RECEIVED
SEP 13 1996
CSTI

DOE/PC/92108--T16

FINAL

TECHNOLOGY DEVELOPMENT FOR COBALT F-T CATALYSTS

Contract No. DE-AC22-92PC92108

QUARTERLY TECHNICAL PROGRESS REPORT No. 13

Covering the Period October 1, 1995 to December 31, 1995

Prepared for:
U.S. Department of Energy
Pittsburgh Energy Technology Center
PETC Project Manager: Richard E. Tischer
P. O. Box 10940
Pittsburgh, PA 15236-0940

Submitted by:
Principal Investigator: Alan H. Singleton
Energy International Corporation
135 William Pitt Way
Pittsburgh, PA 15238

RECEIVED
USDOE/PETC
36 SEP 10 AM 10:45
ACQUISITION & ASSISTANCE DIV.

September 5, 1996

MASTER

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

EXECUTIVE SUMMARY

Eight new catalysts were prepared by Calsicat during this reporting period in order to investigate the effect of the reduction and passivation procedures which would be typically used on commercial batches of catalysts. These new catalysts had similar formulations to those used previously for Co.005 and Co.047. The main differences between the catalysts in each of these two catalyst series reside in the reduction and passivation procedures used.

A total of 8 runs were performed in the slurry bubble column reactor (SBCR) in order to evaluate the reduction procedure which would be used on large batches of catalysts as well as the passivation procedure using soya wax coating of the Co catalysts after reduction in H_2 .

A series of three non-promoted Co/Al_2O_3 catalysts calcined and reduced at Calsicat under semi-commercial conditions and flaked in soya wax for easier handling and shipment of the reduced catalysts yielded very low CO conversions in the SBCR. However, a small batch of the same catalyst reduced in the laboratory scale reduction system at EI was very active. On the other hand a larger batch of the same non-promoted catalyst hydrogen reduced in the same laboratory scale reduction unit yielded also a very low CO conversion in the SBCR. In addition, the larger batch reduction process seemed to have irreversibly damaged this catalyst which could not be reduced completely even when the catalyst was re-reduced in small batches at standard conditions yielding usually completely reduced catalysts. The large amount of water produced during reduction of large batches of catalysts is suspected to affect the reducibility of these non-promoted catalysts. None of the problems encountered with the reduction and passivation of the non-promoted catalysts were observed with the Ru-promoted catalysts, confirming again that the presence of Ru promotes the reduction of the Co catalysts.

TPR experiments were carried out on both the promoted and unpromoted catalysts in order to determine the optimum time required for complete catalyst reduction. The results of this investigation confirmed previous results showing that Ru acts primarily as a reduction promoter. In addition, the presence of potassium did not alter its effect on Co reducibility. Much longer time was required for the non-promoted catalyst to achieved its maximum reduction.

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

TABLE OF CONTENTS

	<u>Page No.</u>
EXECUTIVE SUMMARY	I
LIST OF TABLES	iv
ACKNOWLEDGMENT	v
I. INTRODUCTION AND BACKGROUND	1
II. PROJECT DESCRIPTION	1
III. OBJECTIVES	3
IV. SUMMARY OF WORK ACCOMPLISHED THIS QUARTER	4
V. DETAILED DESCRIPTION OF TECHNICAL PROGRESS	4
A. Task 1: Catalyst Development	4
Technology Assessment.	4
Catalyst Formulation	4
Catalyst Characterization	6
B. Task 2: Catalyst Testing	6
C. Task 5: Catalyst Preparation Facility	9
VI. PLANS FOR THE NEXT REPORTING PERIOD	9
VII. ASSESSMENT OF PROSPECTS FOR FUTURE PROGRESS	10
VIII. APPENDICES	19
A. Chronology of Runs in Slurry Bubble Column Reactors	A1
B. Slurry Bubble Column Reactor Data	B1

LIST OF TABLES

<u>Table No.</u>	<u>Title</u>	<u>Page No.</u>
1	List of Co-Based F-T Catalysts Formulated	11
2	Reducibility Data of Promoted and Unpromoted Catalysts	17
3	Summary of M3-SBCR and M4-SBCR Latest Results	18

ACKNOWLEDGMENT

The following persons contributed to this report: Rachid Oukaci, William Gall, Alan Singleton, and Ronald W. Genser, from Energy International Corporation.

I. INTRODUCTION AND BACKGROUND

The goal of this project is the development of a commercially viable, cobalt-based Fischer-Tropsch (F-T) catalyst for use in a slurry bubble column reactor. Cobalt-based catalysts have long been known as being active for F-T synthesis. They typically possess greater activity than iron-based catalysts, historically the predominant catalyst being used commercially for the conversion of syngas based on coal, but possess two disadvantages that somewhat lessen its value: (1) cobalt tends to make more methane than iron does, and (2) cobalt is less versatile with low H_2/CO ratio syngas due to its lack of water-gas shift activity. Therefore, the major objectives of this work are (1) to develop a cobalt-based F-T catalyst with low ($< 5\%$) methane selectivity, (2) to develop a cobalt-based F-T catalyst with water-gas shift activity, and (3) to combine both these improvements into one catalyst. It will be demonstrated that these catalysts have the desired activity, selectivity, and life, and can be made reproducibly. Following this experimental work, a design and a cost estimate will be prepared for a plant to produce sufficient quantities of catalyst for scale-up studies.

II. PROJECT DESCRIPTION

The Cobalt Fischer-Tropsch Catalyst Project is divided into five tasks designed to systematically develop catalysts through thorough investigation of influences of various promoters, additives, and supports on minimizing methane selectivity and increasing water-gas-shift activity.

Cobalt has long been known to be an excellent catalyst for the F-T synthesis. Nevertheless, all currently operating F-T plants feeding coal produced syngas use iron catalysts, in spite of the fact that cobalt-based catalysts have higher activity. Two factors that lower cobalt's value as a F-T

catalyst are its poorer selectivity, that is, it produces more methane and its inability to be used with low H₂/CO ratio syngas because of its lack of water-gas shift activity. The broad objective of this proposal is to overcome these deficiencies.

In pursuing F-T catalyst development, there are several aspects that need to be considered. These are catalyst formulation, catalyst pretreatment, and catalyst performance. All of these aspects will be dealt with in this project.

In broad terms, the technical approach that will be used is outlined below.

- a. Conduct a thorough review of the literature on F-T synthesis, both the journal literature and the patent literature. In this review, identify approaches for improving methane selectivity of cobalt-based catalysts, identify additives that have WGS activity, identify catalyst formulation options, and define critical pretreatment parameters.
- b. Based on the above review, develop a list of catalyst formulations with potential for low methane selectivity and a list of catalyst formulations with potential for promoting the WGS reaction.
- c. Screen these catalysts in a small, fixed-bed reactor. If no catalyst meets the target specifications, go back to step b. Otherwise, run catalysts that meet discrimination criteria in a slurry bubble column reactor.
- d. Once catalysts with low methane selectivity and WGS activity have been identified, develop a catalyst combining both these functions and test as described above.
- e. Having found catalysts that meet the desired criteria for activity and selectivity, optimize the pretreatment conditions.

- f. Demonstrate catalyst reproducibility by having a commercial subcontractor prepare multiple batches for testing.
- g. Demonstrate catalyst stability by running aging tests in a slurry bubble column reactor.
- h. Based on above results, prepare a design for a plant to produce demonstration scale batches of catalyst. Develop capital and operating costs of this plant.

The program to carry out the above outlined work will consist of five major tasks:

Task 1 -- Catalyst Development

Task 2 -- Catalyst Testing

Task 3 -- Catalyst Reproducibility Tests

Task 4 -- Catalyst Aging Tests

Task 5 -- Preliminary Design and Cost Estimate for a Demonstration Scale

Catalyst Production Facility

All aspects of the catalyst's role in F-T processing will be addressed, including catalyst preparation, pretreatment, and performance (activity, selectivity, and aging). In addition to gathering process data, the catalyst will be subjected to a number of analytical measurements at each stage to see how various treatments have affected the catalyst and its performance.

III. OBJECTIVES

The objective of this project is to investigate the influence of various promoters, additives, and supports on minimizing the methane selectivity and increasing the water-gas shift (WGS) activity of cobalt (Co) Fischer-Tropsch (F-T) catalysts. The ultimate goal of this investigation is

to identify and demonstrate a catalyst preparation procedure that will be scaled up for the reproducible synthesis of commercial quantities of supported CO catalysts with desired activity, selectivity, and lifetime for use in F-T synthesis in three-phase slurry bubble column reactors.

IV. SUMMARY OF WORK ACCOMPLISHED THIS QUARTER

Eight new catalysts were prepared by Calsicat during this period following the formulations used previously for Co.005 and Co.047. The main differences between the catalysts in each of these two catalysts series reside in the reduction and passivation procedures used.

TPR experiments were carried out on both promoted and unpromoted catalysts in order to determine the optimum time required for complete catalyst reduction.

During this reporting period, a total of 8 runs were performed in the slurry bubble column reactor. All these run were carried out in order to evaluate the reduction procedure which would be used on large batches of catalysts as well as the passivation procedure using soya wax coating of the Co catalysts after reduction in H_2 for possible scale-up for commercial applications.

V. DETAILED DESCRIPTION OF TECHNICAL PROGRESS

A. TASK 1: CATALYST DEVELOPMENT

a. Technology Assessment (Subtask 1.1)

Except for regular updating of the literature with the most recent publications, there was no activity during this period to report in this subtask.

b. Catalyst Formulation (Subtasks 1.2, 1.3, 1.4)

A list of all the catalysts formulated so far within Subtask 1.2 is given in Table 1 on page

11 with their compositions. Eight new catalysts were prepared by Calsicat during this period following the formulations used previously for Co.005 (CAL.15-CAL.17, CAL.19-CAL.20, and CAL.24) and Co.047 (CAL.18 and CAL.25). The main differences between the catalysts in each of these two catalysts series reside in the reduction and passivation procedures used for each one.

These new catalyst preparations resulted from discussions between EI and Calsicat which revealed a number of critical scale-up problems associated with the pretreatment and the handling of Co catalysts in reduced state.

One of the problems was encountered when three large batches of the non-promoted catalyst (CAL.15-CAL.17) equivalent to Co.005 were prepared by Calsicat and reduced under semi-commercial conditions and passivated in soya wax. All three catalysts showed very low activity. In order to ascertain that the low activity was not due to the preparation procedure, or the waxing process used at Calsicat, other pretreatment conditions were tried using calcined batches of the same catalysts supplied by Calsicat. CAL.19 was reduced in a small batch at EI in the laboratory scale reduction system using the same conditions that resulted in the very active Co.005 catalyst. CAL.20 was also reduced at EI but in a larger batch in order to simulate the conditions used at Calsicat. Following the low activity result obtained with CAL.20, CAL.24 was obtained by rereducing twice CAL.20, but this time in a smaller batch and similar conditions to those used for CAL.19.

CAL.18, a Ru promoted catalyst, was prereduced in a large batch at Calsicat and protected in soya wax. CAL.25 is a small batch of the same catalyst as CAL.18 which was shipped in the calcined state and reduced at EI under standard conditions for comparison purposes.

c. Catalyst Characterization (Subtask 1.6)

Temperature Programmed Reduction (TPR)

TPR experiments were carried out in an automated Altamira Instruments AMI-1 system in order to determine the optimum time required for complete catalyst reduction. The reduction time and the corresponding H₂ consumption may add a significant amount to the overall cost of the catalyst. The catalysts tested were the non-promoted catalyst Co.005, the Ru-promoted catalyst Co.053 and the Ru-K-promoted catalyst CAL.13.

A first TPR is carried out from ambient temperature to 350°C under 10% H₂ in argon. The temperature is then maintained at 350°C for the time required for "normal" reduction (different times were tried: 2 h for all catalysts and 4, 10, and 16 for Co.005). The catalyst is then cooled to ambient temperature and a second TPR is then performed up to 900°C to determine the amount of catalyst remaining unreduced after the 350°C reduction. The reducibility results are shown in Table 2 on page 17. These results confirmed previous results showing that Ru acts mainly as a reduction promoter. In addition, the presence of potassium did not alter its effect on Co reducibility. It is also clear from these results that much longer time (at least 16 h) is required for the non-promoted catalyst to achieve its maximum reduction.

B. TASK 2: CATALYST TESTING

a. Subtask 2.1 - Fixed Bed Reaction Studies:

This subtask was completed in the previous period.

b. Subtask 2.2 - Slurry Bubble Column Testing (SBCR)

1. Run Chronology

During this reporting period a total of 8 runs were performed in the SBCR's, Runs M3-60,

61, and 62, and Runs M4-42, 45, 47, and 48. A chronology of the experimental runs performed in the two slurry bubble column reactors - M3 and M4 - is given in Appendix A. All comparisons of CO conversion and CH_4 discussed in this chronology were obtained from results obtained at the following reaction conditions: 220°C temperature, 450 psi pressure, 2/1 H_2/CO feed gas ratio, and 900 SLH total gas flow.

A complete summary of all runs made in the M3-SBCR is given in Table I in Appendix B. Four tables were prepared in order to compare catalyst activities for Runs 2 to 62 in M3-SBCR at the same run conditions (see Tables II, III, IV, and V in Appendix B).

A complete summary of all runs made in the M4-SBCR is given in Table VI in Appendix B. Four tables were prepared to compare catalyst activities for Runs 3 to 48 in M4-SBCR at the same run conditions (see Tables VII, VIII, IX, and X in Appendix B).

2. Discussion of Results

(a) Evaluation of Wax Coated Non-Promoted Catalysts from Calsicat

Three SBCR runs were carried out during this period using catalysts prepared at Calsicat following the successful formulations used for Co.005 previously prepared and tested at EI. The catalysts (CAL.15-CAL.17) were calcined and reduced at Calsicat under semi-commercial conditions and flaked in soya wax for easier handling and shipment of the reduced catalysts. All catalysts yielded 2.0% CO conversion or lower (see Runs 3060, 3061, and 4042 in Table 3 on page 18). In order to assess the reason for such low activity a small batch of the same catalyst was shipped in the dry, calcined state and H_2 reduced in EI's laboratory scale reduction column (CAL.19). This catalyst was very active yielding 13.6% CO conversion (see Run 3062 in Table 3). This result indicate that the actual formulation and preparation of the three catalysts CAL.15.

CAL.16 and CAL.17, up to their calcination were not the cause of their low activity. Thus, it was necessary to investigate the effect of the reduction procedure as well as the passivation process used by Calsicat.

Another batch of the same non-promoted $\text{Co}/\text{Al}_2\text{O}_3$ catalyst (CAL.20) received from Calsicat was hydrogen reduced in our laboratory scale reduction unit. However, a batch of 220 g, larger than usually used, was charged this time to the reduction unit and was reduced at standard conditions: 350°C for 18 hours with 5 SLM H_2 flow rate. The resulting CO conversion was only 3.4% (see Run 4045 in Table 3). This result indicate that the wax coating method of passivating the reduced Co catalysts was not the cause for their low activity. About 100 g of this reduced catalyst was re-reduced twice at the same conditions (CAL.24). The CO conversion only increased to 4.9% (see Run 4047 in Table 3). The results indicate that the H_2 reduction of non-promoted $\text{Co}/\text{Al}_2\text{O}_3$ catalysts is more difficult than for promoted catalysts and only small batches can be completely reduced in our laboratory reduction column at standard conditions. In addition, the larger batch semi-commercial reduction process seemed to have irreversibly damaged this catalyst which could not be reduced completely even when the re-reduction was carried out in small batches at standard conditions yielding usually completely reduced catalysts . The large amount of water produced during reduction of large batches of catalysts is suspected to affect the reducibility of these non-promoted catalysts. Further tests which will be carried out during the next reporting period in order to elucidate this problem.

(b) Evaluation of Wax Coated Promoted Catalyst from Calsicat

Run No. 4043 was made in M4-SBCR with a Ru-promoted catalyst from Calsicat (CAL.18) that was hydrogen reduced and coated with soya wax. A similar catalyst (CAL.25) that was reduced

at EI and charged in Synfluid was run at the same conditions. The wax coated catalyst yielded a CO conversion of 8.4% vs. 9.5% for the uncoated catalyst (see Runs 4043 and 4048 in Table 3). The catalyst activity was much higher than that of previous batches of wax coated catalysts, but further improvements in this passivation procedure are needed. None of the problems encountered with the reduction and passivation of the non-promoted catalysts were observed with these promoted catalysts, confirming again that the presence of Ru promotes the reduction of the Co catalysts.

C. TASK 5: CATALYST PREPARATION FACILITY

The objective of Task 5 was redefined in agreement with the Program Manager. The new objective of Task 5 is the cost estimate for the preparation of commercial quantities of the best catalyst identified in other tasks of this project. Formulation CAL-13 was chosen for the preparation of cost estimates by a catalyst manufacturer (Calsicat).

Discussions between EI and Calsicat have revealed a number of critical scale-up problems involving particularly the pretreatment and handling of Co catalysts in reduced state. Further SBCR testing using Co catalysts prepared by Calsicat and subjected to various pretreatments was required and undertaken during this reporting period (see Tasks 1 and 2) in order to address some of these issues.

VI. PLANS FOR THE NEXT REPORTING PERIOD

Additional runs will be made in the SBCR to complete the evaluation of the reduction procedure used for non-promoted Co catalysts. The writing of the final report will be continued.

VII. ASSESSMENT OF PROSPECTS FOR FUTURE PROGRESS

The technical approach which has been proposed remains the same. Report writing is proceeding well but it is taking longer than anticipated due to the large volume of data. An extension was requested in order to complete any additional experimental work associated with Task 5 as well to complete all report writing.

Table 1. List of Co-based FT Catalysts Formulated

CAT. NO.	wt% Co	wt% M	wt% Prom.	Support	Basis	Prepared
Co.001	20%	1% Re	1% La ₂ O ₃ 0.13% K	γ -alumina	U.S. Pat. 4,880,763	P
Co.002	20%	0.43% Ru	1% La ₂ O ₃	γ -alumina	U.S. Pat. 4,413,064	P
Co.003	20%	0.5% Ru	1% La ₂ O ₃	γ -alumina	U.S. Pat. 4,413,064	P
Co.004	20%	0.43% Ru	1% La ₂ O ₃	γ -alumina	Reproduce Co.002	P
Co.005	20%	0.00	0.00	γ -alumina	Base Catalyst	P
Co.005A	20%	0.4% Ru	0.00	γ -alumina	Ru added to calcined Co.005 by IW impreg.	P
Co.006	12%	0.75% Re	0.00	Titania	U.S. Pat. 4,794,009	P
Co.007	20%	0.00	0.00	Titania	Base Catalyst	P
Co.008	20%	0.00	0.00	Silica	UK Pat. Appl. GB 2 125 062 A (Kneaded with excess liquid)	P
Co.009	20%	0.5% Ru	0.00	γ -alumina	Ru-Promoted Catalyst (use Ru Chloride, single-step aqueous IW)	P
Co.010	20%	0.00	0.00	γ -alumina	Base Catalyst (non-calcined)	P
Co.010A	20%	0.4% Ru	0.00	γ -alumina	Ru added to dried Co.010 by IW impreg.	P
Co.011	20%	0.00	0.00	Silica	UK Pat. Appl. GB 2 125 062 A (Kneaded)	P
Co.012	20%	0.00	0.00	Silica	Base Catalyst (Inc. Wetness)	P
Co.013	20%	0.00	0.00	Titania	Base Catalyst like Co.007, but all aqueous	P
Co.014	12%	0.5% Ru	0.00	Titania	Ru-Promoted Catalyst (aqueous IW co- impregnation)	P
Co.015	20%	0.43% Ru	1% La ₂ O ₃	γ -Alumina	Similar to Co.002, but all aqueous	P

Table 1. List of Co-based FT Catalysts Formulated (contd.)

CAT. NO.	wt% Co	wt% M	wt% Prom.	Support	Basis	Prepared
Co.016	20%	0.43% Ru	1% La ₂ O ₃	γ -Alumina	Similar to Co.015, but calcined after Co impregnation	P
Co.017	20%	0.5% Ru	1% La ₂ O ₃	γ -Alumina	Similar to Co.003, but all aqueous	P
Co.018	20%	0.5% Ru	0.00	γ -Alumina	Ru-Promoted Catalyst (single-step, aqueous IW)	P
Co.019	20%	0.5% Ru	0.00	Silica	Ru-Promoted Catalyst (single-step, aqueous IW)	P
Co.020	0.00	0.5% Ru	0.00	γ -Alumina	Ru Base Catalyst	P
Co.020A	20%	0.4% Ru	0.00	γ -Alumina	Co added to dried Co.020 by IW impreg.	P
Co.020B	20%	0.4% Ru	0.00	γ -Alumina	Co added to reduced Co.020 by IW impreg.	P
Co.020C	20%	0.4% Ru	0.00	γ -Alumina	Co added to calcined Co.020 by IW impreg.	P
Co.021	20%	0.00	0.7% Zr	Silica	U.K. Pat. Appl. GB 2 125 062 A (single-step, aqueous kneaded)	P
Co.022	20%	0.00	0.7% Zr	Silica	U.K. Pat. Appl. GB 2 125 062 A (aqueous, multiple-steps, kneaded Co pre-impregnation, IW Zr)	P
Co.023	20%	0.00	1.4% Zr	Silica	U.K. Pat. Appl. GB 2 125 062 A (aqueous, multiple-steps, kneaded Co pre-impregnation, IW Zr)	P
Co.024	20%	0.00	8.5% Zr	Silica	Eur. Pat. Appl. 0 167 215 A2 (non-aqueous, IW, multiple-steps, Zr pre-impregnation)	P
Co.025	20%	0.00	8.5% Zr	Silica	Similar to Co.024 but aqueous Zr pre-impregnation	P

Table 1. List of Co-based FT Catalysts Formulated (contd.)

CAT. NO.	wt% Co	wt% M	wt% Prom.	Support	Basis	Prepared
Co.026	20%	0.00	0.00	Silica (Davison Grade 59)	Similar to Co.012 but different grade silica	P
Co.027	20%	0.5% Ru	0.00	Silica (Davison Grade 59)	Similar to Co.019 but different grade silica	P
Co.028	20%	0.5% Ru	0.5% K	γ -alumina	Ru- and K-Promoted Catalyst (single-step IW)	P
Co.029	30%	0.5% Ru	0.5% K	γ -alumina	Similar to Co.028 but 30% Co	P
Co.030	20%	0.00	0.1% Zr	γ -alumina	Zr-Promoted Catalyst (single-step aqueous IW)	P
Co.031	20%	0.00	1.4% Zr	γ -alumina	Zr-Promoted Catalyst (single-step aqueous IW)	P
Co.032	20%	0.00	8.5% Zr	γ -alumina	Zr-Promoted Catalyst (single-step aqueous IW)	P
Co.033	20%	0.00	8.5% Zr	γ -alumina	Multiple-steps, aqueous IW, Co pre-impregnation	P
Co.034	20%	0.00	8.5% Zr	γ -alumina	Multiple-steps, aqueous IW, Zr pre-impregnation	P
Co.035	20%	0.00	8.5% Zr	Silica	Zr-Promoted Catalyst (single-step aqueous, kneaded)	P
Co.036	20%	0.00	8.5% Zr	Silica	Multiple-steps, aq. Co pre-impreg. by kneading, aqueous IW Zr impreg.	P
Co.037	12%	0.00	0.00	Titania	Similar to Co.013, but TiO_2 mainly anatase	P
Co.038	12%	0.5% Ru	0.00	Titania	Similar to Co.014, but TiO_2 mainly anatase	P
Co.039	12%	0.00	0.00	Titania	Similar to Co.007, but only 12% Co	P
Co.040	12%	0.00	0.00	Titania	Similar to Co.013, but only 12% Co	P
Co.041	20%	0.5% Ru	8.5% Zr	Silica	Similar to Co.025, but Ru-promoted	P

Table 1. List of Co-based FT Catalysts Formulated (contd.)

CAT. NO.	wt% Co	wt% M	wt% Prom.	Support	Basis	Prepared
Co.042	0.00	0.00	8.5% Zr	Silica	Blank Zr-promoted SiO ₂	P
Co.043	20%	0.5% Ru	8.5% Zr 0.5% K	Silica	Similar to Co.041, but K-promoted	P
Co.044	20%	0.00	15% Zr	Silica	Similar to Co.025, but 15% Zr	P
Co.045	20%	0.00	4% Zr	Silica	Similar to Co.025, but 4% Zr	P
Co.046	12%	0.75% Re	4% SiO ₂	Titania	Similar to Co.006, but SiO ₂ -promoted	-
Co.047	20%	0.5% Ru	0.3% K	γ -alumina	Similar to Co.028, but 0.3% K	P
Co.048	20%	0.5% Ru	8.5% Zr 0.3% K	Silica	Similar to Co.043, but 0.3% K	P
Co.049	20%	0.5% Ru	0.1% K	γ -alumina	Similar to Co.047, but 0.1% K	P
Co.050	20%	0.5% Ru	8.5% Zr 0.1% K	Silica	Similar to Co.048, but 0.1% K	P
Co.051	0.00	0.5% Ru	0.00	Titania (R)		P
Co.052	0.00	0.5% Ru	0.00	Titania (A)		P
Co.053	20%	0.5% Ru	0.00	γ -alumina	Similar to Co.018 (New Batch)	P
Co.054	20%	0.00	8.5% Zr 0.3% K	Silica	Similar to Co.043, but without Ru	P
Co.055	20%	1% Re	1% La ₂ O ₃	γ -alumina	Similar to Co.001, but without K	P
Co.056	20%	0.00	8.5% La ₂ O ₃	Silica	Similar to Co.025, but La instead of Zr	P
Co.057	20%	1% Re	1% La ₂ O ₃	Silica	Similar to Co.055, but with SiO ₂ support	P
Co.058	20%	0.00	1% La ₂ O ₃	γ -alumina	Similar to Co.055, but without Re (one-step impreg.)	P
Co.059	20%	0.00	1% La ₂ O ₃	γ -alumina	Similar to Co.015, but without Re (two-step impreg.)	P
Co.060	30%	0.00	0.00	γ -alumina	Similar to Co.005, but with 30% Co	P
Co.061	30%	0.5% Ru	0.00	γ -alumina	Similar to Co.053, but with 30% Co	P

Table 1. List of Co-based FT Catalysts Formulated (contd.)

CAT. NO.	wt% Co	wt% M	wt% Prom.	Support	Basis	Prepared
Co.062	30%	0.5% Ru	1.5% K	γ -alumina	Similar to Co.029, but with 1.5% K	P
Co.063	20%	0.00	8.5% La	γ -alumina	Multiple-steps, aqueous IW. La pre-impregnation	P
Co.064	20%	0.5% Ru	8.5% Zr	γ -alumina	Multiple-steps, aqueous IW. Zr pre-impregnation	P
Co.065	20%	0.5% Ru	8.5% Zr 0.3% K	γ -alumina	Multiple-steps, aqueous IW. Zr pre-impregnation	P
Co.066	15%	0.5% Ru, 5.0% Fe	0.00	γ -alumina	Ru- and Fe-Promoted Catalyst (single-step, aqueous IW)	P
Co.067	20%	2.0% Pd	0.00	γ -alumina	Pd-Promoted Catalyst (single-step, aqueous IW)	P
Co.068	20%	1.0% Pd	0.00	γ -alumina	Similar to Co.067, but with 1% Pd	P
Co.069	20%	2.0% Ru	0.00	γ -alumina	Similar to Co.053, but with 2% Ru	P
Co.070	13%	0	0.00	γ -alumina	Similar to Co.005, but with 13% Co	P
CAL.01 (97E-13E)	20%	0.5% Ru	0.00	γ -alumina	Similar to Co.018 (Calsicat Prep.)	P
CAL.02 (97E-16B)	20%	0.5% Ru	0.00	γ -alumina	Similar to CAL.01 (New Batch)	P
CAL.03 (97E-13F)	20%	0.5% Ru	0.00	γ -alumina	Multiple-step impreg., Similar to CAL.02	P
CAL.04 (97E-50C)	20%	0.5% Ru	0.3% K	γ -alumina	Similar to Co.047 Stand. Calc. in Air	P
CAL.05 (97E-50D)	20%	0.5% Ru	0.3% K	γ -alumina	Similar to Co.047 Stand. Calc. in N ₂	P
CAL.06 (97E-51A)	20%	0.5% Ru	0.3% K	γ -alumina	Similar to Co.047 Red. and Pas. in Air	P
CAL.07 (97E-51B)	20%	0.5% Ru	0.3% K	γ -alumina	Similar to Co.047 Red. and Protected in Paraffin (51.3% Cat. Conc.)	P
CAL.08 (97E-51C)	20%	0.5% Ru	0.3% K	γ -alumina	Similar to Co.047 Calc., Red. and Protected in Paraffin (54.4% Cat. Conc.)	P

Table 1. List of Co-based FT Catalysts Formulated (contd.)

CAT. NO.	wt% Co	wt% M	wt% Prom.	Support	Basis	Prepared
CAL.09 (97E-69C)	20%	0.5% Ru	0.3% K	γ -alumina	Similar to CAL.05, Reduced and Protected in Soya (51.7% Cat. Conc.)	P
CAL.10 (97E-79A)	20%	0.5% Ru	0.3% K	γ -alumina (Condea)	Similar to CAL.05, but on Condea Al_2O_3	P
CAL.11 (29F-07B)	20%	0.5% Ru	0.3% K	γ -alumina	Similar to CAL.05	P
CAL.12 (29F-05D)	20%	0.5% Ru	0.3% K	γ -alumina	Similar to CAL.05	P
CAL.13 (29F-07E)	20%	0.5% Ru	0.3% K	γ -alumina	Similar to CAL.05	P
CAL.15 (29F-38B)	20%	0.00	0.00	γ -alumina	Similar to Co.005, Reduced and Protected in Soya Wax	P
CAL.16 (29F-3D)	20%	0.00	0.00	γ -alumina	Similar to Co.005, Reduced and Protected in Soya Wax	P
CAL.17 (29F-39E)	20%	0.00	0.00	γ -alumina	Similar to Co.005, Reduced and Protected in Soya Wax	P
CAL.18 (29F-40C)	20%	0.5% Ru	0.3% K	γ -alumina	Similar to CAL.13	P
CAL.19 (29F-39A)	20%	0.00	0.00	γ -alumina	Similar to CAL.15, 16 and 17, Reduced at EI under standard conditions	P
CAL.20 (29F-39A,B,C)	20%	0.00	0.00	γ -alumina	Similar to CAL.19, Reduced at EI in large batch	P
CAL.24	20%	0.00	0.00	γ -alumina	CAL.20 Re-reduced twice at EI using standard conditions	P
CAL.25	20%	0.5% Ru	0.3% K	γ -alumina	Similar to CAL.018, but reduced and passivated in Synfluid	P
Fe.01	0%	30%Fe	1.5%Cu	Silica		P

Table 2. Reducibility Data of Promoted and Unpromoted Catalysts Obtained by TPR

Catalyst	Time of Reduction at 350°C (hours)	% Co Reduced at 350°C (Time = 0)	Total % Co Reduction (after n hours)
Co.005	4	27.7	69.3
	10	28.2	73.2
	16	27.9	75.1
Co.053	2	26.3	96.6
CAL.13	2	-	97.3

Table 3

SUMMARY OF ADDITIONAL M3 AND M4 SBCR RUN RESULTS

a) Unless otherwise noted, total flow is ca. 15 L/min. STP, or 3 cm/sec linear gas flow.

Flows: N2-563 SLH, H2-225 SLH, CO-112 SLH

b) Conversion is total CO conversion over the period (%).

c) Conversion and selectivities are calculated using N2 as an internal standard in the GC analysis of the offgas.

d) Prod. rate: Rate for production of total hydrocarbons, C1+ (kg/kg cat., hr).

e) Alpha: Based on GC analysis of offgas and liquid product.

Run No	Cat. No	Cat. wt, g	Per No	Time Start	Time Stop	Temp C	Pres psi	H2: CO	Synfl cc/hr	Conv. %	Prod. Rate	Selectivities				Alpha GC	Alpha Liq	Comments
												ICH4	IC2	IC3+	IC02			
3060	CAL.15	15	1	6	13	220	450	2.0	20	2.0	0.09	-	-	100	-	0.84	-	Flaked in Soya
3061	CAL.17	15	1	6	13	220	450	2.0	20	1.2	0.06	-	-	100	-	0.80	-	Flaked in Soya
3062	CAL.19	15	1	6	14	220	450	2.0	20	13.6	0.66	3.2	-	96.0	0.81	0.88	-	
4042	CAL.16	15	1	6	13	220	450	2.0	20	<1.0	0.04	-	-	100	-	-	-	Flaked in Soya
4043	CAL.18	15	1	6	13	220	450	2.0	20	8.4	0.41	-	-	98.9	1.13	0.89	-	Flaked in Soya
4045	CAL.20	15	1	6	14	220	450	2.0	20	3.4	0.17	-	-	100	-	0.86	-	
4047	CAL.24	16	1	6	13	220	450	2.0	20	4.9	0.22	-	-	100	-	0.87	-	
4048	CAL.25	15	1	23	38	220	450	2.0	20	9.5	0.46	-	-	99.5	0.47	0.89	-	

VIII. APPENDICES

APPENDIX A

CHRONOLOGY OF RUNS IN SLURRY BUBBLE COLUMN REACTORS

CHRONOLOGY OF RUNS MADE IN THE SLURRY BUBBLE COLUMN REACTORS DURING THE FOURTH QUARTER OF 1995

Task 2.0 -- Catalyst Testing

Subtask 2.2 - Slurry Bubble Column Testing

Three runs were made (3060, 3061, and 4042) in the SBCR's at standard run conditions, but at a lower reaction temperature (220°C) using 15 gm of catalyst provided by Calsicat. Each catalyst (CAL.15, CAL.16, and CAL.17) contained 20% Co on alumina support with no additives or promoters, but were flaked in Soya wax. The CO conversion for each catalyst was 2% or lower so each run was terminated after a few hours.

Run 3062 in the M3-SBCR was started with a charge of 15 gm of Calsicat Catalyst No. CAL.19. This catalyst contained 20% Co on alumina support with no additives. The catalyst received was dry and approximately 50 gm was reduced in our hydrogenation unit at 350°C for 18 hours. The CO conversion was 13.6%, the THC productivity was 0.66 Kg C₁+/Kg cat. hr., and the CH₄ selectivity was 3.2%. The results indicated that laboratory scale reduction of small batches of non-promoted Co/Al₂O₃ catalyst resulted in a well reduced and very active catalyst.

Run 4045 in the M4-SBCR was started with a 15 gm of non-promoted Co/Al₂O₃ catalyst supplied by Calsicat (CAL.20). A 220 gm batch was charged to our laboratory scale fluidized reduction unit and reduced at standard conditions. The CO conversion was only 3.4% at standard run conditions. The run was stopped and flushed out for the next run.

Run 4047 in the M4-SBCR was started with 15 gm of the non-promoted Co/Al₂O₃ catalyst (CAL.20) that was recharged to the H₂ reduction unit and re-reduced in a 100 gm batch. The CO conversion only increased to 4.9%. The run was stopped and the unit was flushed out for the next run.

Run 4043 in the M4-SBCR was charged with 15 gm of a promoted catalyst from Calsicat (CAL.18) and run at standard startup conditions except a reaction temperature of 220°C. This catalyst contained 20% Co, 0.5% Ru, and 0.3% K and was hydrogen reduced and coated with Soya wax by Calsicat. The CO conversion was 8.4%, the THC was 0.41 Kg C₁+/Kg catalyst/hr, and less than 1.0% CH₄ selectivity. This is about 90% of the catalyst activity that would be obtained by a dry catalyst - H₂ reduced and charged in synfluid.

Run 4048 in the M4-SBCR was started with 15 gm of a promoted catalyst from Calsicat (CAL.25) and run at the same conditions as the above runs. This catalyst contained 20% Co, 0.5% Ru, and 0.3% K and was hydrogen reduced at EI and charged in synfluid. The CO conversion was

9.5%, the THC was 0.46 Kg C₁+/Kg catalyst hr., and less than 1.0% CH₄ selectivity. This catalyst activity was within the expected values obtained previously with similar catalysts.

APPENDIX B

SLURRY BUBBLE COLUMN REACTOR DATA

Table I. SUMMARY OF M3 SBCR RUN RESULTS

- a) Unless otherwise noted, total flow is ca. 15 L/min. STP, or 3 cm/sec linear gas flow.
 b) Conversion is total CO conversion over the period (%).
 c) Conversion and selectivities are calculated using N2 as an internal standard in the GC analysis of the offgas
 d) Prod. rate: Rate for production of total hydrocarbons, C1+ (kg/kg cat., hr).
 e) Alpha: Based on GC analysis of offgas and liquid product.

Run No	Cat. No	Cat. wt,g	Per No	Time Start	Time Stop	Temp C	Pres psi	H2: CO	Synfl cc/hr	Conv. %	Prod. Rate	Selectivities				Alpha GC	Alpha Liq	fin/Paraffin		Olefins C6-18%	Comments
												%CH4	%C2	%C3+	%CO2			C3	C4		
2	Co.001	16.5	1	162	177	225	450	2.0	20	15.9	0.70	2.3	0.81	96.4	0.53	0.98	0.88	5.00	2.27	25.2	
2	Co.001	16.5	2	202	228	200	450	2.0	20	3.9	0.17	0.0	0.0	99.9	0.00	0.81	0.91	0.00	0.00	21.7	
2	Co.001	16.5	3	254	280	240	450	2.0	20	30.9	1.36	11.7	1.8	85.5	1.04	0.87	0.77	2.63	1.64	22.4	
2	Co.001	16.5	4	302	323	225	450	1.2	20	9.9	0.59	0.7	0.3	98.4	0.67	0.76	0.90	0.00	7.14	29.4	
2	Co.001	16.5	5	350	372	225	450	2.0	20	15.3	0.68	6.0	1.0	92.5	0.49	0.84	0.88	4.00	2.70	23.1	
2	Co.001	16.5	6	398	420	225	300	2.0	20	12.5	0.55	6.1	1.13	92.2	0.63	0.79	0.86	4.35	2.86	21.7	
2	Co.001	16.5	7	446	468	240	300	2.0	20	22.9	1.02	16.5	0.81	81.5	1.16	0.71	0.79	3.03	1.79	22.4	
2	Co.001	16.5	8	494	516	240	600	2.0	20	29.9	1.33	12.6	1.6	85.0	0.84	0.76	0.82	2.63	1.69	22.4	
2	Co.001	16.5	9	517	540	240	600	2.0	0	29.5	1.31	12.0	1.72	85.3	0.96	0.76	—	2.50	1.56	22.4	
2	Co.001	16.5	9	541	564	240	600	2.0	0	28.4	1.26	10.4	1.7	87.1	0.89	0.77	—	3.03	1.72	—	
2	Co.001	16.5	9	565	588	240	600	2.0	0	27.9	1.27	11.1	1.74	86.2	0.93	0.76	—	3.03	1.72	—	
2	Co.001	16.5	9	589	612	240	600	2.0	0	27.0	1.20	10.7	1.72	86.7	0.89	0.76	0.82	2.78	2.00	—	
2	Co.001	16.5	10	637	660	240	600	2.0	20	26.4	1.17	11.0	1.7	86.4	0.85	0.77	0.83	2.86	1.96	22.4	G.C. Calib
2	Co.001	16.5	11	684	706	225	450	2.0	20	11.6	0.51	5.4	1.0	93.0	0.61	0.81	0.87	5.26	3.45	23.8	
3	Co.005	19.5	1	12	36	240	450	2.0	20	33.2	1.23	5.6	1.61	91.8	1.06	0.80	0.81	2.04	1.27	23.1	G.C. Calib
3	Co.005	19.5	2	60	84	220	450	2.0	20	15.0	0.56	2.9	0.61	96.2	0.24	0.86	0.87	4.55	3.23	21.7	
3	Co.005	19.5	3	108	132	240	450	1.2	20	18.5	0.94	6.9	1.0	91.3	0.85	0.81	—	5.88	3.85	26.6	
3	Co.005	19.5	4	156	179	240	450	2.0	20	29.6	1.11	11.5	1.8	85.8	0.91	0.76	0.78	2.22	1.39	21.7	
4	Co.002	20.1	1	37	59	240	450	2.0	20	36.1	1.32	22.9	3.22	72.4	1.51	0.66	0.77	0.65	0.31	16.8	
4	Co.002	20.1	2	85	106	220	450	2.0	20	16.6	0.60	3.8	1.13	94.7	0.35	0.84	0.88	2.44	0.89	—	
4	Co.002	20.1	3	133	149	210	600	1.0	20	5.2	0.28	0.0	0.0	99.1	0.87	0.89	0.94	0.00	0.00	—	Power Fail
5	Co.003	15.1	1	15	35	240	450	2.0	20	31.7	1.53	16.7	2.4	79.8	1.16	0.71	—	1.30	0.60	18.2	G.C. Calib
5	Co.003	15.1	2	61	83	220	450	2.0	20	13.2	0.63	5.1	1.0	93.4	0.51	0.82	0.90	4.55	1.89	—	
5	Co.003	15.1	3	88	107	240	450	2.0	20	28.4	1.37	15.1	2.4	81.4	1.11	0.75	—	1.45	0.97	—	
5	Co.003	15.1	4	133	155	240	450	1.0	20	13.1	0.95	4.2	1.24	93.3	1.24	0.83	0.88	6.67	3.70	—	
5	Co.003	15.1	5	181	203	240	600	1.0	20	13.4	0.97	3.9	1.1	93.7	1.30	0.81	—	5.26	3.45	30.1	
5	Co.003	15.1	6	217	227	240	450	2.0	20	25.4	1.23	14.9	2.4	81.7	1.03	0.73	—	1.89	1.19	—	
6	Co.011	15.3	1	13	35	240	450	2.0	20	14.3	0.67	7.6	1.6	89.4	1.42	0.78	0.83	4.17	2.57	21.7	
6	Co.011	15.3	2	61	83	220	450	2.0	20	5.1	0.23	0.0	0.0	97.2	2.78	0.87	0.82	—	—	—	
6	Co.011	15.3	3	88	107	240	450	2.0	20	13.5	0.63	5.4	1.7	91.1	1.86	0.79	—	4.00	2.83	—	
6	Co.011	15.3	4	133	155	240	450	1.0	20	6.3	0.44	0.4	1.02	95.5	3.05	0.82	0.88	—	—	—	
6	Co.011	15.3	5	181	203	240	600	1.0	20	6.7	0.46	0.2	0.9	96.0	2.91	0.84	0.89	12.00	3.67	27.3	G.C. Calib
6	Co.011	15.3	6	217	226	240	450	2.0	20	12.0	0.57	5.9	1.8	90.4	1.91	0.78	—	4.40	2.43	—	
7	Co.012	15.8	1	14	36	240	450	2.0	20	13.9	0.63	6.1	1.51	90.6	1.74	0.80	0.89	4.00	2.57	17.5	
7	Co.012	15.8	2	62	84	220	450	2.0	20	5.1	0.23	0.0	0.2	97.8	2.02	0.89	0.90	—	2.50	—	
7	Co.012	15.8	3	88	92	240	450	2.0	20	13.1	0.59	6.1	1.71	90.4	1.75	0.80	—	5.00	2.25	—	Power Fail
7	Co.012	15.8	4	134	156	240	450	1.0	20	3.9	0.26	4.8	2.3	86.3	6.64	0.70	0.85	16.00	3.50	—	
7	Co.012	15.8	5	182	204	240	600	1.0	20	4.3	0.28	0.1	2.1	91.6	9.29	0.75	0.82	8.50	3.50	30.8	
7	Co.012	15.8	6	218	227	240	450	2.0	20	7.2	0.32	7.3	3.2	85.1	4.45	0.70	—	5.00	3.17	—	

Table I. SUMMARY OF SBCR RUN RESULTS (continued)

- a) Unless otherwise noted, total flow is ca. 15 L/min. STP, or 3 cm/sec linear gas flow.
 b) Conversion is total CO conversion over the period (%).
 c) Conversion and selectivities are calculated using N₂ as an internal standard in the GC analysis of the offgas
 d) Prod. rate: Rate for production of total hydrocarbons, C₁+ (kg/kg cat.,hr).
 e) Alpha: Based on GC analysis of offgas and liquid product.

Run No	Cat. No	Cat. wt.g	Per No	Time Start	Time Stop	Temp C	Pres psi	H ₂ : CO	Synfl cc/hr	Conv. %	Prod. Rate	Selectivities				Alpha GC	Alpha Liq	fin/Paraffin		Olefins C ₆ -18%	Comments
8	Co.015	15.0	1	14	35	240	450	2.0	20	28.3	1.37	12.7	2.0	84.1	1.24	0.76	0.80	1.61	1.07	19.6	G.C. Calib
8	Co.015	15.0	2	61	83	220	450	2.0	20	11.5	0.56	4.4	1.0	93.91	0.80	0.81	0.89	3.60	2.14	—	
8	Co.015	15.0	3	97	106	240	450	2.0	20	26.4	1.28	13.2	2.11	83.5	1.12	0.75	—	1.69	1.20	—	
8	Co.015	15.0	4	133	155	240	450	1.0	20	11.5	0.83	4.8	1.2	92.5	1.53	0.80	0.85	5.60	3.29	—	
8	Co.015	15.0	5	181	191	240	600	1.0	20	12.4	0.90	4.9	0.84	93.6	0.73	0.84	0.85	5.20	3.14	30.8	Power Fail
9	Co.011	15.0	1	13	35	240	450	2.0	20	18.5	0.89	8.8	1.7	88.8	0.77	0.78	0.83	3.18	1.85	20.3	G.C. Calib
9	Co.011	15.0	2	61	82	220	450	2.0	20	6.3	0.31	0.0	1.0	98.6	0.41	0.88	0.93	12	1.80	—	
9	Co.011	15.0	3	97	107	240	450	2.0	20	16.6	0.80	8.4	2.1	88.7	0.81	0.77	—	3.30	2.00	—	
9	Co.011	15.0	4	133	155	240	450	1.0	20	8.0	0.58	1.3	1.31	96.3	1.16	0.82	0.87	7.00	2.83	—	
9	Co.011	15.0	5	181	203	240	600	1.0	20	8.7	0.63	1.4	1.1	96.4	1.05	0.83	0.87	5.00	2.67	30.5	
9	Co.011	15.0	6	228	229	240	450	2.0	20	14.7	0.71	7.9	2.2	89.1	0.85	0.78	—	3.78	1.67	—	Power Fail
11	Co.017	15.0	1	9	31	240	450	2.0	20	27.2	1.32	11.2	1.8	85.9	1.14	0.77	0.80	2.09	1.20	30.8	
11	Co.017	15.0	2	55	79	220	450	2.0	20	11.4	0.55	5.0	0.0	94.8	0.22	0.88	0.90	5.00	3.20	—	
11	Co.017	15.0	3	81	103	240	450	2.0	20	25.9	1.26	11.7	1.61	85.6	1.14	0.77	—	1.95	1.26	—	
11	Co.017	15.0	4	129	151	240	450	1.0	20	11.6	0.84	5.0	0.0	93.9	1.19	0.82	0.86	25.0	2.88	—	
11	Co.017	15.0	5	177	199	240	600	1.0	20	11.6	0.84	4.2	0.0	94.7	1.17	0.86	0.86	24.0	1.63	21.0	G.C. Calib
11	Co.017	15.0	6	213	221	240	450	2.0	20	24.3	1.20	12.1	1.4	86.4	0.08	0.78	—	2.47	1.64	—	
12	Co.018	15.6	1	13	35	240	450	2.0	20	33.8	1.56	9.7	2.01	86.6	1.68	0.75	0.85	1.81	1.13	21.0	G.C. Calib
12	Co.018	15.6	2	61	80	220	450	2.0	20	12.6	0.59	2.8	0.0	97.1	0.08	0.90	0.88	—	—	—	
12	Co.018	15.6	3	97	107	240	450	2.0	20	27.9	1.30	9.4	1.9	87.7	1.03	0.75	—	2.65	2.17	—	
12	Co.018	15.6	4	133	155	240	450	1.0	20	12.4	0.86	3.3	0.0	95.0	1.67	0.80	0.86	—	—	—	
12	Co.018	15.6	5	181	203	240	600	1.0	20	13.0	0.90	3.2	0.0	94.9	1.86	0.80	0.85	—	—	38.5	
12	Co.018	15.6	6	217	226	240	450	2.0	20	26.4	1.22	10.1	1.4	86.8	1.74	0.73	—	2.89	2.05	—	
13	Co.016	14.7	1	16	35	240	450	2.0	20	26.4	1.31	8.3	1.71	89.3	0.68	0.78	0.81	2.00	1.41	21.7	G.C. Calib
13	Co.016	14.7	2	65	83	220	450	2.0	20	9.7	0.48	0.0	0.01	99.9	0.00	0.91	0.88	—	—	—	TCD weak.
13	Co.016	14.7	3	89	105	240	450	2.0	20	25.2	1.25	9.2	1.72	88.6	0.51	0.78	—	2.10	1.41	—	CH ₄ peaks
13	Co.016	14.7	4	134	155	240	450	1.0	20	10.9	0.81	1.2	0.79	97.7	0.32	0.84	0.86	—	—	—	are lower
13	Co.016	14.7	5	181	203	240	600	1.0	20	11.4	0.85	0.0	0.49	99.3	0.25	0.92	0.86	—	—	32.2	than
13	Co.016	14.7	6	210	226	240	450	2.0	20	22.7	1.12	3.8	1.98	93.7	0.46	0.79	—	2.37	1.41	—	expected.
14	Co.019	15.2	1	14	35	240	450	2.0	20	13.9	0.66	0.4	1.7	97.2	0.70	0.80	0.86	5.33	2.67	26.6	G.C. Calib
14	Co.019	15.2	2	66	83	220	450	2.0	20	3.8	0.18	0.0	1.71	96.7	1.56	0.88	—	—	—	—	New TCD
14	Co.019	15.2	3	88	105	240	450	2.0	20	12.2	0.57	0.0	2.03	96.3	1.67	0.80	—	5.60	3.80	—	
14	Co.019	15.2	4	133	155	240	450	1.0	20	—	—	—	—	—	0.85	—	—	—	—	—	Repair G.C.
14	Co.019	15.2	5	169	178	240	600	1.0	20	5.9	0.41	0.0	1.5	96.1	2.42	0.80	—	8.50	13.00	—	Valve Leak
14	Co.019	15.2	6	193	203	240	450	2.0	20	10.2	0.48	0.8	2.23	95.0	1.96	0.79	—	4.80	3.40	—	CH ₄ peaks
14	Co.019	15.2	7	217	226	240	450	1.0	20	5.1	0.36	0.0	1.6	95.4	3.09	0.80	—	—	—	—	undetected.
15	Co.005	14.7	2	62	83	220	450	2.0	20	10.7	0.53	0.0	0.94	98.4	0.70	0.83	0.88	4.25	3.25	—	
15	Co.005	14.7	3	86	105	240	450	2.0	20	25.3	1.25	7.6	1.8	89.6	1.01	0.78	—	2.42	1.50	—	
15	Co.005	14.7	4	134	155	240	450	1.0	20	11.6	0.85	0.0	1.12	97.5	1.37	0.82	0.85	7.00	4.60	—	
15	Co.005	14.7	5	182	203	240	600	1.0	20	12.3	0.90	0.0	1.0	97.7	1.33	0.83	0.85	7.00	4.40	—	
15	Co.005	14.7	6	210	226	240	450	2.0	20	23.0	1.13	5.9	1.8	91.4	0.99	0.78	—	3.20	2.00	—	

Table I. SUMMARY OF SBCR RUN RESULTS (continued)

- a) Unless otherwise noted, total flow is ca. 15 L/min. STP, or 3 cm/sec linear gas flow.
 b) Conversion is total CO conversion over the period (%).
 c) Conversion and selectivities are calculated using N₂ as an internal standard in the GC analysis of the offgas.
 d) Prod. rate: Rate for production of total hydrocarbons, C₁+ (kg/kg cat., hr).
 e) Alpha: Based on GC analysis of offgas and liquid product.

Run No	Cat. No	Cat. wt,g	Per No	Time Start	Time Stop	Temp C	Pres psi	H2: CO	Synfl cc/hr	Conv. %	Prod. Rate	Selectivities				Alpha GC	Alpha Liq	fin/Paraffin		Olefins C6-18%	Comments	
												%CH4	%C2	%C3+	%CO2			C3	C4			
16	Co.002	15.4	1	14	35	240	450	2.0	20	30.1	1.42	12.5	2.52	83.9	1.09	0.75	0.80	--	1.00	0.66	17.5	G.C. Calib
16	Co.002	15.4	2	67	83	220	450	2.0	20	12.8	0.60	4.2	1.3	93.9	0.65	0.80	0.86	2.57	1.63	--		
16	Co.002	15.4	3	91	107	240	450	2.0	20	28.2	1.34	17.3	2.91	78.8	0.99	0.71	--	0.93	0.65	--		
16	Co.002	15.4	4	136	155	240	450	1.0	20	12.6	0.89	4.4	1.61	92.8	1.21	0.79	0.84	4.43	2.88	--		
16	Co.002	15.4	5	182	198	240	600	1.0	20	13.1	0.92	3.6	1.4	93.9	1.12	0.81	0.84	4.29	2.75	25.2		
16	Co.002	15.4	6	209	227	240	450	2.0	20	25.6	1.22	17.4	3.1	78.7	0.83	0.71	--	1.00	0.66	--		
17	Co.025	15.6	1	21	35	240	450	2.0	20	26.6	1.24	10.7	2.1	86.4	0.82	0.76	0.82	2.25	1.47	21.7	G.C. Calib	
17	Co.025	15.6	2	62	83	220	450	2.0	20	8.4	0.39	0.0	1.1	96.9	1.94	0.82	0.92	6.50	3.00	--		
17	Co.025	15.6	3	90	107	240	450	2.0	20	21.5	1.00	9.0	2.03	88.0	1.03	0.77	--	2.64	1.64	--		
17	Co.025	15.6	4	134	155	240	450	1.0	20	10.3	0.71	0.8	1.2	96.7	1.30	0.82	0.93	7.67	4.25	--		
17	Co.025	15.6	5	181	203	240	600	1.0	20	11.7	0.81	1.3	1.12	96.5	1.12	0.83	0.88	8.00	4.25	32.9		
17	Co.025	15.6	6	217	226	240	450	2.0	20	19.9	0.93	9.3	2.2	87.7	0.91	0.76	--	2.92	1.85	--		
18	Co.004	15.0	1	20	39	240	450	2.0	20	33.9	1.64	15.3	2.4	80.9	1.37	0.74	0.79	1.17	0.78	20.3	Repair G.C.	
18	Co.004	15.0	2	66	87	220	450	2.0	20	15.1	0.73	4.1	1.61	94.0	0.29	0.81	0.85	3.83	2.25	--		
18	Co.004	15.0	3	92	111	240	450	2.0	20	32.7	1.59	15.7	2.6	80.2	1.49	0.73	--	1.20	0.80	--		
18	Co.004	15.0	4	138	159	240	450	1.0	20	14.7	1.06	4.1	1.24	93.2	1.44	0.80	0.83	6.17	3.75	--		
18	Co.004	15.0	5	186	207	240	600	1.0	20	15.0	1.09	3.6	1.13	94.1	1.18	0.82	0.83	5.67	4.00	33.6		
18	Co.004	15.0	6	214	230	240	450	2.0	20	28.4	1.38	14.9	2.5	86.5	1.13	0.73	--	1.58	1.03	--		
19	Co.021	15.6	1	16	35	240	450	2.0	20	23.2	1.08	9.4	2.0	88.0	0.73	0.77	0.82	2.56	1.54	20.3		
19	Co.021	15.6	2	62	83	220	450	2.0	20	8.3	0.38	0.0	1.3	98.2	0.51	0.82	0.88	4.33	3.33	--		
19	Co.021	15.6	3	90	107	240	450	2.0	20	21.8	1.02	10.2	2.2	86.7	0.95	0.76	--	2.50	1.53	--		
19	Co.021	15.6	4	134	155	240	450	1.0	20	9.9	0.69	1.7	1.6	95.5	1.41	0.81	0.83	6.00	3.80	--		
19	Co.021	15.6	5	182	203	240	600	1.0	20	11.5	0.80	1.8	1.22	95.8	1.16	0.83	0.85	6.50	3.80	30.8		
19	Co.021	15.6	6	210	226	240	450	2.0	20	19.9	0.93	9.6	2.3	87.2	0.95	0.76	--	2.31	1.38	--		
20	Co.041	15.8	1	17	37	240	450	2.0	20	25.3	1.16	11.0	2.1	86.0	0.88	0.76	0.84	2.94	1.61	20.3		
20	Co.041	15.8	2	66	75	220	450	2.0	20	9.1	0.41	0.0	1.51	97.8	0.65	0.82	0.91	8.00	2.75	--		
20	Co.041	15.8	3	90	109	240	450	2.0	20	26.3	1.21	9.5	1.9	87.8	0.82	0.78	--	2.81	1.71	--		
20	Co.041	15.8	4	136	148	240	450	1.0	20	12.7	0.88	1.9	1.2	95.9	0.95	0.83	0.86	9.00	4.20	--		
20	Co.041	15.8	5	169	178	240	600	1.0	20	13.2	0.91	2.0	1.01	96.1	0.93	0.84	--	7.00	3.50	--		
20	Co.041	15.8	6	193	203	240	450	2.0	20	24.6	1.13	9.4	1.8	87.9	0.92	0.78	--	2.93	1.75	--		
21	Co.014	15.1	1	24	38	240	450	2.0	20	8.5	0.40	8.3	3.54	85.8	2.43	0.74	0.83	2.75	1.67	17.5	G.C. Calib	
21	Co.014	15.1	2	68	86	220	450	2.0	20	3.2	0.15	0.0	2.34	93.4	4.31	0.76	0.86	3.50	3.00	--		
21	Co.014	15.1	3	93	110	240	450	2.0	20	7.1	0.34	8.7	3.0	85.9	2.46	0.71	--	3.00	2.00	--		
21	Co.014	15.1	4	138	157	240	450	1.0	20	2.2	0.15	0.0	2.8	89.3	7.92	0.67	0.84	9.00	4.00	--		
21	Co.014	15.1	5	186	206	240	600	1.0	20	2.1	0.15	0.0	2.6	94.8	2.68	0.71	0.81	4.50	3.50	--		
22	Co.040	14.5	1	19	32	240	450	2.0	20	1.8	0.09	0.0	4.01	94.1	1.89	0.71	0.82	2.50	2.00	--	G.C. Calib	
22	Co.040	14.5	2	43	63	220	450	2.0	20	0.7	0.03	0.0	0.73	97.1	2.17	0.91	--	1.00	2.00	--	Shut down	

Table I. SUMMARY OF SBCR RUN RESULTS (continued)

- a) Unless otherwise noted, total flow is ca. 15 L/min, STP, or 3 cm/sec linear gas flow.
 b) Conversion is total CO conversion over the period (%).
 c) Conversion and selectivities are calculated using N2 as an internal standard in the GC analysis of the offgas
 d) Prod. rate: Rate for production of total hydrocarbons, C1+ (kg/kg cat./hr).
 e) Alpha: Based on GC analysis of offgas and liquid product.

Run No	Cat. No	Cat. wt, g	Per No	Time Start	Time Stop	Temp C	Pres psi	H2: CO	Synfl cc/hr	Conv. %	Prod. Rate	Selectivities				Alpha GC	Alpha Liq	fin/Paraffin		Olefins C6-18%	Comments
23	Co.047	15.8	1	21	39	240	450	2.0	20	28.2	1.29	7.7	1.5	89.3	1.47	0.79	0.84	3.14	1.69	24.5	
23	Co.047	15.8	2			220	450	2.0	20	--	--	--	--	--	--	--	--	--	--	--	Repair G.C.
23	Co.047	15.8	3	94	111	240	450	2.0	20	25.6	1.17	8.9	1.5	88.2	1.38	0.78	--	3.15	2.00	--	
23	Co.047	15.8	4	141	159	240	450	1.0	20	11.9	0.81	2.9	0.9	94.1	2.13	0.82	0.88	7.33	4.75	--	
23	Co.047	15.8	5	187	207	240	600	1.0	20	11.8	0.81	2.6	0.8	94.6	2.01	0.82	0.87	7.00	3.60	--	
23	Co.047	15.8	6	215	226	240	450	2.0	20	24.0	1.10	10.7	1.9	85.7	1.71	0.75	--	3.54	2.13	--	
24	Co.049	15.6	1	19	39	240	450	2.0	20	30.6	1.41	10.9	1.8	85.7	1.66	0.76	0.82	2.09	1.30	14.0	
24	Co.049	15.6	2	71	87	220	450	2.0	20	12.0	1.07	2.7	0.9	95.3	1.09	0.81	0.95	4.25	3.25	--	
24	Co.049	15.6	3	95	111	240	450	2.0	20	29.5	1.37	9.5	1.6	87.6	1.30	0.78	--	2.32	1.40	--	
24	Co.049	15.6	4	139	159	240	450	1.0	20	12.6	0.87	3.1	1.0	94.1	1.80	0.81	0.86	8.33	4.20	--	
24	Co.049	15.6	5	187	207	240	600	1.0	20	13.4	0.93	2.6	0.9	94.8	1.68	0.82	0.88	8.33	4.20	37.8	
24	Co.049	15.6	6	211	231	240	450	2.0	20	24.9	1.16	10.4	1.7	86.5	1.36	0.76	--	2.75	1.75	--	
25	Co.047	15.6	1	19	33	240	450	2.0	20	28.1	1.30	8.8	1.6	88.1	1.50	0.78	0.85	2.93	1.88	25.9	Repeat R23
25	Co.047	15.6	2	55	69	220	450	2.0	20	7.4	0.34	1.5	1.2	96.3	1.02	0.76	0.89	3.00	4.67	--	
25	Co.047	15.6	3	93	159	240	450	2.0	20	25.6	1.19	8.9	1.6	87.9	1.48	0.77	--	3.14	2.00	--	
25	Co.047	15.6	4	143	159	240	450	1.0	20	10.8	0.75	3.0	1.0	94.2	1.84	0.81	0.94	8.00	4.75	--	
25	Co.047	15.6	5	189	207	240	600	1.0	20	12.4	0.86	2.2	0.8	95.6	1.39	0.83	0.86	7.33	4.50	36.4	
25	Co.047	15.6	6	215	231	240	450	2.0	20	23.2	1.08	9.6	1.7	87.4	1.28	0.77	--	3.50	2.07	--	
26	Co.031	15.9	1	19	39	240	450	2.0	20	30.9	1.41	12.1	1.9	84.9	1.12	0.75	0.83	1.83	1.14	22.4	
26	Co.031	15.9	2	67	87	220	450	2.0	20	13.6	0.62	3.9	0.9	94.6	0.49	0.80	0.85	4.20	2.67	--	
26	Co.031	15.9	3	93	111	240	450	2.0	20	29.5	1.35	12.2	2.1	84.6	1.15	0.75	--	1.97	1.25	--	
26	Co.031	15.9	4	141	159	240	450	1.0	20	12.9	0.88	3.6	1.1	94.3	1.11	0.80	0.88	7.75	4.00	--	
26	Co.031	15.9	5	189	207	240	600	1.0	20	13.9	0.95	3.5	1.0	94.4	1.12	0.81	0.85	6.80	3.71	30.1	
26	Co.031	15.9	6	221	230	240	450	2.0	20	26.6	1.22	12.0	2.2	84.9	0.96	0.74	--	2.30	1.43	--	
27	Co.029	15.9	1	23	39	240	450	2.0	20	28.3	1.27	8.3	1.6	87.9	2.21	0.77	0.84	3.40	2.20	27.3	
27	Co.029	15.9	2	71	87	220	450	2.0	20	9.5	0.43	1.7	1.1	96.0	1.23	0.80	0.89	5.67	3.00	--	
27	Co.029	15.9	3	99	111	240	450	2.0	20	25.7	1.16	7.7	1.6	88.8	1.86	0.78	--	4.00	2.36	--	
27	Co.029	15.9	4	150	159	240	450	1.0	20	12.0	0.82	1.9	0.9	95.4	1.88	0.83	0.90	8.33	4.75	--	
27	Co.029	15.9	5	191	207	240	600	1.0	20	12.1	0.82	1.7	0.9	95.6	1.75	0.83	0.89	7.67	4.75	39.9	
27	Co.029	15.9	6	222	230	240	450	2.0	20	23.7	1.08	8.2	1.7	88.5	1.60	0.78	--	3.92	2.67	--	
28	CoW.01	15.0	1	19	36	240	450	2.0	20	1.1	0.05	0.0	12.9	83.9	4.23	0.58	--	3.33	2.50	--	Shut down

Table I. SUMMARY OF SBGR RUN RESULTS (continued)

- a) Unless otherwise noted, total flow is ca. 15 L/min. STP, or 3 cm/sec linear gas flow.
 b) Conversion is total CO conversion over the period (%).
 c) Conversion and selectivities are calculated using N₂ as an internal standard in the GC analysis of the offgas
 d) Prod. rate: Rate for production of total hydrocarbons, C₁+ (kg/kg cat., hr).
 e) Alpha: Based on GC analysis of offgas and liquid product.

Run No	Cat. No	Cat. wt.g	Per No	Time Start	Time Stop	Temp C	Pres psi	H ₂ : CO	Synfl cc/hr	Conv. %	Prod. Rate	Selectivities				Alpha GC	Alpha Liq	fin/Paraffin		Olefins C ₆ -18%	Comments
												%CH ₄	%C ₂	%C ₃ +	%CO ₂			C ₃	C ₄		
29	Co.053	25.2	1	21	39	240	450	2.0	20	42.0	1.19	15.8	2.3	79.5	2.42	0.73	--	1.00	0.67	17.5	
29	Co.053	25.2	2	71	87	220	450	2.0	20	20.5	0.59	5.7	4.8	89.0	0.50	0.79	0.84	3.38	2.10	--	
29	Co.053	25.2	3	95	111	240	450	2.0	20	39.2	1.13	15.8	2.9	79.2	2.09	0.72	--	1.11	0.74	--	
29	Co.053	25.2	4	143	159	240	450	1.0	20	18.4	0.79	5.3	2.6	90.6	1.52	0.80	0.84	5.86	3.56	--	
29	Co.053	25.2	5	191	207	240	600	1.0	20	19.7	0.85	4.6	1.2	92.9	1.34	0.82	--	5.71	3.44	33.6	
29	Co.053	25.2	6	239	255	240	600	2.0	20	40.8	1.17	14.8	2.1	81.4	1.68	0.75	0.80	1.10	0.74	--	
29	Co.053	25.2	7	303	304	240	450	2.0	20	31.5	0.45	21.0	3.9	72.2	2.93	0.63	--	1.34	0.97	--	G.C. Calib
29	Co.053	25.2	8	332	351	260	450	2.0	20	31.0	0.44	36.4	5.3	52.6	5.74	0.52	--	2.60	1.75	--	
29	Co.053	25.2	9	375	376	240	450	2.0	20	18.0	0.55	23.0	3.5	72.1	1.46	0.66	--	3.21	2.05	--	
29	Co.053	25.2	10	415	423	240	450	2.0	20	21.6	0.98	14.4	2.5	82.4	0.82	0.72	0.79	2.87	1.79	25.9	G.C. Calib

Feed Gas Rates for Run 29

Per No	N ₂ Sl/h	H ₂ Sl/h	CO Sl/h	Total Sl/h
1	565	225	112	902
2	565	225	112	902
3	565	225	112	902
4	565	169	169	903
5	565	169	169	903
6	565	225	112	902
7	733	112	56	901
8	733	112	56	901
9	551	234	117	912
10	367	348	175	890

Table I. SUMMARY OF SBCR RUN RESULTS (continued)

- a) Unless otherwise noted, total flow is ca. 15 L/min. STP, or 3 cm/sec linear gas flow.
 b) Conversion is total CO conversion over the period (%).
 c) Conversion and selectivities are calculated using N₂ as an internal standard in the GC analysis of the offgas.
 d) Prod. rate: Rate for production of total hydrocarbons, C₁+ (kg/kg cat., hr).
 e) Alpha: Based on GC analysis of offgas and liquid product.

Run No	Cat. No	Cat. wt.g	Per No	Time Start	Time Stop	Temp C	Pres psi	H ₂ : CO	Synfl cc/hr	Conv. %	Prod. Rate	Selectivities				Alpha GC	Alpha Liq	fin/Paraffin		Olefins C ₆ -18%	Comments
												%CH ₄	%C ₂	%C ₃ +	%CO ₂			C ₃	C ₄		
30	Co.053	29.6	1	26	39	240	450	2.0	20	41.8	1.02	22.6	2.9	71.5	3.05	0.66	0.77	0.99	0.65	19.6	
30	Co.053	29.6	2	55	63	260	450	2.0	20	46.9	1.11	40.6	5.5	46.0	7.98	0.45	--	0.83	0.64	--	
30	Co.053	29.6	3	79	87	280	450	2.0	20	41.4	0.96	41.9	6.5	42.0	9.63	0.40	--	2.06	1.35	--	
30	Co.053	29.6	4	103	111	240	450	2.0	20	19.9	0.49	19.2	3.6	75.8	1.45	0.64	--	4.29	2.50	--	
30	Co.053	29.6	5	131	135	265	450	2.0	20	36.4	0.89	36.4	5.2	54.4	4.04	0.53	--	2.45	1.60	--	
30	Co.053	29.6	6	154	159	280	450	2.0	20	39.6	0.96	48.3	5.9	39.0	6.84	0.40	--	2.44	1.62	--	
30	Co.053	29.6	7	174	183	300	450	2.0	20	40.7	0.94	42.4	6.8	40.7	10.2	0.47	--	3.11	2.03	--	
30	Co.053	29.6	8	198	207	309	450	2.0	20	38.3	0.85	22.8	7.3	58.3	11.6	0.62	--	3.76	2.48	--	G.C. Calib
30	Co.053	29.6	9	220	231	310	450	2.0	20	37.5	0.87	55.5	7.2	25.5	11.8	0.13	--	3.93	2.67	--	
30	Co.053	29.6	10	242	254	320	450	2.0	20	40.8	0.90	61.7	7.4	14.5	16.4	0.00	--	3.62	2.63	--	
30	Co.053	29.6	11	270	279	320	450	1.0	20	30.8	0.92	42.9	6.0	26.9	24.2	0.30	--	5.68	4.28	--	Plug. Preht.
31	Co.055	15.0	1	23	39	240	450	2.0	20	30.03	1.46	23.7	3.73	70.2	2.3	0.61	0.81	0.90	0.60	20.3	
31	Co.055	15.0	2	71	87	220	450	2.0	20	9.1	0.44	10.6	2.53	85.7	1.1	0.61	0.85	2.89	1.80	--	
31	Co.055	15.0	3	98	110	240	450	2.0	20	25.8	1.26	23.9	3.94	70.1	--	0.58	--	1.06	0.70	--	
31	Co.055	15.0	4	143	159	240	450	1.0	20	14.7	1.06	5.5	1.44	91.7	1.4	0.78	0.83	5.71	3.22	--	
31	Co.055	15.0	5	196	207	240	600	1.0	20	16.1	1.16	4.7	1.21	92.8	1.3	0.80	0.83	6.17	3.11	33.6	
31	Co.055	15.0	6	222	234	240	450	2.0	20	29.1	1.42	18.0	2.84	77.8	--	0.69	--	1.40	0.91	--	
32	Co.044	16.4	1	23	39	240	450	2.0	20	20.9	0.93	6.7	1.91	90.8	0.6	0.77	0.83	3.42	2.17	23.1	
32	Co.044	16.4	2	71	87	220	450	2.0	20	10.3	0.46	0.0	0.92	98.8	0.3	0.85	--	4.33	4.50	--	
32	Co.044	16.4	3	102	110	240	450	2.0	20	21.8	0.97	6.4	1.72	91.3	--	0.79	--	3.00	1.77	--	
32	Co.044	16.4	4	143	159	240	450	1.0	20	9.87	0.25	2.1	3.19	92.5	2.2	0.61	0.87	7.33	4.00	--	
32	Co.044	16.4	5	174	182	240	450	2.0	20	20.2	0.89	6.8	1.85	90.8	--	0.79	--	2.92	1.75	--	
33	Co.053	31.4	1	24	39	240	450	2.0	20	41.4	0.94	23.2	3.1	69.6	4.1	0.65	0.76	0.82	0.58	21.7	G.C. Calib
33	Co.053	31.4	2	54	63	240	300	2.0	20	35.2	0.47	29.9	3.9	59.6	6.6	0.55	--	0.89	0.70	--	
33	Co.053	31.4	3	78	87	240	300	2.0	20	38.7	0.38	31.1	3.9	57.5	7.5	0.54	--	0.97	0.71	--	
33	Co.053	31.4	4	102	111	250	300	2.0	20	39.6	0.38	43.1	4.6	41.1	11.2	0.38	--	0.99	0.77	--	
33	Co.053	31.4	5	126	135	260	300	2.0	20	37.7	0.37	42.1	4.6	42.4	10.9	0.42	--	1.76	1.21	--	
33	Co.053	31.4	6	150	159	260	450	2.0	20	45.0	0.44	43.2	4.8	40.9	11.1	0.44	--	1.35	0.95	--	
33	Co.053	31.4	7	174	183	260	450	2.0	20	45.7	0.73	46.4	4.6	40.2	8.8	0.43	--	1.06	0.77	--	
33	Co.053	31.4	8	198	207	260	450	2.0	20	49.2	0.98	44.4	4.3	43.5	7.8	0.51	--	0.87	0.65	--	
33	Co.053	31.4	9	222	230	240	450	2.0	20	16.1	0.38	33.7	4.8	59.2	2.3	0.35	--	3.14	1.91	--	

Feed Gas Rates for Run 33

Per No	N ₂ Sl/h	H ₂ Sl/h	CO Sl/h	Total Sl/h
1	563	225	112	900
2	338	135	67	540
3	250	100	50	400
4	250	100	50	400
5	250	100	50	400
6	250	100	50	400
7	160	160	80	400
8	100	200	100	400
9	563	225	112	900

Table I. SUMMARY OF SBCR RUN RESULTS (continued)

- a) Unless otherwise noted, total flow is ca. 15 L/min. STP, or 3 cm/sec linear gas flow.
 b) Conversion is total CO conversion over the period (%).
 c) Conversion and selectivities are calculated using N₂ as an internal standard in the GC analysis of the offgas.
 d) Prod. rate: Rate for production of total hydrocarbons, C₁+ (kg/kg cat./hr).
 e) Alpha: Based on GC analysis of offgas and liquid product.

Run No	Cat. No	Cat. wt,g	Per No	Time Start	Time Stop	Temp C	Pres psi	H ₂ : CO	Synfl cc/hr	Conv. %	Prod. Rate	Selectivities				Alpha GC	Alpha Liq	fin/Paraffin		Olefins C ₆ -18%	Comments
												%CH ₄	%C ₂	%C ₃ +	%CO ₂			C ₃	C ₄		
34	Co.060	15.6	1	23	32	240	450	2.0	20	31.4	1.46	14.0	2.3	82.2	1.5	0.75	0.79	1.61	1.00	23.1	G.C. Calib
34	Co.060	15.6	2	71	87	220	450	2.0	20	13.0	0.60	0.1	1.8	97.8	0.3	0.81	0.88	4.00	2.83	—	G.C. Calib
34	Co.060	15.6	3	102	111	240	450	2.0	20	28.8	1.34	14.1	2.4	82.2	1.3	0.73	—	1.87	1.17	—	
34	Co.060	15.6	4	150	157	240	450	1.0	20	13.5	0.94	4.3	1.8	92.5	1.5	0.77	0.85	7.00	4.67	—	
34	Co.060	15.6	5	191	207	240	600	1.0	20	12.8	0.89	2.2	1.6	94.9	1.3	0.82	0.86	6.60	4.33	38.5	G.C. Calib
34	Co.060	15.6	6	222	230	240	450	2.0	20	24.9	1.16	13.8	2.8	82.2	1.2	0.74	—	2.73	1.73	—	
35	Co.041	26.0	1	23	39	240	450	2.0	20	35.7	1.00	13.6	2.1	82.9	1.4	0.79	0.82	1.09	0.74	18.2	
35	Co.041	26.0	2	54	63	250	450	2.0	20	42.1	1.17	27.3	4.6	64.4	3.7	0.65	—	0.49	0.41	—	G.C. Calib
35	Co.041	26.0	3	78	87	260	450	2.0	20	45.1	1.24	41.7	6.8	44.9	6.6	0.51	—	0.35	0.37	—	
35	Co.041	26.0	4	102	111	260	450	2.0	20	46.7	0.77	39.1	4.6	49.9	6.5	0.56	—	0.66	0.52	—	
35	Co.041	26.0	5	126	135	260	450	2.0	20	49.6	0.61	39.4	4.0	49.6	7.0	0.57	—	0.70	0.52	—	
35	Co.041	26.0	6	150	159	260	450	2.0	20	47.9	0.95	33.1	3.9	58.7	4.3	0.64	—	0.75	0.52	—	
35	Co.041	26.0	7	174	183	260	450	2.0	20	49.7	1.24	30.9	4.4	61.3	3.4	0.66	—	0.71	0.49	—	
35	Co.041	26.0	8	198	206	240	450	2.0	20	19.6	0.55	17.3	2.6	79.1	1.0	0.71	—	2.08	1.63	—	

Feed Gas Rates for Run 35

Per No	N ₂ Sl/h	H ₂ Sl/h	CO Sl/h	Total Sl/h
1	568	225	112	905
2	568	225	112	905
3	568	225	112	905
4	341	135	68	544
5	253	100	50	403
6	163	160	80	403
7	103	200	100	403
8	571	225	112	908

Table I. SUMMARY OF SBCR RUN RESULTS (continued)

- a) Unless otherwise noted, total flow is ca.15 L/min. STP, or 3 cm/sec linear gas flow.
 b) Conversion is total CO conversion over the period (%).
 c) Conversion and selectivities are calculated using N2 as an internal standard in the GC analysis of the offgas
 d) Prod. rate: Rate for production of total hydrocarbons, C1+ (kg/kg cat., hr).
 e) Alpha: Based on GC analysis of offgas and liquid product.

Run No	Cat. No	Cat. wt,g	Per No	Time Start	Time Stop	Temp C	Pres psi	H2: CO	Synfl cc/hr	Conv. %	Prod. Rate	Selectivities				Alpha GC	Alpha Liq	fin/Paraffin		Olefins C6-18%	Comments
												%CH4	%C2	%C3+	%CO2			C3	C4		
36	Co.032	15.9	1	23	39	240	450	2.0	20	24.0	1.10	9.1	1.8	88.2	0.83	0.77	0.83	3.23	2.00	25.2	
36	Co.032	15.9	2	71	87	220	450	2.0	20	7.7	0.35	0.0	1.5	97.8	0.77	0.81	0.91	4.00	3.33	--	
36	Co.032	15.9	3	102	111	240	450	2.0	20	21.1	0.97	8.7	2.4	88.2	0.68	0.78	--	3.08	1.86	--	G.C. Calib
36	Co.032	15.9	4	126	135	240	450	1.0	20	9.5	0.65	1.4	1.2	96.5	0.87	0.83	--	7.67	4.50	--	
36	Co.032	15.9	5	150	159	240	450	2.0	20	18.2	0.83	8.9	1.6	88.9	0.64	0.78	--	3.36	2.36	--	
36	Co.032	15.9	6	174	183	250	450	2.0	20	23.3	1.07	14.5	3.0	81.6	1.01	0.73	--	2.29	1.48	--	
36	Co.032	15.9	7	199	207	260	450	2.0	20	25.3	1.17	23.5	3.8	71.2	1.51	0.61	--	1.76	1.15	--	G.C. Calib
36	Co.032	15.9	8	222	230	240	450	2.0	20	11.0	0.51	10.4	2.9	85.9	0.88	0.67	--	3.33	2.33	--	
37	Co.045	15.9	1	23	39	240	450	2.0	20	14.8	0.67	8.0	1.7	89.4	0.91	0.76	0.84	2.78	1.90	20.3	
37	Co.045	15.9	2	54	63	220	450	2.0	20	5.1	0.23	0.0	1.5	97.7	0.77	0.80	0.88	4.00	3.00	--	
37	Co.045	15.9	3	78	87	240	450	2.0	20	13.8	0.63	8.2	1.9	89.0	0.89	0.76	--	3.00	1.80	--	
37	Co.045	15.9	4	102	111	240	450	1.0	20	6.5	0.44	0.1	1.4	97.3	1.16	0.82	--	5.00	2.00	--	
37	Co.045	15.9	5	126	135	240	450	2.0	20	13.4	0.61	0.6	1.8	88.9	0.80	0.79	--	2.00	0.00	--	
37	Co.045	15.9	6	150	159	250	450	2.0	20	19.6	0.91	17.5	2.5	80.0	--	0.77	--	--	0.00	--	G.C. Calib
37	Co.045	15.9	7	174	183	260	450	2.0	20	27.4	1.26	30.1	5.2	62.2	2.49	0.61	--	0.83	0.60	--	
37	Co.045	15.9	8	198	207	240	450	2.0	20	13.7	0.63	9.3	1.7	87.4	0.78	0.75	--	2.67	1.67	--	
38	Co.058	15.9	1	23	39	240	450	2.0	20	28.0	1.28	11.9	2.1	85.1	0.91	0.75	0.85	1.88	1.17	22.4	
38	Co.058	15.9	2	47	63	220	450	2.0	20	11.7	0.54	1.4	1.4	96.9	0.38	0.81	--	4.00	3.00	--	
38	Co.058	15.9	3	74	88	240	450	2.0	20	12.7	0.87	3.2	1.3	94.5	1.01	0.81	--	7.25	4.40	--	
38	Co.058	15.9	4	96	111	240	450	2.0	20	26.4	1.21	11.9	2.2	85.0	0.87	0.74	--	2.09	1.26	--	
39	Co.064	15.9	1	23	39	240	450	2.0	20	34.2	1.56	13.6	2.3	82.6	1.55	0.73	0.85	1.40	0.92	21.0	G.C. Calib
39	Co.064	15.9	2	47	62	220	450	2.0	20	15.0	0.68	4.6	1.2	93.8	0.44	0.78	--	4.17	2.38	--	
39	Co.064	15.9	3	71	87	240	450	2.0	20	15.9	1.09	4.7	1.2	92.9	1.28	0.80	--	7.86	3.88	--	
39	Co.064	15.9	4	95	111	240	450	2.0	20	33.1	1.52	15.7	2.6	80.3	1.52	0.72	--	1.37	0.90	--	
40	Co.063	15.0	1	23	40	240	450	2.0	20	8.7	0.43	6.5	0.9	92.6	0.09	0.74	--	7.67	3.40	25.9	
40	Co.063	15.0	2	47	63	220	450	2.0	20	2.0	0.95	0.1	0.0	99.9	0.00	0.67	--	7.00	7.00	--	
40	Co.063	15.0	3	71	87	240	450	1.0	20	3.6	0.27	2.3	1.3	95.9	0.54	0.76	--	13.00	5.50	--	
40	Co.063	15.0	4	95	111	240	450	2.0	20	9.5	0.46	8.1	1.9	89.6	0.40	0.74	--	4.80	3.17	--	
41	Co.062	15.0	1	23	38	240	450	2.0	20	6.6	0.32	3.5	0.3	95.3	1.00	0.76	0.89	9.50	3.50	25.9	
41	Co.062	15.0	2	47	62	220	450	2.0	20	1.8	0.09	0.0	0.0	99.9	0.00	0.88	--	4.00	5.00	--	
41	Co.062	15.0	3	71	86	240	450	1.0	20	2.7	0.19	0.1	1.0	96.9	1.99	0.77	--	10.00	4.00	--	
41	Co.062	15.0	4	95	109	240	450	2.0	20	5.6	0.27	4.3	2.1	92.0	1.60	0.74	--	5.70	4.00	--	
42	Co.065	15.9	1	23	38	240	450	2.0	20	27.6	1.25	7.9	2.0	88.6	1.61	0.79	0.84	2.94	1.88	28.0	G.C. Calib
42	Co.065	15.9	2	47	62	220	450	2.0	20	10.0	0.46	0.0	2.0	97.3	0.67	0.82	--	5.33	3.25	--	
42	Co.065	15.9	3	71	86	240	450	1.0	20	13.11	0.89	1.2	1.5	95.7	1.67	0.84	--	7.00	5.50	--	
42	Co.065	15.9	4	95	110	240	450	2.0	20	26.2	1.19	9.0	2.1	87.3	1.57	0.78	--	3.06	2.13	--	
43	CoW.12	9.1	1	23	38	240	450	2.0	20	6.1	0.47	20.3	6.1	66.3	7.29	0.61	0.83	3.63	2.33	11.9	
43	CoW.12	9.1	2	54	62	279	450	2.0	20	25.1	1.86	32.4	5.4	51.3	11.0	0.52	--	1.62	1.12	--	

Table I. SUMMARY OF SBCR RUN RESULTS (continued)

- a) Unless otherwise noted, total flow is ca. 15 L/min, STP, or 3 cm/sec linear gas flow.
 b) Conversion is total CO conversion over the period (%).
 c) Conversion and selectivities are calculated using N2 as an internal standard in the GC analysis of the offgas
 d) Prod. rate: Rate for production of total hydrocarbons, C1+ (kg/kg cat., hr).
 e) Alpha: Based on GC analysis of offgas and liquid product.

Run No	Cat. No	Cat. wt,g	Per No	Time Start	Time Stop	Temp C	Pres psi	H2: CO	Synfl cc/hr	Conv. %	Prod. Rate	Selectivities				Alpha GC	Alpha Liq	fin/Paraffin		Olefins		Comments
												%CH4	%C2	%C3+	%CO2			C3	C4	C6-18%		
44	CoW.11	15.6	1	23	38	240	450	2.0	20	4.7	0.20	8.4	6.3	74.4	10.9	0.60	--	5.40	3.50	--		
44	CoW.11	15.6	2	47	62	260	450	2.0	20	12.7	0.51	18.6	6.1	59.8	15.4	0.56	--	4.57	3.00	--		
44	CoW.11	15.6	3	71	80	280	450	2.0	20	24.5	0.94	25.6	6.3	47.3	20.8	0.49	--	3.38	2.29	--		
45	Fe.01	15.9	1	23	38	240	450	2.0	20	3.4	0.14	0.0	7.5	84.8	7.7	0.72	0.77	2.80	1.50	--		
45	Fe.01	15.9	2	71	62	280	450	2.0	20	14.5	0.55	17.2	8.8	54.0	19.9	0.54	--	1.51	1.00	--		
45	Fe.01	15.9	3	95	109	300	450	2.0	20	19.0	0.66	23.3	10.0	39.8	26.7	0.44	0.76	1.36	1.05	14.0		
46	CoW.05	15.7	1	23	38	240	450	2.0	20	4.9	0.23	10.9	6.5	81.9	0.74	0.60	0.78	3.11	2.14	13.3		
46	CoW.05	15.7	2	71	86	280	450	2.0	20	14.0	0.66	44.2	10.5	42.5	2.84	0.41	0.82	0.82	0.68	14.0		
46	CoW.05	15.7	3	95	110	300	450	2.0	20	19.4	0.89	54.4	11.	28.2	6.39	0.16	0.78	0.69	0.62	9.8		
47	Co.070	15.6	1	23	38	240	450	2.0	20	22.8	1.07	10.9	2.7	85.7	0.70	0.75	0.85	2.60	1.56	24.5		
47	Co.070	15.6	2	47	63	220	450	2.0	20	8.6	0.40	0.0	4.3	95.7	0.02	0.82	--	--	--	--		
47	Co.070	15.6	3	71	87	220	450	1.0	20	1.2	0.08	0.0	--	94.5	--	0.62	--	--	--	--		
47	Co.070	15.6	4	95	111	240	450	1.0	20	5.3	0.37	3.7	4.2	90.3	1.76	0.71	--	--	--	--		
47	Co.070	15.6	5	119	135	240	450	2.0	20	19.8	0.93	10.4	2.1	86.8	0.68	0.76	--	2.85	1.71	--		
47	Co.070	15.6	6	143	158	240	600	2.0	20	20.5	0.96	9.6	2.2	87.6	0.61	0.77	--	2.36	1.40	--		
48	Cow.13	15.5	1	23	38	240	450	2.0	20	8.5	0.39	10.9	8.1	76.9	4.30	0.74	0.89	4.00	3.00	21.0	G.C. Calib	
48	Cow.13	15.5	2	47	62	260	450	2.0	20	20.0	0.90	19.9	5.0	68.5	6.61	0.64	--	2.56	1.74	--		
48	Cow.13	15.5	3	71	86	279	450	2.0	20	25.73	1.11	34.5	6.0	48.1	11.4	0.48	--	2.17	1.52	--		
48	Cow.13	15.5	4	95	110	300	450	2.0	20	28.0	1.12	41.2	7.4	32.0	19.4	0.35	--	2.22	1.61	--		
48	Cow.13	15.5	5	117	133	240	450	2.0	20	2.62	0.12	12.3	18.6	62.9	6.2	0.66	--	5.00	3.50	--		
49	Co.068	15.5	1	23	39	242	450	2.0	20	26.7	1.26	18.9	4.6	75.3	1.19	0.68	0.77	0.52	0.34	20.3		
49	Co.068	15.5	2	47	62	259	450	2.0	20	34.5	1.62	35.3	6.4	55.0	3.38	0.54	--	0.35	0.27	--		
49	Co.068	15.5	3	71	86	278	450	2.0	20	34.6	1.61	53.2	7.5	33.0	6.30	0.34	--	0.59	0.46	--		
49	Co.068	15.5	4	102	110	299	450	2.0	20	28.4	1.31	63.2	8.4	20.3	8.11	--	--	1.07	0.81	--		
49	Co.068	15.5	5	114	116	241	450	2.0	20	3.8	0.18	34.8	16.7	45.8	2.65	0.55	--	2.57	1.60	--		
50	Co.066	15.5	1	23	38	240	450	2.0	20	21.1	0.99	11.3	3.5	83.6	1.58	0.72	0.81	3.19	1.94	--		
50	Co.066	15.5	2	47	62	260	450	2.0	20	36.1	1.66	21.6	4.2	70.1	4.09	0.64	--	1.72	1.13	--		
50	Co.066	15.5	3	71	86	279	450	2.0	20	36.9	1.66	37.6	6.2	48.1	8.10	0.47	--	2.01	1.37	--		
50	Co.066	15.5	4	95	110	299	450	2.0	20	31.1	1.35	40.7	7.9	39.7	11.7	0.37	--	3.35	2.27	--		
50	Co.066	15.5	5	119	133	239	450	2.0	20	3.7	0.17	15.1	17.0	64.6	3.31	0.67	--	7.00	12.00	--		
60	CAL.15	15	1	6	13	220	450	2.0	20	2.0	0.09	-	-	100	-	0.84	-	-	-	--	Soya Wax	
61	CAL.17	15	1	6	13	220	450	2.0	20	1.2	0.06	-	-	100	-	0.80	-	-	-	--	Soya Wax	
62	CAL.19	15	1	6	14	220	450	2.0	20	13.6	0.66	3.2	-	96.0	0.81	0.88	-	-	-	--		

Table II. M3 SBCR RUN RESULTS

COMPARISON OF CATALYST ACTIVITY AT SIMILAR RUN CONDITIONS

Period No.	Temperature	Pressure	H ₂ /CO Ratio
1	240 C	450psi	2.0

a) Unless otherwise noted, total flow is ca.15 L/min. STP, or 3 cm/sec linear gas flow.

b) Conversion is total CO conversion over the period (%).

c) Conversion and selectivities are calculated using N₂ as an internal standard in the GC analysis of the

d) Prod. rate: Rate for production of total hydrocarbons, C₁+ (kg/kg cat.,hr).

e) Alpha: Based on GC analysis of offgas and liquid product.

Run No	Cat. No	Cat. wt,g	Conv. %	Prod. Rate	Selectivities				Alpha GC	Alpha Liq	Olefin/Paraffin		Olefins C6-18,%
					%CH4	%C2	%C3+	CO			C3	C4	
5	Co.003	15.1	31.7	1.53	16.7	2.4	79.8	1.2	0.71	--	1.30	0.60	18.2
6	Co.011	15.3	14.3	0.67	7.6	1.6	89.4	1.4	0.78	0.83	4.17	2.57	21.7
7	Co.012	15.8	13.9	0.63	6.1	1.5	90.6	1.7	0.80	0.89	4.00	2.57	17.5
8	Co.015	15.0	28.3	1.37	12.7	2.0	84.1	1.2	0.76	0.80	1.61	1.07	19.6
9	Co.011	15.0	18.5	0.89	8.8	1.7	88.8	0.8	0.78	0.83	3.18	1.85	20.3
11	Co.017	15.0	27.2	1.32	11.2	1.8	85.9	1.1	0.77	0.80	2.09	1.20	30.8
12	Co.018	15.6	33.8	1.56	9.7	2.0	86.6	1.7	0.75	0.85	1.81	1.13	21.0
13	Co.016	14.7	26.4	1.31	(1)	1.7	89.3	0.7	0.78	0.81	2.00	1.41	21.7
14	Co.019	15.2	13.9	0.66	(2)	1.7	97.2	0.7	0.80	0.86	5.33	2.67	26.6
15	Co.005	14.7	27.1	1.34	7.9	1.6	89.7	0.8	0.79	0.82	2.30	1.38	23.1
16	Co.002	15.4	30.1	1.42	12.5	2.5	83.9	1.1	0.75	0.80	1.00	0.66	17.5
17	Co.025	15.6	26.6	1.24	10.7	2.1	86.4	0.8	0.76	0.82	2.25	1.47	21.7
18	Co.004	15.0	33.9	1.64	15.3	2.4	80.9	1.4	0.74	0.79	1.17	0.78	20.3
19	Co.021	15.6	23.2	1.08	9.4	2.0	88.0	0.7	0.77	0.82	2.56	1.54	20.3
20	Co.041	15.8	25.3	1.16	11.0	2.1	86.0	0.9	0.76	0.84	2.94	1.61	20.3
21	Co.014	15.1	8.5	0.40	8.3	3.5	85.8	2.4	0.74	0.83	2.75	1.67	17.5
22	Co.040	14.5	1.8	0.09	0.0	4.0	94.1	1.9	0.71	0.82	2.50	2.00	--
23	Co.047	15.8	28.2	1.29	7.7	1.5	89.3	1.5	0.79	0.84	3.14	1.69	24.5
24	Co.049	15.6	30.6	1.41	10.9	1.8	85.7	1.7	0.76	0.82	2.09	1.30	14.0
25	Co.047	15.6	28.1	1.30	8.8	1.6	88.1	1.5	0.78	0.85	2.93	1.88	25.9
26	Co.031	15.9	30.9	1.41	12.1	1.9	84.9	1.1	0.75	0.83	1.83	1.14	22.4
27	Co.029	15.9	28.3	1.27	8.3	1.6	87.9	2.2	0.77	0.84	3.40	2.20	27.3
28	CoW.01	15.0	1.1	0.05	0.0	12.9	83.9	4.2	0.58	--	3.33	2.50	--
29	Co.053	25.2	42.0	1.19	15.8	2.3	79.5	2.4	0.73	--	1.00	0.67	17.5
30	Co.053	29.6	41.8	1.02	22.6	2.9	71.5	3.1	0.66	0.77	0.99	0.65	19.6
31	Co.055	15.0	30.0	1.46	23.7	3.7	70.2	2.3	0.61	0.81	0.90	0.60	20.3
32	Co.044	16.4	20.9	0.93	6.7	1.9	90.8	0.6	0.77	0.83	3.42	2.17	23.1
33	Co.053	31.4	41.4	0.94	23.2	3.1	69.6	4.1	0.65	0.76	0.82	0.58	21.7
34	Co.060	15.6	31.4	1.46	14.0	2.3	82.2	1.5	0.75	0.79	1.61	1.00	23.1
35	Co.041	26.0	35.7	1.00	13.6	2.1	82.9	1.4	0.79	0.76	1.09	0.74	18.2
36	Co.032	15.9	24.0	1.10	9.1	1.8	88.2	0.8	0.77	0.83	3.23	2.00	25.2
37	Co.045	15.9	14.8	0.67	8.0	1.7	89.4	0.9	0.76	0.84	2.78	1.90	20.3
38	Co.058	15.9	28.0	1.28	11.9	2.1	85.1	0.9	0.75	0.85	1.88	1.17	22.4
39	Co.064	15.9	34.2	1.56	13.6	2.3	82.6	1.6	0.73	0.85	1.40	0.92	21.0
40	Co.063	15.0	8.7	0.43	6.5	0.9	92.6	0.1	0.74	--	7.67	3.40	25.9
41	Co.062	15.0	6.6	0.32	3.5	0.3	95.3	1.0	0.76	0.89	9.50	3.50	25.9
42	Co.065	15.9	27.6	1.25	7.9	2.0	88.6	1.6	0.79	0.84	2.94	1.88	28.0
43	CoW.12	9.1	6.1	0.47	20.3	6.1	66.3	7.3	0.61	0.83	3.63	2.33	11.9
44	CoW.11	15.6	4.7	0.20	8.4	6.3	74.4	10.9	0.60	--	5.40	3.50	--
45	Fe.01	15.9	3.4	0.14	0.0	7.5	84.8	7.7	0.71	0.77	2.80	1.50	--
46	CoW.05	15.7	4.9	0.23	10.9	6.5	81.9	0.7	0.60	0.78	3.11	2.14	13.3
47	Co.070	15.6	22.8	1.07	10.9	2.7	85.7	0.7	0.75	0.85	2.60	1.56	24.5
48	CoW.13	15.5	8.5	0.39	10.9	8.1	76.9	4.3	0.74	0.89	4.00	3.00	21.0
49	Co.068	15.5	26.7	1.26	18.9	4.6	75.3	1.2	0.68	0.77	0.52	0.34	20.3
50	Co.066	15.5	21.1	0.99	11.3	3.5	83.6	1.6	0.72	0.81	3.19	1.94	--

Note Catalyst for Run 9 screened thru 170 x 400 mesh.

Catalysts For Runs 11 thru 20, and 23 thru 50 screened thru 150 x 400 mesh

Catalysts for Runs 21 and 22 screened thru 100 x 400 mesh.

(1) Weak TCD filaments in G.C. CH₄ peaks smaller than expected.

(2) Internal valve in G.C. leaked. CH₄ peak undetected.

Table III. M3 SBCR RUN RESULTS

COMPARISON OF CATALYST ACTIVITY AT SIMILAR RUN CONDITIONS

Period No.	Temperature	Pressure	H2/CO Ratio
2	220 C	450psi	2.0

a) Unless otherwise noted, total flow is ca. 15 L/min. STP, or 3 cm/sec linear gas flow.

b) Conversion is total CO conversion over the period (%).

c) Conversion and selectivities are calculated using N2 as an internal standard in the GC analysis of the o

d) Prod. rate: Rate for production of total hydrocarbons, C1+ (kg/kg cat., hr).

e) Alpha: Based on GC analysis of offgas and liquid product.

Run No	Cat. No	Cat. wt, g	Conv. %	Prod. Rate	Selectivities				Alpha GC	Alpha Liq	Olefin/Paraffin		Olefins C6-18, %
					%CH4	%C2	%C3+	%CO2			C3	C4	
5	Co.003	15.1	13.2	0.63	5.1	1.0	93.4	0.5	0.82	0.90	4.55	1.89	--
6	Co.011	15.3	5.1	0.23	0.0	0.0	97.2	2.8	0.87	0.82	--	--	--
7	Co.012	15.8	5.1	0.23	0.0	0.2	97.8	2.0	0.89	0.90	--	2.50	--
8	Co.015	15.0	11.5	0.56	4.4	1.0	93.9	0.8	0.81	0.89	3.60	2.14	--
9	Co.011	15.0	6.3	0.31	0.0	1.0	98.6	0.4	0.88	0.93	12.00	1.80	--
11	Co.017	15.0	11.4	0.55	5.0	0.0	94.8	0.2	0.88	0.90	5.00	3.20	--
12	Co.018	15.6	12.6	0.59	2.8	0.0	97.1	0.1	0.90	0.88	--	--	--
13	Co.016	14.7	9.7	0.48	(1)	0.1	99.9	0.0	0.91	0.88	--	--	--
14	Co.019	15.2	3.8	0.18	(2)	1.7	96.7	1.6	0.88	--	--	--	--
15	Co.005	14.7	10.7	0.53	0.0	0.9	98.4	0.7	0.83	0.88	4.25	3.25	--
16	Co.002	15.4	12.8	0.60	4.2	1.3	93.9	0.7	0.80	0.86	2.57	1.63	--
17	Co.025	15.6	8.4	0.39	0.0	1.1	96.9	1.9	0.82	0.92	6.50	3.00	--
18	Co.004	15.0	15.1	0.73	4.1	1.6	94.0	0.3	0.81	0.85	3.83	2.25	--
19	Co.021	15.6	8.3	0.38	0.0	1.3	98.2	0.5	0.82	0.88	4.33	3.33	--
20	Co.041	15.8	9.1	0.41	0.0	1.5	97.8	0.7	0.82	0.91	8.00	2.75	--
21	Co.014	15.1	3.2	0.15	0.0	2.3	85.8	4.3	0.76	0.86	3.50	3.00	--
22	Co.040	14.5	0.7	0.35	0.0	0.7	97.1	2.2	0.91	--	1.00	2.00	--
23	Co.047	15.8	--	--	(3)	--	--	--	--	--	--	--	--
24	Co.049	15.6	12.0	1.07	2.7	0.9	95.3	1.1	0.81	0.95	4.25	3.25	--
25	Co.047	15.6	7.4	0.34	1.5	1.2	96.3	1.0	0.76	0.89	3.00	4.67	--
26	Co.031	15.9	13.6	0.62	3.9	0.9	94.6	0.5	0.80	0.85	4.20	2.67	--
27	Co.029	15.9	9.5	0.43	1.7	1.1	96.0	1.2	0.80	0.89	5.67	3.00	--
29	Co.053	25.2	20.5	0.59	5.7	4.8	89.0	0.5	0.79	0.84	3.38	2.10	--
31	Co.055	15.0	9.1	0.44	10.6	2.5	85.7	1.1	0.61	0.85	2.89	1.80	--
32	Co.044	16.4	10.3	0.46	0.0	0.9	98.8	0.3	0.85	--	4.33	4.50	--
34	Co.060	15.6	13.0	0.60	0.1	1.8	97.8	0.4	0.81	0.88	4.00	2.83	--
36	Co.032	15.9	7.7	0.35	0.0	1.5	97.8	0.8	0.81	0.91	4.00	3.33	--
37	Co.045	15.9	5.1	0.23	0.0	1.5	97.7	0.8	0.80	0.88	4.00	3.00	--
38	Co.058	15.9	11.7	0.54	1.4	1.4	96.9	0.4	0.81	--	4.00	3.00	--
39	Co.064	15.9	15.0	0.68	4.6	1.2	93.8	0.4	0.78	--	4.17	2.38	--
40	Co.063	15.0	2.0	0.09	0.1	0.0	99.9	0.0	0.67	--	7.00	7.00	--
41	Co.062	15.0	1.9	0.09	0.0	0.1	99.9	0.0	0.88	--	4.00	5.00	--
42	Co.065	15.9	10.0	0.46	0.0	2.0	97.3	0.7	0.82	--	5.33	3.25	--
47	Co.070	15.6	8.6	0.40	0.0	4.3	95.7	0.0	0.82	--	--	--	--
60	CAL.15	15.0	2.0	0.09	0.0	0.0	100.0	0.0	0.84	--	--	--	--
61	CAL.17	15.0	1.2	0.06	0.0	0.0	100.0	0.0	0.80	--	--	--	--
62	CAL.19	15.0	13.6	0.66	3.2	0.0	99.5	0.8	0.88	--	--	--	--

Note Catalyst for Run 9 screened thru 170 x 400 mesh.

Catalysts For Runs 11 thru 20, and 23 thru 47 screened thru 150 x 400 mesh

Catalysts for Runs 21 and 22 screened thru 100 x 400 mesh.

(1) Weak TCD filaments in G.C. CH4 peaks smaller than expected.

(2) Internal valve in G.C. leaked. CH4 peak undetected.

(3) Replaced dual column restrictor valve.

Table IV. M3 SBCR RUN RESULTS

COMPARISON OF CATALYST ACTIVITY AT SIMILAR RUN CONDITIONS

Period No.	Temperature	Pressure	H2/CO Ratio
4	240 C	450psi	1.0

a) Unless otherwise noted, total flow is ca.15 L/min. STP, or 3 cm/sec linear gas flow.

b) Conversion is total CO conversion over the period (%).

c) Conversion and selectivities are calculated using N2 as an internal standard in the GC analysis of the o

d) Prod. rate: Rate for production of total hydrocarbons, C1+ (kg/kg cat., hr).

e) Alpha: Based on GC analysis of offgas and liquid product.

Run No	Cat. No	Cat. wt,g	Conv. %	Prod. Rate	Selectivities				Alpha GC	Alpha Liq	Olefin/Paraffin		Olefins C6-18,%
					%CH4	%C2	%C3+	%CO2			C3	C4	
5	Co.003	15.1	13.1	0.95	4.2	1.2	93.3	1.2	0.83	0.88	6.67	3.70	--
6	Co.011	15.3	6.3	0.44	0.4	1.0	95.5	3.1	0.82	0.88	--	--	--
7	Co.012	15.8	3.9	0.26	4.8	2.3	86.3	6.6	0.70	0.85	16.00	3.50	--
8	Co.015	15.0	11.5	0.83	4.8	1.2	92.5	1.5	0.80	0.85	5.60	3.29	--
9	Co.011	15.0	8.0	0.58	1.3	1.3	96.3	1.2	0.82	0.87	7.00	2.83	--
11	Co.017	15.0	11.6	0.84	5.0	0.0	93.9	1.2	0.82	0.86	25.00	2.88	--
12	Co.018	15.6	12.4	0.86	3.3	0.0	95.0	1.7	0.80	0.86	--	--	--
13	Co.016	14.7	10.9	0.81	(1)	0.8	97.7	0.3	0.84	0.86	--	--	--
14	Co.019	15.2	--	--	(2)	--	--	--	0.80	--	--	--	--
15	Co.005	14.7	11.6	0.85	0.0	1.1	97.5	1.4	0.82	0.85	7.00	4.60	--
16	Co.002	15.4	12.6	0.89	4.4	1.6	92.8	1.2	0.79	0.84	4.43	2.88	--
17	Co.025	15.6	10.3	0.71	0.8	1.2	96.7	1.3	0.82	0.93	7.67	4.25	--
18	Co.004	15.0	14.7	1.06	4.1	1.2	93.2	1.4	0.80	0.83	6.17	3.75	--
19	Co.021	15.6	9.9	0.69	1.7	1.4	95.5	1.4	0.81	0.83	6.00	3.80	--
20	Co.041	15.8	12.7	0.88	1.9	1.2	95.9	1.0	0.83	0.86	9.00	4.20	--
21	Co.014	15.1	2.2	0.15	0.0	2.8	89.3	7.9	0.67	0.84	9.00	4.00	--
23	Co.047	15.8	11.9	0.81	2.9	0.9	94.1	2.1	0.82	0.88	7.33	4.75	--
24	Co.049	15.6	12.6	0.87	3.1	1.0	94.1	1.8	0.81	0.86	8.33	4.20	--
25	Co.047	15.6	10.8	0.75	3.0	1.0	94.2	1.8	0.81	0.90	8.00	4.75	--
26	Co.031	15.9	12.9	0.88	3.6	1.1	94.3	1.1	0.80	0.88	7.75	4.00	--
27	Co.029	15.9	12.0	0.82	1.9	0.9	95.4	1.9	0.83	0.90	8.33	4.75	--
29	Co.053	25.2	18.4	0.79	5.3	2.6	90.6	1.5	0.80	0.84	5.86	3.56	--
31	Co.055	15.0	14.7	1.06	5.5	1.4	91.7	1.4	0.78	0.83	5.71	3.22	--
32	Co.044	16.4	9.9	0.25	2.1	3.2	92.5	2.2	0.61	0.87	7.33	4.00	--
34	Co.060	15.6	13.5	0.94	4.3	1.8	92.5	1.5	0.77	0.85	7.00	4.67	--
36	Co.032	15.9	9.5	0.65	1.4	1.2	96.5	0.9	0.83	--	7.67	4.50	--
37	Co.045	15.9	6.5	0.44	0.1	1.4	97.3	1.2	0.82	--	5.00	2.00	--
38	Co.058	15.9	12.7	0.87	3.2	1.3	94.5	1.0	0.81	--	7.25	4.40	--
39	Co.064	15.9	15.9	1.09	4.7	1.2	92.9	1.3	0.80	--	7.86	3.88	--
40	Co.063	15.0	3.6	0.26	2.3	1.3	95.9	0.5	0.76	--	13.00	5.50	--
41	Co.062	15.0	2.7	0.19	0.1	1.0	96.9	2.0	0.77	--	10.00	4.00	--
42	Co.065	15.9	13.1	0.89	1.2	1.5	95.7	1.7	0.84	--	7.00	5.50	--
47	Co.070	15.6	5.3	0.37	3.7	4.2	90.3	1.8	0.71	--	2.85	1.71	--

Note Catalyst for Run 9 screened thru 170 x 400 mesh.

Catalysts For Runs 11 thru 20, and 27 thru 47 screened thru 150 x 400 mesh

Catalysts for Runs 21 and 22 screened thru 100 x 400 mesh.

(1) Weak TCD filaments in G.C. CH4 peaks smaller than expected.

(2) Internal valve in G.C. leaked. CH4 peak undetected.

Table V. M3 SBCR RUN RESULTS

COMPARISON OF CATALYST ACTIVITY AT SIMILAR RUN CONDITIONS

Period No.	Temperature	Pressure	H ₂ /CO Ratio
5	240 C	600psi	1.0

a) Unless otherwise noted, total flow is ca. 15 L/min. STP, or 3 cm/sec linear gas flow.

b) Conversion is total CO conversion over the period (%).

c) Conversion and selectivities are calculated using N₂ as an internal standard in the GC analysis of th

d) Prod. rate: Rate for production of total hydrocarbons, C₁+ (kg/kg cat., hr).

e) Alpha: Based on GC analysis of offgas and liquid product.

Run No	Cat. No	Cat. wt, g	Conv. %	Prod. Rate	Selectivities				Alpha GC	Alpha Liq	Olefin/Paraffin C3	Olefins C4	Olefins C6-18, %
5	Co.003	15.1	13.4	0.97	3.9	1.1	93.7	1.3	0.81	--	5.26	3.45	30.1
6	Co.011	15.3	6.7	0.46	0.2	0.9	96.0	2.9	0.84	0.89	12.00	3.67	27.3
7	Co.012	15.8	4.3	0.28	0.1	2.1	91.6	6.3	0.75	0.82	8.50	3.50	--
8	Co.015	15.0	12.4	0.90	4.9	0.8	93.6	0.7	0.84	0.85	5.20	3.14	30.8
9	Co.011	15.0	8.7	0.63	1.4	1.1	96.4	1.1	0.83	0.87	5.00	2.67	30.5
11	Co.017	15.0	11.6	0.84	4.2	0.0	94.7	1.2	0.86	0.86	24.00	1.63	21.0
12	Co.018	15.6	13.0	0.90	3.2	0.0	94.9	1.9	0.80	0.85	--	--	38.5
13	Co.016	14.7	11.4	0.85	(1)	0.5	99.2	0.3	0.92	0.86	--	--	32.2
14	Co.019	15.2	5.9	0.41	(2)	1.5	96.1	2.4	0.80	--	--	--	--
15	Co.005	14.7	23.0	0.90	0.0	1.0	97.7	1.3	0.83	0.85	7.00	4.40	36.4
16	Co.002	15.4	13.1	0.92	3.6	1.4	93.9	1.1	0.81	0.84	4.29	2.75	25.2
17	Co.025	15.6	19.9	0.81	9.3	1.1	96.5	1.1	0.83	0.88	8.00	4.25	32.9
18	Co.004	15.0	15.0	1.09	3.6	1.1	94.1	1.2	0.82	0.83	5.67	4.00	33.6
19	Co.021	15.6	11.5	0.80	1.8	1.2	95.8	1.2	0.83	0.85	6.50	3.80	30.8
20	Co.041	15.8	13.2	0.91	2.0	1.0	96.1	0.9	0.84	0.87	7.00	3.50	31.5
21	Co.014	15.1	2.1	0.15	0.0	2.6	94.8	2.7	0.71	0.81	4.50	3.50	23.1
23	Co.047	15.8	11.8	0.80	2.6	0.8	94.6	2.0	0.82	0.87	7.00	3.60	38.5
24	Co.049	15.6	13.4	0.92	2.6	0.9	94.8	1.7	0.82	0.88	8.33	4.20	37.8
25	Co.047	15.6	12.4	0.86	2.2	0.8	95.6	1.3	0.83	0.86	7.33	4.50	36.4
26	Co.031	15.9	13.9	0.95	3.5	1.0	94.4	1.1	0.81	0.85	6.80	3.71	30.1
27	Co.029	15.9	12.1	0.82	1.7	0.9	95.6	1.8	0.83	0.89	7.67	4.75	39.9
29	Co.053	25.2	19.7	0.85	4.6	1.2	92.9	1.3	0.82	0.85	5.71	3.44	33.6
31	Co.055	15.0	16.1	1.16	4.7	1.2	92.8	1.3	0.80	0.83	6.17	3.11	33.6
34	Co.060	15.6	12.8	0.89	2.2	1.6	94.9	1.2	0.82	0.86	6.60	4.33	38.5

Note Catalyst for Run 9 screened thru 170 x 400 mesh.

Catalysts For Runs 11 thru 20, and 24 thru 34 screened thru 150 x 400 mesh

Catalyst for Runs 21 screened thru 100 x 400 mesh.

(1) Weak TCD filaments in G.C. CH₄ peaks smaller than expected.

(2) Internal valve in G.C. leaked. CH₄ peak undetected.

Table VI. SUMMARY OF M4 SBCR RUN RESULTS

- a) Unless otherwise noted, total flow is ca.15 L/min. STP, or 3 cm/sec linear gas flow.
 b) Conversion is total CO conversion over the period (%).
 c) Conversion and selectivities are calculated using N2 as an internal standard in the GC analysis of the offgas
 d) Prod. rate: Rate for production of total hydrocarbons, C1+ (kg/kg cat., hr).
 e) Alpha: Based on GC analysis of offgas and liquid product.

Run No	Cat. No	Cat. wt,g	Per No	Time Start	Time Stop	Temp C	Pres psi	H2: CO	Synfl cc/hr	Conv. %	Prod. Rate	Selectivities				Alpha GC	Alpha Liq	Olefin/Paraffi		Olefins C6-18,%	Comments
3	Co.002	15.2	1	25	35	240	450	2.0	20	29.4	1.42	17.3	2.3	79.4	1.01	0.73	0.82	0.91	0.60	17.5	
3	Co.002	15.2	2	73	83	220	450	2.0	20	11.8	0.56	4.7	1	93.7	0.59	0.81	0.90	2.71	1.63	--	G.C.Calib
3	Co.002	15.2	3	97	107	240	450	2.0	20	26.4	1.28	16.0	3.1	80.1	0.88	0.73	--	0.98	0.66	--	
3	Co.002	15.2	4	145	155	240	450	1.0	20	11.6	0.83	3.9	2.4	92.8	0.84	0.81	0.87	4.29	3.14	--	G.C.Calib
3	Co.002	15.2	5	182	203	240	600	1.0	20	12.9	0.92	4.0	1.5	93.5	0.91	0.81	0.82	4.29	2.75	24.5	
3	Co.002	15.2	6	217	226	240	450	2.0	20	24.2	1.17	17.1	3.1	79.0	0.83	0.71	--	1.03	0.70	--	
4	Co.024	15.4	1	20	37	240	450	2.0	20	25.5	1.21	8.6	2.0	89.0	0.43	0.79	0.84	2.93	1.93	21.7	
4	Co.024	15.4	2	68	85	220	450	2.0	0	9.5	0.45	0.0	2.1	97.6	0.27	0.83	0.91	5.33	4.00	--	No Synfl
4	Co.024	15.4	3	92	109	240	450	2.0	0	23.7	1.13	9.5	2.1	88.0	0.45	0.77	--	2.81	1.88	--	
4	Co.024	15.4	4	140	157	240	450	1.0	0	10.3	0.73	0.5	1.6	97.2	0.71	0.83	0.87	8.33	4.75	--	
4	Co.024	15.4	5	188	205	240	600	1.0	0	11.3	0.80	0.9	1.5	97.0	0.65	0.83	0.87	6.50	3.80	36.4	
4	Co.024	15.4	6	212	229	240	450	2.0	0	21.5	1.02	9.3	2.3	87.9	0.50	0.76	--	2.93	2.07	--	
5	Co.035	15.4	1	16	37	240	450	2.0	20	24.8	1.18	8.5	2.1	89.0	0.47	0.78	0.84	3.13	1.94	23.1	
5	Co.035	15.4	2	68	85	220	450	2.0	20	8.8	0.42	0.0	2.3	97.4	0.31	0.82	--	5.33	4.00	--	
5	Co.035	15.4	3	99	109	240	450	2.0	20	23.5	1.11	8.7	2.1	88.6	0.61	0.77	--	3.07	1.94	--	
5	Co.035	15.4	4	136	157	240	450	1.0	20	10.4	0.73	0.9	0.0	98.4	0.65	--	0.83	--	--	--	G.C.Calib
5	Co.035	15.4	5	184	205	240	600	1.0	20	10.7	0.76	0.7	1.4	97.1	0.75	0.84	0.88	6.25	4.50	27.3	
5	Co.035	15.4	6	212	228	240	450	2.0	20	19.4	0.92	7.8	2.3	89.4	0.56	0.79	--	3.08	1.77	--	
6	Co.028	15.4	1	23	40	240	450	2.0	20	21.2	1.00	6.1	1.6	91.3	1.01	0.81	0.83	4.86	3.00	28.7	
6	Co.028	15.4	2	67	88	220	450	2.0	20	6.6	0.31	0.0	1.9	97.4	0.72	0.83	0.90	5.50	4.00	--	
6	Co.028	15.4	3	95	112	240	450	2.0	20	20.1	0.94	5.8	1.6	91.6	1.02	0.81	--	4.25	2.67	--	
6	Co.028	15.4	4	139	160	240	450	1.0	20	9.2	0.65	0.0	1.3	97.3	1.46	0.85	0.88	9.50	3.75	--	
6	Co.028	15.4	5	189	208	240	600	1.0	20	9.5	0.67	0.0	1.1	97.5	1.36	0.85	0.88	6.00	3.50	40.6	
6	Co.028	15.4	6	213	232	240	450	2.0	20	18.0	0.84	5.7	1.6	91.5	1.12	0.80	--	4.57	2.88	--	
7	Co.043	15.4	1	18	39	240	450	2.0	20	13.0	0.61	3.7	1.8	93.4	1.06	0.79	0.85	5.60	3.17	27.3	
7	Co.043	15.4	2	53	63	220	450	2.0	20	4.3	0.20	0.0	1.4	96.3	2.25	0.81	0.91	4.00	3.00	--	
7	Co.043	15.4	3	94	111	240	450	2.0	20	12.3	0.58	3.0	1.5	93.9	1.58	0.80	--	5.00	2.83	--	
7	Co.043	15.4	4	138	159	240	450	1.0	20	5.2	0.37	0.0	0.0	99.4	0.64	0.83	0.89	7.00	5.00	--	
7	Co.043	15.4	5	191	207	240	600	1.0	20	5.9	0.41	0.0	2.2	94.8	2.99	0.82	0.89	6.00	3.75	30.1	G.C.Calib
7	Co.043	15.4	6	215	231	240	450	2.0	20	10.2	0.47	4.7	2.1	91.4	1.79	0.78	--	5.50	3.20	--	Repair G.C.
8	Co.006	15.0	1	19	40	240	450	2.0	20	2.7	0.13	0.1	0.2	98.8	1.75	0.67	0.85	3.33	2.33	16.1	Shut down
9	Co.048	15.4	1	19	40	240	450	2.0	12	19.1	0.90	9.9	1.6	87.4	1.05	0.77	0.88	3.60	2.09	20.3	
9	Co.048	15.4	2	70	84	220	450	2.0	12	6.1	0.28	1.8	1	95.2	1.93	0.80	0.91	3.67	3.00	--	
9	Co.048	15.4	3	93	111	240	450	2.0	20	17.8	0.84	10.1	1.7	86.9	1.33	0.77	--	3.30	2.10	--	
9	Co.048	15.4	4	139	159	240	450	1.0	20	8.2	0.57	2.3	1.0	93.8	2.98	0.82	0.90	8.50	4.33	--	
9	Co.048	15.4	5	189	207	240	600	1.0	20	11.9	0.83	2.7	0.9	94.4	1.93	0.84	0.89	5.75	3.20	14.0	
9	Co.048	15.4	6	217	226	240	450	2.0	20	24.2	1.17	17.1	3.1	79.0	0.83	0.71	--	1.03	0.70	--	

Table VI. SUMMARY OF M4 SBCR RUN RESULTS (continued)

- a) Unless otherwise noted, total flow is ca. 15 L/min. STP, or 3 cm/sec linear gas flow.
 b) Conversion is total CO conversion over the period (%).
 c) Conversion and selectivities are calculated using N2 as an internal standard in the GC analysis of the offgas
 d) Prod. rate: Rate for production of total hydrocarbons, C1+ (kg/kg cat. hr).
 e) Alpha: Based on GC analysis of offgas and liquid product.

Run No	Cat. No	Cat. wt,g	Per No	Time Start	Time Stop	Temp C	Pres psi	H2: CO	Synfl cc/hr	Conv. %	Prod. Rate	Selectivities				Alpha GC	Alpha Liq	Olefin/Paraffi		Olefins C6-18,%	Comments
10	CAL.02	15.9	1	19	40	240	450	2.0	20	34.5	1.58	12.9	2.0	83.9	1.23	0.75	0.84	1.66	1.06	21.0	
10	CAL.02	15.9	2	69	88	220	450	2.0	20	14.9	0.68	4.6	0.9	94.0	0.47	0.81	0.88	4.40	2.29	--	
10	CAL.02	15.9	3	91	112	240	450	2.0	20	34.2	1.57	12.6	2.0	84.4	1.00	0.75	--	1.71	1.06	--	
10	CAL.02	15.9	4	139	160	240	450	1.0	20	14.6	1.00	4.6	1.1	93.3	0.97	0.80	0.88	7.20	4.00	--	
10	CAL.02	15.9	5	187	201	240	600	1.0	20	16.4	1.12	4.2	1.0	94.0	0.89	0.82	0.86	5.83	3.86	35.7	
10	CAL.02	15.9	6	215	230	240	450	2.0	20	30.9	1.42	13.3	2.1	83.7	0.90	0.74	--	1.90	1.21	--	
11	CAL.03	15.6	1	19	40	240	450	2.0	20	29.7	1.39	13.5	2.1	83.4	1.08	0.74	0.86	1.65	1.03	18.2	
12	Co.053	15.9	1	22	40	240	450	2.0	20	34.2	1.56	12.6	2.0	84.2	1.23	0.75	0.83	1.60	1.00	24.5	
12	Co.053	15.9	2	69	88	220	450	2.0	20	14.4	0.66	4.3	1.0	94.3	0.48	0.81	0.89	4.20	2.67	--	
12	Co.053	15.9	3	93	112	240	450	2.0	20	34.0	1.56	13.4	2.2	83.2	1.21	0.74	--	1.50	0.94	--	
12	Co.053	15.9	4	150	152	240	450	1.0	20	13.3	0.91	4.3	1.2	93.3	1.18	0.80	0.89	6.60	3.71	--	
12	Co.053	15.9	5	189	208	240	600	1.0	20	15.6	1.06	4.0	0.9	94.0	1.01	0.82	0.87	5.50	3.57	32.2	
12	Co.053	15.9	6	223	231	240	450	2.0	20	29.8	1.37	12.8	2.0	84.3	0.94	0.75	--	1.89	1.10	--	
13	Co.054	15.7	1	23	40	240	450	2.0	20	10.4	0.48	4.7	1.8	92.3	1.17	0.78	0.86	5.75	4.00	25.9	
13	Co.054	15.7	2	71	88	220	450	2.0	20	0.2	0.01	0.0	20	60.8	19.5	0.33	0.94	8.00	5.00	--	
13	Co.054	15.7	3	102	112	240	450	2.0	20	10.6	0.49	4.5	1.5	92.8	1.23	0.79	--	5.50	3.75	--	
13	Co.054	15.7	4	143	160	240	450	1.0	20	5.2	0.36	0.0	1.2	97.0	1.85	0.83	0.95	6.00	4.50	--	
13	Co.054	15.7	5	191	208	240	600	1.0	20	5.0	0.34	0.0	1.3	96.9	1.78	0.82	0.93	6.50	3.33	30.8	
13	Co.054	15.7	6	223	230	240	450	2.0	20	8.8	0.40	4.7	2.0	91.7	1.54	0.78	--	5.00	3.50	--	
14	BlendA	20.0	1	25	39	240	450	2.0	20	29.3	1.41	10.1	1.6	86.3	2.02	0.77	0.86	2.23	1.35	23.1	
14	BlendA	20.0	2	69	87	220	450	2.0	20	12.4	0.60	4.3	0.9	93.9	0.95	0.81	0.91	3.80	2.33	--	
14	BlendA	20.0	3	93	111	240	450	2.0	20	27.5	1.33	10.5	1.7	86.4	1.44	0.76	--	2.09	1.32	--	
14	BlendA	20.0	4	143	158	240	450	1.0	20	12.7	0.91	3.4	1.0	94.0	1.61	0.81	0.86	7.50	3.83	--	
14	BlendA	20.0	5	191	207	240	600	1.0	20	14.1	1.02	3.7	1.0	93.8	1.45	0.82	0.89	6.40	3.43	32.9	
14	BlendA	20.0	6	215	231	240	450	2.0	20	27.0	1.29	11.5	1.9	85.5	1.12	0.76	--	2.04	1.30	--	
15	Co.034	13.0	1	21	39	240	450	2.0	20	27.5	1.54	10.4	1.6	87.2	0.80	0.78	0.84	2.21	1.40	21.0	G.C.Calib
15	Co.034	13.0	2	45	87	220	450	2.0	20	11.0	0.61	4.0	0.9	94.5	0.59	0.82	0.90	4.00	3.00	--	
15	Co.034	13.0	3	95	111	240	450	2.0	20	26.6	1.49	11.5	1.9	85.9	0.82	0.76	--	2.10	1.33	--	
15	Co.034	13.0	4	141	159	240	450	1.0	20	11.2	0.94	3.9	1.0	94.0	1.02	0.82	0.87	8.33	4.00	--	
15	Co.034	13.0	5	189	207	240	600	1.0	20	11.8	0.99	3.9	1.1	94.0	1.03	0.83		5.75	3.80	37.8	
15	Co.034	13.0	6	215	231	240	450	2.0	20	21.6	1.19	10.9	1.9	86.3	0.87	0.76	--	3.33	2.15	--	
16	CAL.04	16.1	1	21	39	240	450	1.8	20	26.3	1.34	7.1	1.3	90.3	1.38	0.80	0.85	4.80	3.18	32.9	H2/CO:
16	CAL.04	16.1	2	54	163	220	450	1.8	20	8.4	0.42	2.6	1.0	94.1	2.31	0.80	0.88	5.00	4.00	--	1.76/1.0
17	CAL.08	15.0	1	21	39	240	450	1.8	20	16.9	0.93	5.9	1.0	91.7	1.36	0.82	0.88	5.20	3.33	28.7	H2/CO:
17	CAL.08	15.0	2	47	62	220	450	1.8	20	5.4	0.28	0.1	0.8	96.9	2.23	0.83	--	4.00	3.00	--	1.76/1.0
18	CAL.07	15.0	1	21	39	240	450	2.0	20	20.6	1.03	7.7	1.2	90.0	1.09	0.81	0.88	5.00	3.00	32.2	
18	CAL.07	15.0	2	47	62	220	450	2.0	20	6.7	0.33	1.8	1.4	95.0	1.81	0.84	--	4.00	3.00	--	

Table VI. SUMMARY OF M4 SBCR RUN RESULTS (continued)

- a) Unless otherwise noted, total flow is ca 15 L/min. STP, or 3 cm/sec linear gas flow.
 b) Conversion is total CO conversion over the period (%).
 c) Conversion and selectivities are calculated using N2 as an internal standard in the GC analysis of the offgas
 d) Prod. rate: Rate for production of total hydrocarbons, C1+ (kg/kg cat., hr).
 e) Alpha: Based on GC analysis of offgas and liquid product.

Run No	Cat. No	Cat. wt,g	Per No	Time Start	Time Stop	Temp C	Pres psi	H2: CO	Synfl cc/hr	Conv. %	Prod. Rate	Selectivities				Alpha GC	Alpha Liq	Olefin/Paraffi		Olefins C6-18,%	Comments
19	CAL.05	15.7	1	23	39	240	450	2.0	20	26.6	1.22	7.3	1.3	90.2	1.19	0.82	0.86	4.11	2.70	18.2	G.C.Calib
19	CAL.05	15.7	2	47	62	220	450	2.0	20	9.0	0.41	2.3	1.4	94.8	1.56	0.84	--	5.50	3.00	--	
20	CAL.06	15.0	1	15	30	240	450	2.0	20	5.6	0.26	3.1	2.1	92.0	2.86	0.80	0.90	4.50	3.50	30.8	G.C.Calib
20	CAL.06	15.0	2	55	63	240	450	2.0	20	3.5	0.16	0.0	3.3	92.8	3.87	0.80	0.85	3.00	2.50	--	
20	CAL.06	15.0	3	103	110	240	450	2.0	20	1.7	0.08	0.0	3.3	89.5	7.22	0.80	--	1.50	3.00	--	Cat. Loss
21	Co.004	15.9	1	23	40	240	450	2.0	20	39.3	1.80	15.2	2.3	81.2	1.38	0.74	0.89	1.16	0.73	23.1	
21	Co.004	15.9	2	71	88	220	450	2.0	20	16.1	0.74	8.1	1.2	90.2	0.48	0.78	0.87	3.38	2.22	--	
21	Co.004	15.9	3	105	110	240	450	2.0	20	37.6	1.47	16.4	2.3	80.2	1.20	0.73	--	1.10	0.70	--	
21	Co.004	15.9	4	136	138	240	450	1.0	20	14.9	1.02	7.4	1.4	89.9	1.29	0.77	0.84	4.67	2.82	--	
21	Co.004	15.9	5	166	184	240	600	1.0	20	18.4	1.26	6.1	1.1	91.9	0.94	0.81	0.84	5.25	2.91	--	G.C.Repair
21	Co.004	15.9	6	199	207	240	600	2.0	20	39.0	1.80	14.2	1.9	83.0	0.91	0.78	0.82	0.85	0.77	--	
21	Co.004	15.9	7	212	214	240	450	2.0	20	34.6	1.59	15.8	2.3	81.0	1.00	0.76	--	0.86	0.81	--	G.C.Repair
22	BlendB	30.5	1	23	39	240	450	2.0	20	35.6	1.64	12.7	1.6	79.4	6.29	0.75	0.81	1.40	0.81	27.3	
22	BlendB	30.5	2	78	87	240	450	1.0	20	15.8	1.07	1.5	0.9	90.5	7.06	0.80	0.83	5.00	2.22	38.5	G.C.Calib
22	BlendB	30.5	3	125	135	240	450	0.7	20	10.6	0.86	0.8	0.8	92.6	5.83	0.82	0.87	7.33	3.20	33.6	G.C.Calib
22	BlendB	30.5	4	150	158	240	450	1.0	20	14.1	0.99	3.9	1.0	91.0	4.07	0.80	--	5.40	2.25	--	
22	BlendB	30.5	5	174	183	240	450	2.0	20	30.1	1.44	13.2	1.8	82.4	2.56	0.75	--	1.33	0.69	--	
22	BlendB	30.5	6	191	207	260	450	1.0	20	23.5	1.63	10.0	1.9	82.1	6.02	0.74	--	2.92	1.15	--	
22	BlendB	30.5	7	223	232	280	450	1.0	20	26.9	1.79	17.8	3.1	68.4	10.7	0.64	--	3.00	1.88	--	
22	BlendB	30.5	8	247	255	280	450	0.7	20	17.1	1.34	8.8	2.6	78.8	9.8	0.70	--	6.00	3.53	--	
23	CAL.09	15.0	1	23	40	240	450	2.0	20	17.4	0.84	0.02	1.2	97.9	0.95	0.84	0.88	5.40	3.33	29.4	G.C.Calib
23	CAL.09	15.0	2	57	63	220	450	2.0	20	6.6	0.32	0.2	0.9	98.0	0.92	0.90	--	4.00	3.00	--	

Table VI. SUMMARY OF M4 SBCR RUN RESULTS (continued)

- a) Unless otherwise noted, total flow is ca. 15 L/min. STP, or 3 cm/sec linear gas flow.
 b) Conversion is total CO conversion over the period (%).
 c) Conversion and selectivities are calculated using N2 as an internal standard in the GC analysis of the offgas
 d) Prod. rate: Rate for production of total hydrocarbons, C1+ (kg/kg cat., hr).
 e) Alpha: Based on GC analysis of offgas and liquid product.

Run No	Cat. No	Cat. wt, g	Per No	Time Start	Time Stop	Temp C	Pres psi	H2: CO	Synfl cc/hr	Conv. %	Prod. Rate	Selectivities					Alpha GC	Alpha Liq	Olefin/Paraffi		Olefins C6-18, %	Comments
												%CH4	%C2	%C3+	%CO2				C3	C4		
24	Co.053	28.5	1	23	39	240	450	2.0	20	50.4	1.28	14.1	2.1	81.8	2.03	0.75	0.79	1.14	0.68	--	--	G.C. Calib
24	Co.053	28.5	2	54	63	250	450	2.0	20	53.5	1.34	24.2	3.6	67.9	4.24	0.66	--	0.66	0.48	--	--	
24	Co.053	28.5	3	78	87	260	450	2.0	30	55.3	1.36	38.2	5.2	49.0	7.64	0.53	--	0.53	0.47	--	--	
24	Co.053	28.5	4	102	110	260	450	2.0	30	52.8	2.13	29.1	4.0	62.1	4.79	0.64	--	0.68	0.49	--	--	
24	Co.053	28.5	5	126	135	260	450	2.0	30	58.9	1.90	28.5	3.9	62.8	4.90	0.65	--	0.70	0.48	--	--	
24	Co.053	28.5	6	146	158	260	450	2.0	30	42.6	1.74	26.9	3.8	66.3	2.96	0.65	--	0.99	0.67	--	--	
24	Co.053	28.5	7	175	182	260	450	2.0	30	51.5	1.31	31.6	4.5	60.0	3.90	0.60	--	0.94	0.65	--	--	
24	Co.053	28.5	8	199	208	260	450	2.0	30	58.1	1.89	27.6	3.7	65.1	3.67	0.66	--	0.88	0.56	--	--	
24	Co.053	28.5	9	218	231	260	450	2.0	30	62.9	2.05	23.2	3.0	70.6	3.20	0.71	--	0.93	0.58	--	--	
24	Co.053	28.5	10	259	263	275	450	2.0	30	72.1	2.24	39.1	5.0	46.4	9.53	0.57	--	0.41	0.34	--	--	
24	Co.053	28.5	11	290	304	260	450	2.0	30	48.8	1.62	29.0	3.8	65.4	1.83	0.65	--	1.78	1.09	--	--	

Feed Gas Rates for Run 24

Per No	N2 Sl/h	H2 Sl/h	CO Sl/h	Total Sl/h
1	563	225	112	900
2	563	225	112	900
3	563	225	112	900
4	360	360	180	900
5	288	288	144	720
6	540	360	180	1080
7	563	225	112	900
8	200	288	144	632
9	108	288	144	540
10	108	288	144	540
11	108	288	144	540

Table VI. SUMMARY OF M4 SBCR RUN RESULTS (continued)

- a) Unless otherwise noted, total flow is ca. 15 L/min. STP, or 3 cm/sec linear gas flow.
 b) Conversion is total CO conversion over the period (%).
 c) Conversion and selectivities are calculated using N₂ as an internal standard in the GC analysis of the offgas.
 d) Prod. rate: Rate for production of total hydrocarbons, C₁+ (kg/kg cat., hr).
 e) Alpha: Based on GC analysis of offgas and liquid product.

Run No	Cat. No	Cat. wt, g	Per No	Time Start	Time Stop	Temp C	Pres psi	H ₂ : CO	Synfl cc/hr	Conv. %	Prod. Rate	Selectivities				Alpha GC	Alpha Liq	Olefin/Paraffi		Olefins C ₆ -18, %	Comments
25	Co.056	15.0	1	23	39	240	450	2.0	20	11.4	0.55	7.8	3.6	87.2	1.43	0.67	0.87	3.60	2.30	20.3	
25	Co.056	15.0	2	47	63	220	450	2.0	20	4.5	0.22	0.3	2.7	95.7	1.27	0.73	--	4.67	3.00	--	
26	CAL.10	15.6	1	23	39	240	450	2.0	20	21.9	1.01	5.4	1.5	91.9	1.25	0.79	0.85	3.60	2.27	25.9	
26	CAL.10	15.6	2	54	63	240	450	2.0	20	21.7	1.30	8.3	1.1	89.9	0.68	0.80	--	3.78	2.45	--	
26	CAL.10	15.6	3	78	87	240	450	2.0	20	17.2	1.04	11.7	1.4	86.1	0.78	0.76	--	3.57	2.30	--	
26	CAL.10	15.6	4	102	111	240	450	2.0	20	17.7	1.01	11.9	1.4	86.0	0.73	0.77	--	3.52	2.28	--	
26	CAL.10	15.6	5	118	126	240	450	2.0	20	16.2	0.75	4.9	1.7	92.3	1.10	0.77	--	4.29	2.75	--	

Feed Gas Rates for Run 26

Per No	N ₂ SI/h	H ₂ SI/h	CO SI/h	Total SI/h
1	563	225	112	900
2	108	288	144	540
3	54	288	144	486
4	25	274	137	436
5	563	225	112	900

Table VI. SUMMARY OF M4 SBCR RUN RESULTS (continued)

- a) Unless otherwise noted, total flow is ca. 15 L/min. STP, or 3 cm/sec linear gas flow.
 b) Conversion is total CO conversion over the period (%).
 c) Conversion and selectivities are calculated using N2 as an internal standard in the GC analysis of the offgas
 d) Prod. rate: Rate for production of total hydrocarbons, C1+ (kg/kg cat., hr).
 e) Alpha: Based on GC analysis of offgas and liquid product.

Run No	Cat. No	Cat. wt, g	Per No	Time Start	Time Stop	Temp C	Pres psi	H2: CO	Synfl cc/hr	Conv. %	Prod. Rate	Selectivities				Alpha GC	Alpha Liq	Olefin/Paraffi		Olefins C6-18, %	Comments
27	Co.050	14.6	1	23	39	240	450	2.0	20	20.4	1.01	6.8	1.9	90.2	1.04	0.78	0.87	2.50	1.69	18.9	
27	Co.050	14.6	2	78	87	220	450	2.0	20	8.1	0.39	0.0	4.8	92.6	2.56	0.79	0.87	8.50	3.00	--	
27	Co.050	14.6	3	102	111	240	450	2.0	20	19.8	0.98	9.1	2.6	87.0	1.30	0.76	--	2.50	1.69	--	
27	Co.050	14.6	4	142	157	240	450	1.0	20	8.4	0.61	1.1	2.9	93.3	2.78	0.79	0.90	6.25	5.00	--	
27	Co.050	14.6	5	173	182	240	450	2.0	20	17.3	0.87	9.9	3.0	85.4	1.74	0.75	--	2.50	1.75	--	
28	Co.057	15.8	1	23	40	240	450	2.0	20	18.7	0.86	5.3	1.5	92.3	0.98	0.81	0.85	3.27	2.36	23.1	
28	Co.057	15.8	2	71	88	220	450	2.0	20	6.0	0.27	0.0	1.9	97.2	0.93	0.79	--	5.50	4.00	--	G.C. Repair
28	Co.057	15.8	3	102	112	240	450	2.0	20	19.4	0.90	7.7	2.1	89.3	0.97	0.77	--	3.70	2.27	--	
28	Co.057	15.8	4	126	135	240	450	1.0	20	8.1	0.56	1.3	4.6	92.7	1.44	0.79	--	7.33	5.67	--	
28	Co.057	15.8	5	150	159	240	450	2.0	20	18.0	0.83	7.6	3.3	88.0	1.00	0.76	--	3.89	2.30	--	
28	Co.057	15.8	6	175	184	250	450	2.0	20	25.3	1.16	13.2	2.8	82.5	1.60	0.73	--	2.30	1.45	--	
28	Co.057	15.8	7	198	208	260	450	2.0	20	29.7	1.36	22.7	3.9	70.7	2.75	0.65	--	1.39	0.92	--	
28	Co.057	15.8	8	222	231	240	450	2.0	20	13.8	0.63	8.7	2.6	87.4	1.34	0.75	--	3.11	2.11	--	
29	Co.061	45.4	1	39	41	240	450	2.0	20	29.0	0.46	14.4	2.6	81.6	1.53	0.72	0.80	1.49	0.94	18.9	G.C. Calib
29	Co.061	45.4	2	54	64	220	450	2.0	20	11.8	0.19	3.9	1.9	93.5	0.73	0.77	--	3.67	2.29	--	Cat. Loss
29	Co.061	45.4	3	78	86	240	450	2.0	20	24.4	0.39	13.3	2.5	83.2	1.08	0.72	--	1.67	1.08	--	Cat. Loss
30	Co.011	15.9	1	23	40	240	450	2.0	20	8.0	0.36	5.8	3.9	87.8	2.49	0.71	0.89	5.75	3.00	22.4	G.C. Repair
30	Co.011	15.9	2	54	64	250	450	2.0	20	15.8	0.72	10.0	3.0	84.8	2.28	0.74	--	4.22	2.40	--	
30	Co.011	15.9	3	78	87	260	450	2.0	20	23.6	1.06	18.1	3.7	74.5	3.72	0.67	--	2.21	1.54	--	G.C. Repair
30	Co.011	15.9	4	102	111	270	450	2.0	20	28.3	1.26	26.5	3.4	64.9	5.23	0.60	--	1.67	1.14	--	
30	Co.011	15.9	5	126	135	278	450	2.0	20	28.5	1.27	34.5	4.0	55.1	6.43	0.53	--	1.84	1.26	--	
30	Co.011	15.9	6	150	159	280	450	2.0	20	36.0	0.95	40.3	4.5	47.9	7.32	0.48	--	1.77	1.20	--	
30	Co.011	15.9	7	174	183	280	450	2.0	20	38.5	0.77	43.7	4.7	43.7	7.90	0.45	--	1.93	1.29	--	
30	Co.011	15.9	8	198	207	280	450	2.0	20	36.0	1.15	38.5	4.5	50.9	6.07	0.52	--	2.18	1.43	--	
30	Co.011	15.9	9	222	230	240	450	2.0	20	4.4	0.20	6.9	4.0	85.5	3.63	0.66	--	6.00	3.67	--	

Feed Gas Rates for Run 30

Per No	N2 SI/h	H2 SI/h	CO SI/h	Total SI/h
1	558	225	112	895
2	558	225	112	895
3	558	225	112	895
4	558	225	112	895
5	558	225	112	895
6	338	135	67	540
7	250	100	50	400
8	160	160	80	400
9	558	225	112	895

Table VI. SUMMARY OF M4 SBCR RUN RESULTS (continued)

- a) Unless otherwise noted, total flow is ca. 15 L/min. STP, or 3 cm/sec linear gas flow.
 b) Conversion is total CO conversion over the period (%).
 c) Conversion and selectivities are calculated using N2 as an internal standard in the GC analysis of the offgas
 d) Prod. rate: Rate for production of total hydrocarbons, C1+ (kg/kg cat. hr).
 e) Alpha: Based on GC analysis of offgas and liquid product.

Run No	Cat. No	Cat. wt,g	Per No	Time Start	Time Stop	Temp C	Pres psi	H2: CO	Synfl cc/hr	Conv. %	Prod. Rate	Selectivities				Alpha GC	Alpha Liq	Olefin/Paraffi		Olefins C6-18,%	Comments
33	CAL.13	15.9	1	23	39	241	450	2.0	20	28.1	1.28	6.4	1.4	90.9	1.29	0.81	0.85	3.64	2.15	23.8	
33	CAL.13	15.9	2	47	63	240	450	2.0	20	25.5	1.21	6.7	1.3	90.8	1.17	0.81	--	3.80	2.45	--	
33	CAL.13	15.9	3	71	87	240	450	2.0	20	25.8	1.18	6.8	1.3	90.8	1.14	0.80	--	3.80	2.25	--	
33	CAL.13	15.9	4	95	111	240	450	2.0	20	25.1	1.15	6.7	1.4	90.6	1.24	0.80	--	4.33	2.55	--	
33	CAL.13	15.9	5	119	135	238	450	2.0	20	22.4	1.02	5.7	1.4	91.8	1.14	0.80	--	4.25	2.50	--	
33	CAL.13	15.9	6	143	159	243	450	2.0	20	27.4	1.25	7.9	1.7	89.0	1.40	0.79	--	3.54	2.13	--	
33	CAL.13	15.9	7	162	178	240	450	2.0	20	23.8	1.09	6.4	1.5	91.0	1.13	0.80	--	4.88	2.55	--	
33	CAL.13	15.9	8	186	203	240	450	2.0	20	22.5	1.03	6.3	1.6	91.1	1.07	0.79	--	4.50	2.60	--	G.C. Calib
33	CAL.13	15.9	9	210	231	241	450	2.0	20	23.2	1.06	6.7	1.6	90.5	1.12	0.81	0.86	4.22	2.45	25.2	
33	CAL.13	15.9	10	234	255	240	450	2.0	20	21.9	1.00	6.4	1.6	90.9	1.05	0.79	--	4.50	2.78	--	
33	CAL.13	15.9	11	262	279	240	450	2.0	20	21.9	1.00	6.3	1.6	91.1	1.02	0.80	--	4.37	2.50	--	
33	CAL.13	15.9	12	282	303	240	450	2.0	20	21.4	0.98	6.1	1.5	91.4	1.01	0.80	--	4.25	2.78	--	
33	CAL.13	15.9	13	306	327	240	450	2.0	20	20.1	0.92	5.9	1.6	91.5	1.05	0.80	--	4.71	2.56	--	
33	CAL.13	15.9	14	331	351	240	450	2.0	20	20.3	0.93	6.0	1.7	91.1	1.12	0.79	--	4.13	2.67	--	
33	CAL.13	15.9	15	360	373	240	450	2.0	20	18.5	0.85	7.2	1.5	90.3	0.98	0.80	--	4.20	3.00	--	G.C. Calib
33	CAL.13	15.9	16	385	398	240	450	2.0	20	19.8	0.91	6.8	1.4	90.8	1.02	0.79	0.85	4.71	2.40	24.5	
33	CAL.13	15.9	17	402	423	240	450	2.0	20	18.4	0.84	7.5	1.6	89.9	1.09	0.78	--	4.00	2.50	--	
33	CAL.13	15.9	18	428	447	239	450	2.0	20	17.2	0.78	7.1	1.6	90.3	1.06	0.78	--	4.43	2.88	--	
33	CAL.13	15.9	19	510	519	241	450	2.0	20	15.6	0.71	6.9	1.5	90.6	1.11	0.78	--	4.67	2.63	--	Down 48hr
33	CAL.13	15.9	20	522	543	241	450	2.0	20	14.5	0.66	6.8	1.2	91.1	0.88	0.77	--	4.50	3.00	--	
33	CAL.13	15.9	21	546	567	240	450	2.0	20	13.9	0.64	6.9	1.2	91.1	0.76	0.77	0.88	5.40	3.00	26.6	
33	CAL.13	15.9	22	570	591	240	450	2.0	20	13.6	0.62	6.9	1.5	90.7	0.98	0.77	--	5.40	3.00	--	
33	CAL.13	15.9	23	596	614	240	450	2.0	20	14.1	0.64	7.0	1.5	90.6	0.95	0.77	--	5.40	3.00	--	
33	CAL.13	15.9	24	617	638	240	450	2.0	20	13.5	0.62	7.0	1.5	90.6	0.87	0.77	--	5.40	2.86	--	
33	CAL.13	15.9	25	641	662	240	450	2.0	20	13.1	0.60	7.1	1.5	90.5	0.86	0.76	--	6.50	2.86	--	
33	CAL.13	15.9	26	665	686	240	450	2.0	20	12.8	0.59	7.3	1.4	90.6	0.73	0.76	--	5.20	2.86	--	
33	CAL.13	15.9	27	689	710	240	450	2.0	20	12.6	0.58	7.2	1.4	90.5	0.86	0.76	--	5.20	2.86	--	
33	CAL.13	15.9	28	713	734	240	450	2.0	20	12.4	0.57	7.5	1.6	90.0	1.01	0.76	0.84	5.20	2.86	25.9	
33	CAL.13	15.9	29	737	758	240	450	2.0	20	12.4	0.57	7.6	1.5	90.2	0.74	0.76	--	5.20	2.86	--	
33	CAL.13	15.9	30	761	782	241	450	2.0	20	12.3	0.56	7.9	1.6	89.6	0.82	0.76	--	5.20	3.00	--	
33	CAL.13	15.9	31	785	806	241	450	2.0	20	12.3	0.56	7.8	0.7	90.9	0.52	0.76	--	6.50	2.86	--	
33	CAL.13	15.9	32	811	830	241	450	2.0	20	12.1	0.55	7.7	1.1	90.6	0.61	0.75	--	6.50	2.86	--	
33	CAL.13	15.9	33	833	854	240	450	2.0	20	11.7	0.54	7.7	1.5	90.1	0.74	0.75	0.84	5.20	2.86	--	
33	CAL.13	15.9	34	857	878	241	450	2.0	20	11.8	0.54	8.0	0.6	91.0	0.50	0.76	--	6.50	2.86	--	
33	CAL.13	15.9	35	881	902	240	450	2.0	20	11.5	0.53	8.0	0.3	91.2	0.47	0.76	--	6.50	2.86	25.9	
33	CAL.13	15.9	36	905	926	240	450	2.0	20	11.3	0.52	8.6	1.1	89.9	0.44	0.75	0.88	6.50	3.17	--	
33	CAL.13	15.9	37	929	950	240	450	2.0	20	11.3	0.52	8.8	1.3	89.5	0.46	0.75	--	6.50	3.17	--	
33	CAL.13	15.9	38	953	974	240	450	2.0	20	11.3	0.52	9.2	1.6	88.4	0.81	0.74	--	5.00	2.71	--	
33	CAL.13	15.9	39	977	998	240	450	2.0	20	11.3	0.52	9.3	1.6	88.4	0.75	0.75	--	5.00	3.33	--	
33	CAL.13	15.9	40	1001	1022	241	450	2.0	20	10.8	0.49	10.2	0.8	88.4	0.52	0.74	--	5.00	2.86	--	
33	CAL.13	15.9	41	1031	1046	241	450	2.0	20	12.9	0.60	9.3	0.0	90.7	0.00	0.77	--	5.40	3.00	--	
33	CAL.13	15.9	42	1049	1069	240	450	2.0	20	11.2	0.52	9.4	0.6	89.6	0.37	0.75	0.86	5.50	2.86	22.4	

Table VI. SUMMARY OF M4 SBCR RUN RESULTS (continued)

- a) Unless otherwise noted, total flow is ca. 15 L/min. STP, or 3 cm/sec linear gas flow.
 b) Conversion is total CO conversion over the period (%).
 c) Conversion and selectivities are calculated using N₂ as an internal standard in the GC analysis of the offgas
 d) Prod. rate: Rate for production of total hydrocarbons, C₁+ (kg/kg cat. .hr).
 e) Alpha: Based on GC analysis of offgas and liquid product.

Run No	Cat. No	Cat. wt,g	Per No	Time Start	Time Stop	Temp C	Pres psi	H2: CO	Synfl cc/hr	Conv. %	Prod. Rate	Selectivities				Alpha GC	Alpha Liq	Olefin/Paraffi		Olefins C6-18.%	Comments
												%CH4	%C2	%C3+	%CO2			C3	C4		
37	Co.005	25.0	1	1	18	216	450	2.0	20	8.1	0.23	0	--	--	--	--	--	--	--	--	
37	Co.005	25.0	2	20	38	221	450	2.0	20	12.6	0.36	1.5	3.9	93.9	0.71	0.90	0.89	--	--	26.6	
37	Co.005	25.0	3	41	62	221	450	2.0	20	14.4	0.42	2.9	--	96.5	0.60	0.91	--	--	--	--	Repair G.C.
37	Co.005	25.0	4	65	86	221	450	2.0	20	14.9	0.43	3.4	5.0	91.1	0.49	0.88	--	6.33	--	--	
37	Co.005	25.0	5	89	110	221	450	2.0	20	14.4	0.42	3.6	9.0	86.8	0.60	0.85	--	6.67	7.50	--	
37	Co.005	25.0	6	113	134	221	450	2.0	20	14.1	0.41	3.8	8.0	87.7	0.58	0.85	--	5.00	15.00	--	
37	Co.005	25.0	7	137	158	222	450	2.0	20	14.8	0.43	4.4	6.6	88.5	0.55	0.82	0.90	5.50	3.20	23.1	
37	Co.005	25.0	8	165	182	221	450	2.0	20	14.1	0.41	4.3	5.3	89.9	0.50	0.80	--	5.50	4.25	--	
37	Co.005	25.0	9	185	206	220	450	2.0	20	13.3	0.39	3.9	3.6	92.0	0.53	0.79	--	5.25	3.20	--	
37	Co.005	25.0	10	209	230	221	450	2.0	20	13.6	0.39	5.1	3.2	91.3	0.51	0.78	--	5.50	2.67	--	
37	Co.005	25.0	11	233	254	221	450	2.0	20	13.5	0.39	4.7	3.6	91.2	0.48	0.78	0.89	4.60	3.20	22.4	
37	Co.005	25.0	12	257	278	221	450	2.0	20	13.3	0.39	4.5	3.1	91.9	0.49	0.78	--	4.40	2.67	--	
37	Co.005	25.0	13	281	302	221	450	2.0	20	13.1	0.38	4.7	3.3	91.5	0.49	0.78	--	4.40	2.67	--	
37	Co.005	25.0	14	305	326	221	450	2.0	20	12.7	0.37	4.9	4.1	90.5	0.52	0.78	--	4.40	2.67	--	
37	Co.005	25.0	15	329	350	221	450	2.0	20	12.4	0.36	4.9	3.9	90.6	0.54	0.77	--	4.60	2.67	--	
37	Co.005	25.0	16	353	374	221	450	2.0	0	12.5	0.36	5.2	3.8	90.5	0.54	0.77	0.83	4.60	2.67	--	Stop Syn FI
37	Co.005	25.0	17	377	397	221	450	2.0	0	12.5	0.36	5.1	3.3	90.9	0.56	0.77	--	4.60	2.67	--	
37	Co.005	25.0	18	401	422	221	450	2.0	0	12.9	0.37	5.3	3.9	90.4	0.42	0.77	0.87	4.80	2.83	--	
37	Co.005	25.0	19	425	446	221	450	2.0	0	12.3	0.36	5.1	3.1	91.6	0.44	0.77	--	4.60	2.83	--	
37	Co.005	25.0	20	449	470	221	450	2.0	0	8.6	0.41	10.4	2.5	86.7	0.37	0.72	--	4.14	2.63	--	
37	Co.005	25.0	21	473	494	221	450	2.0	0	9.1	0.43	10.5	2.6	86.5	0.37	0.74	--	4.43	2.63	25.2	
37	Co.005	25.0	22	497	518	221	450	2.0	0	8.9	0.42	10.8	2.8	85.9	0.45	0.73	0.86	4.43	2.63	--	
37	Co.005	25.0	23	521	542	221	450	2.0	0	8.7	0.41	10.9	2.7	85.9	0.50	0.73	--	4.43	2.63	--	
37	Co.005	25.0	24	545	554	221	450	2.0	0	8.5	0.41	10.9	3.2	85.3	0.50	0.72	--	4.43	3.00	--	
37	Co.005	25.0	25	574	590	221	450	2.0	0	8.1	0.38	10.9	3.5	84.9	0.55	0.72	--	4.29	2.86	--	
37	Co.005	25.0	26	593	614	221	450	2.0	0	7.9	0.37	10.8	3.5	85.1	0.54	0.72	--	4.14	2.86	--	
37	Co.005	25.0	27	617	638	220	450	2.0	0	7.6	0.36	10.8	3.1	85.6	0.57	0.72	0.86	4.00	2.71	--	
37	Co.005	25.0	28	641	662	220	450	2.0	0	7.6	0.36	10.8	2.6	85.9	0.54	0.72	--	4.00	2.71	--	
37	Co.005	25.0	29	674	686	221	450	1.5	0	5.6	0.32	8.4	2.6	88.2	0.78	0.73	--	5.00	2.83	--	
37	Co.005	25.0	30	698	710	221	450	1.5	0	4.8	0.29	10.3	3.0	85.9	0.81	0.71	0.85	5.00	3.40	--	
37	Co.005	25.0	31	731	734	215	450	1.5	0	3.2	0.19	8.3	4.5	85.1	2.03	0.70		4.50	12.00	--	
37	Co.005	25.0	32	742	758	221	450	1.5	20	5.6	0.35	8.6	3.1	87.6	0.71	0.75		4.80	3.20	--	Add Syn FI
37	Co.005	25.0	33	774	782	220	450	2.0	20	10.4	0.31	4.7	3.0	91.6	0.70	0.75		4.40	2.50	--	
37	Co.005	25.0	34	785	806	220	450	2.0	20	10.3	0.29	4.7	2.9	91.6	0.70	0.75		3.67	2.50	--	
37	Co.005	25.0	35	813	830	220	450	1.5	20	4.5	0.28	9.7	3.3	86.2	0.82	0.72		4.60	3.20	--	

Feed Gas Rates for Run 37

Per No	N ₂ SI/h	H ₂ SI/h	CO SI/h	Total SI/h
1	563	225	112	900
20	360	360	180	900
29	360	324	216	900
30	300	360	240	900
33	563	225	112	900
35	300	360	240	900

Table VI. SUMMARY OF M4 SBCR RUN RESULTS (continued)

- a) Unless otherwise noted, total flow is ca. 15 L/min. STP. or 3 cm/sec linear gas flow.
 b) Conversion is total CO conversion over the period (%).
 c) Conversion and selectivities are calculated using N2 as an internal standard in the GC analysis of the offgas
 d) Prod. rate: Rate for production of total hydrocarbons, C1+ (kg/kg cat., hr).
 e) Alpha: Based on GC analysis of offgas and liquid product.

Run No	Cat. No	Cat. wt.g	Per No	Time Start	Time Stop	Temp C	Pres psi	H2: CO	Synfl cc/hr	Conv. %	Prod. Rate	Selectivities				Alpha GC	Alpha Liq	Olefin/Paraffi		Olefins C6-18, %	Comments
38	CAL.14	15.0	1	17	25	240	450	2.0	20	25.5	1.23	6.2	1.8	91.0	1.04	0.79	-	4.75	2.80	--	Shut Down
42	CAL.16	15.0	1	6	13	220	450	2.0	20	<1.0	0.04	-	-	100	-	-	-	-	-	--	Soya Wax
43	CAL.18	15.0	1	6	13	220	450	2.0	20	8.4	0.41	-	-	98.9	1.13	0.89	-	-	-	--	Soya Wax
45	CAL.20	15.0	1	6	14	220	450	2.0	20	3.4	0.17	-	-	100	-	0.86	-	-	-	--	
47	CAL.24	16.0	1	6	13	220	450	2.0	20	4.9	0.22	-	-	100	-	0.87	-	-	-	--	
48	CAL.25	15.0	1	23	38	220	450	2.0	20	9.5	0.46	-	-	99.5	0.47	0.89	-	-	-	--	
52	CAL.27	15.0	1	18	22	220	450	2.0	20	<1.0	0.02	-	-	100	-	-	-	-	-	--	Soya Wax
53	CAL.28	15.0	1	13	15	220	450	2.0	20	0.5	0.03	-	-	100	-	-	-	-	-	--	Soya Wax

Table VII. M4 SBCR RUN RESULTS

COMPARISON OF CATALYST ACTIVITY AT SIMILAR RUN CONDITIONS

Period No.	Temperature	Pressure	H ₂ /CO Ratio
1	240 C	450psi	2.0

a) Unless otherwise noted, total flow is ca.15 L/min. STP, or 3 cm/sec linear gas flow.

b) Conversion is total CO conversion over the period (%).

c) Conversion and selectivities are calculated using N₂ as an internal standard in the GC analysis of the

d) Prod. rate: Rate for production of total hydrocarbons, C₁+ (kg/kg cat.,hr).

e) Alpha: Based on GC analysis of offgas and liquid product.

Run No	Cat. No	Cat. wt,g	Conv. %	Prod. Rate	Selectivities				Alpha GC	Alpha Liq	Olefin/Paraffin		Olefins C6-18,%
					%CH ₄	%C ₂	%C ₃ +	%CO ₂			C3	C4	
3	CO.002	15.2	29.4	1.42	17.3	2.3	79.4	1.0	0.73	0.82	0.91	0.60	17.5
4	CO.024	15.4	25.5	1.21	8.6	2.0	89.0	0.4	0.79	0.84	2.93	1.93	21.7
5	CO.035	15.4	24.8	1.18	8.5	2.1	89.0	0.5	0.78	0.84	3.13	1.94	23.1
6	CO.028	15.4	21.2	1.00	6.1	1.6	91.3	1.0	0.81	0.83	4.86	3.00	28.7
7	CO.043	15.4	13.0	0.61	3.7	1.8	93.4	1.1	0.79	0.85	5.60	3.17	27.3
8	CO.006	15.0	2.7	0.25	0.1	0.2	98.8	1.8	0.67	0.85	3.33	2.33	16.1
9	CO.048	15.4	19.1	0.90	9.9	1.6	87.4	1.1	0.77	0.88	3.60	2.09	20.3
10	CAL.02	15.9	34.5	1.58	12.9	2.0	83.9	1.2	0.75	0.81	1.66	1.06	21.0
11	CAL.03	15.6	29.7	1.39	13.5	2.1	83.4	1.1	0.74	0.86	1.65	1.03	18.2
12	CO.053	15.9	34.2	1.56	12.6	2.0	84.2	1.2	0.75	0.83	1.60	1.00	24.5
13	CO.054	15.7	10.4	0.48	4.7	1.8	92.3	1.2	0.78	0.86	5.75	4.00	25.9
14	BlendA	20.0	29.3	1.41	10.1	1.6	86.3	2.0	0.77	0.86	2.23	1.35	23.1
15	CO.034	13.0	27.5	1.54	10.4	1.6	87.2	0.8	0.78	0.84	2.21	1.40	21.0
16	CAL.04	16.1	26.3	1.34	7.1	1.3	90.3	1.4	0.80	0.85	4.80	3.18	32.9
17	CAL.08	15.0	16.9	0.93	5.9	1.0	91.7	1.4	0.82	0.88	5.20	3.33	28.7
18	CAL.07	15.0	20.6	1.03	7.7	1.2	90.0	1.1	0.81	0.88	5.00	3.00	32.2
19	CAL.05	15.7	26.6	1.22	7.3	1.3	90.2	1.2	0.82	0.86	4.11	3.00	28.7
20	CAL.06	15.0	5.6	0.26	3.1	2.1	92.0	2.9	0.80	0.90	4.50	3.50	30.8
21	CO.004	15.9	39.3	1.80	15.2	2.3	81.2	1.4	0.74	0.80	1.16	0.73	23.1
23	CAL.09	15.0	17.4	0.84	0.0	1.2	97.9	1.0	0.83	0.88	5.40	3.33	29.4
24	CO.053	28.5	50.4	1.28	14.1	2.1	81.8	2.0	0.75	0.79	1.14	0.68	21.7
25	CO.056	15.0	11.4	0.55	7.8	3.6	87.2	1.4	0.67	0.87	3.60	2.30	20.3
26	CAL.10	15.6	21.9	1.01	5.4	1.5	91.9	1.3	0.79	0.85	3.60	2.27	25.9
27	Co.050	14.6	20.4	1.01	6.8	1.9	90.2	1.0	0.78	0.87	2.50	1.69	18.9
28	Co.057	15.8	18.7	0.86	5.3	1.5	92.2	1.0	0.81	0.85	3.27	2.36	23.1
29	Co.061	45.4	29.0	0.46	14.4	2.6	81.6	1.5	0.72	0.80	1.49	0.94	18.9
30	Co.011	15.9	5.0	0.36	5.8	3.9	87.8	2.5	0.71	0.89	5.75	3.00	22.4
31	CAL.12	15.9	27.6	1.26	7.9	1.0	90.0	1.1	0.79	0.84	3.50	2.07	25.2
32	CAL.11	15.9	30.6	1.40	7.8	1.4	89.6	1.2	0.80	0.84	3.91	3.33	26.6
33	CAL.13	15.9	28.1	1.28	6.4	1.4	90.9	1.3	0.81	0.85	3.64	2.15	23.8

Note Catalysts for Runs 3 thru 15 (except 8) screened through 150 x 400 mesh.
Catalyst for Run 8 screened thru 100 x 400 mesh.
Catalysts Nos. CAL.07-CAL.09 were prereduced and coated with soya wax.
Catalyst No. CAL.06 was H₂ reduced and air stabilized.
Catalyst No. Co.061 contains 30 % cobalt.
H₂ to CO ratio for Runs 16 and 17 was 1.76/1.0.

Table VIII. M4 SBCR RUN RESULTS

COMPARISON OF CATALYST ACTIVITY AT SIMILAR RUN CONDITIONS

Period No.	Temperature	Pressure	H ₂ /CO Ratio
2	220 C	450psi	2.0

a) Unless otherwise noted, total flow is ca.15 L/min. STP, or 3 cm/sec linear gas flow.

b) Conversion is total CO conversion over the period (%).

c) Conversion and selectivities are calculated using N₂ as an internal standard in the GC analysis of the

d) Prod. rate: Rate for production of total hydrocarbons, C₁+ (kg/kg cat.,hr).

e) Alpha: Based on GC analysis of offgas and liquid product.

Run No	Cat. No	Cat. wt,g	Conv. %	Prod. Rate	Selectivities				Alpha GC	Alpha Liq	Olefin/Paraffin		Olefins C ₆ -18,%
					%CH ₄	%C ₂	%C ₃ +	%CO ₂			C ₃	C ₄	
3	CO.002	15.2	11.8	0.56	4.7	1.0	93.7	0.6	0.81	0.90	2.71	1.63	--
4	CO.024	15.4	9.5	0.45	0.0	2.1	97.6	0.3	0.83	0.91	5.33	4.00	--
5	CO.035	15.4	8.8	0.42	0.0	2.3	97.4	0.3	0.82	--	5.33	4.00	--
6	CO.028	15.4	6.6	0.31	0.0	1.9	97.4	0.7	0.83	0.90	5.50	4.00	--
7	CO.043	15.4	4.3	0.20	0.0	1.4	96.3	2.3	0.81	0.91	4.00	3.00	--
9	CO.048	15.4	6.1	0.28	1.8	1.0	95.2	1.9	0.80	0.91	3.67	3.00	--
10	CAL.02	15.9	14.9	0.68	4.6	0.9	94.0	0.5	0.81	0.88	4.40	2.29	--
12	CO.053	15.9	14.4	0.66	4.3	1.0	94.3	0.5	0.81	0.89	4.20	2.67	--
13	CO.054	15.7	0.2	0.01	0.0	20.0	60.8	19.5	0.33	0.94	8.00	5.00	--
14	BlendA	20.0	12.4	0.60	4.3	0.9	93.9	1.0	0.81	0.91	3.80	2.33	--
15	CO.034	13.0	11.0	0.61	4.0	0.9	94.5	0.6	0.82	0.90	4.00	3.00	--
16	CAL.04	16.1	8.4	0.42	2.6	1.0	94.1	2.3	0.80	0.88	5.00	4.00	--
17	CAL.08	15.0	5.4	0.28	0.1	0.8	96.9	2.2	0.83	--	4.00	3.00	--
18	CAL.07	15.0	6.7	0.33	1.8	1.4	95.0	1.8	0.85	--	4.00	3.00	--
19	CAL.05	15.7	9.0	0.41	2.3	1.4	94.8	1.6	0.84	--	5.50	3.00	--
20	CAL.06	15.0	3.5	0.16	0.0	3.3	92.8	3.9	0.80	0.85	3.00	2.50	--
21	CO.004	15.9	16.1	0.74	8.1	1.2	90.2	0.5	0.78	0.86	3.38	2.22	--
23	CAL.09	15.0	6.6	0.32	0.2	0.9	98.0	0.9	0.90	--	4.00	3.00	--
25	CO.056	15.0	4.5	0.22	0.0	2.7	95.7	1.3	0.73	--	4.67	3.00	--
27	Co.050	14.6	8.1	0.39	0.0	4.8	92.6	2.6	0.79	0.87	8.50	3.00	--
28	Co.057	15.8	6.0	0.28	0.0	1.9	97.2	0.9	0.79	--	5.50	4.00	--
29	Co.061	45.4	11.8	0.19	3.9	1.9	93.5	0.7	0.77	--	3.67	2.29	--
42	CAL.16	15.0	1.0	0.04	-	-	100.0	-	-	--	--	--	--
43	CAL.18	15.0	8.4	0.41	-	-	98.9	1.1	0.89	--	--	--	--
45	CAL.20	15.0	3.4	0.17	-	-	100.0	-	0.86	--	--	--	--
47	CAL.24	16.0	4.9	0.22	-	-	100.0	-	0.87	--	--	--	--
48	CAL.25	15.0	9.5	0.46	-	-	99.5	0.5	0.89	--	--	--	--

Note Catalysts for Runs 3-21 (except 8), 25-29, and 45-48 screened thru 150 x 400 mesh.

Catalyst for Run 8 screened thru 100 x 400 mesh.

Catalysts Nos. CAL.07-CAL.09, CAL.16 and CAL.18 were prereduced and coated with soya wax.

Catalyst No. CAL.06 was H₂ reduced and air stabilized.

Blend A contains 15.0 g of Cat. No. Co.005 plus 5.0 g of Cat. No. WGS.03

Catalyst No. Co.061 contains 30 % cobalt.

H₂ to CO ratio for Runs 16 and 17 was 1.76/1.0.

Table IX. M4 SBCR RUN RESULTS

COMPARISON OF CATALYST ACTIVITY AT SIMILAR RUN CONDITIONS

Period No.	Temperature	Pressure	H ₂ /CO Ratio
4	240 C	450psi	1.0

a) Unless otherwise noted, total flow is ca.15 L/min. STP, or 3 cm/sec linear gas flow.

b) Conversion is total CO conversion over the period (%).

c) Conversion and selectivities are calculated using N₂ as an internal standard in the GC analysis of the

d) Prod. rate: Rate for production of total hydrocarbons, C₁+ (kg/kg cat.,hr).

e) Alpha: Based on GC analysis of offgas and liquid product.

Run No	Cat. No	Cat. wt,g	Conv. %	Prod. Rate	Selectivities				Alpha GC	Alpha Liq	Olefin/Paraffin		Olefins C6-18,%
					%CH ₄	%C ₂	%C ₃ +	%CO ₂			C3	C4	
3	CO.002	15.2	11.6	0.83	3.9	2.4	92.8	0.8	0.81	0.87	4.29	3.14	--
4	CO.024	15.4	10.3	0.73	0.5	1.6	97.2	0.7	0.83	0.87	8.33	4.75	--
5	CO.035	15.4	10.4	0.73	0.9	0.0	98.4	0.7	--	0.83	--	--	--
6	CO.028	15.4	9.2	0.65	0.0	1.3	97.3	1.5	0.85	0.88	9.50	3.75	--
7	CO.043	15.4	5.2	0.37	0.0	0.0	99.4	0.6	0.83	0.89	7.00	5.00	--
9	CO.048	15.4	8.2	0.57	2.3	1.0	93.8	3.0	0.82	0.90	8.50	4.33	--
10	CAL.02	15.9	14.6	1.00	4.6	1.0	93.3	1.0	0.80	0.88	7.20	4.00	--
12	CO.053	15.9	13.3	0.91	4.3	1.2	93.3	1.2	0.80	0.89	6.60	3.71	--
13	CO.054	15.7	5.2	0.36	0.0	1.2	97.0	1.9	0.83	0.95	6.00	4.50	--
14	BlendA	20.0	12.7	0.91	3.4	1.0	94.0	1.6	0.81	0.86	7.50	3.83	--
15	CO.034	13.0	11.2	0.94	3.9	1.0	94.0	1.0	0.82	0.87	8.33	4.00	--
21	CO.004	15.9	14.9	1.02	7.4	1.4	89.9	1.3	0.77	0.84	4.67	2.82	--
27	Co.050	14.6	8.4	0.61	1.1	2.9	93.3	2.8	0.79	0.90	6.25	5.00	--
28	Co.057	15.8	8.1	0.56	1.3	4.6	92.7	1.4	0.79	--	7.33	5.67	--

Note Catalysts for Runs 3 through 28 screened thru 150 x 400 mesh.

Table X. M4 SBCR RUN RESULTS

COMPARISON OF CATALYST ACTIVITY AT SIMILAR RUN CONDITIONS

Period No.	Temperature	Pressure	H ₂ /CO Ratio
5	240 C	600psi	1.0

a) Unless otherwise noted, total flow is ca. 15 L/min. STP, or 3 cm/sec linear gas flow.

b) Conversion is total CO conversion over the period (%).

c) Conversion and selectivities are calculated using N₂ as an internal standard in the GC analysis of t

d) Prod. rate: Rate for production of total hydrocarbons, C₁+ (kg/kg cat., hr).

e) Alpha: Based on GC analysis of offgas and liquid product.

Run No	Cat. No	Cat. wt, g	Conv. %	Prod. Rate	Selectivities				Alpha GC	Alpha Liq	Olefin/Paraffin		Olefins C6-18, %
					%CH ₄	%C ₂	%C ₃ +	%CO ₂			C3	C4	
3	CO.002	15.2	12.9	0.92	4.0	1.5	93.5	0.91	0.81	0.82	4.29	2.75	24.5
4	CO.024	15.4	11.3	0.80	0.9	1.5	97.0	0.65	0.83	0.87	6.50	3.80	36.4
5	CO.035	15.4	10.7	0.76	0.7	1.4	97.1	0.75	0.84	0.88	6.25	4.50	27.3
6	CO.028	15.4	9.5	0.67	0.0	1.1	97.5	1.36	0.85	0.88	6.00	3.50	40.6
7	CO.043	15.4	5.9	0.41	0.0	2.2	94.8	2.99	0.82	0.89	6.00	3.75	30.1
9	CO.048	15.4	11.9	0.83	2.7	0.9	94.4	1.93	0.84	0.89	5.75	3.20	14.0
10	CAL.02	15.9	16.4	1.12	4.2	1.0	94.0	0.89	0.82	0.86	5.83	3.86	35.7
12	CO.053	15.9	15.6	1.06	4.0	0.9	94.0	1.00	0.82	0.87	5.50	3.57	32.2
13	CO.054	15.7	5.0	0.34	0.0	1.3	96.9	1.78	0.82	0.93	6.50	3.33	30.8
14	BlendA	20.0	14.1	1.02	3.7	1.0	93.8	1.45	0.82	0.89	6.40	3.43	32.9
15	CO.034	13.0	11.8	0.99	3.9	1.1	94.0	1.03	0.83	0.87	5.75	3.80	37.8
21	CO.004	15.9	18.4	1.26	6.1	1.1	91.9	0.94	0.81	0.84	5.25	2.91	32.2

Note Catalysts for Runs 3 through 21 screened thru 150 x 400 mesh.