FILM STUDY GROUP

REPORT ON MICROFILM REEL NO. 35

Prepared by

SHELL DEVELOPMENT COMPANY

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SHELL DEVELOPMENT COMPANY

DATE January 17, 1946

TO SHELL DEVELOPMENT COMPANY, SAN FRANCISCO

FROM SHELL DEVELOPMENT COMPANY, EMERYVILLE

SUBJECT U. S. TECHNICAL OIL MISSION: MICROFILM ROLLS 35 AND 36

Attached are reports on Rolls 35 and 36 (formerly 3B and 4B) of the Technical Oil Mission microfilm, as requested in Mr. A. E. Miller's letter to you of November 29, 1945. These reports have been prepared under the plan set up jointly by the Petroleum Industry War Council and the Petroleum Administration for War.

The films contain chiefly miscellaneous material on the Fischer-Tropsch synthesis. There were no outstanding sections of sufficient general value to warrant translations or detailed abstracts. All the material in the films has been abstracted, or listed by title.

We are returning the microfilm rolls under separate cover.

W. J. Hund

HHV/pl
Attach: Report on Roll 35
Report on Roll 36

cc: (with attach)
20 - Shell Development Company, San Francisco, Mr. Westermann
1 - Shell Development Company, San Francisco, Mr. Kunreuther

Shell Development Co.
Emeryville, California
January 17, 1946

Report on Roll 35 (formerly 3B) of U. S. Technical Oil Mission Microfilm

This roll reproduces technical documents taken from the Kunrchemie A. G., Sterkrade-Holten, Germany. This company was a leader in the field of Fischer-Tropsch synthesis, and the film contains a large amount of material concerning this important synthesis. Most of the items are letters, brief progress reports, or patent applications; there are no outstanding reports. Among the subjects of interest are:

Production of soaps from higher aldehydes and alcohols.
Patent applications relating to the Fischer-Tropsch synthesis.
Miscellaneous information on Fischer-Tropsch operation, including start-up procedures, recycle operations, catalyst reactivation, operating problems.
Experimental work with iron catalysts, including one extensive report (Item 1, Bag 3452).
Wax production and processing.
Oxidation of ethylene to ethylene oxide.
"Oxo" process for synthesis of higher alcohols and aldehydes, including information on product composition.
Correspondence regarding Fischer-Tropsch plant for Japan, with design data, etc.
Data on Diesel fuels from Fischer-Tropsch.

All material is covered by the following abstracts. These are identified only by item numbers, since there are no page numbers on the film. No translations or detailed abstracts have been made. Value ratings have not been assigned.

Roll 35 - Abstracts (Original Identification Roll 3B)
Target 30/5.01, Ruhrchemie A.G., Sterkrade-Holten
Bag 3440 (continued)

Item 61 Letter concerning cetane reference fuel. Holten, December 12, 1941 2 pg.

Item 62 Aldehyde oxidation: C_{11}-C_{16} Aldehydes in admixture with hydrocarbons (from "Oxo" reaction) are oxidized and the resulting acids are neutralized to soaps concurrently in a treatment with air and sodium carbonate at room temperature. Holten, September 26, 1941 5 pg.

Item 63 Soap production: C_{14}-C_{19} Alcohols in admixture with hydrocarbons are converted to soaps by fusing with caustic. The soap is purified by dissolving in aqueous ethyl alcohol, adjusting to a pH of 9.1, and removing the neutral oil. Other solvents may be used. Holten, September 26, 1941 2 pg.

Item 64 Patent Applications.

Reduction of Fischer-Tropsch iron catalyst, where the dried precipitated catalyst is only partially reduced (about 8%) at low temperature and with large amounts of excess hydrogen. Frankfurt, November 23, 1938 8 pg.

Processing of Fischer-Tropsch products where the gases, after removal of the heavy liquid fraction, are heated with aqueous or alcoholic caustic prior to condensation. Frankfurt, April 30, 1940 12 pg.

Extending the life of cobalt catalyst by using it first at high throughput in later stages and then at lower throughputs in the first stage. Frankfurt, September 14, 1939 11 pg.

Pretreatment of Kieselguhr for iron Fischer-Tropsch catalysts with potassium hydroxide. Frankfurt, July 17, 1939 9 pg.

Catalyst for Fischer-Tropsch where other metals such as copper constitute between 50 and 200% of the iron content. Frankfurt, September 25, 1937 6 pg.

Process for Fischer-Tropsch, using a catalyst containing more than 40% of a hydrogenating metal and a contact time of more than one minute. Frankfurt, July 17, 1937 7 pg.

Catalyst for Fischer-Tropsch containing more than 50 g, per liter of reduced cobalt and which is used at a space rate of more than 1 $m^3/h/kg$ cobalt, possibly with gas recycle. Frankfurt, May 15, 1937 7 pg.

Fischer-Tropsch process with a $CO:H_2$ ratio of 1:2 or 1:1,5 over cobalt-thorium catalyst and at pressures of 5 atmospheres or more. Frankfurt, January 25, 1937 9 pg.

Item 65 Schedule of research work to be done during the vacation of the supervisor. Holten, August 6, 1942 4 pg.

Item 66 Short monthly operating summaries of the refinery at Oberhausen-Holten 1942-1944. Gives some data on Fischer-Tropsch operation. Holten 62 pg.

Item 67 Investigation of alleged content of higher boiling hydrocarbons in tail gases. Holten, April 12, 1943 13 pg.

Item 68 Letter discussing the availability of propane-propylene fraction containing 60% olefins for chlorination. December 14, 1939 4 pg.

Item 69 Table showing the action on various gasolines, containing thiophene in some cases, of a formaldehyde-H_2SO_4 mixture. Holten, April 4, 1943 1 pg.

Letter concerning removal of sulfur dust from water gas. Holten, November 21, 1943 2 pg.

Item 70 Report on the C_4 content of synthesis gasoline of 150-160°C E.P. Rauxel, March 7, 1940 8 pg.

Item 71 Analysis of a mixed gasoline (cracked plus synthesis). Holten May 25, 1939 2 pg.

Item 72 Miscellaneous curves giving properties of synthesis gasoline. 15 pg.

Item 73 Determination of iron carbonyl in water gas. Holten, August 4, 1942 3 pg.

Item 74 Data curves for reactor tube design 1 pg.

Item 75 General report on Fischer-Tropsch by Franz Fischer. Mülheim, June 2, 1933 6 pg.

Item 76 Report on the requirements for analytical control for a Fischer-Tropsch plant. Holten, November 19, 1936 8 pg.

Item 77 Effect of inerts (CO_2) in the synthesis gas on the reaction and on wax deposition. The effects were checked in the laboratory, apparently with regular cobalt catalyst. Tests were started after the catalyst had been in operation for over 600 hours and contained 280% wax on a cobalt metal basis. Yields of liquid product decreased with increasing inert concentration and wax deposition decreased. As a matter of fact, wax was removed slowly at 42% inert in the gas. Holten, March 8, 1937 3 pg.

Item 78 True boiling point curves of synthesis product. Holten, July 13, 1937 2 pg.

Item 79 Reduction of cobalt-thorium catalyst under pressure. No advantage of reduction at 20 atm. over reduction at 1 atm was noted. Holten, July 9, 1937 1 pg.

Item 80 Reactor Experiments: Discussion of operation and changes such as use of catalyst of smaller particle size. Holten, December 23, 1937 5 pg.

Item 81 Application of used caustic for gasoline scrubber. Holten, January 13, 1938 2 pg.

Item 82 Development or iron catalysts for Fischer-Tropsch. This report includes a historical review of catalyst developments and a comparison of iron and cobalt catalysts. The chief advantages of iron catalysts mentioned are lower hydrogenation activity which permits formation of more olefins, less sensitivity to variations in operating conditions, and applicability to gases with a wide range of $CO:H_2$ ratios. Pretreatment is discussed and the fact mentioned that it is not possible to predict results under pressure from atmospheric experiments. The effect of catalyst preparation technique (methods are not described) and operating variables on product distribution is shown and it is mentioned that a catalyst has been developed which produces isoparaffins preferentially giving a 72 O.N. for the 200°C E.P. gasoline. Holten, September 12, 1940 25 pg.

Item 83 Methods for yield work-up; Criticism of one method and proposal of another based on H_2 and CO balance plus exact gas analyses. Holten, February 19, 1942 11 pg.

CO Balance: Holten, February 7, 1944 9 pg.

CO_2 contraction, N_2 contraction and CH_4 formation. Holten, July 18, 1942 etc. 7 pg.

Item 84 Measurements or the rate of mixing of two gases in the Fischer-Tropsch plant. Holten, January 11, 1943 3 pg.

Item 85 Effect of drying method (steam or gas) on the ease of catalyst removal from the reactors. Holten, March 1, 1943 2 pg.

Item 86 Desirability of hydrogenation of the catalyst after wax extraction. Holten, January 25, 1944 2 pg.

Technique for catalyst removal. Holten, April 26, 1938 4 pg.

Item 87 Table of periodic screening analyses of catalyst for atmospheric pressure synthesis. Holten, April 14, 1942 2 pg.

Item 88 Hard and soft wax production in medium pressure synthesis. Holten, May 6, 1942 2 pg.

Item 89 Effect of flow rate on yields at medium pressures. Holten, January 25, 1944 2 pg.

Item 90 Operation at medium and atmospheric pressure in series. This is commercial operation and includes yield data and intermediate operating conditions. Schematic flowsheet is included. Holten, April 3, 1941 5 pg

Item 91 Economic calculations on the production of gas for commercial and home use from water gas. This is a complete analysis of the economic factors. Holten, October 14, 1941 24 pg.

Item 92 Chlorination and dehydrochlorination of wax. The process is used on hydrocarbons above C_{18}. Chlorine is added to melted wax at 100-150°C. 100 kg. of chlorine are required for 500 kg. of wax. Dehydrochlorination is carried out at 200-380°C at a throughput of one liter per hour per liter of reaction space. The oxydation of the product (containing olefins) is carried out at 120°C with sulfuric acid and sodium bichromate, 1200 kg. 40% H_2SO_4 and 250 kg. of bichromate are required for 100 kg. olefins. The bichromate is recovered electrolytically at 4.6 volt. Plant cost estimate is included. The product, "Saurewachs" (acid wax), appears to have a wide field of application. This a proposal, not an actual plant. Holten, August 17, 1940 15 pg.

Bag No. 3452, Target 30/5.01, Ruhrchemie A.G., Sterkrade-Holten.

Item 1 Experiments in Fischer-Tropsch synthesis over iron catalyst with gas recycle. The catalyst used is only described by the code number F 1552; it was designed to give high yields of wax. A lamellar reactor was used at a pressure of 20 atm. The temperature was 251°C and 2.5 volumes of gas were recycled per volume of fresh charge. The flow rate was 100 m^3/hr. for 892 l. or 360 kg. of catalyst. About 130g. of C_{3+} per m^3 of CO plus H_2 was obtained in a 4 months run, of which about 36% was wax. Results were somewhat poorer than with tubular reactor. Holten, July 1942 143 pg.

Item 2 General observations in Fischer-Tropsch synthesis. Description of the gas recycle method in which wax and heavy oil are first removed from the recycle gas. This process permits an increase in the CO partial pressure without carbon deposition and thus yields a higher percentage of unsaturates. Holten, February 19, 1941 3 pg.

Curves showing the ideal CO_2 and/or water formations at various $CO:H_2$ ratios. Holten, April 23, 1940 2 pg.

Technique for filling tubular reactors with catalyst. Holten, March 8, 1940 2 pg.

Study of reaction mechanism by comparing a regular cobalt catalyst, a mixed cobalt catalyst on Kieselguhr, and Lurgi iron catalyst. Holten, February 29, 1940 2 pg.

Metering of gas in pressure synthesis
Holten, May 8, 1939 6 pg.

Item 3 Use of oil in place of water as a cooling medium in tubular reactor. Gas oil, a heavy gasoline-gas oil mixture, and n-heptane were tried. In general the results were not encouraging.
Holten, October 16, 1941 12 pg.

Item 5 Liquid phase synthesis. This is a series of reports up to September 6, 1941 on experiments by Bamag with oil recycle. In the opinion of Ruhrchemie the results showed no improvement over their own dry recycle process. Temperatures were somewhat higher (208°C), with conversion toward the end of the run (24th to 35th days) averaging 57% of the CO + H_2. Methane production, which had started very low (4-5%), was about 14% toward the end of the run.
Holten, 1939-1941 32 pg.

Item 4 Lurgi reports on Fischer-Tropsch. This is a series of reports by Lurgi and Ruhrchemie on experimental work. On the film No. 7 is first,

No. 1. The method of preparing cobalt-chromium-Kiesulguhr catalyst is described as are the synthesis gas used, reactors, yield calculations, and product distribution. The effect of pressure was investigated from atmospheric to 80 atm. At constant space velocity, yield of liquid product increases sharply up to 150 atm. and then levels out. The effect of gas recycle was also investigated. Frankfurt, December 7, 1937 15 pg.

No. 2. Copper containing catalysts were investigated. A normal catalyst (Co : Th : Kieselguhr= 100:18:615) was soaked in a solution of copper oxide-ammonia, dried and reduced. It contained 12.7% Cu on the basis of cobalt. At 220°C and 50 atm. it yielded a liquid product containing 40% water soluble alcohols. Acid formation was very low. Total yield was only 100 g./m³. Oxygenated products yield appears to increase with increasing pressure, temperatures, CO concentration, and copper content. The preparation of a very active combination catalyst is described (Fe:Cu:Th:Kieselguhr + K_2CO_3 = 100:25:18:8). The synthesis gas used had a CO:H_2 ratio of 2:1. At 35 atm. and 250°C very good yields were obtained. Frankfurt, January 26, 1938 6 pg.

No. 3. It was found that cobalt catalyst with reduced concentration of active ingredients was equal to the concentrated one,
Frankfurt, February 2, 1938 3 pg.

No. 4. Continuation of pressure experiments with cobalt catalyst. By proper choice of conditions a product containing 67%v gasoline (60-70% olefins), 30% gas oil and only 3% wax could be obtained. Frankfurt, February 8, 1938 5 pg.

No. 5. A pressed (pilled) Ruhrchemie catalyst was tested which gave wax yield of 40-50% and appeared to maintain high activity very well.
Frankfurt, February 15, 1938 4 pg.

No. 6. A low concentration catalyst (100 Co:5ThO_2:10 MgO:600 Kieselguhr) was tested for 7-1/2 months with and without recycle. The average yield was 139 g./m^3 of ideal gas at 87% H_2 conversion. The liquid product was 1210 grams per gram of cobalt. This showed that the low concentration catalyst had a longer life than the normal one. By proper choice of conditions in the recycle process, activity decline due to wax formation can be practically completely eliminated. Increasing pressure is a far more satisfactory means of increasing yield than is increasing temperature. Frankfurt, April 26, 1939 15 pg.

No. 7. The preparation of a catalyst (Fe:Cu:Al:Kieselguhr= 100:5:9:120) is described which was used at 20 atm. with gas recycle and which was followed by a cobalt catalyst stage. The yield was 170 g./m^3 of inert-free water gas. The wax yield was 63%v of the product and the olefin content of the gasoline was 77%. Frankfurt, September 19, 1939 7 pg.

Item 8 Test with various reactor designs. In the experiments were used lamellar reactor for pressure, a large tube reactor (48 tubes, 3 inches I.D.), a narrow tube reactor (0.4 inch I.D.), and a single tube reactor (0.7 inch I.D.). Holten, 1938-1940 19 pg.

Item 7 Tests with "mixed catalyst". The composition is Co:ThO_2:MgO: Kieselguhr= 28.8:1.4:2:54.6. Holten, 1939 8 pg.

Item 6 Start up procedures for Fischer-Tropsch. Spraying of diesel oil on the catalyst was tried to wash off any acids that may be formed. Gasoline was also used. Other tests used a low throughput (25% of normal) which was increased to normal in one case after 1-1/4 days. Holten, 1940 34 pg.

Item 9 Cost estimate for an ethane cracking plant, to produce ethylene. Holten, July 31, 1939 12 pg.

Item 10 Direct oxidation of ethylene to ethylene oxide. The process discussed is based on French patent 729952, which is apparently used in this country by Union Carbon and Carbide. I.G. Farben contracted for the process with the French owners, Societe Francaise de Catalyse Generalysee. A 1000 lbs./day pilot plant was built by Distillers Company in England and is described:

Ethylene (from alcohol) is mixed with 20 times its volume of air after purification to remove sulfur, acetylene, aldehydes, etc. Reaction takes place in a tubular reactor over silver coated aluminum rods. The heat of reaction is removed by an oil bath which is maintained at 200-210°C. The reaction temperature is estimated to be 400-500°C. The exit gases are cooled to 18°C in copper equipment (to avoid formic acid corrosion) and contain 2.5% ethylene oxide, 4% carbon dioxide and 0-0.4% ethylene. The ethylene oxide is removed with activated charcoal (in this country with water under pressure), stripped off with steam, the water is condensed, and the oxide is absorbed in water to form a 15-20% solution.

The ethylene oxide solution is fractionated with open steam at about 10 psig. so that the top temperature is 24°C. The cooling water temperature should not be too low because solid hydrates begin to form at 12°C. The ethylene oxide yield is 55% of theoretical based on ethylene consumed.

The catalyst used to be prepared by grinding up thin silver foil of 0.0002 to 0.0004 inches thickness with a solution of gum arabic to a thick homogeneous paste. The gum was washed out by decantation and suction, and the powder was dried and passed through a silk screen. The powder was heated to 400°C for a short time to get a certain matting effect and then placed on the aluminum carrier with a suspension of celite in ethyl acetate. More recently the catalyst is prepared by grinding pure silver carbonate with corundum powder and a 1% solution of pure gum Tragacanth in a ball mill of porcelain and placing it on the aluminum rods by dipping. Two dippings are necessary, with subsequent drying at 100-150°C and heating to 400° for 30 minutes in an electric furnace.

The life of the catalyst is quite long and its performance is adequate. It is hoped that yields can be increased to 60%.

The heat of reaction is discussed and the Union Carbon and Carbide installation is described roughly and a comparison between oxidation and chlorination is made. Energy requirements are also listed.

The contract between the French company and I.G. is attached. I.G. Ludwigshafen, March 23, 1939 31 pg.

Item 11 Note concerning the recovery of alcohols from effluents of the Fischer-Tropsch synthesis, November 4, 1943 3 pg.

Item 12 Letters concerning analyses of samples in connection with the Oxo process - letter of transmittal of a sample of C_6 aldehyde, Holten, December 8, 1947

Letter of transmittel with samples of sulfonated Oxo alcohols with discussion of problems in the sulfochlorination, I.G. Ludwigshafen, October 25, 1941 2 pg.

Analysis of C_{16} Oxo-alcohols Ruhrchemie, Holten January 10, 1944 1 pg.

Analyses of the C_{11}/C_{12} and C_{14} charge to the Oxo process and analyses of the reaction products. Henkel, Düsseldorf, June 26, 1943 2 pg.

Analysis of Oxo alcohols for branching, and position of the hydroxyl group. From n-1-olefins, the alcohols are primary, and most of them are normal. Henkel, Düsseldorf, December 3, 1941 4 pg.

Letter concerning supply of samples Henkel, Düsseldorf, September 18, 1941 2 pg.

Analysis of C_{16} Oxo alcohols Henkel, Düsseldorf, May 16, 1941 4 pg.

Item 13 Discussion of the cost of cobalt catalyst between Ruhrchemie and its licensees. Ruhrchemie, Holten, June 25 and September 21, 1940 14 pg.

Item 14 Flowsheet of Syntol plant (lube oil) January 12, 1944 2 pg.

Item 15 The effect of reactor throughput on reactor pressure drop, CO_2 contraction, and CO conversion in Fischer-Tropsch synthesis. This is work done on plant scale by the Brabag. The data appear to be very reliable. Schwarzheide, January 15, 1942 11 pg.

Item 16 Cobalt requirements. A summary of the liquid product production per ton of cobalt at Ruhrchemie and by its licensees over a 2 year period. Holten, April 1, 1943 3 pg.

Item 17 Synthesis procedure. Part of a note on operating technique at Essener Steinkohle. Holten, March 20, 1943 1 pg.

Item 18 Same subject as item 17. Essener Steinkohle has obtained unusually high yields and catalyst life at high throughputs in their Fischer-Tropsch plant. They may be accounted for by:

Shifting more load to the second stage.
Slow start-up of reactors with tail gases and then addition of gradually increasing quantities of synthesis gas.
Addition of H_2 to synthesis gas II.
Individual operation of each reactor with special emphasis on optimum load.
Operation of the second stage in a way to make possible 2-4 months operation without regeneration, which eliminates damage and makes further use in the first stage economical.
Better regeneration by a combination of extraction and hydrogenation. Bergkamen, April 17, 1942 3 pg.

Item 19 Report on a visit to the Fischer-Tropsch plant of Schaffgotsch. Considerable on construction and operating technique. Holten, November 18, 1941 22 pg.

Item 20 Increasing wax yields in Fischer-Tropsch synthesis. Discussion of possible changes in operation and catalysts. Holten, November 1941 5 pg.

Item 21 Meeting of Fischer-Tropsch licensees at Essen. Discussion is concerned with a substitute Kieselguhr for the cobalt catalyst and the availability of an adsorbent for sulfur removal. Essen, July 31, 1941 8 pg.

Item 22 Meeting of Fischer-Tropsch licensees at Essen. Discussion of adsorbents for sulfur removal indicates that high Na_2CO_3 content and high porosity appear to increase the capacity and appear to prevent carbon deposition.

The oxygen content must be higher in highly porous adsorbents apparently in order to maintain all iron in the oxidized state. A discussion of reactor design follows which is largely concerned with heat removal. The capacity of charcoal (A-Kohle) for adsorbing C_{3+} is summarized, and corrosion problems are discussed.

It was found that catalyst reactivation is improved if besides wax extraction a hydrogenation step is included though some operators felt that hydrogenation should not be used unless the reaction temperature had increased to about 195°C. Essen, April 17, 1942 14 pg.

Item 23 Meeting of Fischer-Tropsch licensees at Bergkamen. Discussion of the new operational technique by Essen Steinkohlen (the original report is included in Item 24 but will be abstracted here). The revisions by this company increased catalyst life to 8 months with a production of 450 tons of liquid products per ton of cobalt and a yield of 160 g. of C_{3+} per m^3 of inert free synthesis gas. The measures used to achieve this substantial improvement include: Start up of fresh, very active catalyst with lean gases on the principle of counter-current operation; avoiding damage to the catalyst which may be caused by overloading it; catalyst cannot be exhausted satisfactorily in the second stage and should therefore be moved to the first stage thus dividing the load approximately equally between the two stages which also permits better heat removal. Considerable discussion on the above points follows which should be of considerable interest to anyone considering this type of Fischer-Tropsch process.
Bergkamen, March 26, 1943 18 pg.

Item 24 Meeting of Fischer-Tropsch licensees at Essen. This is a discussion of the cobalt supply situation. (this includes the report discussed above and some additional remarks on the same subject.)
Essen, May 4, 1943 18 pg.

Item 25 Meeting of Fischer-Tropsch licensees at Essen. Discussion of the use of Cottrell precipitators for the removal of dust from synthesis gas. The installation was very successful. Gas pre-purification with activated charcoal is discussed. It was found that CO_2 and particularly steam had a very detrimental effect on catalyst activity though not all operators appeared to agree. This subject is followed by a discussion of the relative merits of extraction and hydrogenation for the reactivation of catalyst and the procedures are described. The consensus of opinion is that hydrogenation at 200°C after extraction is very desirable.

The performance of activated charcoal plants for the recovery of C_3 plus is taken up finally. Holten, January 20, 1944 21 pg.

Item 26 Correspondence of Ruhrchemie with Mitsui Bussan re Japanese project. This is a large amount of correspondence between 1937 and 1939 covering the following subjects:
Differences between thorium and mixed catalyst.
Discussion of plant design for Hokkaido and others including some operating procedures.
Discussion of advantages of medium pressure over atmospheric pressure synthesis.

Evaluation of different samples of Japanese Luxmasse 136 pg.

Item 26 Dehydrogenation of diesel oils. Ideas on a process of hydrogen removal without cracking from C_7-C_{20} paraffins to convert 20% to olefins, apparently mostly alpha as judged by polymerization to lube oil. The process is catalytic at 540 to 560°C in a vacuum. Liquid yield 98%, hydrogen in gas 78%. No further information on catalyst or conditions. Holten, April 12, 1943 2 pg.

Item 27 Miscellaneous diesel oil data. Note on the yield and properties of diesel oil from synthesis over iron catalyst. Holten, June 24, 1941 2 pg.

Evaluation of diesel oil blends. Holten, November 3, 1939 9 pg.

Correspondence concerning a complaint. Holten, July 1939

Prep. of diesel oil blends Holten, March 25, 1939 2 pg.

Patent claims concerned with diesel oils. Holten, January 31, 1939 4 pg.

Suitability of residue from lube oil plant for diesel oil. Holten, August 27, 1938 2 pg.

Problems in connection with the determination of cetane numbers. Holten, April 21, 1938 15 pg.

Preparation of diesel oil from coal carbonization product. Holten, July 28, 1938 14 pg.

Standardization meeting on diesel oil evaluation, Ludwigshafen, April 17, 1942 3 pg.

Vapor lock in mountain tests of diesel fuels. No vapor lock found. Holten, August 7, 1940 3 pg.

Note on aviation diesel oil. Holten, April 18, 1940 2 pg.

Development of diesel motors. Holten, December 12, 1938 3 pg.

Storage stability of cetane and diesel oil. Holten, July 13, 1938 9 pg.

Tests on five army diesel oils. Holten, February 26, 1938 14 pg.

Development of cetane number determination in the Army diesel oil test engine (choke method). Holten, September 16, 1938 5 pg

Speech on the testing of diesel fuels. Holten, November 30, 1938 4 pg.

Methods of preparing diesel fuel. A general discussion of possible methods. Holten, 16 pg.

Item 29 Fischer-Tropsch Synthesis for the preparation of special high grade products. By proper choice of conditions and catalyst the synthesis can be controlled in such a way that products for chemical manufacture can be prepared plus some special gasolines such as aviation fuel.

The case of a plant for 30,000 tons/year prim. products is described: a special iron catalyst is used with water gas of $CO:H_2 = 1:1.25$. The C_5-320 fraction (40%) contains 60% olefins and may be used for lube production. Cost analysis is included. The case of a 60,000 ton/year plant is also taken up where Oxo products, lube oil, polymer gasoline and catalytically cracked gasoline are produced. Holten, May 5, 1941 16 pg.

Item 30 Tests with recycle Fischer-Tropsch to produce olefins for synthetic lube oil using iron catalyst. Yields and analyses of the lube oil are included. Holten, August 13, 1941 15 pg.

Item 31 Swedish project. Plans for an iron catalyst synthesis plant in Sweden with special emphasis on lube oil production. Includes estimated yields and costs. Holten, September 25, 1941 9 pg.

Item 32 Iron catalyst synthesis plant for Ruhrchemie. Plant would produce 50,000 tons/year primary product. Cost and yield work-up. Holten, March 3, 1942 5 pg.

Item 33 Iron catalyst synthesis plant for Upper Silesia. Plant would produce 140,000 ton/year liquid primary product for the production of a maximum amount of diesel oil, and wax for fatty acid production. Holten, June 27, 1941 7 pg.

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