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ITEM NO. 30

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SYNTHETIC LUBRICATING OIL PLANT RHEINPREUSSEN, HOMBERG

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COMBINED INTELLIGENCE OBJECTIVES

SUB-COMMITTEE

CONFIDENTIAL

REPORT ON INVESTIGATION OF SYNTHETIC LUBRICATING OIL PLANT RHEINPREUSSEN, HOMBERG

Reported by:

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on behalf of the

U. S. Technical Industrial Intelligence Committee

CIOS Target Number 30/5.05
Fuels and Lubricants

15 May 1945

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

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PERSONNEL OF INVESTIGATING TEAM:

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SUMMARY

A synthetic lubricating oil plant and laboratory at Schacht I of Rheinpreussen, south-east of Homberg, was inspected on 9th March, 1945. The informant here was Dr. Albert Meusel who had worked with Franz Fischer at Mulheim from 1935 to 1939 and then went to Rheinpreussen Schacht V. Moers, where he developed the process which he later put into operation at Homberg. The Homberg laboratory and plant were built in 1942. All laboratory records and technical personnel, except Dr. Meusel, were moved to Stieppel, near Bochum, about 1st March, 1945.

For the lubricating oil synthesis, Fischer-Tropsch middle oil, boiling range 250-350°C. is chlorinated at 80-100°C. to the extent of 20-25% chlorine by weight. Five volumes of chlorinated oil are reacted with 2 volumes of naphthalene at 70-100°C. in the presence of 8 volumes of Fischer-Tropsch benzin and a small amount of $AlCl_3$ as catalyst. The sludge is withdrawn, the oil is neutralized with lime and bleaching earth, filtered and stripped free of benzin. Subsequent vacuum distillation yields spindle oil and turbine oil overhead, and cylinder stock as bottoms. The fractions are used as such, and are also blended to make motor oils. All products were stated to have a high viscosity index and great resistance to oxidation, but tests on captured samples do not support these claims.

The Homberg lubricating oil plant had a capacity of ten tons per day and operated until about October 1944, when middle oil from Moers was no longer available. Research on grease manufacture was also conducted in the Homberg laboratory and equipment for commercial production was installed in one of the old buildings at Schacht I. No significant information could be obtained about the nature of this work and large scale production was realized for only a couple of months in 1944.

The Homberg plant was never bombed before 5th March, 1945, when three bombs fell, perhaps accidentally from a German plane, causing only slight damage.

1. PLANT AND PERSONNEL

A letter in the files of the Rheinpreussen plant at Moers revealed the existence of a synthetic lubricating oil plant at Homberg which was inspected on 9 March,1945. This was located in the Rheinpreussen plant identified as "Schacht I". In this plant Dr. Albert Meusel, a chemist, was found, and his superior, Herr Emil Kuppers, "Direktor des Steinkohlen Bergwerke Rheinpreussen, der Gewerkschaft Rhineland und der Gewerkschaft Neumuhl." Herr Kuppers, who is not a technical man,explained that the coal in Mines I, II and III, all at the plant which we were visiting, had been exhausted many years ago and the coke ovens had been dismantled. Several of the old buildings are used as repair shops for other Rheinpreussen plants. Mine IV with its coke ovens,between Homberg and Moers, was stated to be in operation currently but without any synthesis or research operations. Mine VI,northwest of Moers, was also stated to have coke ovens only, which were presumably in operation.

Dr.Meusel is a chemist with degrees from Gottingen, Munster and Marburg. He worked with Franz Fischer at the Kohlenforschungs Institute (Mulheim) from 1935 to 1939 when he went to the Moers (Schacht V) plant of Rheinpreussen. There he claims he developed the synthetic lubricating oil process for which the plant was subsequently erected and operated at Homberg. However, Dr. Meusel also stated that this process was similar to that developed by Standard of New Jersey for making Paraflow, so there is some uncertainty about the degree of novelty in his process. Dr. Meusel stated that the General Director of Rheinpreussen, Heinrich Kost (previously arrested by C.I.C. near Moers) had instructed one man from each department to remain in the plant to "hinder" damaging of the plants by the Americans, and apparently Dr. Meusel and Herr Kuppers were designated for this purpose at Homberg.

Dr.Meusel stated that lubricating oil research had been under the direction of a Dr. Kolbel who, with all of his chemists and records, had been moved to Stieppel, near Bochum, about a week before our visit. Research on greases had been under the direction of Dr. Ullmann,who

had also moved to Stieppel. Dr. Meusel stated that about 4 chemists and 8 assistants were previously engaged in research on Fischer-Tropsch and lubricating oil synthesis in a laboratory at Stieppel. In addition, 5 chemists and 8 assistants had been sent to Stieppel. A new lube oil manufacturing plant had been planned for Stieppel but Dr. Meusel thought that a different location had been chosen recently.

In the southwest corner of the Rheinpreussen plant (Schacht I) at Homberg new buildings to accommodate the laboratories and the lube oil synthesis plant had been erected in 1942. The laboratory is shown in Figure I (looking SE) and the lube oil plant in Figure II (looking W). Figure III (looking NW) shows a corner of the lube oil plant on the left and corner of the laboratory on the right with one of the old buildings in the middle background in which the grease making equipment was housed. A closer view of the latter building is shown in Figure IV, looking N.

The laboratory building is arranged with private offices and laboratories along the side shown in Figure I and a large general laboratory occupying the remainder of the ground floor. The basement is devoted to utility services and stock and sample storage. The stocks of glassware and chemicals seemed quite large. There were several shelves filled with product samples, some obviously of a research nature, which would provide a basis for much further questioning of Dr. Meusel. No laboratory records of any kind were found in this building.

2. LUBRICATING OIL SYNTHESIS

The lubricating oil synthesis consists broadly in chlorinating a Fischer-Tropsch middle oil, reacting this with naphthalene in the presence of aluminum chloride as a catalyst, separating the sludge, neutralising, and fractionally distilling the lube oil product.

(a) Chlorination

The oil to be chlorinated is identified as heavy Kogasin and has a boiling range of 250 to 350°C,which was stated not to be critical and for which it was not necessary to fractionate sharply. Chlorination is

accomplished batchwise in an unpacked tower about 1 meter in diameter and 10 meters high, located in the tall (south) end of the building. The tower is made of cast iron and lined with enamel which combination of materials is used for practically all vessels handling oil and HCl. Circulating pumps in similar service are all-porcelain, made by Hescho of Hermsdorf, Thuringia. Connecting lines are of cast iron unlined. During chlorination oil is circulated at the rate of 20 m3/hr downward through the tower with a cooler in the circulating line to hold the temperature at 80 to 100°C. Chlorine is admitted at the bottom of the tower through a single pipe with no special means for distribution. Each charge of oil consists of 2.5 to 3.0 cu.meters and is brought to reaction temperature by a steam preheater. Chlorination is continued until the chlorine content reaches 20 to 25% by weight which requires 3 to 4 hours. Specific gravity is used as a guide to degree of chlorination. A greater degree of chlorination was stated to give a higher yield of heavy lube oil, together with a somewhat poorer viscosity index.

(b) Condensation

The condensation of the chlorinated oil with naphthalene was carried out in a battery of six batch reactors each about 1.5 meters in diameter and 2.5 meters high, made of cast iron, but with only four of the six being enamel lined. It was stated that no serious corrosion of the unlined reactors had been encountered, since the HCl in the system is completely anhydrous. Each reactor has an agitator comprising two cross arms at the bottom of a vertical shaft driven at 150 - 200 RPM. The upper part of one of the reactors is shown by Figure V.

The charge to each reactor consists of 500 - 600 liters of chlorinated oil, 200 - 250 liters of naphthalene, 800 liters of heavy synthetic benzin or Diesel oil (boiling range 130 - 230°C) and either 4 Kg. of metallic aluminum or 12 - 15 Kg. of $AlCl_3$. The naphthalene is free from phenols and nitrogen bases but is not specially distilled for this use. The heavy benzin is used merely as a diluent. The condensation is accomplished at 70 to

100°C and requires 3 to 4 hours per charge. At the end of the reaction the sludge, amounting to about 100 Kg. per charge, is settled out, withdrawn and thrown away.

(c) Neutralization and Bleaching

The clear oil from two reactors at a time is drained into a similar vessel on the floor below where it is agitated for about 1 hour at 100 - 150°C with 40 - 50 Kg. of CaO and 50 kg. of bleaching earth to neutralise acidity and to improve color. The resulting suspension is passed through a plate and frame filter press at 50 - 60°C to remove solids and the effluent oil flows through a settling chamber to eliminate any suspended matter which may get through the filter press.

(d) Stripping

The clarified oil is passed to a benzin stripping column shown in the center of Figure III and also in Figure VI. Preheating and reboiling are accomplished in separate exchangers heated by hot water from a gas fired pipe still with separate coils for the two circuits. It was stated that water for the reboiler was supplied at 240 - 250°C under a pressure of 60 - 80 atm.

(e) Distillation

After benzin stripping the lubricating oil is fractionated in a series of three vacuum stills, of which the second and third are shown in part by Figures VII and VIII respectively. This distillation system was built by Lurgi and its internal construction was unknown to Dr. Meusel. The same type of still was used extensively in Germany for fractionating non-mineral oils. All three stills were maintained at the same pressure of 3-5mm absolute by a steam jet vacuum pump. The oil temperatures in the successive stages were 150 - 170°C, 180 - 190°C and 270 - 350°C. A small unmeasured amount of open steam was admitted to each still. Only the third stage had a fractionating column, this consisting of a tower about 1 meter in diameter and 3 meters high packed with Raschig rings. It was stated that 200 - 300 liters per hour of distillate were pumped back as reflux and about 200 liters per hour withdrawn as overhead product. The normal

charge rate to these stills was 1000 liters per hour and the distribution of products was reported as follows: Overhead from the first still - 150 liters per hour of Diesel oil (fuel); overhead from the second still - 150 liters per hour of spindle oil; overhead from the third still - 200 liters per hour of turbine oil; bottoms from the third still - 500 liters per hour of steam cylinder oil.

(f) Properties of oil

The properties of these fractions were given as follows:

	Spindle Oil	Turbine Oil	Cylinder Oil
Flash point	160-170°C	220°C	285°C
Viscosity	1.5 Eng.at 50°C	3.0-3.5 Eng. at 50°C	6-9 Eng. at 100°C
Pole Height	2.0 - 2.2	2.5	2.7 - 2.8

The steam cylinder oil was reported to be satisfactory for use at temperatures up to 450°C, but this seems improbable.

Dr. Meusel indicated that the oils were equivalent to Pennsylvania stocks in respect to viscosity index, but this is not borne out by the pole height values. He also believed that the oils were highly resistant to oxidation and sludge formation. He did not have any standard test data to support this contention, but offered the following data from a modification of the B.A.M. test. One hundred cc of a motor oil blend of the synthetic fractions having an Engler viscosity of 8 - 10 at 50°C was blown at 172°C with 10 liters of air per hour. The tests given below were obtained on the oil before and after blowing.

	Before blowing	After blowing
Conradson carbon.	0.5	0.6
Neutralization No.	0.00	0.1 or less.

No sludge was precipitated by dilution with benzin either before or after blowing. The oil fractions are

sometimes subjected to a second contacting with 0.5 to 1.0% of bleaching earth but this improved only the appearance.

Captured samples of the primary stocks were tested by the Petroleum Board and the results are quoted below:

	ClOS# 14 Spindle Oil	ClOS# 15 Turbine Oil	ClOS# 11 Cylinder Oil
P.B.Mech. No.	568	569	570
Sp. Gr.	0.901	0.928	0.965
Visc.100°F.c.s.	16.11	43.89	1909
Visc.210°F.c.s.	3.21	5.49	52.39
K.V.I.	53.00	49.00	61.00
Neut. Val.	< 0.05	< 0.05	< 0.05
Pour Pt.	+ 25°F	- 15°F	+ 25°F
Flash Pt. closed	340°F	395°F	525°F
Coke No (Ramsbotham)	0.17	0.24	0.11

The BAM oxidation test was run on ClOS sample 11, Mech. No. 570 with the following results:-

Ramsbotham Coke:

Before oxidation	...	1.15
After oxidation	...	4.46
Increment ...	...	3.31

Viscosity CS at 100°F.:

After oxidation	...	6520

Ratio of viscosity before and after oxidation ... 3.36

Dr. Meusel stated that motor oils were made by blending the cylinder oil and turbine oils, and include more or less spindle oil depending on flash point specifications. Typical compositions were reported to be as follows:

Winter grade: 8-9°Engler at 50°C
45% cylinder oil
47% turbine oil
8% spindle oil

Summer grade: 12° Engler at 50°C
49% cylinder oil
51% turbine oil

Captured samples of motor oils which were supposed to have the above compositions were tested by the Petroleum Board and the results are quoted below:

	CIOS# 12 6-9° Motor Oil	CIOS# 13 Summer Motor Oil
P.B.Mech. No.	571	572
Sp. Gr.	0.939	0.938
Visc. 100°F.c.s.	136.4	187.1
Visc. 210°F.c.s.	11.35	13.66
K.V.I.	70.00	67.00
Neutr. Val.	< 0.05	< 0.05
Pour Pt.	- 10°F	-20°F
Flash Pt.closed	395°F	440°F
Coke No (Ramsbotham)	0.62	0.72

The BAM oxidation test was run on CIOS#13, Mech.No. 572, with the following results:

Ramsbotham coke:
Before oxidation ... 0.72
After oxidation ... 2.45
Increment 1.73

Viscosity CS at 100°F
After oxidation ... 422.8

Ratio of viscosity before and after oxidation 2.26

(g) Plant capacity

The Homberg lube oil plant had a rated capacity of 10 tons per day and employed about 40 men and 40 women. It operated from the date of completion in 1942 or early 1943 until about October 1944 when the supply of Fischer-Tropsch middle oil from Moers was no longer

available. Dr. Meusel stated that I.G. makes lube oils from the products of destructive hydrogenation and that other Fischer-Tropsch plants synthesize lubricants by methods other than that used at Homberg. Dr. Meusel indicated that he had no knowledge of the nature of the other processes.

A record of production costs for 1943 and 1944 (Documents 17 and 29) found at the Rheinpreussen-Moers plant included production volumes and costs for the synthetic lubricating oil plant (Anlage IV) from which Table I below has been prepared. It will be seen that production averaged close to the rated capacity of 10 tons per day during most of the period of operation.

and that a large part of the total product was motor oil. The latter was apparently made to two different specifications ZdM6 and ZdM7, but the details of these specifications were not shown. However, monthly statements to "Arsyn" for 1944 characterize the lubricating oils as follows:

Oil.	Viscosity.
Spindle oil.	3.2/20
Turbine oil.	3.5/50
Motor oil Zdm 7.	9°E
Motor oil Zdm 6.	16-17°E
Steam Cylinder Oil	> 285

TABLE I.
Lubricating Oil Production
Plant IV - Tonnes.

1943	Cylinder Oil	Turbine Oil	Spindle Oil	Motor Oil	Grund Oil & Ruckol	Total
Jan.	34.230	53.870	10.770	9.100		107.970
Feb.	53.500	68.100	30.600	9.100		152.200
Mar.	33.230	17.250	37.770	67.859		155.449
Apl.	30.570	17.451	11.000	99.220		158.241
May	55.540	13.810	24.520	121.660		215.530
June	-	-	11.620	211.700	225.310	448.630
July	-	-	34.950	286.600	25.510	347.060

1943	Cylinder Oil	Turbine Oil	Spindle Oil	Motor Oil	Grund Oil & Ruckol	Total
Aug.	-	-	12.152	334.950		347.102
Sept.	-	-	16.000	429.990	73.560	519.550
Oct.	135.370	28.100	37.600	152.090		353.160
Nov.	72.260	-	18.830	193.660		284.750
Dec.	83.830	14.220	-	200.210		298.260
1943 TOTAL:						1802.822
1944						
Jan.	94.400	26.570	11.440	161.910		294.320
Feb.	64.250	-	-	227.240		291.490
Mar.	98.750	21.530	17.490	150.300		288.070
Apl.	59.140	-	7.170	272.130		338.440
May	105.360	8.300	-	226.580		340.240
June	95.450	14.590	4.430	219.080		333.550
July	65.180	14.320	5.630	86.930		172.060
Aug.	Missing					
Sept.	26.840	-	-	209.050		235.890
Oct.	6.970	7.620	-	46.800		55.390
Later records missing.						
1944 TOTAL:						2349.450

3. GREASE MANUFACTURE

In part of an old building near the new laboratory, equipment for large scale grease manufacture is installed. This construction was started in 1942 but grease production in this plant was realised only for a couple of months during 1944, after which the needs for grease were supplied by other larger manufacturers, not further specified. However, experimental work on grease manufacture was stated to have been continuous at Homberg from 1942 to about a week before our arrival. All of this work was under the direction of Dr. Ullmann, who is supposed to have gone to Stieppel.

The large scale equipment consists of two steam heated grease kettles each of about 250 gal. capacity, a

milling machine, and miscellaneous tanks. Many drums of grease of varying appearance and consistency were standing around the plant, some showing considerable oil separation, but none being identified. There were no raw materials in evidence indicative of the types of grease being made.

Dr. Meusel claimed to be entirely ignorant of the details of the grease research and manufacture but believed the soaps of oxidised paraffin were used and that the oil was sometimes synthetic and sometimes natural. In the sample storage room of the laboratory were a large number of grease samples, and a partial inspection revealed a wide variety of consistencies and colors. All samples were marked only in code and could not be identified. A single sample was picked up more or less at random, but having the appearance of an ordinary cup grease. This sample was analyzed and tested by the Petroleum Board and their report is quoted below:

Identification:	MECH. 575	
Description:	Grease, unknown type from Homberg Plant, Target No. 30/5.05.	
Appearance:	Transparent, brown coloured rather lumpy grease. (About 5 kilos).	
Physical Tests:	Melting Point, I.P.	330F.
	Penetration (unworked).	165.
	" (worked).	240.
	Heat Test (120°C. for 1 hour).	Excellent, no separation and little change in consistency.
Analysis:	Sodium Soap.	17%.
	Free Fatty Acidity.	Nil.
	Free Alkalinity.	Nil.
	Water Content.	Trace.
Characteristics of Separated Mineral Oil:	Specific Gravity.	0.948
	Viscosity at 100F.	361"S.U. 78 c.s.
	Viscosity at 210F.	49" S.U. 7.0 c.s.

Characteristics of Separated Fatty Acids:	I.V.	15
Brown, amorphous, semi-colid acids.	N_D at 18°C	1.4995

Remarked: A high melting point soda base grease of the type usually employed for ball and roller bearings. It is made from a medium bodied engine oil of low V.I. and the isolated acids are without doubt derived from wool grease. The product has the appearance of having been prepared by fusion followed by some type of homogenising.

4. GENERAL PLANT CONDITIONS

The Rheinpreussen Plant (Schact I) at Homberg had suffered no bomb damage until Monday, March 5, 1945. Then three bombs were dropped south of the synthetic lube oil plant, damaging a small HCl gas holder and absorption tower, and breaking windows throughout the lube oil plant and laboratory. There was no apparent damage to equipment inside either of these buildings. Dr. Meusel expressed the opinion that these bombs had been dropped by a German plane by mistake.

At the time of the subject inspection no troops were quartered in the plant and there were no indications that equipment or files in the plant had been molested by Allied troops.

5. RECOMMENDATIONS

Unless the following steps have already been taken by other teams, they should be considered for further exploitation of this target:

1. The files of the Rheinpreussen main office at Homberg should be searched for copies of technical documents which had been evacuated from Moers by the Germans.

2. Dr. Meusel should be interrogated at length about all of his work, both at Homberg and Moers, in addition to his previous activities with Fischer at

Mulheim.

3. Dr. Kolbel and his records should be located and his activities at Moers, Homberg, and Stieppel should be thoroughly investigated.

4. Dr. Ullmann should be located and interrogated about his work on grease at Homberg and elsewhere.

5. Laboratory and plant samples of synthetic lubricating oils, greases, and other products at Homberg should be examined carefully with parties capable of identifying and describing them all, to clear up, among other things, the apparent discrepancy between claimed and measured quality of the lubricating oils.

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