

ITEM No. 30
FILE No. XXVII-54

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CHEMISCHE WERKE ESSENER
STEINKOHLE A.G.
BERGKAMEN GERMANY

Hall, C. C.

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COMBINED INTELLIGENCE OBJECTIVES
SUB-COMMITTEE

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CHEMISCHE WERKE ESSENER STEINKOHLE A.G.
BERGKAMEN, NEAR KAMEN-DORTMUND, GERMANY

Inspection of Fischer-Tropsch Plant
19 & 20 April 1945.

Reported by

Dr. C.C. Hall

on behalf of

British Ministry of Fuel and Power.

CIOS TARGET No. 30/5.06

Fuels & Lubricants.

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

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Personnel of Investigating
Team:

Dr. C.C.Hall, British Ministry of Fuel & Power.
Dr. W.C.Schroeder) U.S.Department of the In-
Dr. G. von Elbe) terior, Bureau of Mines.
Dr. A.R.Powell, U.S.Petroleum Admin. for War.
Dr. E.L.Baldeschwieler, U.S. Pet.Adm. for War.

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Inspection of
Fischer-Tropsch Plant

Introduction.

The site included a large coke-oven installation in addition to the Fischer-Tropsch Plant, but this was not investigated. The entire works had been very severely damaged in the raid of September 9, 1944. Prior to that date, the works had suffered little inconvenience from air raids apart from blackout troubles. The raid of September 9 completely knocked out the plant and it had not operated since.

Personnel Interrogated.

Dr. Hermann Schwenke, Managing Director of the Co. operating the above works and also coking plant in Dortmund;

Dr. Thies, Chief Chemist.

Herr Gabriel, Works Manager.

(Dr. von Löpmann, Works Director and believed to be responsible for increasing catalyst life by careful oven-house control and improved methods of reactivation, was ill and not available, unfortunately, for interrogation)

Production & Purification of Synthesis Gas.

The syngas was prepared from coke and coke-oven gas in 12 demag water-gas sets. In the production of 1,800,000 m³/day of syngas, 800-850 tonnes of hard coke and 550,000 m³ of coke-oven gas were consumed per day. The cycle was: blast 33%, purge 2%, back run with coke-oven gas and steam 25%, up-run with steam 38%, purge 2%, total time, 3 minutes. The syngas contained CO 29%, H₂ 59%. Dust was removed by water-washing and centrifugal separators before passage to the storage holder. A booster then fed the gas to the "Grobreinigung" towers where the H₂S was reduced from ca. 2 gm/m³ to 1 gm./100 m³.

The gas then passed through active charcoal to remove resin-forming constituents which interfere with the Feinreinigung process. The plant consisted of six large absorbers containing, altogether, 80 tonnes of "Desorcx" (Lurgi) carbon. The 6 absorbers were in parallel, 5 on stream and one being steamed. The cycle was 8 hours on stream, and one hour steaming. The charcoal lasts about a year, but as this section of the plant had only been in operation for just over a year, insufficient experience was available to give a firm statement on the life. The decrease in organic sulfur content in this process had not been determined but was believed to be small. The organic sulfur in the gas was in any case a very variable figure depending on the operation of the benzol washer at the coke-ovens.

After a further boosting, the gas passed through the normal "Feinreinigung" system comprising 4 streams of 2 towers each (3 in operation) containing Ruhrchemie luxmasse - soda contact at 180-250°C. The temperature had to be raised when the organic sulfur content of the gas increased. The gas then passed through the final "Feinreinigung" tower containing 1/10th the amount of contact in the whole of the main system. The gas was not reheated before entering this final tower, and the temperature was said to be about 180°C.

The Synthesis (Fischer-Tropsch).

The contact oven house contained 124 normal type atmospheric-pressure ovens, 112-116 on stream at one time. The charge was approximately 1 tonne cobalt per oven in the form of catalyst purchased from Ruhrchemie. The ovens were divided into two stages with, normally, 2/3 rds. on Stage 1 and 1/3rd on Stage 2. The exact distribution depended on catalyst life, plant operation, etc.

The system was:- Stage 1 ovens → direct cooler → active carbon plant → booster → Stage 2 ovens → direct cooler → active carbon plant. The Stage 1 active carbon plant comprised 7 absorbers each containing 15 tonnes of carbon, 2 on stream, 1 steaming, 2 drying and 2 cooling. The Stage 2 system containing 5 similar-sized absorbers, 1 on stream, 1 steaming, 1 drying, 1 cooling and 1 in reserve.

The gas contraction in Stage 1 was 45-50% and the overall contraction 72-75%. The average yield over a year was 156-157 gm. C₂ and higher hydrocarbons/m³ ideal gas, and the maximum, 160 gm. The life of an oven-filling was 8½ months.

A freshly-charged oven was treated first at 185-190° for 24-48 hours with tail gas i.e. Stage 2 residual gas, and was then put on stream in Stage 2 at 180°C.

If the temperature tended to rise too rapidly, the oven throughput was reduced or if the gas contraction fell abnormally, the oven was treated with hydrogen. This latter was rarely necessary in Stage 2 and had never been resorted to at Bergkamen. No hard and fast rule can be laid down concerning the method of initial treatment of an oven; each must be treated according to experience.

The oven remained for 2-3 months on Stage 2 depending on the requirements of the first Stage. When transferred to Stage 1, the operating temperature will be about 190-192°C. unless a solvent extraction is carried out before the transfer in which case the temperature will be lower.

The treatment of the ovens depended on the concentration of CO + H₂ in the syngas. At Kamen where the concentration (88%) was higher than in most other plants, the catalyst had to be more carefully treated in respect to the frequency of reactivation. The reactivations were, alternately, hydrogenation at 195°C. for 24 hours and extraction with 160-220°C. benzine at 120-150°C. with the oven isolated from the gas system. The benzine was distilled and the distillate cooled and returned to the top of the oven in a continuous cycle until the extract leaving the bottom of the oven no longer contained wax. The whole process of cooling down the oven, extracting and restarting occupied 1 to 1½ days.

After three months* in Stage 1, it was stated, a hydrogenation treatment was carried out; then, after 3-4 weeks, a solvent extraction. After a shorter period, a hydrogen

*/Note. Bearing in mind that the catalyst has already spent 2-3 months on Stage 2 without reactivation, before coming on stream in Stage 1, the data marked thus 'x' in the foregoing paragraph are inconsistent. It is possible that the figure "3 months" at the beginning of the paragraph should be "3 weeks"/.

treatment was given and after a further period, a solvent extraction, and so on. The shortest period between re-activation was 8 days.* The whole life of the catalyst was 8-8½ months, during which time a total of 6 extractions* and 8 hydrogenations* will have been carried out. This includes final extraction to ease the removal of catalyst from the oven - a process which takes place in an atmosphere of CO₂.

Products.

The products of the process were given as follows:

C ₂ -C ₄	: 14.7%	Treibgas
C ₅ -C ₉	: 47.9%	Benzin
C ₁₀ -C ₁₄	: 17.3%	Diesel Oil
C ₁₅ -C ₁₈	: 10.7%	Heavy Oil
C ₁₉ -C ₂₄	: 7.7%	Gatsch
C ₂₅ -C ₁₀₀ (?)	: 1.7%	Hard wax from catalyst extractions.

The Treibgas was sold in bottles as motor fuel, and the benzin and Diesel oil were despatched to a blending and distributing center, frequently the Benzol Verband at Duisburg. The Diesel Oil, it was believed, was normally blended with Rumanian petroleum oil. Part of the gatsch was exported, part sent to Deutsche Fettsäure Werke at Witten, and part to the Hydrierwerke-Pöhlitz, Stettin, for the preparation of lubricating oils. The hard wax was sold for ceresine manufacture.

The annual output of the final products tabulated above was given as 80,000 tonnes.

The amount of residual gas produced was 500,000 m³/day. Its calorific value was 3500-3800 cal/m³ and its composition:- CO₂ 20.3%; C_nH_m 1.6%; O₂ 0.1%; CO 10.5%; H₂ 18.0%; CH₄ 30.9%; N₂ 18.5%. 30-40,000 m³/day were used for heating in the "Feinreinigung" process and the rest was returned for heating the coke ovens.

Apart from the normal distillation and stabilization units, there was no plant for further treatment of products. There had been a cracking plant, but this had been transferred to a brown-coal tar refinery.

Research Work.

Dr. Schwenke was understood to say that some research work had been carried out on iron catalysts, but that their interest in it was not great in view of the good results they had obtained with cobalt and the high pressure required for synthesis with iron catalysts.

Dr. Thies, however, who was in charge of the laboratory, was emphatic that no research work on the synthesis had been carried out there. Some catalyst testing had been carried out at the start of the plant, but recently the laboratory had been entirely preoccupied with process control and testing of materials etc.

A Prof. Krüger had come from Leipzig during vacations to work on the oxidation of C₃ and C₄ hydrocarbons. After removal of olefines, the paraffin residue was passed through heated tubes with air, but with what results Thies did not know.

Thies stated that the improved yields and catalyst life obtained in recent years was due partly to improvement in the catalyst, and partly to better operation and control in the contact oven house and in the changing of ovens from stage to stage.

C. C. HALL