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THE M. W. KELLOGG CO.

NEW YORK, N. Y.

PETROLEUM RESEARCH LABORATORY

RUHRCHEMIE PROCESS FOR THE SYNTHESIS OF HYDROCARBONS FROM CARBON MONOXIDE AND HYDROGEN

DATE February 27, 1939

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FOR THE

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FROM

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THE M. W. KELLOGG COMPANY
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* A more detailed index immediately precedes each major subject discussion.

FOREWORD

A report on the synthesis of hydrocarbons from carbon monoxide and hydrogen was received from Ruhrchemie in the latter part of October, 1938. The material presented in the report was discussed in considerable detail with various members of the personnel of Ruhrchemie, and the Ruhrchemie plant at Holten was visited on several occasions during the month of November. This present report is an attempt to correlate all the information obtained from the above sources.

The subject matter has been arbitrarily divided into three sections:

I. Manufacture of Synthesis Gas

II. Manufacture of Synthesis Catalyst

III. Operation of Synthesis Reaction

A fourth section is made up of information that did not logically fall under the above divisions.

The quantities and dimensions have been given first in the units in common use in the United States and immediately following, in parentheses, in metric units. Attention may be called to the fact that the quantities given in parentheses as "tons" refer to metric tons, i.e., 2200 pounds.

INTRODUCTION

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Ruhrchemie had three complete installations in operation, one each at Holten, Lützkendorf and Ruhland. Only the former plant was visited and the succeeding descriptions will of necessity pertain to the Holten works, which was apparently the oldest and smallest installation. The Holten plant was producing about 800 barrels (90 tons) of oil per day but was being enlarged to such an extent that the production would be about 2,000 barrels (225 tons) per day. By comparison, it appeared that the Lützkendorf plant production was in excess of 6,000 barrels (680 tons) of oil daily. The size of the Ruhland installation was not stated.

SUMMARY

The material covered in this report is not of such nature that it may be adequately summarized. Therefore, only certain items of the more important information pertaining to each section of the report will be set down here.

SUMMARY

Synthesis Gas Manufacture

At Holten, synthesis gas containing hydrogen and carbon monoxide in the ratio of two-to-one was made by the conversion of a part of the carbon monoxide in water gas, which in turn was made from coke in water-gas generators. The synthesis gas was purified by passage over an iron contact, until the total sulfur content was less than 0.06 grams per thousand cubic feet (0.2 grams per hundred cubic meters). The Holten plant (11 generators) had a daily capacity of about 75,000,000 cubic feet (2,000,000 cubic meters) of synthesis gas.

Synthesis Catalyst

The synthesis catalyst used at Holten was prepared by precipitation of cobalt, magnesium and thorium as carbonates, from a nitrate solution, upon kieselguhr, using sodium carbonate as precipitant. The precipitate was dried, formed into particles from 1 to 3 millimeters and reduced with hydrogen. The composition of the reduced catalyst was 32% cobalt, 2.5% magnesia, 1.5% thoria, and 64% kieselguhr (Co:0.08 MgO:0.05 ThO_2:2.0 SiO_2).

Synthesis Reaction

About 800 barrels (90 tons) of oil were being produced daily at Holten from a total of 52 reaction chambers operating at atmospheric pressure. The yield of oil was

about 120 grams per cubic meter of synthesis gas, which corresponded to a production of 0.35 gallons of oil per day per pound of cobalt (2.1 tons of oil per day per ton of cobalt) or 1.9 gallons of oil per day per cubic foot of catalyst (180 kilograms of oil per cubic meter of catalyst). The catalyst had a life of about four months at atmospheric pressure and would produce about 43 gallons of oil per pound of cobalt (255 tons of oil per ton of cobalt) per lifetime. The overall production corresponded to 2.65 barrels of oil per year per pound of cobalt in the plant (665 tons of oil per year per ton of cobalt).

The installation of 72 additional synthesis reaction chambers for operation at seven atmospheres pressure was well under way. Upon completion, the oil production at Holten was expected to be in excess of 2000 barrels daily. In the pressure operation, the oil yield was about 145 grams per cubic meter of synthesis gas, which corresponded to a production of 0.44 gallons of oil per day per pound of cobalt (2.6 tons of oil per day per ton of cobalt) or 2.3 gallons of oil per day per cubic foot of catalyst (225 kilograms of oil per cubic meter of catalyst). Under pressure, the catalyst had a life of about six months and would produce 77

gallons of oil per pound of cobalt (484 tons of oil per ton of cobalt) per lifetime. The above production would correspond to 3.2 barrels of oil per year per pound of cobalt (800 tons of oil per year per ton of cobalt).