

Research and Development Division  
Report No. 2787-Q:20  
Problem No. PQ-2795  
Date: May 22, 1946

Bureau of Mines

TRANSLATIONS OF GERMAN DOCUMENTS ON THE  
DEVELOPMENT OF IRON CATALYSTS FOR THE  
FISCHER-TROPSCH SYNTHESIS---PART II

by

Max Leva and H. V. Atwell

PART OF T. O. M. Reel No. 101

I.C. \_\_\_\_\_  
April 1946

INFORMATION CIRCULAR

UNITED STATES DEPARTMENT OF THE INTERIOR - BUREAU OF MINES

TRANSLATIONS OF GERMAN DOCUMENTS ON THE DEVELOPMENT OF  
IRON CATALYSTS FOR THE FISCHER-TROPSCH SYNTHESIS II<sup>1/</sup>

By Max Leva<sup>2/</sup> and H. V. Atwell<sup>3/</sup>

CONTENTS

	Page
Foreward .....	5
TOM Reel 101 Doc. PG-21576-NID, "Process for the Production of Hydrocarbons (Patent Application)" .....	
Introduction .....	6
Scope of Present Invention .....	6
Operating Conditions .....	8
Induction .....	8
Synthesis .....	8
Example .....	9
Claims .....	10
TOM Reel 101 Doc. PG-21578-NID, "The Middle-Pressure Synthesis with Iron Catalysts, Sept. 9, 1939" .....	
Introduction .....	11
Historical Development .....	11
Results of the Present Study .....	14
Arrangement of the Apparatus .....	14
Preparation of the Catalyst .....	15
Methods of Preparation .....	15
Standard Catalyst .....	15

<sup>1/</sup> The Bureau of Mines will welcome reprinting this paper, provided the following acknowledgment is used: "Reprinted from Bureau of Mines I.C. \_\_\_\_\_".

<sup>2/</sup> Chemical Engineer, Research and Development Division, Bureau of Mines, Central Experiment Station, Pittsburgh, Pa.

<sup>3/</sup> Research Chemist, The Texas Company, Beacon, New York.

	Page
The Synthesis Gas .....	16
Pressure and Temperature Variations .....	17
Durability of the Catalysts .....	17
Reaction Products .....	18
Yields .....	18
Nature of Reaction Products .....	19
Summary .....	20
"Middle-Pressure Synthesis with Iron Catalysts" (A Summary) .....	
Introduction .....	21
Factors Influencing the Synthesis at Lower Temperatures .....	22
Catalyst .....	22
Induction of the Catalyst .....	22
Operating Pressures .....	22
Synthesis Gas Composition .....	22
Reaction Products .....	23
Multistage Operation .....	24
TOM Reel 101 Doc. PG-21579-NID, "Investigation of the Reaction Water Ob- tained from Middle-Pressure Synthesis Experiments with Iron Catalysts and Hydrogen-Rich Starting Gas, F. Weinrotter, April 30, 1941" .....	
Preliminary Observations .....	24
Quantitative Determination of the Alcohols and Fatty Acids in the Reaction Water .....	25
Saponification .....	25
Analysis of Saponification Fraction Boiling Below 100°C. ....	25
Analysis of Saponification Fraction Boiling Above 100°C. ....	25
Further Tests .....	26
TOM Reel 134, Navy 5811, Item IB-23 (First half), "Hydrocarbon Synthesis with Iron Catalysts, Leuna Works, April 5, 1940" .....	
Introduction .....	27
Catalysts .....	27
Description of Converters .....	27
Composition of Synthesis Gas .....	28
Influence of Mode of Reduction Upon Catalyst Activity .....	28
Influence of Various Conditions Upon the Nature of the Synthesis Products .....	29
Influence of the Catalyst .....	30

	<u>Page</u>
Influence of Space Velocity .....	30
Influence of Temperature .....	31
Influence of Pressure .....	31
Composition of the Synthesis Products .....	31
Comparison Between Products from Cobalt and Those from Iron Catalysts .....	31
Effect of Olefin Content Upon Octane Number of the Benzene Fraction .....	32
Effect of Olefin Content Upon Boiling Point of Products ....	32
Behavior of Various Iron Catalysts .....	34
General Considerations.....	34
Product:Water Ratio .....	35
Branched Chains and Octane Number .....	36
X-Ray Investigations of Iron Catalysts .....	36
Yields from Semi-Plant Scale Experiments .....	37
Two-stage Operation .....	38
TOM Reel 86, Bag 3979, Item 78, "Experiences with the Semi-Commercial Synol Research Plant ME458, Report No. 472/44A, Leuna Works, October 10, 1944".	
Introductory Remarks .....	41
Catalyst Reduction .....	41
Description of Apparatus .....	41
Reduction Procedure .....	42
Storage of the Reduced Catalyst .....	45
Synthesis Unit .....	46
Starting, Interrupting, and Stopping the Synthesis .....	46
Plate Reactors .....	47
High-Pressure Water Washing .....	47
Active Carbon Plant .....	47
Distillation .....	47
Present Status of Synol Synthesis and Schedule for Expansion and Improvements .....	47
Manner of Operation .....	48
Recycle operation (Characteristics) .....	48
Effect of CO <sub>2</sub> Formation on Conversion .....	48
Life of Catalyst .....	48
Products .....	49
Space Velocity .....	49
Separation of Products .....	49
Summary of Recycle Operation .....	49

	<u>Page</u>
Recycle and "Sumpf" Phase .....	50
Conversion and Yields .....	52
Catalysts .....	53
Influence of Reduction Conditions on Activity .....	53
Influence of Particle Size on Activity .....	54
Influence of Fused vs. Precipitated Catalyst Form on Activity .....	55
Effect of Catalyst Composition on Synthesis Products .	56
Oven Construction and Different Technical Details.....	57
Appendix .....	58 60

### ILLUSTRATIONS

<u>Figure</u>		<u>Following page</u>
TOM Reel 101, Doc. PG-21578-NID		
1	Variation of Contraction with Time .....	17
2	Increase of Temperature with Time .....	18
3	Variation in Reaction Temperature with Synthesis Gas Com- position .....	23
4	Variation in Yield with Synthesis Gas Composition .....	23
TOM Reel 101, Doc. 21579-NID		
5	Analysis of Reaction Water After Saponification (Microdis- tillation of a 10 cc. Portion of the Fraction Boiling Below 100°C.).....	25
6	Analysis of Reaction Water (Distillation of Fraction Boiling Below 100°C.).....	26
7	Variation in Temperature with Synthesis Gas Composition .....	26
8	Variation in Yield with Synthesis Gas Composition .....	26
TOM Reel 134, Navy 5811, Item IB-23 (First half)		
9	Influence of Space Velocity Upon the Boiling Range of the Reaction Products .....	30
10	Influence of Temperature .....	31
11	Comparison Between Products from Cobalt and Iron Catalysts...	31
12	Relationship Between the Olefin Content, as Determined by the Iodine Number, and Boiling Range.....	32
13	Boiling Range of Products from Hydrocarbon Synthesis .....	39

Figure

Following  
page

TOM Reel 86, Bag 3979, Item 78

14	Scheme for Catalyst Reduction .....	41
15	Temperature Record During the Drying Period of the Silica Gel	43
16	Temperature Differences Between the Center of the Catalyst Reduction Vessel and the Outlet at Various Times.....	44
17	Description of Original Synthesis Unit .....	46
18	Description of Most Recent Synthesis Unit .....	46
19	Description of the Plate-Oven Synthesis Unit .....	57

FOREWARD

This report is a continuation of translations (cf. Part I, Information Circular in press) of German documents seized by the United States Government Technical Oil Mission. Further information is presented on the middle-pressure synthesis with iron catalysts, including a partial translation of a report concerning the operation of a semi-commercial Synol research plant. The following documents were translated:

TOM Reel 101 (originally identified as Special Reel 427) Doc. PG-21576-NID.

TOM Reel 101 Doc. PG-21578-NID.

TOM Reel 101 Doc. PG-21579-NID.

TOM Reel 134, Navy 5811, Item IB-23 (First half).

TOM Reel 86 (originally identified as Reel 10E) Bag 3979, Item 78.

At the end of the report is an appendix referring to the page numbers of the original manuscript.