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DEVELOPMENT OF IMPROVED FISCHER-TROPSCH CATALYSTS FOR PRODUCTION OF LIQUID FUELS

FINAL REPORT
CONTRACT NO. E (46-1)-8008

MASTER

Rostam J. Madon
Edward R. Bucker
William F. Taylor

Prepared for

United States Energy Research and Development Administration
(Department of Energy)
Morgantown Energy Research Center
Morgantown, West Virginia 26505

JULY, 1977

government research

P. O. BOX 8 ■ LINDEN, NEW JERSEY 07036

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GOVERNMENT RESEARCH LABORATORIES
EXXON RESEARCH AND ENGINEERING COMPANY
LINDEN, NEW JERSEY 07036

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FOREWORD

The program entitled "Development of Improved Fischer-Tropsch Catalysts for Production of Liquid Fuels" was carried out at the Government Research Laboratories of Exxon Research and Engineering Company for the United States Energy Research and Development Administration (ERDA) under Contract No. E(46-1)-8008. The program was monitored out of the Morgantown Energy Research Center of ERDA by Mr. W. T. Abel. The work was performed from July 1, 1975 to July 1, 1977. The initial phase consisted of a detailed literature search which was performed to obtain information regarding any beneficial and/or non-deactivating effects of adding sulfur to Fischer-Tropsch catalysts. The initial work was discussed in the Phase I report EXXON/GRU.1KWA.76. This final report discusses in detail some experimental results of sulfur effects on the Fischer-Tropsch synthesis.

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ABSTRACT

An experimental study was conducted in a tubular, packed-bed reactor system to investigate the effects of adding sulfur to catalysts for the Fischer-Tropsch synthesis. Small amounts of sulfur were added to precipitated cobalt, iron, and alumina-impregnated ruthenium catalysts before CO hydrogenation was carried out. Non-traditional catalysts, molybdenum-based and tungsten-based catalysts, were also tested in the oxidized and sulfided forms. The results on all the catalysts used in this study are discussed in this report. In particular, the results of unsulfided and sulfided catalysts are compared, and in several cases distributions of condensed products are represented graphically. Besides sulfur-catalyst interactions, it was noted that there were often significant interactions of process conditions with different sulfided and unsulfided catalysts. Care was taken to minimize the effects of transport phenomena on our catalytic studies.

NOMENCLATURE AND SOME CONVERSION FACTORS

$$\text{Average Contraction} = \frac{(\text{Volume of inlet gas} - \text{Volume of exit gas}) \times 100}{\text{Volume of inlet gas}}$$

CO_2-free Contraction = Average contraction in which the volume of exit gas does not include the amount of CO_2 formed

$$H_2 \text{ usage ratio} = \frac{H_2 \text{ converted/min}}{(CO + H_2) \text{ converted/min}}$$

CO converted to C_5+ = Total CO converted - [CO converted to CH_4, C_2 to C_4 hydrocarbons, and CO_2]

$$\text{Selectivity: CO converted to product X,\%} = \frac{\text{CO converted to product X}}{\text{Total CO converted}} \times 100$$

101.3 kPa (0.1013 MPa) = 1 atm

1 kPa = 0.145 psi

1 J = 0.239 cal = 1.055 x 10^{-3} BTU

1°C = 5/9 (°F-32)

Pressure Conversion Table

kPa	MPa	atm	psi
100	0.1	0.99	14.50
500	0.5	4.94	72.52
1000	1.0	9.87	145.04
1500	1.5	14.81	217.56
2000	2.0	19.74	290.08
2500	2.5	24.68	362.59
3000	3.0	29.62	435.11
3500	3.5	34.55	507.63

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