyst on a support of very low bulk density. Low temperatures (160-180°C) low space velocity (4 liters/hr/kg catalyst) elevated pressure (10-20 kg/sq.cm) and high cobalt content (over 100 gm. cobalt per liter of catalyst) are recommended with a catalyst support consisting of uncalcined magnesia or low density kieselguhr.

R 105508 IVd/120 Filed 24 June, 1939.

Process and apparatus whereby more uniform flow is maintained through a bed of synthesis catalyst by supplying the synthesis gas through a valve or orifice causing a considerably greater pressure drop than the catalyst bed itself.

R 105615 IVd/23b Filed 7 July, 1939.

Preparation of high anti-knock fuels by heating a Fischer-Tropsch product with a small quantity, about 10%, of the bituminous components of hard coal or brown coal, freed from ash, and preferably under pressure and in the presence of a catalyst and hydrogen. Specifically a Pott-Brosch coal extract is mixed with Fischer-Tropsch product boiling from 200-250 C and passed over a molybdena catalyst with hydrogen at 480-500°C under 80 atm pressure, whereby 70 octane gasoline is obtained. The unconverted kogasin is recycled.

<u>Braunkohle-Benzin A.G.</u>
185 130 IVd/120 Filed 3 Nov. 1938.

Controlling the temperature in the catalytic hydrogenation of carbon monoxide by carrying out simultaneously over the same catalyst an endothermic reaction, specifically the catalytic cracking of alcohols and preferably of isobutyl alcohol.

Ruhrchemie
R-103450 IVd/120 Filed 1 Oct., 1938.

Reducing catalysts for hydrogenation of carbon monoxide with hydrogen containing less than 2.5 gms oxides of carbon and less than 1 gm water vapor per cubic meter to get faster reduction and a more active catalyst.

Ruhrchemie
R-103507 IVd/12m Filed 8 Oct., 1938.

In recovering thorium the iron content is minimized by dissolving the iron-thorium slurry with sulfuric acid, adding potassium sulfate to precipitate potassium thorium sulfate and decomposing the latter with sodium carbonate in the presence of enough additional potassium sulfate to maintain the ratio of K to Na sulfate greater than 1:1. The potassium thorium sulfate is washed with saturated potassium sulfate until the wash liquor contains only traces of iron and then the double salt is "cooked" (under conditions not specified) with the sodium carbonate-potassium sulfate mixture to make thorium hydrocarbonate which contains less than 0.3 parts Fe_2O_3 per 100 parts ThO_2.

Improvement on R102874 IVd/12m.

Ruhrchemie
R103605 IVb/12m Filed 24 Oct.,1938.

Improvement on R103507 IVb/12m consisting in treating the washed potassium thorium sulfate with an excess of sodium carbonate to redissolve the initially formed thorium hydrocarbonate as alkali thorium double carbonate and heating this solution to 90°C whereby colloidal iron hydroxide is precipitated, together with a small amount of colbalt which may be recovered by recycling. Sulfuric acid is added to the solution to precipitate thorium hydrocarbonate (free from iron) which is filtered out and washed with water. HCl may be used for this precipitation and the solution may be cooled to precipitate alkali sulfate for reuse.

Ruhrchemie
R103713 IVd/12 o

Regenerating synthesis catalyst in situ by continuing hydrogenation after completing wax removal but with increasing temperature. For example treating for 2.5 hrs at 200°C with a mixture containing 25% N_2 and 75% H_2; raising the temperature to 350°C during the period of $\frac{1}{2}$ hr and treating at this temperature for $\frac{1}{2}$ hr; treating $\frac{1}{2}$ hr at 400°C and finally at 2 hrs at 450°C. Original activity is stated to be restored by this procedure.

Ruhrchemie
R103712 IVd/12 o Filed 7 Nov., 1938.

Used synthesis catalyst is subjected to oxidation under unspecified conditions except "elevated" temperature prior to regeneration with hydrogen, whereby the regeneration is said to proceed more rapidly and effectively.

Ruhrchemie
R103980 IVd/12 o Filed 6 Dec., 1938.

Kieselguhr to be used as a synthesis catalyst support is treated with a relatively volatile acid such as HCl or HNO_3 to remove inorganic impurities and is then oxidized below the sintering temperature to remove organic matter and the remaining traces of acids. Alternatively the metals may be removed as bicarbonates by blowing CO_2 through a suspension of Kieselguhr, after which the Kieselguhr is washed, dried, and calcined 1 hour at 550°C.

Ruhrchemie
R103714 IVd/12 o Filed 7 Nov. 1938.

Synthesis catalysts are regenerated in situ by removing paraffin and then treating at an elevated (not specified) temperature with hydrogen passed at high velocity, preferably 1000 cubic meters per hour per square meter cross section. The hydrogen can be recirculated if the CO and CO_2 content is kept below 2.5 gm per M^3 and H_2O less than 1 gm per M^3. Activity attained this way is stated to equal that of a reworked catalyst.

Braunkohle
B184414 IX/42i Filed 23 Aug. 1938.

A thermocouple with the leads extending in opposite directions from the junction to avoid the problems of electrical insulation etc. associated with parallel leads. For measuring the temperature along the center of a vertical reaction tube the leads would pass through stuffing boxes at the top and bottom of the tube so that the junction could be raised or lowered as desired.

Brabag
B181705 IVd/12 o Filed 31 Jan. 1938.

Addition to B 178085 IVc/12 O carrying out exothermic reactions such as Fischer-Tropsch synthesis with such a large percent of inert gas in the charge gas that the entire heat of reaction can be carried out as sensible heat of the effluent without harmful temperature rise. No data given.

Brabag
B181885 IVd/23b

Cracking heavy hydrocarbons over catalysts which serve at lower temperatures for the synthesis of hydrocarbons from Co and H_2. Such a catalyst which is spent for synthesis can be used for cracking. The oil to be cracked may be vaporized or atomized with H2. A cracking temperature of 300-350°C is suggested.

Brabag
B182020 IVd/12 o Filed 19 Feb. 1938

Pretreating a synthesis catalyst with synthesis gas containing NH_3 for about 20 min. at 185°C. Longer catalyst life is stated to result.

Brabag
B182388 IVd/12 o Filed 15 Mar. 1938.

Fresh catalyst, preferably blanketed with CO_2 when charged to the oven, is wet with synthesis product, at least in the top part of the oven, to minimize the tendency to excessive reaction and harmful overheating of the fresh catalyst when first put into service.

Brabag
B182389 IVd/12 o

Filed 15 Mar. 1938.

Extracting paraffin from synthesis catalyst by supplying vapors of a solvent, preferably synthesis oil, of such a boiling point that condensate therefrom is formed and flows down through the catalyst to extract the wax at a temperature above its melting point.

Brabag
B183662 IVd/23b

Filed 25 June 1938.

To avoid fog formation in condensing oil from synthesis oven effluent by spraying with water, vapors of the oil condensate, or of some oil miscible with the condensate, are combined with the effluent ahead of the water spray.

Ruhrchemie
R102874 IVb/12m

Filed 1 July, 1938.

In the reworking of spent synthesis catalysts the primary Na_2CO_3 precipitate containing Th and Fe is dissolved in H_2SO_4, Th is precipitated as thorium potassium sulfate by K_2SO_4, this is separated and washed and then converted to thorium hydrocarbonate by digestion with concentrated Na_2CO_3 solution.

Ruhrchemie
R102909 IVd/12 o

Filed 20 July, 1938.

Making relatively light products from the hydrogenation of CO by using a catalyst containing not more than 33% by weight of active metal and operating at relatively high temperatures (235-240°C with Co) and high space velocities (up to $9m^3$ synthesis gas per Kg Co per hr).

Ruhrchemie
R102756 IVd/23b

Filed 2 July, 1938.

The octane number of benzin from the hydrogenation of CO is improved (from 5 to 10 points) by passage over material of high surface area such as silica gel, active carbon, acid treated clay etc. at 180-200°C, apparently as a result of isomerization.

Ruhrchemie
R103371 IVb/12n

Filed 20 Sept. 1938.

The calcium impurity in cobalt nitrate solution prepared in reworking catalysts is precipitated by a soluble fluoride in the presence of added magnesium (nitrate). Any excess of soluble fluoride over that required to precipitate Ca will precipitate as $Mg\,F_2$, thus leaving no fluoride in solution to precipitate inactive cobalt fluoride when Na_2CO_3 is added.

Ruhrchemie
R101215 IVd/12 o Filed 6 Jan. 1938.
Addition to R97521 IVc/12 o

Before discharging spent synthesis catalyst for reworking it is treated with inert gas such as steam at temperatures above 300°C and with a velocity of at least 1 meter per second to sweep out remaining oil and wax.

Ruhrchemie
R101219 IV/40a Filed 7 Jan. 1938.

In reworking cobalt synthesis catalysts the iron-thorium sludge is dissolved in acid and then treated with excess sodium carbonate at about 40-50°C to precipitate iron as hydroxide and keep thorium in solution as sodium thorium carbonate which is subsequently hydrolyzed to hydrocarbonate.

Ruhrchemie
R101354 IVd/12 o Filed 21 Jan. 1938.

Spent catalyst, after being freed from paraffin, is discharged and reworked by initial solution of active components in ammonium carbonate solution instead of acid. This is stated to facilitate elimination of impurities but details are not given.

Ruhrchemie
R101389 IVb/26d Filed 25 Jan. 1938.

Organic sulfur compounds in gases are converted to H_2S by heating the gas, preferably with added O_2 and steam rapidly to above 400°C and digesting at this temperature in the absence of a catalyst for a considerably longer time than required for heating. Final heating is preferably accomplished by partial combustion to prevent trouble due to deposition of solids on indirect heating surfaces.

Brabag
B.182409 IVd/12 o Filed 16 Mar. 1938.

In the hydrogenation of CO with a Co catalyst longer life is obtained if steam is added to the synthesis gas during initial operations according to the following schedule for example:

0 to 20 hrs.	2 - 2.5 vol.% steam
20 to 30-50 hrs.	0.7 - 1.5 vol.% steam
30-50 to 100-300 hrs.	0.1 - 0.2 " " "
After 300 hrs.	enough to make dewpoint 20-25°C.

Brabag Filed 27 Aug. 1938.
B184450 IVb/12g

Catalyst ovens or tubes are emptied of catalyst by suddenly applying a gas pressure of 5-20 atm, preferably after wetting the pressure side of the catalyst bed with a liquid.

Brabag Filed 29 May, 1937.
B178627 IV/26d
Addition to B175954 VI/26d

A catalyst containing an oxidizing salt such as sodium nitrite on a support such as active carbon is used for organic sulfur removal (as covered by 175954) and when spent for this purpose is used to convert organic sulfur to H_2S, which can be removed by well known methods.

Brabag Filed 24 June, 1937.
B178984 IVc/12 o

Using the relative CO_2 content or density of end gas in comparison with charge gas as a guide for adjusting operating conditions, particularly coolant supply.

Brabag
B179047 VI/26 d Filed 29 June, 1937.

Carrying out the catalytic removal of organic sulfur compounds from gases by plural stage operation with a higher temperature in the last stage than in the first.

Brabag Filed 14 Aug. 1937.
B179612

Synthesis gas from brown coal is freed from resin forming constituents, independent of desulfuring, by cracking in a cowper stove or adsorbing on active carbon, brown coal, coke, or bleaching earth.

Brabag Filed 8 Sept. 1937.
B179862

Oil from the Fischer Tropsch is neutralized by percolation through bleaching earth at about 150°C.

Brabag Filed 8 Sept. 1937.
B179863

Oil from Fischer Tropsch synthesis is neutralized by contacting with iron oxide in the form of gas purification "Masse" or

"Lautmasse" and the like, at 120-150°C and regenerating the mass by treatment with steam or hot water at a higher temperature (175°C).

Brabag
B177992 IVc/12 o Filed 6 Apr. 1937

Using for the Fischer Tropsch process a synthesis gas prepared from coal or coke and removing residual hydro-carbons from the synthesis gas by active charcoal or by contact with hot sulfuric acid or by cooling sufficiently to condense the hydrocarbons.

Brabag
B178085 IVC/12 o Filed 14 Apr. 1937.

Diluting synthesis gas with reaction products so that the heat of reaction can be carried out as sensible heat of the mixture without excessive temperature rise.

Brabag
B175954 IVb/12e Filed 23 Oct. 1936.

Desulfurizing synthesis gas by contact with an oxidizing agent such as a nitrite, chlorate, permanganate etc. on a support such as active carbon silica gel etc. at a temperature of about 80°C.

Krupp
K 147143 IVb/12g Filed 5 July 1937.

Reactor for the Fischer-Tropsch process in which the cross section of the catalyst bed decreases from inlet to outlet according to the contraction in volume of the reacting gases.

Krupp
K148919 IVb/12g Filed 20 Dec. 1937.

Carrying out Fischer-Tropsch synthesis (or other reactions with large heat effects) in a plurality of stages and introducing between stages sufficient cold charge gas to hold the desired temperature in the subsequent stage.