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TRANSITION METAL-GRAPHITE CATALYSTS FOR PRODUCTION OF LIGHT HYDROCARBONS FROM SYNTHESIS GAS

Quarterly Report for the Period

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Michael P. Rosynek

Texas A & M University
Department of Chemistry
College Station, Texas 77843

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ABSTRACT

Sodium- and potassium-graphites, although possessing high initial activites for the Fischer-Tropsch synthesis, do not behave catalytically for this reaction. A large fraction of carbon monoxide reactant becomes unreactively adsorbed on these materials, probably via formation of stable carbonyl-type structures, and inhibits the overall reaction rate. Furthermore, a permanent and irrecoverable loss of activity occurs after only brief usage due to alkali metal destruction by water formed during the reaction. With only minor variations, the behavior of potassium-reduced iron-graphite is similar to that of pure potassium-graphite. Removal of potassium-containing by-products prior to use considerably lowers the initial activity, but does not prevent the eventual, permanent activity loss.

On the other hand, commercially-available iron-graphites, prepared by reduction with metal aryls, appear to be very promising as Fischer-Tropsch catalysts. Gas phase carbon mass balances observed for these substances are uniformly high; carbon dioxide production is relatively low, and no apparent loss of activity occurs after extended use. Hydrocarbon product distributions are very reproducible and are largely confined, at 300°C, to C_1-C_3 paraffins and olefins. The absolute activities of these materials for hydrocarbon production may be six to seven times that of conventional supported iron catalysts.

I. OBJECTIVE AND SCOPE OF WORK

The objective of this research is the development of a novel process for the production of petrochemical feedstocks based on coal or other carbonaceous materials. Specifically, the project is to investigate the catalytic activities and selectivities of novel alkali and transition-metal graphites in producing light (C_1-C_3) hydrocarbons from H_2/CO synthesis gas.

II. SUMMARY OF PROGRESS TO DATE

A comparison of actual research progress to date vs. project schedule is contained in the "Project Plan and Progress Chart" shown in Fig. 1. In our previous Quarterly Report (November 1976), we described the experimental systems that have been constructed for catalyst preparation and testing, and provided details of the methods to be used for syntheses of graphite intercalation compounds. Also included were preliminary results obtained from the catalytic testing of sodium- and potassium-graphites for the Fischer-Tropsch process.

During the past three months, we have continued our evaluations of the catalytic behaviors of alkali metal-graphites for this reaction, and have extended our study to include two types of iron-graphite catalysts that were prepared by different methods and subjected to various pretreatments.

Based on the results of these investigations, we feel that the exploratory segment of the project, insofar as the establishment of a suitable catalyst preparation method is concerned, has been satisfactorily completed. Subsequent research will concentrate solely on evaluations of the catalytic behaviors of selected transition metal-graphites that have been prepared by what now appears to be the optimum procedure. Technical details of research progress during the most recent contract quarter are contained in the following Section.

III. DETAILED DESCRIPTION OF TECHNICAL PROGRESS

Preliminary results obtained during our study of the behaviors of potassium-reduced transition metal-graphites as catalysts for the Fischer-Tropsch process caused us to doubt the applicability of certain previously-published data (U.S. Patent No. 3,842,121) that had been expected to serve as the basis for our catalyst synthesis techniques. For this reason, we deemed it necessary to quantitatively establish the catalytic properties of pure alkali metal-graphites for the Fischer-Tropsch reaction in order that the more complex behaviors of the three-component catalysts (i.e., alkali metal/transition metal/graphite) could be meaningfully evaluated. Fragmentary test results obtained for sodium- and potassium-graphite catalysts were included in our previous Quarterly Report, and the completed study of these materials is described below. Samples of potassium-reduced

iron chloride-graphite catalysts, subjected to several pretreatments, were then prepared and tested under identical reaction conditions. The results so obtained have allowed several important conclusions to be drawn about the catalytic behaviors of these materials which may be applicable in a broader sense to all alkali-reduced transition metal-graphites. Finally, in order to determine the effect of preparation method on the behavior of transition metal-graphite catalysts for the Fischer-Tropsch synthesis, we have begun an investigation of a commercially-available iron-graphite intercalate for which alkali metals are not employed in the reduction process.

All catalyst testing experiments were performed using the closed-loop recirculation reactor system described in our previous Quarterly Report. The following reaction conditions were common to all runs:

Reaction Temperature = 295-300°C

Initial H_2/CO Ratio = 4.00

Initial Total Pressure = 750.0 Torr

Results obtained for each tested catalyst are described in the following Sub-Sections.

A. Iron/Alumina

Results obtained from a single run with a commercial, H_2-reduced Fe/Al_2O_3 catalyst (Harshaw Chemical Co. No. Fe-0301) were described in our previous Report, and are reproduced in Table I to allow direct comparisons to be made with the experiments reported below. The observed preponderance of methane among the hydrocarbon products is not unusual for the relatively high-temperature, high H_2/CO ratio test conditions employed. The large amount of carbon dioxide in the gaseous product may be due, in part, to incomplete reduction of the iron, since Fe_2O_3 is an effective water-gas shift catalyst under these conditions. The observed CO_2 is definitely a primary reaction product, however, and is not formed via disproportionation of CO reactant ($2\ CO \rightarrow CO_2 + C$), as evidenced by the uniformly high carbon mass balances in the gas phase. Little time-dependent catalyst deactivation was apparent during the run, as shown by the smoothly-increasing CO conversions and the absence of marked decreases in the incremental CO conversion rates. The overall rate of CO conversion to hydrocarbon products during the first hour of reaction corresponded to 0.031 CO molecules/iron atom/hr.

B. Sodium-Graphite ($C_{64}Na$)

Two series of experiments, consisting of several runs each, were performed using two different samples of synthesized sodium-graphite ($C_{64}Na$), and the results are summarized in Tables II and III. Catalyst treatment following each run in a series consisted of a 16 hr evacuation at 300°C. Because of the low vapor pressure (0.014 torr) of metallic sodium at the temperature of catalyst synthesis (300°C), excess alkali metal could not

be completely removed by vacuum distillation following in situ catalyst preparation and remained in the reactor to partially "regenerate" the catalyst during the evacuation period that followed each run. This phenomenon explains certain discrepancies and the lack of well-defined trends among the consecutive runs in each series, and makes a definitive analysis of the results somewhat difficult. Several important features are, nevertheless, apparent from the data presented in these two Tables.

Regardless of absolute activity level, carbon dioxide is absent in all cases from the gaseous, carbon-containing products. This observation may be due either to the known ability of alkali metal-graphites to hydrogenate CO_2 to hydrocarbons (U.S. Patent No. 3,842,113), or to a strong and essentially irreversible adsorption of CO_2 on the catalyst surface. The former explanation appears to be the more likely, considering the relatively high reaction temperature employed. The hydrocarbon product distribution is dominated in most instances by paraffins (primarily C_1-C_3), but considerable amounts of C_2 and C_3 olefins are formed as well. A large amount of CO reactant is lost to the catalyst surface via adsorption in an apparently unreactive form, as evidenced by the very low carbon mass balances observed in all cases. This strongly adsorbed form of CO may be due to generation of stable carbonyl-type structures, and evidently inhibits the overall reaction rate, as seen by the marked decreases in the incremental CO conversion rates during the course of each experiment. The maximum initial rate of CO conversion to hydrocarbon products observed in any of the runs (Series 2, Run 1-C) was 0.58 CO molecules/sodium atom/hr. Following a sufficient number of consecutive experiments with a single sodium-graphite sample, however, permanent loss of catalytic activity always occurred, due to destruction of intercalated sodium by the water that is inevitably formed during the reaction.

C. Potassium-Graphite (C_8K)

The results of four series of runs using separate samples of potassium-graphite (C_8K), prepared at 300°C, are contained in Tables IV-VII. Catalyst treatment following each run in a series again consisted of evacuation for 16 hrs at 300°C. In the case of potassium, excess alkali metal was easily removable by vacuum distillation following catalyst synthesis at 300°C, due to its relatively high vapor pressure (0.28 torr) at this temperature.. Hence, the trends among consecutive runs in a single series presumably reflect true behavior patterns.

Most of the important features observed with potassium-graphite catalysts are similar to those of their sodium analogs, with certain significant differences. Carbon dioxide is again absent from the gaseous products in all cases, even at very low activity levels, due to the CO_2 hydrogenation capability of potassium-graphite, and the carbon-containing products consisted almost entirely of C_1-C_3 hydrocarbons. Unlike the situation observed for sodium-graphite, however, olefins were never present in more than trace amounts among the hydrocarbon products for any of the potassium-graphite samples tested. This phenomenon is probably due to the ability of potassium-graphite to hydrogenate olefins to the corresponding paraffins under the reaction conditions employed, a capability possessed to only a

much lesser extent by sodium-graphite. A large amount of CO reactant is again irreversibly adsorbed in an unreactive form, as shown by the uniformly low carbon mass balances for the first few runs in each series, and effectively inhibits the observed reaction rates. The incremental rate of CO conversion decreases sharply during the course of each experiment, but a partial recovery of lost activity is effected by the 16 hr evacuation period following each run.

The maximum initial rate of CO conversion to hydrocarbon products observed in any of the experiments (Series 4, Run 1-A) was 0.20 CO molecules/potassium atom/hr. It is important to note, however, that, as for sodium-graphite, the Fischer-Tropsch reaction over potassium-graphite is definitely not a catalytic process. Following a sufficient number of consecutive experiments (3 to 4 for our experimental configuration) with a single potassium-graphite sample, permanent and irrecoverable loss of "catalytic" activity must inevitably occur, due to destruction of intercalated potassium atoms by the water formed during reaction. The total amount of carbon monoxide converted, for example, during the fourth series of runs on C_8K (Table VII) prior to complete activity loss was ~ 1500 micromoles, whereas the total initial potassium content of the sample was ~ 5200 micromoles. Although a 1:1 correspondence between total potassium atoms and the number of "active" sites for CO conversion does not necessarily prevail, the permanent loss of activity is apparent.

D. Iron-Graphite (Potassium-Reduced)

Following establishment of the behavior of pure potassium-graphite for the Fischer-Tropsch reaction, samples of iron-graphite (4.5 wt % Fe) were prepared for catalytic testing by reducing the corresponding $FeCl_3$-graphite compound with metallic potassium at 300°C, using the method described in our previous Report. Intercalated potassium necessarily remained in the initial catalyst as C_8K, and it was anticipated that the residual catalytic properties observed after complete destruction of intercalated potassium (3 to 4 runs) would be representative of the iron-graphite component. The results obtained for a single series of five runs using this material are summarized in Table VIII. The reactor was again evacuated for 16 hrs at 300°C following each tabulated experiment.

The overall activity and selectivity behaviors of the potassium-reduced iron-graphite were similar in most respects to those of pure potassium-graphite, with, however, some notable exceptions. Both carbon dioxide and olefinic hydrocarbons were again absent from the gas phase products, and a large fraction of CO reactant was again irreversibly lost to the catalyst surface via unreactive adsorption. The incremental rate of CO conversion decreased markedly, both with increasing reaction time during each individual experiment and at comparable reaction times for successive runs, due to potassium destruction by product water. The absolute level of ethane production, however, was only about one-half that observed for pure C_8K, while that of methane was 8 to 10 times greater, as shown by a comparison of the conversion and product distribution data in Tables VII and VIII. Furthermore, the methane/ethane ratio increased with decreasing activity in the five consecutive runs. An apparently permanent and irrecoverable loss of

activity still occurred, however, following 4 to 5 runs, with no residual activity that could be attributed to an iron-graphite catalyst component. The fifth experiment in Table VIII (Run 1-E) was the last for which measureable conversion could be detected.

In a further attempt to isolate and characterize the true behavior of iron-graphite, an identically-prepared sample of potassium-reduced $FeCl_3$-graphite was purposely exposed to the atmosphere for one hour prior to reactor loading, in order to destroy its C_8K component via reaction with atmospheric oxygen and water. The results obtained for two consecutive Fischer-Tropsch experiments using a single sample of this material are contained in Table IX. It is apparent that the observed "catalytic" properties are quite different from those of either pure potassium-graphite (Table VII) or potassium-reduced iron-graphite (Table VIII). Carbon dioxide is now a major product, together with considerable amounts of olefinic hydrocarbons, both features being similar to those observed for supported iron catalysts (Table I). Little CO reactant is unreactively adsorbed, as evidenced by the high carbon mass balances, but the absolute activity for hydrocarbon production is very low, corresponding to only 0.04 CO molecules/iron atom/hr, also roughly similar to that of Fe/Al_2O_3.

A second sample of air-exposed iron-graphite was washed with deionized water in an attempt to remove the KCl and KOH formed by potassium-reduction of $FeCl_3$ and potassium reaction with atmospheric water, respectively, and its catalytic test results for three consecutive runs are summarized in Table X. The observed behavior was comparable to that of the unwashed sample, but with an even larger level of CO_2 production and lower level of methane formation. Although the initial activity was about 10 times greater than that of its unwashed counterpart, it rapidly deteriorated and became negligibly low after the third consecutive experiment.

It seems clear from the results presented in Tables VIII, IX, and X that potassium-reduced iron-graphites are unsatisfactory catalytic materials for the Fischer-Tropsch reaction, both because of their relatively low activities and because of the apparently permanent and irrecoverable loss of activity that occurs after only brief usage. The reason for this "non-catalytic" behavior, even after supposedly complete removal of resdiual salts, is unclear, but may be due to an unfavorable structural feature imparted to the materials during the alkali metal reduction process, or, more likely, to an adverse effect of residual, "unwashable" KOH. The latter would be formed as a result of any potassium-destruction that involves water, and it is probable that similar Fischer-Tropsch test results would be obtained for other transition metal-graphites prepared by alkali metal reduction of intercalated halides.

E. Iron-Graphite (Metal Aryl-Reduced)

In order to investigate the importance of the method of reduction in determining the catalytic properties of transition metal-graphites for the Fischer-Tropsch reaction, we have recently begun to evaluate, for comparison purposes, the behavior of a commercially-available sample of iron-graphite. The latter, tradenamed "Graphimet", was obtained from the Alfa Chemicals

Division of Ventron Corp. and had an iron content of 2.2 wt %. Its preparation method consists of $FeCl_3$-graphite synthesis, using essentially the same procedure as that employed in our own studies, followed by reduction with a metal aryl (which the Company declined to identify), and subsequent purification and analysis to verify the intercalated nature of the resulting metallic iron. Alkali metals are not used during any stage of the synthesis.

Results obtained for four consecutive runs using a single sample of this iron-graphite (with the usual 16 hr evacuation between experiments) are presented in Table XI, and exhibit several attractive characteristics. Except for the first experiment of the series, the CO_2 content of the carbon-containing products never exceeded 10 mole % after a few hours of reaction, being much less than the amount (> 50 mole %) observed with a conventional supported iron catalyst (Table I). The abnormally large CO_2 production in the early stages of Run 1-A was probably due to partial atmospheric oxidation of the iron, and could have been avoided by subjecting the original catalyst charge to a brief hydrogen treatment prior to its initial use. This opinion is supported by the much smaller amounts of CO_2 that were observed in the three succeeding experiments. The hydrocarbon product distribution was very reproducible for the last three runs, and was largely (~ 95%) confined to the C_1-C_3 fraction, with methane dominating in all cases. Gas phase carbon mass balances were close to 100% in all cases, indicating no loss of CO reactant to the catalyst surface, and no apparent decline in activity occurred either with increasing reaction time during any single experiment or at comparable reaction times in successive experiments. The average initial rate of CO conversion to hydrocarbon products during the last three runs was 0.21 CO molecules/iron atom/hr, or about 6 to 7 times that of a supported iron catalyst (Table I). Finally, the Fischer-Tropsch reaction over this material is definitely catalytic. The total iron content of the sample employed was ~ 200 micromoles, while the total amount of CO converted during the four tabulated experiments was > 1000 micromoles, with no evident loss of activity.

These "Graphimet" materials have the additional advantages of being commercially available at reasonable cost, thus eliminating the time-consuming catalyst syntheses that we have heretofore employed and allowing more time for catalyst testing, and can be handled in the atmosphere without special precautions, requiring only a brief hydrogen treatment following initial reactor loading. Furthermore, vorresponding analogs are available in a variety of loading levels for almost all transition metals whose chlorides can be intercalated into graphite. Consequently, we feel that these materials are clearly the most promising of those investigated by us to date, and that our future evaluations of the potential applicability of transition metal-graphites as Fischer-Tropsch catalysts should be devoted solely to studies made with these substances.

During the next quarter, we plan to begin investigating in detail the catalytic activity and selectivity properties of "Graphimet" transition metal-graphites for the Fischer-Tropsch reaction, concentrating our initial efforts on iron-graphite. Several samples, having a variety of metal loading levels in the range 2-20 wt % iron will be obtained and evaluated for Fischer-Tropsch behavior. Kinetic parameters and product distribution

variations will be established by varying the reaction temperature within the range 200-300°C and the initial H_2/CO reactant ratio in the range 1/1 to 8/1. It is hoped that the data obtained from this survey will provide useful guidelines for further studies involving other transition metal-graphites, particularly those of cobalt, nickel, and ruthenium.

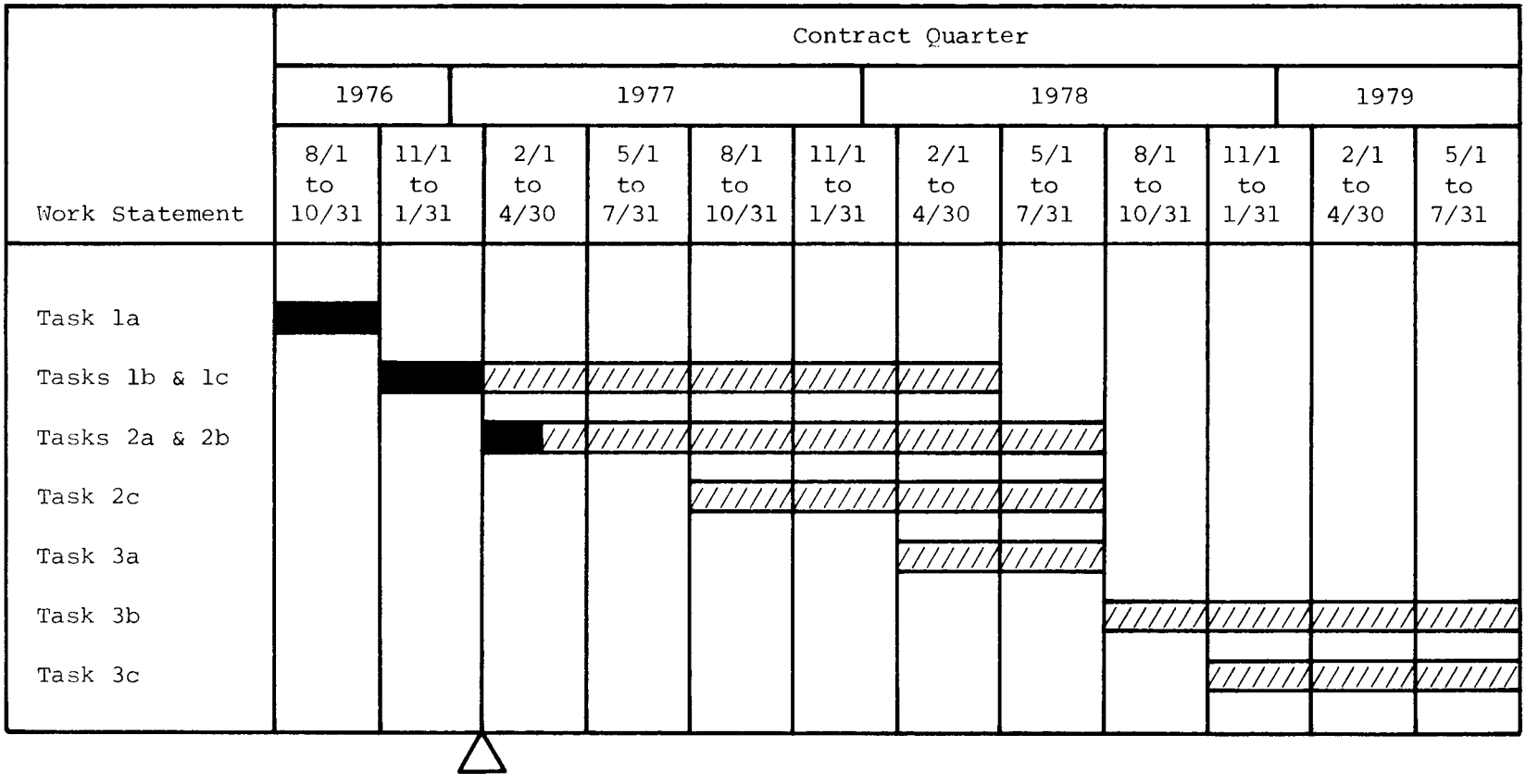
IV. CONCLUSIONS

Sodium- and potassium-graphites, although possessing high initial activities for the Fischer-Tropsch synthesis, do not behave catalytically for this reaction. A large fraction of carbon monoxide reactant becomes unreactively adsorbed on these materials, probably via formation of stable carbonyl-type structures, and inhibits the overall reaction rate. Furthermore, a permanent and irrecoverable loss of activity occurs after only brief usage due to alkali metal destruction by water formed during the reaction. With only minor variations, the behavior of potassium-reduced iron-graphite is similar to that of pure potassium-graphite, with no residual activity that can be attributed to the iron component. Removal of potassium salts prior to use considerably lowers the initial activity, but does not prevent the eventual, permanent activity loss.

On the other hand, commercially-available iron-graphites, prepared by reduction with metal aryls, appear to be very promising as Fischer-Tropsch catalysts. Gas phase carbon mass balances observed for these substances are uniformly high; carbon dioxide production is relatively low, and no apparent loss of activity occurs after extended use. Hydrocarbon product distributions are very reproducible and are largely confined, at 300°C, to C_1-C_3 paraffins and olefins. The absolute activities of these materials for hydrocarbon production may be 6 to 7 times those of conventional supported iron catalysts.

FIGURE 1

Project Plan and Progress Chart



LEGEND

Scheduled

Completed

End of Reporting Period

Table I

Fischer-Tropsch Reaction Results

Expt. No. - Series 1, Run 1-A

Catalyst - Iron on Alumina (14.9 wt % Fe); Harshaw Chemical Co. No. Fe-0301; Reduced in Hydrogen at 400°C.

Weight - 0.47 g Total

Reaction Temperature = 300°C
Initial H_2/CO Ratio = 4.00
Initial Total Pressure = 750.0 Torr

Reaction Time (hrs)	Mole Percent in Gas Phase						
	CO_2	CH_4	C_2H_4	C_2H_6	C_3H_6	C_3H_8	C_4^+
1.10	58.4	29.2	7.6	2.3	2.5	0.0	0.0
2.00	57.5	31.3	5.8	2.7	2.4	0.3	0.0
3.00	57.8	31.7	4.9	3.1	2.0	0.4	0.0
4.00	57.9	31.8	4.1	3.7	2.0	0.6	0.0
5.00	58.2	31.7	3.4	4.0	2.0	0.7	0.0
6.00	56.0	33.3	2.8	4.1	1.8	0.7	1.3
7.00	57.9	30.7	2.7	4.5	1.8	0.8	1.5
8.00	55.2	34.3	2.3	4.4	1.6	0.8	1.4
9.00	55.9	33.5	2.0	4.6	1.6	0.8	1.5

Reaction Time (hrs)	Percent CO Conversion			
	Based on Product Formation	Based on Gas Phase CO Decrease	Rate of CO Conversion (μ-mole/hr)	Percent Carbon Mass Balance in Gas Phase
1.10	3.9	1.8	92.6	102.1
2.00	6.6	7.5	79.4	99.2
3.00	9.3	9.5	68.3	99.8
4.00	11.8	11.6	65.1	100.2
5.00	14.3	12.6	67.3	101.7
6.00	17.9	18.0	91.6	99.8
7.00	19.9	20.4	53.3	99.5
8.00	23.1	23.0	84.0	100.1
9.00	25.2	25.4	54.5	99.8

CO conversions and carbon mass balances are based on total amount of CO admitted into reactor at time t = 0.

Table II

Fischer-Tropsch Reaction Results

Expt. No. - Series 1, Run 1-A

Catalyst - Sodium-Graphite ($C_{64}Na$); Prepared by intercalation at 300°C; Excess sodium remaining.

Weight - 0.50 g (as graphite)

Reaction Temperature = 297°C
Initial H_2/CO Ratio = 4.00
Initial Total Pressure = 750.0 Torr

Reaction Time (hrs)	Mole Percent in Gas Phase						
	CO_2	CH_4	C_2H_4	C_2H_6	C_3H_6	C_3H_8	C_4^+
1.00	0.0	19.5	12.6	58.2	2.4	5.3	1.9
2.00	0.0	24.4	12.5	54.7	2.2	4.4	1.8
3.00	0.0	30.0	9.1	53.7	1.1	4.2	2.0
4.00	0.0	30.7	6.9	55.3	1.1	4.1	1.9
5.00	0.0	36.4	5.3	51.6	1.1	4.0	1.7
6.00	0.0	37.9	4.1	49.5	2.1	3.9	2.6

Reaction Time (hrs)	Percent CO Conversion			
	Based on Product Formation	Based on Gas Phase CO Decrease	Rate of CO Conversion (μ-mole/hr)	Percent Carbon Mass Balance in Gas Phase
1.00	6.9	81.4	181.7	25.6
2.00	11.3	99.7	114.1	11.6
3.00	12.8	100.0	38.5	12.8
4.00	14.2	100.0	36.7	14.2
5.00	15.5	100.0	34.5	15.5
6.00	17.5	100.0	51.3	17.5

CO Conversions and carbon mass balances are based on total amount of CO admitted into reactor at time t = 0.

Table II (cont.)

Fischer-Tropsch Reaction Results

Expt. No. - Series 1, Run 1-B

Catalyst - Sodium-Graphite ($C_{64}Na$); Prepared by intercalation at 300°C; Excess sodium remaining.

Weight - 0.50 g (as graphite)

Reaction Temperature = 297°C
Initial H_2/CO Ratio = 4.00
Initial Total Pressure = 750.0 Torr

Reaction Time (hrs)	Mole Percent in Gas Phase						
	CO_2	CH_4	C_2H_4	C_2H_6	C_3H_6	C_3H_8	C_4^+
1.00	0.0	15.8	13.0	62.1	2.9	6.3	0.0
2.00	0.0	29.4	9.8	48.1	1.8	4.6	6.1
4.05	0.0	45.0	6.3	38.1	1.3	4.0	5.2
5.00	0.0	49.1	4.4	36.7	1.2	3.8	4.8
6.00	0.0	48.9	3.7	37.8	1.1	3.8	4.7

Reaction Time (hrs)	Percent CO Conversion Based on Product Formation	Based on Gas Phase CO Decrease	Rate of CO Conversion (μ-mole/hr)	Percent Carbon Mass Balance in Gas Phase
1.00	2.2	98.1	318.4	14.1
2.00	8.9	100.0	175.5	18.9
4.05	25.8	100.0	88.5	25.8
5.00	27.7	100.0	52.0	27.7
6.00	28.2	100.0	13.4	28.2

CO Conversions and carbon mass balances are based on total amount of CO admitted into reactor at time t = 0.

Table II (cont.)

Fischer-Tropsch Reaction Results

Expt. No. - Series 1, Run 1-C

Catalyst - Sodium-Graphite ($C_{64}Na$); Prepared by intercalation at 300°C; Excess sodium remaining.

Weight - 0.50 g (as graphite)

Reaction Temperature = 297°C
Initial H_2/CO Ratio = 4.00
Initial Total Pressure = 750.0 Torr

Reaction Time (hrs)	Mole Percent in Gas Phase						
	CO_2	CH_4	C_2H_4	C_2H_6	C_3H_6	C_3H_8	C_4^+
1.00	0.0	33.1	19.9	27.1	3.4	4.0	12.2
2.00	0.0	34.6	18.5	27.5	3.4	4.6	11.3
3.00	0.0	34.0	17.3	27.5	3.7	4.8	12.7
4.00	0.0	36.3	17.0	27.3	3.3	4.8	11.3
5.00	0.0	36.8	16.3	27.6	3.4	4.9	10.9
6.00	0.0	36.2	19.3	26.8	3.0	4.3	10.4
7.00	0.0	39.1	15.8	26.9	3.1	4.5	10.6
8.00	0.0	39.6	15.2	27.1	3.0	4.7	10.4
9.00	0.0	39.7	14.9	27.1	3.0	4.7	10.4
10.00	0.0	40.8	14.2	26.7	2.9	4.5	10.8
20.00	0.0	52.6	1.8	32.7	1.7	3.8	7.4

Reaction Time (hrs)	Percent CO Conversion		Rate of CO Conversion (μ-mole/hr)	Percent Carbon Mass Balance in Gas Phase
	Based on Product Formation	Based on Gas Phase CO Decrease		
1.00	5.8	52.0	153.0	53.9
2.00	8.7	65.5	75.1	43.2
3.00	10.9	73.0	55.9	37.8
4.00	12.2	78.7	35.6	33.5
5.00	13.6	84.8	36.7	28.8
6.00	15.6	88.7	52.7	27.0
7.00	16.8	92.3	30.5	24.5
8.00	17.9	95.1	28.8	22.7
9.00	19.0	97.2	28.2	21.7
10.00	20.1	98.9	29.8	21.2
20.00	34.2	99.7	36.9	34.5

CO Conversions and carbon mass balances are based on total amount of CO admitted into reactor at time t = 0.

Table III

Fischer-Tropsch Reaction Results

Expt. No. - Series 2, Run 1-A

Catalyst - Sodium-Graphite ($C_{64}Na$); Prepared by intercalation at 300°C; Excess sodium remaining.

Weight - 0.50 g (as graphite)

Reaction Temperature = 297°C
Initial H_2/CO Ratio = 4.00
Initial Total Pressure = 750.0 Torr

Reaction Time (hrs)	Mole Percent in Gas Phase						
	CO_2	CH_4	C_2H_4	C_2H_6	C_3H_6	C_3H_8	C_4^+
0.25	0.0	5.1	9.8	71.7	3.7	5.9	3.8
0.50	0.0	7.1	10.4	73.3	2.9	2.0	4.4
0.75	0.0	8.9	10.2	67.9	2.8	6.5	3.8
1.00	0.0	9.2	10.5	66.2	2.7	6.6	4.9
1.25	0.0	9.7	11.1	65.7	2.6	6.2	4.7
1.50	0.0	10.5	11.4	64.1	2.8	6.8	4.5
1.75	0.0	10.2	12.1	64.4	2.7	6.5	4.1
2.00	0.0	10.8	12.6	63.6	2.5	6.9	3.6
2.50	0.0	11.2	13.6	61.9	3.0	6.7	3.7
3.00	0.0	12.0	14.3	60.8	3.2	6.7	3.1
3.50	0.0	12.4	14.7	58.5	3.0	6.7	4.7

Reaction Time (hrs)	Percent CO Conversion		Rate of CO Conversion (μ-mole/hr)	Percent Carbon Mass Balance in Gas Phase
	Based on Product Formation	Based on Gas Phase CO Decrease		
0.25	2.8	23.3	295.6	79.5
0.50	4.0	31.1	128.0	72.9
0.75	5.5	37.3	154.3	68.3
1.00	6.7	42.4	121.2	64.3
1.25	7.5	46.5	87.2	61.0
1.50	8.4	50.4	94.2	58.0
1.75	8.9	54.0	54.0	54.9
2.00	9.6	57.5	70.3	52.1
2.50	10.9	65.2	62.8	45.7
3.00	11.8	70.8	53.0	41.0
3.50	13.3	74.6	74.3	38.7

CO Conversions and carbon mass balances are based on total amount of CO admitted into reactor at time t = 0.

Table III (cont.)

Fischer-Tropsch Reaction Results

Expt. No. - Series 2, Run 1-B

Catalyst - Sodium-Graphite ($C_{64}Na$); Prepared by intercalation at 300°C; Excess sodium remaining.

Weight - 0.50 g (as graphite)

Reaction Temperature = 297°C
Initial H_2/CO Ratio = 4.00
Initial Total Pressure = 750.0 Torr

Reaction Time (hrs)	Mole Percent in Gas Phase						
	CO_2	CH_4	C_2H_4	C_2H_6	C_3H_6	C_3H_8	C_4^+
0.25	0.0	15.7	37.1	28.9	7.9	4.7	5.6
0.50	0.0	14.3	34.8	32.2	8.3	4.6	5.8
1.00	0.0	16.2	30.3	36.8	6.4	4.2	6.1
1.50	0.0	18.5	28.8	38.2	5.6	4.1	5.0
2.00	0.0	20.0	27.4	38.1	5.3	4.5	4.7
2.50	0.0	21.8	26.1	37.7	5.4	4.3	4.7
3.00	0.0	23.1	25.2	37.7	4.8	4.3	4.9
3.50	0.0	13.6	27.7	43.5	5.4	4.8	5.0
4.00	0.0	26.4	22.8	37.8	4.2	4.1	4.7
4.50	0.0	28.5	21.6	37.9	3.9	3.8	4.2
5.00	0.0	30.6	20.2	37.5	3.7	3.8	4.2

Reaction Time (hrs)	Percent CO Conversion		Rate of CO Conversion (μ-mole/hr)	Percent Carbon Mass Balance in Gas Phase
	Based on Product Formation	Based on Gas Phase CO Decrease		
0.25	1.6	30.0	158.3	71.6
0.50	2.4	38.3	86.2	64.1
1.00	4.5	53.5	109.8	51.0
1.50	6.1	64.9	81.8	41.3
2.00	7.8	74.7	83.5	33.1
2.50	9.5	83.8	78.8	25.7
3.00	11.1	91.1	84.3	20.0
3.50	11.8	96.5	11.3	15.2
4.00	13.9	99.2	77.9	14.7
4.50	14.9	99.9	48.7	14.9
5.00	16.0	100.0	74.9	16.0

CO Conversions and carbon mass balances are based on total amount of CO admitted into reactor at time t = 0.

Table III (cont.)

Fischer-Tropsch Reaction Results

Expt. No. - Series 2, Run 1-C

Catalyst - Sodium-Graphite ($C_{64}Na$); Prepared by intercalation at 300°C; Excess sodium remaining.

Weight - 0.50 g (as graphite)

Reaction Temperature = 295°C
Initial H_2/CO Ratio = 4.00
Initial Total Pressure = 750.0 Torr

Reaction Time (hrs)	Mole Percent in Gas Phase						
	CO_2	CH_4	C_2H_4	C_2H_6	C_3H_6	C_3H_8	C_4^+
0.28	0.0	25.0	30.0	31.4	5.0	4.3	3.3
0.50	0.0	24.0	27.9	33.6	5.8	4.3	4.4
0.75	0.0	26.0	26.0	34.8	5.1	4.1	4.1
1.00	0.0	28.1	23.9	35.4	4.7	3.7	4.2
1.50	0.0	32.6	19.6	35.7	4.1	3.7	4.3
2.00	0.0	37.0	16.6	35.6	3.6	3.5	3.7
2.50	0.0	41.5	14.0	34.3	3.4	3.5	3.2
3.00	0.0	47.5	12.7	29.4	3.8	3.7	3.1
3.50	0.0	46.7	10.6	32.7	3.3	3.2	3.6

Reaction Time (hrs)	Percent CO Conversion		Rate of CO Conversion (μ-mole/hr)	Percent Carbon Mass Balance in Gas Phase
	Based on Product Formation	Based on Gas Phase CO Decrease		
0.28	4.1	68.0	380.1	36.2
0.50	5.9	80.1	212.7	25.8
0.75	7.3	88.7	146.4	18.6
1.00	8.6	94.5	133.4	14.0
1.50	10.7	99.4	111.3	11.3
2.00	12.2	100.0	81.4	12.3
2.50	13.9	100.0	84.4	13.9
3.00	14.0	100.0	7.5	14.0
3.50	16.1	100.0	111.8	16.1

CO Conversions and carbon mass balances are based on total amount of CO admitted into reactor at time t = 0.

Table III (cont.)

Fischer-Tropsch Reaction Results

Expt. No. - Series 2, Run 1-D

Catalyst - Sodium-Graphite ($C_{64}Na$); Prepared by intercalation at 300°C; Excess sodium remaining.

Weight - 0.50 g (as graphite)

Reaction Temperature = 297°C
Initial H_2/CO Ratio = 4.00
Initial Total Pressure = 750.0 Torr

Reaction Time (hrs)	Mole Percent in Gas Phase						
	CO_2	CH_4	C_2H_4	C_2H_6	C_3H_6	C_3H_8	C_4^+
0.25	0.0	29.4	21.1	49.5	0.0	0.0	0.0
1.00	0.0	26.9	21.7	51.4	0.0	0.0	0.0
1.50	0.0	28.3	16.0	39.7	5.8	7.7	2.5
2.50	0.0	27.8	16.5	41.7	4.3	7.4	2.2
3.50	0.0	29.2	16.4	39.5	3.4	7.0	4.6
4.00	0.0	29.1	16.1	40.1	3.3	7.2	4.2
4.50	0.0	30.1	15.8	39.2	3.4	7.1	4.4
4.75	0.0	30.5	15.7	39.1	3.2	7.1	4.5

Reaction Time (hrs)	Percent CO Conversion		Rate of CO Conversion (μ-mole/hr)	Percent Carbon Mass Balance in Gas Phase
	Based on Product Formation	Based on Gas Phase CO Decrease		
0.25	3.3	53.3	346.9	50.0
1.00	5.9	73.6	91.0	32.4
1.50	9.7	79.3	199.9	30.5
2.50	10.9	86.7	30.0	24.2
3.50	14.3	91.0	89.1	23.3
4.00	15.8	92.8	80.6	23.0
4.50	16.6	94.5	42.7	22.2
4.75	17.0	95.2	35.9	21.7

CO Conversions and carbon mass balances are based on total amount of CO admitted into reactor at time t = 0.

Table III (cont.)

Fischer-Tropsch Reaction Results

Expt. No. - Series 2, Run 1-E

Catalyst - Sodium-Graphite ($C_{64}Na$); Prepared by intercalation at 300°C; Excess sodium remaining.

Weight - 0.50 g (as graphite)

Reaction Temperature = 297°C
Initial H_2/CO Ratio = 4.00
Initial Total Pressure = 750.0 Torr

Reaction Time (hrs)	Mole Percent in Gas Phase						
	CO_2	CH_4	C_2H_4	C_2H_6	C_3H_6	C_3H_8	C_4^+
0.25	0.0	11.5	45.0	19.3	8.7	6.8	8.6
0.50	0.0	14.3	44.5	21.5	7.3	6.9	5.5
0.75	0.0	14.6	42.0	22.0	7.9	6.5	6.9
1.00	0.0	16.6	41.3	21.0	7.8	5.6	7.7
1.50	0.0	19.0	42.0	21.1	6.6	4.8	6.4
2.00	0.0	19.4	38.6	20.5	7.7	5.4	8.3
2.50	0.0	21.0	37.9	20.7	7.0	5.8	7.4
3.00	0.0	22.4	37.6	20.8	6.9	5.2	7.1
3.50	0.0	22.1	35.8	20.1	7.2	5.0	9.7
3.75	0.0	23.2	36.3	20.5	7.4	5.1	7.5
4.00	0.0	23.3	36.0	20.5	7.1	5.4	7.6

Reaction Time (hrs)	Percent CO Conversion		Rate of CO Conversion (μ-mole/hr)	Percent Carbon Mass Balance in Gas Phase
	Based on Product Formation	Based on Gas Phase CO Decrease		
0.25	0.9	13.5	89.6	87.3
0.50	1.3	19.1	44.8	82.2
0.75	1.7	22.7	47.1	79.0
1.00	2.0	25.7	30.7	76.3
1.50	2.4	30.4	16.8	72.0
2.00	3.0	34.3	31.9	68.7
2.50	3.3	37.8	16.2	65.5
3.00	3.6	41.0	14.1	62.5
3.50	4.2	43.8	32.7	60.4
3.75	4.1	45.2	- 3.9	58.9
4.00	4.4	46.9	21.8	57.4

CO Conversions and carbon mass balances are based on total amount of CO admitted into reactor at time t = 0.

Table III (cont.)

Fischer-Tropsch Reaction Results

Expt. No. - Series 2, Run 1-F

Catalyst - Sodium-Graphite ($C_{64}Na$); Prepared by intercalation at 300°C; Excess sodium remaining.

Weight - 0.50 g (as graphite

Reaction Temperature = 297°C
Initial H_2/CO Ratio = 4.00
Initial Total Pressure = 750.0 Torr

Reaction Time (hrs)	Mole Percent in Gas Phase						
	CO_2	CH_4	C_2H_4	C_2H_6	C_3H_6	C_3H_8	C_4^+
0.25	0.0	0.0	50.9	28.4	8.8	6.4	5.7
0.50	0.0	12.5	41.5	25.1	8.2	6.7	6.0
0.75	0.0	12.5	41.2	26.1	8.5	5.6	6.1
1.00	0.0	14.3	40.7	26.4	7.3	5.3	5.9
1.50	0.0	16.9	38.6	25.3	7.5	4.7	7.0
2.00	0.0	18.7	37.2	24.8	7.0	5.5	6.8
2.50	0.0	20.2	36.3	24.2	6.4	4.8	8.0
3.00	0.0	21.1	35.5	23.7	6.4	4.8	8.6

Reaction Time (hrs)	Percent CO Conversion		Rate of CO Conversion (μ-mole/hr)	Percent Carbon Mass Balance in Gas Phase
	Based on Product Formation	Based on Gas Phase CO Decrease		
0.25	0.8	16.0	82.9	84.8
0.50	1.4	21.8	66.1	79.7
0.75	1.8	25.5	38.0	76.3
1.00	2.1	28.8	26.3	73.3
1.50	2.6	33.7	29.2	68.9
2.00	3.1	38.1	24.6	65.0
2.50	3.5	42.2	23.6	61.3
3.00	4.0	45.7	24.9	58.3

CO conversions and carbon mass balances are based on total amount of CO admitted into reactor at time t = 0.

Table IV

Fischer-Tropsch Reaction Results

Expt. No. - Series 1, Run 1-A

Catalyst - Potassium-Graphite (C_8K); Prepared by intercalation at 300°C.

Weight - 0.50 g (as graphite)

Reaction Temperature = 297°C
Initial H_2/CO Ratio = 4.00
Initial Total Pressure = 750.0 Torr

Reaction Time (hrs)	Mole Percent in Gas Phase						
	CO_2	CH_4	C_2H_4	C_2H_6	C_3H_6	C_3H_8	C_4^+
1.00	0.0	24.5	0.0	72.7	0.0	2.8	0.0
2.00	0.0	23.7	0.0	73.6	0.0	2.7	0.0
3.00	0.0	27.3	0.0	70.2	0.0	2.5	0.0
4.00	0.0	29.4	0.0	67.3	0.0	2.8	0.5
5.00	0.0	27.5	0.0	69.6	0.0	2.9	0.0
6.00	0.0	31.9	0.0	65.1	0.0	2.7	0.3
7.00	0.0	31.5	0.0	65.1	0.0	3.4	0.0

Reaction Time (hrs)	Percent CO Conversion		Rate of CO Conversion (μ-mole/hr)	Percent Carbon Mass Balance in Gas Phase
	Based on Product Formation	Based on Gas Phase CO Decrease		
1.00	16.1	96.2	421.6	19.9
2.00	23.8	99.8	201.3	24.0
3.00	26.9	100.0	81.0	26.9
4.00	29.1	100.0	58.7	29.1
5.00	29.2	100.0	0.5	29.2
6.00	31.2	100.0	52.8	31.2
7.00	31.9	100.0	19.5	31.9

CO conversions and carbon mass balances are based on total amount of CO admitted into reactor at time t = 0.

Table IV (cont.)

Fischer-Tropsch Reaction Results

Expt. No. - Series 1, Run 1-B

Catalyst - Potassium-Graphite (C_8K); Prepared by intercalation at 300°C.

Weight - 0.50 g (as graphite)

Reaction Temperature = 297°C
Initial H_2/CO Ratio = 4.00
Initial Total Pressure = 750.0 Torr

Reaction Time (hrs)	Mole Percent in Gas Phase						
	CO_2	CH_4	C_2H_4	C_2H_6	C_3H_6	C_3H_8	C_4^+
1.00	0.0	10.9	0.0	87.6	0.0	1.5	0.0
2.05	0.0	30.3	0.0	68.3	0.0	1.4	0.0
3.00	0.0	29.9	0.0	68.7	0.0	1.4	0.0
5.00	0.0	30.6	0.0	67.6	0.0	1.8	0.0

Reaction Time (hrs)	Percent CO Conversion		Rate of CO Conversion (μ-mole/hr)	Percent Carbon Mass Balance in Gas Phase
	Based on Product Formation	Based on Gas Phase CO Decrease		
1.00	12.0	85.8	313.7	26.2
2.05	17.9	97.4	148.3	20.5
3.00	26.0	100.0	224.9	26.1
5.00	29.3	100.0	41.2	29.3

CO conversions and carbon mass balances are based on total amount of CO admitted into reactor at time t = 0.

Table V

Fischer-Tropsch Reaction Results

Expt. No. - Series 2, Run 1-A

Catalyst - Potassium-Graphite (C_8K); Prepared by intercalation at 300°C.

Weight - 0.50 g (as graphite)

Reaction Temperature = 297°C
Initial H_2/CO Ratio = 4.00
Initial Total Pressure = 750.0 Torr

Reaction Time (hrs)	Mole Percent in Gas Phase						
	CO_2	CH_4	C_2H_4	C_2H_6	C_3H_6	C_3H_8	C_4^+
1.00	0.0	20.9	0.0	75.2	0.0	3.3	0.6
2.00	0.0	24.4	0.0	71.8	0.0	3.4	0.4
3.00	0.0	26.7	0.0	69.6	0.0	3.1	0.6
4.00	0.0	28.2	0.0	68.0	0.0	3.2	0.6
4.91	0.0	27.9	0.0	68.3	0.0	3.2	0.6
6.25	0.0	29.0	0.0	67.4	0.0	3.0	0.6

Reaction Time (hrs)	Percent CO Conversion		Rate of CO Conversion (μ-mole/hr)	Percent Carbon Mass Balance in Gas Phase
	Based on Product Formation	Based on Gas Phase CO Decrease		
1.00	18.6	97.3	486.4	21.3
2.00	25.2	100.0	173.5	25.3
3.00	29.0	100.0	98.1	29.0
4.00	32.2	100.0	84.7	32.2
4.91	34.5	100.0	66.3	34.5
6.25	36.1	100.0	30.8	36.1

CO conversions and carbon mass balances are based on total amount of CO admitted into reactor at time t = 0.

Table V (cont.)

Fischer-Tropsch Reaction Results

Expt. No. - Series 2, Run 1-B

Catalyst - Potassium-Graphite (C_8K); Prepared by intercalation at 300°C.

Weight - 0.50 g (as graphite)

Reaction Temperature = 297°C
Initial H_2/CO Ratio = 4.00
Initial Total Pressure = 750.0 Torr

Reaction Time (hrs)	Mole Percent in Gas Phase						
	CO_2	CH_4	C_2H_4	C_2H_6	C_3H_6	C_3H_8	C_4^+
1.00	0.0	18.7	0.0	80.7	0.0	0.6	0.0
2.00	0.0	25.3	0.0	73.1	0.0	1.6	0.0
3.00	0.0	29.1	0.0	68.9	0.0	1.6	0.4
4.00	0.0	28.4	0.0	69.7	0.0	1.5	0.4
5.00	0.0	30.0	0.0	68.0	0.0	1.6	0.4

Reaction Time (hrs)	Percent CO Conversion		Rate of CO Conversion (μ-mole/hr)	Percent Carbon Mass Balance in Gas Phase
	Based on Product Formation	Based on Gas Phase CO Decrease		
1.00	12.1	76.4	316.4	35.7
2.00	19.7	92.9	198.6	26.8
3.00	25.8	98.0	160.4	27.8
4.00	31.0	99.6	136.8	31.5
5.00	33.5	99.9	63.5	33.6

CO conversions and carbon mass balances are based on total amount of CO admitted into reactor at time t = 0.

Table V (cont.)

Fischer-Tropsch Reaction Results

Expt. No. - Series 2, Run 1-C

Catalyst - Potassium-Graphite (C_8K); Prepared by intercalation at 300°C.

Weight - 0.50 g (as graphite)

Reaction Temperature = 297°C
Initial H_2/CO Ratio = 4.00
Initial Total Pressure = 750.0 Torr

Reaction Time (hrs)	Mole Percent in Gas Phase						
	CO_2	CH_4	C_2H_4	C_2H_6	C_3H_6	C_3H_8	C_4^+
1.00	0.0	19.9	0.0	78.2	0.0	1.9	0.0
2.00	0.0	29.8	0.0	68.9	0.0	1.4	0.0
3.03	0.0	29.9	0.0	66.7	0.8	2.5	0.0
4.00	0.0	30.9	0.1	66.4	0.8	1.7	0.0

Reaction Time (hrs)	Percent CO Conversion		Rate of CO Conversion (μ-mole/hr)	Percent Carbon Mass Balance in Gas Phase
	Based on Product Formation	Based on Gas Phase CO Decrease		
1.00	5.0	48.1	129.9	59.7
2.00	6.5	52.5	39.3	54.0
3.03	6.9	56.6	10.9	50.3
4.00	7.1	60.2	5.4	46.9

CO conversions and carbon mass balances are based on total amount of CO admitted into reactor at time t = 0.

Table V (cont.)

Fischer-Tropsch Reaction Results

Expt. No. - Series 2, Run 1-D

Catalyst - Potassium-Graphite (C_8K); Prepared by intercalation at 300°C.

Weight - 0.50 g (as graphite)

Reaction Temperature = 297°C
Initial H_2/CO Ratio = 4.00
Initial Total Pressure = 750.0 Torr

Reaction Time (hrs)	Mole Percent in Gas Phase						
	CO_2	CH_4	C_2H_4	C_2H_6	C_3H_6	C_3H_8	C_4^+
0.50	0.0	100.0	0.0	0.0	0.0	0.0	0.0
1.00	0.0	100.0	0.0	0.0	0.0	0.0	0.0
2.00	0.0	100.0	0.0	0.0	0.0	0.0	0.0

Reaction Time (hrs)	Percent CO Conversion		Rate of CO Conversion (μ-mole/hr)	Percent Carbon Mass Balance in Gas Phase
	Based on Product Formation	Based on Gas Phase CO Decrease		
0.50	0.1	2.5	4.1	97.6
1.00	0.2	2.4	4.1	97.8
2.00	0.3	12.4	3.4	87.9

CO conversions and carbon mass balances are based on total amount of CO admitted into reactor at time t = 0.

Table VI

Fischer-Tropsch Reaction Results

Expt. No. - Series 3, Run 1-A

Catalyst - Potassium-Graphite (C_8K); Prepared by intercalation at 300°C.

Weight - 0.50 g (as graphite)

Reaction Temperature = 297°C
Initial H_2/CO Ratio = 4.00
Initial Total Pressure = 750.0 Torr

Reaction Time (hrs)	Mole Percent in Gas Phase						
	CO_2	CH_4	C_2H_4	C_2H_6	C_3H_6	C_3H_8	C_4^+
0.50	0.0	29.5	0.0	66.2	0.0	3.1	1.1
1.00	0.0	31.3	0.0	64.5	0.0	2.7	1.5
1.58	0.0	31.9	0.0	64.5	0.0	2.7	1.0
2.17	0.0	33.8	0.0	62.9	0.0	2.8	0.5
2.75	0.0	35.2	0.0	61.1	0.0	2.8	0.9
3.33	0.0	35.8	0.0	60.2	0.0	2.9	1.0
4.00	0.0	37.1	0.0	59.6	0.0	2.8	0.5

Reaction Time (hrs)	Percent CO Conversion		Rate of CO Conversion (μ-mole/hr)	Percent Carbon Mass Balance in Gas Phase
	Based on Product Formation	Based on Gas Phase CO Decrease		
0.50	15.1	100.0	791.5	15.1
1.00	17.7	100.0	133.9	17.7
1.58	21.5	100.0	174.3	21.5
2.17	22.3	100.0	31.8	22.3
2.75	23.5	100.0	56.1	23.5
3.33	25.1	100.0	72.7	25.1
4.00	26.2	100.0	41.9	26.2

CO conversions and carbon mass balances are based on total amount of CO admitted into reactor at time t = 0.

Table VII

Fischer-Tropsch Reaction Results

Expt. No. - Series 4, Run 1-A

Catalyst - Potassium-Graphite (C_8K); Prepared by intercalation at 300°C.

Weight - 0.50 g (as graphite)

Reaction Temperature = 297°C
Initial H_2/CO Ratio = 4.00
Initial Total Pressure = 750.0 Torr

Reaction Time (hrs)	Mole Percent in Gas Phase						
	CO_2	CH_4	C_2H_4	C_2H_6	C_3H_6	C_3H_8	C_4^+
0.25	0.0	27.1	0.0	68.5	0.0	4.4	0.0
0.58	0.0	18.8	0.0	76.7	0.0	4.1	0.3
0.83	0.0	20.2	0.0	75.4	0.0	4.0	0.4
1.08	0.0	21.6	0.0	73.9	0.0	4.0	0.5
1.33	0.0	22.7	0.0	72.8	0.0	4.1	0.5
1.58	0.0	23.7	0.0	71.7	0.0	4.1	0.5
2.08	0.0	25.3	0.0	70.1	0.0	4.1	0.5
2.58	0.0	26.4	0.0	69.0	0.0	4.0	0.6
3.08	0.0	27.3	0.0	68.1	0.0	4.0	0.6
3.58	0.0	28.0	0.0	67.3	0.0	4.1	0.6
4.08	0.0	28.7	0.0	66.8	0.0	4.0	0.5

Reaction Time (hrs)	Percent CO Conversion		Rate of CO Conversion (μ-mole/hr)	Percent Carbon Mass Balance in Gas Phase
	Based on Product Formation	Based on Gas Phase CO Decrease		
0.25	9.9	69.7	1040.9	40.2
0.58	21.3	94.9	890.0	26.4
0.83	26.0	98.7	494.6	27.3
1.08	28.7	99.7	277.3	29.0
1.33	30.7	99.9	215.9	30.8
1.58	32.1	99.9	147.6	32.2
2.08	34.4	100.0	97.3	34.4
2.58	36.2	100.0	106.1	36.2
3.08	37.4	100.0	59.5	37.4
3.58	38.8	100.0	49.8	38.8
4.08	39.3	100.0	32.0	39.3

CO conversions and carbon mass balances are based on total amount of CO admitted into reactor at time t = 0.

Table VII (cont.)

Fischer-Tropsch Reaction Results

Expt. No. - Series 4, Run 1-B

Catalyst - Potassium-Graphite (C_8K); Prepared by intercalation at 300°C.

Weight - 0.50 g (as graphite)

Reaction Temperature = 297°C
Initial H_2/CO Ratio = 4.00
Initial Total Pressure = 750.0 Torr

Reaction Time (hrs)	Mole Percent in Gas Phase						
	CO_2	CH_4	C_2H_4	C_2H_6	C_3H_6	C_3H_8	C_4^+
0.25	0.0	17.7	0.0	81.7	0.0	0.6	0.0
0.50	0.0	21.9	0.0	75.6	0.0	2.5	0.0
0.75	0.0	22.3	0.1	74.7	0.5	2.4	0.0
1.00	0.0	23.8	0.1	73.2	0.5	2.4	0.0
1.25	0.0	25.1	0.1	71.9	0.4	2.5	0.0
1.50	0.0	26.2	0.1	70.8	0.4	2.4	0.0
2.00	0.0	28.0	0.1	69.1	0.4	2.5	0.0
2.25	0.0	28.8	0.1	68.2	0.4	2.5	0.0
2.50	0.0	29.4	0.1	67.6	0.4	2.4	0.0
3.00	0.0	30.1	0.1	67.1	0.4	2.4	0.0
3.25	0.0	31.3	0.1	65.9	0.4	2.3	0.0

Reaction Time (hrs)	Percent CO Conversion		Rate of CO Conversion (μ-mole/hr)	Percent Carbon Mass Balance in Gas Phase
	Based on Product Formation	Based on Gas Phase CO Decrease		
0.25	9.3	47.5	972.7	61.8
0.50	12.1	64.6	290.9	47.4
0.75	13.4	74.7	135.8	38.6
1.00	14.2	82.3	85.8	31.9
1.25	14.7	88.1	56.1	26.6
1.50	15.2	92.0	52.2	23.2
2.00	16.1	96.0	46.8	20.1
2.25	16.4	96.9	30.5	19.4
2.50	16.7	97.6	34.6	19.1
3.00	17.3	98.2	33.8	19.1
3.25	17.5	98.5	21.4	19.0

CO conversions and carbon mass balances are based on total amount of CO admitted into reactor at time t = 0.

Table VII (cont.)

Fischer-Tropsch Reaction Results

Expt. No. - Series 4, Run 1-C

Catalyst - Potassium-Graphite (C_8K); Prepared by intercalation at 300°C.

Weight - 0.50 g (as graphite)

Reaction Temperature = 297°C
Initial H_2/CO Ratio = 4.00
Initial Total Pressure = 750.0 Torr

Reaction Time (hrs)	Mole Percent in Gas Phase						
	CO_2	CH_4	C_2H_4	C_2H_6	C_3H_6	C_3H_8	C_4^+
0.25	0.0	65.4	0.0	34.6	0.0	0.0	0.0
0.50	0.0	62.9	0.0	37.1	0.0	0.0	0.0
0.75	0.0	62.0	0.0	38.0	0.0	0.0	0.0
1.00	0.0	60.8	0.0	39.2	0.0	0.0	0.0
1.25	0.0	61.4	0.0	38.6	0.0	0.0	0.0
1.50	0.0	61.8	0.0	38.2	0.0	0.0	0.0
1.75	0.0	63.2	0.0	36.8	0.0	0.0	0.0
2.00	0.0	64.2	0.0	35.8	0.0	0.0	0.0
2.25	0.0	64.4	0.0	35.6	0.0	0.0	0.0
2.50	0.0	64.7	0.0	35.3	0.0	0.0	0.0

Reaction Time (hrs)	Percent CO Conversion		Rate of CO Conversion (μ-mole/hr)	Percent Carbon Mass Balance in Gas Phase
	Based on Product Formation	Based on Gas Phase CO Decrease		
0.25	0.3	23.5	28.4	76.8
0.50	0.5	47.3	22.9	53.1
0.75	0.6	48.6	15.9	52.1
1.00	0.7	49.5	9.2	51.2
1.25	0.8	50.1	9.3	50.7
1.50	0.9	50.6	11.2	50.3
1.75	1.0	51.1	6.6	49.9
2.00	1.1	51.5	6.8	49.6
2.25	1.1	52.0	8.5	49.1
2.50	1.2	52.4	3.8	48.8

CO conversions and carbon mass balances are based on total amount of CO admitted into reactor at time t = 0.

Table VII (cont.)

Fischer-Tropsch Reaction Results

Expt. No. - Series 4, Run 1-D

Catalyst - Potassium-Graphite (C_8K); Prepared by intercalation at 300°C.

Weight - 0.50 g (as graphite)

Reaction Temperature = 297°C
Initial H_2/CO Ratio = 4.00
Initial Total Pressure = 750.0 Torr

Reaction Time (hrs)	Mole Percent in Gas Phase						
	CO_2	CH_4	C_2H_4	C_2H_6	C_3H_6	C_3H_8	C_4^+
0.33	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.50	0.0	0.0	0.0	100.0	0.0	0.0	0.0
0.75	0.0	80.6	0.0	19.4	0.0	0.0	0.0
1.00	0.0	81.2	0.0	18.8	0.0	0.0	0.0

Reaction Time (hrs)	Percent CO Conversion		Rate of CO Conversion (μ-mole/hr)	Percent Carbon Mass Balance in Gas Phase
	Based on Product Formation	Based on Gas Phase CO Decrease		
0.33	0.0	0.0	0.0	100.0
0.50	0.0	0.9	2.9	99.1
0.75	0.1	1.6	7.4	98.5
1.00	0.1	2.4	3.9	97.7

CO conversions and carbon mass balances are based on total amount of CO admitted into reactor at time t = 0.

Table VIII

Fischer-Tropsch Reaction Results

Expt. No. - Series 1, Run 1-A

Catalyst - Iron-Graphite (4.5 wt % Fe); Iron intercalated as $FeCl_3$, then reduced with potassium at 300°C; Excess potassium remaining as C_8K.

Weight - 0.50 g (as graphite)

Reaction Temperature = 299°C
Initial H_2/CO Ratio = 4.00
Initial Total Pressure = 750.0 Torr

Reaction Time (hrs)	Mole Percent in Gas Phase						
	CO_2	CH_4	C_2H_4	C_2H_6	C_3H_6	C_3H_8	C_4^+
0.25	0.0	73.5	0.0	25.0	0.0	1.5	0.0
0.50	0.0	80.5	0.0	18.6	0.0	0.9	0.0
0.75	0.0	81.9	0.0	17.3	0.0	0.7	0.0
1.00	0.0	83.3	0.0	15.9	0.0	0.7	0.1
1.25	0.0	84.6	0.0	14.5	0.0	0.7	0.1
1.50	0.0	85.8	0.0	13.4	0.0	0.7	0.1
2.01	0.0	86.9	0.0	12.3	0.0	0.7	0.1
2.50	0.0	87.3	0.0	11.9	0.0	0.7	0.1
3.10	0.0	87.5	0.0	11.7	0.0	0.7	0.1
3.50	0.0	87.6	0.0	11.6	0.0	0.7	0.1
4.00	0.0	87.7	0.0	11.5	0.0	0.7	0.1

Reaction Time (hrs)	Percent CO Conversion		Rate of CO Conversion (μ-mole/hr)	Percent Carbon Mass Balance in Gas Phase
	Based on Product Formation	Based on Gas Phase CO Decrease		
0.25	9.2	45.1	957.9	64.1
0.50	26.9	72.2	1851.1	54.8
0.75	37.1	86.0	1062.4	51.2
1.00	44.4	92.7	758.7	51.7
1.25	50.4	96.2	618.2	54.2
1.50	55.2	98.0	508.3	57.3
2.01	60.9	99.4	236.1	59.7
2.50	63.4	99.8	134.3	63.6
3.10	64.6	100.0	49.8	64.6
3.50	65.1	100.0	33.1	65.1
4.00	65.8	100.0	25.1	65.8

CO conversions and carbon mass balances are based on total amount of CO admitted into reactor at time t = 0.

Table VIII (cont.)

Fischer-Tropsch Reaction Results

Expt. No. - Series 1, Run 1-B

Catalyst - Iron-Graphite (4.5 wt % Fe); Iron intercalated as $FeCl_3$, then reduced with potassium at 300°C; Excess potassium remaining as C_8K.

Weight - 0.50 g (as graphite)

Reaction Temperature = 297°C
Initial H_2/CO Ratio = 4.00
Initial Total Pressure = 750.0 Torr

Reaction Time (hrs)	Mole Percent in Gas Phase						
	CO_2	CH_4	C_2H_4	C_2H_6	C_3H_6	C_3H_8	C_4^+
0.30	0.0	91.6	0.0	8.2	0.0	0.2	0.0
0.51	0.0	91.2	0.0	8.4	0.1	0.3	0.0
1.00	0.0	93.0	0.1	6.6	0.1	0.3	0.0
1.50	0.0	93.8	0.1	5.8	0.0	0.2	0.0
2.00	0.0	94.3	0.1	5.4	0.0	0.2	0.0
3.50	0.0	95.0	0.1	4.7	0.0	0.2	0.0
4.00	0.0	95.2	0.1	4.6	0.0	0.2	0.0
4.50	0.0	95.2	0.1	4.5	0.0	0.2	0.1
5.00	0.0	95.3	0.1	4.4	0.0	0.2	0.1
5.50	0.0	95.3	0.1	4.4	0.0	0.2	0.0
6.00	0.0	95.3	0.1	4.4	0.0	0.2	0.0

Reaction Time (hrs)	Percent CO Conversion		Rate of CO Conversion (μ-mole/hr)	Percent Carbon Mass Balance in Gas Phase
	Based on Product Formation	Based on Gas Phase CO Decrease		
0.30	9.3	30.0	809.2	79.4
0.51	19.8	54.7	129o.3	65.0
1.00	27.6	72.8	323.3	54.8
1.50	31.8	81.5	203.5	50.3
2.00	34.8	87.1	156.2	47.8
3.50	40.4	96.1	96.1	44.2
4.00	41.8	97.7	74.2	44.1
4.50	42.8	98.8	54.5	44.1
5.00	43.6	99.5	40.8	44.1
5.50	43.8	99.7	12.0	44.1
6.00	44.1	99.9	14.8	44.2

CO conversions and carbon mass balances are based on total amount of CO admitted into reactor at time t = 0.

Table VIII (cont.)

Fischer-Tropsch Reaction Results

Expt. No. - Series 1, Run 1-C

Catalyst - Iron-Graphite (4.5 wt % Fe); Iron intercalated as $FeCl_3$, then reduced with potassium at 300°C; Excess potassium remaining as C_8K.

Weight - 0.50 g (as graphite)

Reaction Temperature = 298°C
Initial H_2/CO Ratio = 4.00
Initial Total Pressure = 750.0 Torr

Reaction Time (hrs)	Mole Percent in Gas Phase						
	CO_2	CH_4	C_2H_4	C_2H_6	C_3H_6	C_3H_8	C_4^+
0.25	0.0	99.1	0.0	0.9	0.0	0.0	0.0
0.50	0.0	99.2	0.0	0.8	0.0	0.0	0.0
0.75	0.0	99.1	0.1	0.8	0.0	0.0	0.0
1.00	0.0	99.1	0.2	0.7	0.0	0.0	0.0
1.50	0.0	99.0	0.3	0.8	0.0	0.0	0.0
2.00	0.0	98.4	0.4	0.8	0.3	0.0	0.0
2.50	0.0	98.4	0.5	0.8	0.2	0.0	0.0
3.00	0.0	97.8	0.7	0.9	0.4	0.3	0.0
3.50	0.0	97.5	0.8	1.0	0.5	0.2	0.0
4.02	0.0	97.1	1.0	1.1	0.5	0.2	0.0
4.50	0.0	96.7	1.3	1.2	0.6	0.2	0.0

Reaction Time (hrs)	Percent CO Conversion		Rate of CO Conversion (μ-mole/hr)	Percent Carbon Mass Balance in Gas Phase
	Based on Product Formation	Based on Gas Phase CO Decrease		
0.25	0.9	5.3	92.5	95.6
0.50	2.2	16.0	138.0	86.2
0.75	3.7	25.2	150.8	78.5
1.00	4.8	31.1	114.6	73.6
1.50	6.6	39.4	96.5	67.2
2.00	8.2	46.2	80.7	62.0
2.50	9.3	51.8	60.6	57.6
3.00	10.6	56.6	64.0	53.9
3.50	11.6	60.4	55.3	51.2
4.02	12.5	63.5	44.8	49.0
4.50	13.3	65.6	43.1	47.7

CO conversions and carbon mass balances are based on total amount of CO admitted into reactor at time t = 0.

Table VIII (cont.)

Fischer-Tropsch Reaction Results

Expt. No. - Series 1, Run 1-D

Catalyst - Iron-Graphite (4.5 wt % Fe); Iron intercalated as $FeCl_3$, then reduced with potassium at 300°C; Excess potassium remaining as C_8K.

Weight - 0.50 g (as graphite)

Reaction Temperature = 296°C
Initial H_2/CO Ratio = 4.00
Initial Total Pressure = 750.0 Torr

Reaction Time (hrs)	Mole Percent in Gas Phase						
	CO_2	CH_4	C_2H_4	C_2H_6	C_3H_6	C_3H_8	C_4^+
0.25	0.0	100.0	0.0	0.0	0.0	0.0	0.0
0.50	0.0	100.0	0.0	0.0	0.0	0.0	0.0
0.68	0.0	97.3	2.7	0.0	0.0	0.0	0.0
1.00	0.0	96.5	1.5	1.9	0.0	0.0	0.0
1.50	0.0	94.5	3.2	2.3	0.0	0.0	0.0
2.02	0.0	93.6	3.6	2.8	0.0	0.0	0.0
2.50	0.0	90.5	3.9	3.3	2.2	0.0	0.0
3.00	0.0	90.3	4.5	3.5	1.7	0.0	0.0

Reaction Time (hrs)	Percent CO Conversion		Rate of CO Conversion (μ-mole/hr)	Percent Carbon Mass Balance in Gas Phase
	Based on Product Formation	Based on Gas Phase CO Decrease		
0.25	0.1	0.1	7.4	100.4
0.50	0.2	0.7	10.0	99.5
0.68	0.3	1.7	20.4	98.6
1.00	0.4	2.4	8.0	98.0
1.50	0.7	3.5	17.9	97.2
2.02	1.0	4.5	12.5	96.5
2.50	1.2	6.5	12.0	94.7
3.00	1.4	7.5	11.2	94.0

CO conversions and carbon mass balances are based on total amount of CO admitted into reactor at time t = 0.

Table VIII (cont.)

Fischer-Tropsch Reaction Results

Expt. No. - Series 1, Run 1-E

Catalyst - Iron-Graphite (4.5 wt % Fe); Iron intercalated as $FeCl_3$, then reduced with potassium at 300°C; Excess potassium remaining as C_8K.

Weight - 0.50 g (as graphite)

Reaction Temperature = 296°C
Initial H_2/CO Ratio = 4.00
Initial Total Pressure = 750.0 Torr

Reaction Time (hrs)	Mole Percent in Gas Phase						
	CO_2	CH_4	C_2H_4	C_2H_6	C_3H_6	C_3H_8	C_4^+
0.25	0.0	100.0	0.0	0.0	0.0	0.0	0.0
0.50	0.0	100.0	0.0	0.0	0.0	0.0	0.0
1.00	0.0	95.0	2.7	2.3	0.0	0.0	0.0
1.50	0.0	92.4	3.7	3.9	0.0	0.0	0.0

Reaction Time (hrs)	Percent CO Conversion		Rate of CO Conversion (μ-mole/hr)	Percent Carbon Mass Balance in Gas Phase
	Based on Product Formation	Based on Gas Phase CO Decrease		
0.25	0.0	0.0	2.1	101.0
0.50	0.1	0.0	9.2	100.1
1.00	0.2	0.7	5.4	99.5
1.50	0.3	1.4	6.6	99.0

CO conversions and carbon mass balances are based on total amount of CO admitted into reactor at time t = 0.

Table IX

Fischer-Tropsch Reaction Results

Expt. No. - Series 2, Run 1-A

Catalyst - Iron-Graphite (4.5 wt % Fe); Iron intercalated as $FeCl_3$, then reduced with potassium at 300°C; Excess potassium destroyed by exposure to atmosphere.

Weight - 0.50 g (as graphite)

Reaction Temperature = 296°C
Initial H_2/CO Ratio = 4.00
Initial Total Pressure = 750.0 Torr

Reaction Time (hrs)	Mole Percent in Gas Phase						
	CO_2	CH_4	C_2H_4	C_2H_6	C_3H_6	C_3H_8	C_4^+
0.25	100.0	0.0	0.0	0.0	0.0	0.0	0.0
0.50	90.8	0.0	9.2	0.0	0.0	0.0	0.0
1.00	53.1	36.1	8.4	2.4	0.0	0.0	0.0
1.50	35.7	44.3	10.2	2.9	6.9	0.0	0.0
2.00	18.3	55.2	11.1	4.5	6.6	2.4	2.1
3.50	17.5	53.9	11.1	4.9	6.3	2.5	3.7
4.00	17.9	54.6	11.0	4.7	6.2	2.4	3.2

Reaction Time (hrs)	Percent CO Conversion		Rate of CO Conversion (μ-mole/hr)	Percent Carbon Mass Balance in Gas Phase
	Based on Product Formation	Based on Gas Phase CO Decrease		
0.25	0.1	0.0	7.7	100.6
0.50	0.1	0.0	7.5	100.5
1.00	0.4	0.9	12.2	99.4
1.50	0.6	2.2	14.1	98.5
2.00	1.7	6.0	57.2	95.7
3.50	2.2	7.4	9.2	94.9
4.00	2.6	8.5	18.6	94.1

CO conversions and carbon mass balances are based on total amount of CO admitted into reactor at time t = 0.

Table IX (cont.)

Fischer-Tropsch Reaction Results

Expt. No. - Series 2, Run 1-B

Catalyst - Iron-Graphite (4.5 wt % Fe); Iron intercalated as $FeCl_3$, then reduced with potassium at 300°C; Excess potassium destroyed by exposure to atmosphere.

Weight - 0.50 g (as graphite)

Reaction Temperature = 295°C
Initial H_2/CO Ratio = 4.00
Initial Total Pressure = 750.0 Torr

Reaction Time (hrs)	Mole Percent in Gas Phase						
	CO_2	CH_4	C_2H_4	C_2H_6	C_3H_6	C_3H_8	C_4^+
0.25	16.9	67.7	10.1	5.4	0.0	0.0	0.0
0.50	12.8	70.5	7.2	4.5	5.0	0.0	0.0
0.75	11.1	71.5	7.6	4.4	5.4	0.0	0.0
1.00	10.2	74.6	7.4	4.0	3.8	0.0	0.0
1.51	11.3	68.8	9.3	5.6	5.0	0.0	0.0
2.00	8.1	72.4	7.8	5.1	3.9	2.7	0.0
3.00	6.9	72.5	7.1	4.7	5.2	1.4	2.1
3.50	6.6	73.7	7.3	4.9	4.0	1.6	1.8

Reaction Time (hrs)	Percent CO Conversion			
	Based on Product Formation	Based on Gas Phase CO Decrease	Rate of CO Conversion (μ-mole/hr)	Percent Carbon Mass Balance in Gas Phase
0.25	0.1	0.0	15.2	101.2
0.50	0.3	0.0	16.9	100.7
0.75	0.5	0.0	15.6	100.7
1.00	0.6	0.1	11.4	100.5
1.51	0.6	1.1	4.1	99.5
2.00	1.1	1.5	22.8	99.6
3.00	1.7	3.1	15.5	98.6
3.50	1.9	3.3	11.9	98.6

CO conversions and carbon mass balances are based on total amount of CO admitted into reactor at time t = 0.

Table X

Fischer-Tropsch Reaction Results

Expt. No. - Series 3, Run 1-A

Catalyst - Iron-Graphite (4.5 wt % Fe); Iron intercalated as $FeCl_3$, then reduced with potassium at 300°C; Excess potassium destroyed by exposure to atmosphere; KOH and KCl removed by washing.

Weight - 0.50 g (as graphite)

Reaction Temperature = 294°C
Initial H_2/CO Ratio = 4.00
Initial Total Pressure = 750.0 Torr

Reaction Time (hrs)	Mole Percent in Gas Phase						
	CO_2	CH_4	C_2H_4	C_2H_6	C_3H_6	C_3H_8	C_4^+
0.25	90.8	4.4	2.8	0.0	2.0	0.0	0.0
0.50	83.7	7.5	3.2	0.0	3.3	0.0	2.3
0.75	78.7	8.8	5.6	0.4	3.8	0.0	2.6
1.00	77.3	9.1	6.1	0.4	4.1	0.5	2.4
1.50	75.0	10.8	6.9	0.5	4.3	0.3	2.2
2.00	71.2	12.8	8.0	0.6	4.8	0.3	2.3
2.50	67.1	14.6	8.9	0.7	5.1	0.4	3.3
3.00	64.0	16.8	9.6	0.8	5.3	0.3	3.1
3.50	61.6	18.5	10.3	0.8	5.6	0.4	2.8
4.00	59.1	19.9	10.8	0.9	5.9	0.4	3.0

Reaction Time (hrs)	Percent CO Conversion		Rate of CO Conversion (μ-mole/hr)	Percent Carbon Mass Balance in Gas Phase
	Based on Product Formation	Based on Gas Phase CO Decrease		
0.25	2.3	2.0	242.6	100.3
0.50	3.9	4.8	169.8	99.1
0.75	5.1	6.8	118.0	98.3
1.00	5.8	10.5	74.7	95.3
1.50	7.2	13.8	74.0	93.4
2.00	8.2	17.3	54.0	91.0
2.50	9.2	19.7	47.7	89.5
3.00	9.6	21.3	22.2	88.3
3.50	9.9	22.6	14.4	87.2
4.00	10.3	23.9	24.9	86.5

CO conversions and carbon mass balances are based on total amount of CO admitted into reactor at time t = 0.

Table X (cont.)

Fischer-Tropsch Reaction Results

Expt. No. - Series 3, Run 1-B

Catalyst - Iron-Graphite (4.5 wt % Fe); Iron intercalated as $FeCl_3$, then reduced with potassium at 300°C; Excess potassium destroyed by exposure to atmosphere; KOH and KCl removed by washing.

Weight - 0.50 g (as graphite)

Reaction Temperature = 294°C
Initial H_2/CO Ratio = 4.00
Initial Total Pressure = 750.0 Torr

Reaction Time (hrs)	Mole Percent in Gas Phase						
	CO_2	CH_4	C_2H_4	C_2H_6	C_3H_6	C_3H_8	C_4^+
0.25	73.7	0.0	12.7	0.0	13.7	0.0	0.0
0.50	54.5	29.8	9.7	1.7	4.2	0.0	0.0
0.75	49.8	35.0	9.1	1.7	4.4	0.0	0.0
1.00	50.4	34.8	9.5	1.7	3.7	0.0	0.0
2.00	48.8	34.3	10.0	1.9	5.0	0.0	0.0
2.50	46.7	37.5	9.4	1.8	4.7	0.0	0.0
3.00	47.3	37.0	9.1	1.7	4.8	0.0	0.0

Reaction Time (hrs)	Percent CO Conversion		Rate of CO Conversion (μ-mole/hr)	Percent Carbon Mass Balance in Gas Phase
	Based on Product Formation	Based on Gas Phase CO Decrease		
0.25	0.2	0.0	19.4	100.8
0.50	0.4	0.1	24.1	100.3
0.75	0.6	0.8	23.1	99.8
1.00	0.8	1.2	13.0	99.5
2.00	1.2	2.4	10.5	98.8
2.50	1.2	2.0	3.5	99.2
3.00	1.3	2.4	3.3	98.9

CO conversions and carbon mass balances are based on total amount of CO admitted into reactor at time t = 0.

Table X (cont.)

Fischer-Tropsch Reaction Results

Expt. No. - Series 3, Run 1-C

Catalyst - Iron-Graphite (4.5 wt % Fe); Iron intercalated as $FeCl_3$, then reduced with potassium at 300°C; Excess potassium destroyed by exposure to atmosphere; KOH and KCl removed by washing.

Weight - 0.50 g (as graphite)

Reaction Temperature = 292°C
Initial H_2/CO Ratio = 4.00
Initial Total Pressure = 750.0 Torr

Reaction Time (hrs)	Mole Percent in Gas Phase						
	CO_2	CH_4	C_2H_4	C_2H_6	C_3H_6	C_3H_8	C_4^+
0.25	72.5	0.0	27.5	0.0	0.0	0.0	0.0
0.50	36.6	51.3	9.5	2.6	0.0	0.0	0.0
1.00	36.2	52.4	8.6	2.8	0.0	0.0	0.0
1.50	35.4	51.2	8.0	2.2	3.3	0.0	0.0

Reaction Time (hrs)	Percent CO Conversion		Rate of CO Conversion (μ-mole/hr)	Percent Carbon Mass Balance in Gas Phase
	Based on Product Formation	Based on Gas Phase CO Decrease		
0.25	0.1	0.0	5.8	100.6
0.50	0.2	0.0	18.1	100.4
1.00	0.5	0.6	11.7	99.8
1.50	0.7	1.5	13.0	99.2

CO conversions and carbon mass balances are based on total amount of CO admitted into reactor at time t = 0.

Table XI

Fischer-Tropsch Reaction Results

Expt. No. - Series 1, Run 1-A

Catalyst - Iron-Graphite (2.2 wt % Fe); Ventron Corp. "Graphimet" No. 89654.

Weight - 0.50 g (as graphite)

Reaction Temperature = 300°C
Initial H_2/CO Ratio = 4.00
Initial Total Pressure = 750.0 Torr

Reaction Time (hrs)	Mole Percent in Gas Phase						
	CO_2	CH_4	C_2H_4	C_2H_6	C_3H_6	C_3H_8	C_4^+
0.50	81.1	15.2	3.8	0.0	0.0	0.0	0.0
1.66	40.7	30.3	9.6	4.2	10.0	1.2	4.0
3.33	26.3	42.9	6.9	7.6	8.6	2.5	5.3
4.33	26.4	38.7	6.7	10.1	9.8	2.4	5.8
5.33	24.1	41.7	6.0	11.0	8.8	3.1	5.3
6.33	21.0	47.2	5.1	11.0	7.9	3.4	4.5
7.33	21.1	45.0	4.9	12.1	8.3	3.7	4.9
8.33	20.3	46.2	4.6	12.6	7.8	3.8	4.7

Reaction Time (hrs)	Percent CO Conversion		Rate of CO Conversion (μ-mole/hr)	Percent Carbon Mass Balance in Gas Phase
	Based on Product Formation	Based on Gas Phase CO Decrease		
0.50	0.6	0.0	28.9	101.8
1.66	3.1	2.3	57.6	100.8
3.33	7.8	4.5	72.8	103.2
4.33	9.2	4.8	37.1	104.3
5.33	10.9	11.9	44.2	98.9
6.33	12.9	13.8	52.8	99.1
7.33	13.7	16.1	21.6	97.6
8.33	14.7	17.6	27.1	97.1

CO conversions and carbon mass balances are based on total amount of CO admitted into reactor at time t = 0.

Table XI (cont.)

Fischer-Tropsch Reaction Results

Expt. No. - Series 1, Run 1-B

Catalyst - Iron-Graphite (2.2 wt % Fe); Ventron Corp. "Graphimet" No. 89654.

Weight - 0.50 g (as graphite)

Reaction Temperature = 297°C
Initial H_2/CO Ratio = 4.00
Initial Total Pressure = 750.0 Torr

Reaction Time (hrs)	Mole Percent in Gas Phase						
	CO_2	CH_4	C_2H_4	C_2H_6	C_3H_6	C_3H_8	C_4^+
1.00	14.2	43.5	16.6	5.2	10.9	1.3	8.2
2.00	12.3	48.8	15.1	7.1	11.2	1.2	4.3
3.00	10.5	53.7	11.9	8.1	10.8	1.0	4.1
4.00	9.8	54.8	10.5	9.0	9.4	1.5	4.8
5.00	9.4	55.5	9.4	9.7	9.2	1.6	5.2
6.00	9.3	56.7	8.7	10.5	9.0	2.0	3.8
7.00	9.1	56.6	8.0	11.2	8.2	2.1	4.3
8.00	8.6	57.8	7.2	11.1	8.3	2.0	4.9

Reaction Time (hrs)	Percent CO Conversion		Rate of CO Conversion (μ-mole/hr)	Percent Carbon Mass Balance in Gas Phase
	Based on Product Formation	Based on Gas Phase CO Decrease		
1.00	1.9	0.6	51.0	101.3
2.00	3.0	2.3	28.5	100.8
3.00	4.5	2.4	38.0	102.1
4.00	5.7	4.2	30.9	101.5
5.00	6.7	6.2	27.8	100.5
6.00	7.4	6.5	17.6	100.9
7.00	8.3	7.8	23.1	100.5
8.00	9.5	9.2	32.2	100.3

CO conversions and carbon mass balances are based on total amount of CO admitted into reactor at time t = 0.

Table XI (cont.)

Fischer-Tropsch Reaction Results

Expt. No. - Series 1, Run 1-C

Catalyst - Iron-Graphite (2.2 wt % Fe); Ventron Corp. "Graphimet" No. 89654.

Weight - 0.50 g (as graphite)

Reaction Temperature = 297°C
Initial H_2/CO Ratio = 4.00
Initial Total Pressure = 750.0 Torr

Reaction Time (hrs)	Mole Percent in Gas Phase						
	CO_2	CH_4	C_2H_4	C_2H_6	C_3H_6	C_3H_8	C_4^+
1.00	14.1	50.6	15.2	4.1	10.9	0.0	5.2
2.00	12.1	50.1	13.7	6.0	11.0	2.0	5.1
3.00	10.9	52.9	12.0	7.1	10.4	1.7	4.9
4.00	10.3	54.9	10.9	8.0	10.3	1.6	4.0
5.25	9.4	56.0	9.6	8.8	9.4	1.9	4.8
6.00	9.3	55.5	9.0	9.4	9.5	2.5	4.7
7.00	8.9	57.2	8.2	9.8	9.0	2.3	4.7
8.00	8.8	57.9	7.8	10.3	8.7	2.4	4.2

Reaction Time (hrs)	Percent CO Conversion		Rate of CO Conversion (μ-mole/hr)	Percent Carbon Mass Balance in Gas Phase
	Based on Product Formation	Based on Gas Phase CO Decrease		
1.00	1.4	0.5	37.6	101.0
2.00	2.7	2.0	33.1	100.7
3.00	3.7	3.4	26.7	100.4
4.00	4.5	3.6	21.3	101.0
5.00	5.8	4.4	26.0	101.4
6.00	6.4	5.3	21.2	101.1
7.00	7.1	6.5	20.0	100.7
8.00	7.8	7.0	15.8	100.8

CO conversions and carbon mass balances are based on total amount of CO admitted into reactor at time t = 0.

Table XI (cont.)

Fischer-Tropsch Reaction Results

Expt. No. - Series 1, Run 1-D

Catalyst - Iron-Graphite (2.2 wt % Fe); Ventron Corp. "Graphimet" No. 89654.

Weight - 0.50 g (as graphite)

Reaction Temperature = 297°C
Initial H_2/CO Ratio = 4.00
Initial Total Pressure = 750.0 Torr

Reaction Time (hrs)	Mole Percent in Gas Phase						
	CO_2	CH_4	C_2H_4	C_2H_6	C_3H_6	C_3H_8	C_4^+
1.00	11.2	47.8	14.3	5.2	13.7	1.7	6.1
2.00	10.3	48.6	12.7	8.0	12.2	2.1	6.0
3.00	9.2	52.3	10.3	9.1	11.3	1.9	5.9
4.00	9.0	54.5	9.3	10.0	10.9	2.2	4.2
5.00	8.9	54.3	8.6	10.9	10.2	2.2	5.0
6.00	8.6	56.0	7.8	11.2	9.6	2.3	4.5
7.00	8.2	56.9	7.0	11.4	9.1	2.5	4.9
8.00	8.2	57.1	6.7	11.8	9.2	2.6	4.2

Reaction Time (hrs)	Percent CO Conversion		Rate of CO Conversion (μ-mole/hr)	Percent Carbon Mass Balance in Gas Phase
	Based on Product Formation	Based on Gas Phase CO Decrease		
1.00	1.9	0.0	50.4	101.9
2.00	3.3	6.6	37.0	96.8
3.00	4.7	8.0	36.2	96.8
4.00	5.5	9.4	20.8	96.2
5.00	6.3	8.8	21.5	97.5
6.00	7.1	9.1	20.0	98.0
7.00	8.0	15.7	22.7	92.3
8.00	8.4	11.8	12.4	96.7

CO conversions and carbon mass balances are based on total amount of CO admitted into reactor at time t = 0.

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