RESTRICTED.

TO: C.I.O.S. Secretariat, 32 Bryanston Square, London, W.1.

SUBJECT: Visit of CIOS Teams 551 and 551a to Oil Targets in Leuna, Schkopau, Zeitz (Tröglitz), Stassfurt, Heiligenstadt, Leverkusen, Sterkrade, Höchst and Heidelberg.

Personnel on CIOS trips 551 and 551a - 25 June-15 July 1945:

Trip 551.

Dr. W.F.Faragher, U.S. Team Leader.
Capt. C.C.Chaffee, U.S.Ord., Deputy Leader.
Lieut. R.J. Osol, U.S. Ord.
Dr. Hans Schindler, U.S.
Dr. W.A.Horne, U.S.
Mr. J.G.Allen, U.S.
Dr. G.S.Bays, U.S.
Mr. B.L. MacKusick, U.S.

Trip 551a.

Major D.A. Howes, British.

I.G.Farbenindustrie A.G., Leuna (Target 30/4.02).

Synthetic Lube Oil Manufacture.

Additional information has been obtained in the recovery of oil and related products from the aluminum-chloride complex formed in the polymerization reaction.

The $AlCl_3$ sludge obtained by centrifuging the autoclave product is treated with methanol, the oil obtained is neutralized, dried and treated again with $AlCl_3$ (at about 70°C and atmospheric pressure). The $AlCl_3$ sludge is again removed by centrifuging and the oil is neutralized, washed and distilled. The product so obtained is identified as "R" oil (Vis. at 100°C 2.5-3.0°E) and is used for less exacting lubricating purposes. The production of "R" oil amounted to about 700 tons per year.

Decomposition of the $AlCl_3$ sludge obtained in the course of the refining of "R" oil results in the formation of a drying oil used in the protective-coating industry. This product is identified as "RR" oil.

For the manufacture of SS 906, aluminum chloride containing not more than 1% iron is used, whereas in the manufacture of SS 903, aluminum chloride with an iron content of 1.0-2.5% iron is suitable.

The following samples were obtained for further study:-

SS 906 (finished oil)
Light ends from SS 906 operation
Total product from SS 906 operation
Aluminum chloride used for catalyst
"R" oil
"RR" oil
Acetylene hydrogenation catalyst used in ethylene purification.

Toluene Manufacture from Benzene and Methanol.

Development work on the manufacture of toluene from benzene and methanol was carried out at Leuna and a plant operating in accordance with this method had been erected at Waldenburg. The Waldenburg plant had initially a capacity of 40,000 tons/year, but was later enlarged to a capacity of 50,000 tons/year.

The process consists in reacting 4 mols of benzene and one mol of methanol at 350°C and 35 atm., using as catalyst zinc phosphate on kieselguhr. The space velocity is about 0.25, but is reduced with increasing age of the catalyst. The lifetime of the catalyst is 4-6 weeks, during which time a carbon deposit of 30-40% is formed. The catalyst is not regenerated and removal of the catalyst from the reactor is difficult. Attempts to regenerate the catalyst were unsuccessful. A sample of this catalyst was secured for further study.

The methanol used is freed from ammonia and amines by an organic cation exchanger. The benzene used is refined and is low in sulfur but frequently contained acetonitrile which is undesirable but could not be removed in a satisfactory way. The crude reaction product contains about 16-17% by volume toluene, 7% xylenes, 7% heavy residue, besides unreacted benzene. The amount of dimethylether is about 0.3% by volume (calculated as liquid product). The crude product was distilled by means of three columns packed with Raschig rings; the toluene was separated subsequently in a bubble tray column. The xylene fraction was obtained by means of a column packed with Raschig rings. No detailed information on the distillation equipment was available. The maximum monthly toluene production in Waldenburg was 3800 tons of nitration-grade toluene, but decreased because of raw material and transport difficulties. The amount of xylene produced was about 25-30% by wt. of that of toluene and the quantity of alkylbenzenes produced was about the same as that of xylene.

DHD and HF Processes.

Samples of DHD catalysts and additional process details missed in the earlier visits were obtained. One drum (200 liters) of 5931, the standard DHD catalyst made at Leuna, and one drum (200 liters) of 7935, a slightly different preparation made at Ludwigshafen and not yet tested on a commercial scale, were collected. Details of the preparation of 5931 were also obtained, but similar information on 7935 was not available because it was not manufactured at Leuna.

The HF process is essentially the same as the DHD process except for the fact that the former operation is carried out at lower pressures and for shorter reaction periods between regenerations. The HF catalysts are the same as the DHD catalysts, except for lower MoO_3 content. The Germans have found that the higher the paraffin content of the feed stock, the lower the operating pressure should be in order to minimize cracking of paraffins to gas. The highly naphthenic feeds from hydrogenation were dehydrogenated at about 30-40 atm. in the DHD plant. Because of the low paraffin content, and therefore of the low coke formation, an operating period of 160-200 hours between regenerations is practicable, and no automatic cycle-control equipment need be employed. For dehydrogenating crude-oil distillates of far lower naphthene content, a pressure of about 15 atm. is used. Coke yields are higher and regeneration must be more frequent. Reaction periods of only 10 hours are employed, which calls for automatic cycle controls; hence the HF process.

There is no HF plant at Leuna, but the catalyst is made there. Preparation details were obtained for 5% MoO_3 content HF catalyst, but no samples were taken because of its similarity to the 10% HF-DHD material.

Lubricants and Inhibitors.

As a result of the inspection of plant and laboratory facilities at the Ammoniakwerk Merseburg at Leuna and the interrogation of Dr. Lisa Rössig, the following information was obtained on miscellaneous lubricants and inhibitors.

Miscellaneous Lubricants included machine-gun oil, Waffenöl Blau 44; torpedo oil T-1; SS 1631, reported to be a "V" weapon oil; a special low-temperature oil used in the Russian campaign, coded K-10 and K-19; Y-axle oil, red in color; and aviation hydraulic oil, coded Do 2000. The essential characteristics of these lubes follow:

Lubricant.	Specifications.					
	Visc. °Eng.	Pour Pt. °C.	V.I.	Flash Pt.°C.	Blend Formula.	
Waffenöl Blau	1.9 at 20° C.	-	-	125	E-455 VT 120 Mesulfol-II	45% 45 10
Torpedo Oil T-1	11.5-12.5 at 20°C.	Below -50	-		E-515 KSE SS 903	63% 2 35
V weapon Oil SS 1631	2°E at 50°C.	Below -45°C	-	145°C	E-515 KSE SS 903	72% 3% 25%
Lube Oil K-10	1.65 at 99°C.	Below 50°C.	135	-	E-515 SS 903	50% 50%
Lube Oil K-19	2.0 at 99°C.	Below 45°C.	130	-	E-515 SS 903	25% 75%
Y Axle Oil	-	-49 to 58°C.	118-122	-	E-504 R-oil Dye	20% 80% 1%
Hydraulic Oil Do 2000	1.75 at 20°C. 650 at -60°C.	-70°C.	-	120°C.	E-3022 or E-3023 KSE V120 Dye	12% 4% 84% 0.006%

Inhibitors and Additives: E-455, Mesulfol II, E515, KSE, E504, E3022, and E3023. Information on these inhibitors follows:

Product	Chemical Formula.	Remarks.
E-455	$(ROOC(CH_2)_2)_2$ R is alcohol from isobutanol synthesis, BP 140-180°C.	Adipic acid ester is used in machine-gun oil in fairly large percentage.
Mesulfol II	$(R\text{-}O\text{-}C(=S)\text{-}S\text{-}CH_2)_2$ R is C_5 or C_6	The additive is used in machine-gun oil and is used as an extreme pressure additive. Addition of Mesulfol II is controlled to obtain a sulfur content of 3%, and copper test shows no discoloration after three days.
E515	$(RO\text{-}C(=O)(CH_2)_2)_2$ R is alcohol from isobutanol synthesis BP 180-250°C.	Adipic acid ester has been used in fairly large proportions in Torpedo Oil, SS K31, K-9, K-10 which are low-temperature lubes.
KSE	RSO_2NHCH_2COOR R is alcohol from isobutanol synthesis BP 180-250°C.	Additive is used as a corrosion preventive in Torpedo Oil, T-1; SS1631 and hydraulic oil. Should prove of interest as inhibitor in recoil oils.
E504	$(ROOC(CH_2)_2)_2$ R is alcohol from isobutanol BP 160-200°C.	Additive is added to R oil made from neutralized $AlCl_3$ complex, obtained in the manufacture of synthetic lube.
E3022	$ROOCCH_2CH(CH_3)$ $ROOCCH_2CH_2$ R =cyclohexyl	Used in hydraulic oil Do2000 & replaced by E3023
E3023	$(ROOC(CH_2)_2)_2$ R = m-methyl cyclohexyl.	Used in hydraulic oil Do2000

Samples were secured of the following:

E-455	E-504
Mesulfol II	E-3023
KSE	Y-Axle Oil

Rust preventive information obtained is believed to be of importance to the Ordnance Department. In addition to the above data, a number of ZWB reports were found and are listed under "Documents".

Catalysts.

More complete analyses and details of the preparation and production of catalysts made or used by the Organic Division of Ammoniakwerk-Merseburg were obtained.

	Catalyst - Leuna No.	Use.	Production Tons/Mo.
	616	Methanol synthesis from CO and H_2	30
	1132	Isobutanol synthesis from CO and H_2	60
	1750	Hydrogenation of higher alcohols. Mild hydrogenation catalyst.	1
	2493	Dehydrogenation of alcohols to aldehydes.	-
	2730	Polymerization of Isobutylenes to isooctylenes.	-
*	3076	Hydrogenation of diisobutylene to iso-octane.	1
*	3390	Strong hydrogenation catalyst, e.g. hydrogenation of phenol to cyclohexanol.	1
	3510	Production of gasoline from middle oil.	-
	4577	Production of stearyl amine from stearic acid.	8-9 kg/Mo.

Catalyst - Leuna No.	U s e.	Production Tons/Mo.
* 4788	Hydrogenation of acetylene to ethylene	-
* 4821	Polymerization of isobutylene to iso-octylene.	10
* 5058	Hydrogenation of Middle Oil to gasoline (Gas phase)	25
5233	Heavy Water - Army Secret	-
5436	Dehydrogenation and aromatization.	10
* 5623	Synthesis of toluene from benzene & methyl alcohol	150
5655	Hydroforming and dehydrogenation	-
5780	Dehydr[redacted]ation of alcohols. Basic carrier for other catalysts	100
6067	Amine synthesis	very little
6069	Catalyst for the reaction of methane and ammonia to form methyl amine	10
* 6448	Dehydrogenation of n-butane to butylene	100
6523	Conversion of phenol to cyclohexanol	-
* 6545	Heavy Water - Army Secret	-
* 6853	Arobin catalyst. Used for conversion of heavy aromatics to lighter aromatics.	
* 7187	Catalytic-cracking catalyst	100
10927	Tar & Sump-phase hydrogenation	-
26	Ammonia catalyst	

Samples of the catalysts marked with an asterisk (*) were secured for further study. In addition, samples were secured of the following catalysts not mentioned elsewhere:

Hydrogenation catalyst No. 6434	-	200 liters.
Hydrogenation catalyst No. 8376	-	800 liters.
Water Gas Shift Catalyst	-	25 liters.

Synol Process.

Additional information was obtained on the operation of this process. No satisfactory pilot-plant runs had ever been completed, due to interruptions by bombings. Previously obtained flow schemes and product distributions were based solely on small-scale bench models, extrapolated to pilot-plant scale.

A 100-liter drum of the Synol catalyst was obtained.

OXO Process.

Previously described flow schemes for this process had been attempted but proved unsatisfactory. A modified scheme as the plant was finally built and typical run data on a cracked-oil fraction were obtained.

A 100-liter drum of the OXO catalyst was obtained.

Other Samples.

The following hydrocarbon samples were secured at Leuna from processes previously discussed.

- Aviation Alkylate
- Heavy Alkylate
- Feed to Arobin Process (HF residue from Moosbierbaum)
- "TTH" (Tief-Temperatur Hydrierung) process, feed stock & products.
- Crude Isobutanol product

I.G.Farbenindustrie A.G., Schkopau, Target 30/4.02.

One liter of Kybol (all that was available), 3 one-pound samples of aluminum-chloride used in manufacturing lubricating oils SS 903 and SS 906, three drums (each 200 ltr) of SS 903, and three drums of SS 906 (each 200 ltr), were obtained. One small drum each of new and regenerated acetylene hydrogenation catalyst used in ethylene manufacture was also secured.

Inquiry was made to harmonize a discrepancy that was found in the statements made on an earlier visit concerning the production of Zahlenbuna (Buna 85). The capacity of the polymerizer with screw conveyor is 75-100 tons per month, as was stated. In the plant production summary, the total polymer sold as Zahlenbuna is likewise correct; viz., 270 tons per month. The 170 tons are Buna 32.

Completion of data on an earlier flow-sheet for the hydrogenation of acetylene to ethylene was effected.

CIOS Target No. 30/4.07, Braunkohle Benzin A.G. (Brabag IV).

Hydrogenation Plant, Troglitz near Zeitz.

The plant was visited to obtain samples of hydrogenation catalyst No. 5058 and also samples of lubricating oils previously manufactured from the brown-coal tar hydrogenation-separator product. The lube oil samples include one spindle oil obtained by distillation of the dewaxed separator residue and also a neutral oil. Raw oils were made during February and March of 1944. Lube oil manufacture is not currently practised because of bomb damage to the dewaxing and distillation plants.

It was found that 2 hydrogenation stalls with a total of 5 reactor chambers were in operation. The process used is of the low-temperature type (350-400°C) at 300 atm. and brown coal tar is charged.

Target of Opportunity CIOS Group 30, WIFO Blending Station, Stassfurt.

Several members of the team made the trip to Stassfurt, but the presence of the Russians prevented their making any investigation.

Target of Opportunity for CIOS Group 30, Wirtschaftliche Forschungsgesellschaft m.b.H. (WIFO), Heiligenstadt.

Since the MAIN DEPOT Wifo at Stassfurt, known to include a special laboratory for Rust Preventive Research, and in the underground storage, miscellaneous fuels and lubricants, as well as the records of the Central Technical Division, Berlin, could not be investigated, the smaller ARMY COMMAND DEPOT at Heiligenstadt was investigated. Information along the following lines was obtained:

1. Fuel and Lubricant specifications on the following materials handled by the Wifo were obtained:
   a) Army Delivery Motor Fuel
   b) Benzol for Motor Fuel
   c) Automotive Lubricants (Summer & Winter grades)
   d) Gear Oils (Summer and Winter grades)
   e) All purpose grease

2. Samples of all products not previously available for tests were obtained in quantities sufficient for large-scale tests. These samples include:

Motorenoil (Summer)
Nachlaufschmierstoff T 42 (rust preventive oil)
All-Purpose Grease
Gear Oil
Methanol
Glysantin (a glycerol substitute)

3. General operational information regarding the Wifo system and the present location of key personnel and offices was obtained.

I.G.Farbenindustrie A.G., Leverkusen - CIOS Target of Opportunity, Group 30.

Recoil Fluid.

The recoil fluid used regularly by the German Army (triglycol, ethylene glycol and water) was found unsuitable in the winter campaign in Russia. The addition of low molecular weight sulfonamides eliminated this difficulty since, in this way, it was possible to obtain a recoil fluid with not too high viscosity at low temperatures and still maintain the high specific gravity required for satisfactory brake action.

The sulfonamides manufactured at Leverkusen for the above purpose were the monomethylamide of methanesulfonic acid and the methylhydroxyethylamide of methanesulfonic acid.

Additive for Break-in Oil.

Product 891, dichlorodiphenylphosphorous acid, has been manufactured at Leverkusen as an additive for break-in oil for aircraft engines. To increase the solubility in oil, the compound is used in the form of its stearylamine salt; and to further increase ease of handling, the additive was distributed as a solution in alcohol-benzol (50:50). The solution which contains 50% by weight of the stearylamine salt of Product 891 was termed J7, and samples were secured for further study. The break-in oil for aircraft engines consisted of Rotring oil (Red Band) with 2% by weight of J7. By use of the additive, it was possible to reduce the break-in time of German aircraft engines from 70 hours to 20 hours and to eliminate rejects.

Synthetic Lubricating Oil from Tetrahydrofuran.

Synthetic oils of good viscosity index, but poor thermal stability have been prepared at Leverkusen by copolymerization of tetrahydrofuran and ethylene oxide in the presence of $FeCl_3$ and $SOCl_2$. Engine tests with an oil of a viscosity of about 83 SUS at 210°F resulted in ring sticking after short running time, and indicated that the piston was not properly lubricated, probably because of decomposition of the lubricant. The synthetic oil is not miscible with petroleum oil. The product has been used as gear oil and for the lubrication of machinery operating below 280°C. Production of the synthetic oil was irregular and on a small scale, not exceeding 1-2 tons per month.

Samples of this synthetic oil (called M-620) were secured for further study.

CIOS Target No. 30/5.01, Ruhrchemie A.G., Sterkrade-Holten.

Synthetic Lubricating Oil Manufacture.

Automotive lube oil of a viscosity of 6-8°E at 50°C was manufactured at the Ruhrchemie plant by polymerizing olefins in the gasoline-boiling range, using $AlCl_3$ as catalyst. The olefins were obtained by separately cracking Fischer-Tropsch gas oil and "Sweat oil" from the manufacture of wax from Fischer-Tropsch material. Cracking was carried out in a Dubbs unit with steam injection between furnace outlet and reaction chamber inlet. The plant had a design capacity of 1000 tons of oil/month, but due to good operational practices, produced 1500 tons/month.

Development work on the manufacture of aviation-grade brightstock led to the design of a plant, the construction of which was begun in 1943. Due to the air attacks, the equipment was moved to Willingen near Kassel, where the plant was to be erected underground. However, this was not accomplished. The brightstock was to have a viscosity of 38°E at 50°C and should have a higher V.I and better oxidation resistance than the automotive lube oil. This was to be accomplished by polymerizing only olefins in the range C_9 to C_{18} and incorporating an inhibitor (phenthiazin) into the olefin feed stock. The plant was designed for a capacity of about 1000 tons of finished oil per month.

Manufacture of Toluene.

Ruhrchemie developed a process to convert n-heptane to toluene by using a Cr_2O_3-Al_2O_3 catalyst. The reaction takes place at 480-530°C, and no external heating is required for the reactor, since the heat of reaction from the regeneration step is sufficient for the aromatization step. The cycle time planned for the full-scale plant was 60 minutes. Regeneration of the catalyst comprises two steps, viz., 1) burning off the carbon formed during the reaction, 2) reduction of six-valent Cr to three-valent Cr by means of hydrogen liberated during the conversion process. Catalyst life is said to be at least 2 years.

The yield of liquid product amounts to 90-92% by wt. of the feed and the toluene content of the liquid product is 50% by wt.

Development work on the process was finished in October 1944 and a plant for the production of 24,000 tons of toluene per year was designed. Plant construction was abandoned, however, on order of the German government when the plant was about 20% complete.

Miscellaneous.

Supplementary data on the oxidation of high melting wax to high mol. wt. acids (H_2SO_4 and gas stream from the NH_3 oxidation unit) was obtained.

A description of the laboratory method for determining the activity of catalysts was obtained.

Production of high molecular weight alcohols from wax was found not to be a direct operation, but rather only a laboratory reduction by usual methods of the acids made from high-melting wax.

A description and flow sheet of the methanization of coke-oven gas was obtained.

In order to preserve for a later team samples that were still in the plant, arrangements were made with Prof. Fritz Martin to have the samples collected and packaged. For identification, the packages were to be marked "Trip 551". Samples requested were:

Sample.	Quantity.
Catalytic Cracking Catalyst (Granosil, an activated clay obtained from Bleichton-Gesellschaft, m.b.H., Roman Mayr-Haus, München 2).	1 200-liter drum.
Fe-Cu on kieselguhr catalyst for operation at 220°C.	all available up to 1 200-L. drum.
Ni catalyst for methanization of coke-oven gas.	all available up to 1 200-l. drum.
Cr_2O_3 - Al_2O_3 catalyst for cyclizing nC_7 etc.	Up to 1 200-liter drum.
Cobalt Catalyst.	3 tons.
Feinreinigungsmasse	1 200-liter drum.

No samples of products from Co catalyst operation were available at the plant or in any of the Ausweichslager.

I.G.Farbenindustrie, Höchst - CIOS 22/1g. Target of Opportunity for Group 30.

I.G.Farbenindustrie, Höchst, was visited by a detachment from CIOS party 551 on 9 July to obtain further information on synthetic additives used in cutting and metal-drawing oils. In addition to development and manufacturing information already available from previous visits on Höchst compounds of this type, the following additional information and samples were obtained:

1) - The Metal-Drawing Oil, Säure E, is MEPASIN sulfamido acetic acid, which is obtained by acetone extraction of the unreacted MEPASIN from Bohrmittel H[illegible]. A 1-1.5% water

suspension of the acid (pH=4) is used as the drawing agent.

This material has been used with partial success on non-bonderized metals and was being considered as a substitute for the soap solution previously used in the final drawing process.

Plant-scale tests have been made on the drawing of bonderized metals, starting with the metal discs. Full-scale production tests were also made on the final draw of 3.7 cm. steel shells. The tests were only partly successful and no definite conclusion on the efficiency of the material can be drawn at present. The difficulties encountered when working with Säure E included the following points:

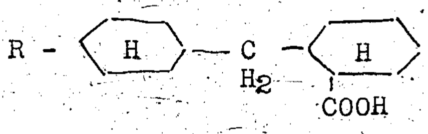
a) Material treated with Säure E must be drawn immediately since the effective film tends to shrink, thereby leaving some metal areas uncovered;

b) The solution of Säure E causes reddening and peeling of the skin.

According to the limited experience gained, it seemed to be possible to overcome these difficulties by adjusting the pH of the working solution to values between 5 and 7. This was done by the addition of zincate solution (sufficient to neutralize one-half of the Säure E used) to a 0.5% solution of Säure E.

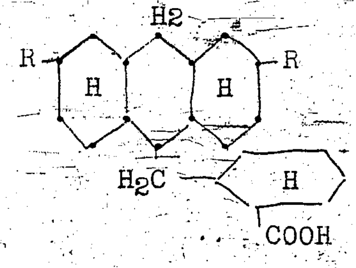
Better results without the above-mentioned disadvantages are expected from the use of isopropylcyclohexyl butyric acid which can be used in form of its Na salt and in exactly the same way as the usual soap. No production-scale tests on this material have been made, but laboratory tests indicate that it is about 5 times as efficient (calculated from the amount of chemical required for covering the metal surface) as the usual soap solution.

2) The raw material for the emulsifying agents made at Höchst was KOGASIN II from Fischer-Tropsch synthesis. In order to be less dependent upon this source of material, a research program was in progress along the lines of condensing alkyl benzene or anthracene with phthalic anhydride in the presence of $AlCl_3$, and then hydrogenating this type of compound. The chemical structure of the compound from ALKYL benzene was of the type -



where R is C_3-C_8

The compound from anthracene had the formula:



Where ~~R is H~~ R is C_3-C_8, for proposed future preparations.

Laboratory-scale work on the preparation of these compounds was under way and no conclusions as to the properties of these compounds as additives was available.

3) - A drum sample of Bohrmittel H has been secured for test, either as a cutting oil, as a gasoline additive, or in the extracted-acid form as a metal-drawing oil.

<u>CIOS Target 30/4.03 - I.G.Farbenindustrie, Ludwigshafen, (Heidelberg).</u>

An interrogation of Pier and his staff was made at Heidelberg for the purpose of obtaining additional information on the subject of hydrogenation catalyst composition and preparation. A complete list of these catalysts and details of their preparation were obtained. This is summarized below.

War research in the hydrogenation field had consisted largely in development of the Arobin Process, DHD Process, double DHD Process for toluene production, and a process to obtain higher isoparaffin content fuels from bituminous coal middle oil by a prehydrogenation over catalyst 7360 to remove oxygen compounds and reduce the nitrogen compounds to amines which were then washed out with dilute sulfuric acid, followed by a hydrogenation cracking over hydrogenfluoride-treated clay.

Catalyst No.	Use.
3510	Aromatization and hydrogenation.
5058	Prehydrogenation and TTH.
6434	Hydrogenation of middle oil.
8376 (-7846_{W250})	General hydrogenation.

Catalyst No.	Use.
7846	Prehydrogenation catalyst (replaced by 8376)
5615 (=6718)	Dehydrogenation of gasoline, hydrogenation of di-isobutylene, reduction of higher alcohols.
7019	Aromatization.
7360	Dehydrogenation.
7965	Dehydrogenation.
-	Methane-splitting catalyst.
-	Water-gas shift catalyst.
-	Grude-molybdenum catalyst (Liq. phase hydrogenation).
10927	Grude-Iron catalyst. (Liq. phase hydrogenation).
6448	Butane-Dehydrogenation.
6752	Catalytic Cracking.

Samples and Documents.

A total of approximately ten tons of samples of oil and catalyst were secured on this trip. These samples were delivered to the "Toot Sweet" railhead at Mainz, packed and labelled for shipment to the U.K. and U.S. as shown in the attached list. A detailed list of samples is attached. The further transport of these samples from Mainz is being arranged by the Ordnance Department through Captain Chaffee.

There are also attached lists of documents secured from I.G. at Leuna and from Ruhrchemie at Sterkrade. These latter documents were secured at Nuttlar where they had been stored.

DETAILED SAMPLE LIST
CIOS Trips 551 and 551a.

As a result of CIOS Trips 551 and 551a, the following samples were collected for distribution to the indicated agencies:

Number.	Description.	Quantity.	To.
1.	Aviation Alkylate ET 120 (line)	100 L	TIIC
2.	Aviation Alkylate ET 120 (storage)	100 L	TIIC
3.	Arobin Feed (HF bottoms)	200 L	TIIC
4.	Light ends from SS 906, Leuna	200 L	TIIC
5.	SS 906 Leuna	200 L	TIIC
6.	SS 903 Schkopau	200 L	Ordnance
7.	Y Axle Oil (dyed red)	200 L	Ord. TIIC
8.	Ester Oil - 504 (Adipate)	200 L	Ord. TIIC
9.	Iso-octane Hydro.Cat (used) 3076?	100 L	TIIC
10.	Acetylene Hydro Cat - S (regn)	24 Kg.	TIIC
11.	Arobin Cat (used 3 Mo) ½ full 6853	200 L	TIIC
12.	Acetylene Hydro.Cat. S, New	24 Kg.	TIIC
13.	SS 903 Schkopau	200 L	Br.
14.	SS 903 Schkopau	200 L	TIIC
15.	SS 906 Schkopau	200 L	Br
16.	SS 906 Schkopau	200 L	TIIC
17.	Isobutanol Cat. No.1132 ?	100 L	TIIC
18.	Isobutanol Cat.	100 L	TIIC
19.	Toluene Cat. No. 5623	200 L	TIIC
20.	Acetylene Hydro.Cat., Leuna, 4788	100 L	TIIC
21.	Kybol - Schkopau, Glass	1 L box	TIIC
22.	$AlCl_3$, Schkopau, 3 one-pnd. samples	1 box	TIIC
23.	Synol Cat.	100 L	TIIC
24.	Oxo Cat.	100 L	TIIC
25.	Ester Oil No. 504	200 L	Br.
26.	Y Axle oil	200 L	Br.
27.	Spindle oil - Zeitz (Box)	2 L	TIIC
28.	Lube Oil Zeitz	2 L	TIIC
29.	SS 906 Schkopau	200 L	Ord.
30.	Hydro Cat No. 5058, Zeitz	100 L	TIIC
31.	" " " "	100 L	TIIC
32.	" " " "	100 L	TIIC
33.	" " " "	100 L	TIIC
34.	Isobutylene Poly.Cat.4821 Schkölen	100 L	TIIC
35.	" " " " "	100 L	TIIC
36.	Cat.Cracking Cat. No.7187 Schkölen	200 L	TIIC
37.	" " " " "	200 L	TIIC
38.	Heavy alkylate - Leuna	2 L	TIIC
39.	Hydro Cat. No. 8376	200 L	TIIC
40.	Hydro Cat. No. 8376	200 L	TIIC

Number.	Description.	Quantity.	To.
41.	Hydro Cat. No. 8376	200 L	TIIC
42.	" " " "	200 L	TIIC
43.	" " " 6434	200 L	TIIC
44.	DHD catalyst No. 5931	200 L	TIIC
45.	" " " 7935	200 L	TIIC
46.	Distillation feed TTH (Leuna) I	200 L	TIIC
47.	Charge to TTH (Leuna) II	200 L	TIIC
48.	Gasoline from TTH (Leuna) III	200 L	TIIC
49.	Diesel Oil TTH (Leuna) IV	200 L	TIIC
50.	Crude Isobutanol "	200 L	TIIC
51.	Light Syn.Lub.Oil 120°C Fl.	200 L	Br.
52.	Light Syn.Lub.Oil 170°C Fl.	200 L	Ord.
53.	KSE Blending Agent (packed wi 56 & 58)	1 L (box)	Br.
54.	" " " (" 55 & 57)	1 L (box)	Ord.-TIIC.
55.	Mesulfol II	1 L	Br.
56.	Mesulfol II	1 L	Ord-TIIC
57.	Inhibitor "R"	1 L	Br.
58.	Inhibitor "R"	1 L	Ord-TIIC
59.	$AlCl_3$ - C_2H_4 Poly. - Leuna	2 lbs	TIIC
60.	"RR" oil - Leuna box	1 L	Br.
61.	" " " "	1 L	Ord-TIIC
62.	$AlCl_3$-C_4 Isom.-Leuna (packed w.59)	2 lbs	TIIC
63.	Total Product SS 906-Leuna operation	2 Gal.	TIIC
64.	"R" Oil 145, can	5 L	Br.
65.	" " "	5 L	Ord-TIIC
66.	" 175 "	5 L	Ord-TIIC
67.	" " "	5 L	Br.
68.	N-Butane Dehydro.Cat. No. 6448	100 L	TIIC
69.	" " " "	100 L	TIIC
70.	Hydro Catalyst No. 3390	25 L	TIIC
71.	Water gas shift catalyst	25 L	TIIC
72.	Hydro catalyst No. 6545	100 ml.	TIIC
73.	" " " 1750	25 L	TIIC
74.	Inhibitor "R"	50 L	Ord.
75.	" "	50 L	Br.
76.	" "	50 L	TIIC
77.	Ester Oil E 455, can	2 Gal	Br.
78.	" " " "	100 L	Ord-TIIC
79.	" " 3023, can	2 Gal.	Br.
80.	" " " "	100 L	Ord-TIIC

The above samples were all secured from Leuna, except where noted. The following samples were secured from the WIFO Blending Station at Heiligenstadt:

81.	Fl. Nachlaufschmierstoff T42	50 L	TIIC

Number.	Description.		Quantity.	To.
82.	Fl. Nachlaufschmierstoff T42		50 L	Ordn.
83.	" "		50 L	Brit.
84.	" "		50 L	Br.
85.	Gear Oil, can		5 Gal.	Br.
86.	" " "		5 Gal.	Ord-TIIC
87.	Summer Motor Oil (10 1 lit.cartons)		2 Gal.	Ord-TIIC
88.	" " " " " "		2 Gal.	Br.
89.	Glysantin	in box with 87 & 103	1 Qt.	Ord-TIIC
90.	"		1 Qt.	Ord-TIIC
91.	Abschmierfett TL 6014B		1 Gal.	Ord-TIIC
92.	Methanol Anti-freeze		1 Qt.	Ord-TIIC
93.	" " "		1 Qt.	Ord-TIIC
94.	Glysantin	in box with 88	1 Qt.	Br.
95.	"		1 Qt.	Br.
96.	Abschmierfett TL 6014B		1 Gal.	Br.
97.	Methanol Anti-freeze		1 Qt.	Br.
98.	" " "		1 Qt.	Br.

Underlined destination indicates labeling - other party also interested. Nos. 21, 27, 28, 38, 59, 62, 70, 72 and 73 are all packed in one box.

Samples from Leverkusen

99.	Product J.7		2 Kg.	(Glass)-Box	Br.
100.	" "		2 Kg.	(Glass)	TIIC
101.	Product M-620	(Packed with 99)	$\frac{1}{2}$ lb.		Br.
102.	" "	(Packed with 100)	$\frac{1}{2}$ lb.		TIIC
103.	" "	(Packed with 87)	$\frac{1}{2}$ lb.		Ord.

DOCUMENTS SECURED FROM I.G.,LEUNA.
CIOS Trips 551 & 551a.

Reports from Zentrale für Wissenschaftliches Berichtswesen der Luftfahrtforschung des Generalluftzeugmeisters (ZWH).

1. No. 1722 Beeinflussung der Klopfgrenzkurve von aromatenhaltigen Kraftstoffen durch verschiedene Öle.
2. No. 893/2 Das Siedenverhalten von Flugmotorenkraftstoffen.
3. No. 689 Verhalten von Kraftstoffen in SG-Behältern.
4. No. 893/3 Rückstandsbildung von bleihaltigen Kraftstoffen.
5. No. 690 Beschreibung der russischen Flugmotoren "AM 35" und "AM 38".
6. No. 1150 Klopfmessung mit dem DVL-Verfahren der Druckbeschleunigung.
7. No. 1382 Prüfung von Laboratoriumsverfahren zur Bestimmung des Bleigehaltes in Kraftstoffen.
8. No. 1327 Über Laboratoriums- und Motorverfahren zur Prüfung der Klopffestigkeit von Otto-Kraftstoffen.
9. No.523/7 Einfluss der Triebwerksgestaltung und der Betriebsbedingungen auf das Klopfverhalten von Kraftstoffen. 7. Teilbericht.
10. No. 688 Einfluss des Bleigehalts von Kraftstoffen auf Bauteile von Flugmorotren (2 copies).
11. No.1053 Regelung von Zustandsgrössen, insbesondere von Gastemperaturen am Ende langerer Rohrleitungen, 1. Teilbericht.
12. No. 695 Messung der Kolbentemperatur am laufenden Motor.
13. No.523/5 Einfluss der Triebswerksgestaltung und der Betriebsbedingungen auf das Klopfverhalten von Kraftstoffen. 5. Teilbericht: Versuche am BMV VI-Einzylinder-Motor, Reihe 9 mit Vergaserbetrieb.
14. No.1679 Der Einfluss der Betriebsbedingungen auf die Kolbentemperatur.
15. No.523/2 Einfluss der Triebwerksgestaltung und der Betriebsbedingungen auf das Klopfverhalten von Kraftstoffen. 2. Teil: Versuche am Fiat-Einzylinder-Prüfstand mit Kraftstoffeinspritzung.

Miscellaneous Reports.

16. Bericht über die Bleiempfindlichkeit von Kraftstoffen.
17. Ölprüfungs-Ringversuche im Auftrage der DVL, Heidebroek, Technische Hochschule, Dresden, 10 Januar, 1945.
18. Bericht uber die Untersuchung von 9 definierten Ölen des Ammoniakwerkes Merseburg, Öllaboratorium des Herrn Dr.H.Zorn, Heidebroek, Technische Hochschule, Dresden, 10 Februar, 1945.

DOCUMENTS SECURED FROM RUHRCHEMIE NUTTLAR, CIOS TRIP 551 & 551A.

A. Reports by Institute for Automotive Research carried out at request of German Ministry of Transportation:

1. Efficiency and Economics of Gas-Driven Vehicles. HEFT 3.

2. (i) Investigations on Automotive Diesels
   (ii) Fresh Oil Lubrication of Main Bearings
   (iii) Investigation of Radiation in Combustion space of high speed Diesel engine. HEFT 4.

3. Research om the combustion process in high speed Diesels. HEFT 5.

4. Cylinder and Piston Ring wear. HEFT 29.

5. Measurement of knock ratings in Otto engines HEFT 31.

6. Determination of knock noise in Otto engines by electro-acoustic instruments. HEFT 33.

7. Mechanical losses in high speed Diesel engines HEFT 34.

8. Comparison of Bearing metals HEFT 52.

9. (i) Injection of fuel into Diesel engines
   (ii) Ignition delay measurements by photocells of various wavelengths HEFT 53.

10. Determination of Lubricating Oil film strength HEFT 54.

11. Effect of fuel and engine on the starting of Diesel engines HEFT 55.

12. Mixture formation in the injection nozzle HEFT 57.

13. Lubrication of glass in the boundary region HEFT 59.

14. Operation of 2 stroke engines with liquefied gas HEFT 60.

15. Scavenger action explained on the basis of a new thoery of expansion flow HEFT 61.

16. Investigation of the suction stroke in Diesel engines HEFT 62.

17. (i) Ignition delay and rating of fuels
(ii) Ignition delay in Diesel & Otto fuels HEFT 63.

18. The effect of air flow on fuel distribution in Diesel engines HEFT 76

B. <u>Progress Reports of above Institute:</u>

19. Review of theory of mixture formation in Otto and Diesel engines.

20. Motor ratings for Diesel fuels.

21. Knocking in multi-cylinder engines.

22. Motor Testing of synthetic Otto fuels.

23. Effect of anti-freezes on metals and rubbers.

24. Status of research on 2 stroke engines.

25. Review on mixture formation and combustion in Diesel engines.

26. Bomb tests on mixture formation and combustion in gasoline injection.

27. Experiments on the use of liquefied gas for Diesel operation.

28. Experiments on a carburettor engine with auto ignition

29. Reports from a meeting on 2 stroke engines.

30. Reports on a meeting on carburettor problems.

C. <u>Miscellaneous.</u>

31. Instructions for the operation of a cathode ray oscillograph.

32. Investigations on the development of operating a mixture-fed engine by auto ignition (TH Stuttgart) (FKFS392)

33. Cold starting tests with Wehrmacht All Purpose Oil (Adam Opel).

34. Thesis - Determination of pressure characteristics of lube oils.

35. Thermal stability of gear oils (T.H.Stuttgart).

36. Knock testing of aviation gasolines in single cylinder engines (I.G.Oppau) Report 474.

37. Knock testing by the Oppau method (IG Oppau) Report 489.

38. Behavior of aviation fuels at high altitudes.

39. (i) Report on mixture formation in Otto engines on starting

(ii) Vapor pressure and starting procedure at low temperature.

40. Fuel rating with respect to vapor lock.

41. Minutes of meeting on knock testing in I.G. and CFR engines etc.

42. Memorandum on fuel problems for aviation.

43. History and uses of IG engine "k" (Diesel).

44. Determination of cetane numbers of Diesel fuels by method of Dr. Neumann.

45. Cooperative work on development of a test Diesel engine.

46. Comparison of engines for determination of cetane numbers.

47. The IG Test-Diesel.

48. Minutes of meeting on standardisation of Diesel Fuel Testing.

49. Standardisation of engine testing of Diesel fuels.

50. Sludge formation in aviation lubes.

51. Lubricating oil testing in single cylinder JUMO 205.

52. Intava Report - attempted evaluation of oil tests in the BMW engine.

53. Intava Report - Testing of aviation oils in DKW engine.

54. Gear tests at oil temperature of 150°C (T.H. stuttgart).

55. Thermal stability of gear oil Wehrmacht 8E.

56. Oil Testing with the Almen machine

57. 10 drawings from Oppau report 478 - Wear Testing Mach.

58. 3 " " " " 542 " "

59. 9 " " " " 518 " "

60. Testing of synthetic oil in Humboldt-Dentz engine.

61. Report on lubricating qualtities of oils.

62. 2 Vacuum reports on Hypoid gear oils.

63. Testing of gear oils.

64. ditto.

65. Test for the cold properties of lubricating oils.

66. Determination of minimum flow temperature of lubricating oils.

67. Cranking tests with new Wehrmacht winter oils.

68. Development of low temperatureviscosimeter.

69. Procedure for cranking tests at low temperatures.

70. Pumping of low pour lubes in engines.

71. Determination of pumpability of bunker oils.

72. ditto.

73. ditto.

74. Cold start tests with Wehrmacht All Purpose oil on BMW 2-liter engine.

75. ditto. on Maybach engine.

76. Pumpability of gear oils at low temperatures.

77. Cooperation tests on vapor lock.

78. Report on incomplete gear oil tests.

79. Investigation of increase of boiling range of carburettor fuels.

80. Addition of various EP agents to synthetic oil.

81. Tests on effect of Bright Stock on blends containing synthetic residues and distillates.

82. Oxidation resistance of aviation oil blend K2025.

83. Evaluation of lubricants by engine wear.

84. Thermal stability tests of gear oils.

85. Starting of Otto engines at low temperatures.

86. Tests on aviation oil K2015.

87. Foaming of lubricating oils.

88. Ring sticking tests on SS 1060.

89. Cracking tests on Roumanian oil.

90. Pumpability of lubricating oils at low temperture.

91. Knock testing of synthetic gasolines - reaction to equation timing.

92. Ring sticking tests on motor oil 3993.

93. Investigation of ester oil El prepared by RCH.

94. Starting of Otto engines at low temperatures.

95. Investigation of three winter oils from Ludwigshafen.

96. Investigation of regular Wehrmacht winter oil.

97. Testing of motor oil from Nerag.

98. Testing of motor oil 3698.

99. Aviation oil blend K1931.

100. Effect of Oppanol on engine wear.

101. Effect of Oppanol on behavior of engine oil.

102. Aviation oil 1979.

103. Aviation oil 3344.

104. Lubricating properties of low viscosity motor oils.

105. Effect of viscosity on oil consumption.

106. Testing of motor oil 3370.

107. Analytical tests on an ester oil from IG.

108. Ring sticking Almen tests on oil 3370.

109. Testing of experimental oil 3370.

110. Aviation oil K1951.

111. Effect of dilution of motor oils for winter operation on ring sticking.

112. Ring sticking behavior of various commercial aviation oils.

113. Procedure for development of a ring sticking aging and wear test.

114. Dilution of motor oil for winter operation.

115. Oil testing with the NSU motor.

116. Ignition value of RCH cetane.

117. Testing of 4 engine oils for ring sticking.

118. Engine testing of synthetic oils to evaluate effect of additives on ring sticking.

119. Development of ring sticking tests.

120. Engine testing of aviation oil 1929.

121. Comparison of supercharge tests in NSU and BMW engines.

122. Testing of various Wehrmacht standard oils for ring sticking in the Triumph motor.

123. Engine tests on synthetic Lube (aviation) K1880.

124. Development of an engine test for ring sticking.

125. Engine testing of synthetic aviation oil K1860.

126. Engine testing of synthetic lube oils of RCH.

127. Engine testing of synthetic lube oils of low pole height.

128. Testing some aviation oils in NSU engine.

129. Development of engine test for aviation oils in NSU 501-OSC engine.

130. Tests with fuels of varying density.

131. Comparison of SS oil with other Diesel oils with respect to nozzle coking.

132. Supercharged tests with NSU 501-OSL engine.

133. Apparatus for determination of vapor lock.

134. Evaluation of fuels for vapor lock.

135. Effect of engine condition in testing lubricating oils.

136. Tests on Opel 13-liter engine.

137. Tests with mixtures of Gas Öl and gasoline.

138. Progress report on tests with engine from Research Institute for Automotive Engines, Stuttgart.

139. Tests on Gas Oil.

140. Test to classify discrepancies in octane number determination of Ruhr Benzine Fuels.

141. Report on Results of Cooperative Knock Tests.