

## ANNEX II

### SUMMARY OF DATA ON KNOWN FISCHER TROPSCH SYNTHESIS PLANTS IN AXIS EUROPE

In the discussion of each plant there is summarized the most pertinent information contained in the British reports from aerial reconnaissance, including the British estimate of plant capacity, followed by our comments under the heading "Discussion".

## HOLTEN

Company: Ruhrbenzin A.G.

Date Coverage: Aug. 21, 1942 (Repts. D-112 and D-162).

Location: On road between Sterkrade and Holten, about 1/4 Mi. E. of village of Holten, annex to ammonia and chemical works of Ruhrchemie A.G.

Plant Area: Triangle 3700' x 4100' x 2250', of which oil synthesis in S. part measures 1300' x 900'.

Description: Synthesis from CO + H<sub>2</sub> (Fischer Tropsch)

(a) Power Plant: Serves both chemical works and oil plant being extended (March '42) by 1/3 which would raise boiler capacity by at least 50%.

(b) Gas manufacture: 2 groups of watergas generators:- 1 with 7 generators,  
1 with 4 generators (with construction on two more begun between November '41 and January '42).

Gasholder 110' D.

Cooling Tower 48'D.

H<sub>2</sub>S Removal - 8 towers 36'D.

Organic Sulfur Removal (Feinreinigung)- 12 towers 18' D.

There is also a Linde plant. The watergas generators seem to point to an insufficient supply of coke oven gas to meet the requirements of both the NH<sub>3</sub> and the Fischer plant.

(c) Synthesis: Contact oven house 540' x 115', with probably 90-100 low pressure ovens, 60 of which may be for first stage, 30 in second stage and 6 standby.

(d) Refinery: Two groups of condensers 18' D., activated carbon plant, stabilizing, propane and butane columns, fractionating plant for primary products, T.V.P. cracking plant, lubricating oil plant.

(e) Tankage: Lube oil storage - 4,712 M<sup>3</sup>  
Finished Product - 25,795 M<sup>3</sup>  
Primary Product - 2,958 M<sup>3</sup>  
Tankage is being expanded and there may also be some underground storage tanks.

## Holten (Contd.)

- (f) Sundries: There is quite some unidentified new construction going on which seems connected with the oil plant. There is also a catalyst plant, one of the three in Germany (the other two being at Schwartzheide and at Luetzkendorf).

Estimated Capacity: 90,000-100,000 T/Yr. of primary products.

This capacity is predicated on the assumption that one oven (L.P. type) of 10 M x 2-1/2 M and 5 M. high has a capacity of 1,000 T/Yr.; the capacity of a medium pressure oven (5.2 M. high, 2.7 M. diameter) would be 1,200 T/yr.

### Discussion:

We believe that our previous estimate of 100,000 Tons for 1941 and 1942 is about right, but that for 1943 an increase of 20%, or say to 125,000 may be expected. Even though these figures are not very much different from the British figures they were arrived at in a different manner, and in view of the importance of the data on the Holten plant for estimating capacities of various other Fischer plants we think it is useful to go into some detail here into this matter.

### 1. Size of Ovens

(a) Low pressure type of catalyst chambers: These are boxes having the following measurements:

2.5 metres high  
1.5 metres wide  
5-6 metres long

(b) Medium pressure catalyst chambers: These are vertical cylinders having the following measurements:

5.2 metres high (17 Ft.)  
2.7 metres diameter (9 Ft.)

### 2. Capacity of Ovens

The capacity in terms of primary product (liquid product, plus recovered propane and butane) may be taken as follows:

Low Pressure Ovens -- 750 T/Yr.  
Medium Pressure Ovens - 1200T/Yr.

## Holten (Contd.)

### 3. Size of Contact Oven House

The synthesis building at Holten was reported in November 1938 to be about 170 metres long and 35 metres wide. It has a platform 5 metres high in the center, running the full length of the building, the converters being arranged left and right of this corridor. In the center ample space is reserved for operating control (central operating room). Between the ovens and the wall is a track for the transport of the catalyst containers. The size of the building checks very closely with the size given in Reports D-112 and D-162 (540 Ft. x 115 Ft.) and it appears, therefore, that since November 1938 it has not been further extended.

### 4. Number of Ovens

In November 1938 the above synthesis building housed 52 low pressure ovens with room for an additional 72 medium pressure ovens which were then under construction.

### 5. Yields of Products

The following shows the yields in grams per cubic metre of Ideal synthesis gas (i.e., gas consisting of only CO and H<sub>2</sub> in proper proportion without any inerts), with the yields for actual gas in parenthesis.

<u>Process</u>	<u>Low Pressure</u>	<u>Medium Pressure</u>
Liquid Product IBP-35°C.	120 (101)	150 (126)
Gasol (Propane and Butane)	<u>15 ( 13)</u>	<u>10 ( 9)</u>
Total	135 (114)	160 (135)

### 6. Capacity of Holten

The 52 old ovens were reported to have a capacity of 90 tons of primary product per day, or say 34,000 tons per year, requiring about 35,000-40,000 cubic metres of synthesis gas per hour (gas with 15-17% inerts). It was reported that upon completion of the 72 medium pressure ovens, this capacity would be raised to 85,000-90,000 tons of primary product per year, requiring a gas production of 80,000-90,000 M<sup>3</sup>.

### 7. Gas Manufacture

The gas requirements were manufactured in 11 Demag generators (system Humphries, Glasgow), 6 of which have a rated capacity of 6,800 cubic metres per hour each, the 5 newer units 7,800 cubic metres per hour each. In actual operation these units

## Holten (Contd.)

produce 7,400 and 8,500 cubic metres per hour each, respectively. In November 1938, 4 units were in operation with one as standby. The total capacity of the 11 generators was about 80,000-90,000 cubic metres per hour gas. The August 21, 1942 coverage of Holten showed that they were still operating with 11 generators, but had begun construction on two more between November 1941 and January 1942.

The generators are operated automatically with coke charged to them every three minutes at the rate of 200 kg., i.e., about 100 tons per 24 hours.

### 8. H<sub>2</sub>S Removal

The Holten H<sub>2</sub>S removal plant consisted in 1938 of two sets of four towers of the common type as used in coke gas oven plants. The gas passes 3 towers in series, one tower of the set being refilled. The above-mentioned coverage shows that the same number of towers is still being used.

### 9. Organic Sulfur Removal

The organic sulfur removal had five sets of two towers each, of which one set is spare. It is equipped with one heater per set, using tail gas and air, both from a main line. The above-mentioned reconnaissance shows that since November 1938 two towers have been added to this plant.

### 10. Summary

On the basis of a gas production of 90,000 m<sup>3</sup>/Hr. and the above yield figures, we can make the following estimates:

	<u>Fr. Prod./Yr.</u>
L.P. ovens, say 40,000 m <sup>3</sup> /Hr. at 114 gr. at 8,000 Hrs. =	36,500
M.P. ovens, say 50,000 m <sup>3</sup> /Hr. " 135 " " 8,000 " =	54,000
	<u>90,500</u>

which checks with the expected capacity given under "6" above.

On the basis of the oven capacity, we arrive at the following estimate:

52 L.P. ovens at 750 T/Yr. =	39,000 T/Yr.
72 M.P. ovens at 1200 T/Yr. =	86,400 T/Yr.
	<u>125,400 T/Yr.</u>

Holten (Contd.)

The construction of two additional watergas generators seems to point to the probability that the plant will be run closer to its oven capacity. We have rounded our figure of 90,000 T/Yr. off to 100,000 T. for 1941 and 1942, and taken 125,000 Tons for 1943.

CASTROP-RAUXEL

Company: Gewerkschaft Viktor

Date Coverage: April 16, 1942 (Rep. D-156)

Location: 1-1/4 Mil N.E. of Rauxel railway station, alongside the Gewerkschaft Viktor coal mine.

Plant Area: 3300' x 2350'

Description: Fischer Tropsch Synthesis (probably both L.P. and H.P.).

- (a) Coke Oven Plant: Battery 450' long, about 150 ovens.  
By-products plant includes NH<sub>3</sub> and benzol recovery and purification.
- (b) Power Station: Boiler House 200 x 125 Ft.  
Generator Hall 115 x 90 Ft.
- (c) Gasmanufacture: CO from coke ovens, supplemented by CO + H<sub>2</sub> from watergas plant of 180 x 120 Ft. with four generators.  
H<sub>2</sub>S removal 200x90' with four towers at 40' D.  
Organic sulfur removal - 6 towers at 19' D.
- (d) Synthesis Contact oven house 310 x 90 Ft., probably 30 L.P. and 60 H.P. ovens, with another one (same size) under construction.
- (e) Refinery
- (f) Tankage: Total capacity about 22,700 Tons
- (g) Sundries: There is also an NH<sub>3</sub> synthesis plant on the site.

Estimated Capacity:

Old Plant	- 30 x 1000 + 60 x 1200 = say	100,000 T/Yr.
New Plant (in Op. 1943)		<u>100,000</u>
Total for 1943		200,000

Castrop-Rauxel (Contd.)

Discussion:

We do not know the basis for the British estimate of the number of ovens in the old synthesis building, but believe that the size of the reactor house and the sulfur removal capacity indicate a capacity of about 60% of Holten--60,000 T/Yr.

The new contact oven house probably has about 70 M.P. ovens which at 1200 T/Yr. would raise the capacity by about 84,000 T/Yr. The total capacity for 1943 is then about 150,000 T/Yr.

( We did not receive either photographs or line drawings of this plant).



## HOESCH

Company: Hoesch Benzin G.m.b.H.

Date Coverage: April 16, 1942 (Rep. D-164)

Location: Hoesch in suburb Wambelohholz, 2-1/2 Mi. N.E.  
of center of Dortmund.  
Koelin-Neuessen Steelworks are on the west.

Plant Area: 2100 x 870 Ft.

Description: Fischer Tropsch Process

- (a) Power Station: 175 x 70 Ft., being extended  
with a new section of 70 Ft.
- (b) Gasmanufacture: Watergas generators, probably  
supplemented by gas from adjacent  
coking plant.

In June 1941, building 200 x 95 Ft.,  
with 6 generators, now being extended  
to 305 x 95 Ft. with three more gen-  
erators (one of which is ready).

H<sub>2</sub>S Removal: 280 x 100 Ft., 4 towers  
at 35 Ft.

Organic Sulfur Removal: 6 ( 3 pairs)  
towers 18 Ft. D., with room for  
2 ( 1 pair) more, but no signs of its  
construction being started.

- (c) Synthesis: Contact oven house 300 x 90 Ft.,  
apparently only of M.P. Type  
(reaction in open) - 72 ovens  
9 Ft. D. (in June 1941 some less).
- (d) Refinery: Heater house with chimney, possibly  
also cracking, wax removal and lube  
oil.
- (e) Tankage: Storage capacity 23,400 T.

Estimated Capacity: 72 ovens at 1200 T/Yr. - 86,000 T/Yr.

Discussion: We concur with the British estimate for 1943, which we  
suggest to round off to 90,000 T., but suggest 70,000  
tons for 1942 and 60,000 tons for 1941.

HOMBERG ( MOERS / OERBECK)

Company: Rheinpreussen

Date Coverage: August 19, 1942 (Rep. D-200)

Location: Homberg, adjoining Haniel coal mine to the N. W., 12 Mi. W. of the Rhine in the angle formed by the Rheinberg-Krefeld and Duisburg-Kleve Railways.

Plant Area: 3200 x 3000'

Description: Synthesis (Fischer-Tropsch)

- (a) Gas manufacture: Two watergas plants, one with 6 and one with 4 generators (with extension to 6 under way).

Two banks of coke ovens, one at 1100' with about 300 ovens, 1 at 430' with about 130 ovens (modern).

NH<sub>3</sub> and benzol, etc., recovery; possibly ethylene recovery through deep cooling, tar separation and treatment.

H<sub>2</sub>S removal of coke oven gas in 10 boxes.

H<sub>2</sub>S removal Watergas, 8 towers 45' D.

Organic Sulfur Removal, 10 towers 20' D.

- (b) Synthesis: Contact oven house 790' x 120', probably 200 ovens (2 rows at 100).

- (c) Refinery: Columns with heater houses, etc. Probably also lubeoil.

- (d) Tankage: About 11,300 Tons.

Estimated Production: About 200,000 T/Yr. with about 20% more (due to greater efficiency) as from the end of 1942.

Discussion:

The contact oven house is just about 50% longer than Ruhrbenzin's Holten Plant. It was one of the early Fischer plants; the older part operates the L.P. Process; the new part (both old and new now in one building) probably operates the H.P. Process. While we do not know whether the same relation between L.P. and H.P. ovens exists at Homberg, we feel that without too much of an error, the capacity of this plant can be estimated at 50% higher than Holten, or at 150,000 Tons for 1941 and 1942, and at 190,000 Tons for 1943.

While the H<sub>2</sub>S removal for the watergas plant appears to have about 60% more capacity than Holten, the organic sulfur removal is about the same.

LUTZKENDORF

Company: Wintershall A.G. (formerly operated by its subsidiary Mitteldutsche Treibstoff und Oelwerke A.G.)

Date Coverage: April 17, 1942 (Reports D-89 and D-177)

Location: Between villages of Grumpa and Geisel Roelitz, immediately S. of railway Herschburg-Stoebnitz, connected with conveyor with S. end of Lutzkendorf Grube.

Plant Area: 1 Mi. x 1740'.

Description: Both Hydrogenation and Synthesis (Fischer Tropsch).

(a) Power Plant: Boiler House 400' x 70', built in two parts, 330' old part, 70' new part.  
Generator house 400' x 20' (or 200 x 40?)  
Fuel probably brown coal briquettes.  
Works also draw electricity from Grosskayna power station.

(b) Fischer-Tropsch:

(i) Gas manufacture: 4 Winkler generators at 100 x 100' or Baring pattern.  
2 gasholders and probably one more building.

(ii) Two contact oven houses, 306' x 80' and 415' x 80', houses being some 350' apart, which may be used for extension.  
Five towers.

(c) Hydrogenation:

(i) Gas manufacturing: H<sub>2</sub> drawn from Winkler generators mentioned above. H<sub>2</sub> storage 100' D. Compressor House 190' x 70'.

(ii) Hydrogenation Proper:  
One pair of stalls, stall size 36' x 27'.  
Reaction vessels 40' - 50' long, 5' D. suggesting 700 ats.

(d) Refinery:  
Two furnace houses, 2 columns for distillation and stabilization. May include lubeoil production facilities, also iso-octane.

Luetzkendorf (Contd.)

- (c) Tankage: Tankage is enormous. Apart from sizeable tankage in other parts of the works there is about 75,000 T. tank farm on N. side of hydroplant.

Estimated Capacity:

Fischer Tropsch part:	100,000-200,000 T/Yr.
Hydro part (on LTC tar):	<u>125,000 T/Yr.</u>
Total	225,000 -325,000

Discussion:

There are many anomalies in the plant that make any estimate of the capacity highly speculative. Balancing all factors, our estimate of the capacity is as follows:

Fischer-Tropsch	150,000
Hydrogenation	125,000*

\*The hydro products are believed to be mostly lubeoil and diesel oil.

SCHWARZEIDE

Company: Brabag

Date Coverage: April 17, 1942 (Rep. D-88)

Location: 1-1/4 Mi. N. of Ruhland, 1 Mi. N. of the Schwarze Alster, W. of railway from Dresden to Cottbus and 6 Mi. N. of Kueckenberg. New autobahn runs along N.W. side of plant. Has branch canal to Schwarze Alster.

Plant Area: 5100' x 3000'

Description: 2 complete F.T. units, oil refinery and catalyst plant.

- (a) Raw Material: Brown coal briquettes from neighboring plants at mines Lauchhammer, Zschornegorda Sued and Victoria III.
- (b) Power Plant: Boilerhouse 230' x 75' with a 100' foot extension under construction.  
Generator hall 115' x 115'.
- (c) Gas manufacture:
  - (i) Old Plant: 1 Wintershall Schmalfeldt generator for production gas directly from brown coal (probably no longer in use because of unsatisfactory performance.)  
A gas plant of unidentified type of 350' x 50' with 2 gasholders at D 110' (probably not in use.)  
2 Koppers generators using briquettes with 2 gas holders D. 110'.  
H<sub>2</sub>S removal, 8 towers D. 38'.  
Org. S. " 12 " D. 15'.
  - (ii) New Plant: 4 Koppers generators (with 1 or 2 more under construction).  
4 Gasholders; 1 at D. 70', 1 at D. 123', and 2 at D. 75'.  
H<sub>2</sub>S removal, 8 towers D. 38'  
Organic S. removal, 12 towers at D. 15' with 2 more under construction.

## Schwartzheide (Contd.)

### Old Plant.

This plant is 700' long and we would roughly estimate that it contains two rows of 70 ovens, in total, therefore, 140 ovens. On the basis of an average production of 750 T/Yr. per oven, this would correspond to a capacity of about 100,000 tons of primary product per year.

### New Plant

The ovens at Schwartzheide have only  $2/3$  of the diameter of the standard type of medium pressure ovens and, assuming that their capacity would be proportionate to their cross-sections, they would have only about 45% of the capacity of the standard ovens, as used at Holten, or say 540 tons of primary product per year per oven.

The 480 ovens would represent on this basis an annual capacity of about 250,000 tons of primary product per annum, and the total Schwartzheide capacity would be 350,000 T/Yr. We have at present no data on the capacity of the Koppers units installed at the Schwartzheide Plant which would enable us to make a cross check of the above on the basis of the amount of water gas produced. However, the sulfur purification equipment forms an important step in the synthesis gas manufacture and, if anything, may be expected to be greater per cubic meter of synthesis gas in the case of brown coal than in the case of hard coal.

A comparison of the sulfur purification equipment of Holten with that of Schwartzheide gives the following picture.

	<u>Holten</u>	<u>Schwartzheide</u>
H <sub>2</sub> S Removal	8 towers of 36' D.	Old Plant - 8 towers 38' D. New Plant - 8 towers 38' D.
Ratio	1	: 2.3
Organic Sulfur Removal	12 towers of 18' D.	Old Plant - 12 towers of 15' D. New Plant - 12 towers of 15' D. with two more building,
Ratio	1	: 1.5 (incl. 2 under constr)

On the basis of the gas purification equipment, therefore, the capacity of Schwartzheide would be only about double that of Holten, or say 250,000 T/Yr. We believe, therefore, that the capacity of Schwartzheide lies somewhere between 250,000 T/Yr. and 350,000 T/Yr., and have tentatively put it down at the arbitrary figure of 300,000 T/Yr. for 1943 and revised our 1941 and 1942 estimates to 200,000 tons and 250,000 tons respectively.

## Schwartzheide (Contd.)

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DESHO"ITZ

Company: Schaffgotsch Benzin G.m.b.H.  
Date Coverage: Oct. 6, 1942 (Rep. D-175)  
Location: 5 Mi. N. of Cosel  
Plant Area: 5,150' x 2,150'  
Description: Hydrocarbon Synthesis (Fischer-Tropsch) at medium pressures.

- (a) Power Plant: 1 boiler house 286' x 195'.  
Generator halls, 1 at 85 x 45' and 1 at 85 x 70'.
- (b) Coke Oven Plant: About 190 ovens.  
By-product plant includes NH<sub>3</sub> separation, benzol plant. (tank 40' D. and 16 tanks, total 2,000 Tons, for final benzol fraction storage), tar pitch treatment and fractionation.
- (c) Gas manufacture: Watergas plant 205 x 98' being extended to length of 420' and possible more.  
29 gasholders 85' D.  
H<sub>2</sub>S removal 98 x 90' with 4 towers 34' D.  
Organic Sulfur Removal 210 x 65', 6 towers 13' D.  
Compressor House, 210 x 117'.
- (d) Synthesis: Contact oven house of open type 143 x 70' "until recently", being extended to 285'.  
Older section had 48 ovens 9'D., 10 more have been added with total room for about 90.
- (e) Refinery: Fractionating and stabilization columns. May also include luboil manufacture. Probably no cracking unit.
- (f) Tankage: Two groups of tanks, totaling 3,400 T. (more tankage in Cosel whence oil is conveyed by pipeline).

Discussion:

We concur with the British estimate of 60,000 T/Yr. for 1942 and 110,000 T/Yr. for 1943 -upon completion of all 90 ovens which however will not be the case till perhaps July 1st 1943. For the first half of 1943 the plant may be operating at an estimated annual rate of 70,000 T/Yr.