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

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ABSTRACT

Sodium- and potassium-graphite intercalates, 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 the water molecules that are necessarily formed during 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 from this material prior to use imparts behavior similar to that of an alumina-supported iron catalyst, but does not prevent the eventual, permanent loss of catalytic activity.

The activity for Fischer-Tropsch conversion of a commercially-available metal aryl-reduced iron-graphite intercalate decreases with increasing reaction time, but eventually becomes stabilized at a level that is relatively independent of pretreatment conditions. The overall activity of this material is similar to that of a commercial iron/alumina catalyst, but its selectivity characteristics in the temperature range 225-325°C are considerably different. The iron-graphite intercalate produces substantially smaller amounts of carbon dioxide and larger amounts of C_2^+ hydrocarbon products at one atmosphere pressure than does the iron/alumina catalyst under identical conditions.

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 via the Fischer-Tropsch process.

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. Following construction, testing, and calibration of a suitable atmospheric-pressure catalytic reactor and analytical system, studies during the first year of the project have centered on evaluating the catalytic behaviors of the following graphite intercalates for the Fischer-Tropsch process:

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

2.) Potassium-Graphite (C_8K)

3.) Iron-Graphite (Potassium-Reduced)

4.) Iron-Graphite (Sodium Aryl-Reduced)

Variable parameters have included pretreatment conditions, reaction temperature, total pressure, and initial H_2:CO reactant ratio. Furthermore, in order to establish a suitable basis for comparison, additional studies were performed using a commercial iron/alumina catalyst under similar reaction conditions. Significant differences were observed in both overall catalytic activity and product distribution among the various materials tested, and technical details of research progress are described in the following Sections.

III. DETAILED DESCRIPTION OF TECHNICAL PROGRESS

Work on this project began with the construction of appropriate experimental systems for the preparation, handling, and testing of catalysts, and progressed to an evaluation of suitable catalyst sources and/or preparation methods. Following these initial stages, our primary emphasis has been on studies of the catalytic behaviors of the prepared and purchased materials. Results obtained during the first year of the project are most conveniently discussed within the framework of these three principal segments.

A. Systems Construction

1. Catalyst Preparation and Handling Chamber

A controlled-atmosphere chamber was assembled to enable handling, in an oxygen- and water-free environment, the anhydrous transition metal chlorides and pure alkali metals required for certain of the catalyst preparations. The system is based on a Kewaunee Co. Model 2C-610 vacuum dry box, having a total internal volume of 70 liters, and is equipped with a Sargent-Welch Model 8815 direct-drive rotary vacuum pump (150 liters/min) operated through a refrigerated cold trap. A Torsion Co. Model DWM-2 balance having a sensitivity of 2 mg is permanently contained within the chamber and allows *in situ* weighing of all catalyst components during the preparation procedure. Pressure measurements are made with a Wallace and Tiernan Co. Model 61-050 aneroid gauge (0-800 torr) and a Fredericks Co. Model 2C thermocouple gauge (0-1000 microns). Purified nitrogen is supplied to the chamber through a Linde 5A molecular sieve drying train and liquid nitrogen-cooled trap. The vacuum/pressure gauges and cold traps, plus associated valves, by-passes, and all-metal manifolding are mounted on a vertical panel that is attached directly to the chamber, thus making the entire system self-contained.

In operation, required reagents and materials are placed within the box; the glove ports are evacuated initially and then isolated, and the main chamber is evacuated to < 100 microns. The box is then quickly filled with purified nitrogen to atmospheric pressure, and the evacuation/re-filling procedure is repeated. The entire system has been used to maintain working O_2/H_2O levels of < 20 ppm for 2-3 hours, which is judged adequate performance for typical applications.

2. Atmospheric Pressure Catalytic Reactor System

An all-glass reaction system was constructed to enable testing of the various catalysts for activity and selectivity behaviors in Fischer-Tropsch syntheses. The system is of the recirculation (stirred-batch) type, having a total volume of 350 ml, and consists of a mixing vessel that contains ~ 85% of the system volume, an isolatable by-pass trap, a U-shaped reactor with spiral pre-heater section, and a circulation pump consisting of appropriate check valves and a glass-enclosed iron piston activated by a pulsed toroid. Additional provisions exist for introducing hydrogen and carbon monoxide reactants into the system through refrigerated traps. The reactor containing the catalyst sample is thermostatted to $\pm$ 0.5°C at the desired reaction temperature in a Hoskins Co. Model FA-120 crucible furnace energized by a Barber-Colman Co. Model 520Y digital proportional band controller. Reactor temperature is monitored by a Thermo-Electric Co. Model 31606-011 digital readout connected to an iron-constantan thermocouple positioned in the furnace at the midpoint of the catalyst bed.

The reaction system is connected via greased stopcocks to appropriate pressure-measuring devices and to a conventional diffusion-pumped high vacuum gas handling system. Evacuation is achieved in two stages with a

Lammert Co. Model 10202 direct-drive rotary pump (42 liters/min) and a Varian Co. Model M-2 oil diffusion pump (175 liters/sec). Gas pressures during evacuation and reactant admission are measured in three overlapping ranges using a calibrated Granville-Phillips Co. Model 260 ionization/ thermocouple gauge controller and a Validyne Co. Model DM56A-895 variable capacitance manometer with digital readout to 0.1 torr and an accuracy of $\pm$ 0.2% of reading.

Analyses of reactant/product mixtures are accomplished by periodically expanding samples (0.3 vol %) from the circulating gas stream into a previously-evacuated sample loop of a gas sampling valve that is installed in a Carle Co. Model AGC-111 gas chromatograph. Separation of gas mixtures containing hydrogen, carbon monoxide, carbon dioxide, water, methane, ethylene, ethane, propylene, propane, C_4's, and C_5^+ fractions has been successfully effected using a 1/8" x 12' stainless steel column packed with 80/100 mesh Porapak R and maintained at an isothermal oven temperature of 80°C. An entire analysis, including column backflush to elute C_4's and C_5^+ materials, requires less than 15 minutes. Output from the thermal conductivity detector of the gas chromatograph is displayed on a Linear Instruments Corp. Model 252A/E1 strip-chart recorder equipped with an electronic integrator. Quantitative analyses of reaction product mixtures are based on integrated component peak areas, following appropriate corrections for differing thermal response factors.

3. Other Equipment

All of the equipment and experimental systems described in Sections A.1. and A.2. are intended solely for this project. Additional instruments and equipment available within our laboratory for this research, but not devoted to it, include a fully-equipped thermogravimetric and gas adsorption apparatus, based on a Cahn Co. Model RG recording electrobalance, for adsorption and surface area measurements of prepared catalysts and graphite substrates; an Electronic Associates Inc. Model 1200 quadrupole mass spectrometer for supplementary analyses of reaction product mixtures, and an IMS Associates, Inc. Model 8080 microcomputer system with digital tape drive and teletype I/O for processing gas chromatographic data.

B. Evaluation of Catalyst Preparation Methods

Our exploratory investigation of suitable catalyst preparation methods was based largely on the previously-published work of Croft (J. Austral. Chem. Soc. 9, 184 [1956]) and Tamaru (U.S. Patent No. 3,842,121 [1974]), whose techniques appeared to be generally applicable to the present research. Group VIB (Cr, Mo, W) and VIII (Fe, Co, Ni, Ru, Pd, Os, Pt) transition metals can be intercalated into the graphite structure by weighing, in a moisture-free environment, appropriate amounts of the anhydrous metal chloride and powdered, ash-free graphite into a tubular glass vessel. The mixture is evacuated at 25°C to $< 10^{-3}$ torr, isolated, and then heated in a static vacuum at 300-400°C for 3-6 hours, the optimum heating temperature varying only slightly with the identity of the metal chloride. For $FeCl_3$-

graphite, for example, which is the combination that we have investigated most extensively, heating for six hours at 300°C provides satisfactory results. Intercalation of the less volatile $CrCl_3$, on the other hand, requires temperatures nearer 400°C and somewhat longer heating times, as well as the presence of gaseous Cl_2 oxidizing agent to achieve maximum insertion levels. Maximum attainable intercalation levels differ considerably for the various transition metal chlorides of interest, as shown by the results of Croft (and verified by us for $FeCl_3$), who used an excess of metal chloride in each case:

Metal Chloride	Maximum Intercalation Level (wt %)	Equivalent Molecular Formula
$CrCl_3$	76	C_4CrCl_3
$MoCl_5$	25	$C_{68}MoCl_5$
WCl_6	26	$C_{94}WCl_6$
$FeCl_3$	56	$C_{11}FeCl_3$
$CoCl_3$	55	$C_{11}CoCl_3$
$NiCl_2$	--	--
$RuCl_3$	3	$C_{556}RuCl_3$
$PdCl_4$	54	$C_{393}PdCl_4$
$OsCl_4$	--	--
$PtCl_4$	37	$C_{98}PtCl_4$

Materials containing less than the maximum attainable levels are easily obtained by adjusting the graphite/metal chloride ratio in the original mixture. In these cases, little non-intercalated metal chloride remains after heating, and washing is usually unnecessary.

Reduction of intercalated metal chlorides to the corresponding free transition metals, while maintaining the latter in their unique interlayer positions, cannot normally be accomplished by "conventional" techniques. Treatment with gaseous hydrogen at 300-400°C, for example, causes many of the metal chlorides to migrate out of the graphite structure and results in a phase separation in the final metal/graphite products. One method that may be used to effect *in situ* reduction involves adding a weighed excess (1:1 by weight of graphite) of alkali metal (sodium, potassium, rubidium, or cesium) to the reaction vessel under an oxygen- and moisture-free environment, evacuating at 25°C to $< 10^{-3}$ torr, and then heating at 250-300°C for 3-4 hours in a static vacuum. Excess alkali metal, required to ensure complete and intimate contact with the transition metal chloride-graphite, is then removed by heating the vessel for an additonal 6-10 hours under dynamic vacuum conditions. This procedure causes the alkali metal to distill out of the hot reaction tube and condense on its cooler walls above the heated region.

Using this technique, the final reduced metal-graphite product retains, in most instances, the powdery texture of the original pure graphite substrate, but necessarily contains a certain amount of intercalated alkali metal in addition to the transition metal. The former can be completely

removed, if desired, by exposure to moist air, followed by aqeous washing to remove the resulting KOH, and final overnight drying at 110°C. Pure alkali metal-graphites ($C_{64}Na$, C_8K, C_8Rb, and C_8Cs) may be prepared using the same method as that outlined in these paragraphs, but eliminating the transition metal chloride intercalation step. We have applied these general techniques to prepare the sodium-graphite ($C_{64}Na$) and potassium-graphite (C_8K) samples whose catalytic behaviors are described in Sections C.2 and C.3 below, and the potassium-reduced iron-graphite (both with and without excess intercalated potassium) discussed in Section C.4.

An alternative method for in situ reduction of intercalated transition metal chlorides involves treatment with a metal aryl contained in an appropriate solvent, followed by removal of excess solvent. The Alfa Chemicals Div. of Ventron Corp. employs this technique, using a sodium naphthalene derivative as reducing agent, to prepare the transition metal-graphites that are marketed under the tradename "Graphimets". We have obtained a sample of their iron-graphite analog, and have extensively investigated its catalytic behavior for the Fischer-Tropsch process, as discussed in Section C.5. below.

C. Catalyst Testing for Fischer-Tropsch Behavior

All experimental testing and evaluation of prepared and purchased catalysts were performed using the reactor system and analytical procedures described in Section A.2. Except as noted in the applicable Tables, typical catalyst sample size for all experiments was 0.5 g, with reaction temperatures varied within the range 225-325°C, total initial pressures at or near one atmosphere, and initial H_2/CO reactant ratios of 2/1 to 4/1. The results of all tests performed are summarized in the following Sections, which have been segregated according to the various catalysts studied.

1. Iron/Alumina

In order to establish a suitable basis of comparison for the observed behaviors of graphite-based catalysts, several series of experiments were performed using a commercial iron/alumina catalyst. The material employed for this purpose was Harshaw Chemical Co. No. FE-0301, supplied as 20 wt% Fe_2O_3 on a γ-alumina support having a measured BET-N_2 surface area of 41 m^2/g. It was received in the form of 3/16" tablets, and was subsequently crushed and sized to 60/80 mesh particles. Reduction of the Fe_2O_3 to free iron was effected by evacuation at 400°C to $< 10^{-4}$ torr, treatment with 750 torr of circulating H_2 for eight hours at the same temperature (with continuous removal of the gaseous water generated by the reduction), and final evacuation to $< 10^{-4}$ torr. The final product was stored under dry argon, and aliquots were removed, as needed, for experimentation.

Comparative results obtained from four successive experiments using a single sample of iron/alumina are presented in Table I, and the corresponding variations in CO conversion levels with reaction time for each run are summarized by the open points in Fig. 2. Reaction temperature for all runs

was 300°C, and sample treatment between experiments involved overnight evacuation at the same temperature to $< 10^{-4}$ torr. The large progressive decrease in initial reaction rate observed for the first three runs is caused by coke/carbide deposition on the catalyst surface, as evidenced by the uniformly low carbon mass balances for Runs 1-A and 1-B and by the large amounts of carbon dioxide in the reaction product during the early stages of these two experiments. The relatively close similarity between the conversion-time results of Runs 1-C and 1-D and the latter stages of Run 1-B suggests that the activity of the catalyst becomes stabilized after 1-2 total hours of reaction time. Such behavior is typical of iron-based Fischer-Tropsch catalysts. The total initial rate of CO conversion to all products in Run 1-D corresponded to 0.114 CO molecules/Fe atom/hr.

As expected, the observed hydrocarbon product distributions in these experiments were very dependent on the extent of CO reaction. Because olefins are the primary C_2^+ hydrocarbon products formed during the Fischer-Tropsch synthesis, with the corresponding paraffins being formed by subsequent hydrogenation of the unsaturates, the C_2^+ hydrocarbon products were dominated by olefins at low CO conversions (as in Runs 1-C and 1-D) and by paraffins at high CO conversions (Runs 1-A and 1-B). Methane constituted approximately 50-60% of the total reaction product obtained from the stabilized catalyst under the reaction conditions employed for all experiments.

Following completion of Run 1-D (total cumulative reaction time = 12.25 hours), the catalyst was regenerated by treatment with an excess of circulating oxygen for three hours at 400°C (with an in-line trap maintained at -196°C to condense the CO_2 and H_2O combustion products), followed by re-reduction with hydrogen at 400°C, as described above. The relative amounts of CO_2 and H_2O formed during the oxygen treatment corresponded to a total coke/carbide level on the catalyst of 2.5 wt%, and to a composition of $CH_{0.3}$. Most of the carbon imbalance observed during the four runs was accounted for by this result. The catalytic behavior of the reactivated sample for a single run (2-A) is shown in Table I, and is represented by the solid points in Fig. 2. It is apparent that both the activity and selectivity characteristics of the regenerated catalyst are very similar to those of the fresh material (Run 1-A). It is likely that a decrease in initial activity such as that observed in Runs 1-B through 1-D would occur for subsequent experiments using the regenerated material.

The effects of variations in reaction temperature on overall catalytic activity and product selectivity for iron/alumina were established by performing a series of single experiments (each employing a fresh catalyst sample to obviate corrections for the progressive activity decline observed in Fig. 2) at five reaction temperatures in the range 225-325°C. Total initial pressure was 750 torr in each case, with an initial H_2/CO reactant ratio of 2/1. The results of these experiments are contained in Table II, and corresponding plots of product distribution vs. CO conversion for each run are shown in Figs. 3 to 7. Initial product distributions (extrapolated to 0% conversion) for all runs as a function of reaction temperature are summarized in Fig. 8.

Overall initial activity increased regularly with increasing reaction

temperature up to 300°C, but a slight decline in initial rate was observed at 325°C, perhaps due to a decrease in the surface concentration of adsorbed hydrogen, such as occurs for some olefin hydrogenation reactions. Certain additional trends are apparent from these data. As seen from the summarized results in Fig. 8, the initial product mole fraction of carbon dioxide tended to increase somewhat with increasing reaction temperature, while that of the C_4^+ hydrocarbon fraction exhibited a concomitant decrease. The initial selectivities to methane and C_2+C_3 olefins, on the other hand, were relatively insensitive to changes in reaction temperature, being approximately 30% and 20%, respectively, of the total initial carbon-containing products over the entire temperature range investigated. As shown in Figs. 3 to 7, the initial selectivity to C_2+C_3 paraffins, when extrapolated to 0% CO conversion, was essentially zero at all temperatures. It should be noted that the high selectivities to methane and CO_2 that were observed in all of these experiments are characteristic of the behavior of supported iron catalysts for H_2/CO conversions at total pressures near one atmosphere. (M.A. Vannice, J. Catal. 37, 449 [1975]).

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

Two series of experiments, consisting of several runs each, were performed at 300°C using two different samples of synthesized sodium-graphite ($C_{64}Na$), and the results are summarized in Tables III and IV. Conversion-time data for Runs 1-C through 1-F of Series 2 (Table IV) are contained in Fig. 9. Catalyst treatment following each experiment in a single series consisted of overnight evacuation at 300°C. Because of the low vapor pressure of metallic sodium (0.014 torr) 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 consequently 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 of the two series, and makes a definitive analysis of the results somewhat difficult. Certain general features are, nevertheless, apparent from these data.

Regardless of absolute activity level, CO_2 was 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 irrversible 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 observed, even at relatively high CO conversions. 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 rates of CO conversion 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/Na atom/hr. Following a sufficient number of consecutive experiments with a single sodium-graphite sample, however, permanent and irrecoverable loss of catalytic activity always occurred, due to destruction of intercalated sodium by the water that is inevitably formed during the reaction.

3. Potassium-Graphite (C_8K)

The results of four series of runs at 300°C using separate samples of potassium-graphite (C_8K), prepared at 300°C, are contained in Tables V-VIII. Conversion-time data for one of these (Series 4) are plotted in Fig. 10. Catalyst treatment following each run in a series again involved overnight evacuation at 300°C. In the case of potassium, unlike that of sodium, 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 experiments in a single series presumably reflect true behavior patterns.

Most of the important features observed with potassium-graphite catalysts were similar to those of their sodium analogs, with, however, certain significant differences. Carbon dioxide was again absent from the gaseous products in all cases, even at very low activity levels, due to the CO_2 hydrogenating 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 very rapidly under the reaction conditions employed, a capability possessed to only a much lesser extent by sodium-graphite. A large amount of CO reactant was again observed to irreversibly adsorb in an unreactive form, as shown by the uniformly low carbon mass balances for the first few runs in each series, and to effectively inhibit the overall reaction rates. The incremental rate of CO conversion decreased sharply during the course of each experiment, but a partial recovery of lost activity was effected by the evacuation period that followed 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/K atom/hr. It is important to note, however, that, as for sodium-graphite, the Fischer-Tropsch reaction over potassium-graphite is definitely not a catalyst process in the strictest sense of the term. 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 VIII) 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 con-

version does not necessarily prevail, the permanent loss of activity is apparent.

4. 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 Section B. above. Intercalated potassium necessarily remained in the initial catalyst as C_8K, and it was anticipated that the residual catalytic properties observed for this material 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 consecutive runs at 300°C using a sample of this catalyst are summarized in Table IX and presented graphically in Fig. 11. The reactor was again evacuated overnight 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 observed for 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 the CO reactant was again irreversibily 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 VIII and IX. 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 IX (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 exposed to the laboratory 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 at 300°C using a single sample of this material are contained in Table X. It is apparent that the observed "catalytic" properties are quire different from those of either pure potassium-graphite (Table VIII) or potassium-reduced iron-graphite (Table IX). Carbon dioxide was now a major product, together with considerable fractions of olefinic hydrocarbons, both features being similar to those observed for the iron/alumina catalyst discussed in Section C.1. above. Little CO reactant was unreactively adsorbed, as evidenced by the high carbon mass balances, but the absolute activity for hydrocarbon production was very low, corresponding to only 0.04 CO molecules/Fe atom/hr.

A second sample of air-exposed iron-potassium-graphite was washed with deionized water in an attempt to remove the intercalated KCl and KOH formed during the potassium-reduction of $FeCl_3$ and the potassium reaction with atmospheric water, respectively. Results obtained for three consecutive runs at 300°C using this sample are presented in Table XI and are summarized in Fig. 12. The observed behavior was comparable to that of the unwashed sample (Table X), but with an even larger level of CO_2 production and a 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 IX, X, and XI, and in Figs. 11 and 12 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 residual 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.

5. 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, we have studied extensively the catalytic behavior for the Fischer-Tropsch reaction of a commercially-available iron-graphite intercalate (containing 2.2 wt% Fe) obtained from the Alfa Chemicals Div. of Ventron Corp., and prepared as described in Section B. above. We have explored several aspects of this material within the framework of the present project, and the results obtained are summarized in the Sections that follow.

a. Sample Deactivation and Reproducibility. Table XII contains the results obtained from two separate series of four consecutive runs each at 300°C, using for each series a single sample of the iron-graphite as received (no pretreatment) and with overnight evacuation between each experiment in a series. Conversion-time data for one of these series (Series 7) are plotted in Fig. 13. As observed for the Fe/Al_2O_3 comparison catalyst (Fig. 2), a considerable decrease in activity occurred following the first run in the series, due to the probable deposition of a coke/carbide layer on the catalyst. The latter postulate is supported by the progressive decrease in carbon mass balance that occurred with increasing reaction time during this experiment. Following Run 1-A, however, the differences in activity observed for Runs 1-B, 1-C, and 1-D of Series 7 were not significant, and the catalyst appeared to have stabilized by the end of Run 1-B. Likewise, when compared at similar CO conversion levels, the product distributions for the last three runs of this series were virtually identical. (Compare, for example, the 2.50 hr sample for Run 1-B and the 6.00 hr samples for Runs 1-C and 1-D.)

In order to check the reproducibility of catalyst behavior, an additional series of experiments was performed at 300°C, in which a fresh sample of the iron-graphite was employed in each case, subjected only to overnight evacuation prior to use. The results are summarized in Table XIII and in Fig. 14. It is evident that both the overall activity for CO conversion and the product selectivity are quite similar for each of the four catalyst samples. (Compare, for example, the general characteristics for the 3.00 hr sample of each experiment.)

b. Effect of Pretreatment. Further experiments were performed to establish the effects of pretreatment variations on the subsequent catalytic behavior of the iron-graphite intercalate. A catalyst sample was treated initially with 750 torr of circulating hydrogen at 300°C for three hours, evacuated overnight at 300°C, and then used for five consecutive Fischer-Tropsch experiments at the same temperature. The results are contained in Table XIV and are presented graphically in Fig. 15. The initial activity in Run 1-A was 4 to 5 times that observed for the untreated catalyst samples (Fig. 14), suggesting that the hydrogen pretreatment caused substantial additional reduction of the intercalated iron species. However, a progressive decrease in initial activity was again observed for the first three runs, with little additional decrease occurring after Run 1-C. The activities observed for Runs 1-D and 1-E were virtually identical, and were only slightly lower than that of run 1-C. The average initial rate of CO conversion in Runs 1-D and 1-E was 0.055 CO molecules/Fe atom/hr. Significantly, this activity is not greatly different from that of the stabilized version of an untreated sample (Fig. 13, Runs 1-C and 1-D).

Following pretreatment with 470 torr of circulating carbon monoxide for four hours at 300°C and overnight evacuation at this temperature, an iron-graphite sample was used for four consecutive Fischer-Tropsch experiments at 300°C, the results of which are presented in Table XV and in Fig. 16. Although the initial activity observed for the first run (1-A) was 4 to 5 times lower than that of Run 1-A in the case of hydrogen pretreatment, the progressive activity decrease that occurred in subsequent experiments (1-B through 1-D) closely paralleled the results of the preceeding Series. The initial rate of CO conversion in Run 1-D was 0.065 CO molecules/Fe atom/hr. Carbon mass balances in all runs after the first were close to 100%. At comparable CO conversion levels, the product distributions obtained following pretreatment in CO were very similar to those observed in the case of hydrogen pretreatment. (Compare, for example, the 3.00 hr sample of Table XV, Run 1-D to the 4.02 hr sample of Table XIV, Run 1-D.)

The general conclusion to be drawn from these pretreatment studies is that, although the initial behavior of an iron-graphite catalyst may vary considerably as a function of pretreatment reagent and conditions, both the overall activity for CO conversion and the product selectivity for these materials become independent of pretreatment conditions, following a certain "run-in" or stabilization period.

c. Effect of Reaction Temperature on Product Distribution. In order to assess the effect of reaction temperature variations on the observed

Fischer-Tropsch product distributions for the iron-graphite intercalate, a series of five separate experiments was performed using an initial H_2/CO reactant ratio of 500/250 torr, and in which the reaction temperature was varied in 25° increments from 225° to 325°C. In order to eliminate possible ambiguities due to deactivation effects, a fresh, unpretreated catalyst sample was employed for each experiment and was merely evacuated overnight prior to use. The results of these runs are contained in Table XVI. The same experiments were then repeated, but using catalyst samples that had been pretreated in circulating hydrogen, as described in Section C.5.b. above, and these results are summarized in Table XVII. Cumulative product distributions as a function of CO conversion are presented for the latter series of experiments in Figs. 17 to 21, and initial product distributions (extrapolated to 0% CO conversion) are depicted as a function of reaction temperature in Fig. 22. At similar CO conversion levels, little difference in product distribution was observed for the untreated and hydrogen pre-treated samples, although, as expected, the absolute activities of the latter were considerably greater than those of the former.

Because these temperature-dependency experiments for the iron-graphite intercalate were performed using reaction conditions identical to those employed for the corresponding runs with the Fe/Al_2O_3 comparison catalyst (Table II and Figs. 3 to 8), product distributions observed for the two types of catalysts can be compared directly. Certain important differences are immediately apparent when such a comparison is made. At all reaction temperatures within the range explored, the iron-graphite catalyst produced significantly less carbon dioxide (only 20-30% as much, depending on temperature) than did the iron/alumina catalyst, at both low and intermediate conversions. Moreover, although the initial mole fraction of carbon dioxide product increased with increasing reaction temperature over the iron/alumina, the opposite effect was observed over the iron-graphite (See Figs 8 and 22). At temperatures of $\geq$ 250°C, the amounts of methane produced were not significantly different for the two catalysts, but the mole fractions of C_2^+ hydrocarbon products were substantially greater for the iron-graphite intercalate than for the iron/alumina catalyst. At 300°C, for example, the C_2^+ hydrocarbon fraction constituted 65% of the initial carbon-containing product over the iron-graphite, and only 30% in the case of the iron/alumina catalyst.

The reason for these differences in catalytic behavior for the two types of materials tested is not clear. It is apparent, however, that the iron-graphite intercalate exhibits no preferential size selectivity toward smaller hydrocarbon products that might have been expected because of the restricted accessibility of the intercalated iron atoms. This result suggests that reaction may occur primarily along graphite layer edges, rather than between the layers. The significantly smaller amounts of carbon dioxide produced by the iron-graphite are potentially important from an economic standpoint, and a characterization of the overall catalytic behavior of this material should be extended to reaction pressures greater than one atmosphere to delineate its catalytic features under typical Fischer-Tropsch operating conditions for iron-based catalysts.

When normalized to the same total iron content, the overall activities

of the two types of catalysts were virtually identical at $\leq$ 275°C, as shown in Fig. 23, while the activity of the iron-graphite slightly exceeded that of the iron/alumina catalyst at reaction temperatures > 275°C. This agreement may be fortuitous, however, since the percentage exposure of the iron atoms is not yet known for either os the catalysts. The approximate linearity of the curves in Fig. 23 in the region 225-275°C corresponds to an apparent activation energy for CO conversion of ~ 26 kcal/mole over both of the catalysts, a typical value for non-diffusion-limited Fischer-Tropsch syntheses over iron catalysts. The curvature exhibited in Fig. 23 in the region 275-300°C and the decline at > 300°C may be due to increasing diffusion limitation effects at these temperatures.

IV. CONCLUSIONS

Sodium- and potassium-graphite intercalates, 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 the water molecules that are necessarily formed during 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 imparts behavior similar to that of an alumina-supported iron catalyst, but does not prevent the eventual, permanent activity loss.

The activity for Fischer-Tropsch conversion of a commercially-available metal aryl-reduced iron-graphite intercalate decreases with increasing reaction time, but eventually becomes stabilized at a level that is relatively independent of pretreatment reagent. The overall activity of this material is similar to that of an alumina-supported iron catalyst, but its selectivity characteristics in the temperature range 225-325°C are considerably different. The iron-graphite intercalate produces substantially smaller amounts of carbon dioxide and larger amounts of C_2^+ hydrocarbon products at one atmosphere reaction pressure than does the iron/alumina catalyst under identical conditions.

V. FUTURE WORK

Having completed our preliminary characterization of the catalytic behavior of iron-graphite intercalate for the Fischer-Tropsch synthesis at one atmosphere pressure, we plan to extend these studies during the next contract quarter to include a commercial cobalt-graphite catalyst and, for comparison purposes, an unpromoted and a doubly-promoted cobalt/kieselguhr catalyst.

List of Figures

Fig. 16 % CO Conversion vs. Reaction Time for Commercial Iron-Graphite (CO pretreated) at 300°C.
Data and other reaction parameters are given in Table XV.

Fig. 17 Product Distribution vs. % CO Conversion for Commercial Iron-Graphite at 225°C.
Data and other reaction parameters are given in Table XVII.

Fig. 18 Product Distribution vs. % CO Conversion for Commercial Iron-Graphite at 250°C.
Data and other reaction parameters are given in Table XVII.

Fig. 19 Product Distribution vs. % CO Conversion for Commercial Iron-Graphite at 275°C.
Data and other reaction parameters are given in Table XVII.

Fig. 20 Product Distribution vs. % CO Conversion for Commercial Iron-Graphite at 300°C.
Data and other reaction parameters are given in Table XVII.

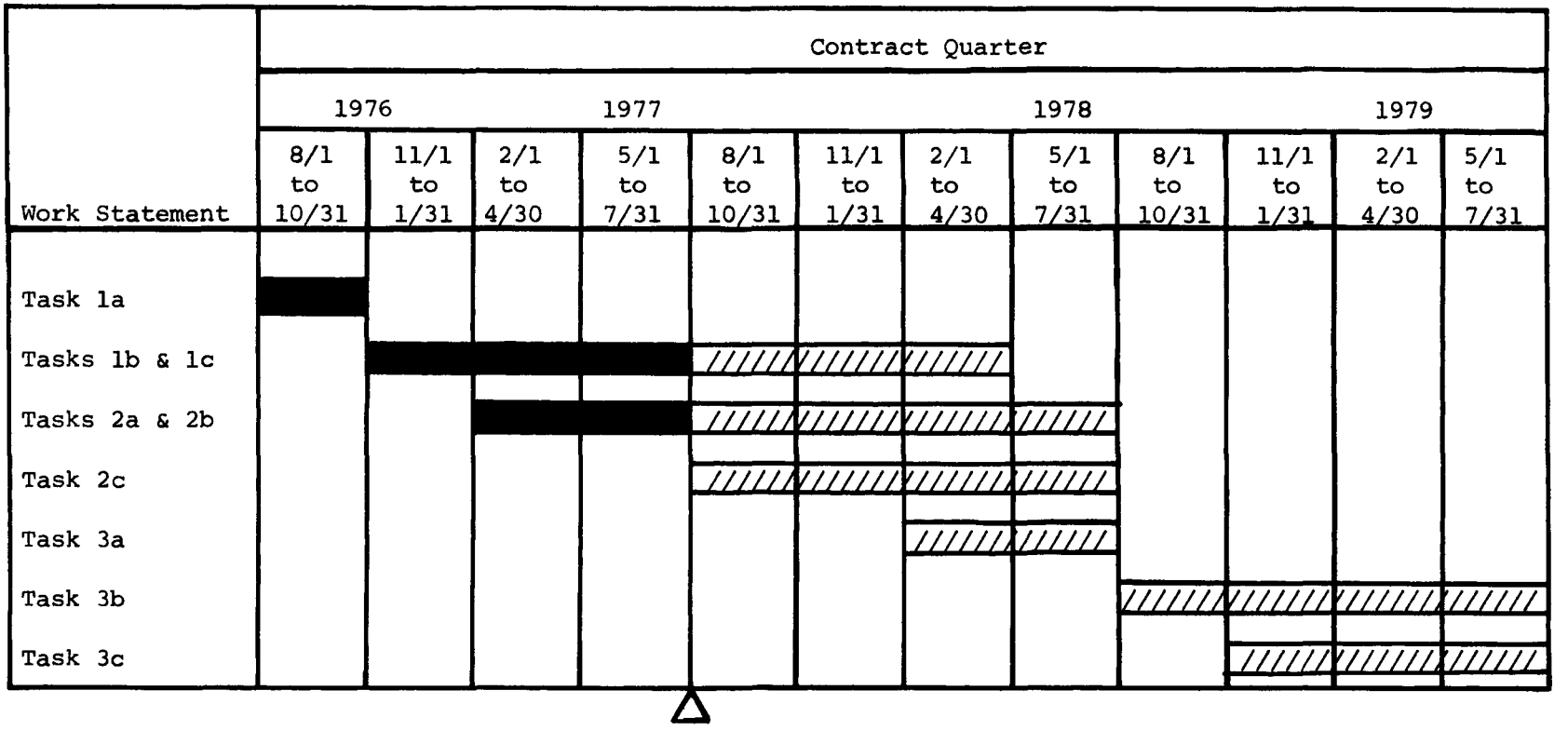
Fig. 21 Product Distribution vs. % CO Conversion for Commercial Iron-Graphite at 325°C.
Data and other reaction parameters are given in Table XVII.

Fig. 22 Initial Product Distribution vs. Reaction Temperature for Commercial Iron-Graphite.
Data and other reaction parameters are given in Table XVII.

Fig. 23 Temperature Dependences of Initial CO Reaction Rates over Fe/Al_2O_3 and Iron-Graphite.
Data and other reaction parameters are given in Tables II and XVII.

FIGURE 1

Project Plan and Progress Chart



LEGEND

Scheduled

Completed

End of Reporting Period

FIGURE 2

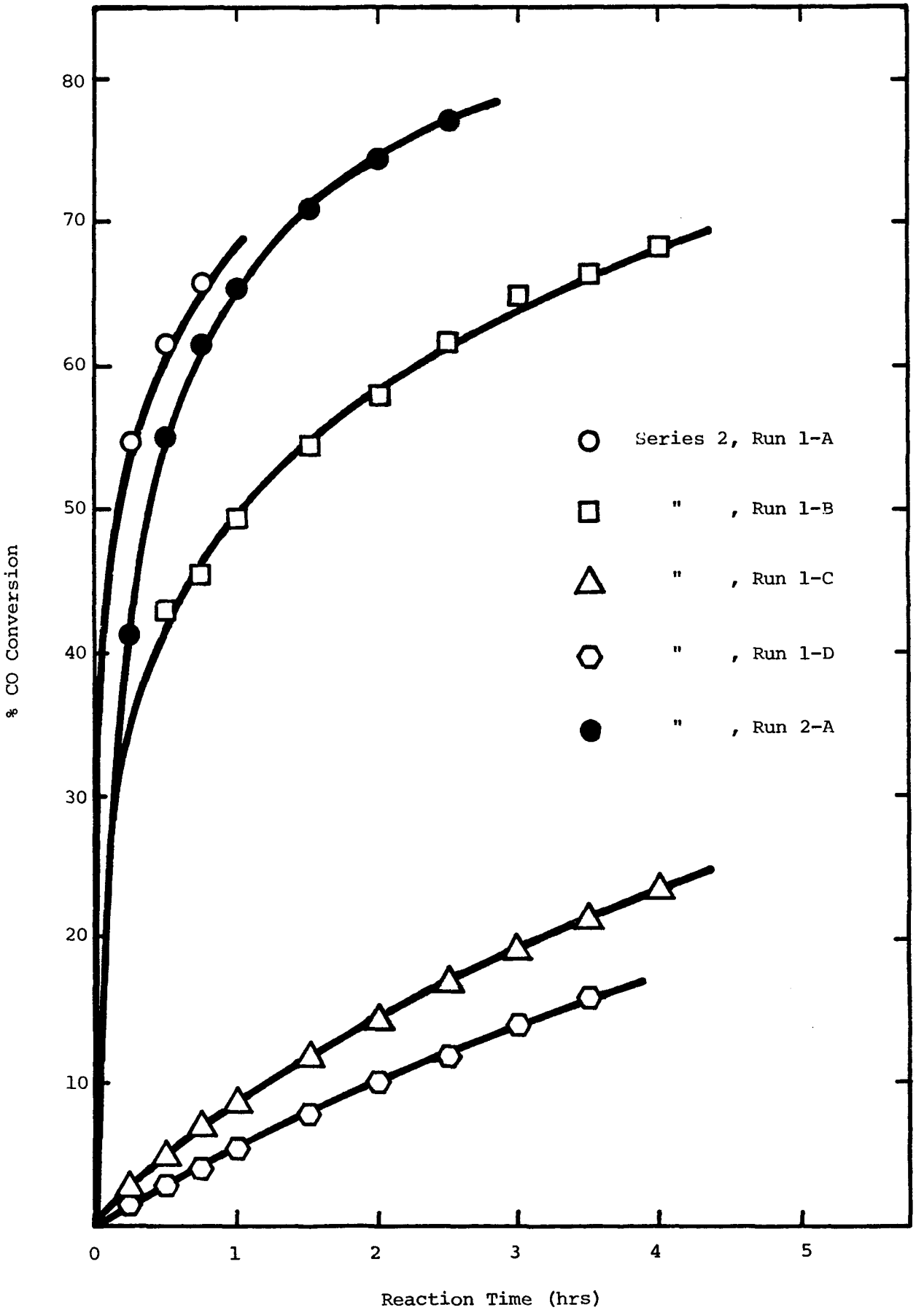

80
70
60
50
40
30
20
10
0
1
2
3
4
5
% CO Conversion
Reaction Time (hrs)
Series 2, Run 1-A
" , Run 1-B
" , Run 1-C
" , Run 1-D
" , Run 2-A

FIGURE 3

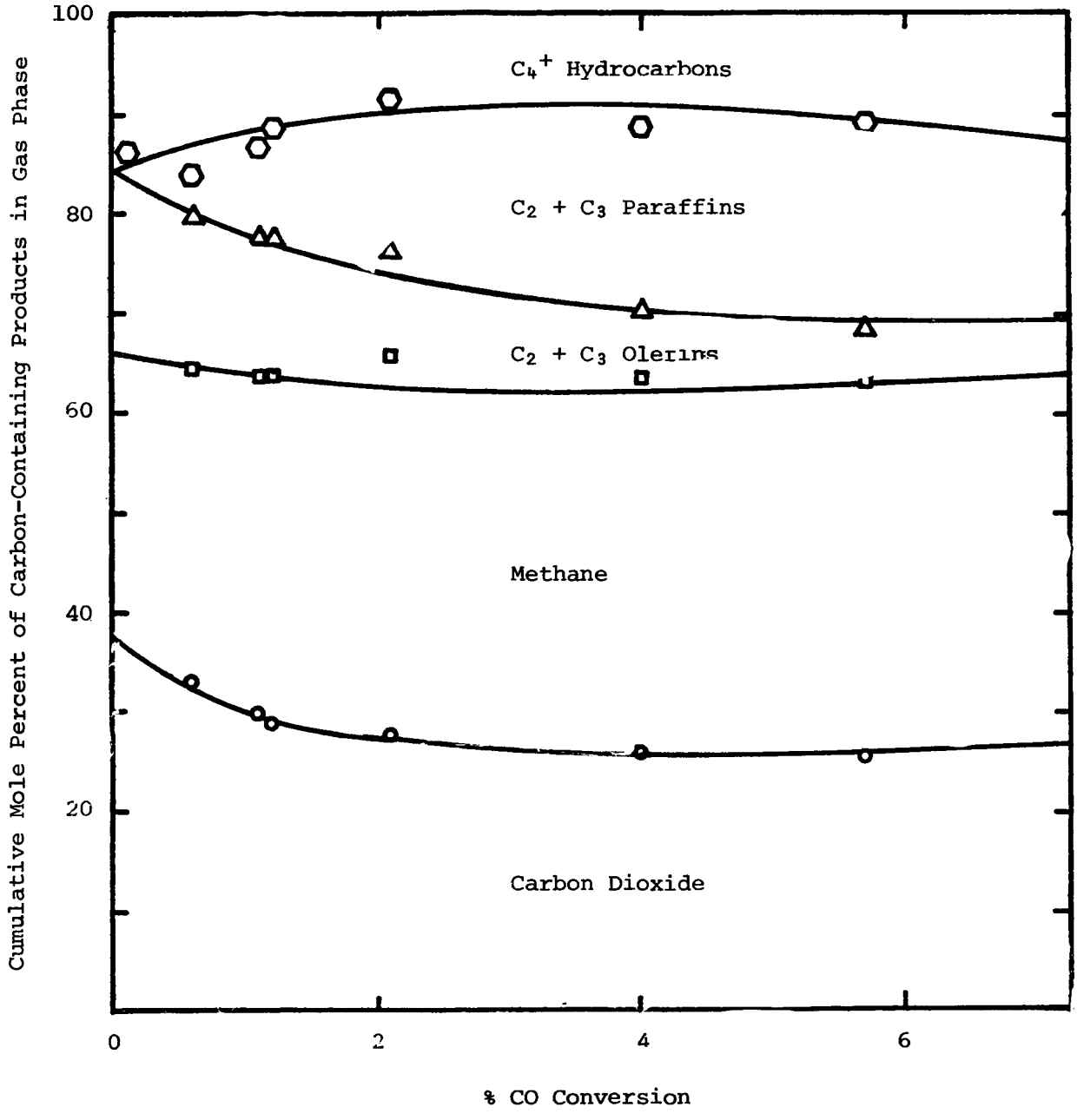

100
80
60
40
20
0
2
4
6
C_4^+ Hydrocarbons
C_2 + C_3 Paraffins
C_2 + C_3 Olefins
Methane
Carbon Dioxide
Cumulative Mole Percent of Carbon-Containing Products in Gas Phase
% CO Conversion

FIGURE 4

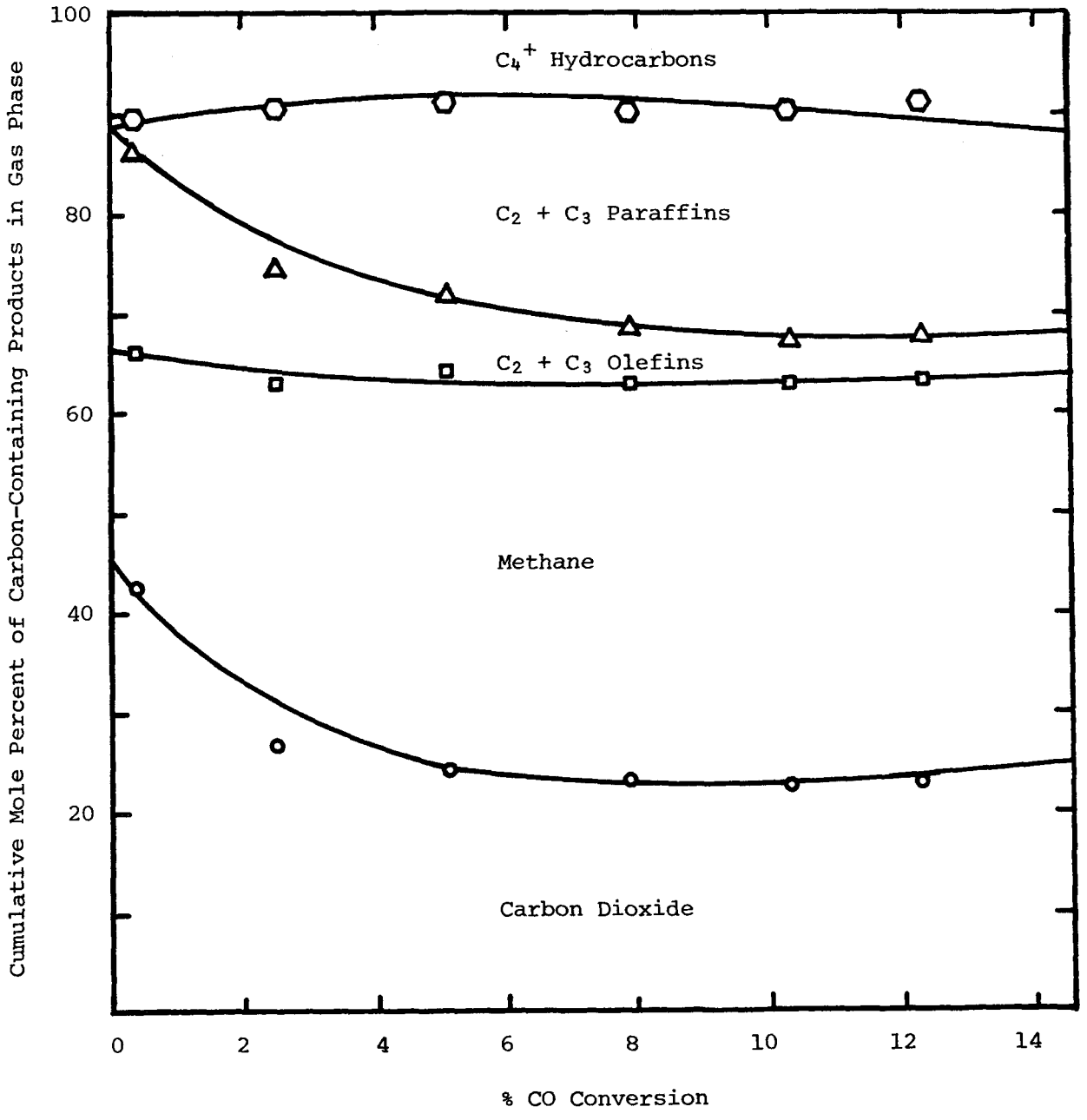

100
80
60
40
20
0
2
4
6
8
10
12
14
C_4^+ Hydrocarbons
C_2 + C_3 Paraffins
C_2 + C_3 Olefins
Methane
Carbon Dioxide
Cumulative Mole Percent of Carbon-Containing Products in Gas Phase
% CO Conversion

FIGURE 5

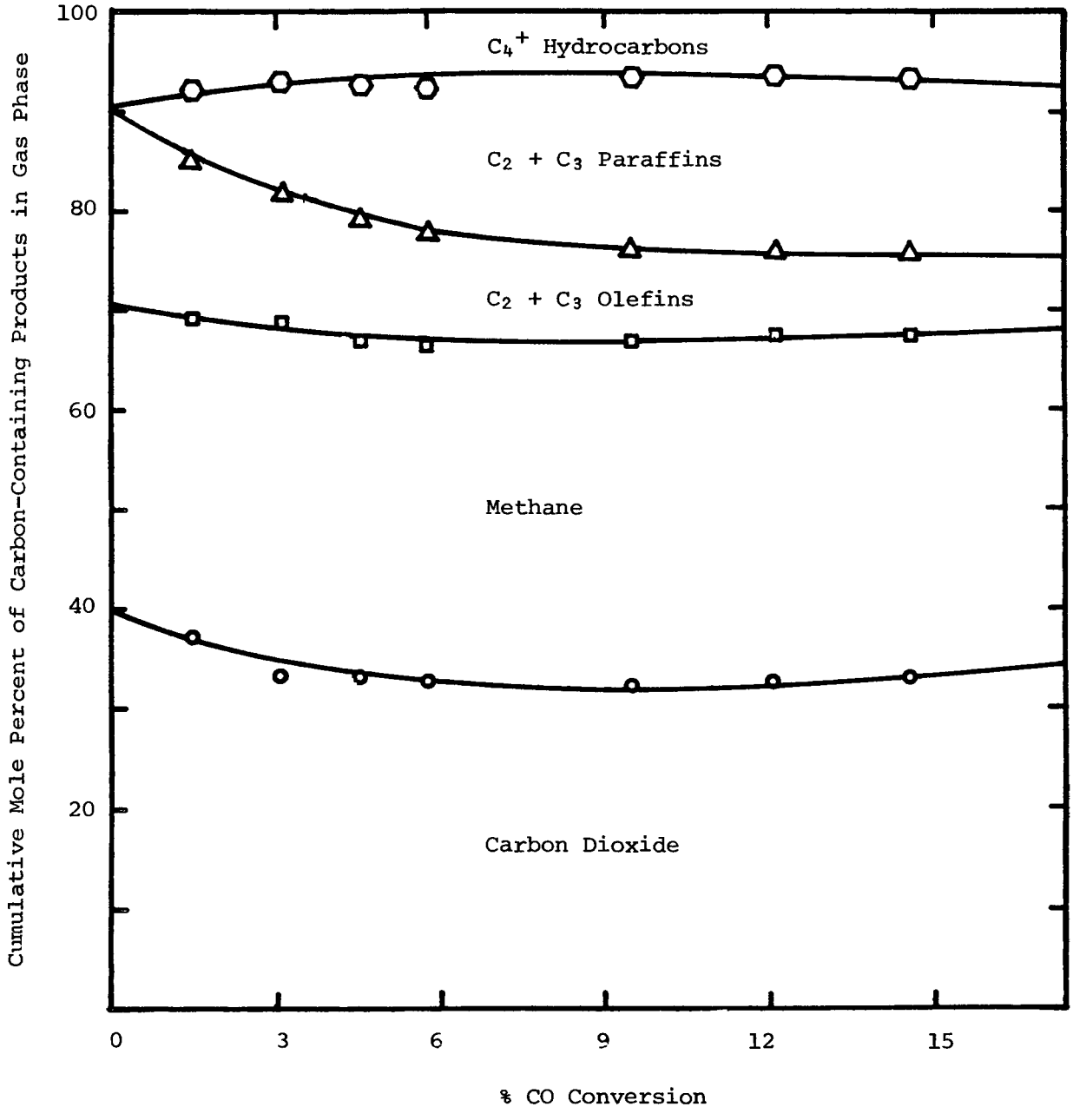

100
80
60
40
20
0
3
6
9
12
15
C_4^+ Hydrocarbons
C_2 + C_3 Paraffins
C_2 + C_3 Olefins
Methane
Carbon Dioxide
Cumulative Mole Percent of Carbon-Containing Products in Gas Phase
% CO Conversion

FIGURE 6

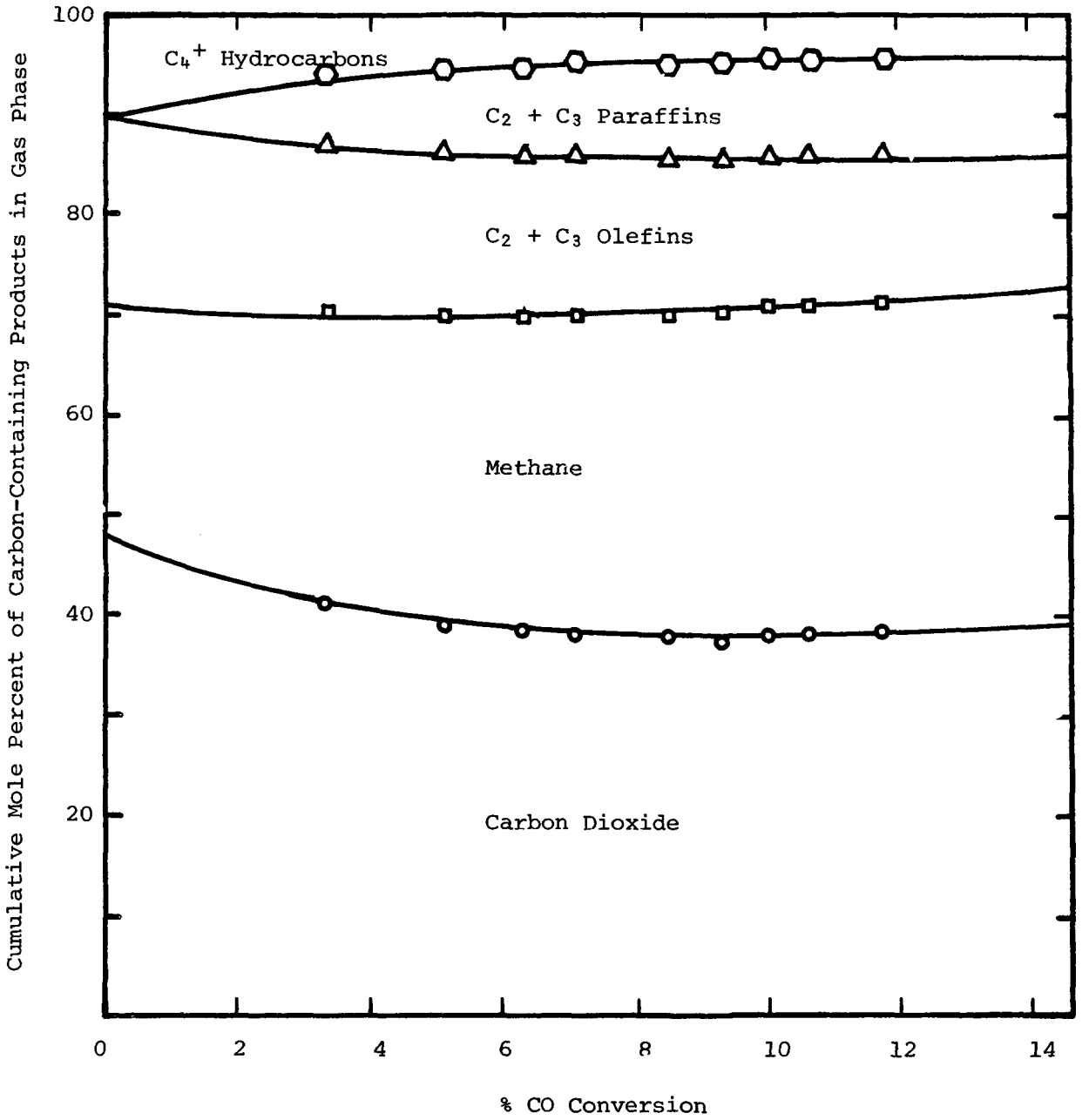

100
80
60
40
20
0
2
4
6
8
10
12
14
C_4^+ Hydrocarbons
C_2 + C_3 Paraffins
C_2 + C_3 Olefins
Methane
Carbon Dioxide
Cumulative Mole Percent of Carbon-Containing Products in Gas Phase
% CO Conversion

FIGURE 7

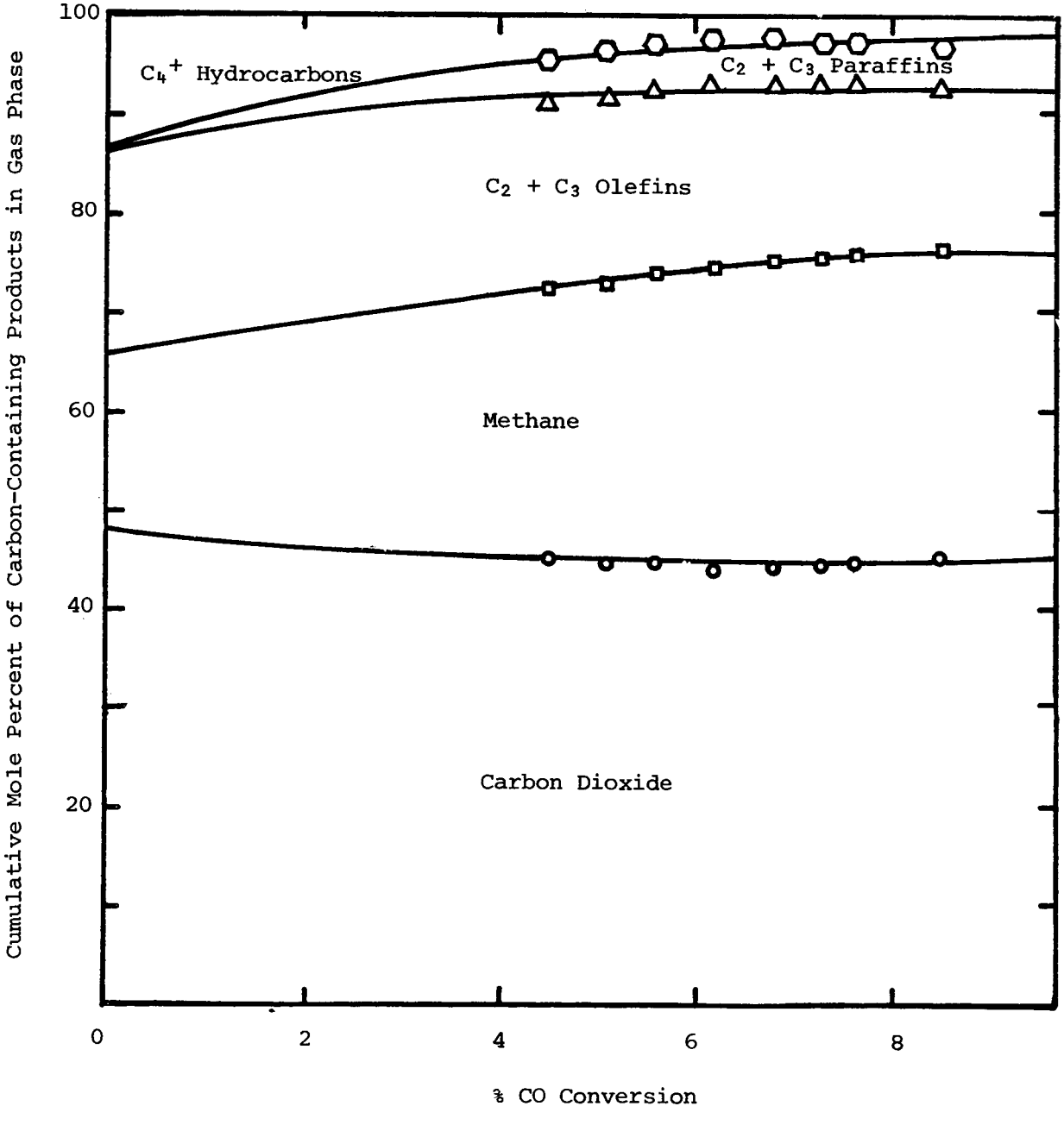

100
80
60
40
20
0
2
4
6
8
C_4^+ Hydrocarbons
C_2 + C_3 Paraffins
C_2 + C_3 Olefins
Methane
Carbon Dioxide
Cumulative Mole Percent of Carbon-Containing Products in Gas Phase
% CO Conversion

FIGURE 8

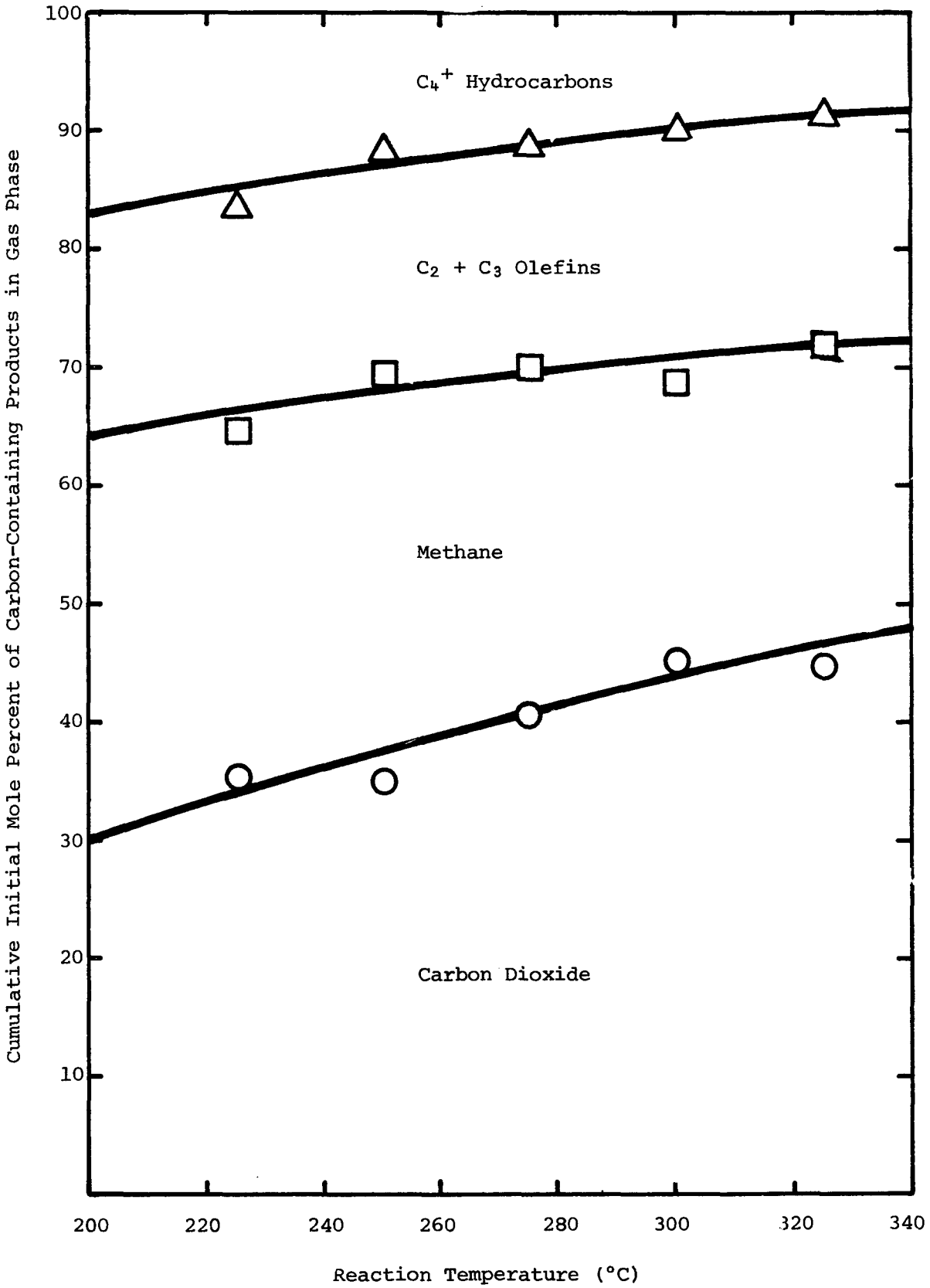

Cumulative Initial Mole Percent of Carbon-Containing Products in Gas Phase
100
90
80
70
60
50
40
30
20
10
C_4^+ Hydrocarbons
C_2 + C_3 Olefins
Methane
Carbon Dioxide
200
220
240
260
280
300
320
340
Reaction Temperature (°C)

FIGURE 9

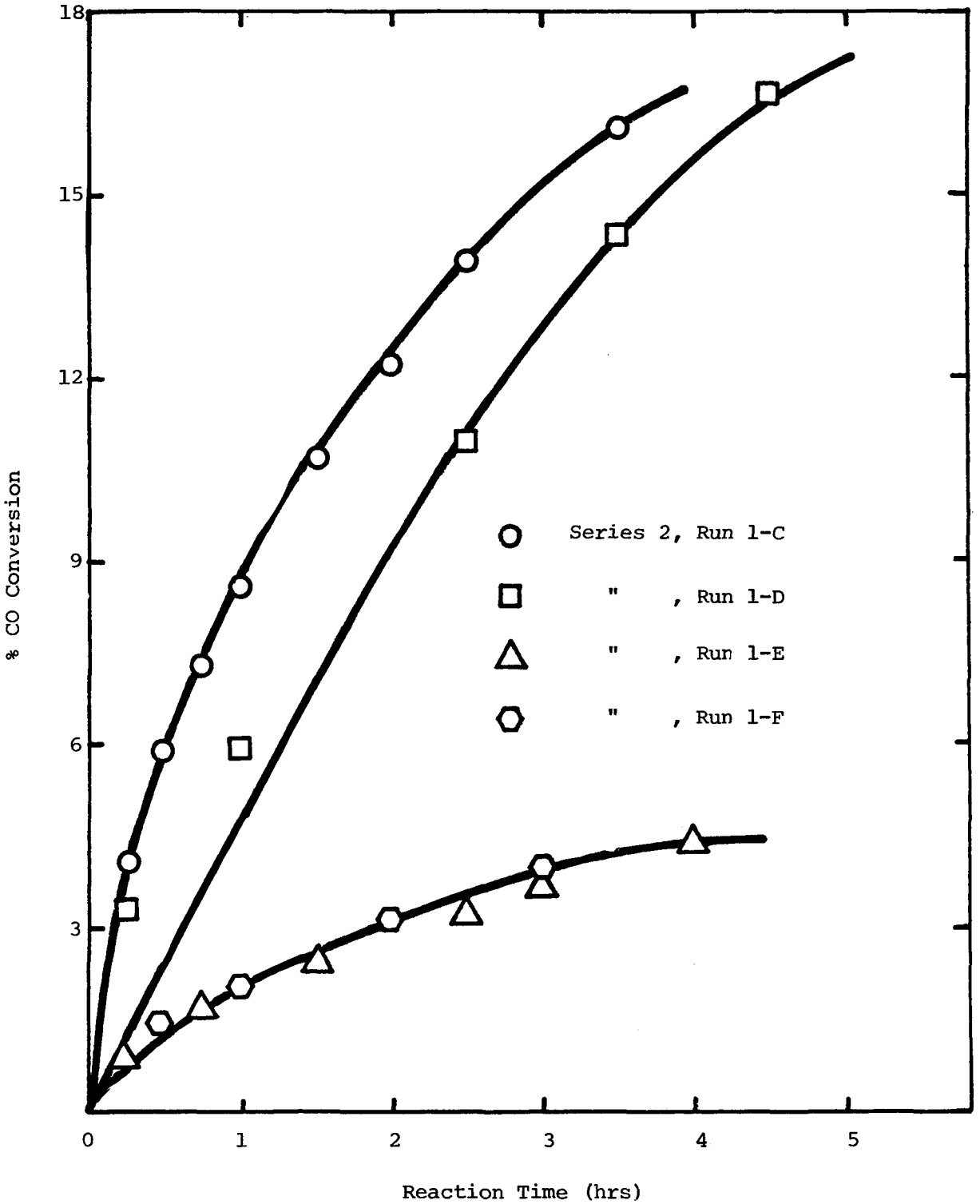

18
15
12
9
6
3
0
1
2
3
4
5
% CO Conversion
Reaction Time (hrs)
Series 2, Run 1-C
" , Run 1-D
" , Run 1-E
" , Run 1-F

FIGURE 10

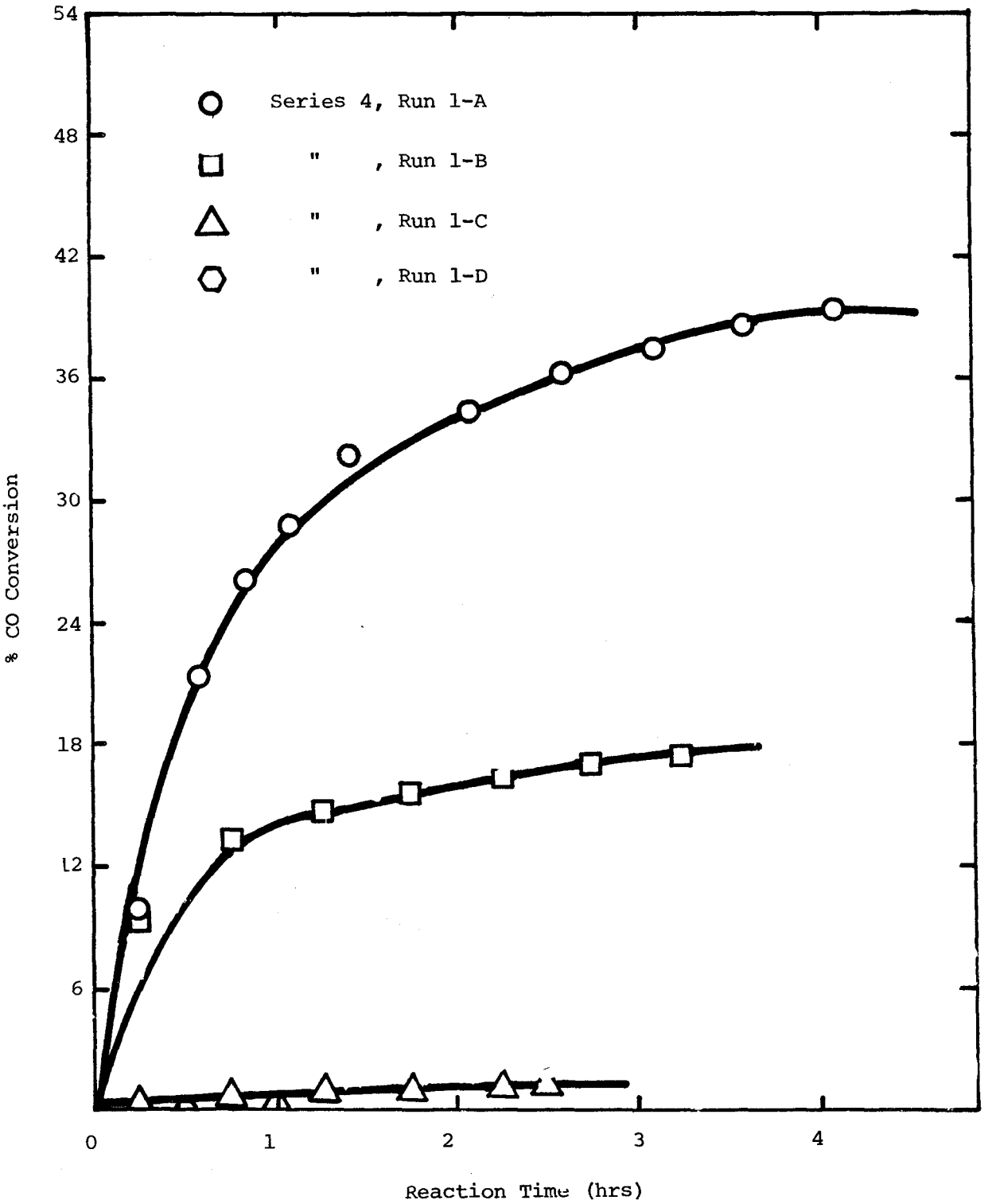

54
48
42
36
30
24
18
12
6
0
1
2
3
4
% CO Conversion
Reaction Time (hrs)
Series 4, Run 1-A
" , Run 1-B
" , Run 1-C
" , Run 1-D

FIGURE 11

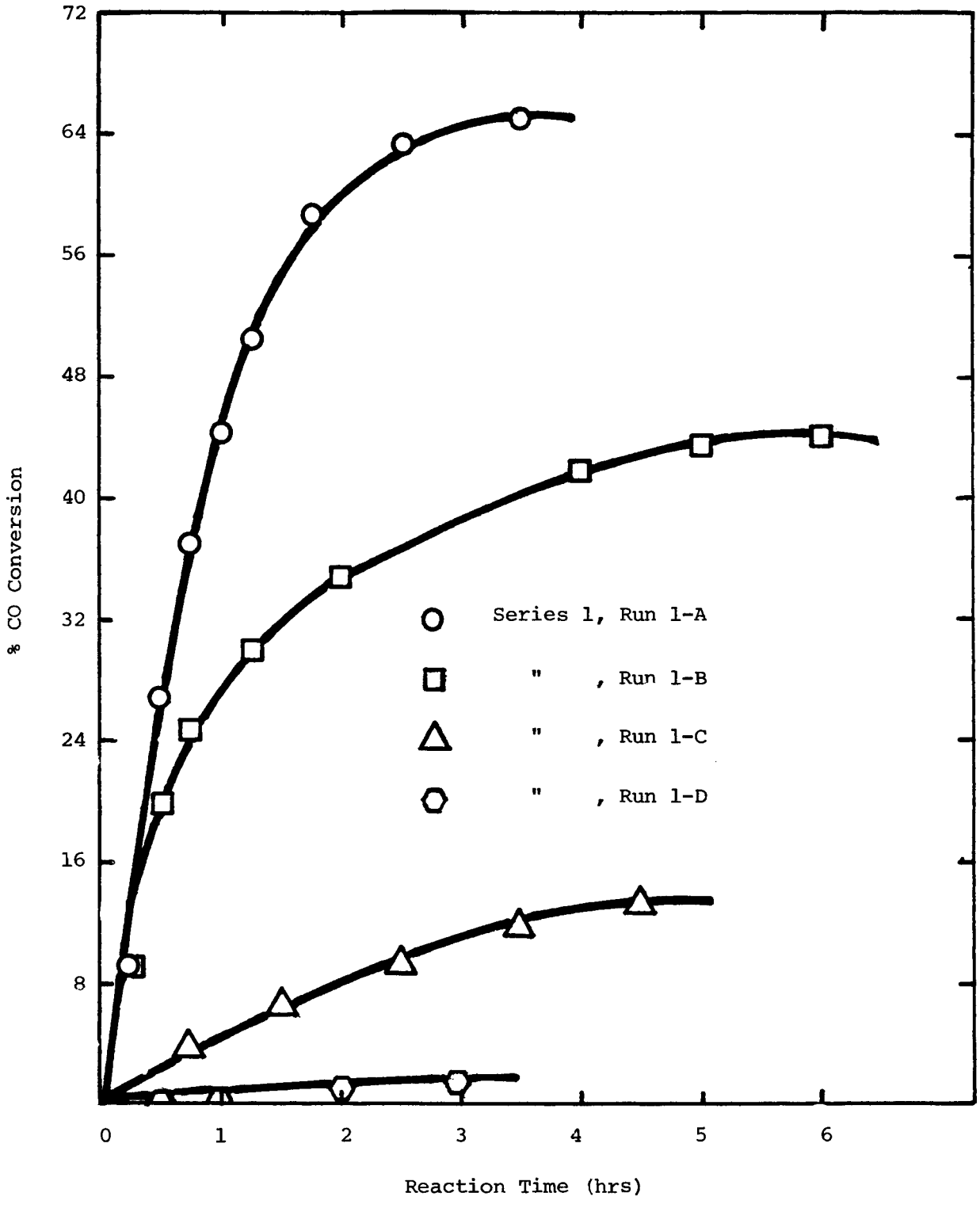

72
64
56
48
40
32
24
16
8
% CO Conversion
0
1
2
3
4
5
6
Reaction Time (hrs)
Series 1, Run 1-A
" , Run 1-B
" , Run 1-C
" , Run 1-D

FIGURE 12

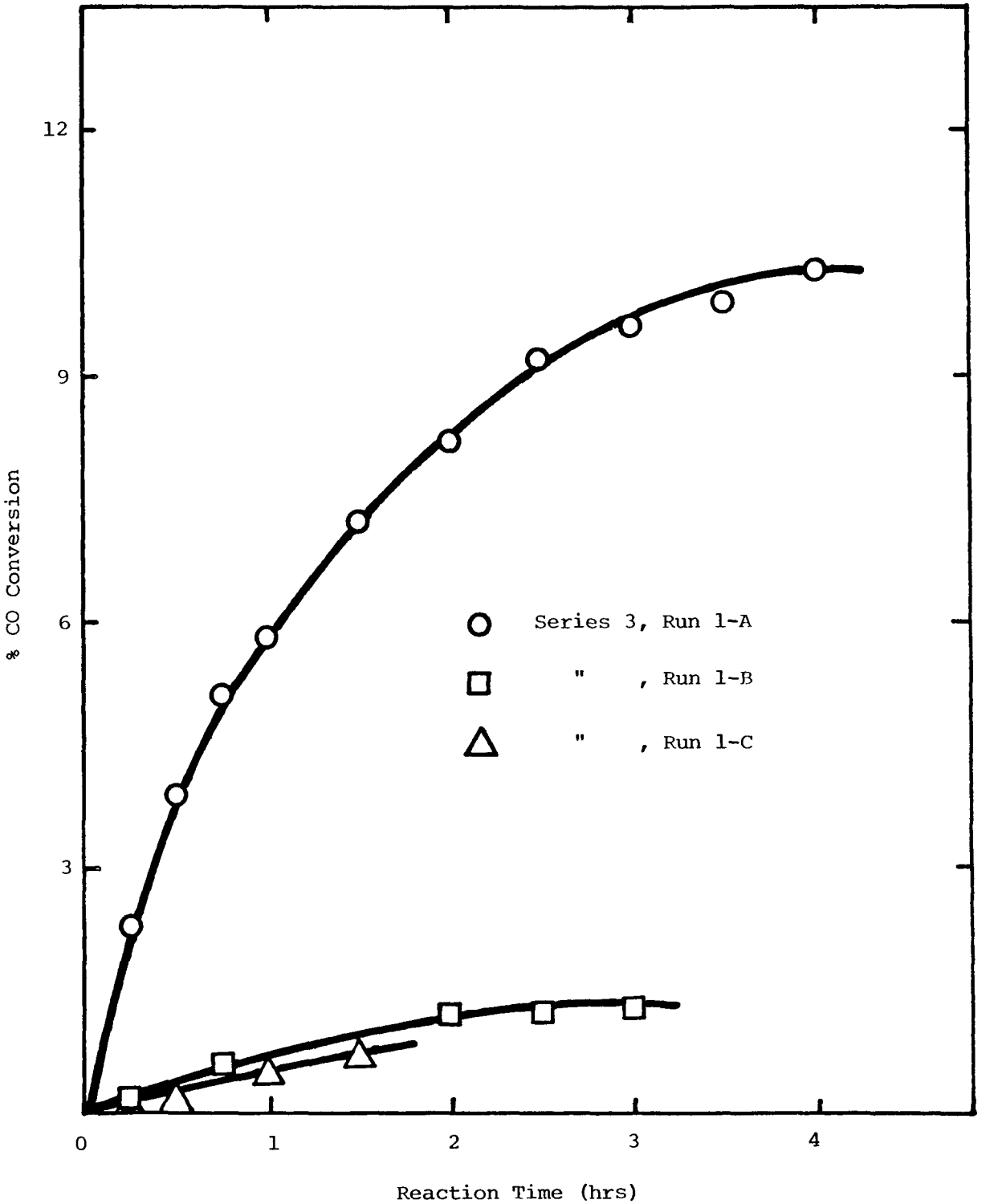

12
9
6
3
0
1
2
3
4
% CO Conversion
Reaction Time (hrs)
Series 3, Run 1-A
" , Run 1-B
" , Run 1-C

FIGURE 13

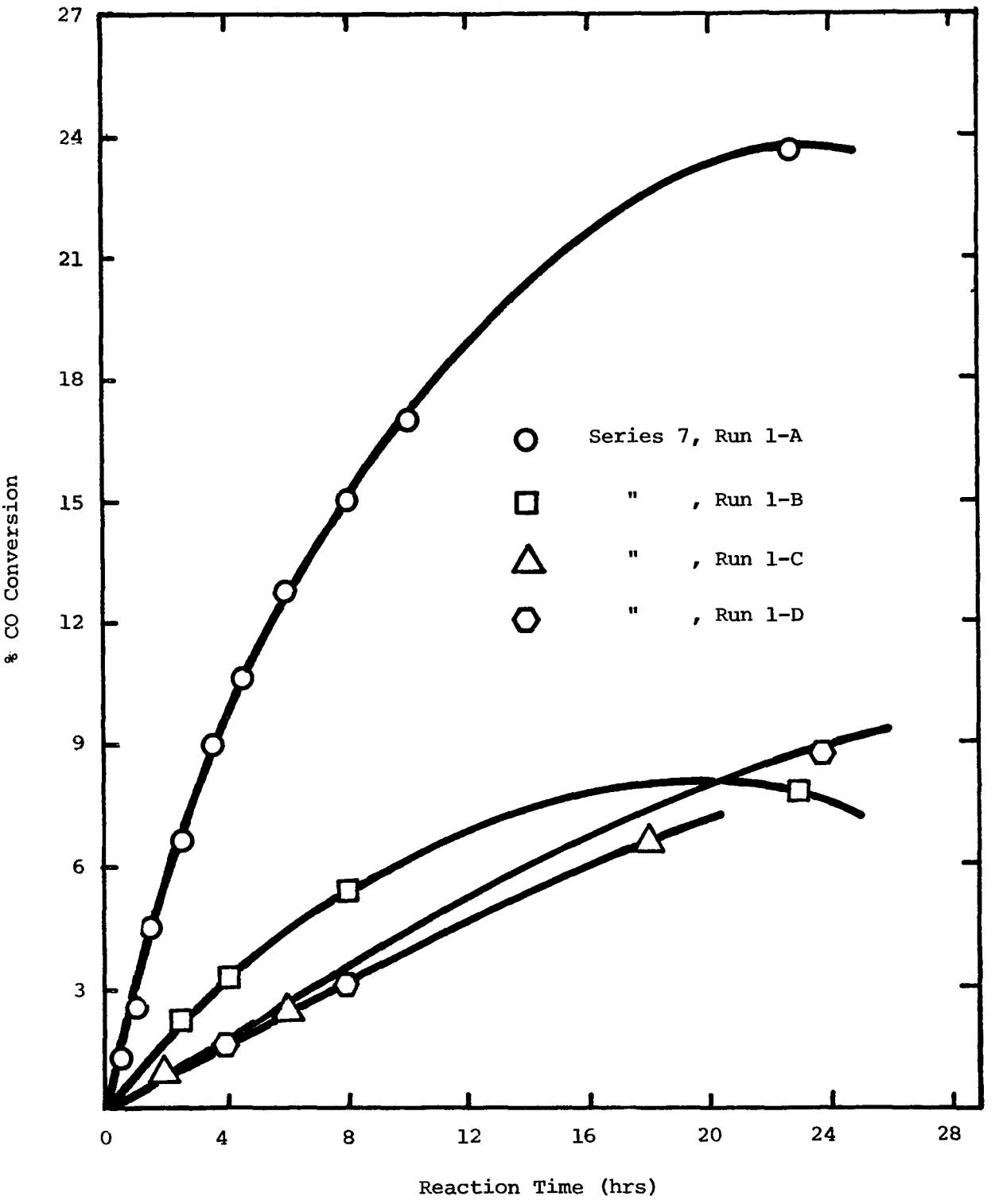

27
24
21
18
15
12
9
6
3
% CO Conversion
0
4
8
12
16
20
24
28
Reaction Time (hrs)
Series 7, Run 1-A
" , Run 1-B
" , Run 1-C
" , Run 1-D

FIGURE 14

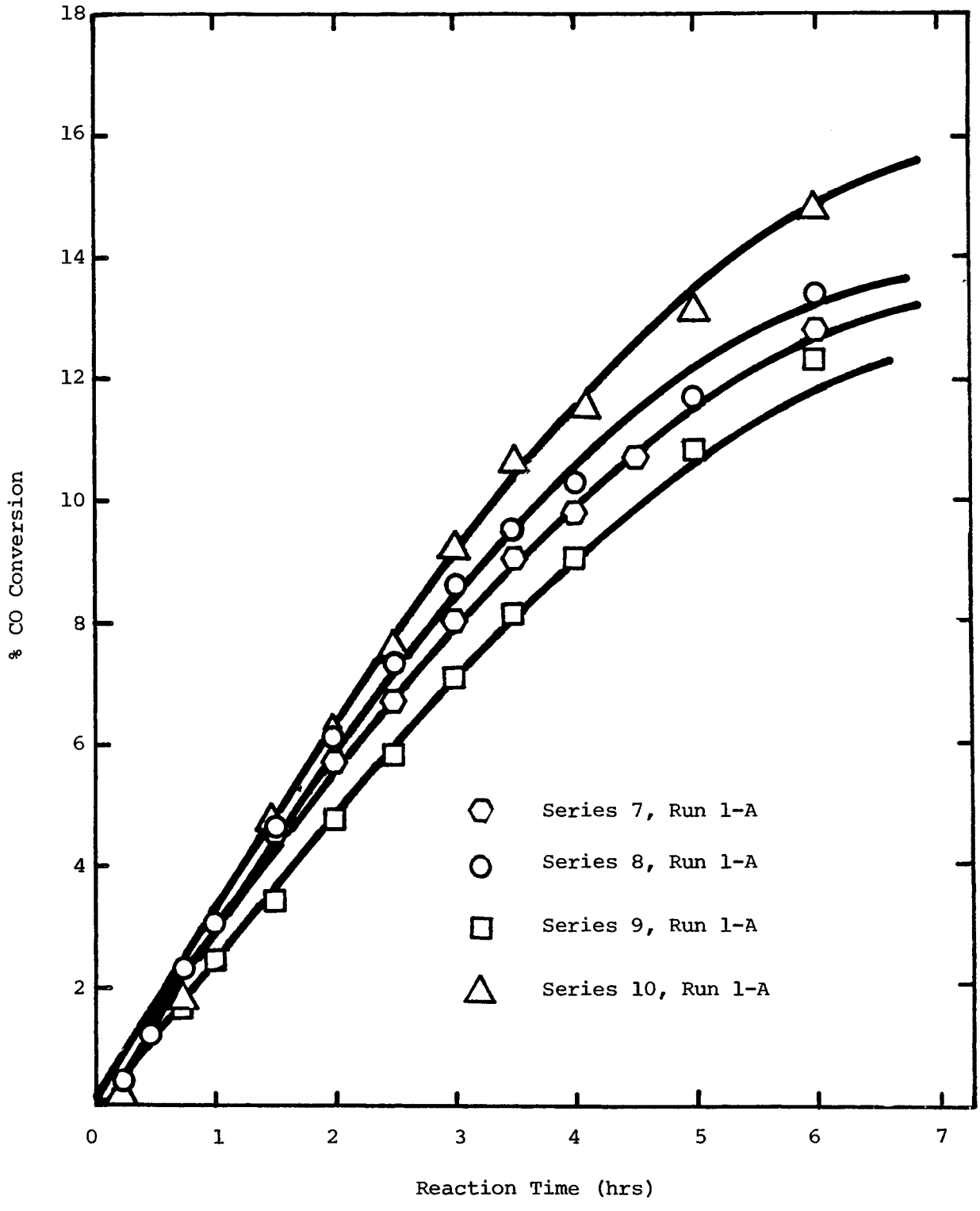

18
16
14
12
10
8
6
4
2
% CO Conversion
0
1
2
3
4
5
6
7
Reaction Time (hrs)
Series 7, Run 1-A
Series 8, Run 1-A
Series 9, Run 1-A
Series 10, Run 1-A

FIGURE 15

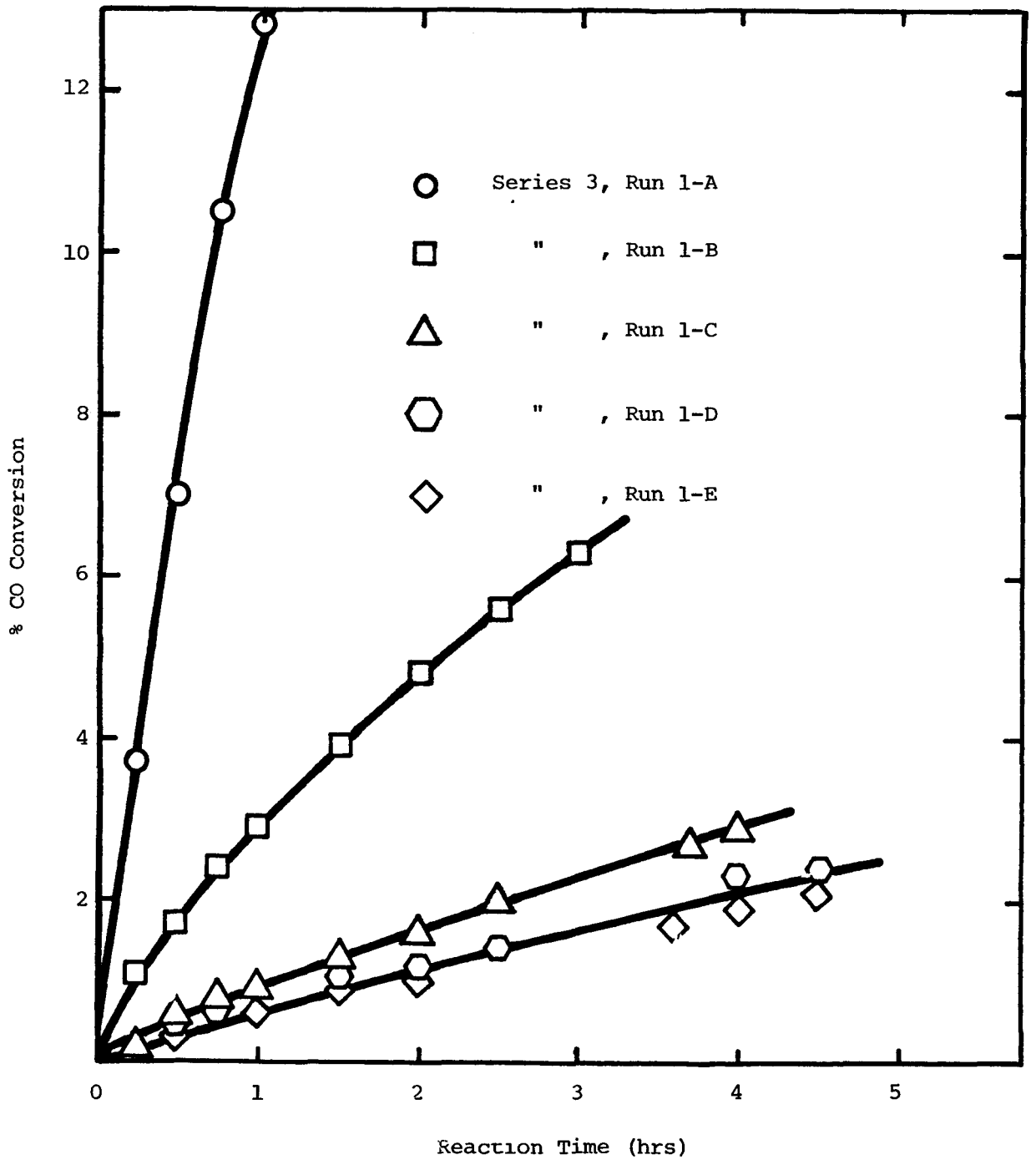

12
10
8
6
4
2
0
1
2
3
4
5
% CO Conversion
Reaction Time (hrs)
Series 3, Run 1-A
" , Run 1-B
" , Run 1-C
" , Run 1-D
" , Run 1-E

FIGURE 16

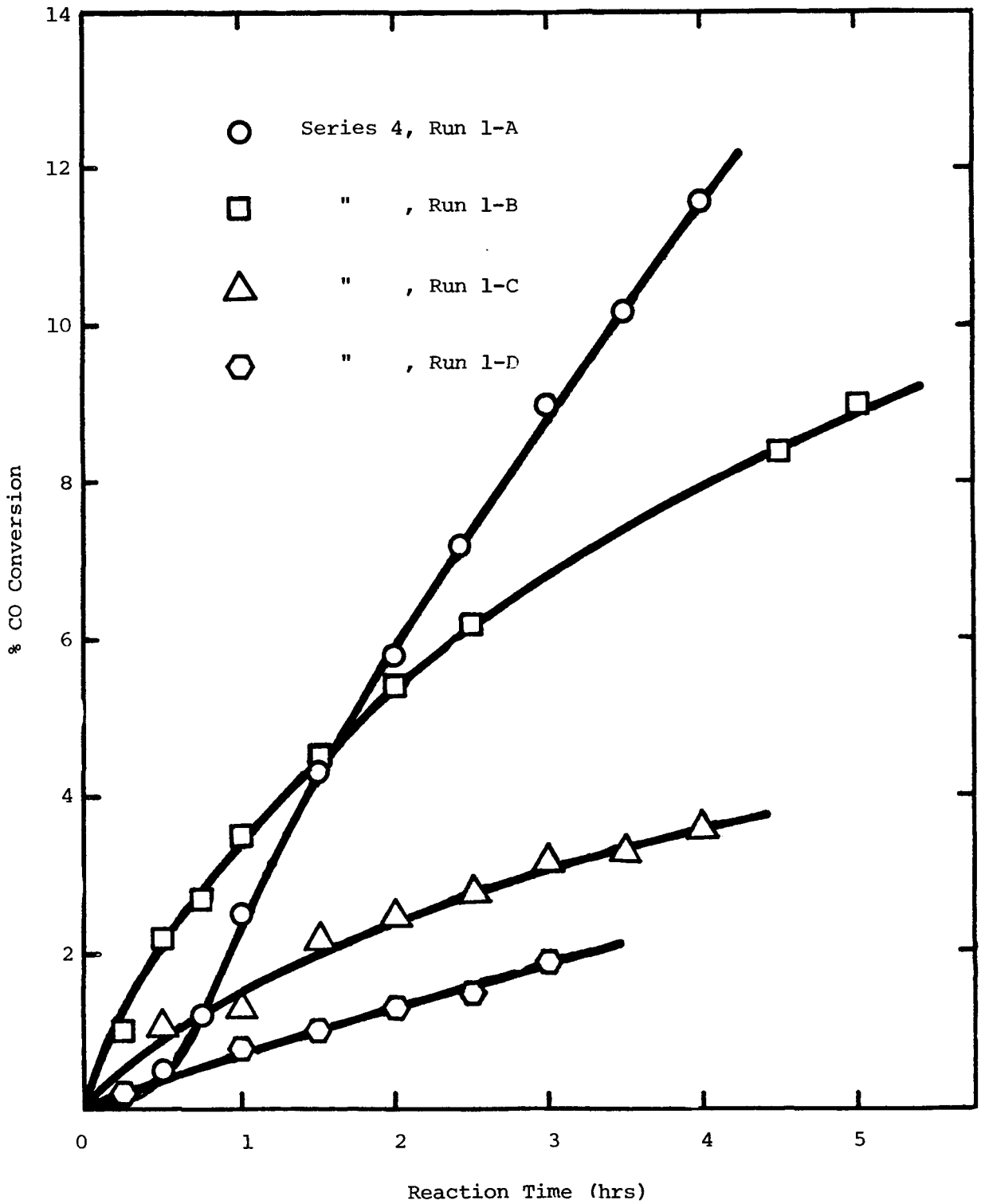

Series 4, Run 1-A
" , Run 1-B
" , Run 1-C
" , Run 1-D
% CO Conversion
Reaction Time (hrs)
0
1
2
3
4
5
2
4
6
8
10
12
14

FIGURE 17

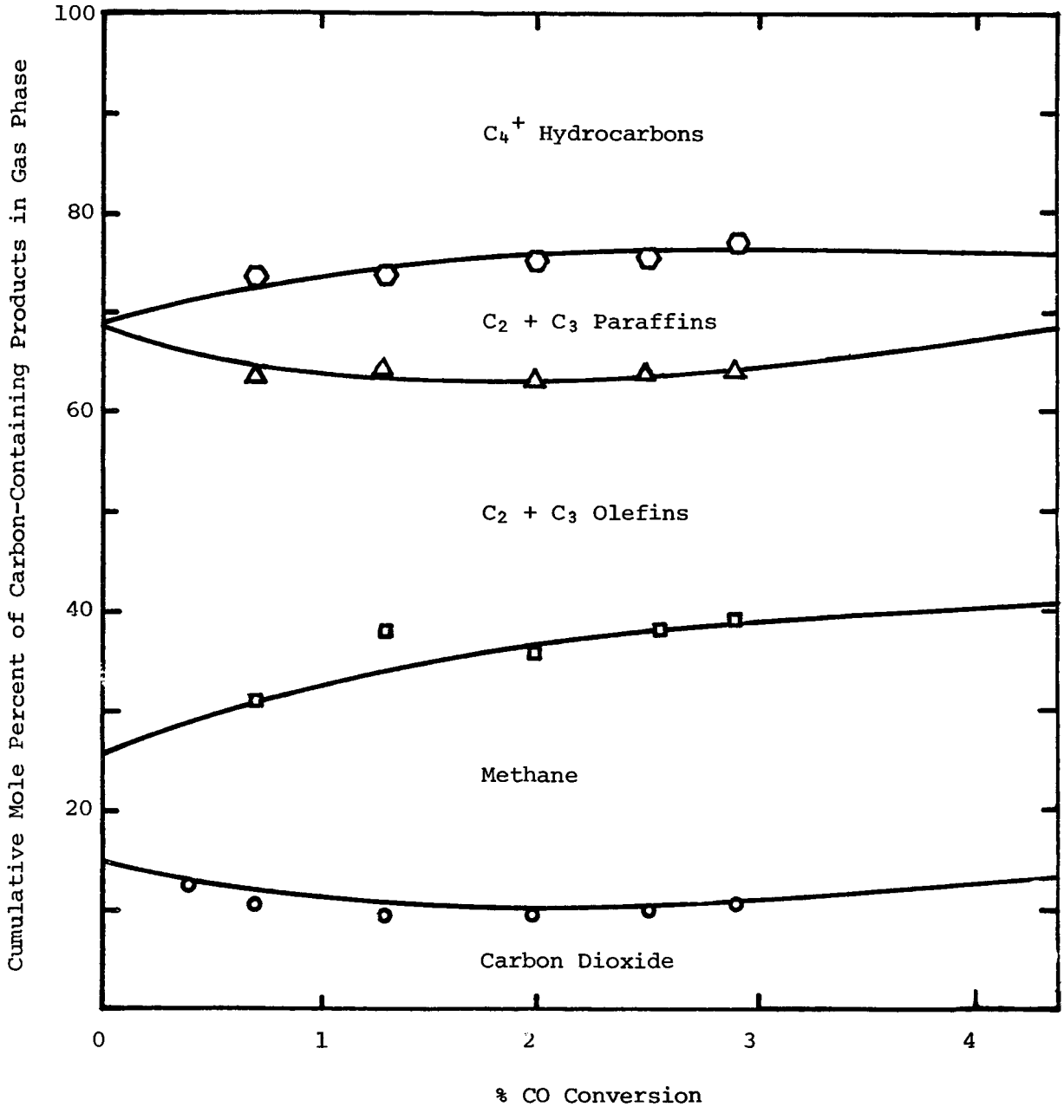

Cumulative Mole Percent of Carbon-Containing Products in Gas Phase
100
80
60
40
20
0
1
2
3
4
% CO Conversion
C4+ Hydrocarbons
C2 + C3 Paraffins
C2 + C3 Olefins
Methane
Carbon Dioxide

FIGURE 18

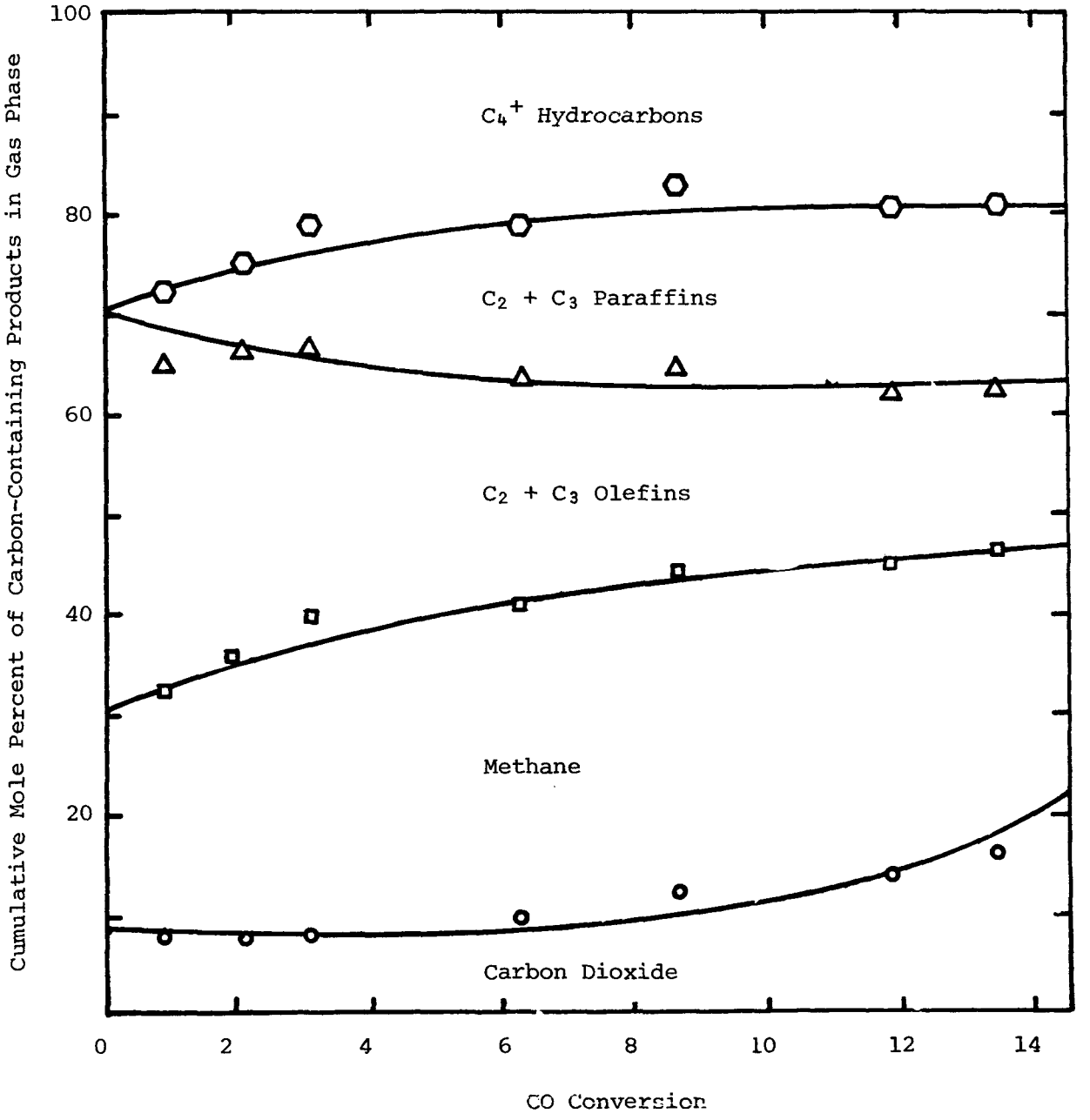

100
80
60
40
20
0
2
4
6
8
10
12
14
Cumulative Mole Percent of Carbon-Containing Products in Gas Phase
CO Conversion
C_4^+ Hydrocarbons
C_2 + C_3 Paraffins
C_2 + C_3 Olefins
Methane
Carbon Dioxide

FIGURE 19

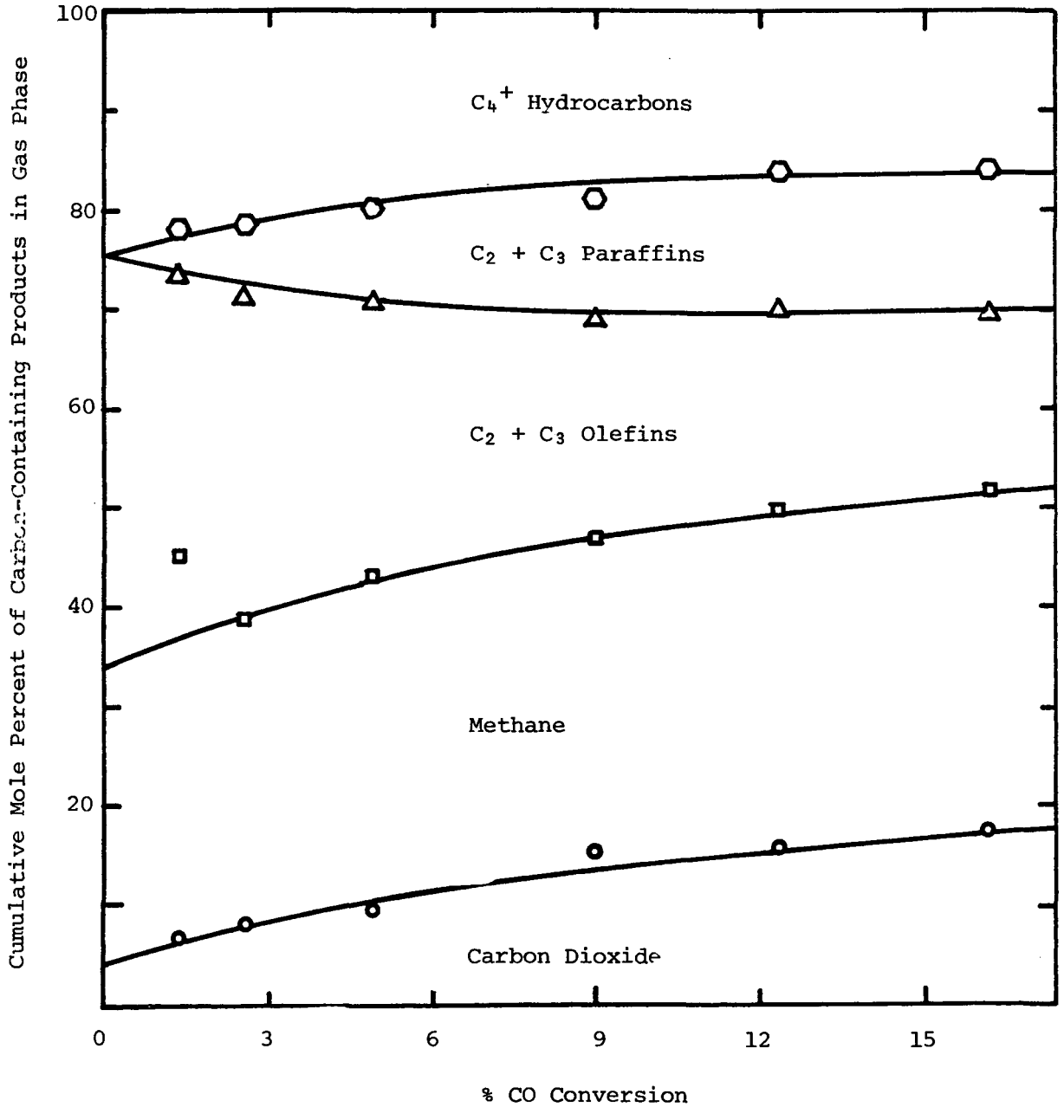

100
80
60
40
20
0
3
6
9
12
15
Cumulative Mole Percent of Carbon-Containing Products in Gas Phase
% CO Conversion
C4+ Hydrocarbons
C2 + C3 Paraffins
C2 + C3 Olefins
Methane
Carbon Dioxide

FIGURE 20

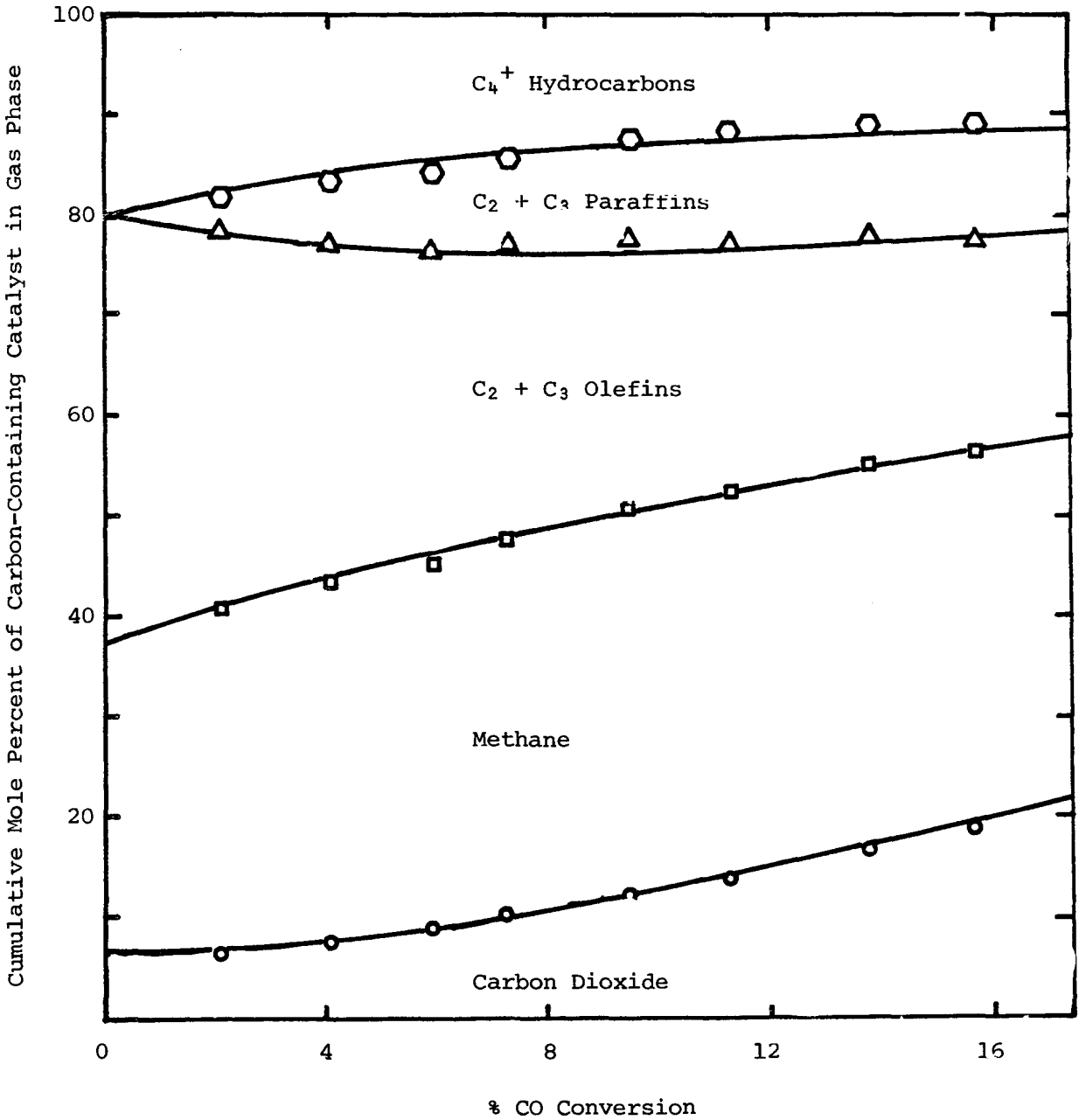

100
80
60
40
20
0
4
8
12
16
C_4^+ Hydrocarbons
C_2 + C_3 Paraffins
C_2 + C_3 Olefins
Methane
Carbon Dioxide
Cumulative Mole Percent of Carbon-Containing Catalyst in Gas Phase
% CO Conversion

FIGURE 21

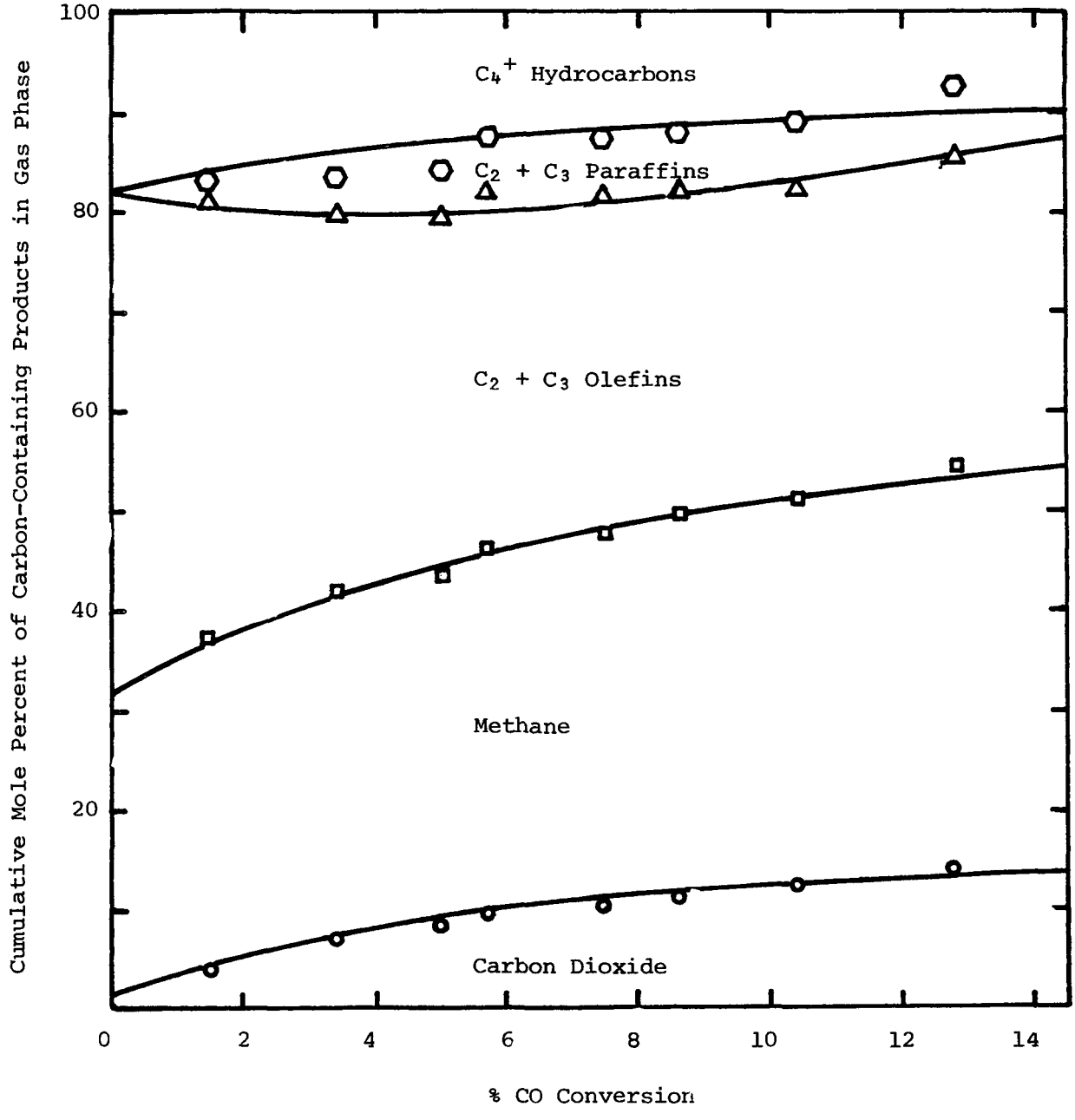
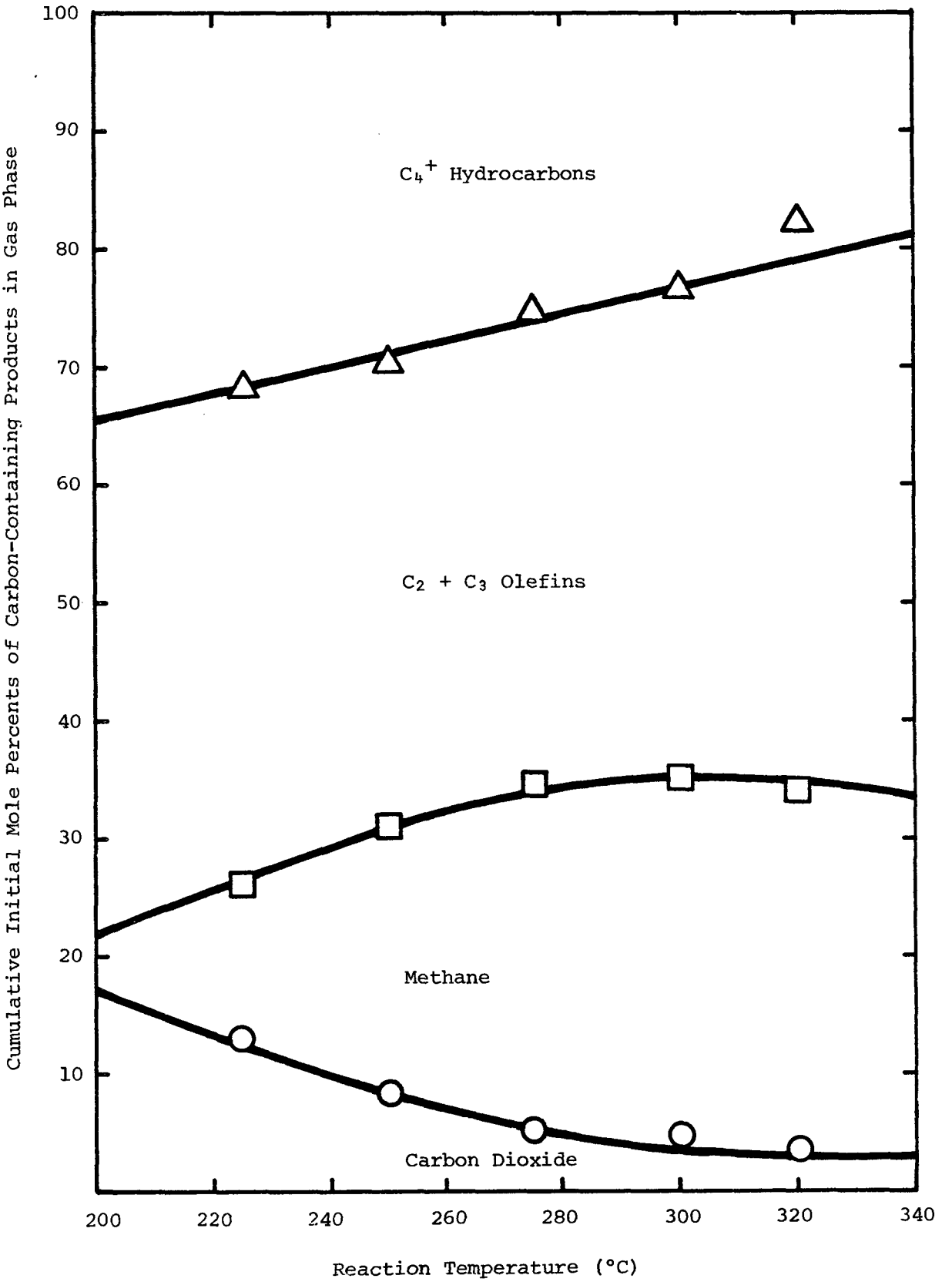

100
80
60
40
20
0
2
4
6
8
10
12
14
C_4^+ Hydrocarbons
C_2 + C_3 Paraffins
C_2 + C_3 Olefins
Methane
Carbon Dioxide
Cumulative Mole Percent of Carbon-Containing Products in Gas Phase
% CO Conversion

FIGURE 22


Cumulative Initial Mole Percents of Carbon-Containing Products in Gas Phase
100
90
80
70
60
50
40
30
20
10
C_4^+ Hydrocarbons
C_2 + C_3 Olefins
Methane
Carbon Dioxide
200
220
240
260
280
300
320
340
Reaction Temperature (°C)

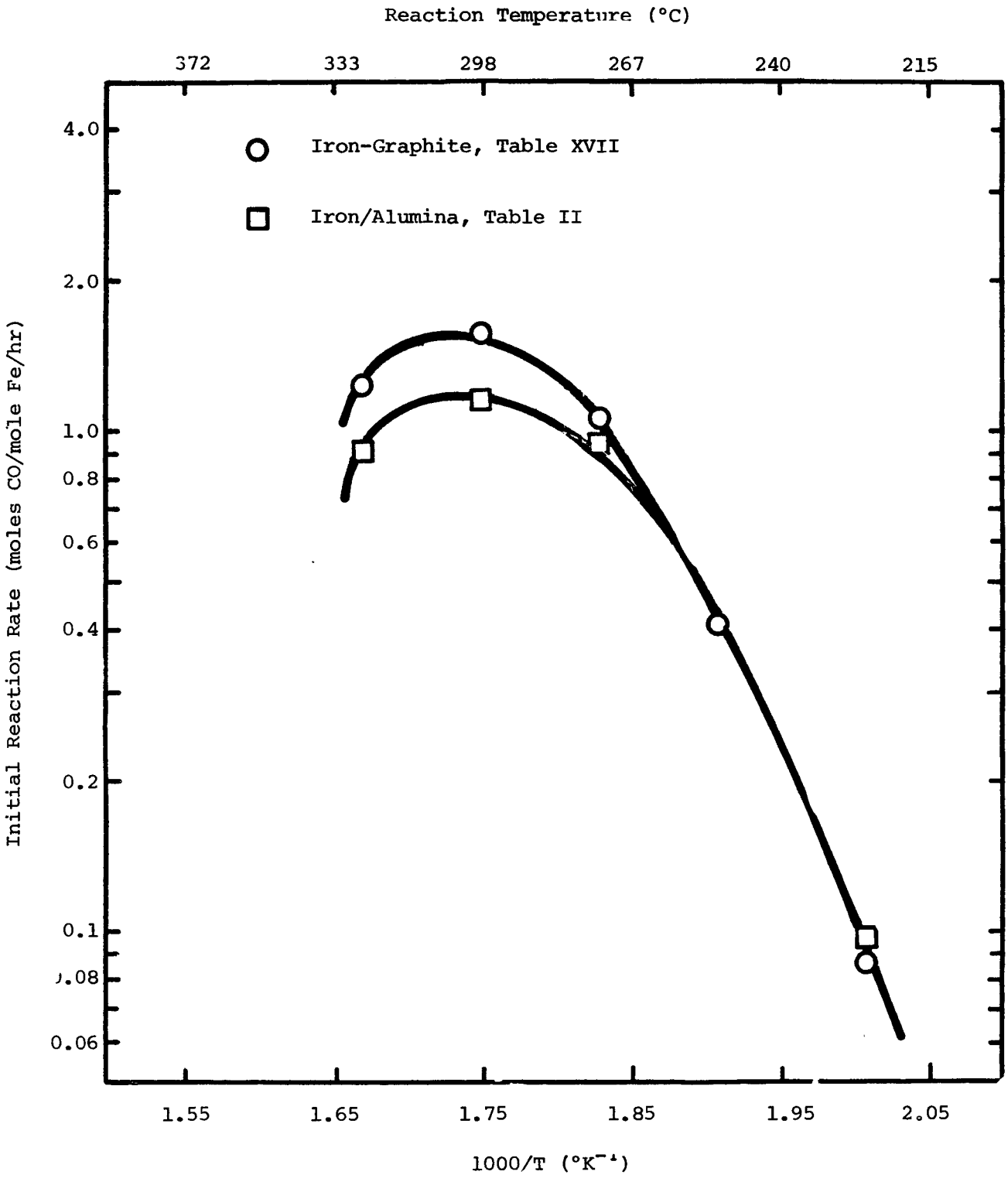

Reaction Temperature (°C)
372
333
298
267
240
215
Iron-Graphite, Table XVII
Iron/Alumina, Table II
Initial Reaction Rate (moles CO/mole Fe/hr)
4.0
2.0
1.0
0.8
0.6
0.4
0.2
0.1
0.08
0.06
1.55
1.65
1.75
1.85
1.95
2.05
1000/T (°K⁻¹)

Table I

Fischer-Tropsch Reaction Results

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

Catalyst - Iron on Alumina (14.9 wt% Fe); Harshaw Chemical Co. No. FE-0301; Reduced in Hydrogen for 16 hrs at 400°C, then evacuated for 16 hrs at 300°C.

Weight - 0.47 g Total

Reaction Temperature = 306°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's	C_5^+
0.27	33.2	43.8	0.2	13.6	0.3	6.6	1.6	0.7
0.50	18.9	54.7	0.1	15.8	0.2	7.7	1.8	0.8
0.75	10.5	60.9	0.1	17.4	0.2	8.3	1.8	0.8

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		
0.27	54.7	70.2	5320.0	84.5
0.50	61.5	78.2	756.6	83.4
0.75	65.7	83.6	429.8	82.1

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

Table I (cont.)

Fischer-Tropsch Reaction Results

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

Catalyst - Iron on Alumina (14.9 wt% Fe); Harshaw Chemical Co. No. FE-0301; Evacuated for 16 hrs at 300°C following Series 2, Run 1-A.

Weight - 0.47 g Total

Reaction Temperature = 303°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's	C_5^+
0.25	42.3	36.8	0.9	11.0	1.9	4.5	1.8	0.8
0.50	37.8	39.8	0.7	12.6	1.3	5.3	1.8	0.8
0.75	23.6	49.5	0.6	15.4	1.2	6.7	2.1	0.9
1.00	18.6	53.2	0.6	16.4	1.1	7.1	2.1	0.9
1.51	11.8	58.5	0.5	17.7	1.0	7.7	2.0	0.9
2.00	7.2	61.8	0.5	18.6	0.9	8.1	2.1	0.9
2.50	5.0	63.7	0.4	18.9	0.7	8.2	2.1	0.9
3.00	3.2	65.6	0.3	19.0	0.6	8.2	2.1	0.9
3.50	2.1	66.5	0.3	19.4	0.5	8.2	2.0	0.9
4.00	1.3	67.5	0.2	19.4	0.4	8.3	2.0	0.9

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	30.9	46.1	3179.4	84.9
0.50	43.0	56.4	1270.0	86.6
0.75	45.5	62.8	258.6	82.7
1.00	49.3	67.3	394.4	82.0
1.51	54.4	73.8	259.4	80.6
2.00	58.0	78.6	195.3	79.5
2.50	61.7	82.3	192.9	79.5
3.00	64.8	85.6	155.2	79.1
3.50	66.4	88.5	88.2	78.0
4.00	68.3	91.0	97.7	77.3

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

Table I (cont.)

Fischer-Tropsch Reaction Results

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

Catalyst - Iron on Alumina (14.9 wt% Fe); Harshaw Chemical Co. No. FE-0301; Evacuated for 16 hrs at 300°C following Series 2, Run 1-B.

Weight - 0.47 g Total

Reaction Temperature = 302°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's	C_5^+
0.25	21.8	51.1	14.7	4.2	7.1	1.0	0.0	0.0
0.50	18.3	53.1	13.1	5.7	7.0	1.2	1.7	0.0
0.76	17.2	52.9	11.8	7.3	7.0	1.2	1.7	0.9
1.00	16.1	54.6	10.4	8.1	6.6	1.2	2.0	0.9
1.50	14.7	56.1	8.7	9.8	6.3	1.5	2.1	0.8
2.00	13.8	56.5	7.5	11.1	6.2	1.9	2.1	0.9
2.50	12.6	58.4	6.4	11.7	5.8	2.1	2.2	0.8
3.00	11.7	59.8	5.6	12.4	5.6	2.2	2.1	0.6
3.50	11.0	60.7	4.9	12.8	5.3	2.6	2.0	0.6
4.00	10.4	61.0	4.5	13.4	5.2	2.8	2.1	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		
0.25	2.8	3.6	289.3	99.2
0.50	5.0	6.4	233.5	98.7
0.76	7.0	8.9	195.2	98.1
1.00	8.7	11.1	189.5	97.7
1.50	11.8	14.9	156.1	96.9
2.00	14.4	18.3	135.2	96.0
2.50	17.0	21.4	139.2	95.6
3.00	19.4	24.3	124.0	95.1
3.50	21.6	27.6	114.3	94.0
4.00	23.6	30.2	101.7	93.4

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

Table I (cont.)

Fischer-Tropsch Reaction Results

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

Catalyst - Iron on Alumina (14.9 wt% Fe); Harshaw Chemical Co. No. FE-0301; Evacuated for 16 hrs at 300°C following Series 2, Run 1-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's	C_5^+
0.25	16.8	61.3	13.3	2.9	5.8	0.0	0.0	0.0
0.50	15.5	60.9	12.8	3.7	5.7	0.0	1.4	0.0
0.75	15.1	60.5	12.2	4.6	5.7	0.4	1.4	0.0
1.00	14.2	59.9	11.2	5.1	5.9	1.0	1.8	1.0
1.50	13.6	60.2	10.1	6.4	5.9	1.0	2.0	0.9
2.00	12.5	61.3	8.6	7.3	6.2	1.2	1.9	0.9
2.50	12.0	62.5	7.9	8.3	5.5	1.3	1.7	0.7
3.00	11.4	63.2	7.0	8.9	5.3	1.5	1.9	0.8
3.50	10.8	63.7	6.4	9.5	5.2	1.7	2.0	0.9

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		
0.25	1.5	0.7	154.8	100.8
0.50	2.8	2.4	135.0	100.4
0.75	4.0	3.9	125.7	100.1
1.00	5.5	5.8	155.8	99.7
1.50	7.7	8.4	114.2	99.3
2.00	10.1	11.7	124.1	98.4
2.50	11.9	14.2	94.9	97.8
3.00	14.0	16.5	107.0	97.5
3.50	16.1	19.0	111.5	97.1

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

Table I (cont.)

Fischer-Tropsch Reaction Results

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

Catalyst - Iron on Alumina (14.9 wt % Fe); Harshaw Chemical Co. No. FE-0301; Regenerated in Oxygen for 3 hrs at 400°C following Series 2, Run 1-D, then re-reduced in Hydrogen for 16 hrs at 400°C.

Weight - 0.47 g Total

Reaction Temperature = 301°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's	C_5^+
0.25	32.3	44.2	0.2	13.0	0.3	7.3	1.9	0.8
0.50	24.4	51.0	0.2	14.0	0.3	7.4	1.9	0.8
0.75	19.5	55.0	0.1	14.9	0.2	7.5	1.9	0.8
1.00	15.9	57.6	0.1	15.6	0.2	8.0	1.8	0.8
1.50	10.6	61.6	0.1	16.6	0.2	8.1	1.9	0.8
2.00	7.3	64.4	0.1	17.2	0.2	8.4	1.8	0.8
2.50	4.9	66.1	0.1	17.7	0.1	8.4	1.9	0.8

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	41.3	47.7	4295.2	93.6
0.50	55.0	61.1	1430.2	94.0
0.75	61.5	67.7	676.9	93.9
1.00	65.4	72.4	400.2	93.0
1.50	71.0	78.4	291.5	92.6
2.00	74.4	82.4	178.4	92.0
2.50	77.1	85.7	140.9	91.4

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

Table II

Fischer-Tropsch Reaction Results

Expt. No. - Series 9, Run 1-A

Catalyst - Iron on Alumina (14.9 wt% Fe); Harshaw Chemical Co. No. FE-0301; Reduced in Hydrogen for 8 hrs at 400°C, then evacuated for 16 hrs at 300°C.

Weight - 0.10 g Total

Reaction Temperature = 225°C
Initial H_2/CO Ratio = 2.00
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's	C_5^+
1.00	32.9	31.7	6.8	4.1	8.5	0.0	8.3	7.5
2.00	29.4	34.4	5.2	6.4	8.3	3.1	6.9	6.4
2.25	28.8	35.0	4.6	7.2	8.9	3.9	6.5	5.2
4.00	27.9	37.9	2.7	9.4	8.0	5.5	5.1	3.5
7.00	25.6	37.9	1.5	11.2	5.2	7.4	7.1	4.1
10.0	25.3	37.9	1.1	12.2	4.0	8.8	6.9	3.8

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	0.6	0.1	29.2	100.5
2.00	1.1	0.7	23.9	100.4
2.25	1.2	0.9	19.8	100.4
4.00	2.1	1.3	20.8	100.8
7.00	4.0	3.4	27.6	100.6
10.00	5.7	6.1	24.3	99.6

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

Table II (cont.)

Fischer-Tropsch Reaction Results

Expt. No. - Series 8, Run 1-A

Catalyst - Iron on Alumina (14.9 wt% Fe); Harshaw Chemical Co. No. FE-0301; Reduced in Hydrogen for 8 hrs at 400°C, then evacuated for 16 hrs at 300°C.

Weight - 0.10 g Total

Reaction Temperature = 250°C
Initial H_2/CO Ratio = 2.03
Initial Total Pressure = 756.4 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's	C_5^+
1.00	26.7	36.4	3.3	9.1	8.0	4.6	6.9	5.0
2.00	24.5	39.7	1.9	12.2	5.6	7.3	5.2	3.6
3.00	23.2	39.7	1.3	12.9	4.3	8.9	6.3	3.4
4.00	22.9	39.8	1.1	13.5	3.6	9.2	6.3	3.6
5.00	23.2	40.0	1.0	13.6	3.2	9.9	5.9	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		
1.00	2.5	2.3	126.6	100.2
2.00	5.1	5.3	109.2	99.8
3.00	7.9	7.7	121.7	100.2
4.00	10.3	10.5	102.4	99.7
5.00	12.3	12.6	88.4	99.7

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

Table II (cont.)

Fischer-Tropsch Reaction Results

Expt. No. - Series 7, Run 1-A

Catalyst - Iron on Alumina (14.9 wt% Fe); Harshaw Chemical Co. No. FE-0301; Reduced in Hydrogen for 8 hrs at 400°C, then evacuated for 16 hrs at 300°C.

Weight - 0.10 g Total

Reaction Temperature = 275°C
Initial H_2/CO Ratio = 2.00
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's	C_5^+
0.25	37.1	32.2	7.5	5.8	8.1	1.9	3.9	3.6
0.50	33.3	35.5	5.2	8.3	7.8	2.9	4.4	2.6
0.75	33.2	33.9	4.4	9.8	7.7	3.8	4.6	2.6
1.00	32.5	34.1	3.9	10.6	6.9	4.4	5.1	2.5
2.00	32.2	34.7	3.1	11.9	6.1	5.3	4.2	2.5
3.00	32.7	34.8	2.9	12.2	5.6	5.5	4.0	2.2
4.00	33.0	34.4	2.7	12.3	5.4	5.5	4.3	2.4

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		
0.25	1.5	1.6	253.7	99.8
0.50	3.1	3.2	282.5	99.9
0.75	4.5	4.6	236.6	99.9
1.00	5.8	5.7	222.7	100.0
2.00	9.5	9.5	160.9	99.9
3.00	12.1	12.2	113.1	99.9
4.00	14.6	14.2	109.4	100.4

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

Table II (cont.)

Fischer-Tropsch Reaction Results

Expt. No. - Series 6, Run 1-A

Catalyst - Iron on Alumina (14.9 wt% Fe); Harshaw Chemical Co. No. FE-0301; Reduced in Hydrogen for 8 hrs at 400°C, then evacuated for 16 hrs at 300°C.

Weight - 0.10 g Total

Reaction Temperature = 300°C
Initial H_2/CO Ratio = 2.00
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's	C_5^+
0.25	41.1	29.3	8.6	5.8	7.8	1.4	4.0	2.1
0.50	39.2	30.7	8.3	6.8	7.8	1.7	3.4	2.0
0.75	38.6	31.2	8.1	7.3	7.8	1.8	3.4	1.8
1.00	38.5	31.5	8.1	7.7	7.6	1.8	3.2	1.6
1.50	38.0	32.0	8.0	7.9	7.5	1.8	3.2	1.6
2.00	37.4	32.9	7.9	7.9	7.3	1.9	3.0	1.6
2.50	38.2	32.7	7.8	8.1	7.1	1.7	3.0	1.5
3.00	38.3	32.9	7.8	8.0	7.1	1.7	2.9	1.4
4.00	38.6	32.8	7.7	8.0	6.9	1.7	2.9	1.4

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		
0.25	3.3	3.7	571.9	99.6
0.50	5.1	5.4	308.9	99.7
0.75	6.3	6.4	205.7	99.9
1.00	7.1	7.6	136.0	99.4
1.50	8.5	8.6	121.5	99.9
2.00	9.3	9.6	75.5	99.7
2.50	10.0	10.4	59.1	99.7
3.00	10.6	10.9	50.7	99.7
4.00	11.7	12.0	46.8	99.7

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

Table II (cont.)

Fischer-Tropsch Reaction Results

Expt. No. - Series 5, Run 1-A

Catalyst - Iron on Alumina (14.9 wt% Fe); Harshaw Chemical Co. No. FE-0301; Reduced in Hydrogen for 8 hrs at 400°C, then evacuated for 16 hrs at 300°C.

Weight - 0.10 g Total

Reaction Temperature = 325°C
Initial H_2/CO Ratio = 2.01
Initial Total Pressure = 751.8 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's	C_5^+
0.50	44.9	27.9	11.8	3.8	6.9	0.6	2.6	1.5
0.75	44.6	28.2	11.8	3.8	7.0	0.9	2.3	1.4
1.00	44.3	29.2	11.5	3.8	6.9	0.9	2.3	1.1
1.50	43.9	30.0	11.6	3.8	6.8	0.8	1.9	1.3
2.00	44.0	30.4	11.3	3.8	6.5	0.8	2.1	1.1
2.50	44.2	30.8	11.0	3.7	6.3	0.7	2.0	1.1
3.00	44.6	31.1	10.8	3.8	6.2	0.7	1.9	0.9
4.00	45.1	31.6	10.2	3.7	5.8	0.8	1.9	0.9

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		
0.50	4.5	4.7	250.3	99.8
0.75	5.1	6.0	106.1	99.1
1.00	5.6	6.2	73.1	99.4
1.50	6.2	7.1	59.3	99.2
2.00	6.8	8.0	50.4	98.8
2.50	7.3	8.3	40.4	99.0
3.00	7.6	8.8	30.0	98.8
4.00	8.5	9.6	38.6	98.9

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

Table III

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's	C_5^+
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		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	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 the total amount of CO admitted into the reactor at time t = 0.

Table III (cont.)

Fischer-Tropsch Reaction Results

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

Catalyst - Sodium-Graphite ($C_{64}Na$); Prepared by intercalation at 300°C; Evacuated for 16 hrs at 300°C following Series 1, Run 1-A.

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's	C_5^+
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		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	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 the total amount of CO admitted into the reactor at time t = 0.

Table III (cont.)

Fischer-Tropsch Reaction Results

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

Catalyst - Sodium-Graphite ($C_{64}Na$); Prepared by intercalation at 300°C; Evacuated for 16 hrs at 300°C following Series 1, Run 1-B.

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's	C_5^+
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	28.1	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 the total amount of CO admitted into the reactor at time t = 0.

Table IV

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's	C_5^+
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			
	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	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 the total amount of CO admitted into the reactor at time t = 0.

Table IV (cont.)

Fischer-Tropsch Reaction Results

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

Catalyst - Sodium-Graphite ($C_{64}Na$); Prepared by intercalation at 300°C; Evacuated for 16 hrs at 300°C following Series 2, Run 1-A.

Weight - 0.50 g (as grapgite)

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's	C_5^+
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 the total amount of CO admitted into the reactor at time t = 0.

Table IV (cont.)

Fischer-Tropsch Reaction Results

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

Catalyst - Sodium-Graphite ($C_{64}Na$); Prepared by intercalation at 300°C; Evacuated for 16 hrs at 300°C following Series 2, Run 1-B.

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's	C_5^+
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			
	Based on Product Formation	Based on Gas Phase CO Decrease	Rate of CO Conversion (μ-mole/hr)	Percent Carbon Mass Balance in Gas Phase
0.28	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 the total amount of CO admitted into the reactor at time t = 0.

Table IV (cont.)

Fischer-Tropsch Reaction Results

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

Catalyst - Sodium-Graphite ($C_{64}Na$); Prepared by intercalation at 300°C; Evacuated for 16 hrs at 300°C following Series 2, Run 1-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's	C_5^+
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 the total amount of CO admitted into the reactor at time t = 0.

Table IV (cont.)

Fischer-Tropsch Reaction Results

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

Catalyst - Sodium-Graphite ($C_{64}Na$); Prepared by intercalation at 300°C; Evacuated for 16 hrs at 300°C following Series 2, Run 1-D.

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's	C_5^+
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 the total amount of CO admitted into the reactor at time t = 0.

Table IV (cont.)

Fischer-Tropsch Reaction Results

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

Catalyst - Sodium-Graphite ($C_{64}Na$); Prepared by intercalation at 300°C; Evacuated for 16 hrs at 300°C following Series 2, Run 1-E.

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's	C_5^+
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		
0.50	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 the total amount of CO admitted into the reactor at time t = 0.

Table V

Fischer-Tropsch Reaction Results

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

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

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's	C_5^+
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 the total amount of CO admitted into the reactor at time t = 0.

Table V (cont.)

Fischer-Tropsch Reaction Results

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

Catalyst - Potassium-Graphite (C_8K); Prepared by intercalation at 300°C; Evacuated for 16 hrs at 300°C following Series 1, Run 1-A.

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's	C_5^+
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 the total amount of CO admitted into the reactor at time t = 0.

Table VI

Fischer-Tropsch Reaction Results

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

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

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's	C_5^+
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 the total amount of CO admitted into the reactor at time t = 0.

Table VI (cont.)

Fischer-Tropsch Reaction Results

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

Catalyst - Potassium-Graphite (C_8K); Prepared by intercalation at 300°C; Evacuated for 16 hrs at 300°C following Series 2, Run 1-A.

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's	C_5^+
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 the total amount of CO admitted into the reactor at time t = 0.

Table VI (cont.)

Fischer-Tropsch Reaction Results

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

Catalyst - Potassium-Graphite (C_8K); Prepared by intercalation at 300°C; Evacuated for 16 hrs at 300°C following Series 2, Run 1-B.

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's	C_5^+
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 the total amount of CO admitted into the reactor at time t = 0.

Table VI (cont.)

Fischer-Tropsch Reaction Results

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

Catalyst - Potassium-Graphite (C_8K); Prepared by intercalation at 300°C; Evacuated for 16 hrs at 300°C following Series 2, Run 1-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's	C_5^+
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 the total amount of CO admitted into the reactor at time t = 0.

Table VII

Fischer-Tropsch Reaction Results

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

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

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's	C_5^+
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 the total amount of CO admitted into the reactor at time t = 0.

Table VIII

Fischer-Tropsch Reaction Results

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

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

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's	C_5^+
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			
	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	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 the total amount of CO admitted into the reactor at time t = 0.

Table VIII (cont.)

Fischer-Tropsch Reaction Results

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

Catalyst - Potassium-Graphite (C_8K); Prepared by intercalation at 300°C; Evacuated for 16 hrs at 300°C following Series 4, Run 1-A.

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's	C_5^+
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	43.6	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 the total amount of CO admitted into the reactor at time t = 0.

Table VIII (cont.)

Fischer-Tropsch Reaction Results

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

Catalyst - Potassium-Graphite (C_8K); Prepared by intercalation at 300°C; Evacuated for 16 hrs at 300°C following Series 4, Run 1-B.

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's	C_5^+
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			
	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	0.3	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 the total amount of CO admitted into the reactor at time t = 0.

Table VIII (cont.)

Fischer-Tropsch Reaction Results

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

Catalyst - Potassium-Graphite (C_8K); Prepared by intercalation at 300°C; Evacuated for 16 hrs at 300°C following Series 4, Run 1-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's	C_5^+
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 the total amount of CO admitted into the reactor at time t = 0.

Table IX

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 in initial catalyst 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's	C_5^+
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	75.2	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 the total amount of CO admitted into the reactor at time t = 0.

Table IX (cont.)

Fischer-Tropsch Reaction Results

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

Catalyst - Iron-Graphite (4.5 wt% Fe); Potassium-reduced; Evacuated for 16 hrs at 300°C following Series 1, Run 1-A.

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's	C_5^+
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	0.0	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			
	Based on Product Formation	Based on Gas Phase CO Decrease	Rate of CO Conversion (μ-mole/hr)	Percent Carbon Mass Balance in Gas Phase
0.30	9.3	30.0	809.2	79.4
0.51	19.8	54.7	1290.3	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 the total amount of CO admitted into the reactor at time t = 0.

Table IX (cont.)

Fischer-Tropsch Reaction Results

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

Catalyst - Iron-Graphite (4.5 wt% Fe); Potassium-Reduced; Evacuated for 16 hrs at 300°C following Series 1, Run 1-B.

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's	C_5^+
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	31.3	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 the total amount of CO admitted into the reactor at time t = 0.

Table IX (cont.)

Fischer-Tropsch Reaction Results

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

Catalyst - Iron-Graphite (4.5 wt% Fe); Potassium-Reduced; Evacuated for 16 hrs at 300°C following Series 1, Run 1-C.

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's	C_5^+
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 the total amount of CO admitted into the reactor at time t = 0.

Table IX (cont.)

Fischer-Tropsch Reaction Results

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

Catalyst - Iron-Graphite (4.5 wt% Fe); Potassium-Reduced; Evacuated for 16 hrs at 300°C following Series 1, Run 1-D.

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's	C_5^+
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 the total amount of CO admitted into the reactor at time t = 0.

Table X

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's	C_5^+
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 the total amount of CO admitted into the reactor at time t = 0.

Table X (cont.)

Fischer-Tropsch Reaction Results

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

Catalyst - Iron-Graphite (4.5 wt% Fe); Potassium-Reduced and exposed to atmosphere; Evacuated for 16 hrs at 300°C following Series 2, Run 1-A.

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's	C_5^+
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		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	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 the total amount of CO admitted into the reactor at time t = 0.

Table XI

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's	C_5^+
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 the total amount of CO admitted into the reactor at time t = 0.

Table XI (cont.)

Fischer-Tropsch Reaction Results

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

Catalyst - Iron-Graphite (4.5 wt% Fe); Potassium-Reduced, exposed to atmosphere, and washed; Evacuated for 16 hrs at 300°C following Series 3, Run 1-A.

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's	C_5^+
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 the total amount of CO admitted into the reactor at time t = 0.

Table XI (cont.)

Fischer-Tropsch Reaction Results

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

Catalyst - Iron-Graphite (4.5 wt% Fe); Potassium-Reduced, exposed to atmosphere, and washed; Evacuated for 16 hrs at 300°C following Series 3, Run 1-B.

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's	C_5^+
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 the total amount of CO admitted into the reactor at time t = 0.

Table XII

Fischer-Tropsch Reaction Results

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

Catalyst - Iron-Graphite (2.2 wt% Fe); Ventron Corp. "Graphimet" No. 89654; Sodium Aryl-Reduced; Evacuated for 16 hrs at 300°C prior to initial use.

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's	C_5^+
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 the total amount of CO admitted into the reactor at time t = 0.

Table XII (cont.)

Fischer-Tropsch Reaction Results

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

Catalyst - Iron-Graphite (2.2 wt% Fe); Ventron Corp. "Graphimet" No. 89654; Evacuated for 16 hrs at 300°C following Series 1, Run 1-A.

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's	C_5^+
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 the total amount of CO admitted into the reactor at time t = 0.

Table XII (cont.)

Fischer-Tropsch Reaction Results

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

Catalyst - Iron-Graphite (2.2 wt% Fe); Ventron Corp. "Graphimet" No. 89654; Evacuated for 16 hrs at 300°C following Series 1, Run 1-B.

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's	C_5^+
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 the total amount of CO admitted into the reactor at time t = 0.

Table XII (cont.)

Fischer-Tropsch Reaction Results

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

Catalyst - Iron-Graphite (2.2 wt% Fe); Ventron Corp. "Graphimet" No. 89654; Evacuated for 16 hrs at 300°C following Series 1, Run 1-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's	C_5^+
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 the total amount of CO admitted into the reactor at time t = 0.

Table XII (cont.)

Fischer-Tropsch Reaction Results

Expt. No. - Series 7, Run 1-A

Catalyst - Iron-Graphite (2.2 wt% Fe); Ventron Corp. "Graphimet" No. 89654; Sodium Aryl-Reduced; Evacuated for 16 hrs at 300°C prior to initial use.

Weight - 0.50 g (as graphite)

Reaction Temperature = 300°C
Initial H_2/CO Ratio = 4.00
Initial Total Pressure = 500.0 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's	C_5^+
0.50	10.9	33.9	17.1	2.7	16.6	0.0	10.3	8.5
0.75	9.1	38.9	18.3	3.1	16.1	0.0	7.8	6.8
1.00	8.7	40.7	17.4	4.3	16.5	0.0	7.7	4.8
2.00	8.9	42.8	13.8	6.9	14.6	2.2	7.0	3.9
3.00	10.6	43.3	11.5	9.0	13.5	2.4	6.1	3.7
4.00	12.4	43.7	10.1	10.1	12.8	2.3	5.5	2.9
5.00	13.7	43.9	8.9	10.8	12.1	2.7	5.2	2.7
6.00	15.8	43.3	8.2	11.2	11.3	2.6	5.0	2.6
8.00	17.1	43.9	6.7	12.1	10.3	3.1	4.7	2.2
10.00	18.0	43.9	5.9	12.5	9.7	3.4	4.5	2.1
22.80	25.3	42.1	3.9	12.4	7.0	3.8	3.7	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
0.50	1.3	1.5	66.8	99.8
0.75	1.9	2.4	42.6	99.5
1.00	2.6	3.8	48.2	98.8
2.00	5.7	7.3	38.4	98.3
3.00	8.0	10.7	43.2	97.3
4.00	9.8	13.3	29.2	96.5
5.00	11.6	15.1	31.4	96.5
6.00	12.8	17.0	20.7	95.9
8.00	15.1	20.9	19.7	94.2
10.00	17.0	23.8	16.1	93.1
22.80	23.6	41.7	8.9	81.9

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

Table XII (cont.)

Fischer-Tropsch Reaction Results

Expt. No. - Series 7, Run 1-B

Catalyst - Iron-Graphite (2.2 wt% Fe); Ventron Corp. "Graphimet" No. 89654; Evacuated for 16 hrs at 300°C following Series 7, Run 1-A.

Weight - 0.50 g (as graphite)

Reaction Temperature = 300°C
Initial H_2/CO Ratio = 4.00
Initial Total Pressure = 500.0 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's	C_5^+
0.25	19.5	46.6	19.8	0.0	14.2	0.0	0.0	0.0
0.50	18.4	47.2	18.8	3.6	12.0	0.0	0.0	0.0
0.75	18.2	51.8	17.8	3.2	9.0	0.0	0.0	0.0
1.00	17.7	48.0	17.4	3.5	8.0	0.0	5.5	0.0
1.50	19.2	48.0	17.5	3.2	8.1	0.0	4.1	0.0
2.00	19.0	48.7	15.7	3.3	7.9	0.0	3.2	2.3
2.50	19.7	48.4	15.3	3.9	8.0	0.0	2.7	2.0
3.00	19.7	47.0	14.3	3.8	8.7	1.3	3.4	1.7
4.00	21.1	48.2	13.7	4.4	7.3	0.9	3.0	1.4
6.00	22.7	48.1	12.2	5.3	6.6	1.2	2.6	1.2
8.00	23.7	47.9	11.1	6.0	6.8	1.3	2.0	1.1

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	0.4	0.3	24.1	100.0
0.50	0.6	- 0.1	17.0	100.7
0.75	0.8	0.2	14.1	100.6
1.00	1.2	0.7	23.9	100.5
1.50	1.5	1.3	11.8	100.2
2.00	2.0	1.5	17.5	100.5
2.50	2.3	2.1	11.1	100.2
3.00	2.8	2.0	17.3	100.8
4.00	3.3	3.2	8.5	100.1
6.00	4.4	5.6	9.2	98.8
8.00	5.4	7.6	8.3	97.7

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

Table XII (cont.)

Fischer-Tropsch Reaction Results

Expt. No. - Series 7, Run 1-C

Catalyst - Iron-Graphite (2.2 wt% Fe); Ventron Corp. "Graphimet" No. 89654; Evacuated for 16 hrs at 300°C following Series 7, Run 1-B.

Weight - 0.50 g (as graphite)

Reaction Temperature = 300°C
Initial H_2/CO Ratio = 4.00
Initial Total Pressure = 500.0 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's	C_5^+
0.25	31.1	54.2	14.7	0.0	0.0	0.0	0.0	0.0
0.50	30.7	52.5	16.8	0.0	0.0	0.0	0.0	0.0
1.00	23.8	50.2	16.6	0.0	9.4	0.0	0.0	0.0
2.00	21.6	54.2	14.7	4.1	5.5	0.0	0.0	0.0
3.00	21.7	55.1	13.8	3.0	6.4	0.0	0.0	0.0
4.00	21.0	52.5	13.4	3.4	6.2	1.5	1.9	0.0
6.00	21.5	51.8	12.4	3.8	6.6	1.5	2.4	0.0
18.00	25.6	49.3	9.1	5.5	5.4	1.5	2.0	1.6

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	0.1	- 0.6	10.2	100.7
0.50	0.2	0.6	5.3	99.6
1.00	0.5	0.3	9.7	100.2
2.00	0.9	1.3	7.2	99.7
3.00	1.3	1.9	6.0	99.4
4.00	1.8	2.6	8.3	99.1
6.00	2.4	5.5	5.9	96.9
18.00	6.6	11.4	6.0	95.2

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

Table XII (cont.)

Fischer-Tropsch Reaction Results

Expt. No. - Series 7, Run 1-D

Catalyst - Iron-Graphite (2.2 wt% Fe); Ventron Corp. "Graphimet" No. 89654; Evacuated for 16 hrs at 300°C following Series 7, Run 1-C.

Weight - 0.50 g (as graphite)

Reaction Temperature = 300°C
Initial H_2/CO Ratio = 4.00
Initial Total Pressure = 500.0 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's	C_5^+
0.25	24.4	46.5	14.2	0.0	14.9	0.0	0.0	0.0
0.51	21.6	51.0	17.8	0.0	9.6	0.0	0.0	0.0
1.02	20.5	51.5	16.5	3.0	8.5	0.0	0.0	0.0
2.00	18.0	53.9	14.3	2.6	5.5	0.0	5.6	0.0
3.00	18.7	53.9	13.8	2.7	7.0	0.0	3.9	0.0
4.00	19.9	54.2	13.5	3.2	6.0	0.0	3.2	0.0
6.00	21.9	53.6	12.5	3.5	6.0	0.0	2.5	0.0
8.00	22.6	51.3	11.5	3.9	5.7	1.1	2.3	1.8
23.83	31.6	45.6	8.2	5.0	5.1	1.3	1.8	1.4

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		
0.25	0.2	- 0.3	12.0	100.5
0.51	0.3	- 0.3	5.5	100.5
1.02	0.5	0.0	7.7	100.5
2.00	1.0	0.8	8.3	100.1
3.00	1.3	0.9	6.5	100.4
4.00	1.6	2.2	5.0	99.4
6.00	2.3	3.0	5.6	99.3
8.00	3.1	4.6	7.5	98.6
23.83	8.7	11.6	6.0	97.1

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

Table XIII

Fischer-Tropsch Reaction Results

Expt. No. - Series 7, Run 1-A

Catalyst - Iron-Graphite (2.2 wt% Fe); Ventron Corp. "Graphimet" No. 89654; Evacuated for 16 hrs at 300°C prior to use.

Weight - 0.50 g (as graphite)

Reaction Temperature = 300°C
Initial H_2/CO Ratio = 4.00
Initial Total Pressure = 500.0 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's	C_5^+
0.50	10.9	33.9	17.1	2.7	16.6	0.0	10.3	8.5
0.75	9.1	38.9	18.3	3.1	16.1	0.0	7.8	6.8
1.00	8.7	40.7	17.4	4.3	16.5	0.0	7.7	4.8
2.00	8.9	42.8	13.8	6.9	14.6	2.2	7.0	3.9
3.00	10.6	43.3	11.5	9.0	13.5	2.4	6.1	3.7
4.00	12.4	43.7	10.1	10.1	12.8	2.3	5.5	2.9
5.00	13.7	43.9	8.9	10.8	12.1	2.7	5.2	2.7
6.00	15.8	43.3	8.2	11.2	11.3	2.6	5.0	2.6
8.00	17.1	43.9	6.7	12.1	10.3	3.1	4.7	2.2
10.00	18.0	43.9	5.9	12.5	9.7	3.4	4.5	2.1
22.80	25.3	42.1	3.9	12.4	7.0	3.8	3.7	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
0.50	1.3	1.5	66.8	99.8
0.75	1.9	2.4	42.6	99.5
1.00	2.6	3.8	48.2	98.8
2.00	5.7	7.3	38.4	98.3
3.00	8.0	10.7	43.2	97.3
4.00	9.8	13.3	29.2	96.5
5.00	11.6	15.1	31.4	96.5
6.00	12.8	17.0	20.7	95.9
8.00	15.1	20.9	19.7	94.2
10.00	17.0	23.8	16.1	93.1
22.80	23.6	41.7	8.9	81.9

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

Table XIII (cont.)

Fischer-Tropsch Reaction Results

Expt. No. - Series 8, Run 1-A

Catalyst - Iron-Graphite (2.2 wt% Fe); Ventron Corp. "Graphimet" No. 89654; Evacuated for 16 hrs at 300°C prior to use.

Weight - 0.50 g (as graphite)

Reaction Temperature = 300°C
Initial H_2/CO Ratio = 4.00
Initial Total Pressure = 500.0 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's	C_5^+
0.25	8.2	27.4	23.1	0.0	23.7	0.0	17.5	0.0
0.50	5.9	34.0	20.6	2.5	18.3	0.0	11.8	6.9
1.00	5.6	41.6	17.5	4.2	16.8	0.0	8.9	5.5
1.50	6.5	43.5	15.5	5.9	16.1	1.9	6.6	4.0
2.00	9.7	43.0	13.8	7.2	14.9	1.9	5.8	3.7
2.50	8.8	44.1	12.7	8.6	14.3	1.6	6.4	3.5
3.00	9.9	44.0	11.5	9.3	13.4	2.4	6.1	3.4
3.50	11.0	44.3	10.7	9.9	13.0	1.9	6.0	3.2
4.00	12.1	44.3	10.1	10.3	12.4	2.4	5.5	2.9
5.00	14.2	44.2	9.1	10.9	11.7	2.4	5.0	2.5
6.00	15.9	43.2	8.3	10.9	11.1	2.7	5.1	2.9

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	0.4	0.3	28.4	100.1
0.50	1.2	1.5	56.5	99.7
1.00	3.0	4.2	52.5	98.8
1.50	4.6	6.1	54.4	98.5
2.00	6.1	7.9	52.3	98.2
2.50	7.3	9.6	41.3	97.7
3.00	8.6	11.3	43.1	97.2
3.50	9.5	13.0	31.6	96.5
4.00	10.3	13.5	28.1	96.8
5.00	11.7	15.0	23.8	96.6
6.00	13.4	16.9	29.9	96.5

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

Table XIII (cont.)

Fischer-Tropsch Reaction Results

Expt. No. - Series 9, Run 1-A

Catalyst - Iron-Graphite (2.2 wt% Fe); Ventron Corp. "Graphimet" No. 89654; Evacuated for 16 hrs at 300°C prior to use.

Weight - 0.50 g (as graphite)

Reaction Temperature = 301°C
Initial H_2/CO Ratio = 4.00
Initial Total Pressure = 500.0 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's	C_5^+
0.25	23.7	37.7	20.9	0.0	17.7	0.0	0.0	0.0
0.50	11.3	36.2	17.8	2.6	15.8	0.0	9.6	6.7
1.00	8.1	40.3	15.1	3.6	15.5	2.2	10.1	5.1
1.50	7.3	43.6	16.3	4.9	16.0	1.6	6.2	4.1
2.00	7.0	43.7	14.8	6.4	16.0	1.8	6.3	3.8
2.50	7.1	45.0	13.6	7.8	15.0	1.7	6.4	3.5
3.00	7.4	44.8	12.2	8.6	14.5	2.3	6.4	3.7
3.50	7.8	45.5	11.2	9.5	14.0	2.4	6.2	3.5
4.00	8.3	46.3	10.3	10.4	13.4	2.2	5.9	3.1
5.00	9.1	46.3	8.8	11.4	12.7	2.6	6.0	3.0
6.00	10.2	46.3	7.8	12.1	12.2	2.7	5.8	2.8

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	0.3	17.2	99.9
0.50	1.0	1.2	55.1	99.8
1.00	2.4	2.8	53.4	99.6
1.50	3.4	5.0	35.4	98.4
2.00	4.7	7.0	44.8	97.7
2.50	5.8	8.7	38.0	97.1
3.00	7.1	10.0	43.1	97.1
3.50	8.1	11.2	37.2	96.9
4.00	9.0	12.3	29.1	96.7
5.00	10.8	15.0	30.9	95.7
6.00	12.3	17.3	26.3	95.0

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

Table XIII (cont.)

Fischer-Tropsch Reaction Results

Expt. No. - Series 10, Run 1-A

Catalyst - Iron-Graphite (2.2 wt% Fe); Ventron Corp. "Graphimet" No. 89654; Evacuated for 16 hrs at 300°C prior to use.

Weight - 0.50 g (as graphite)

Reaction Temperature = 299°C
Initial H_2/CO Ratio = 4.00
Initial Total Pressure = 500.0 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's	C_5^+
0.25	33.8	32.5	15.2	0.0	18.6	0.0	0.0	0.0
0.50	12.6	32.1	14.1	2.2	14.0	0.0	12.6	12.3
1.00	8.0	39.2	15.8	3.4	15.7	0.0	9.8	8.2
1.50	7.1	41.4	14.6	5.4	15.6	0.0	7.7	8.2
2.00	7.3	44.3	13.0	7.2	15.2	1.3	7.1	4.7
2.50	7.9	45.0	11.6	8.7	14.4	1.9	6.7	3.7
3.00	8.5	44.7	10.3	9.7	13.6	1.6	7.3	4.3
3.50	9.1	44.8	9.3	10.3	12.6	2.2	7.1	4.4
4.10	10.0	45.2	8.6	11.0	12.6	2.9	6.0	3.8
5.00	11.4	45.7	7.8	11.8	11.5	2.7	5.9	3.2
6.00	12.6	45.2	7.0	12.1	11.0	2.8	5.8	3.5

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	0.2	0.5	14.5	99.7
0.50	1.1	1.3	62.1	99.8
1.00	2.8	4.0	70.7	98.8
1.50	4.7	7.1	68.1	97.6
2.00	6.2	10.0	49.3	96.2
2.50	7.6	12.1	48.6	95.5
3.00	9.2	13.7	56.3	95.5
3.50	10.6	15.4	47.5	95.2
4.10	11.5	16.6	27.5	95.0
5.00	13.1	19.0	30.4	94.1
6.00	14.8	20.5	29.1	94.3

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

Table XIV

Fischer-Tropsch Reaction Results

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

Catalyst - Iron-Graphite (2.2 wt% Fe); Ventron Corp. "Graphimet" No. 89654; Pretreated in hydrogen for 3 hrs at 300°C prior to initial use, then evacuated for 16 hrs at 300°C.

Weight - 0.50 g (as graphite)

Reaction Temperature = 298°C
Initial H_2/CO Ratio = 4.00
Initial Total Pressure = 500.0 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's	C_5^+
0.25	3.4	39.2	16.8	2.7	19.8	2.8	9.2	6.1
0.50	4.2	41.2	15.7	4.6	18.6	1.7	8.8	5.3
0.75	4.9	41.3	13.8	5.7	17.5	1.8	9.4	5.6
1.00	6.0	38.8	13.7	7.0	18.2	1.6	9.1	5.6
1.50	7.2	42.7	11.0	7.9	16.5	2.4	7.8	4.4
2.00	8.3	42.6	9.8	8.9	15.9	2.6	7.8	4.1
2.50	9.1	43.9	9.1	9.4	15.1	2.9	6.9	3.7
3.00	10.0	43.0	8.6	9.7	14.7	2.8	7.4	3.8

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	3.7	6.1	256.4	97.6
0.50	7.0	10.2	227.6	96.8
0.75	10.5	13.7	244.0	96.8
1.00	12.8	17.7	161.0	95.1
1.50	16.9	22.5	140.2	94.4
2.00	20.4	26.6	122.4	93.8
2.50	22.6	29.8	78.0	92.8
3.00	24.6	32.3	68.7	92.4

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

Table XIV (cont.)

Fischer-Tropsch Reaction Results

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

Catalyst - Iron-Graphite (2.2 wt% Fe); Ventron Corp. "Graphimet" No. 89654; Evacuated for 16 hrs at 300°C following Series 3, Run 1-A.

Weight - 0.50 g (as graphite)

Reaction Temperature = 299°C
Initial H_2/CO Ratio = 4.01
Initial Total Pressure = 501.1 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's	C_5^+
0.25	6.3	46.7	20.9	2.6	14.6	0.0	9.0	0.0
0.50	7.2	51.5	20.5	2.3	14.1	0.0	4.4	0.0
0.75	8.1	49.7	19.1	2.7	12.8	0.0	5.2	2.4
1.00	9.1	50.3	19.2	3.0	12.7	0.0	3.8	2.0
1.50	10.4	50.0	17.8	3.5	11.6	1.1	3.8	1.8
2.00	11.7	49.5	16.0	4.0	11.4	1.0	4.1	2.2
2.50	12.8	48.7	15.4	4.2	10.5	1.1	4.3	3.1
3.00	13.7	47.9	15.5	4.4	11.1	1.6	3.7	2.2

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	1.1	0.3	77.9	100.8
0.50	1.7	0.9	37.2	100.7
0.75	2.4	1.7	53.8	100.8
1.00	2.9	2.2	30.4	100.6
1.50	3.9	3.2	34.6	100.7
2.00	4.8	4.3	31.5	100.5
2.50	5.6	5.4	30.4	100.3
3.00	6.3	5.9	23.4	100.5

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

Table XIV (cont.)

Fischer-Tropsch Reaction Results

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

Catalyst - Iron-Graphite (2.2 wt% Fe); Ventron Corp. "Graphimet" No. 89654; Evacuated for 16 hrs at 300°C following Series 3, Run 1-B

Weight - 0.50 g (as graphite)

Reaction Temperature = 299°C
Initial H_2/CO Ratio = 4.00
Initial Total Pressure = 500.0 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's	C_5^+
0.26	22.4	50.0	27.6	0.0	0.0	0.0	0.0	0.0
0.50	14.1	53.2	18.1	2.1	12.5	0.0	0.0	0.0
0.77	14.0	54.1	17.9	2.4	11.6	0.0	0.0	0.0
1.00	14.6	55.8	18.0	2.5	9.1	0.0	0.0	0.0
1.50	15.5	53.8	18.0	2.1	10.6	0.0	0.0	0.0
2.00	15.7	55.5	17.2	2.1	9.5	0.0	0.0	0.0
2.50	16.0	52.4	16.1	2.9	8.4	0.0	4.2	0.0
3.70	18.5	51.9	14.6	2.9	9.0	0.0	3.1	0.0
4.00	19.1	51.5	15.3	3.1	8.5	0.0	2.5	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		
0.26	0.2	0.0	16.4	100.9
0.50	0.6	0.0	25.5	100.7
0.77	0.8	0.2	13.1	100.6
1.00	0.9	0.0	8.4	101.0
1.50	1.3	1.1	12.0	100.2
2.00	1.6	1.4	10.6	100.2
2.50	2.0	1.9	16.7	100.2
3.70	2.7	3.0	9.8	99.8
4.00	2.9	3.1	11.2	99.8

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

Table XIV (cont.)

Fischer-Tropsch Reaction Results

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

Catalyst - Iron-Graphite (2.2 wt% Fe); Ventron Corp. "Graphimet" No. 89654; Evacuated for 16 hrs at 300°C following Series 3, Run 1-C.

Weight - 0.50 g (as graphite)

Reaction Temperature = 299°C
Initial H_2/CO Ratio = 4.00
Initial Total Pressure = 500.0 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's	C_5^+
0.25	18.9	64.4	16.7	0.0	0.0	0.0	0.0	0.0
0.50	13.3	55.7	17.5	0.0	13.5	0.0	0.0	0.0
1.00	13.1	56.4	17.0	2.7	10.8	0.0	0.0	0.0
1.53	13.3	56.6	16.5	2.4	11.3	0.0	0.0	0.0
2.00	13.9	58.1	16.8	2.0	9.1	0.0	0.0	0.0
3.58	16.5	55.1	15.8	2.9	9.6	0.0	0.0	0.0
4.02	17.1	55.8	15.6	2.7	8.7	0.0	0.0	0.0
4.50	18.3	54.1	15.3	2.9	9.4	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	0.2	0.0	10.6	101.0
0.50	0.3	0.0	12.4	101.1
1.00	0.6	0.0	8.5	100.9
1.53	0.9	0.5	8.9	100.4
2.00	1.0	0.5	6.5	100.5
3.58	1.7	1.7	7.9	100.0
4.02	1.9	1.3	5.9	100.6
4.50	2.1	2.1	8.5	100.1

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

Table XIV (cont.)

Fischer-Tropsch Reaction Results

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

Catalyst - Iron-Graphite (2.2 wt% Fe); Ventron Corp. "Graphimet" No. 89654; Evacuated for 16 hrs at 300°C following Series 3, Run 1-D.

Weight - 0.50 g (as graphite)

Reaction Temperature = 299°C
Initial H_2/CO Ratio = 4.04
Initial Total Pressure = 504.0 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's	C_5^+
0.50	21.2	50.1	16.5	0.0	12.3	0.0	0.0	0.0
0.75	18.1	52.7	16.5	1.9	10.7	0.0	0.0	0.0
1.00	18.3	50.2	16.4	2.1	12.9	0.0	0.0	0.0
1.50	19.0	52.1	16.9	2.2	9.9	0.0	0.0	0.0
2.00	18.7	51.4	17.0	2.4	10.5	0.0	0.0	0.0
2.50	19.7	51.1	16.6	2.8	9.8	0.0	0.0	0.0
4.00	27.4	46.1	13.5	2.2	8.3	0.0	2.5	0.0
4.52	20.5	51.0	14.1	2.6	8.1	0.0	3.7	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		
0.50	0.5	0.0	16.4	101.0
0.75	0.6	0.0	11.5	100.7
1.00	0.7	0.0	7.1	100.7
1.50	1.0	0.5	7.3	100.5
2.00	1.2	0.8	8.3	100.4
2.50	1.4	1.1	6.2	100.3
4.00	2.3	1.5	10.4	100.7
4.52	2.4	2.4	4.5	100.0

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

Table XV

Fischer-Tropsch Reaction Results

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

Catalyst - Iron-Graphite (2.2 wt% Fe); Ventron Corp. "Graphimet" No. 89654; Pretreated in carbon monoxide for 4 hrs at 320°C prior to initial use, then evacuated for 16 hrs at 300°C.

Weight - 0.50 g (as graphite)

Reaction Temperature = 300°C
Initial H_2/CO Ratio = 4.00
Initial Total Pressure = 500.1 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's	C_5^+
0.50	12.5	45.6	18.5	0.0	23.4	0.0	0.0	0.0
0.75	7.9	46.3	18.1	3.4	18.4	0.0	5.9	0.0
1.00	6.5	42.0	16.2	3.9	15.8	0.0	10.7	4.9
1.51	7.0	44.8	13.8	6.8	15.1	1.2	6.6	4.8
2.00	7.9	45.7	12.1	8.7	15.1	1.5	5.6	3.4
2.43	8.6	45.2	10.7	10.1	14.8	2.4	5.5	2.6
3.00	9.3	45.9	9.2	11.0	13.6	2.5	5.3	3.2
3.50	10.1	45.8	8.4	11.7	13.2	2.6	5.0	3.1
4.00	10.8	45.3	7.8	12.1	12.4	3.1	5.6	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		
0.50	0.5	0.1	33.3	100.5
0.75	1.2	0.9	47.6	100.3
1.00	2.5	2.2	87.6	100.3
1.51	4.3	4.9	61.6	99.4
2.00	5.8	7.4	53.2	98.4
2.42	7.2	9.3	53.7	97.8
3.00	9.0	11.3	57.4	97.8
3.50	10.2	12.9	39.3	97.3
4.00	11.6	14.1	50.3	97.6

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

Table XV (cont.)

Fischer-Tropsch Reaction Results

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

Catalyst - Iron-Graphite (2.2 wt% Fe); Ventron Corp. "Graphimet" No. 89654; Evacuated for 16 hrs at 300°C following Series 4, Run 1-A.

Weight - 0.50 g (as graphite)

Reaction Temperature = 300°C
Initial H_2/CO Ratio = 4.00
Initial Total Pressure = 500.1 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's	C_5^+
0.25	6.0	47.8	24.5	3.4	18.3	0.0	0.0	0.0
0.50	5.7	45.4	19.9	4.4	16.5	0.0	8.2	0.0
0.75	6.7	48.3	19.4	4.6	13.7	2.4	4.9	0.0
1.00	7.2	46.3	18.1	5.3	12.6	2.0	6.0	2.4
1.50	8.0	47.2	16.7	6.5	13.5	1.0	4.2	2.8
2.00	9.0	47.1	15.2	7.3	13.0	2.2	3.8	2.3
2.50	9.8	47.9	14.3	7.9	12.2	1.6	3.8	2.4
4.52	12.4	48.3	11.5	9.7	11.1	1.9	3.4	1.7
5.00	12.8	48.2	11.0	9.5	11.0	2.3	3.6	1.6

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	1.0	0.3	69.8	100.7
0.50	2.2	0.9	84.8	101.3
0.75	2.7	2.1	30.0	100.6
1.00	3.5	2.6	58.7	101.0
1.50	4.5	3.6	33.7	100.9
2.00	5.4	4.5	32.3	100.9
2.50	6.2	5.4	24.4	100.7
4.52	8.4	8.2	19.5	100.2
5.00	9.0	8.7	19.9	100.3

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

Table XV (cont.)

Fischer-Tropsch Reaction Results

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

Catalyst - Iron-Graphite (2.2 wt% Fe); Ventron Corp. "Graphimet" No. 89654; Evacuated for 16 hrs at 300°C following Series 4, Run 1-B.

Weight - 0.50 g (as graphite)

Reaction Temperature = 299°C
Initial H_2/CO Ratio = 4.00
Initial Total Pressure = 500.1 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's	C_5^+
0.26	8.5	41.0	18.6	2.5	15.1	0.0	14.2	0.0
0.50	8.9	47.0	20.2	2.4	11.7	0.0	9.8	0.0
0.75	9.7	53.7	21.8	3.0	11.8	0.0	0.0	0.0
1.00	10.1	53.8	21.4	3.1	11.5	0.0	0.0	0.0
1.50	9.7	50.0	18.1	3.4	11.7	2.0	5.1	0.0
2.00	11.1	51.1	17.8	3.6	10.2	1.9	4.3	0.0
2.50	11.7	50.9	16.9	4.4	10.6	1.6	3.9	0.0
3.00	12.3	50.6	16.4	4.7	10.5	1.5	4.2	0.0
3.50	12.8	52.4	16.1	5.1	10.1	0.0	3.4	0.0
4.00	13.7	52.0	15.8	5.5	10.2	0.0	2.8	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		
0.26	0.8	0.0	55.4	101.9
0.50	1.1	0.0	19.0	101.8
0.75	1.1	0.0	1.7	101.4
1.00	1.3	0.4	15.4	101.0
1.50	2.2	1.1	27.9	101.0
2.00	2.5	1.0	10.8	101.5
2.50	2.8	1.6	13.3	101.3
3.00	3.2	1.9	11.6	101.3
3.50	3.3	2.6	5.6	100.8
4.00	3.6	3.3	8.4	100.3

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

Table XV (cont.)

Fischer-Tropsch Reaction Results

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

Catalyst - Iron-Graphite (2.2 wt% Fe); Ventron Corp. "Graphimet" No. 89654; Evacuated for 16 hrs at 300°C following Series 4, Run 1-C.

Weight - 0.50 g (as graphite)

Reaction Temperature = 299°C
Initial H_2/CO Ratio = 4.00
Initial Total Pressure = 500.2 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's	C_5^+
0.25	12.1	61.4	26.5	0.0	0.0	0.0	0.0	0.0
0.50	9.1	59.6	20.1	0.0	11.2	0.0	0.0	0.0
1.00	9.5	56.0	20.0	2.2	12.3	0.0	0.0	0.0
1.50	10.4	58.3	18.9	2.8	9.6	0.0	0.0	0.0
2.00	10.6	58.5	18.5	3.0	9.3	0.0	0.0	0.0
2.50	11.4	57.0	17.7	3.4	10.4	0.0	0.0	0.0
3.00	11.2	55.7	16.8	3.2	9.0	0.0	4.0	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	13.9	101.1
0.50	0.5	0.0	18.2	101.2
1.00	0.8	0.0	11.9	100.9
1.50	1.0	0.3	8.1	100.7
2.00	1.3	0.4	7.8	100.9
2.50	1.5	0.9	8.5	100.6
3.00	1.9	1.3	12.1	100.6

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

Table XVI

Fischer-Tropsch Reaction Results

Expt. No. - Series 14, Run 1-A

Catalyst - Iron-Graphite (2.2 wt% Fe); Ventron Corp. "Graphimet" No. 89654; Evacuated for 16 hrs at 300°C prior to use.

Weight - 0.50 g (as graphite_

Reaction Temperature = 225°C
Initial H_2/CO Ratio = 2.00
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's	C_5^+
1.00	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3.00	73.9	0.0	26.1	0.0	0.0	0.0	0.0	0.0
5.00	38.1	0.0	21.5	9.3	31.2	0.0	0.0	0.0
8.00	20.9	0.0	16.5	9.1	19.8	13.5	20.2	0.0
11.00	16.2	0.0	13.8	9.0	20.3	6.3	19.9	14.5
14.00	12.2	23.8	11.0	8.1	14.8	7.2	12.2	10.6
17.00	11.5	27.6	10.5	8.3	15.3	5.0	12.2	9.5
24.00	11.3	28.3	9.7	9.8	13.8	6.7	12.5	7.9

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	0.0	0.0	0.5	100.0
3.00	0.0	0.3	0.3	99.8
5.00	0.1	0.3	1.5	99.8
8.00	0.3	0.5	2.6	99.8
11.00	0.5	0.7	3.3	99.8
14.00	0.7	1.4	2.5	99.3
17.00	0.8	1.1	2.1	99.7
24.00	1.2	1.5	2.4	99.7

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

Table XVI (cont.)

Fischer-Tropsch Reaction Results

Expt. No. - Series 12, Run 1-A

Catalyst - Iron-Graphite (2.2 wt% Fe); Ventron Corp. "Graphimet" No. 89654; Evacuated for 16 hrs at 300°C prior to use.

Weight - 0.50 g (as graphite)

Reaction Temperature = 250°C
Initial H_2/CO Ratio = 2.00
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's	C_5^+
0.25	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1.00	40.4	0.0	26.8	0.0	32.9	0.0	0.0	0.0
2.00	26.9	0.0	29.0	9.4	34.6	0.0	0.0	0.0
3.00	14.8	0.0	18.6	7.1	24.2	4.8	14.4	16.0
4.00	11.1	23.2	14.9	5.8	17.7	5.8	10.3	11.3
6.00	10.8	29.2	13.3	6.8	17.7	5.8	9.7	6.6
8.00	12.0	28.0	12.1	7.6	16.5	4.2	10.8	8.7
12.00	14.5	29.6	9.7	9.2	15.9	4.2	9.6	7.3
13.50	14.7	30.2	8.9	9.7	15.1	4.6	9.6	7.2
16.26	15.8	29.8	7.7	10.2	14.1	5.1	10.2	6.9
22.25	20.4	29.1	6.1	10.9	12.8	5.2	9.7	5.7

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
0.25	0.0	- 0.9	1.3	100.9
1.00	0.1	- 1.2	3.2	101.3
2.00	0.2	- 1.1	3.7	101.2
3.00	0.5	- 0.8	14.5	101.3
4.00	0.7	- 0.9	10.7	101.7
6.00	1.2	0.0	8.9	101.1
8.00	1.7	0.9	10.8	100.8
12.00	2.6	2.0	10.2	100.6
13.50	3.1	2.9	13.5	100.2
16.26	3.8	3.6	11.4	100.3
22.25	5.3	5.7	10.7	99.6

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

Table XVI (cont.)

Fischer-Tropsch Reaction Results

Expt. No. - Series 15, Run 1-A

Catalyst - Iron-Graphite (2.2 wt% Fe); Ventron Corp. "Graphimet" No. 89654; Evacuated for 16 hrs at 300°C prior to use.

Weight - 0.50 g (as graphite)

Reaction Temperature = 275°C
Initial H_2/CO Ratio = 2.00
Initial Total Pressure = 750.1 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's	C_5^+
0.25	85.6	0.0	14.4	0.0	0.0	0.0	0.0	0.0
1.00	21.2	0.0	18.1	4.9	20.2	0.0	16.4	19.2
1.50	13.4	25.7	14.9	4.5	15.6	0.0	12.2	13.8
2.00	12.5	30.7	16.3	4.7	16.9	2.9	8.2	7.8
3.00	11.7	32.7	14.4	5.7	16.9	3.2	8.8	6.7
4.00	12.4	34.2	13.7	7.1	16.3	2.7	7.9	5.8
5.00	13.5	33.0	12.1	8.2	16.0	2.9	8.4	6.0
6.00	14.7	33.6	10.8	8.9	14.8	2.9	8.8	5.4
7.00	16.0	34.3	10.0	9.6	14.2	3.2	7.9	4.8

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	- 1.0	4.9	101.1
1.00	0.5	- 0.6	26.0	101.0
1.50	0.8	0.2	28.7	100.7
2.00	1.0	0.3	15.6	100.7
3.00	1.7	1.2	30.9	100.5
4.00	2.3	2.1	25.7	100.2
5.00	3.1	2.6	32.9	100.4
6.00	3.8	3.6	31.6	100.2
7.00	4.4	3.7	27.0	100.7

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

Table XVI (cont.)

Fischer-Tropsch Reaction Results

Expt. No. - Series 11, Run 1-A

Catalyst - Iron-Graphite (2.2 wt% Fe); Ventron Corp. "Graphimet" No. 89654; Evacuated for 16 hrs at 300°C prior to use.

Weight - 0.50 g (as graphite)

Reaction Temperature = 300°C
Initial H_2/CO Ratio = 2.00
Initial Total Pressure = 750.1 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's	C_5^+
0.50	13.1	31.1	19.3	3.3	17.4	0.0	7.9	7.8
0.75	11.3	31.0	18.2	3.5	17.6	3.8	9.6	5.0
1.00	10.9	34.0	17.5	3.7	17.1	2.3	7.8	6.7
1.30	10.8	36.5	17.1	4.9	16.9	2.1	6.5	5.2
2.00	10.8	36.1	16.0	5.9	16.8	2.0	7.0	5.3
2.50	11.3	37.1	15.5	6.6	16.0	1.9	7.0	4.7
3.00	11.6	38.5	14.3	7.4	15.5	2.0	6.7	4.0
3.50	12.0	38.2	13.5	8.1	15.5	2.2	6.9	3.7
4.00	12.4	38.8	12.7	8.7	15.0	2.2	6.4	3.7
5.00	13.2	38.8	11.2	9.6	14.5	2.2	6.6	3.9
6.00	14.0	38.9	10.1	10.4	14.2	2.9	6.0	3.5

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	0.5	- 0.4	71.9	100.9
0.75	0.9	0.1	65.1	100.8
1.00	1.2	0.4	55.6	100.8
1.30	1.8	1.3	80.6	100.5
2.00	2.5	1.5	41.8	101.0
2.50	3.0	2.3	48.4	100.8
3.00	3.6	2.9	50.9	100.7
3.50	4.2	3.4	49.7	100.8
4.00	4.7	4.4	42.8	100.3
5.00	5.9	5.1	49.0	100.7
6.00	6.8	6.5	41.6	100.3

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

Table XVI (cont.)

Fischer-Tropsch Reaction Results

Expt. No. - Series 16, Run 1-A

Catalyst - Iron-Graphite (2.2 wt% Fe); Ventron Corp. "Graphimet" No. 89654; Evacuated for 16 hrs at 300°C prior to use.

Weight - 0.50 g (as graphite)

Reaction Temperature = 325°C
Initial H_2/CO Ratio = 2.00
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's	C_5^+
0.50	16.2	26.2	18.3	2.8	17.3	0.0	11.1	8.1
0.75	14.6	32.7	19.1	2.9	16.3	0.0	7.9	6.5
1.00	12.8	33.4	18.0	3.1	16.6	1.3	8.5	6.4
1.50	12.2	38.1	17.5	4.0	16.0	1.4	6.7	4.1
2.00	12.2	39.2	16.6	5.0	15.6	1.2	6.1	4.1
2.50	12.3	40.2	15.4	5.8	15.4	1.6	6.2	3.2
3.00	12.7	40.4	14.5	6.5	14.9	1.5	5.9	3.6
4.00	13.4	41.0	13.0	7.4	14.3	1.6	5.9	3.2
5.00	14.1	42.1	12.2	8.0	13.8	1.5	5.3	2.9

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
0.50	0.8	0.4	80.5	100.3
0.75	1.2	1.4	79.0	99.8
1.00	1.9	2.0	118.5	99.9
1.50	2.9	3.0	81.6	99.9
2.00	3.9	4.2	88.9	99.8
2.50	4.9	5.3	83.9	99.5
3.00	5.8	6.2	74.4	99.6
4.00	7.3	7.7	66.4	99.6
5.00	8.4	8.8	45.8	99.5

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

Table XVII

Fischer-Tropsch Reaction Results

Expt. No. - Series 17, Run 1-A

Catalyst - Iron-Graphite (2.2 wt% Fe); Ventron Corp. "Graphimet" No. 89654; Pretreated in hydrogen for 3 hrs at 300°C, then evacuated for 1 hr at 300°C prior to use.

Weight - 0.50 g (as graphite)

Reaction Temperature = 225°C
Initial H_2/CO Ratio = 2.00
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's	C_5^+
1.00	12.6	0.0	16.5	5.6	26.7	0.0	16.8	21.8
2.00	10.7	20.4	14.1	5.1	18.6	5.0	12.8	13.3
4.00	9.7	28.4	11.7	6.4	18.3	3.2	12.5	9.8
6.00	9.5	26.2	9.9	7.0	17.7	4.6	14.0	11.3
8.00	9.9	28.2	9.4	8.3	15.8	4.0	14.6	9.9
10.00	10.5	28.4	8.4	8.6	16.7	4.4	12.8	10.1

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		
1.00	0.4	0.0	21.9	100.4
2.00	0.7	0.6	13.4	100.1
4.00	1.3	0.9	13.4	100.4
6.00	2.0	1.7	15.0	100.3
8.00	2.5	2.9	10.1	99.6
10.00	2.9	3.9	10.4	99.1

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

Table XVII (cont.)

Fischer-Tropsch Reaction Results

Expt. No. - Series 19, Run 1-A

Catalyst - Iron-Graphite (2.2 wt% Fe); Ventron Corp. "Graphimet" No. 89654; Pretreated in hydrogen for 3 hrs at 300°C, then evacuated for 1 hr at 300°C prior to use.

Weight - 0.50 g (as graphite)

Reaction Temperature = 250°C
Initial H_2/CO Ratio = 2.00
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's	C_5^+
0.50	7.9	24.7	14.5	3.6	17.7	3.7	16.0	11.8
1.00	7.3	28.8	12.2	4.5	18.3	4.7	13.6	10.7
1.25	7.3	31.7	12.0	5.6	18.5	3.5	12.4	9.1
2.00	8.1	31.8	10.3	7.8	17.7	3.4	12.3	8.6
4.00	9.5	31.4	6.8	10.0	15.8	5.1	12.8	8.6
6.00	12.2	32.2	5.1	11.7	15.1	6.6	9.8	7.5
8.00	14.1	30.7	4.0	11.8	13.2	6.6	11.8	7.7
9.50	16.1	30.5	3.4	11.4	12.3	7.3	11.3	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		
0.50	0.9	0.5	80.1	100.4
1.00	1.9	1.9	80.2	99.9
1.25	2.1	2.3	40.8	99.8
2.00	3.1	3.5	59.3	99.6
4.00	6.3	7.4	68.7	98.9
6.00	8.7	10.1	52.0	98.6
8.00	11.9	13.9	68.7	98.0
9.50	13.5	15.9	48.2	97.6

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

Table XVII (cont.)

Fischer-Tropsch Reaction Results

Expt. No. - Series 21, Run 1-A

Catalyst - Iron-Graphite (2.2 wt% Fe); Ventron Corp. "Graphimet" No. 89654; Pretreated in hydrogen for 3 hrs at 300°C, then evacuated for 1 hr at 300°C prior to use.

Weight - 0.50 g (as graphite)

Reaction Temperature = 275°C
Initial H_2/CO Ratio = 2.00
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's	C_5^+
0.25	7.1	38.1	13.3	2.5	14.8	2.2	12.6	9.4
0.50	8.2	30.6	13.4	4.0	18.8	3.3	12.3	9.4
1.00	9.9	33.2	11.1	6.4	16.9	2.5	11.7	8.4
2.00	15.8	33.1	7.3	8.7	15.0	3.2	10.1	6.7
3.00	16.0	33.9	5.9	9.7	14.0	4.0	10.3	6.3
4.00	17.9	33.5	4.9	10.1	13.1	4.5	9.6	6.3

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	1.4	1.1	240.7	100.3
0.50	2.6	2.5	211.6	100.1
1.00	4.9	5.4	196.9	99.5
2.00	9.0	10.2	178.6	98.8
3.00	12.4	14.0	145.2	98.4
4.00	15.2	17.2	121.9	98.0

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

Table XVII (cont.)

Fischer-Tropsch Reaction Results

Expt. No. - Series 18, Run 1-A

Catalyst - Iron-Graphite (2.2 wt% Fe); Ventron Corp. "Graphimet" No. 89654; Pretreated in hydrogen for 3 hrs at 300°C, then evacuated for 1 hr at 300°C prior to use.

Weight - 0.50 g (as graphite)

Reaction Temperature = 300°C
Initial H_2/CO Ratio = 2.00
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's	C_5^+
0.25	6.3	34.4	17.9	3.1	19.6	0.0	10.1	8.6
0.50	7.4	35.9	15.8	4.6	17.9	1.6	10.3	6.5
0.75	8.8	36.5	13.9	5.7	17.2	2.0	10.0	6.0
1.00	10.1	37.4	12.8	6.6	16.6	2.0	9.0	5.5
1.50	12.1	38.5	11.0	7.7	15.9	2.3	7.9	4.7
2.00	13.7	38.7	9.9	8.3	14.9	2.5	7.8	4.3
3.00	16.7	38.3	8.7	8.8	13.8	2.7	7.3	3.8
4.00	18.8	37.7	8.0	9.0	12.8	2.6	7.2	3.9

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		
0.25	2.1	1.5	360.0	100.6
0.50	4.1	3.7	355.0	100.5
0.75	5.9	5.4	311.4	100.5
1.00	7.3	7.1	231.3	99.9
1.50	9.5	9.7	192.2	99.7
2.00	11.3	11.6	153.5	99.7
3.00	13.8	13.7	108.0	100.1
4.00	15.7	15.5	81.3	100.2

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

Table XVII (cont.)

Fischer-Tropsch Reaction Results

Expt. No. - Series 20, Run 1-A

Catalyst - Iron-Graphite (2.2 wt% Fe); Ventron Corp. "Graphimet" No. 89654; Pretreated in hydrogen for 3 hrs at 300°C, then evacuated for 1 hr at 300°C prior to use.

Weight - 0.50 g (as graphite)

Reaction Temperature = 325°C
Initial H_2/CO Ratio = 2.00
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's	C_5^+
0.25	4.0	33.8	21.5	2.1	21.5	0.0	10.0	7.0
0.50	7.9	34.1	19.2	2.8	18.5	0.9	8.8	7.8
0.75	8.6	34.9	18.0	3.2	18.0	1.4	8.9	6.9
1.00	9.5	36.7	18.1	4.0	17.7	1.3	8.2	4.6
1.50	10.4	37.4	17.0	4.5	16.7	1.4	7.5	5.1
2.00	11.3	38.2	16.5	4.8	16.0	1.3	7.2	4.6
3.00	12.6	38.4	15.8	5.2	15.5	1.5	6.8	4.2
4.00	13.2	37.3	15.8	5.6	15.4	1.4	7.1	4.3

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	1.5	2.1	263.7	99.5
0.50	3.4	3.8	329.9	99.6
0.75	4.9	5.4	260.6	99.6
1.00	5.7	6.3	139.8	99.4
1.50	7.5	8.3	154.2	99.2
2.00	8.6	9.6	96.4	99.0
3.00	10.4	11.7	75.3	98.7
4.00	12.1	14.0	65.0	98.7

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

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