SLURRY FISCHER-TROPSCH/MOBIL TWO-STAGE PROCESS OF CONVERTING SYNGAS TO HIGH-OCTANE GASOLINE. QUARTERLY REPORT, 1 OCTOBER-31 DECEMBER 1982

MOBIL RESEARCH AND DEVELOPMENT CORP.
PAULSBORO, NJ

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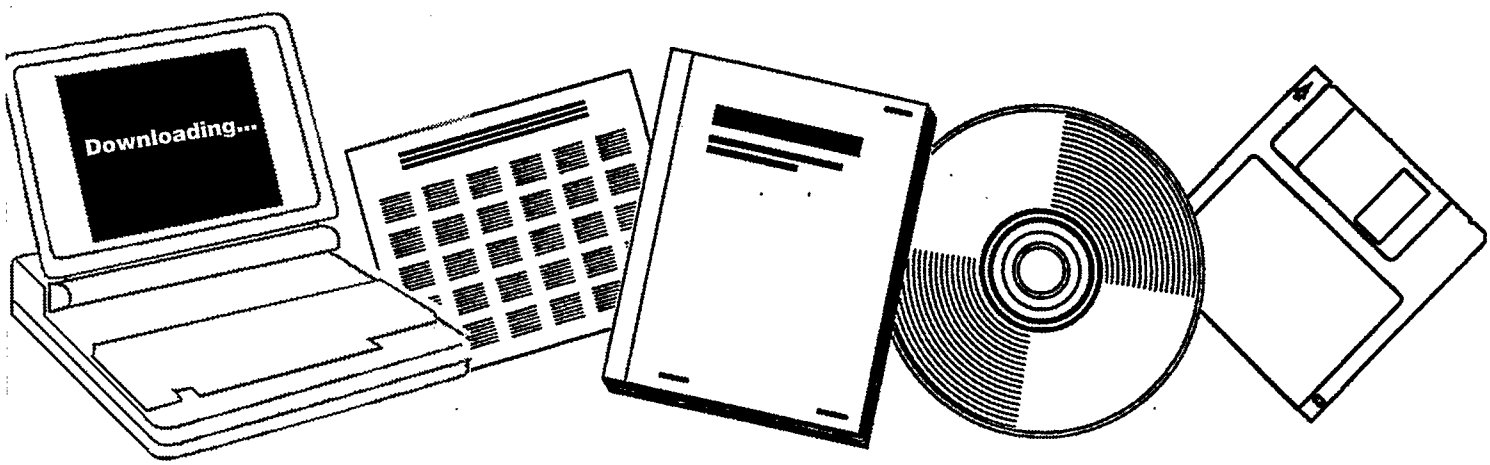

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QUARTERLY REPORT FOR THE PERIOD
1 OCTOBER - 31 DECEMBER, 1982

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I. Abstract

Long-term stability of a $Fe/Cu/K_2CO_3$ Fischer-Tropsch catalyst, designated as I-B, was successfully established using the two-stage bench-scale pilot plant. Eighty-six days on stream operation with high gas throughput and conversion have been demonstrated. A total hydrocarbon production of 815 g/g-Fe was obtained. This is substantially greater than the productions reported in the literature. Process variable studies were carried out during the latter part of the run including pressure, superficial feed-gas velocity, feed H_2/CO ratio, and addition of a potassium-salt. Low H_2/CO feed gas (0.6 instead of 0.7), which resulted in better usage of the synthesis gas, was used for twenty-eight days. Higher operation pressure (2.5 MPa instead of 1.48 MPa), resulting in even higher gas throughput, was carried out for twenty-one days. No substantial change in the Fischer-Tropsch catalyst aging rate during these studies was observed. The addition of a potassium-salt resulted in an immediate reduction of methane + ethane yield. A second-stage ZSM-5 catalyst (II-B) has accumulated two regenerations and a total on-stream time of eighty-seven days. No apparent loss of activity was observed after regeneration.

The two-stage bench-scale pilot plant was modified to include devices for improving separation of the reactor-wax (heavy hydrocarbons retained in the slurry reactor under the operating conditions) and the Fischer-Tropsch catalyst. These devices are ready for testing.

Detailed analytical procedures and supporting tests for analyzing the hydrogen, the carbon monoxide, the feed-gas, the first-stage Fischer-Tropsch products, and the second-stage ZSM-5 products are summarized. Due to the wide distribution and diversity of the Fischer-Tropsch products, comprehensive analytical schemes were developed with great effort.

Gasoline stability tests for gum formation and oxidation showed that existent (heptane washed) gum contents were all within acceptable limits for conventional gasoline, as were the oxidation stabilities indicated by the induction period method. However, total residues on evaporation (unwashed gum) were generally high, probably due to the presence of a small amount of high-boiling, heptane-soluble hydrocarbons.

II. Objective and Scope of the Project

The overall objective of the contract is to develop a two-stage slurry Fischer-Tropsch/ZSM-5 process for direct conversion of synthesis gas, of the type produced in a coal gasification system, to high octane gasoline. The specific objective is to design, construct, and operate a bench-scale pilot plant so that the economic potential of this process concept can be evaluated. To accomplish these objectives, the following specific tasks will be undertaken:

Task 1 - Design of Bench-Scale Pilot Plant

A two-stage slurry F-T/ZSM-5 bench-scale pilot plant will be designed for conversion of synthesis gas to high octane gasoline. The slurry F-T reactor will be 5.1 cm diameter and 762 cm high. The fixed-bed ZSM-5 reactor will be 5.1 cm diameter and 10-46 cm high. A distillation column will be designed to obtain stabilized gasoline products.

Task 2 - Construction and Shakedown of Pilot Plant

The pilot plant will be constructed in MRDC Paulsboro Laboratory. The unit will be shaken down when completed.

Task 3 - Operation of Pilot Plant

At least three slurry F-T catalysts will be tested in the bench-scale pilot plant. One of these catalysts may be provided by DOE's alternate catalyst development projects. The best first-stage catalyst together with a ZSM-5 class zeolite catalyst will be used for process variable studies and catalyst aging tests in the bench-scale unit. Products obtained from the unit will be evaluated to define their qualities.

Task 4 - Conceptual Design Study

A preliminary conceptual design of the process will be developed for a commercial size plant for the conversion of synthesis gas to high octane gasoline. Scoping costs of the plant will be estimated.

III. Summary of Progress to Date

The third run of the two-stage bench-scale pilot plant, designed as Run CT-256-3, was concluded after eighty-six days on stream. The highlights of the run were:

- The evaluation of the second Fischer-Tropsch catalyst, a $Fe/Cu/K_2CO_3$ catalyst designated as I-B, was completed. The catalyst showed excellent stability and high production of hydrocarbons (815 g/gFe).

- The ranges of the operating conditions for the first-stage slurry Fischer-Tropsch reactor were:

Temperature, °C	259-267
Pressure, MPa	1.13-2.51
H_2/CO Feed Ratio, Molar	0.6-1.0
Superficial Feed-Gas Velocity, cm/s	1.2-4.4
Space Velocity, NL/gFe-hr	1.3-3.4
Catalyst Loading, wt % (nominal)	11-20

  The H_2 + CO conversion ranged from 54 to 93 mol % and the methane + ethane yield from 6 to 18 wt % of the total hydrocarbons produced.

- The second-stage ZSM-5 catalyst (II-B) has accumulated two regenerations and a total on-stream time of eighty-seven days. No apparent loss of activity was observed after each regeneration. The ranges of the operating conditions for the second-stage reactor during this run were:

Temperature, Inlet, °C	288-466
GHSV, l/hr	1,350-4,580

  An average of 3.3 °C/day increase on the inlet temperature was used to maintain a constant operating severity. Maximum gasoline yield was obtained at an operating severity index, expressed as the molar ratio of $i\text{-}C_4/(C_3^{=}+C_4^{=})$ in the product, of 0.5-1.0. Peak research octane numbers of 90-94 were achieved at severity indexes of 0.3-2.0.

- During a major interruption in Fischer-Tropsch synthesis operation, the Fischer-Tropsch catalyst slurry was unloaded and then reloaded into the slurry reactor. Substantial deterioration of the catalyst activity and substantial increase in methane + ethane yield were observed, probably due to catalyst damage incurred when it was exposed to air.

- The Fischer-Tropsch reactor-wax yield increased significantly with decreasing methane + ethane yield.

- Process variable studies were conducted during the latter part of the run. The results are:

  - Use of 0.6 H_2/CO feed ratio synthesis gas instead of 0.7 lowered the methane + ethane yield. It also gave better usage of the synthesis gas since the H_2/CO usage ratio was nearly 0.6

  - Higher operating pressure at the same superficial feed-gas velocity in the slurry reactor resulted in slightly lower H_2/CO conversion, but a significantly lower methane + ethane yield. It also increased the oxygenate yield significantly.

  - Addition of a potassium-salt to the slurry reactor drastically decreased the methane + ethane yield.

- A "hydrodynamic upset" of the slurry reactor was observed at the end of the run, probably due to catalyst settling. This resulted in low H_2+CO conversion and lower temperature at the upper portion of the reactor. The upset disappeared after eight hours of high gas velocity operation, but reappeared after the velocity was reduced. Low velocity operation of the slurry reactor may not be desirable.

After the end of Run CT-256-3, the two-stage bench-scale pilot plant was shut down for modifications. The major modification was addition of two external filter assemblies to withdraw reactor-wax from the first-stage slurry reactor. Other modifications included installation and replacement of many filter elements, installation of pressure transducers and heating tape, and replacement of the flange gaskets for the first-stage reactor.

Analytical procedures and supporting tests for the current pilot plant operation are summarized. The streams that required analysis include carbon monoxide, hydrogen, the combined feed gas, the first-stage Fischer-Tropsch products (gaseous, aqueous, liquid hydrocarbon, and reactor-wax phases), and the second-stage ZSM-5 products (gaseous, aqueous, and liquid hydrocarbon phases). The gaseous streams are analyzed on-line using a Mobil-developed automated gas chromatographic (GC) system. The non-acid and acid oxygenates in the Fischer-Tropsch aqueous phase are determined by fused silica capillary column GC (FS-GC) and ion chromatography, respectively. Oxygenates in the

Fischer-Tropsch liquid hydrocarbon phase are determined using GC analysis. The Fischer-Tropsch liquid hydrocarbon phase is analyzed using various GC and liquid chromatography (LC) techniques, while its carbon number distribution is routinely obtained using an FS-GC capillary column. More detailed analysis of the Fischer-Tropsch liquid hydrocarbon is performed on selected cases using distillation, oxygenate separation, and a GC equipped with an olefin scrubber and flame ionization detectors. The analysis of Fischer-Tropsch reactor-wax is done using FS-GC, LC, and solvent extraction. The second-stage liquid hydrocarbon product is analyzed using a GC system and an olefin scrubber. Various supporting tests are also employed, including acid number, bromine number, hydroxyl number, simulated distillation, kinematic viscosity, surface tension, vacuum distillation, and octane numbers.

Gasoline stability tests for gum formation and oxidation showed that existent (heptane washed) gum contents were all within acceptable limits, as were the oxidation stabilities. However, total residues on evaporation (unwashed gum) were generally high, probably due to the presence of a small amount of high-boiling, heptane-soluble hydrocarbons.

The task on "Conceptual Design Study" has been initiated. The process design basis was constructed and the conceptual design work is in progress.

IV. Detailed Description of Technical Progress

A. Task 3 - Operation of the Pilot Plant

1. Run CT-256-3 - Conclusion

The third BSU run, designated as Run CT-256-3, using Catalyst I-B (containing $Fe/Cu/K_2CO_3$) in the first-stage bubble-column F-T reactor and Catalyst II-B (a ZSM-5 class catalyst) in a second-stage fixed-bed reactor, was smoothly started up on July 27, 1982. The major objectives of the runs were to evaluate the performance of the F-T catalyst I-B over an extended period of time and then to perform process variable studies.

Major highlights from this run were:

- Smooth operation of the slurry F-T reactor with high catalyst loading (19.5 wt % initially), high synthesis gas throughput, and high conversion, was demonstrated over a period of eighty-six days.

  The ranges of the first-stage slurry F-T reactor operating conditions and performance were:

H_2+CO flow rate, Nm^3/hr	1.0-2.6
Temperature, °C	259-267
Pressure, MPa	1.13-2.51
H_2/CO feed molar ratio	0.6-1.0
Superficial feed-gas velocity, cm/s	1.2-4.4
Space velocity, NL/gFe-hr	1.3-3.4
Catalyst Loading, wt % (nominal)	11-20
H_2+CO conversion, mol %	54-93
Methane + ethane yield, wt % HC	6-18
Hydrocarbon production, gHC/gFe	815

- The Catalyst I-B is an excellent catalyst from a stability point of view.

- The ranges of the second-stage fixed-bed reactor operating conditions were:

Temperature inlet, °C	288-466
GHSV, l/hr	1,350-4,580

  This catalyst performed satisfactorily in converting the first-stage F-T products into high octane gasoline.

- There were two small and one large interruption in the Fischer-Tropsch synthesis operation. A slight loss in Fischer-Tropsch catalyst activity and a slight increase in methane yield were observed during the small interruptions. The major interruption took place at sixty-one DOS due to a leak at the bottom flange of the slurry reactor. The slurry was unloaded and reloaded into the reactor after a new gasket was installed. Substantial deterioration of the catalyst activity and substantial increase in the methane + ethane yield were observed. The F-T catalyst seems to be very sensitive to exposure to the air.

- The reactor-wax yield increased significantly with decreasing methane + ethane yield.

- A H_2/CO feed ratio of 0.6 (instead of 0.7) was used for twenty-six days with no significant effect on the F-T catalyst stability. Lower methane + ethane yield was observed during this time. The H_2/CO usage ratio is very close to 0.6 as indicated by the fact the exit H_2/CO ratio remained at nearly 0.6 over a wide range of conversion. The usage of the synthesis gas is better at 0.6 feed-gas H_2/CO ratio.

- Higher operating pressure with constant superficial feed-gas velocity in the slurry F-T reactor resulted in a slightly lower H_2+CO conversion, but a significant decrease in methane + ethane yield (from 11 wt % to 9% when pressure increased from 1.48 MPa to 2.51 MPa). The oxygenate yield also increased significantly over the same pressure range.

- Addition of a potassium-salt to the slurry reactor drastically decreased the methane + ethane yield from 13 wt % to 8% with little change on synthesis gas conversion. Unfortunately, no conclusions on catalyst stability could be drawn.

- The gas holdup data in the slurry bubble-column were estimated using a system of DP-cell legs. There was no significant change of gas holdup profiles in the first seventy-five DOS. Catalyst concentration profiles along the bubble-column were also measured and found to follow profiles predicted by a published mathematical model on slurry settling.

- A "hydrodynamic upset" of the slurry reactor occurred at eighty-two DOS, probably due to catalyst settling, resulting in a low H_2+CO conversion and a 5°C lower temperature at the upper portion of the reactor. The

upset disappeared after eight hours of high gas velocity operation, but reappeared after the velocity was lowered.

- o A second-stage ZSM-5 reactor operating severity index, expressed as the $i\text{-}C_4/(C_3^= + C_4^=)$ molar ratio in the product, of 0.5-1.0 gave maximum gasoline yield. Higher pressure operation had no significant effect on the second-stage operation and yield. Peak research octane numbers of 90-94 were obtained for the raw gasoline at severity indexes of 0.3-2.0.

a. First-Stage Fischer-Tropsch Reactor Operation

The last Quarterly Report (July-September, 1982) contained details of the start-up and pretreatment of the third BSU run, designated as Run CT-256-3. These will not be repeated here. A brief discussion of the synthesis operation was also given. A detailed description and discussion of the entire run is given here. The run lasted eighty-six days and was very successful, providing high conversion at high synthesis gas throughput for a long period of time, as well as a great deal of new information on slurry F-T reactor performance. The F-T catalyst used in this run was Catalyst I-B, the same $Fe/Cu/K_2CO_3$ catalyst used in run CT-256-2.

Immediately after the catalyst pretreatment, at which point the carbon monoxide conversion had reached 82%, the slurry reactor temperature was lowered to 260°C in steps of 3°C over a thirty-seven hour period. With each drop in temperature, the conversion first declined, then gradually increased back to the original conversion level. This policy of temperature reduction kept the conversion high during this transition period. The pressure was increased to 1.48 MPa at this time, establishing the conditions which were used for the majority of the run. This brought the carbon monoxide conversion to about 90%, which was one of the objectives of the run. Other priorities were long-term stability and process variable studies. These were done, including operating at 2.52 MPa (350 psig) and also using a H_2/CO molar feed ratio of 0.6 for extended periods.

Figure 1 shows the conversion and methane + ethane selectivities, as well as the temperature pressure, and superficial gas velocity for the entire run. The range of synthesis conditions and performance of the first stage F-T reactor were:

H_2 + CO flow rate, Nm^3/hr	1.0-2.6
H_2/CO feed ratio, molar	0.6-1.0
Superficial feed-gas vel., cm/s	1.2-4.4
Space velocity, NL/gFe-hr	1.3-3.4

Temperature, °C	259-267
Pressure, MPa	1.13-2.51
H_2 + CO conversion, mol %	54-93
Methane + Ethane yield, wt %	6-18

The run can be roughly divided into two parts. In the first part, a long-term aging study on the Catalyst I-B was carried out. After the long-term stability of the synthesis operation was well established, a period of process variable studies was commenced at sixty-one days on-stream. The process variables examined included:

- Superficial feed-gas velocity
- Reactor pressure
- Feed H_2/CO ratio
- Addition of a potassium-salt

The range of synthesis conditions mentioned above includes the period of process variable studies.

The synthesis operation was interrupted three times during the run. The first interruption was due to a false alarm and lasted nine hours, during which time the unit was purged with nitrogen. The second interruption was caused by a small slurry leak at the 305 cm flange. Tightening the flange stopped the leak, and synthesis gas flow was restored after thirty-six hours. Both of these interruptions caused a slight decrease in conversion and a corresponding increase in methane + ethane selectivity. This type of behavior has been observed before. The third interruption was another slurry leak, this time at the bottom flange. The leak could not be stopped by merely tightening the flange, so the slurry had to be removed while the gasket was replaced. The slurry was then reloaded after fifty hours and synthesis continued. The result was a substantial increase in the methane + ethane selectivity (from 13 to 19%) and a substantial decrease in H_2 + CO conversion (from 87 to 70%) which rose over a five-day period to 80%, aided by a 2°C temperature increase. It appears that exposure to air is detrimental to catalyst performance.

At eighty-one DOS, an amount of potassium-salt was added to the slurry reactor through the catalyst slurry loading pot in an effort to lower the methane + ethane yield. It is clear from Figure 1 that this did occur, the methane + ethane selectivity dropping from 13 to 8% with little change on synthesis gas conversion. Unfortunately, however, an unusual upset which occurred about twelve hours after the potassium-salt

addition negated any improvement that addition of the potassium-salt might have imparted to the H_2 + CO conversion. Addition of a potassium salt to a slurry F-T reactor has been reported by Koelbel and Ralek (1980) previously.

This "Hydrodynamic Upset" took place following a process-variable study, the variation of the superficial gas velocity. The velocity had been brought down as low as 1.1 cm/s for the study, after which it was reestablished at 2.6 cm/s. The potassium-salt was then added, and the conversion then dropped rapidly from over 80% to 55%, while the reactor temperature above the 305 cm level was 5°C lower than that below 305 cm. It was suspected that the catalyst had settled during the low-velocity operation. Therefore, at eighty-two DOS, the reactor pressure was dropped in stages to 1.48 MPa (200 psig) in order to increase the linear superficial gas velocity in the slurry reactor. This higher gas velocity reestablished uniform reactor temperature after three days. At that time, the synthesis gas conversion also rose to 78%. The superficial feed-gas velocity at this point was 4.2 cm/s. However, when the pressure was increased back to 2.51 MPa (350 psig) the next day, the temperature discrepancies returned with conversion slowly dropping back to the 55% level. It was this failure to reestablish the high conversion after this upset which caused the ending of run CT-256-3. The total hydrocarbon production for the run was 815 gHC/gFe, a significantly high figure.

Material balances were performed daily. Tables A-1 and A-2 summarize the operating conditions and results for this run. Detailed analytical breakdowns of the first-stage product were also performed. Table A-3 shows the composition of the hydrocarbon products produced by the Fischer-Tropsch catalyst for several balances. The oxygenated products were broken down separately and are displayed in Table A-4. In addition, the oxygenates contained in the aqueous phase were analyzed, as shown in Table A-5. The reactor-wax, which was removed by filtration, was broken down on the basis of carbon number. Table A-6 tabulates the results of these studies, while Figures 2 and 3 are graphical representations of some of these distributions. It is interestsing to note that between six and twenty-one DOS the distribution had reached a steady-state at 1.48 MPa reactor pressure with peak carbon numbers of 27-28 and similar average carbon numbers. The initial wax medium obviously contained some heavier components as indicated by a peak carbon number of 35 at six DOS. At higher reactor pressures (2.17 MPa and higher), however, slightly heavier hydrocarbons are retained in the slurry reactor as shown in Figure 3. The shift is small with a peak carbon number about 30-31 and an average carbon-numbers of about 28-29.

Reactor-wax was removed regularly to keep the level in the slurry reactor at 610-670 cm. By using DP-cell readings to determine the slurry inventory in the reactor at any given time, a cumulative reactor-wax production plot was constructed (Figure 4). This plot is very smooth up to sixty-one DOS as indicated by the least-squares-fitted curve included in Figure 4. The reactor-wax production rate at any given time was estimated using the corresponding slope of the curve at the given time. In this way, the reactor-wax yields as a percentage of the total hydrocarbon yield were calculated and included in Tables A-1 and A-2. The reactor-wax production data between sixty-one and seventy-four DOS were out-of-line because the major operational upset occurred at sixty-one DOS. During that time, the slurry was unloaded from and reloaded into the reactor. The reactor-wax yields up to sixty-one DOS are plotted against the methane + ethane selectivities in Figure 5. It is obvious from this plot that at lower methane + ethane yields, the reactor-wax yield increases significantly.

Inclusion of all hydrocarbons and oxygenates from a total material balance allows the construction of a Schultz-Flory type plot (Flory, 1967). One of these, from eleven DOS, is shown in Figure 6. There is a distinct change in the slope of the distribution from α (probability of chain growth) = 0.79 to 0.88 at carbon number twenty-two, coinciding approximately with the inclusion of the reactor-wax. This trend resembles that of a similar plot given for run CT-256-1 (see Figure 2 of April-June 1982 Quarterly Report). As explained earlier, this phenomena may be due to the fact that in a slurry system large molecules can re-entrain themselves onto active catalyst sites, allowing for further chain growth.

As mentioned earlier, process variable studies were carried out in the slurry reactor during the run. Variables studied included superficial gas velocity, pressure, feed H_2/CO ratio, and addition of a potassium-salt. The results of the first three studies wil now be presented.

As the superficial gas velocity is lowered, the residence time of the synthesis gas is increased, which should obviously lead to an increased synthesis gas conversion. Table 3 illustrates this point, showing three different space velocities and the results. It is seen that in addition to the conversion, the methane yield and the exit H_2/CO ratio show definite trends. The methane yield goes down slightly. At higher conversions more water is produced by the Fischer-Tropsch reaction, which in turn causes the water-gas shift reaction to produce more hydrogen. This results in a higher H_2/CO ratio in the exit gas.

In another study, the H_2/CO ratio in the feed gas was changed from 0.7 to 0.6 to observe its effect on slurry reactor performance. This was done at sixty-five DOS and continued until the end of the run. At the time of the switch, however, the catalyst was in the process of recovering from the third upset, which had occurred at sixty-one DOS. It has already been seen that following an upset such as this, the conversion is initially low, then climbs steadily to a point slightly lower than that before the upset. Similarly, the methane + ethane selectivity is initially high, but then declines gradually to a level somewhat above the previous one. This seems to correspond to a "reactivation" of the catalyst. Looking at Figure 1, this same trend is evident following the upset, but it appears that the methane + ethane selectivity declines to the same level it was before the upset. It is logical to conclude that the lower H_2/CO ratio in the feed enabled this to occur. By decreasing the amount of available hydrogen, the yields of hydrogen-rich components, such as methane and ethane, were decreased.

Also interesting is the effect of the feed H_2/CO ratio on the H_2/CO ratio in the exit gas shown in Figure 7. Data from the whole run are used to construct this plot. Consequently, they include wide ranges of operational variables and result in a large spread of the data. The lines shown on the figure are least-squares-fitted lines. Here it is seen that a feed ratio of 0.6 causes the exit ratio to remain at nearly that same ratio over a wide range of conversions. At 0.7 H_2/CO feed ratio, however, an excess of hydrogen appears at all times, particularly at the higher conversions. This figure indicates that the H_2/CO usage ratio is very close to 0.6. When a feed H_2/CO ratio higher than the usage ratio is used, the excess hydrogen is reflected as higher H_2/CO in the exit gas. The exit H_2/CO ratio increases with increasing synthesis gas conversion because the water-gas shift reaction favors the formation of hydrogen according to thermodynamic equilibrium. It appears, then, that there are distinct advantages to operate the synthesis at a feed H_2/CO ratio close to the usage ratio, i.e., lower methane + ethane yield and better usage of the synthesis gas. However, the long-term effects on catalyst aging have yet to be determined. Also, most of the 0.6 H_2/CO data were taken when the operating pressure was higher than it was for the 0.7 data, so further study is needed.

Pressure effects were studied at a feed H_2/CO ratio of 0.6 and a temperature of 267°C. As the pressure was changed, the synthesis gas flow rate was altered so that the same superficial feed-gas velocity was maintained, i.e., 2.6 cm/s. Table 4 shows the results of this process variable study. The pressure was varied from 1.48 to 2.51 MPa (200 to 350 psig) over an eight-day period. It is seen that the methane and ethane yields decrease as the pressure is raised. This is due to the higher probability

of the chain-growth under higher pressure. The effect on synthesis gas conversion, though, is less clear. The conversion drops slightly with increasing pressure although the superficial feed-gas velocity is maintained constant. The 2% drop in conversion between 2.17 and 2.51 MPa may be mainly due to experimental data scattering. However, the space velocities were greatly increased due to higher pressure operation. This increase in the space velocity is more than sufficient to compensate for the slightly lower conversion at the same feed-gas velocity. Of course, the other major advantage is the significant drop in the methane yield.

The effect of pressure on the yield of oxygenated products was also noted, as shown in Table 5. This shows that as the pressure is increased, so is the oxygenate yield. The magnitude of the increase is not clear from this table, however, because the other process variables were also changed (H_2/CO ratio, superficial velocity, and temperature).

Also studied during this run was the gas holdup in the slurry reactor. This was done by using a system of DP-cell legs spaced along the bubble-column reactor. (See April-June 1981 Quarterly Report for details on this setup.) This resulted in estimated holdups for sections of the column between any two legs. Table 6 summarizes overall gas holdups taken from different times on-stream. It can be seen from this table that the holdup did not change very much over the first seventy-five days on-stream. However, the data from seventy-nine to eighty-one DOS show a hysteresis effect of the gas holdup. That is, once the velocity was dropped to 1.1 cm/s, the gas holdup did not respond instantly with raising the velocity. This may have been due to catalyst settling at the low velocity as described earlier, and difficulty in re-entraining the catalyst at the higher velocity. Figure 8 illustrates the typical gas holdup profiles along the bubble-column reactor. This profile is similar to that reported by Langemann and Koelbel (1967) in cold-flow bubble-columns.

The gas holdup near the top of the column is high, due to the fact that the bubbles have to disengage from the slurry, i.e., an end effect. At the bottom of the column there is a short zone where the gas holdup changes dynamically with distance. This arises from the bubble dispersion, formation, and coalescence. After that the holdup decreases, probably due to the fact that the gas volume contracts as the reaction proceeds. Two separate profiles show that the gas holdup is similar at the beginning and the end of the run, with absolute differences due to the change in the gas velocity.

Finally, catalyst concentration profiles were obtained by taking slurry samples from several fixed locations of the bubble-column reactor and then by burning off the wax from the samples. The solids concentration was then plotted in semi-log fashion in Figure 9 for different days on-stream, corresponding to different gas velocities. The straight lines shown by this plot indicates that the trend of the catalyst concentration profile follows very well with the established solid settling mathematical model in bubble-columns (Kato, et al., 1982). Highlights of this figure are:

- Increased velocity decreases the catalyst settling, so a flatter profile is achieved.
- The profile is steeper during the hydrodynamics upset at eighty-two DOS, indicating increased catalyst settling. The profile after the upset is slightly flatter.

Unfortunately, no meaningful catalyst concentration profile data were available between ten and eighty-two DOS. It also is not clear if the larger concentration profile at the end of the run could be completely attributed to lower gas velocity.

b. Second-Stage Fixed-Bed ZSM-5 Reactor Operation

In the last Quarterly Report, it was reported that a second-stage reactor, containing 215 g of II-B ZSM-5 catalyst, was brought on-stream one hour after the end of the F-T catalyst pretreatment. The material balances performed over the sixty-seven days of second-stage operation are summarized in Table A-7 of Appendix A. The properties of the raw liquid hydrocarbons collected from the ambient and chilled condensers are reported in Table A-8, while Table A-9 gives the detailed product hydrocarbon compositions.

Also, as mentioned in previous Quarterly Reports, the severity of the second-stage operation was guided by the $i\text{-}C_4/(C_3^{=}+C_4^{=})$ molar ratio (the severity index) in the combined gas stream after the second-stage reactor. To achieve a severity index of 0.8-1.0, the initial inlet temperature of the second-stage reactor was set to 343°C in continuation of a cycle started in run CT-256-2 (see July-September, 1982 Quarterly Report). In the current run, the catalyst was regenerated twice with no apparent loss of activity. During the twenty-five day second cycle and the unfinished thirty-two day third cycle operation, the second-stage inlet temperature had to be increased at about 3.3 °C/day to maintain the target severity. The fixed-bed inlet temperature and the temperature rise across the catalyst bed are reported in Figure 10.

Figure 11 shows the effect of second-stage operating severity index on the hydrocarbon yield. As in the July-September, 1982 Quarterly Report, the alkylate yield is estimated by alkylating first butenes and then propylene with i-butanes. If there is an excess of light olefins, they are converted to "Cat-Poly gasoline" using conventional catalytic polymerization process. In making this plot the product yields are renormalized after excluding the components that either bypass or are nonreactive to the ZSM-5 catalyst, i.e., reactor-wax and C_4^- paraffins. Peak C_5^+ gasoline yields of 85-90 wt % could be achieved when a severity index was maintained at 0.5-1. High pressure operation (2.51 MPa versus 1.48 MPa) had no significant effect on the second-stage operation and yield.

Figure 12 shows the Research Octane Number, and the aromatic and olefin content of the raw liquid hydrocarbon product collected in the cold and chilled condenser of the pilot plant, as a function of the second-stage operating severity index. Peak octane number of 90-94 is obtained for severity indexes of 0.3-2.0. The corresponding aromatics content is 30-50 wt % and olefins content is 5-25 wt %. Too high aromatics content is equivalent to high severity or reduced gasoline yield. Too low aromatics content, however, also results in a low gasoline yield. Hence, optimal gasoline yield is restricted to a severity index of 0.5-1.0. Motor octane number for the raw liquid hydrocarbon products are summarized in Table A-8.

Another indication of the second-stage catalyst performance is the acid number of the raw liquid hydrocarbon products, also reported in Table A-8. Acid numbers of 0.04-0.4 show the ability of the ZSM-5 catalyst to convert organic acids. For comparison, first-stage F-T liquid hydrocarbon products have acid number of 1.1-3.0. Finally, the ASTM distillation properties of the raw hydrocarbon products did not vary much with catalyst aging or changing operating severity.

2. Bench-Scale Unit Modifications

After the end of the third run the BSU was shut down for modifications. The major modification was addition of two external filter assemblies to withdraw reactor-wax from the first-stage reactor. The assemblies were installed to withdraw wax from 157 and 762 cm above the distributor.

A schematic of the external filter assembly is shown in Figure 13. The slurry from the reactor is brought into the filter vessel, maintained at 204-260°C, via valve V-1. The catalyst settling in the vessel is prevented by continuous

agitation provided by the stirrer. The slurry can be purged with hydrogen to remove dissolved carbon monoxide, carbon dioxide, and water from the slurry. The filtered reactor-wax can be collected in the wax receiver maintained at a certain pressure depending upon the differential pressure desired across the filter. The concentrated slurry deposited in the filter vessel can be frequently flushed back into the reactor by pressuring the filter vessel through the wax receiver. If necessary, the filter vessel and filter surface can be flushed with hot solvent using the solvent pot and the contents can then be pushed back into the reactor. The size of the filter is 1.59 cm OD x 12 cm long with ten micron pore size filter element.

A trial operation of the filter assembly was, however, unsuccessful. The reactor-wax withdrawal rate was lower than expected and the filter element got plugged after withdrawing about 200 g of reactor-wax. The solvent cleaning of the filter or the filter blowback did not significantly improve the operation. The filter vessel was then modified to carry out separation of the catalyst from the slurry by catalyst settling and was very successful. This method will be described in full details in the next Quarterly Report.

Other minor modifications included:

1. The ten micron filter element at 305 cm level of the first-stage reactor was replaced with a new element. The older element was in use for 106 days (Runs CT-256-2 and -3).

2. Another identical filter (ten micron, 1.59 cm OD x 30.5 cm long) was installed inside the slurry reactor at 762 cm level to provide additional wax withdrawal capability.

3. The two micron filter (1.25 cm OD x 12.7 cm long), inserted into the slurry reactor from the side tube at 458 cm level, was replaced with a five micron filter to improve the filtration rate.

4. A new ten micron filter (1.25 cm OD x 12.7 cm long) was inserted into the slurry reactor from the side tube at 610 cm level.

5. All gaskets between flanges of the first-stage reactor were replaced with new "Graphoil"[1] (0.3175 cm thick) gaskets. The old gaskets were made of "Bimetallic" [1] material and were found to split and leak during a run.

[1]A registered trade mark.

6. Ten pressure transducers were installed to record unit pressures on the datalogger computer.

7. Additional heating tape was added on the conical part of the disengager bottom and the flange at 762 cm level of the slurry reactor. Previously only one tape was used for this section. Additional heating of this section should minimize heat loss.

3. Analytical Procedures and Supporting Tests

The streams that require analysis include carbon monoxide, hydrogen, the combined feed gas, the first-stage F-T products (gaseous, aqueous, liquid hydrocarbon, and reactor-wax phases), and the second-stage products (gaseous, aqueous, and liquid hydrocarbon phases). The analytical procedures and supporting tests for these streams are summarized in this subsection.

a. Carbon Monoxide, Hydrogen, and Combined Feed-Gas

These streams are analyzed on-line using a Mobil-developed automated gas chromatographic (GC) system. The same system is used for on-line analysis of the gaseous product streams from both the first-stage and the second-stage reactors.

b. First-Stage Fischer-Tropsch Products

The analysis of the F-T products are very complicated because of the wide boiling range and the diversity of the product components. Figure 14 summarizes the analytical scheme.

The combined gas stream from the cold and chilled condenser are analyzed on-line using the on-line GC system. The stream contains N_2, H_2, CO, CO_2, H_2O, and hydrocarbons. The amount of hydrocarbons heavier than C_8 is insignificant in this stream. A typical GC plot for such a sample is given in (A) of Figure 15.

Non-acidic oxygenates in the aqueous phase are determined by fused silica capillary column GC (FS-GC) as indicated in Figure 16. Acids are determined by ion chromatography. The major oxygenates in the aqueous phase identified by gas chromatography-mass spectrometry (GC-MS) are summarized in Table 7. Normally, the C_1-C_8 linear alcohols are

the major components with smaller amounts of ketones, acids, and mixed esters.

The C_5^+ oxygenates present in the liquid-hydrocarbon phase are determined as previously reported by Di Sanzo (1981). Recently the gas chromatographic analysis has been improved by employing fused silica capillary columns and cool on-column splitless injections. Figures 17 and 18 represent typical gas chromatograms of C_6^+ alcohols and acids, and C_5^+ ketones and esters, respectively, isolated from the hydrocarbon phase by liquid chromatography (LC). Normally, linear alcohols are the major oxygenates, followed by methylketones. Mixed esters as a result of secondary reactions between the various acids (acetic, propanoic, butyric, etc.) and alcohols are also present. The C_5^+ acid content has been determined to be generally low (~0.1% wt of hydrocarbon phase). With these methods, oxygenates up to C_{40} can readily be determined.

The C_1 to C_5 oxygenates present in hydrocarbon phase are determined by aqueous extraction of the hydrocarbon phase followed by gas chromatographic analysis of the aqueous extract.

An optional analysis for the aqueous F-T product is Acid Number.

The liquid hydrocarbon phase contains mainly olefins and paraffins. The olefinic and paraffinic compositional analysis is carried out by various GC and LC techniques. Carbon number distribution is readily obtained (<1 hour) by a single injection onto an FS-GC capillary column. A typical chromatogram is given in Figure 19. This simple technique will indicate how the major olefins, i.e., linear α-olefins and cis, trans-2 linear olefins, vary with respect to the normal paraffins. Significant changes in the reactor hydrocarbon composition is thus readily detected.

A more detailed analysis is also performed on selected material balances. A liquid hydrocarbon sample is separated into two fractions distilled at 196°C B.P. (about C_{11}) by distillation. The C_{11}^- fraction after removing the oxygenates by passage through a silica gel SepPak(1) (Waters Associates, Milford, Mass.) is injected into a gas chromatograph equipped with an olefin scrubber and two flame ionization detectors. By comparing detector signals total olefins/paraffins can be determined. In addition, major components are identified. Figure 20 shows typical chromatograms of these analyses. The C_{12}^+ olefins/paraffins are determined as described by Di Sanzo (1981).

(1)A registered trade mark.

Other analyses for the first-stage liquid hydrocarbon product include Acid Number, Bromine Number, Hydroxyl Number, and Simulated Distillation.

The reactor-wax withdrawn from the slurry reactor consists of components with a carbon number distribution from about C_8 to C_{70}^+. A gas chromatographic technique has been developed employing a short (8 m) fused silica capillary column. The reactor-wax (catalyst-free) after being dissolved in hot toluene is injected into the capillary column by the cool on-column injection technique. The latter injection technique minimizes discrimination for the high boiling components. A sample chromatogram is given in Figure 21 for a F-T wax sample employed as a start-up medium in the operation of the two-stage bench-scale pilot plant.

A LC method has also been developed for the determination of oxygenates in the reactor-wax. Total oxygenates is obtained by weighing the isolated oxygenate fraction after solvent evaporation. Carbon number distribution of the oxygenates is then obtained by FS-GC with cool on-column injection. Alcohols and ketones (major oxygenates) can be distinguished chromatographically.

Other analyses for the F-T reactor-wax are Kinematic Viscosity, Surface Tension, Vacuum and Analytical Distillation, and Specific Gravity.

c. Second-Stage ZSM-5 Products

The products from the second-stage ZSM-5 reactor are separated into three streams, i.e., gaseous, aqueous, and liquid hydrocarbons. Analysis of the gaseous product is similar to that of the first-stage gaseous product using an on-line GC system. A typical chromatogram is included as (B) of Figure 15. The aqueous stream from the ZSM-5 reactor contains insignificant amounts of oxygenates and only its pH values are occasionally measured.

Analyses of the liquid hydrocarbon product from the ZSM-5 reactor is more complex. A three-column GC system and an olefin scrubber are used. This setup is similar to a system employed for the Methanol-to-Gasoline process (Bloch, et al., 1977). The system is highly automated and can identify individual components up to approximately C_{10}.

The small amount of components boiling above 204°C are determined by capillary column GC and identified by GC-MS. Finally, a LC method has been developed for the determination of trace oxygenates which may be present.

Other analyses employed for the second-stage liquid hydrocarbon product include Research and Motor Octane Numbers, and Acid Number.

4. Product Evaluation

Two raw gasoline product samples, taken at sixty-six and seventy-eight DOS from Run CT-256-3, were tested for existent and total gums (ASTM D381) and oxidation stability (ASTM D525).

Metal deactivator at 0.5 lb per 1000 bbl. and antioxidant at 2.5 lb per 1000 bbl. were used in one portion and the antioxidant level was increased to 15 lb per 1000 bbl. in a second portion. As shown in Table 8, existent (heptane-washed) gum contents of 1 to 4 mg/100 ml were found in all samples, thus meeting the 5 mg/100 ml maximum specification of ASTM D439 for automotive gasolines. However, total residues on evaporation were very high (ranging up to 119 mg/100 ml) in several of the tests, indicating the presence of high-boiling, heptane-soluble materials. The higher antioxidant usage rates were only partially effective for reducing the total residue levels. The high-boiling materials were confirmed by subsequent ASTM D86 distillations, in which end points up to 249°C were measured (225°C is a typical end-point specification maximum for U.S. gasolines). The drastic difference in the total gums for the two samples may be due to operating condition differences in the second-stage reactor.

The ASTM D525 procedure provides an indication of gasoline tendencies to react with oxygen to form gum during storage. ASTM D439 specifications require 240 minutes or more for the stability period in this test; time periods of 620 to 825 minutes were obtained for these samples, indicating acceptable performance.

Standard N.A.C.E. (National Association of Corrosion Engineers) corrosion tests were conducted on a water-washed composite raw gasoline sample (ASTM D974 total acid number of 0.05 mg KOH/g) of Run CT-256-3 to determine the corrosion tendencies. The N.A.C.E. test method involves contacting a cylindrical steel specimen with a constantly stirred mixture of 91% distilled water (maintained at 38°C) for a period of 3-1/2 hours. Performance is expressed by a scale dependent on a visual observation of the rust on the steel specimen surface.

Metal deactivator at 1 lb. per 1000 bbl. and two different antioxidants at 10 lb. per 1000 bbl. were added to two separate portions of the sample. The N.A.C.E. corrosion tests were conducted on duplicate samples from these two portions and on an additized petroleum-sourced unleaded gasoline. Tests also

were run on these fuels with a commercial corrosion inhibitor at a conventional level of 2.1 lb. per 1000 bbl. The steel specimen surfaces were severely rusted in tests of fuel samples without corrosion inhibitor. Testing of the fuels containing the corrosion inhibitor, on the other hand, indicated satisfactory protection, showing zero to less than 0.1% (2 or 3 spots of no more than 1 mm diameter) of the surface rusted. Based on these results, it is concluded that the use of a commercial corrosion inhibitor will satisfactorily control the fuel's corrosion tendencies.

Long-term 43°C storage stability testing of this additized, water-washed composite product is in progress. Results will be reported in our next quarterly summary.

5. Conclusions

The third run of the two-stage bench-scale pilot plant, designed as Run CT-256-3, was concluded after eighty-six days on stream. The highlights of the run were:

- The evaluation of the second Fischer-Tropsch catalyst, a $Fe/Cu/K_2CO_3$ catalyst designated as I-B, was completed. The catalyst showed excellent stability and high production of hydrocarbons (815 g/gFe).

- The ranges of the operating conditions for the first-stage slurry Fischer-Tropsch reactor were:

Temperature, °C	259-267
Pressure MPa	1.13-2.51
H_2/CO Feed Ratio, Molar	0.6-1.0
Superficial Feed-Gas Velocity, cm/s	1.2-4.4
Space Velocity, NL/gFe-hr	1.3-3.4
Catalyst Loading, wt % (nominal)	11-20

  The H_2+CO conversion ranged from 54 to 93 mol % and the methane + ethane yield from 6 to 18 wt % of the total hydrocarbons produced.

- The second-stage ZSM-5 catalyst (II-B) has accumulated two regenerations and a total on-stream time of eighty-seven days. No apparent loss of activity was observed after each regeneration. The range of the operating conditions for the second-stage reactor during this run were:

Temperature, Inlet, °C	288-466
GHSV, 1/hr	1,350-4,580

An average of 3.3 °C/day increase on the inlet temperature was used to maintain a constant operating severity. Maximum gasoline yield was obtained at an operating severity index, expressed as the molar ratio of $i\text{-}C_4/(C_3^{=} + C_4^{=})$ in the product, of 0.5-1.0. Peak Research Octane Numbers of 90-94 were achieved at severity index of 0.3-2.0.

- Two small and one large interruption in the F-T synthesis operation occurred. A slight loss in F-T catalyst activity and a slight increase in the methane yield were observed during the small interruption. The F-T catalyst slurry were unloaded and then reloaded into the slurry reactor during the major interruption. Substantial deterioration of the F-T catalyst activity and a substantial increase of the methane + ethane yield were observed, probably due to catalyst damage incurred when it was exposed to air.

- The F-T reactor wax yield increased significantly with decreasing methane + ethane yield.

- Process variable studies were conducted during the latter part of the run. The results are:

  - Use of 0.6 H_2/CO feed ratio synthesis gas instead of 0.7 lowered the methane yield. It also gave better usage of the synthesis gas since the H_2/CO usage ratio was nearly 0.6.

  - Higher operating pressure at the same superficial feed-gas velocity in the slurry reactor resulted in slightly lower H_2+CO conversion, but a significantly lower methane + ethane yield. It also increased the oxygenate yield significantly.

  - Addition of a potassium-salt to the slurry reactor drastically decreased the methane + ethane yield.

- A "hydrodynamic upset" of the slurry reactor was observed at the end of the run, probably due to catalyst settling resulting in low H_2+CO conversion and lower temperatures at the upper portion of the reactor. The upset disappeared after eight hours of high gas velocity operation, but re-appeared after the velocity was reduced.

After the end of Run CT-256-3, the two-stage bench-scale pilot plant was shut down for modifications. The major modification was addition of two external filter assemblies to withdraw reactor-wax from the first-stage slurry reactor. Other modifications included installation and replacement of many filter elements, installation of pressure transducers and heating tape, and replacement of the flange gaskets for the first-stage reactor.

Analytical procedures and supporting tests for the current pilot plant operation are summarized. The streams that required analysis include carbon monoxide, hydrogen, the combined feed gas, the first-stage F-T products (gaseous, aqueous, liquid hydrocarbon, and reactor-wax phases), and the second-stage ZSM-5 products (gaseous, aqueous, and liquid hydrocarbon phases). The gaseous streams are analyzed on-line using a Mobil-developed automated gas chromatographic (GC) system. The non-acid and acid oxygenates in the F-T aqueous phase are determined by fused silica capillary column GC (FS-GC) and ion chromatography respectively. Oxygenates in the F-T liquid hydrocarbon phase are determined using GC analysis. The F-T liquid hydrocarbon phase is analyzed using various GC and liquid chromatography (LC) techniques, while its carbon number distribution is routinely obtained using a FS-GC capillary column. More detailed analysis of the F-T liquid hydrocarbon is performed on selected cases using distillation, oxygenate separation, and a GC equipped with a olefin scrubber and flame ionization detectors. The analysis of F-T reactor-wax is done using FS-GC, LC, and solvent extraction. The second-stage liquid hydrocarbon product is analyzed using a GC system and an olefin scrubber. Various supporting tests are also employed, including acid number, bromine number, hydroxyl number, simulated distillation, kinematic viscosity, surface tension, vacuum distillation, and octane numbers.

Gasoline stability tests for gum formation and oxidation showed that existent (heptane washed) gum contents were all within acceptable limits, as were the oxidation stabilities. However, total residues on evaporation (unwashed gum) were generally high, probably due to the presence of a small amount of high-boiling, heptane-soluable hydrocarbons.

6. Future Work

- The two-stage bench-scale pilot plant will be operated to test new devices for F-T reactor-wax/catalyst separation.

- The two-stage bench-scale pilot plant will be operated to evaluate a new F-T catalyst.
- The evaluation of the raw gasoline product from the bench-scale pilot plant will be continued.

B. Task 4 - Conceptual Design Study

1. Task Status

This task was initiated. The process design basis, including the material balance and operating conditions, was constructed based on the data obtained from the two-stage bench-scale pilot plant. The design basis data were forwarded to Mobil's Engineering Department at Princeton, New Jersey, and the conceptual design work is now in progress.

2. Future Plan

Additional work on this task include process design, equipment sizing, and cost estimation. The task is expected to be complete by March 1983. The results of the study will be included in the Final Report.

V. NOMENCLATURE

P	Pressure, (MPa)
T	Temperature, (^{o}C)
u	Superficial velocity, (cm/s)
w	Weight fraction of catalyst in slurry, (gCat/g slurry)

Greek Letters

α	Probability of the chain-growth
ε_g	Gas holdup, (mL gas/mL expanded slurry)

Superscripts

i	At reactor inlet

Subscripts

c	Catalyst
g	Gas

VI. LITERATURE

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Table 1

Major Events in Run CT-256-3

(Excluding Rx-Wax & Slurry Inventory)

DOS	Major Events
-0.4-0.0	Pretreatment: 1st-Stage: 282°C; 1.14 MPa; 4.2 cm/s.
0.0-8.0	Syntheses Started: 1st-Stage: 282-260°C, 1.48 MPa; 4.2-3.7 cm/s.
8.0-16.0	2nd-Stage:on: 329-385°C.
16.3-17.9	2nd-Stage Regeneration Upset: Unit under nitrogen nine hrs.
18.0-29.4	1st-Stage: 260-261°C; 3.7-3.5 cm/s. 2nd-Stage: 343-304-346°C.
29.7	Upset: Leak at 305 cm level flange; unit under nitrogen purge 36.5 hrs.
29.7-45.9	1st-Stage: 3.45-3.0 cm/s. 2nd-Stage: 346-466°C.
46.5-47.8	2nd-Stage Regeneration
50.0-59.7	1st-Stage: 261-266°C. 2nd-Stage: 304-318°C.
59.8-60.8	1.48-2.17 MPa Upset: Leak at 0 cm level flange. Slurry unloaded, then reloaded after fifty hrs.
60.9-67.9	1st-Stage: 267°C; 1.48 MPa; 3.1-2.5 cm/s. H_2/CO in feed: 0.7-0.6 2nd-Stage: 323-349°C.
67.9-80.0	1st-Stage: 1.48-2.5 MPa: 2.5-3.7-1.0-2.8-2.5 cm/s 2nd-Stage: 349-408°C.
80.8	Addition of a potassium-salt.
81.3-85.9	Hydrodynamic Upset 1st-Stage: 2.51-1.48-2.51 MPa. 2nd-Stage: 408⟶426°C.
86.0	End Synthesis

Table 2

Ranges of Operation Results (Run CT-256-3)

First Stage	Range of Results
H_2+CO Conv., mol %	54-93
Methane + Ethane Yield, wt % HC	6-18
Reactor-Wax Yield, wt % HC	3-13

Second-Stage Hydrocarbon Yield, Wt %

	Before Alkylation	After Alkylation
C_1+C_2	9-20	9-20
C_3-C_4	14-38	12-28
C_5-C_{11}	32-55	46-68
C_{12}+ (excel. reactor-wax)	1-9	1-9

Properties of Raw Liquid Hydrocarbons (1)

Aromatics, Wt %	12-41
Acid No., mgKOH/gHC (unwashed)	0.04-0.4
Octane No., R+O	82-94
M+O	74-84

(1) Collected in ambient and chilled condensers.

Table 3

Effect of Superficial Feed-Gas Velocity on Slurry Fischer-Tropsch Reactor Performance (1)

(Run CT-256-3)

DOS	75.4	76.5	77.4
Gas Superficial Velocity, cm/s	2.5	2.1	1.6
Space Velocity, NL/gFe-hr	3.12	2.53	1.95
H_2+CO Conv., mol %	77.1	87.2	93.1
Methane, wt % HC	8.8	8.5	7.8
Methane + Ethane, wt % HC	12.7	12.6	12.2

(1) 0.6 H_2/CO, 267°C, 2.51 MPa

Table 4

Effect of Pressure on Slurry Fischer-Tropsch Reactor Performance (1)

DOS	66.8	68.8	72.4	74.8
Pressure, MPa	1.48	1.82	2.17	2.51
Space Velocity, NL/gFe-hr	1.95	2.32	2.77	3.12
H_2+CO Conv., mol %	81.2	81.7	79.5	77.5
Methane, wt % HC	10.8	10.1	9.4	8.7
Methane + Ethane, wt % Hc	14.8	14.4	13.6	12.6

(1) 0.6 H_2/CO, 267°C, 2.6 cm/s superficial feed-gas velocity.

Table 5

Effect of Pressure on Oxygenates Yield from First-Stage Fischer-Tropsch Reactor

DOS	50.6	74.5
Pressure, MPa	1.48	2.51
Temperature, ^{o}C	263	267
Feed H_2/CO, molar	0.7	0.6
Superficial Feed-Gas Velocity, cm/s	3.1	2.6
Space Velocity, NL/gFe-hr	2.18	3.15
H_2+CO Conversion, mol %	85.2	77.5
Oxygenates, wt % of HC	8.6	12.0

Table 6

Summary of Estimated Gas Holdup from DP-Cell Data

DOS	9.2	75.5	78.6	78.8	80.8
u_g^i, cm/s	3.9	2.6	1.1	2.6	2.6
T, C	260	267	260-267	260-267	267
P, MPa	1.48	2.51	2.51	2.51	2.51
w_c, wt %	14.3	13.9	11.7	12.0	12.0
ε_g, vol %	26.6	19.7	6.8	9.3	19.8

Table 7

Identities of Major Aqueous Phase Oxygenates

Peak No. (1)	Oxygenates
1	methanol
2	ethanol
3	acetone
4	isopropanol
5	t-butyl alcohol
6	1-propanol
7	butanal
8	methylethyl ketone
9	2-butanol
10	ethyl acetate
11	isobutanol
12	2-methyl-2-butanone
13	acetic acid
14	1-butanol
15	2-pentanone
16	pentanal+3-pentanone
17	2-pentanol
18	ethyl propanoate
19	propyl acetate
20	methyl butanoate
21	propanoic acid
22	3-methyl-1-butanol
24	1-pentanol
25	2-hexanone
26	butyric acid
27	other C_6 oxygenates
28	1-hexanol
29	other C_7 oxygenates
30	1-heptanol
31	other C_8 oxygenates
32	1-octanol

(1) Identified by gas chromatography-mass spectrometry.

Table 8

Raw Gasoline Product Evaluations

Material Balances	Days on Stream	Additive Pkg. No.*	ASTM D381 Gums, mg/100 mL		ASTM D525 Oxidation Stab., mins.
			Existent	Total (Unwashed)	
CT-256-3-57	66.5	1	4	119	620
CT-256-3-57	66.5	2	4	81	710
CT-256-3-63	78.5	1	1	37	660
CT-256-3-63	78.5	2	2	12	825

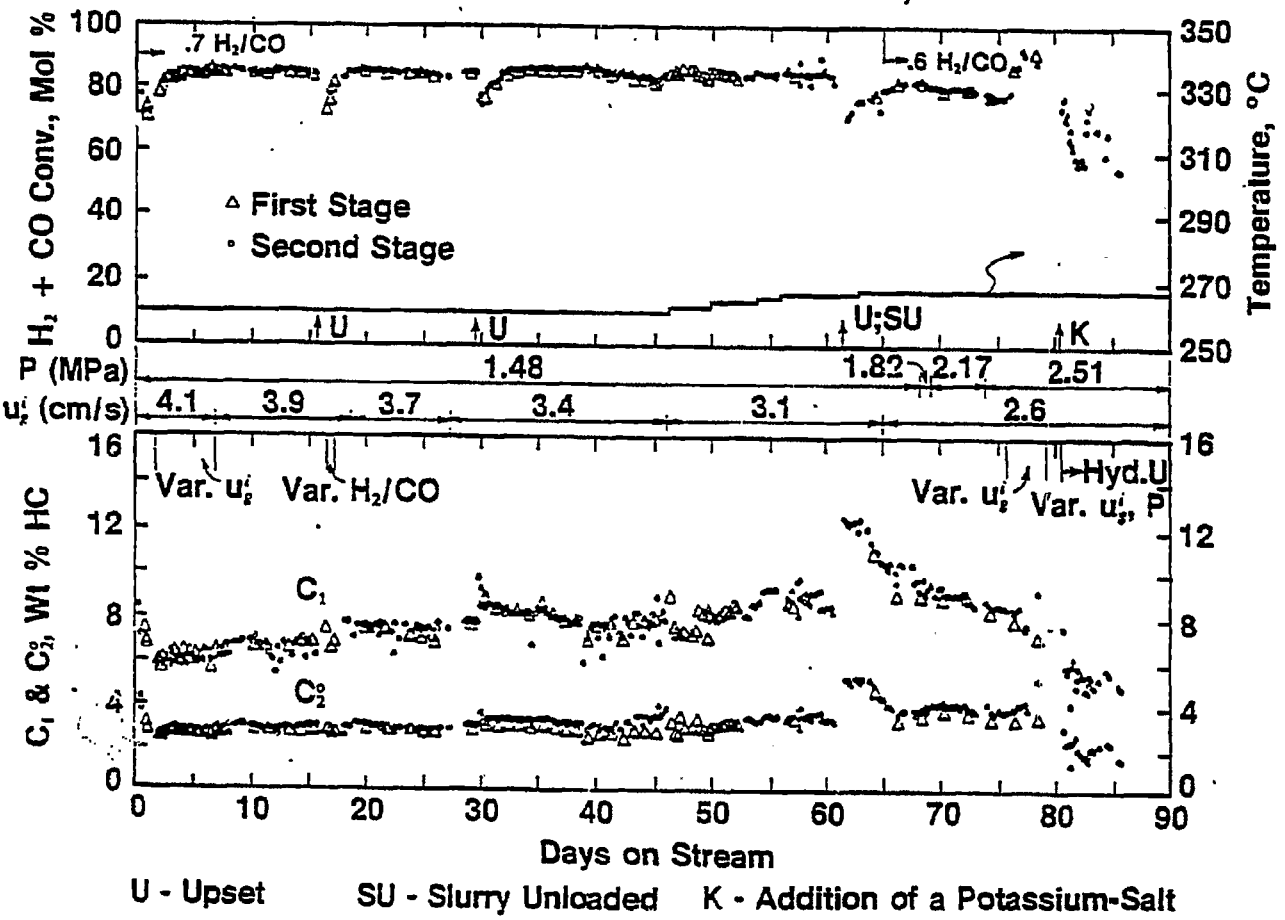
*Additive Package No. 1 -- 0.5 lb/1000 bbl. metal deactivator +
2.5 lb/1000 bbl. antioxidant.

*Additive Package No. 2 -- 0.5 lb/1000 bbl. metal deactivator +
15 lb/1000 bbl. antioxidant.

FIGURE 1

SYNTHESIS GAS CONVERSION AND METHANE & ETHANE YIELD

(RUN CT-256-3 1ST-STAGE CATALYST I-B:PPTD Fe/Cu/K_2CO_3; 2ND-STAGE CATALYST II-B:ZSM-5)



U - Upset SU - Slurry Unloaded K - Addition of a Potassium-Salt

FIGURE 2

REACTOR-WAX CARBON-NUMBER DISTRIBUTION

(Run CT-256-3)

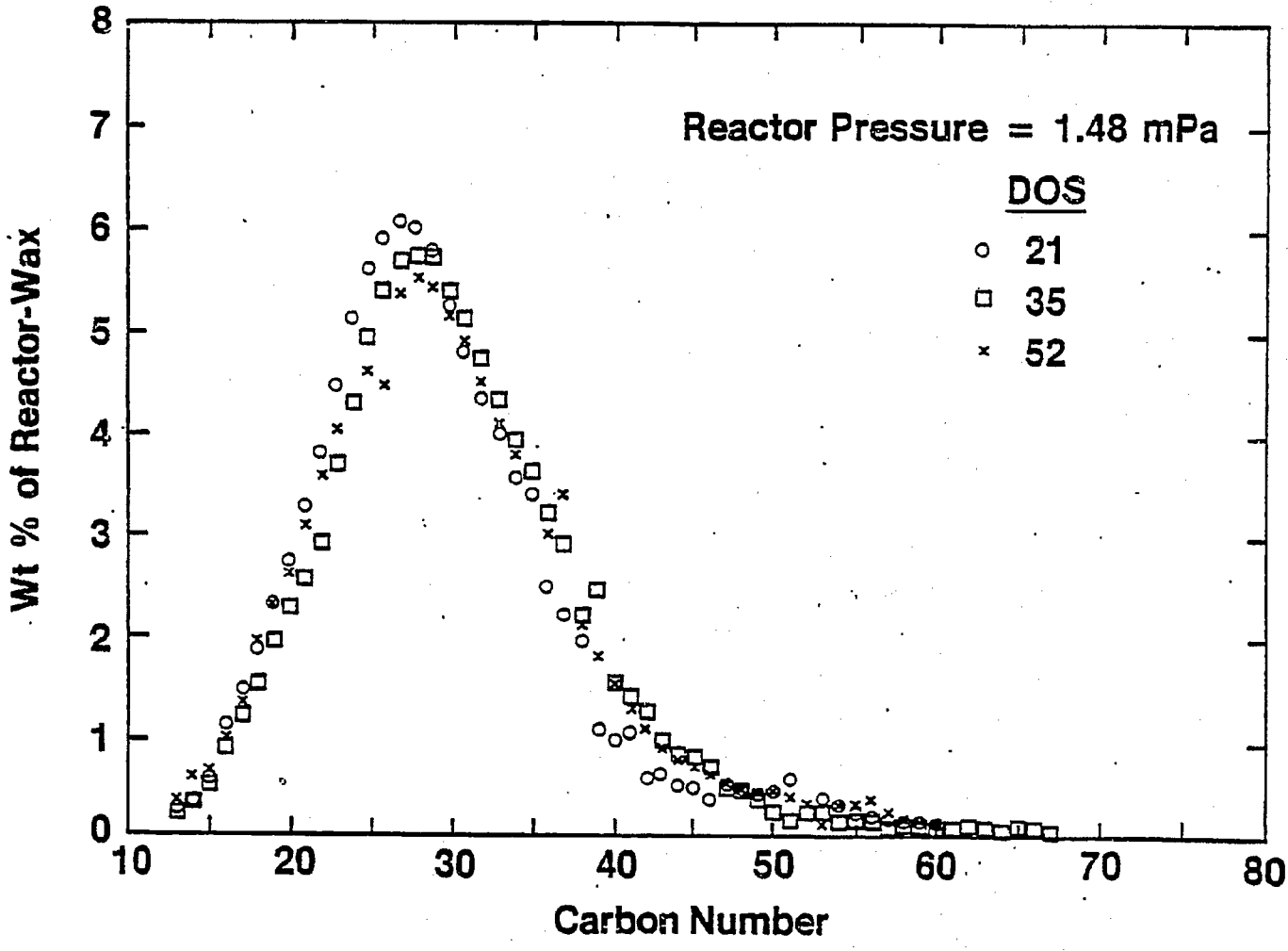


FIGURE 3

EFFECT OF REACTOR PRESSURE ON REACTOR-WAX CARBON-NUMBER DISTRIBUTION

(Run CT-256-3)

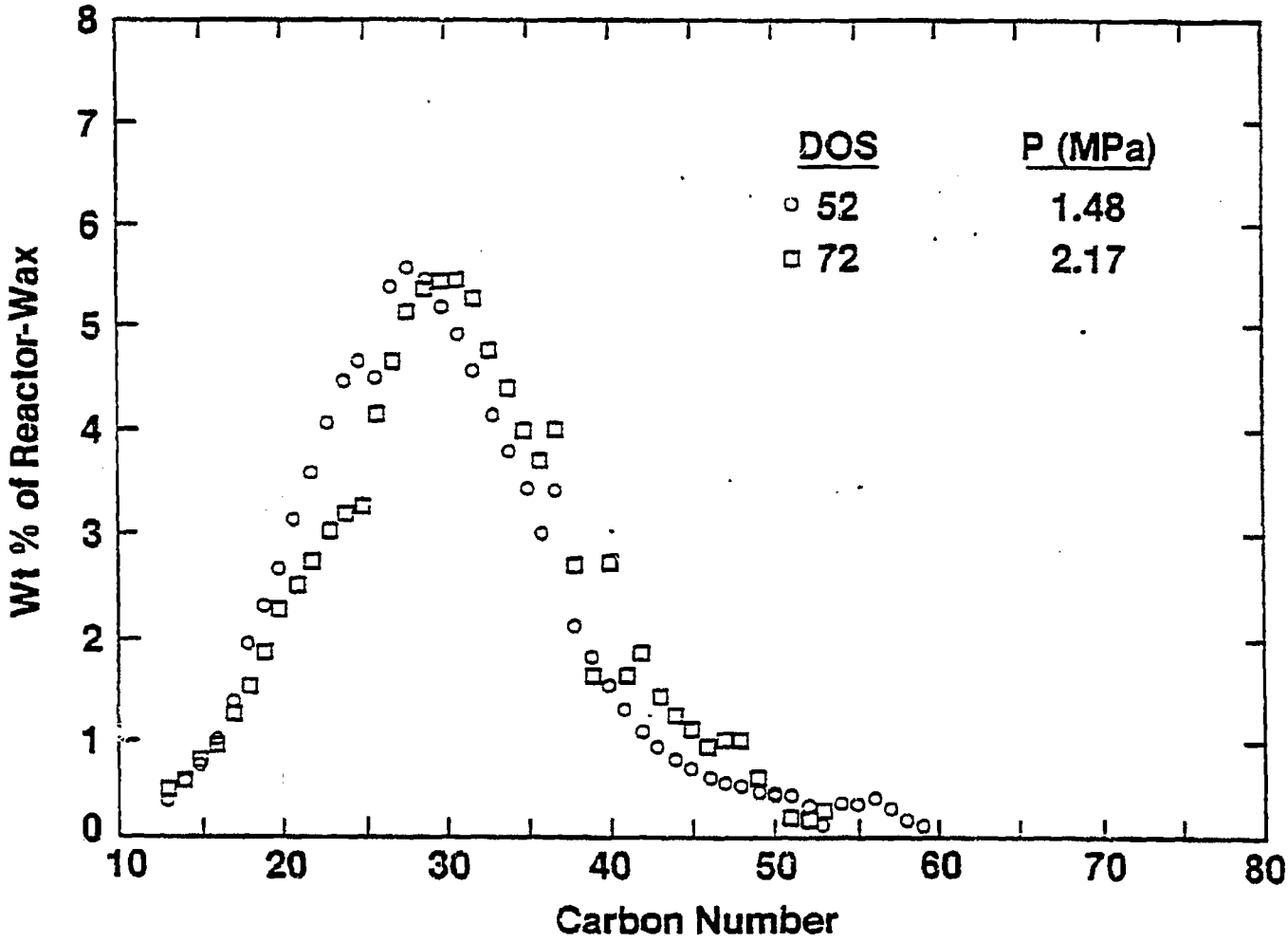


FIGURE 4

CUMULATIVE REACTOR-WAX PRODUCTION
FROM FIRST-STAGE
FISCHER-TROPSCH REACTOR

(Run CT-256-3)

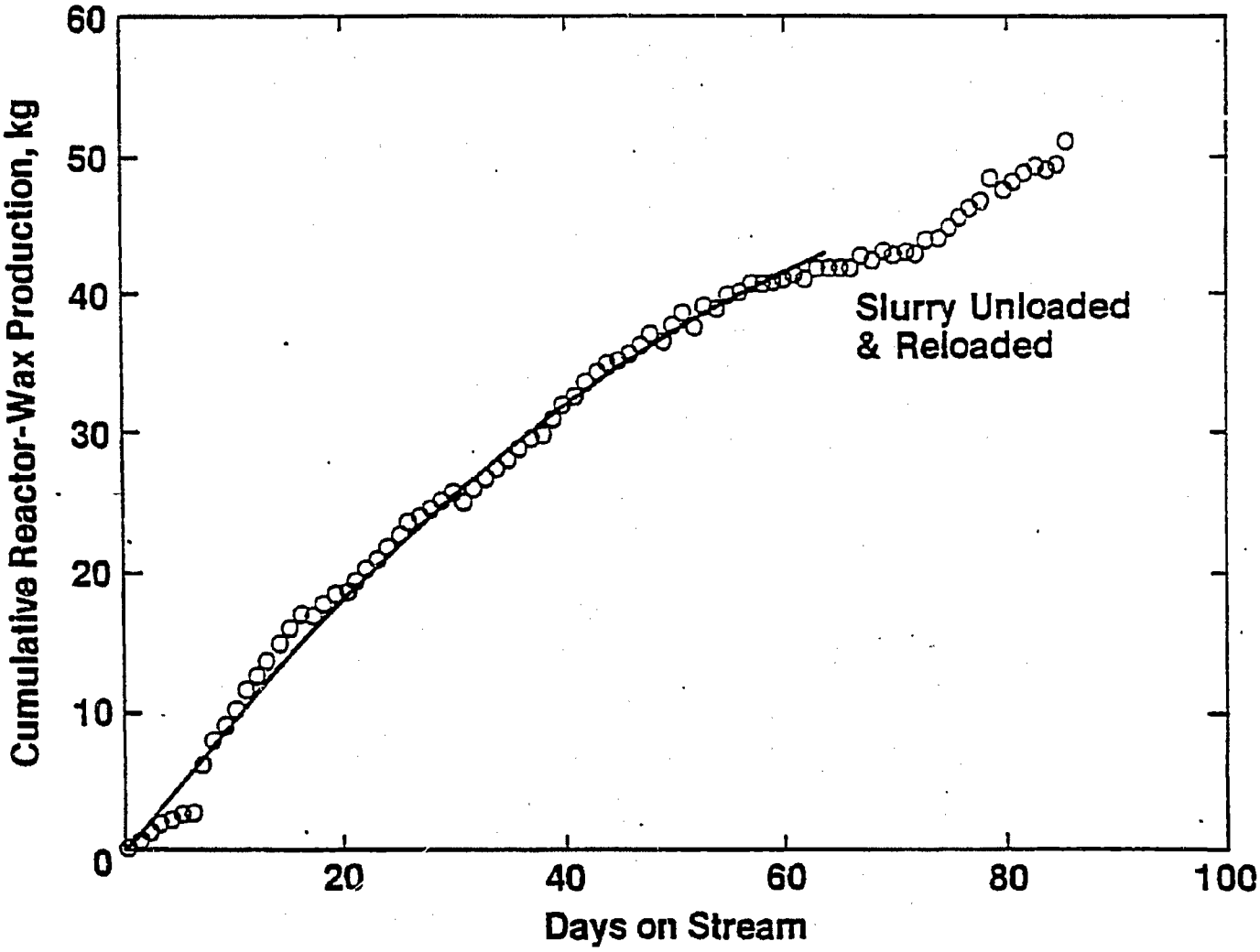


FIGURE 5

REACTOR-WAX YIELD

(Run CT-256-3)

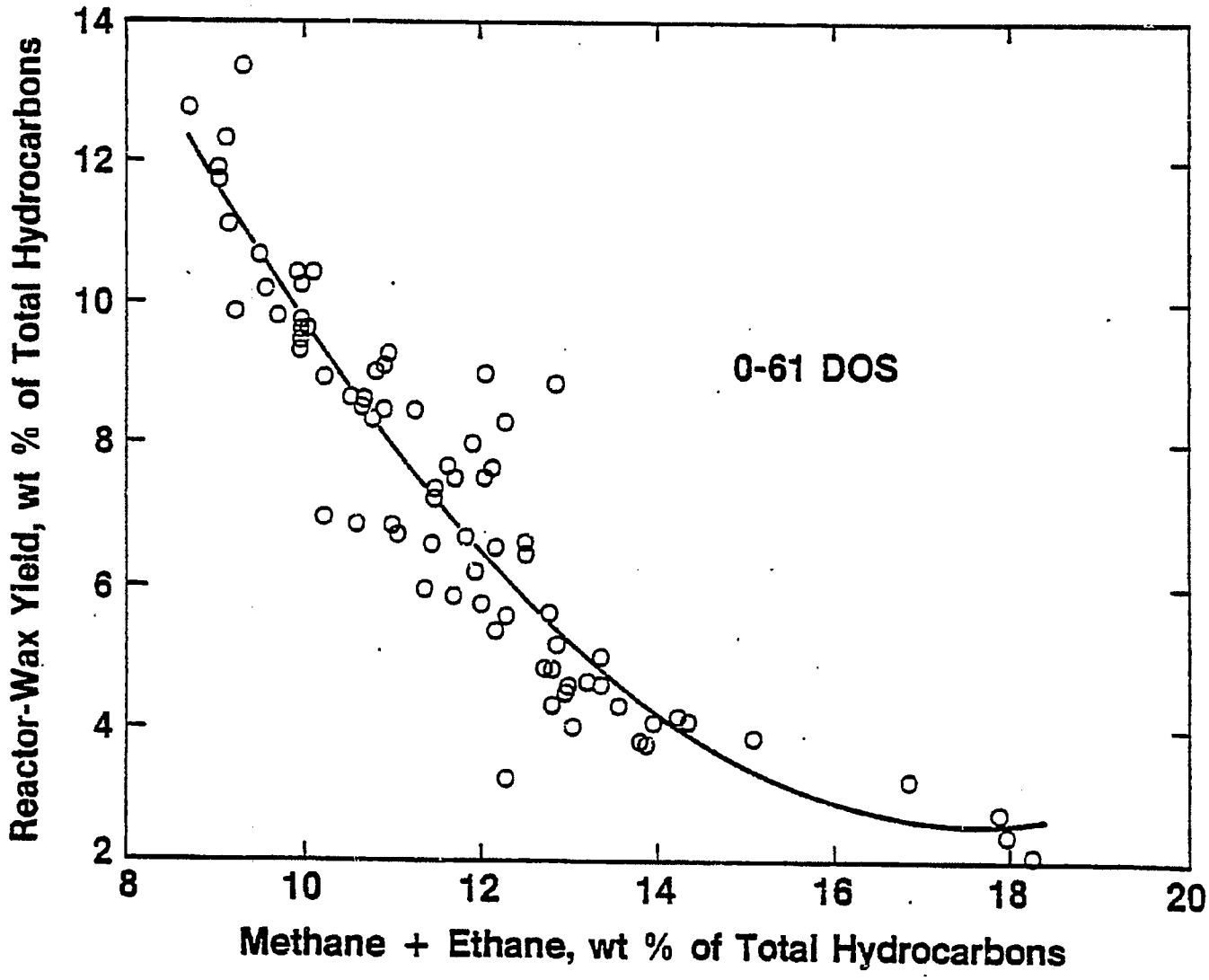


FIGURE 6

SCHULZ-FLORY DISTRIBUTION FOR FIRST-STAGE FISCHER-TROPSCH PRODUCTS

(Run CT-256-3, 11.5 Days TOS
Reactor-Wax Yield — 9.5 wt %)

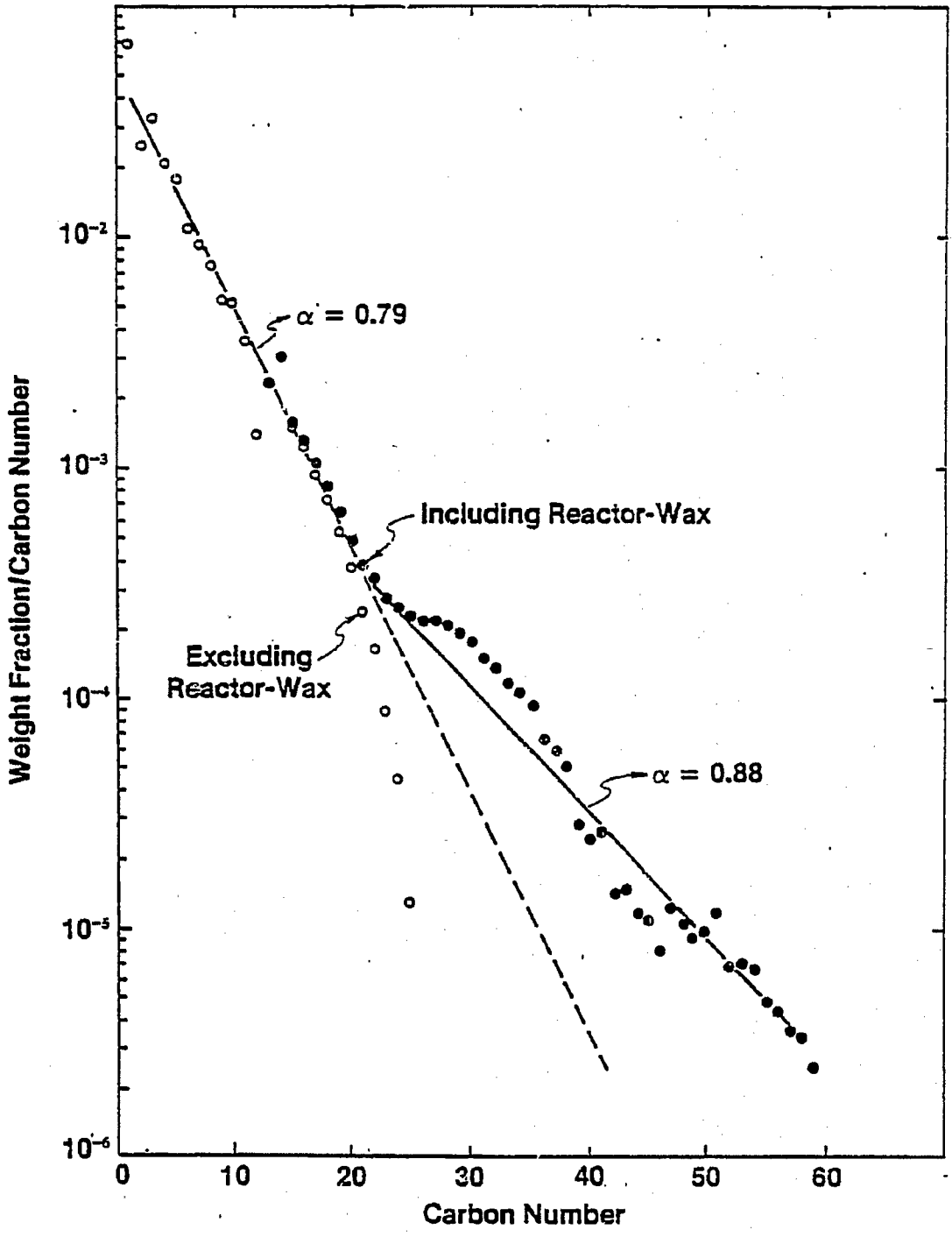


FIGURE 7

EXIT H_2/CO RATIO OF FIRST-STAGE SLURRY FISCHER-TROPSCH REACTOR

(Run CT-256-3)

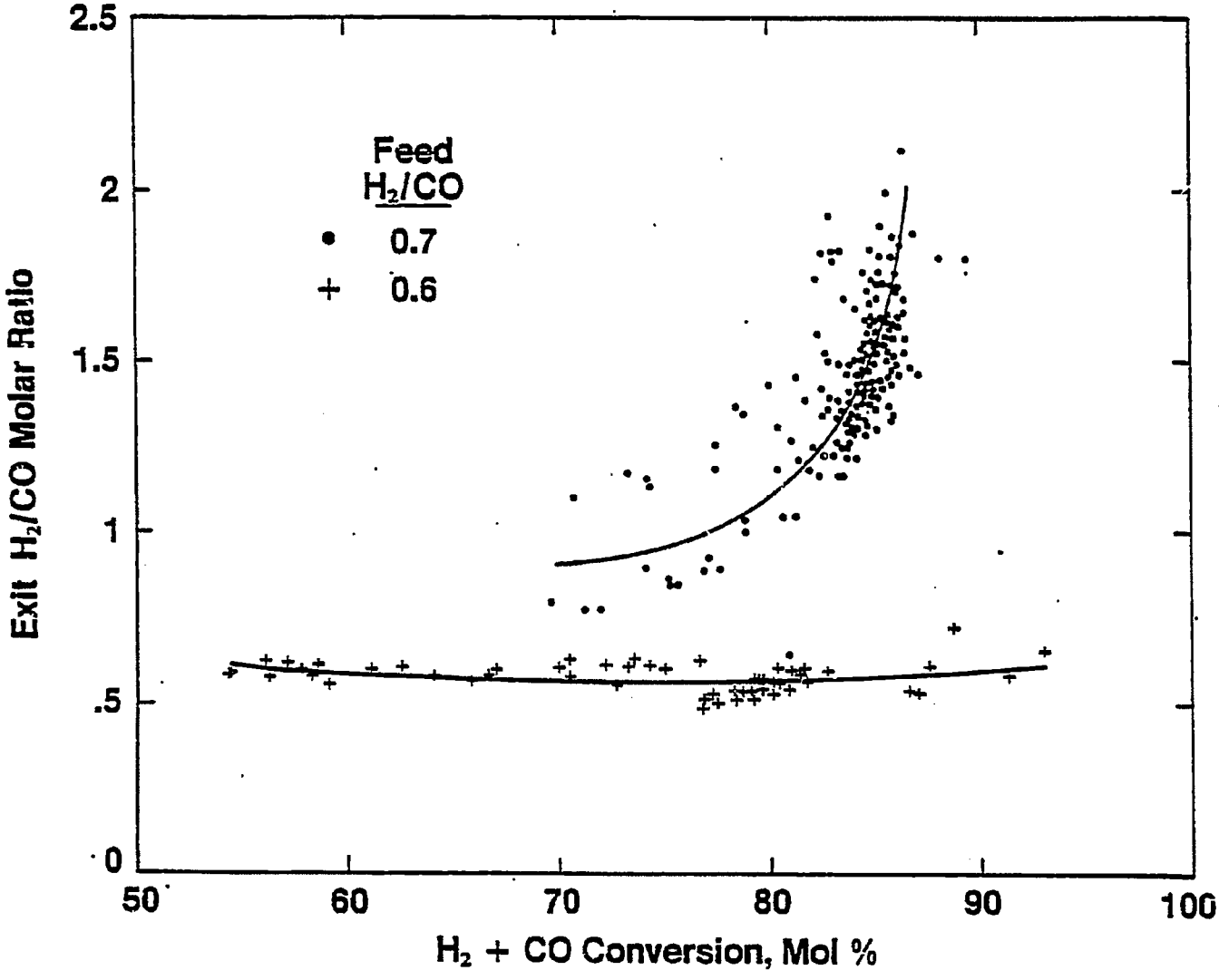


FIGURE 8

SLURRY FISCHER-TROPSCH BUBBLE-COLUMN GAS HOLDUP PROFILES

(Run CT-256-3)

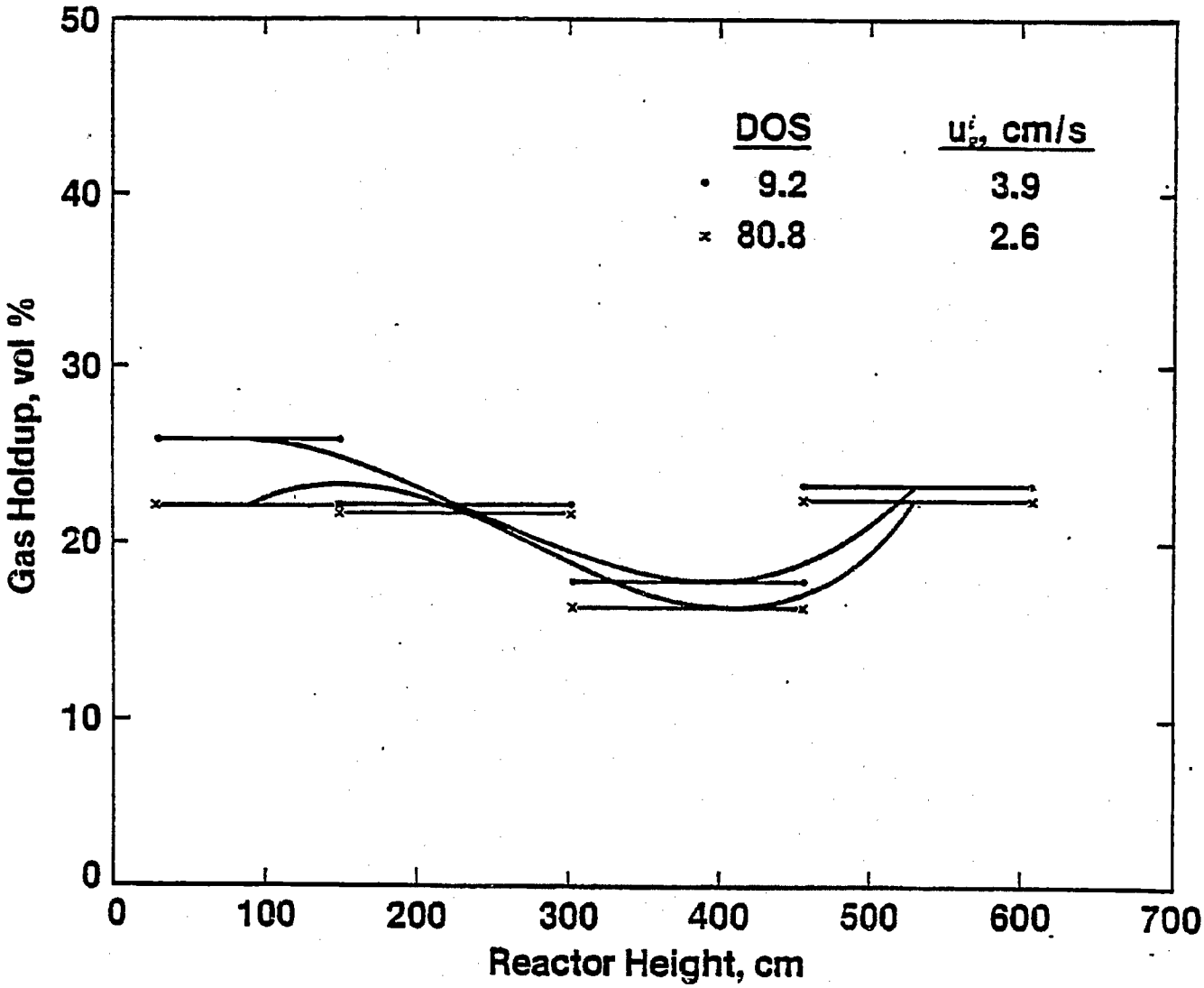
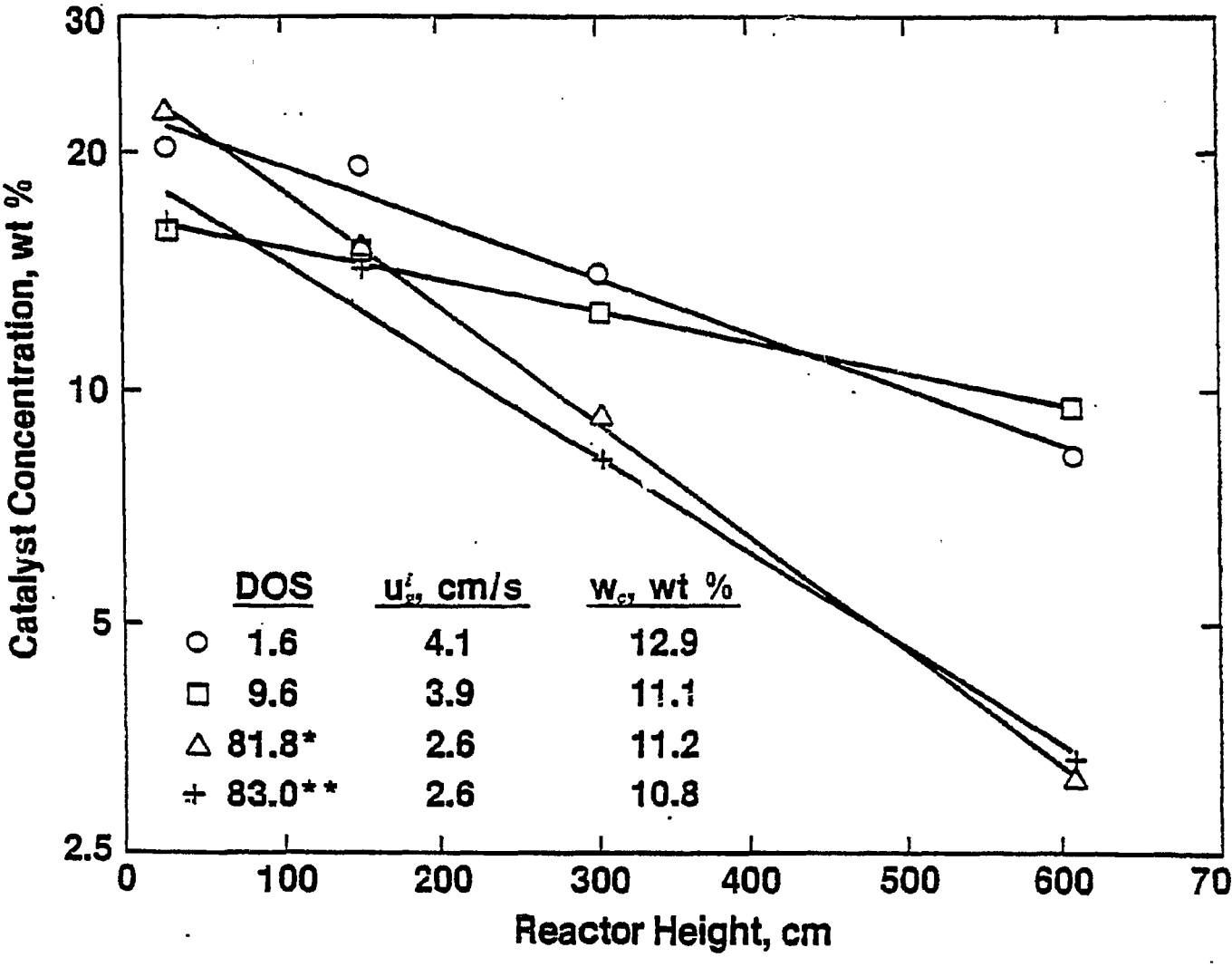


FIGURE 9

SLURRY FISCHER-TROPSCH BUBBLE-COLUMN CATALYST CONCENTRATION PROFILES

(Run CT-256-3)



*During hydrodynamic upset

**After hydrodynamic upset was corrected

FIGURE 10

SECOND-STAGE FIXED-BED ZSM-5 REACTOR INLET AND OUTLET TEMPERATURES

(Run CT-256-3)

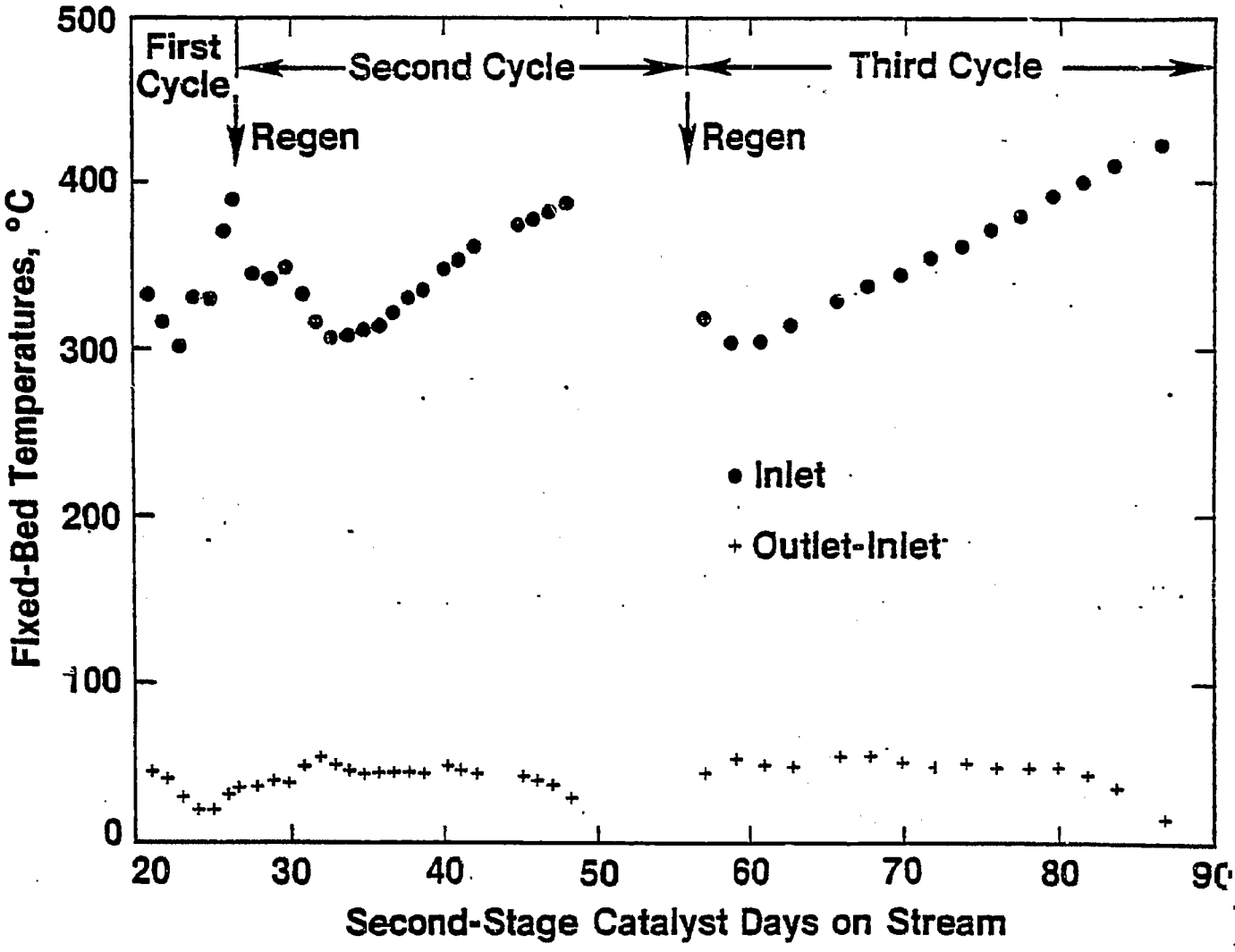
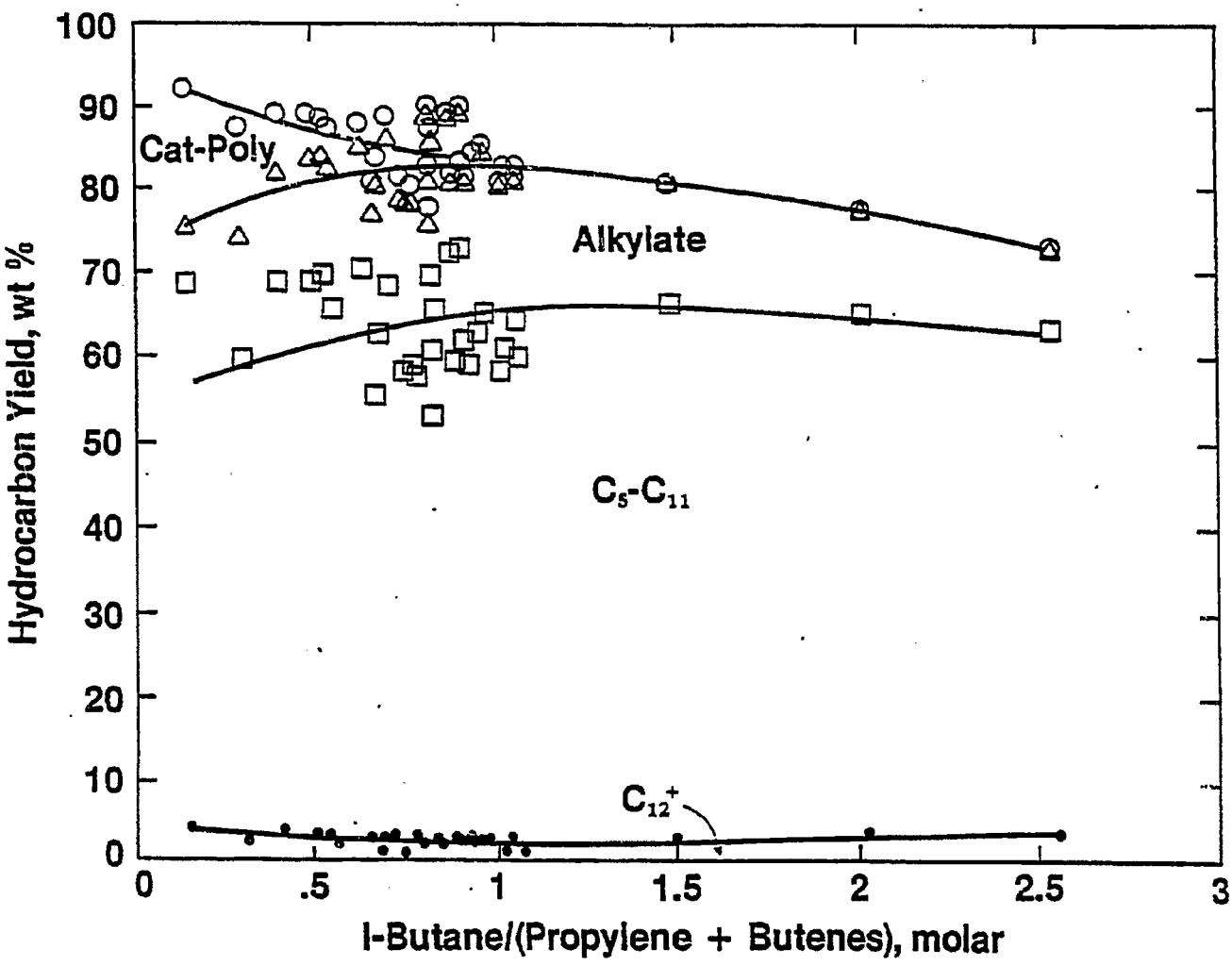


FIGURE 11

PRODUCT YIELDS VERSUS SECOND-STAGE OPERATING SEVERITY

(Run CT-256-3)



*Excluding C_4^- paraffins in feed and reactor-wax

FIGURE 12

SECOND-STAGE RAW LIQUID HYDROCARBON PROPERTIES

(Run CT-256-3)

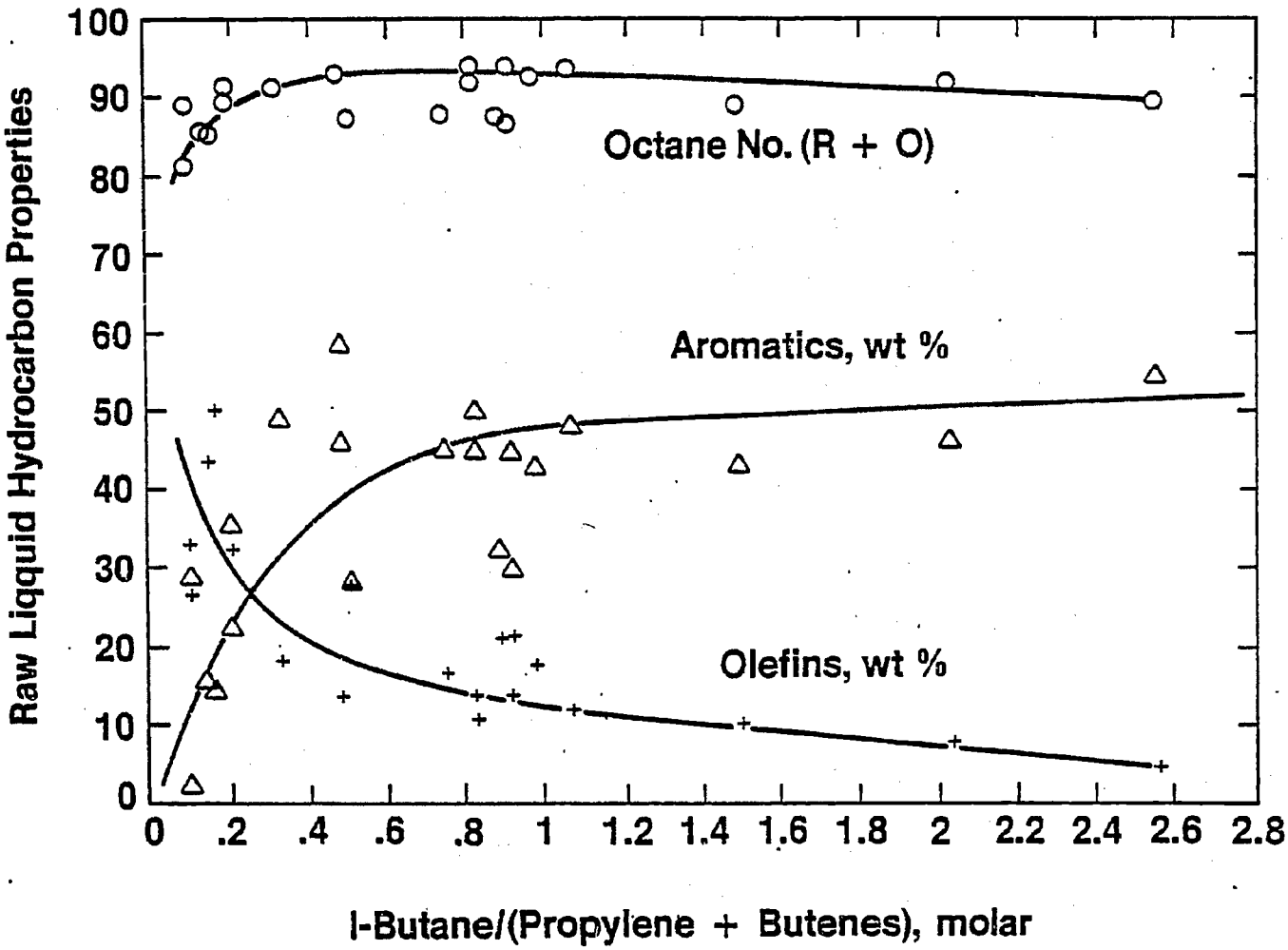


FIGURE 13

SCHEMATIC OF THE EXTERNAL WAX FILTER ASSEMBLY

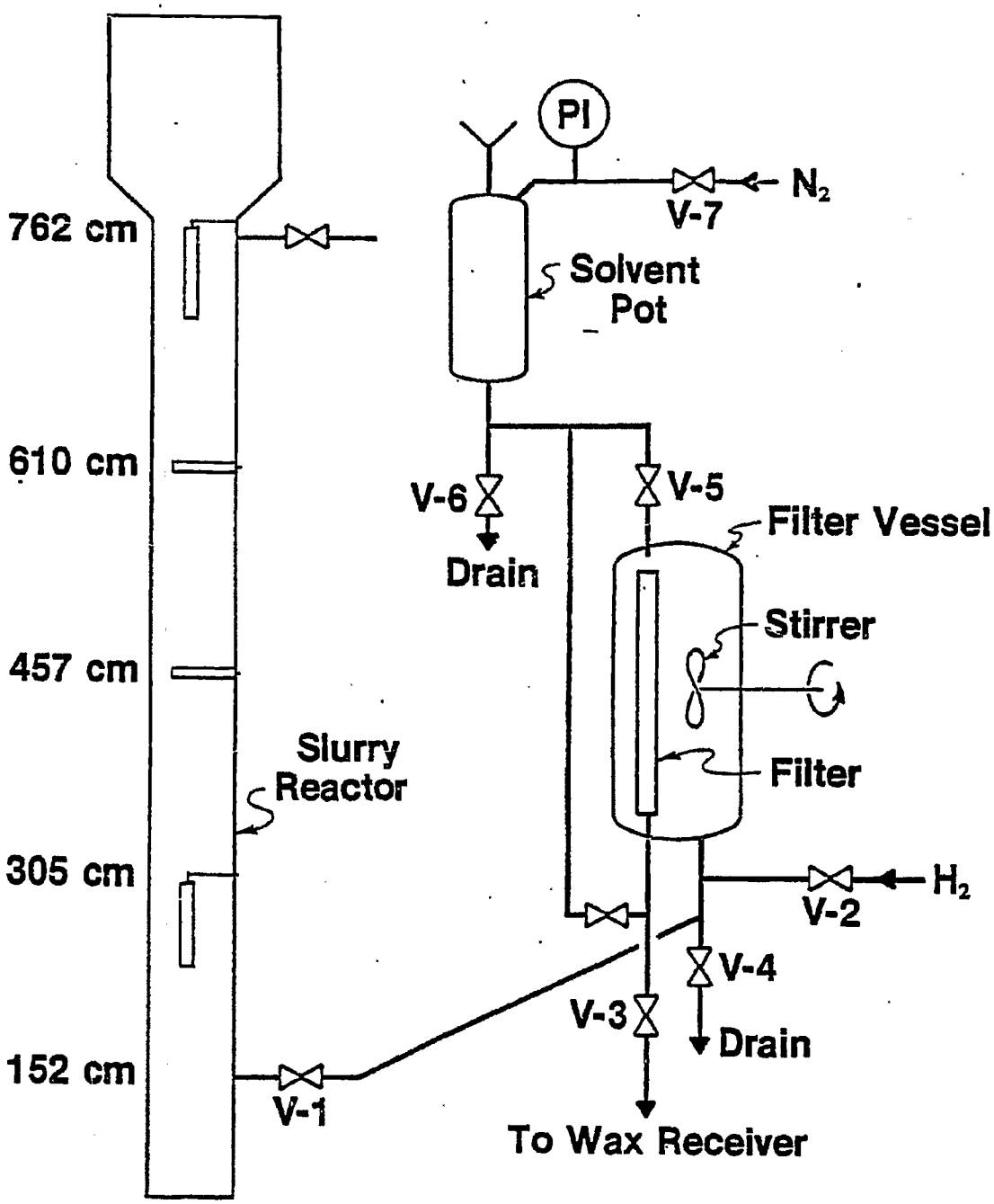


FIGURE 14

ANALTYICAL SCHEME OF FISCHER-TROPSCH PRODUCTS

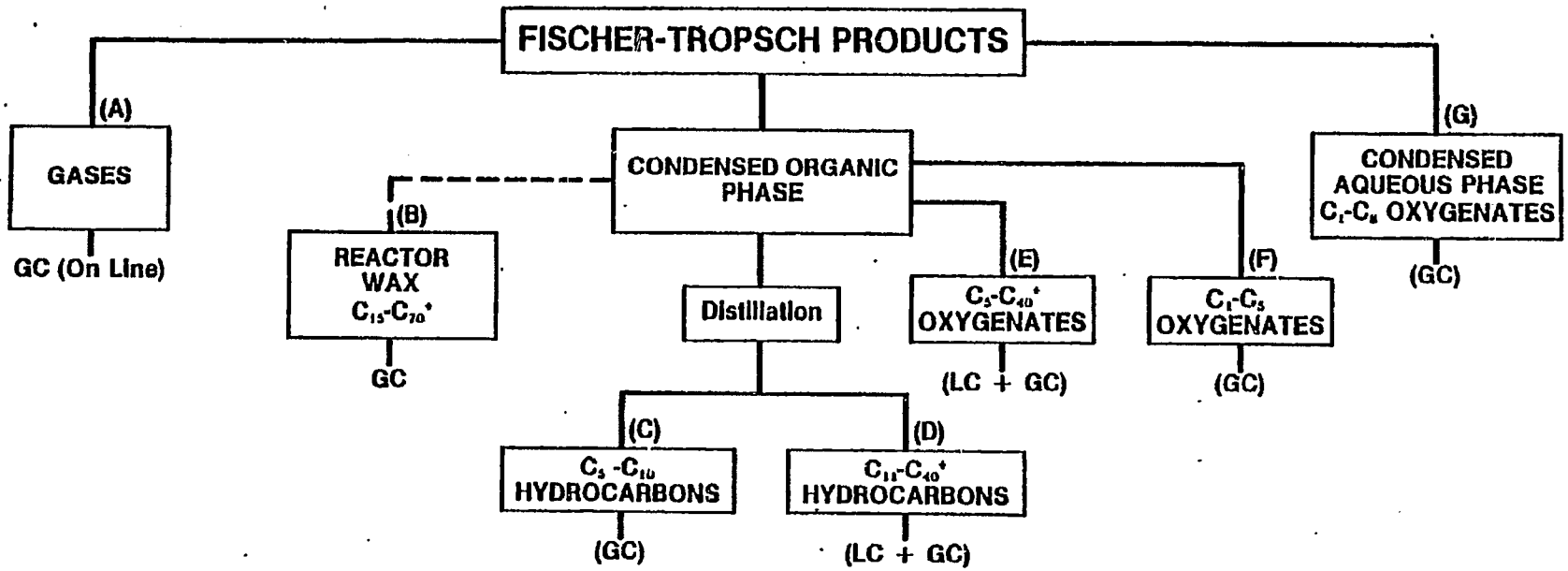
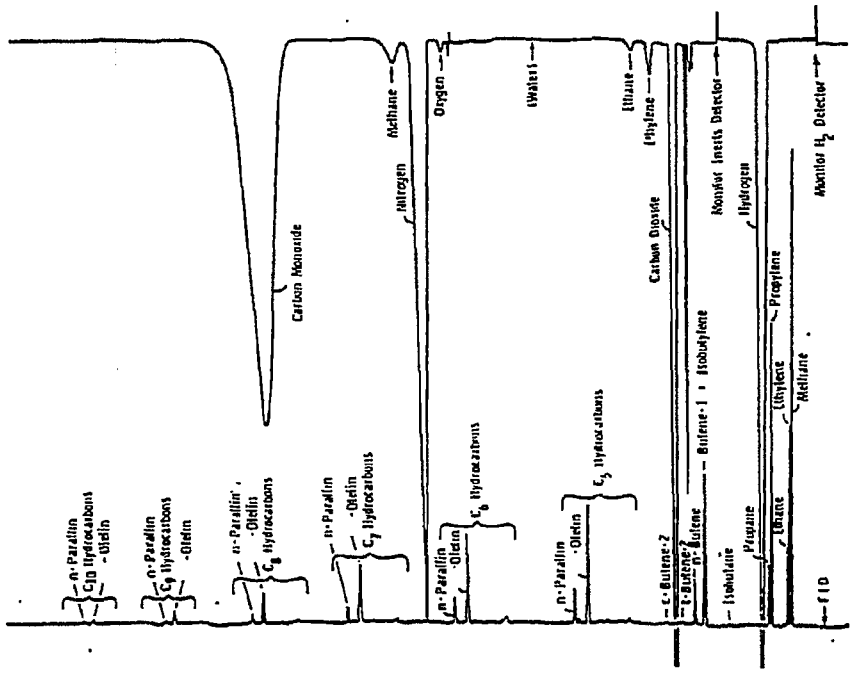


FIGURE 15

GC PLOT OF TYPICAL COMBINED GAS SAMPLES

(A) FIRST-STAGE REACTOR GAS SAMPLE



(B) SECOND-STAGE REACTOR GAS SAMPLE

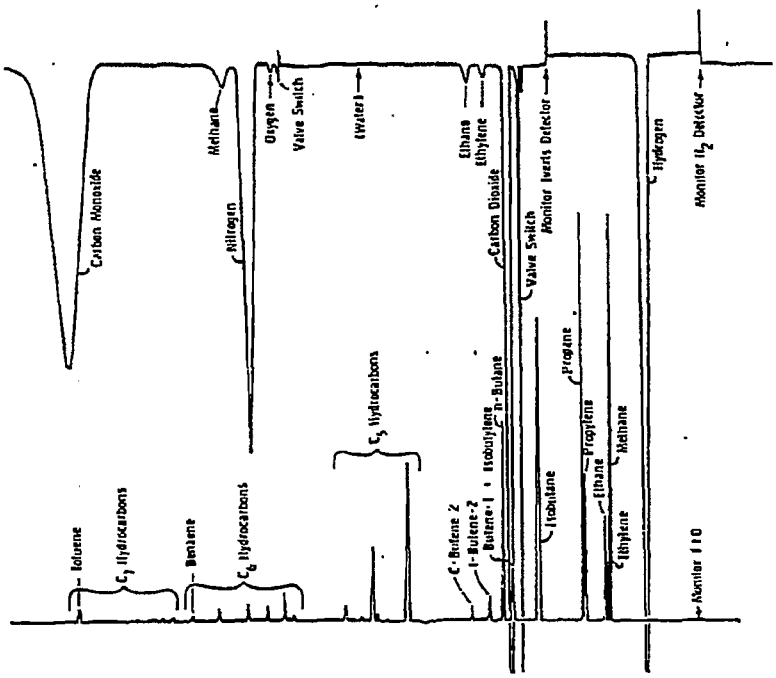
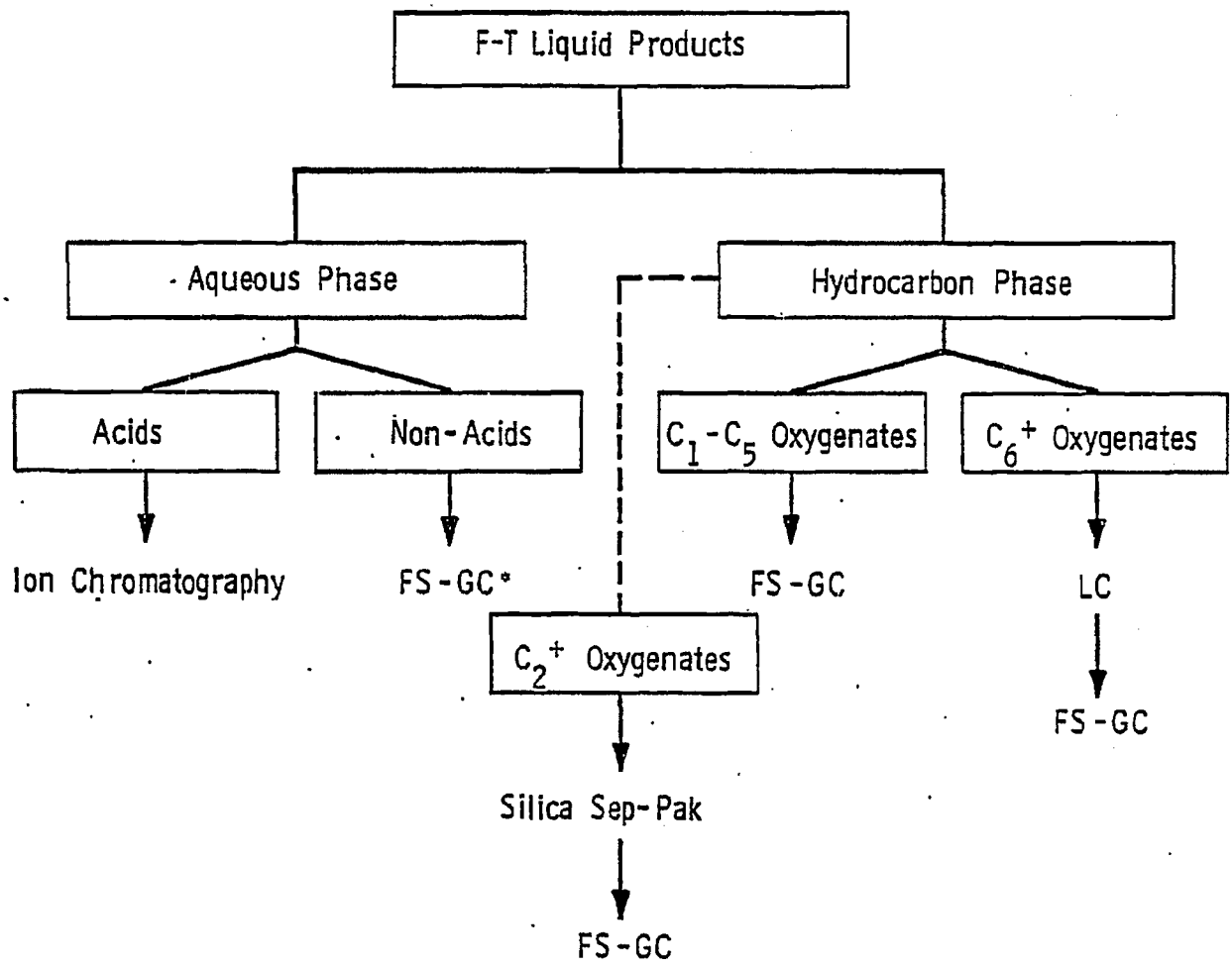


FIGURE 16

ANALYTICAL SCHEME OF FISCHER-TROPSCH OXYGENATES



* FS-GC = Fused Silica Capillary Gas Chromatography.

FIGURE 17

GAS CHROMATOGRAM OF C_6^+ ORGANIC PHASE ALCOHOLS AND ACIDS

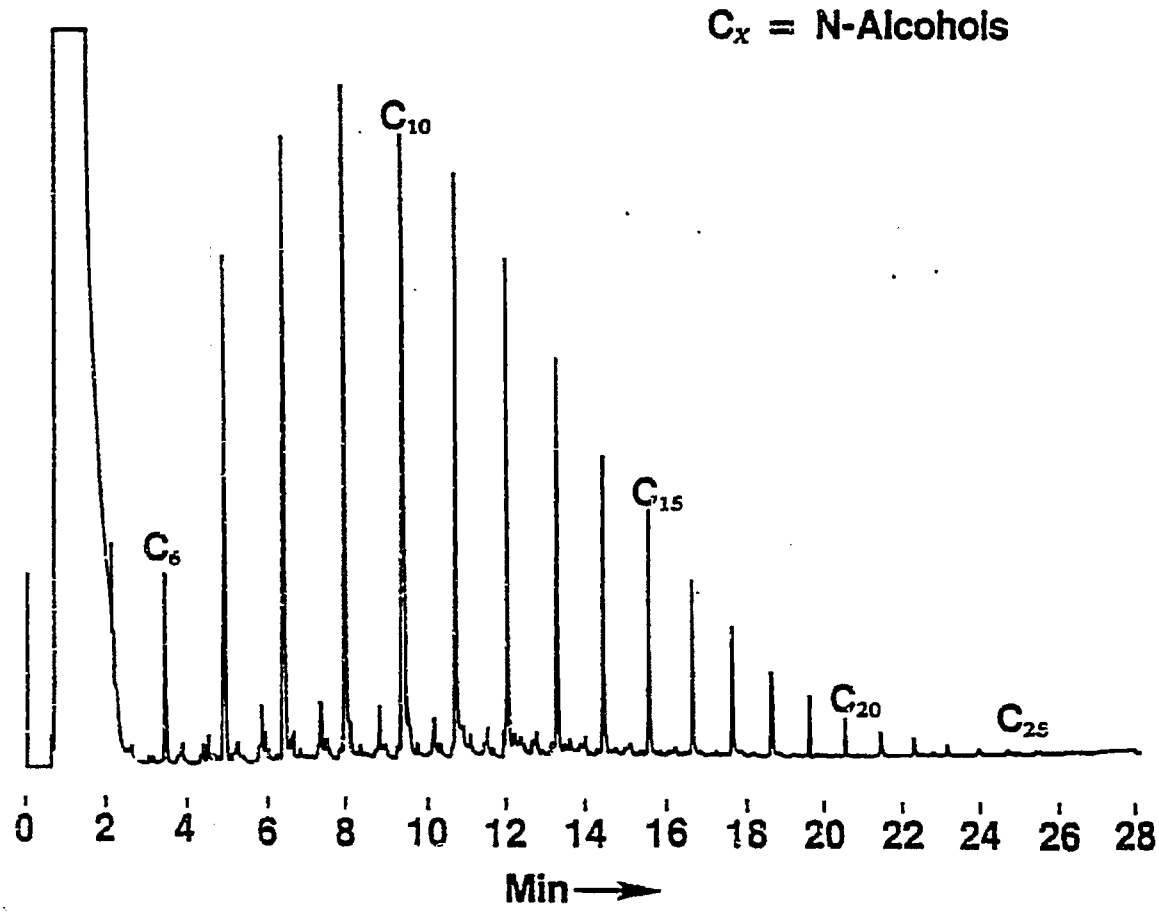


FIGURE 18

GAS CHROMATOGRAM OF C_5^+ ORGANIC PHASE KETONES AND ESTERS

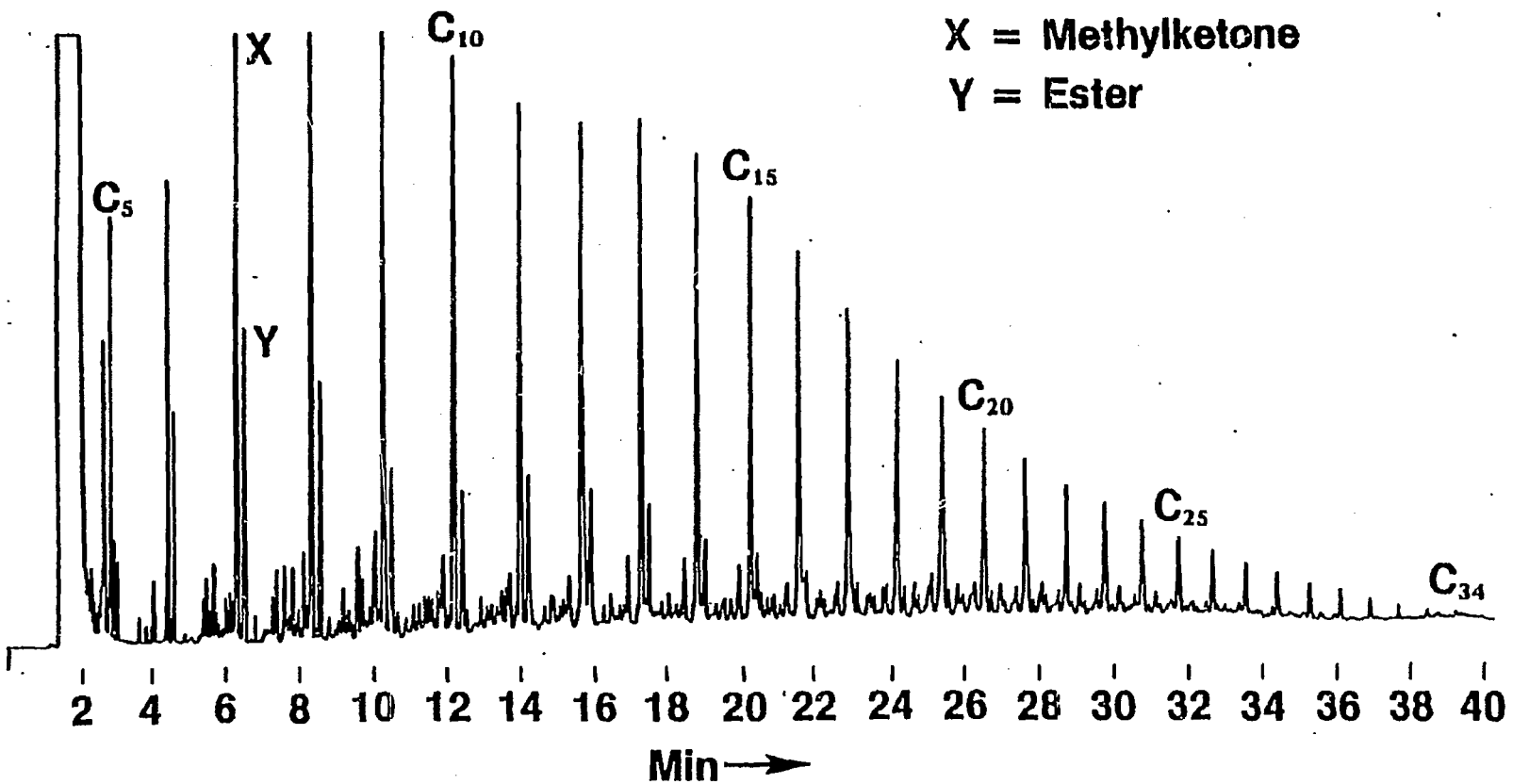


FIGURE 19

TYPICAL GAS CHROMATOGRAM OF TOTAL LIQUID HYDROCARBON PHASE

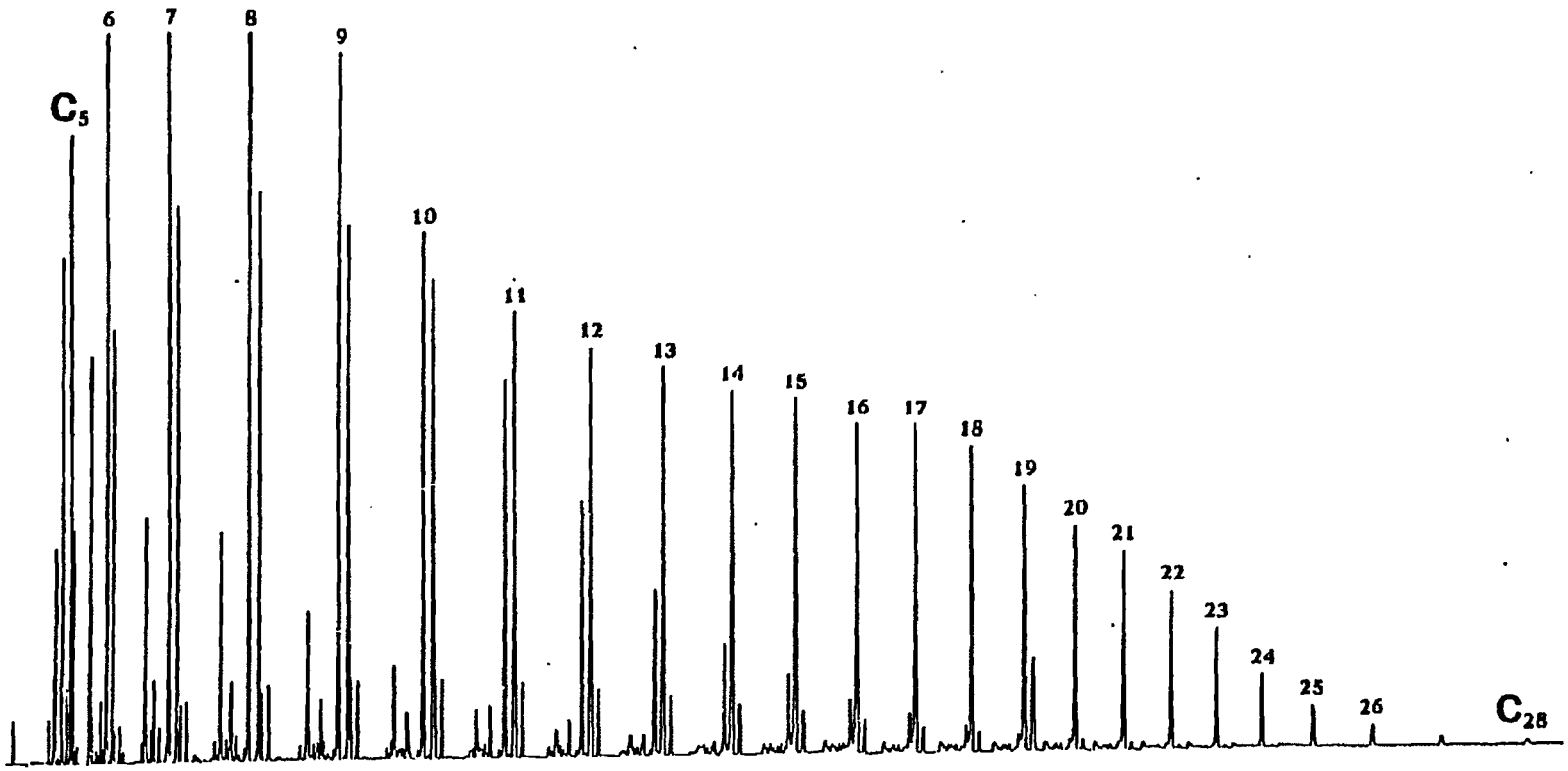
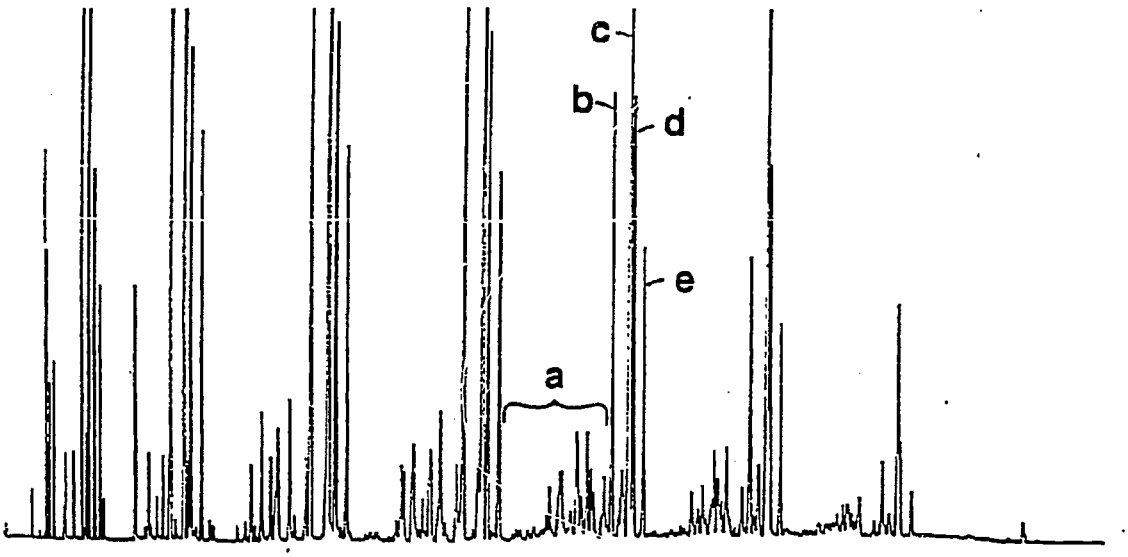


FIGURE 20

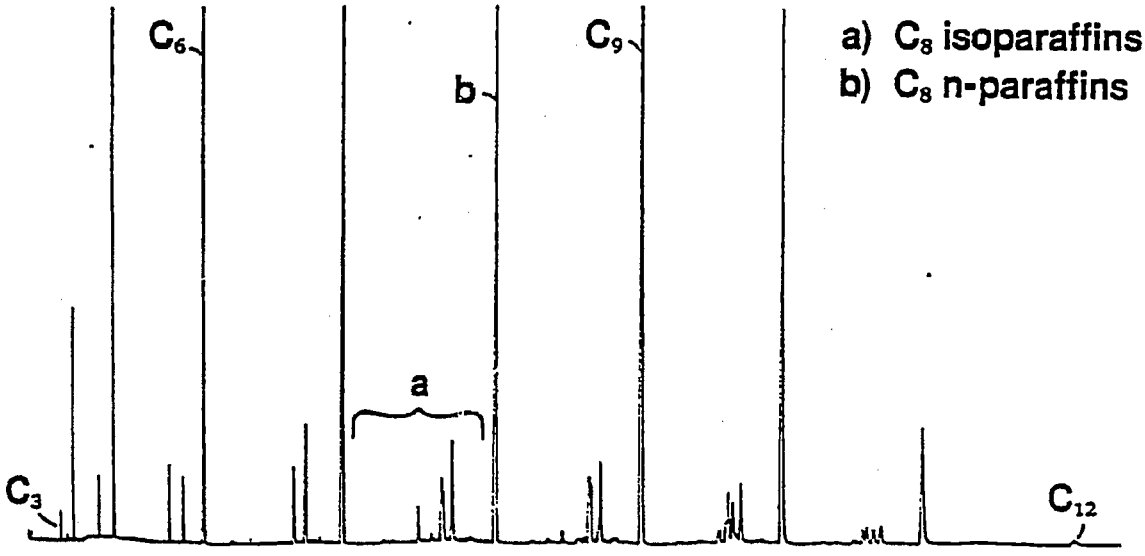
TYPICAL CHROMAGRAMS OF C_{11}^- FROM LIQUID HYDROCARBON PHASE

(A) OLEFINS + PARAFFINS



a) C_9 isoolefins + isoparaffins
b) C_9 α-olefin
c) C_9 n-paraffin
d) C_9 t-β-olefin
e) C_9 c-β-olefin

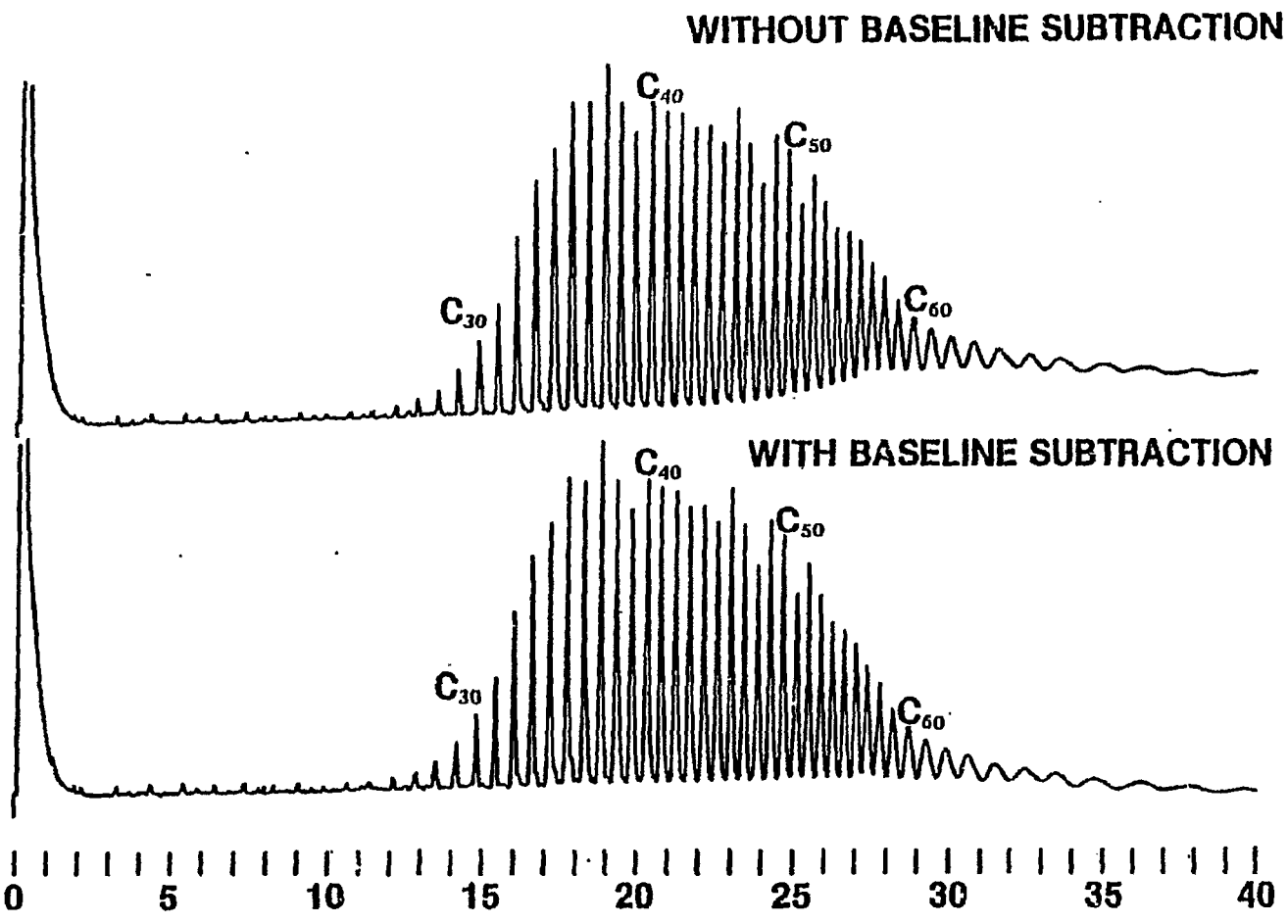
(B) PARAFFINS ONLY



a) C_8 isoparaffins
b) C_8 n-paraffins

FIGURE 21

GAS CHROMATOGRAM OF A HEAVY REACTOR-WAX



APPENDIX A

MATERIAL BALANCE DATA FROM CT-256

Table A-1
First Stage Fischer-Tropsch Slurry Reactor
Operating Conditions and Material Balances
Second-Stage Not-Operative
Run CT-256-3

(Nitrogen-Free Basis)										
M.B. No.	3- 1	3- 2	3- 3	3- 4	3- 5	3- 46	3- 47	3- 48	3- 49	3- 50
Days On-stream	3.4	4.4	5.4	6.4	7.4	48.5	49.5	50.5	51.5	52.5
First-Stage Conditions:										
Charge H2/CO (Molar)	0.701	0.676	0.677	0.689	0.677	0.675	0.680	0.678	0.681	0.693
Temperature, oC	257	259	259	259	259	261	261	261	262	262
Pressure, MPa	1.480	1.480	1.480	1.480	1.480	1.480	1.494	1.501	1.487	1.487
Feed Sup. Vel., cm/s	3.652	3.713	3.696	3.719	3.918	3.210	3.131	3.149	3.176	3.230
Space Vel., NL/gFe-hr	2.373	2.402	2.394	2.404	2.541	2.101	2.068	2.088	2.082	2.120
N2 in Feed, Mol %	6.5	6.7	6.6	6.7	6.4	6.5	6.4	6.4	6.5	6.4
Conversions, Mol % :										
H2	75.36	79.19	78.59	79.53	79.53	80.37	78.82	80.02	78.53	77.56
CO	90.29	91.75	90.68	90.98	91.59	89.85	88.74	90.42	90.13	88.92
H2+CO	84.14	86.69	85.79	86.30	86.72	86.03	84.73	86.22	85.43	84.27
Yields, Wt % of Products :										
Hydrocarbons (1)	21.24	22.50	21.81	21.87	22.10	22.73	22.03	21.52	21.44	22.47
CO2	67.92	68.10	68.02	68.54	68.43	66.64	66.38	68.17	68.05	65.65
H2O (1)	1.07	0.82	0.94	0.79	0.86	0.71	0.78	0.65	0.72	0.87
H2	1.11	0.94	0.93	0.89	0.92	0.85	0.91	0.89	0.95	1.01
CO	8.66	7.64	8.30	7.90	7.70	9.07	9.90	8.76	8.84	10.00
Total	100	100	100	100	100	100	100	100	100	100
Bal Recovery, Wt % of Charge:	106.03	102.57	106.38	107.80	103.71	106.01	107.55	103.73	105.69	104.97
g HC/Nm3 (H2+CO) convtd.:	217	218	222	223	216	227	227	210	214	225
Selectivities, Wt % of HC :										
Methane	5.69	5.85	5.85	5.86	6.15	7.59	7.86	7.99	8.20	7.97
Ethene	2.29	2.16	2.12	1.91	1.79	1.40	1.49	1.52	1.53	1.51
Ethane	2.75	2.61	2.60	2.61	2.74	2.85	2.95	3.21	3.33	3.11
Propene	7.64	7.54	7.56	7.32	7.54	7.84	8.18	8.13	8.41	8.17
Propane	1.38	1.39	1.50	1.51	1.59	1.88	1.88	2.22	2.27	1.93
Butenes	6.10	6.00	6.06	5.86	6.03	5.87	6.04	6.21	6.39	5.99
i-Butane	0.08	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
n-Butane	1.44	1.47	1.48	1.48	1.57	1.85	1.92	1.95	2.00	1.91
C5 - C11	14.79	15.71	15.34	14.49	14.52	8.63	9.12	8.72	9.14	8.78
Light Hydrocarbons (3)	21.15	20.42	19.89	20.62	20.60	33.34	31.02	30.12	29.01	31.91
Heavy Hydrocarbons (4)	23.82	24.17	25.54	25.85	25.69	22.23	23.29	23.73	23.62	22.75
Slurry Rx. Wax	12.76	12.34	11.89	11.75	11.14	6.42	6.18	5.97	5.85	5.76
Total	100	100	100	100	100	100	100	100	100	100

(1) Including Oxygenates
(2) In Gas Phase Only
(3) Collected in Chilled and Ambient Condensers
(4) Collected in Hot Condenser

Table A-2
First Stage Fischer-Tropsch Slurry Reactor
Operating Conditions and Material Balances
Based on Inter-Reactor Sample
Run CT-256-3

(Nitrogen-Free Basis)										
M.B. No.	3- 8	3- 9	3- 11	3- 12	3- 13	3- 19	3- 20	3- 21	3- 22	3- 23
Days On-stream	10.3	11.3	13.4	14.4	15.4	20.0	21.0	22.0	23.0	24.0
First-Stage Conditions:										
Charge H2/CO (Molar)	0.680	0.679	0.681	0.688	0.684	0.689	0.689	0.683	0.685	0.687
Temperature, oC	259	260	260	259	260	259	259	260	260	259
Pressure, MPa	1.480	1.480	1.480	1.480	1.480	1.480	1.480	1.480	1.480	1.487
Feed Sup. Vel., cm/s	3.850	3.851	3.926	3.906	3.887	3.729	3.701	3.734	3.829	3.736
Space Vel., NL/gFe-hr	2.580	2.569	2.600	2.578	2.598	2.494	2.498	2.502	2.507	2.516
N2 in Feed, Mol %	4.5	4.9	5.6	5.9	4.7	4.7	3.9	4.5	6.6	4.5
Conversions, Mol % :										
H2	78.40	77.91	77.74	76.22	77.24	78.85	82.33	79.12	78.36	81.17
CO	91.35	90.70	91.15	89.54	89.90	90.88	92.31	90.91	89.37	90.77
H2+CO	86.11	85.53	85.72	84.11	84.76	85.97	88.24	86.12	84.89	86.86
Yields, Wt % of Products :										
Hydrocarbons (1)	21.62	21.06	21.52	21.01	20.48	21.85	29.09	21.77	19.43	23.59
CO2	68.26	68.28	68.53	68.64	68.79	68.20	61.65	67.98	69.41	65.90
H2O (1)	0.90	1.01	0.69	0.71	0.85	0.87	0.81	0.92	0.78	0.86
H2	1.00	1.01	1.02	0.98	0.99	0.94	0.87	0.95	0.95	0.89
CO	8.21	8.65	8.24	8.66	8.89	8.15	7.58	8.38	9.43	8.77
Total	100	100	100	100	100	100	100	100	100	100
Bal Recovery, Wt % of Charge:	100.38	102.30	102.11	113.65	107.55	106.08	96.81	103.05	106.61	100.18
g HC/Nm3 (H2+CO) conv.:	205	205	208	231	211	218	253	211	198	220
Selectivities, Wt % of HC :										
Methane	6.37	6.60	6.60	6.98	6.95	7.12	9.42	6.93	7.55	6.02
Ethene	1.65	1.66	1.61	1.66	1.41	1.47	3.75	1.47	1.64	1.32
Ethane	2.87	2.93	2.87	2.90	2.96	2.86	1.91	2.79	3.13	2.52
Propene	7.46	7.64	7.64	8.04	7.86	7.82	10.02	7.54	8.18	6.64
Propane	1.78	1.85	1.84	1.83	1.81	1.90	2.46	1.81	2.23	1.77
Butenes	6.03	6.04	6.25	6.57	6.35	6.40	8.07	5.99	6.81	5.50
i-Butane	0.00	0.07	0.06	0.07	0.07	0.07	0.08	0.06	0.07	0.05
n-Butane	1.68	1.75	1.80	1.92	1.85	1.96	2.46	1.85	2.06	1.69
C5 - C11 (2)	15.68	14.19	18.93	21.18	11.56	14.30	17.02	12.71	12.38	15.69
Light Hydrocarbons (3)	17.13	17.23	14.16	12.54	18.18	17.29	13.81	18.50	20.13	19.27
Heavy Hydrocarbons (4)	28.56	29.27	27.33	25.00	31.39	28.62	20.87	30.62	26.93	29.95
Slurry Rx. Wax	10.43	10.26	9.88	9.80	9.60	9.26	9.08	9.00	8.91	8.68
Total	100	100	100	100	100	100	100	100	100	100

(1) Including Oxygenates
(2) In Gas Phase Only
(3) Collected in Chilled and Ambient Condensers
(4) Collected in Hot Condenser

Table A-2 (Contd.)
First Stage Fischer-Tropsch Slurry Reactor
Operating Conditions and Material Balances
Based on Inter-Reactor Sample
Run CT-256-3

(Nitrogen-Free Basis)										
M.B. No.	3- 24	3- 25	3- 28	3- 29	3- 30	3- 31	3- 32	3- 33	3- 34	3- 35
Days On-stream	25.0	26.0	29.0	30.5	31.5	32.5	33.5	34.5	35.5	36.5
First-Stage Conditions:										
Charge H2/CO (Molar)	0.685	0.689	0.694	0.665	0.686	0.679	0.702	0.696	0.695	0.685
Temperature, oC	260	260	261	261	260	260	260	260	259	260
Pressure, MPa	1.480	1.480	1.480	1.480	1.487	1.480	1.480	1.446	1.480	1.494
Feed Sup. Vel., cm/s	3.732	3.727	3.590	3.530	3.546	3.428	3.426	3.472	3.409	3.375
Space Vel., NL/gFe-hr	2.497	2.489	2.388	2.343	2.373	2.282	2.279	2.253	2.273	2.267
N2 in Feed, Mol %	4.5	4.7	4.9	5.2	5.0	5.1	5.1	5.2	5.0	5.0
Conversions, Mol % :										
H2	78.35	77.47	78.16	71.19	75.58	77.80	79.45	79.50	79.07	79.86
CO	90.33	89.04	89.80	80.15	86.21	89.61	91.15	91.60	91.97	91.44
H2+CO	85.46	84.32	85.03	76.57	81.88	84.83	86.33	86.63	86.68	86.73
Yields, Wt % of Products :										
Hydrocarbons (1)	21.48	21.54	21.94	20.39	21.66	21.96	22.63	22.37	23.56	22.99
CO2	67.71	66.58	67.22	60.55	64.26	66.85	67.54	68.27	67.28	67.42
H2O (1)	0.77	0.79	0.75	0.35	0.57	0.78	0.78	0.81	0.82	0.84
H2	1.00	1.03	0.98	1.22	1.09	0.99	0.95	0.93	0.96	0.91
CO	9.04	10.06	9.11	17.50	12.43	9.43	8.10	7.61	7.38	7.84
Total	100	100	100	100	100	100	100	100	100	100
Bal Recovery, Wt % of Charge:	101.76	103.47	106.10	107.54	105.26	104.61	103.66	104.61	103.32	103.74
g HC/Nm3 (H2+CO) conv.:	207	214	220	234	224	219	217	216	225	222
Selectivities, Wt % of HC :										
Methane	7.19	6.84	7.36	8.16	7.79	7.71	7.57	7.66	7.50	7.23
Ethene	1.55	1.47	1.52	2.12	1.71	1.54	1.41	1.40	1.29	1.34
Ethane	2.88	2.80	2.87	2.95	2.96	3.00	2.92	2.95	2.77	2.75
Propene	7.86	7.42	7.94	8.47	8.11	8.09	7.88	8.02	7.86	7.57
Propane	1.92	1.93	1.94	1.97	1.99	2.04	1.98	2.01	1.76	1.88
Butenes	6.25	6.04	6.30	6.52	6.41	6.42	6.25	6.34	6.07	6.01
i-Butane	0.06	0.06	0.07	0.07	0.07	0.07	0.07	0.07	0.06	0.06
n-Butane	1.94	1.87	1.97	1.99	2.00	2.03	1.99	2.01	1.94	1.93
C5 - C11 (2)	13.70	13.28	13.81	13.88	15.29	15.87	14.35	14.28	12.68	12.55
Light Hydrocarbons (3)	18.37	18.56	18.50	21.57	18.93	17.94	18.28	17.85	19.58	18.50
Heavy Hydrocarbons (4)	28.86	30.44	28.35	22.79	24.76	25.95	27.38	28.44	29.97	31.73
Slurry Rx. Wax	8.62	8.54	8.46	8.45	8.84	8.30	8.99	7.97	7.66	7.63
Total	100	100	100	100	100	100	100	100	100	100

(1) Including Oxygenates
(2) In Gas Phase Only
(3) Collected in Chilled and Ambient Condensers
(4) Collected in Hot Condenser

Table A-2 (Contd.)
First Stage Fischer-Tropsch Slurry Reactor
Operating Conditions and Material Balances
Based on Inter-Reactor Sample
Run CT-256-3

(Nitrogen-Free Basis)										
M.B. No.	3- 36	3- 37	3- 38	3- 39	3- 40	3- 41	3- 42	3- 43	3- 44	3- 53
Days On-stream	37.5	38.5	39.5	40.5	41.5	42.5	43.5	44.5	45.5	57.5
First-Stage Conditions:										
Charge H2/CO (Molar)	0.674	0.695	0.679	0.693	0.689	0.689	0.693	0.687	0.689	0.675
Temperature, oC	260	259	260	260	260	260	260	260	260	264
Pressure, MPa	1.487	1.480	1.494	1.480	1.480	1.480	1.508	1.494	1.494	1.480
Feed Sup. Vel., cm/s	3.391	3.402	3.370	3.407	3.379	3.452	3.267	3.292	3.270	3.180
Space Vel., NL/gFe-hr	2.275	2.273	2.282	2.288	2.269	2.277	2.228	2.232	2.217	2.095
N2 in Feed, Mol %	4.7	4.8	4.3	4.1	4.2	5.8	4.5	4.1	4.1	5.8
Conversions, Mol % :										
H2	80.75	80.74	80.94	80.25	79.08	79.38	76.16	77.52	75.43	78.35
CO	91.32	91.44	91.16	90.97	89.38	90.10	88.13	89.06	87.58	88.61
H2+CO	87.06	87.06	87.03	86.59	85.18	85.73	83.23	84.36	82.62	84.47
Yields, Wt % of Products :										
Hydrocarbons (1)	22.52	23.91	22.67	21.64	20.28	22.10	19.51	22.57	21.32	21.78
CO2	67.47	66.39	67.53	68.13	66.46	66.63	66.67	64.85	64.86	66.32
H20 (1)	0.70	0.85	0.73	0.74	2.29	0.75	2.04	0.89	0.74	0.54
H2	0.90	0.90	0.87	0.93	0.98	0.99	1.07	1.08	1.17	0.96
CO	8.40	7.95	8.20	8.56	9.99	9.53	10.71	10.60	11.91	10.40
Total	100	100	100	100	100	100	100	100	100	100
Bal Recovery, Wt % of Charge:	98.66	102.29	102.52	100.40	101.16	98.98	105.10	98.36	99.34	103.97
g HC/Nm3 (H2+CO) conv.:	207	226	216	201	194	205	198	212	206	217
Selectivities, Wt % of HC :										
Methane	7.16	6.71	6.93	7.63	7.88	7.35	8.14	6.98	7.69	8.30
Ethene	1.39	1.27	1.37	1.45	1.54	1.39	1.58	1.36	1.51	1.64
Ethane	2.73	2.54	2.64	2.83	2.94	2.76	3.12	2.66	2.86	3.47
Propene	7.62	7.11	7.28	8.02	8.29	7.62	8.45	7.22	7.91	8.79
Propane	1.89	1.76	1.88	1.94	2.06	1.87	2.17	1.83	1.97	2.31
Butenes	6.14	5.81	5.88	6.39	6.68	6.13	6.87	5.78	6.33	6.94
i-Butane	0.06	0.06	0.06	0.07	0.07	0.07	0.07	0.06	0.07	0.08
n-Butane	1.95	1.85	1.87	2.05	2.14	1.98	2.22	1.85	2.02	2.15
C5 - C11 (2)	15.79	16.29	14.72	15.96	17.49	16.74	17.74	14.36	15.60	15.54
Light Hydrocarbons (3)	18.12	18.99	21.12	17.98	22.77	17.81	18.74	21.35	17.13	17.24
Heavy Hydrocarbons (4)	28.62	29.05	28.04	27.63	20.11	28.37	22.96	28.93	29.24	27.68
Slurry Rx. Wax	7.47	7.31	7.22	6.96	6.84	6.82	6.72	6.69	6.59	4.83
Total	100	100	100	100	100	100	100	100	100	100

(1) Including Oxygenates
(2) In Gas Phase Only
(3) Collected in Chilled and Ambient Condensers
(4) Collected in Hot Condenser

Table A-2 (Contd.)
First Stage Fischer-Tropsch Slurry Reactor
Operating Conditions and Material Balances
Based on Inter-Reactor Sample
Run CT-256-3

(Nitrogen-Free Basis)								
M.B. No.	3- 56	3- 57	3- 58	3- 59	3- 60	3- 61	3- 62	3- 63
Days On-stream	64.5	66.5	68.5	70.5	72.5	74.5	76.5	78.5
First-Stage Conditions:								
Charge H2/CO (Molar)	0.691	0.693	0.601	0.601	0.607	0.596	0.600	0.634
Temperature, oC	266	265	265	266	265	266	266	264
Pressure, MPa	1.577	1.535	1.825	2.170	2.170	2.515	2.515	2.515
Feed Sup. Vel., cm/s	2.857	2.773	2.665	2.568	2.591	2.567	2.204	1.402
Space Vel., NL/gFe-hr	2.036	1.923	2.186	2.587	2.616	3.014	2.612	1.602
N2 in Feed, Mol %	7.1	7.3	7.7	4.6	4.5	4.0	3.2	6.9
Conversions, Mol % :								
H2	71.87	84.02	83.88	80.35	80.25	79.77	88.61	91.02
CO	78.73	80.57	83.27	79.36	79.23	78.68	87.60	92.11
H2+CO	75.93	81.98	83.50	79.73	79.62	79.09	87.98	91.69
Yields, Wt % of Products :								
Hydrocarbons (1)	20.15	20.16	21.17	19.75	20.04	19.62	20.81	18.54
CO2	60.42	61.47	62.61	60.49	59.90	58.41	66.64	73.96
H2O (1)	0.16	0.05	0.04	0.09	0.08	0.05	0.05	0.09
H2	1.19	0.72	0.65	0.78	0.80	0.80	0.48	0.37
CO	18.08	17.59	15.54	18.89	19.19	19.19	12.03	7.04
Total	100	100	100	100	100	100	100	100
Bal Recovery, Wt % of Charge:	110.68	104.53	102.78	104.33	103.37	102.78	98.79	106.33
g HC/Nm3 (H2+CO) conv.:	236	206	220	218	218	219	197	178
Selectivities, Wt % of HC :								
Methane	10.77	9.08	8.45	8.49	8.66	7.90	7.79	9.30
Ethene	2.84	2.54	2.25	2.56	2.37	2.36	2.06	2.41
Ethane	4.85	3.50	3.51	3.83	3.67	3.47	3.55	4.75
Propene	11.40	9.61	9.02	9.60	9.55	8.62	8.74	0.00
Propane	2.90	2.35	2.29	2.57	2.57	2.43	2.53	0.00
Butenes	8.32	8.70	6.69	7.18	7.22	6.48	6.70	9.27
i-Butane	0.14	0.08	0.09	0.13	0.12	0.13	0.12	0.16
n-Butane	2.50	0.51	2.07	2.26	2.32	2.23	2.30	2.71
C5 - C11 (2)	22.38	15.45	12.72	18.44	18.68	15.11	15.88	24.40
Light Hydrocarbons (3)	14.22	19.75	23.46	20.14	19.15	22.74	22.89	13.61
Heavy Hydrocarbons (4)	14.07	23.41	25.21	18.92	19.43	22.74	20.74	19.36
Slurry Rx. Wax	3.24	4.13	3.76	4.04	4.59	4.59	5.62	12.23
Total	100	100	100	100	100	100	100	100

(1) Including Oxygenates
(2) In Gas Phase Only
(3) Collected in Chilled and Ambient Condensers
(4) Collected in Hot Condenser

Table A-3
Composition of Hydrocarbon Products from
First-Stage Slurry F-T Reactor
Run CT-256-3

M.B.No.	3-1	3-2	3-3	3-4	3-5	(1) 3-8	(1) 3-9	(1) 3-11	(1) 3-12	(1) 3-13
Days On Stream	3.4	4.4	5.4	6.4	7.4	10.4	11.4	13.4	14.4	15.4
METHANE	5.69	5.85	5.85	5.86	6.15	6.37	6.60	6.60	6.98	6.95
ETHENE	2.29	2.16	2.12	1.91	1.79	1.65	1.66	1.61	1.66	1.41
ETHANE	2.75	2.61	2.60	2.61	2.74	2.87	2.93	2.87	2.90	2.96
PROPENE	7.64	7.54	7.56	7.32	7.54	7.46	7.64	7.64	8.04	7.86
PROPANE	1.38	1.39	1.50	1.51	1.59	1.78	1.85	1.84	1.83	1.81
I-BUTANE	0.08	0.07	0.07	0.07	0.07	0.00	0.07	0.06	0.07	0.07
1-BUTENE+2-METHYLPROPENE	5.68	5.58	5.66	5.46	5.61	5.61	5.78	5.83	6.16	5.98
N-BUTANE	1.44	1.47	1.48	1.48	1.57	1.68	1.75	1.80	1.92	1.85
TRANS-2-BUTENE	0.16	0.16	0.15	0.14	0.15	0.16	0.00	0.16	0.16	0.14
CIS-2-BUTENE	0.26	0.27	0.26	0.26	0.27	0.27	0.26	0.26	0.26	0.24
3-METHYL-1-BUTENE	0.39	0.34	0.45	0.31	0.30	0.34	0.26	0.27	0.27	0.26
I-PENTANE	0.24	0.36	0.22	0.18	0.17	0.18	0.16	4.54	0.17	0.17
1-PENTENE	4.21	4.30	4.32	4.11	4.19	4.14	4.27	1.51	4.89	0.04
2-METHYL-1-BUTENE	0.28	0.19	0.22	0.17	0.17	0.19	0.15	0.15	0.19	4.43
N-PENTANE	1.13	1.17	1.20	1.20	1.25	1.36	1.37	0.16	1.64	1.39
TRANS-2-PENTENE	0.11	0.12	0.12	0.12	0.13	0.13	0.13	0.01	0.15	0.06
CIS-2-PENTENE	0.15	0.15	0.14	0.14	0.15	0.15	0.15	0.00	0.16	0.13
2-METHYL-2-BUTENE	0.01	0.00	0.00	0.01	0.01	0.03	0.01	0.00	0.01	0.27
CYCLOPENTANE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08
HEXENES + ISO-HEXANES	0.62	0.67	0.74	0.68	0.66	0.63	0.58	0.81	0.20	0.12
2,3-DIMETHYLBUTANE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.11
2-METHYLPENTANE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.17
3-METHYLPENTANE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.15
1-HEXENE	2.61	2.99	2.85	2.70	2.67	2.57	2.64	3.08	3.46	0.11
N-HEXANE	0.77	0.93	0.88	0.87	0.90	0.92	0.95	1.17	1.28	0.10
HEPTENES + ISO-HEPTANES	0.54	0.64	0.59	0.57	0.57	1.06	0.51	0.85	0.95	0.00
1-HEPTENE	1.38	1.60	1.58	1.46	1.38	1.17	1.19	1.83	2.25	0.00
1-TRANS-3-DIMETHYL-N5	0.00	0.00	0.00	0.00	0.00	0.00	0.16	0.00	0.00	0.00
N-HEPTANE	0.49	0.56	0.54	0.55	0.54	0.50	0.51	0.86	1.01	0.00
C8-OLEFINS + ISO-P	0.45	0.33	0.35	0.31	0.31	0.69	0.22	0.66	0.80	0.00
1-OCTENE	0.60	0.63	0.55	0.53	0.52	0.40	0.35	0.98	1.30	0.00
N-OCTANE	0.28	0.29	0.24	0.27	0.25	0.21	0.19	0.53	0.74	0.00
C9-OLEFINS + ISO-P	0.26	0.16	0.15	0.11	0.16	0.84	0.26	0.78	0.73	0.00
C9-OLEFINS	0.19	0.17	0.13	0.12	0.11	0.10	0.07	0.36	0.51	0.00
N-NONANE	0.09	0.10	0.07	0.08	0.08	0.07	0.05	0.37	0.47	0.00
ACETONE	0.04	0.23	0.05	0.44	0.34	0.17	0.29	0.89	0.48	0.00
1-PROPANOL	0.06	0.04	0.04	0.23	0.24	0.20	0.22	0.15	0.36	0.00
N-BUTANONE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.66	0.00
UNKNOWN LITE HYDRO-CARB LIQ (2)	21.15	20.42	19.90	20.63	20.60	17.13	17.23	14.16	12.54	18.18
UNKNOWN HVY. HYDRO-CARB LIQ (3)	23.82	24.17	25.54	25.85	25.69	28.56	29.27	27.33	25.00	31.39
SLURRY REACTOR WAX	12.76	12.34	11.89	11.75	11.14	10.43	10.26	9.88	9.80	9.60

(1) Based on Inter-Reactor Sample
(2) Collected in Ambient and Chilled Condensers
(3) Collected in Hot Condenser

Table A-3 (Contd.)
Composition of Hydrocarbon Products from
First-Stage Slurry F-T Reactor
Run CT-256-3

	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
M.B.No.	3-19	3-20	3-21	3-22	3-23	3-24	3-25	3-28	3-29	3-30
Days On Stream	20.0	21.0	22.0	23.0	24.0	26.0	27.0	29.0	30.5	31.5
METHANE	7.12	9.42	6.93	7.55	6.02	7.19	6.84	7.36	8.16	7.79
ETHENE	1.47	3.75	1.47	1.64	1.32	1.55	1.47	1.52	2.12	1.71
ETHANE	2.86	1.91	2.79	3.13	2.52	2.88	2.80	2.87	2.95	2.96
PROPENE	7.82	10.02	7.54	8.18	6.64	7.86	7.42	7.94	8.47	8.11
PROPANE	1.90	2.46	1.81	2.23	1.77	1.92	1.93	1.94	1.97	1.99
I-BUTANE	0.07	0.08	0.06	0.07	0.05	0.06	0.06	0.07	0.07	0.07
1-BUTENE+2-METHYLPROPENE	6.02	7.61	5.65	6.44	5.19	5.89	5.71	5.95	6.26	6.11
N-BUTANE	1.96	2.46	1.85	2.06	1.69	1.94	1.87	1.97	1.99	2.00
TRANS-2-BUTENE	0.15	0.18	0.13	0.14	0.12	0.14	0.12	0.13	0.10	0.11
CIS-2-BUTENE	0.24	0.29	0.21	0.23	0.19	0.22	0.20	0.21	0.17	0.20
3-METHYL-1-BUTENE	0.24	0.30	0.22	0.25	0.20	0.23	0.22	0.22	0.26	0.24
I-PENTANE	0.15	0.19	0.14	0.16	0.13	0.15	0.15	0.14	0.17	0.16
1-PENTENE	4.56	5.70	4.12	4.82	4.02	4.40	4.28	4.44	4.57	4.62
2-METHYL-1-BUTENE	0.13	0.15	0.11	0.13	0.11	0.11	0.11	0.11	0.12	0.14
N-PENTANE	1.51	1.88	1.37	1.59	1.33	1.48	1.40	1.49	1.43	1.53
TRANS-2-PENTENE	0.12	0.14	0.11	0.11	0.10	0.11	0.10	0.10	0.08	0.09
CIS-2-PENTENE	0.14	0.16	0.13	0.13	0.12	0.12	0.11	0.11	0.09	0.10
2-METHYL-2-BUTENE	0.01	0.00	0.00	0.25	0.00	0.00	0.00	0.00	0.00	0.00
2,2-DIMETHYLBUTANE	0.00	0.00	0.00	0.00	0.04	0.00	0.05	0.00	0.00	0.00
CYCLOPENTANE	0.00	0.00	0.00	0.09	0.09	0.00	0.08	0.00	0.00	0.00
HEXENES + ISO-HEXANES	0.07	0.23	0.15	0.03	0.00	0.18	0.00	0.19	0.20	0.21
2,3-DIMETHYLBUTANE	0.00	0.00	0.00	0.11	0.06	0.00	0.06	0.00	0.00	0.00
1-HEXENE	2.82	3.42	2.37	3.27	2.65	2.63	2.59	2.69	2.82	2.92
N-HEXANE	1.03	1.24	0.87	1.18	0.99	0.96	0.92	0.96	0.94	1.02
HEPTENES + ISO-HEPTANES	0.49	0.52	0.33	0.09	0.70	0.41	0.39	0.40	0.35	0.43
1-HEPTENE	1.28	1.43	1.03	0.00	1.50	1.15	1.13	1.19	1.31	1.45
N-HEPTANE	0.55	0.60	0.39	0.00	0.65	0.48	0.47	0.49	0.48	0.56
C8-OLEFINS + ISO-P	0.23	0.16	0.56	0.00	0.49	0.18	0.18	0.21	0.16	0.27
1-OCTENE	0.41	0.40	0.25	0.00	0.74	0.38	0.36	0.38	0.42	0.55
N-OCTANE	0.24	0.23	0.13	0.00	0.44	0.23	0.20	0.21	0.19	0.27
C9-OLEFINS + ISO-P	0.15	0.11	0.28	0.00	0.77	0.37	0.29	0.23	0.10	0.39
1-NONENE	0.00	0.00	0.15	0.00	0.00	0.00	0.00	0.00	0.12	0.19
C9-OLEFINS	0.11	0.08	0.00	0.00	0.31	0.05	0.12	0.13	0.04	0.09
N-NONANE	0.08	0.07	0.00	0.00	0.26	0.07	0.09	0.10	0.04	0.07
ACETONE	0.27	0.31	0.20	0.08	0.29	0.23	0.23	0.26	0.33	0.36
I-PROPANOL	0.31	0.34	0.25	0.05	0.24	0.28	0.22	0.34	0.38	0.38
N-BUTANONE	0.35	0.38	0.26	0.00	0.37	0.30	0.30	0.31	0.34	0.39
UNKNOWN LITE HYDRO-CARB LIQ (2)	17.29	13.81	18.50	20.13	19.27	18.37	18.56	18.50	21.57	18.93
UNKNOWN HVY HYDRO-CARB LIQ (3)	28.62	20.87	30.62	26.93	29.95	28.86	30.44	28.35	22.79	24.76
SLURRY REACTOR WAX	9.26	9.08	9.00	8.91	8.68	8.62	8.54	8.46	8.45	8.84

(1) Based on Inter-Reactor Sample
(2) Collected in Ambient and Chilled Condensers
(3) Collected in Hot Condenser

Table A-3 (Contd.)
Composition of Hydrocarbon Products from
First-Stage Slurry F-T Reactor
Run CT-256-3

	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
M.B.No.	3-31	3-32	3-33	3-34	3-35	3-36	3-37	3-38	3-39	3-40
Days On Stream	32.5	33.5	34.5	35.5	36.5	37.5	38.5	39.5	40.5	41.5
METHANE	7.71	7.57	7.66	7.50	7.23	7.16	6.71	6.93	7.63	7.88
ETHENE	1.54	1.41	1.40	1.29	1.34	1.39	1.27	1.37	1.45	1.54
ETHANE	3.00	2.92	2.95	2.77	2.75	2.73	2.54	2.64	2.83	2.94
PROPENE	8.09	7.88	8.02	7.86	7.57	7.62	7.11	7.28	8.02	8.29
PROPANE	2.04	1.98	2.01	1.76	1.88	1.89	1.76	1.88	1.94	2.06
I-BUTANE	0.07	0.07	0.07	0.06	0.06	0.06	0.06	0.06	0.07	0.07
1-BUTENE+2-METHYLPROPENE	6.10	5.92	5.99	5.71	5.70	5.82	5.48	5.59	6.07	6.34
N-BUTANE	2.03	1.99	2.01	1.94	1.93	1.95	1.85	1.87	2.05	2.14
TRANS-2-BUTENE	0.12	0.13	0.14	0.13	0.12	0.12	0.11	0.11	0.12	0.12
CIS-2-BUTENE	0.20	0.21	0.22	0.22	0.20	0.20	0.22	0.18	0.20	0.22
3-METHYL-1-BUTENE	0.23	0.21	0.22	0.20	0.20	0.21	0.20	0.20	0.21	0.22
I-PENTANE	0.14	0.15	0.14	0.14	0.13	0.14	0.13	0.13	0.14	0.15
1-PENTENE	4.63	4.41	4.53	4.24	4.24	4.53	4.42	4.33	4.74	4.91
2-METHYL-1-BUTENE	0.11	0.11	0.11	0.10	0.10	0.12	0.10	0.09	0.12	0.11
N-PENTANE	1.54	1.49	1.54	1.46	1.43	1.55	1.51	1.47	1.61	1.65
TRANS-2-PENTENE	0.09	0.10	0.11	0.10	0.10	0.10	0.10	0.09	0.10	0.10
CIS-2-PENTENE	0.11	0.12	0.12	0.11	0.11	0.11	0.11	0.10	0.11	0.11
2-METHYL-2-BUTENE	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00
HEXENES + ISO-HEXANES	0.22	0.19	0.20	0.18	0.17	0.22	0.25	0.21	0.23	0.25
1-HEXENE	2.90	2.68	2.79	2.49	2.52	2.91	3.08	2.81	3.07	3.20
N-HEXANE	1.03	0.97	1.03	0.93	0.92	1.06	1.13	1.02	1.11	1.16
HEPTENES + ISO-HEPTANES	0.47	0.40	0.42	0.36	0.34	0.47	0.51	0.43	0.46	0.50
1-HEPTENE	1.45	1.22	1.23	1.04	1.06	1.46	1.59	1.37	1.43	1.69
N-HEPTANE	0.59	0.51	0.53	0.45	0.44	0.61	0.66	0.56	0.58	0.69
C8-OLEFINS + ISO-P	0.33	0.23	0.25	0.14	0.11	0.33	0.33	0.24	0.27	0.38
1-OCTENE	0.64	0.47	0.39	0.31	0.31	0.61	0.67	0.53	0.58	0.67
N-OCTANE	0.35	0.26	0.22	0.17	0.17	0.35	0.36	0.29	0.33	0.37
C9-OLEFINS + ISO-P	0.32	0.24	0.18	0.12	0.04	0.30	0.41	0.28	0.26	0.48
C9-OLEFINS	0.27	0.21	0.11	0.08	0.07	0.28	0.25	0.21	0.23	0.31
N-NONANE	0.19	0.16	0.08	0.06	0.05	0.21	0.20	0.16	0.17	0.23
N-DECANE	0.13	0.11	0.05	0.00	0.02	0.11	0.13	0.11	0.10	0.15
N-DECENES	0.11	0.11	0.04	0.00	0.02	0.12	0.13	0.10	0.10	0.14
ACETONE	0.32	0.27	0.30	0.25	0.22	0.33	0.43	0.31	0.33	0.37
I-PROPANOL	0.35	0.37	0.38	0.36	0.33	0.38	0.40	0.33	0.40	0.40
N-BUTANONE	0.38	0.30	0.32	0.26	0.25	0.35	0.42	0.33	0.35	0.42
UNKNOWN LITE HYDRO-CARB LIQ (2)	17.94	18.28	17.85	19.58	18.50	18.12	18.99	21.12	17.98	22.77
UNKNOWN HVY HYDRO-CARB LIQ (3)	25.95	27.38	28.44	29.97	31.73	28.62	29.05	28.04	27.63	20.11
SLURRY REACTOR WAX	8.30	8.99	7.97	7.66	7.63	7.47	7.31	7.22	6.96	6.84

(1) Based on Inter-Reactor Sample
(2) Collected in Ambient and Chilled Condensers
(3) Collected in Hot Condenser

Table A-3 (Contd.)
Composition of Hydrocarbon Products from
First-Stage Slurry F-T Reactor
Run CT-256-3

M.B.No.	(1) 3-41	(1) 3-42	(1) 3-43	(1) 3-44	3-46	3-47	3-48	3-49	3-50	(1) 3-53
Days On Stream	42.5	43.5	44.5	45.5	48.5	49.5	50.5	51.5	52.5	57.5
METHANE	7.35	8.14	6.98	7.69	7.59	7.86	7.99	8.20	7.97	8.30
ETHENE	1.39	1.58	1.36	1.51	1.40	1.49	1.52	1.53	1.51	1.64
ETHANE	2.76	3.12	2.66	2.86	2.85	2.95	3.21	3.33	3.11	3.47
PROPENE	7.62	8.45	7.22	7.91	7.84	8.18	8.13	8.41	8.17	8.79
PROPANE	1.87	2.17	1.83	1.97	1.89	1.88	2.22	2.27	1.93	2.31
I-BUTANE	0.07	0.07	0.06	0.07	0.07	0.07	0.07	0.07	0.07	0.08
1-BUTENE+2-METHYLPROPENE	5.82	6.50	5.50	6.00	5.56	5.72	5.87	6.02	5.62	6.52
N-BUTANE	1.98	2.22	1.85	2.02	1.85	1.92	1.95	2.00	1.91	2.15
TRANS-2-BUTENE	0.12	0.13	0.11	0.11	0.12	0.12	0.13	0.14	0.14	0.16
CIS-2-BUTENE	0.20	0.24	0.17	0.21	0.19	0.20	0.21	0.23	0.23	0.26
3-METHYL-1-BUTENE	0.21	0.23	0.19	0.21	0.20	0.00	0.21	0.23	0.22	0.28
I-PENTANE	0.13	0.15	0.13	0.14	0.37	0.20	0.19	0.22	0.15	0.16
1-PENTENE	4.63	5.07	4.23	4.60	0.00	0.17	3.85	3.90	3.71	4.83
2-METHYL-1-BUTENE	0.10	0.11	0.09	0.11	0.00	0.26	0.09	0.09	0.10	0.13
N-PENTANE	1.59	1.76	1.44	1.58	3.58	3.80	1.25	1.29	1.28	1.63
TRANS-2-PENTENE	0.10	0.11	0.09	0.10	0.00	0.00	0.09	0.11	0.11	0.13
CIS-2-PENTENE	0.11	0.12	0.10	0.11	0.00	0.00	0.10	0.11	0.11	0.15
2-METHYL-2-BUTENE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00
UNKNOWN C5-MONOOLEFINS	0.00	0.00	0.00	0.00	4.48	4.70	0.00	0.00	0.00	0.00
2,2-DIMETHYLBUTANE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.14	0.14	0.00
CYCLOPENTANE	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.05	0.04	0.00
HEXENES + ISO-HEXANES	0.23	0.26	0.19	0.21	0.00	0.00	0.07	0.04	0.03	0.26
ISO-C6-P10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.03	0.00
2,3-DIMETHYLBUTANE	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.00
2-METHYLPENTANE	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.00
3-METHYLPENTANE	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.00	0.00
1-HEXENE	3.10	3.31	2.69	2.91	0.00	0.00	1.56	1.65	1.55	3.04
N-HEXANE	1.15	1.23	0.99	1.06	0.00	0.00	0.54	0.59	0.58	1.12
HEPTENES + ISO-HEPTANES	0.50	0.55	0.43	0.45	0.00	0.00	0.09	0.15	0.15	0.53
1-HEPTENE	1.57	1.67	1.30	1.42	0.00	0.00	0.32	0.37	0.33	1.40
N-HEPTANE	0.65	0.72	0.55	0.59	0.00	0.00	0.12	0.14	0.14	0.60
C8-OLEFINS + ISO-P	0.34	0.34	0.24	0.28	0.00	0.00	0.01	0.03	0.03	0.26
1-OCTENE	0.69	0.66	0.51	0.56	0.00	0.00	0.04	0.04	0.04	0.44
N-OCTANE	0.39	0.39	0.29	0.31	0.00	0.00	0.02	0.02	0.02	0.25
C9-OLEFINS + ISO-P	0.37	0.43	0.36	0.36	0.00	0.00	0.00	0.00	0.00	0.15
C9-OLEFINS	0.32	0.24	0.20	0.22	0.00	0.00	0.00	0.00	0.00	0.00
N-NONANE	0.24	0.19	0.15	0.17	0.00	0.00	0.00	0.00	0.00	0.00
N-DECANE	0.16	0.11	0.10	0.10	0.00	0.00	0.00	0.00	0.00	0.11
N-DECENES	0.16	0.11	0.10	0.11	0.00	0.00	0.00	0.00	0.00	0.08
ACETONE	0.35	0.43	0.30	0.34	0.03	0.00	0.16	0.17	0.13	0.29
I-PROPANOL	0.37	0.36	0.29	0.37	0.00	0.00	0.00	0.00	0.00	0.33
N-BUTANONE	0.38	0.44	0.34	0.36	0.00	0.00	0.00	0.00	0.00	0.41
UNKNOWN LITE HYDRO-CARB LIQ (2)	17.81	18.74	21.35	17.13	33.34	31.02	30.13	28.96	31.90	17.24
UNKNOWN HVY HYDRO-CARB LIQ (3)	28.37	22.96	29.93	29.24	22.23	23.29	23.73	23.62	22.75	27.68
SLURRY REACTOR WAX	6.82	6.72	6.69	6.59	6.42	6.18	5.97	5.85	5.76	4.83

(1) Based on Inter-Reactor Sample
(2) Collected in Ambient and Chilled Condensers
(3) Collected in Hot Condenser

Table A-3 (Contd.)
Composition of Hydrocarbon Products from
First-Stage Slurry F-T Reactor
Run CT-256-3

M.B.No.	(1) 3-56	(1) 3-57	(1) 3-58	(1) 3-59	(1) 3-60	(1) 3-61	(1) 3-62	(1) 3-63
Days On Stream	64.5	66.5	68.5	70.5	72.5	74.5	76.5	78.5
METHANE	10.77	9.08	8.45	8.49	8.66	7.90	7.79	9.30
ETHENE	2.84	2.54	2.25	2.56	2.37	2.36	2.06	2.41
ETHANE	4.85	3.50	3.51	3.83	3.67	3.47	3.55	4.75
PROPENE	11.40	9.61	9.02	9.60	9.55	8.62	8.74	0.00
PROPANE	2.90	2.35	2.29	2.57	2.57	2.43	2.53	0.00
I-BUTANE	0.14	0.08	0.09	0.13	0.12	0.13	0.12	0.16
1-BUTENE+2-METHYLPROPENE	7.84	6.45	6.43	6.90	6.93	6.22	6.38	8.50
N-BUTANE	2.50	0.51	2.07	2.26	2.32	2.23	2.30	2.71
TRANS-2-BUTENE	0.16	2.14	0.09	0.09	0.10	0.08	0.11	0.30
CIS-2-BUTENE	0.32	0.11	0.16	0.19	0.20	0.18	0.20	0.48
3-METHYL-1-BUTENE	0.50	0.19	0.32	0.44	0.40	0.35	0.34	0.58
I-PENTANE	0.25	0.28	0.17	0.22	0.26	0.20	0.18	0.25
1-PENTENE	5.39	0.34	0.00	4.80	4.87	4.30	4.42	6.07
2-METHYL-1-BUTENE	0.20	4.95	0.00	0.16	0.16	0.14	0.14	0.26
N-PENTANE	1.85	0.13	0.00	1.66	1.71	1.58	1.65	2.12
TRANS-2-PENTENE	0.12	1.54	0.00	0.07	0.07	0.06	0.08	0.21
CIS-2-PENTENE	0.15	0.09	0.00	0.09	0.11	0.08	0.10	0.24
2-METHYL-2-BUTENE	0.00	0.10	0.00	0.00	0.12	0.02	0.02	0.00
HEXENES + ISO-HEXANES	0.46	0.28	0.00	0.38	0.37	0.29	0.33	0.58
1-HEXENE	3.51	3.00	4.36	3.18	3.23	2.68	2.68	4.04
N-HEXANE	1.29	0.98	1.43	1.16	1.19	1.04	1.08	1.58
HEPTENES + ISO-HEPTANES	1.01	0.41	0.83	0.71	0.65	0.52	0.51	1.21
1-HEPTENE	2.07	1.35	2.46	1.80	1.79	1.34	1.35	2.18
N-HEPTANE	0.87	0.49	0.85	0.73	0.74	0.57	0.64	1.04
C8-OLEFINS + ISO-P	0.78	0.21	0.32	0.50	0.47	0.29	0.36	0.71
1-OCTENE	1.08	0.43	0.98	0.80	0.83	0.56	0.59	1.01
N-OCTANE	0.58	0.19	0.37	0.39	0.42	0.28	0.33	0.61
C9-OLEFINS + ISO-P	0.85	0.50	0.11	0.45	0.45	0.29	0.39	0.62
C9-OLEFINS	0.54	0.00	0.28	0.35	0.32	0.21	0.27	0.41
N-NONANE	0.38	0.00	0.13	0.22	0.21	0.13	0.18	0.31
N-DECANE	0.26	0.00	0.07	0.17	0.16	0.10	0.14	0.19
N-DECENES	0.24	0.00	0.04	0.14	0.13	0.08	0.11	0.18
ACETONE	0.82	0.46	0.20	0.67	0.62	0.40	0.28	0.41
I-PROPANOL	0.50	0.00	0.26	0.38	0.44	0.30	0.29	0.53
N-BUTANONE	1.06	0.44	0.00	0.79	0.61	0.50	0.52	0.86
UNKNOWN LITE HYDRO-CARB LIQ (2)	14.22	19.75	23.46	20.14	19.15	22.74	22.89	13.61
UNKNOWN HVY HYDRO-CARB LIQ (3)	14.07	23.41	25.21	18.92	19.43	22.74	20.74	19.36
SLURRY REACTOR WAX	3.24	4.13	3.76	4.04	4.59	4.59	5.62	12.23

(1) Based on Inter-Reactor Sample
(2) Collected in Ambient and Chilled Condensers
(3) Collected in Hot Condenser

Table A-4
Composition of Fischer-Tropsch
Hydrocarbon Phase Oxygenates
Run CT-256-3

M.B.No.	3-4	3-48	3-61	3-64
Days on Stream	6.4	50.5	74.5	80.5
Component	Weight % of Hydrocarbon Phase			
METHANOL	0.350	0.650	1.800	1.330
FORMIC ACID	0.033	0.090	0.040	0.120
ETHANOL	1.550	2.310	5.270	4.550
ACETIC ACID	0.140	0.290	0.340	0.510
ACETONE	0.170	0.420	0.540	0.370
PROPANOLS	1.520	2.250	3.940	3.410
PROPANOIC ACIDS	0.058	0.130	0.150	0.280
C4-ESTERS + I-KETONE	0.210	0.460	0.570	0.500
BUTANOLS	0.910	1.390	2.190	1.970
BUTANOIC ACIDS	0.037	0.081	0.070	0.140
C5-ESTERS + I-PENTANONE	0.190	0.360	0.410	0.380
PENTANOLS	0.843	0.842	1.132	0.940
C6-ESTERS + I-KETONES	0.000	0.000	0.000	0.204
HEXANOLS	0.151	0.334	0.638	0.000
C7-ESTERS + I-KETONES	0.001	0.001	0.039	0.568
HEPTANOLS	0.427	0.627	1.117	0.025
C8-ESTERS + I-KETONES	0.133	0.064	0.234	0.681
OCTANOLS	0.583	0.781	1.126	0.416
C9-ESTERS + I-KETONES	0.356	0.347	0.428	0.669
NONANOLS	0.532	0.667	0.941	1.501
C10-ESTERS + I-KETONES	0.432	0.447	0.533	0.621
DECANOLS	0.418	0.515	0.747	1.388
C11-ESTERS + I-KETONES	0.402	0.460	0.517	0.547
C11-NOLS	0.283	0.380	0.558	1.105
C12 PLUS ESTERS + I-KETONES	1.376	1.781	2.249	2.111
C12 PLUS ALKANOLS	0.503	0.883	1.370	2.765
Total, Wt %	11.608	16.561	26.900	27.100
Yield per HC Produced,g/100g	4.793	8.922	12.293	--

Table A-5
Composition of Fischer-Tropsch
Aqueous Phase Organic Oxygenates
Run CT-256-3

M.B.No.	3-4	3-10	3-25	3-32	3-48
Days On Stream	6.4	12.4	26.0	33.5	50.5
Component	Weight % of Aqueous Phase				
METHANOL	5.01	7.46	7.68	7.16	10.40
ETHANOL	11.49	15.45	14.85	14.26	17.45
ACETIC ACID	0.59	0.39	0.15	0.20	0.10
ACETONE	0.67	1.22	1.50	1.45	2.27
N-PROPANOL	3.07	4.80	5.45	5.27	5.10
I-PROPANOL	0.43	0.87	1.01	1.02	1.28
PROPANOIC ACIDS	0.16	0.15	0.14	0.17	0.10
C4-ESTERS + I-KETONE	0.23	0.21	0.73	0.68	1.09
N-BUTANOL	1.02	2.32	2.34	2.12	1.51
N-2-BUTANOL	0.11	0.09	0.36	0.36	0.31
OTHER BUTANOLS	0.03	0.03	0.02	0.02	0.03
BUTANOIC ACIDS	0.07	0.08	0.15	0.18	0.12
C5-N-METHYL KETONE	0.00	0.00	0.00	0.00	0.00
C5-ESTERS + I-PENTANONE	0.08	0.25	0.40	0.37	0.46
N-1-PENTANOL	0.35	0.72	1.11	0.95	0.45
N-2-PENTANOL	0.00	0.07	0.10	0.10	0.04
OTHER PENTANOLS	0.02	0.06	0.08	0.07	0.05
C6-N-METHYL KETONE	0.03	0.10	0.19	0.18	0.12
N-1-HEXANOL	0.08	0.22	0.41	0.33	0.12
N-1-HEPTANOL	0.00	0.06	0.13	0.11	0.02
N-1-OCTANOL	0.00	0.01	0.03	0.03	0.00
C9+ ALKANOLS	0.03	0.10	0.29	0.21	0.00
Total, Wt %	23.47	34.66	37.12	35.24	41.02
Yield per HC Produced,g/100g	0.84	---	1.34	1.20	1.22

Table A-6
Composition of Fischer-Tropsch Reactor Wax
Run CT-256-3

Days On-Stream	6	20.8	23.8	35	42.4	51.5	60.8	68.8	71.7	83.3
Press., MPa	1.48	1.48	1.48	1.48	1.48	1.48	1.82	1.48	2.17	2.51
Temp., oC	260	260	260	260	260	262	266	267	267	267
Carbon No.	Weight %									
13-20	5.39	10.79	10.34	9.20	12.23	11.06	10.51	8.51	9.92	9.54
21-25	18.14	22.27	21.22	18.47	23.01	19.86	17.80	13.69	14.73	18.27
26-30	25.25	29.23	27.92	27.95	25.42	26.08	28.10	26.75	24.72	25.61
31-35	22.84	20.19	21.90	21.81	18.63	20.79	22.44	25.24	23.87	21.18
36-40	12.45	8.86	11.21	12.43	10.31	11.98	13.20	14.26	14.74	13.33
41-45	8.14	3.43	4.86	5.43	4.86	4.96	5.09	7.45	7.36	7.35
46-50	4.15	2.41	1.82	2.45	2.83	2.70	2.11	3.60	3.99	3.72
51-55	1.50	2.01	0.73	1.06	1.69	1.59	0.76	0.50	0.66	1.00
56-60	0.79	0.81	0.00	0.60	1.01	0.97	0.00	0.00	0.00	0.00
61-67	1.36	0.00	0.00	0.61	0.00	0.00	0.00	0.00	0.00	0.00
Mol Avg C No.	30.0	27.4	27.6	28.3	27.3	27.8	27.8	29.1	28.7	28.4
Peak C No.	35	27	28	28	26	28	28	30	31	30

Table A-7
Second-Stage Fixed-Bed ZSM-5 Reactor
Operating Conditions and Material Balances
Run CT-256-3

(Nitrogen-Free Basis)	(1)								
M.B. No.	3- 6	3- 7	3- 8	3- 9	3- 10	3- 11	3- 12	3- 13	3- 19
Days On-stream	8.3	9.3	10.3	11.3	12.4	13.4	14.4	15.4	20.0
First-Stage Conditions:									
Charge H2/CO (Molar)	0.685	0.682	0.680	0.679	0.681	0.681	0.688	0.684	0.689
Temperature, oC	259	260	259	260	260	260	259	260	259
Pressure, MPa	1.480	1.480	1.480	1.480	1.480	1.480	1.480	1.480	1.480
Feed Sup. Vel., cm/s	3.982	3.888	3.923	3.920	3.943	3.948	3.945	3.956	3.797
Space Vel., NL/gFe-hr	2.563	2.535	2.580	2.569	2.610	2.600	2.578	2.598	2.494
N2 in Feed, Mol %	7.1	5.8	6.3	6.5	5.6	6.1	6.8	6.4	6.4
Second-Stage Conditions:									
Temp., Inlet, oC	330	332	316	302	329	329	369	388	347
Outlet, oC	330	378	357	332	346	349	401	424	385
Pressure, MPa	1.425	1.432	1.446	1.446	1.446	1.439	1.446	1.439	1.446
GHSV, hr	3502	2928	3143	3160	2833	3194	3611	3214	3096
Days On-stream	0.4	1.4	2.4	3.4	4.4	5.4	6.4	7.4	2.2
Conversions, Mol % :									
H2	77.30	80.59	78.78	79.10	80.96	78.40	76.47	79.50	80.64
CO	91.70	92.49	91.59	91.19	92.49	91.56	89.99	90.44	91.62
H2+CO	85.84	87.67	86.40	86.30	87.82	86.23	84.48	86.00	87.14
Yields, Wt % of Products :									
Hydrocarbons	18.72	21.83	20.53	20.40	23.19	20.21	20.16	23.04	22.59
CO2	72.07	68.97	69.37	69.62	67.20	69.90	69.69	66.44	67.73
H2O	1.29	0.99	1.34	0.98	1.25	1.18	1.08	1.01	1.37
H2	0.94	0.93	0.96	0.94	0.93	0.97	0.95	0.91	0.85
CO	6.97	7.28	7.80	8.07	7.43	7.74	8.13	8.59	7.45
Total	100	100	100	100	100	100	100	100	100
Bal Recovery, Wt % of Charge:	111.93	98.33	102.52	103.60	96.52	103.53	115.45	105.34	106.40
g HC/Nm3 (H2+CO) conv.:	199	198	198	199	208	197	225	230	223
Selectivities, Wt % of HC :									
Methane	8.10	6.57	6.98	6.90	5.38	7.13	7.44	6.05	7.18
Ethene	0.90	0.75	0.82	1.07	2.13	1.45	1.50	1.15	0.55
Ethane	3.76	3.07	3.18	3.17	2.63	3.30	3.32	2.87	3.08
Propene	3.32	2.89	3.46	3.53	2.78	4.72	6.34	4.32	1.54
Propane	7.06	5.78	4.60	3.79	1.93	3.69	5.83	7.38	9.05
Butenes	4.83	4.63	7.24	8.82	7.51	10.67	9.23	5.83	1.97
i-Butane	7.73	6.70	5.13	3.24	0.24	2.75	5.67	6.79	10.66
n-Butane	6.16	5.60	5.29	4.18	2.04	3.76	5.23	5.81	8.22
C5 - C11	45.42	52.65	49.81	48.48	51.71	49.56	43.93	48.48	45.77
C12+ (Excl. Rx. Wax)	2.05	0.93	3.06	6.49	13.31	3.11	1.71	1.73	2.72
Slurry Rx. Wax	10.68	10.43	10.43	10.26	10.20	9.88	9.80	9.60	9.26
Total	100	100	100	100	100	100	100	100	100
i-C4/(C3= + C4=) Molar :	0.81	0.76	0.42	0.23	0.02	0.16	0.31	0.57	2.56
(C3/C3=) Molar Ratio :	2.03	1.91	1.27	1.02	0.66	0.75	0.88	1.63	5.60
Alkylate, Wt % of HC :	14.53	12.70	10.09	6.36	0.48	5.40	11.14	13.17	7.68
Cat-Poly, Wt % of HC :	1.34	1.51	5.74	9.22	10.05	12.74	10.10	3.77	0.00
C5 - C11 PONA, Wt % :									
Paraffins	(2)	(2)	46.36	41.70	35.52	35.06	(2)	39.41	48.68
Olefins	(2)	(2)	32.59	44.95	62.42	52.73	(2)	20.73	6.61
Naphthenes	(2)	(2)	3.82	1.78	0.21	1.66	(2)	8.28	7.14
Aromatics	(2)	(2)	17.23	11.58	1.85	10.54	(2)	31.58	37.57

(1) All MB's except MB # 6 are adjusted for inter-reactor sampling
(2) Not Available

Table A-7 (Contd.)
Second-Stage Fixed-Bed ZSM-5 Reactor
Operating Conditions and Material Balances
Run CT-256-3

(Nitrogen-Free Basis)									
M.B. No.	3- 20	3- 21	3- 22	3- 23	3- 24	3- 25	3- 26	3- 27	3- 28
Days On-stream	21.0	22.0	23.0	24.0	25.0	26.0	27.0	28.0	29.0
First-Stage Conditions:									
Charge H2/CO (Molar)	0.689	0.683	0.685	0.687	0.685	0.689	0.685	0.692	0.694
Temperature, oC	259	260	260	259	260	260	260	261	261
Pressure, MPa	1.480	1.480	1.480	1.487	1.480	1.480	1.480	1.480	1.480
Feed Sup. Vel., cm/s	3.803	3.807	3.820	3.810	3.817	3.804	3.800	3.683	3.663
Space Vel., NL/gFe-hr	2.498	2.502	2.507	2.516	2.497	2.489	2.497	2.409	2.388
N2 in Feed, Mol %	6.5	6.3	6.4	6.3	6.6	6.6	6.3	6.5	6.8
Second-Stage Conditions:									
Temp., Inlet, oC	332	315	306	308	312	314	321	329	334
Outlet, oC	379	370	356	353	356	358	366	373	379
Pressure, MPa	1.446	1.446	1.446	1.446	1.446	1.411	1.411	1.411	1.398
GHSV, hr	3108	3077	3101	3051	3096	3110	2998	2845	2976
Days On-stream	3.2	4.2	5.2	6.2	7.2	8.2	9.2	10.2	11.2
Conversions, Mol % :									
H2	79.78	80.14	79.59	79.82	78.71	79.06	79.12	80.48	79.83
CO	90.95	91.40	90.06	90.86	90.33	89.53	89.63	91.25	90.64
H2+CO	86.39	86.83	85.80	86.36	85.61	85.26	85.36	86.85	86.21
Yields, Wt % of Products :									
Hydrocarbons	20.42	21.21	20.95	21.59	19.98	20.29	19.79	22.26	22.65
CO2	69.26	68.75	67.90	68.09	69.03	67.32	67.97	67.37	66.92
H2O	1.34	1.38	1.27	1.02	1.17	1.99	1.30	1.13	1.15
H2	0.90	0.88	0.91	0.92	0.96	0.94	0.99	0.92	0.90
CO	8.08	7.77	8.97	8.39	8.86	9.46	9.96	8.31	8.37
Total	100	100	100	100	100	100	100	100	100
Bal Recovery, Wt % of Charge:	105.87	104.88	105.02	103.47	103.52	104.79	99.26	100.19	105.72
g HC/Nm3 (H2+CO) conv.:	202	207	208	209	195	202	185	206	224
Selectivities, Wt % of HC :									
Methane	7.83	7.46	6.77	7.27	8.20	7.37	8.00	7.33	7.21
Ethene	0.53	0.55	0.95	0.60	0.71	0.71	0.86	0.81	0.81
Ethane	3.34	3.11	2.99	2.97	3.27	3.17	3.29	3.01	3.00
Propene	1.76	1.98	1.96	2.53	3.09	3.13	3.57	3.28	3.30
Propane	8.55	7.04	5.60	4.92	4.93	5.01	5.29	5.27	5.72
Butenes	2.47	3.13	4.43	5.55	6.09	6.94	6.66	5.60	5.40
i-Butane	10.12	8.96	6.74	5.95	5.76	5.85	6.07	6.75	7.28
n-Butane	7.83	7.37	6.28	5.81	5.54	5.65	5.43	5.79	6.07
C5 - C11	45.94	49.28	52.88	53.46	51.25	50.92	49.56	51.03	50.33
C12+ (Excl. Rx. Wax)	2.56	2.12	2.47	2.27	2.50	2.71	2.81	2.81	2.41
Slurry Rx. Wax	9.08	9.00	8.91	8.68	8.62	8.54	8.47	8.32	8.46
Total	100	100	100	100	100	100	100	100	100
i-C4/(C3= + C4=) Molar :	2.03	1.50	0.92	0.64	0.54	0.51	0.51	0.65	0.73
(C3/C3=) Molar Ratio :	4.64	3.39	2.73	1.85	1.52	1.53	1.42	1.53	1.66
Alkylate, Wt % of HC :	9.22	11.09	12.72	11.64	11.33	11.50	11.94	13.04	13.90
Cat-Poly, Wt % of HC :	0.00	0.00	0.41	2.39	3.62	4.42	4.36	2.59	2.09
C5 - C11 PONA, Wt % :									
Paraffins	47.13	52.97	51.09	51.02	45.66	47.36	44.19	46.66	45.96
Olefins	7.41	10.04	21.46	26.08	28.66	31.83	29.17	24.11	23.88
Naphthenes	7.44	6.00	4.13	3.44	4.87	4.41	3.86	5.85	5.59
Aromatics	38.02	31.00	23.32	19.46	20.81	16.39	22.78	23.38	24.57

(1) All MB's except MB # 6 are adjusted for inter-reactor sampling

Table A-7 (Contd.)
Second-Stage Fixed-Bed ZSM-5 Reactor
Operating Conditions and Material Balances
Run CT-256-3

(Nitrogen-Free Basis)									
M.B. No.	3- 29	3- 30	3- 31	3- 32	3- 33	3- 34	3- 35	3- 36	3- 37
Days On-stream	30.5	31.5	32.5	33.5	34.5	35.5	36.5	37.5	38.5
First-Stage Conditions:									
Charge H2/CO (Molar)	0.665	0.686	0.679	0.702	0.696	0.695	0.685	0.674	0.695
Temperature, oC	261	260	260	260	260	259	260	260	259
Pressure, MPa	1.480	1.487	1.480	1.480	1.446	1.480	1.494	1.487	1.480
Feed Sup. Vel., cm/s	3.594	3.614	3.489	3.499	3.549	3.481	3.448	3.468	3.480
Space Vel., NL/gFe-hr	2.343	2.373	2.282	2.279	2.253	2.273	2.267	2.275	2.273
N2 in Feed, Mol %	6.9	6.8	6.7	7.0	7.3	7.0	7.0	6.9	6.9
Second-Stage Conditions:									
Temp., Inlet, oC	347	352	361	363	368	373	378	383	373
Outlet, oC	395	398	405	410	412	415	417	418	415
Pressure, MPa	1.460	1.467	1.446	1.411	0.101	1.411	1.411	1.377	1.411
GHSV, hr	3246	3109	2890	2831	2812	2840	2817	2822	2845
Days On-stream	12.6	13.6	14.6	15.6	16.6	17.6	18.6	19.6	20.6
Conversions, Mol % :									
H2	72.84	76.71	79.40	80.81	81.11	80.68	81.94	80.80	81.25
CO	80.66	86.99	90.09	91.63	91.91	92.24	92.07	91.39	91.53
H2+CO	77.67	82.81	85.77	87.17	87.48	87.50	87.95	87.13	87.32
Yields, Wt % of Products :									
Hydrocarbons	21.78	21.71	22.10	22.73	21.82	23.00	22.98	20.29	22.18
CO2	58.94	64.47	66.93	67.52	68.82	67.74	67.85	69.60	67.91
H2O	1.01	1.13	1.14	1.31	1.25	1.43	1.25	1.24	1.48
H2	1.16	1.03	0.91	0.88	0.85	0.87	0.80	0.87	0.84
CO	17.10	11.66	8.92	7.56	7.25	6.96	7.12	8.00	7.58
Total	100	100	100	100	100	100	100	100	100
Bal Recovery, Wt % of Charge:	105.89	105.67	105.18	104.68	105.46	105.40	105.42	102.31	105.60
g HC/Nm3 (H2+CO) conv.:	243	224	219	218	211	222	223	193	216
Selectivities, Wt % of HC :									
Methane	7.73	7.93	7.91	7.68	8.08	7.69	7.43	8.44	7.54
Ethene	0.94	0.93	0.97	1.01	1.10	1.06	1.15	1.39	1.24
Ethane	3.05	3.30	3.34	3.51	3.45	3.25	3.21	3.62	3.31
Propene	3.43	3.33	3.32	3.35	3.59	3.90	3.91	4.62	4.31
Propane	6.64	7.62	8.39	8.89	9.46	9.03	9.08	10.23	9.08
Butenes	4.98	4.51	4.23	4.04	4.22	4.37	4.53	5.01	5.06
i-Butane	8.36	8.84	9.32	9.45	9.53	9.26	9.02	9.63	8.87
n-Butane	6.59	6.94	7.35	7.58	7.59	7.61	7.46	7.73	7.38
C5 - C11	46.37	45.93	44.69	45.11	44.25	44.46	44.79	39.91	44.15
C12+ (Excl. Rx. Wax)	1.46	1.83	1.99	0.59	0.75	1.70	1.77	1.94	1.84
Slurry Rx. Wax	8.45	8.84	8.30	8.99	7.97	7.66	7.63	7.47	7.31
Total	100	100	100	100	100	100	100	100	100
i-C4/(C3= + C4=) Molar :	0.84	0.95	1.04	1.07	1.02	0.93	0.89	0.83	0.79
(C3/C3=) Molar Ratio :	1.84	2.18	2.41	2.53	2.52	2.21	2.21	2.11	2.01
Alkylate, Wt % of HC :	15.65	16.37	16.51	16.19	17.14	17.05	16.69	17.85	16.57
Cat-Poly, Wt % of HC :	1.12	0.31	0.00	0.00	0.00	0.48	0.78	1.41	1.68
C5 - C11 PONA, Wt % :									
Paraffins	47.65	45.77	44.82	44.13	42.46	44.93	43.90	40.50	42.46
Olefins	17.64	15.26	14.23	12.99	12.49	13.11	13.10	11.71	14.27
Naphthenes	7.75	8.21	8.55	8.76	9.27	9.15	8.86	8.68	8.35
Aromatics	26.97	30.76	32.40	34.12	35.79	32.80	34.14	39.12	34.92

(1) All MB's except MB # 6 are adjusted for inter-reactor sampling

Table A-7 (Contd.)
Second-Stage Fixed-Bed ZSM-5 Reactor
Operating Conditions and Material Balances
Run CT-256-3

(Nitrogen-Free Basis)									
M.B. No.	3- 38	3- 39	3- 51	3- 52	3- 53	3- 54	3- 55	3- 56	3- 57
Days On-stream	39.5	40.5	53.5	55.5	57.5	59.5	62.5	64.5	66.5
First-Stage Conditions:									
Charge H2/CO (Molar)	0.679	0.693	0.687	0.686	0.675	0.687	0.675	0.691	0.693
Temperature, oC	260	260	262	263	264	264	264	266	265
Pressure, MPa	1.494	1.480	1.508	1.515	1.480	1.508	1.591	1.577	1.535
Feed Sup. Vel., cm/s	3.429	3.462	3.163	3.186	3.247	3.171	2.917	2.919	2.773
Space Vel., NL/gFe-hr	2.282	2.288	2.101	2.094	2.095	2.083	2.067	2.036	1.923
N2 in Feed, Mol %	5.9	5.7	6.6	7.8	7.8	7.8	8.7	9.1	7.3
Second-Stage Conditions:									
Temp., Inlet, oC	392	394	317	303	304	313	327	337	344
Outlet, oC	418	419	362	357	353	361	381	392	395
Pressure, MPa	1.398	1.377	1.322	1.322	1.301	1.294	1.308	1.308	1.342
GHSV, hr	2764	2730	2636	2659	2648	2604	2907	2772	2386
Days On-stream	21.6	22.6	0.6	2.6	4.6	6.6	9.7	11.7	13.7
Conversions, Mol % :									
H2	81.60	81.41	79.29	79.62	79.94	80.04	72.38	76.12	84.21
CO	91.61	91.46	88.86	89.44	89.57	89.87	76.28	81.51	91.00
H2+CO	87.57	87.35	84.96	85.45	85.69	85.87	74.70	79.31	82.31
Yields, Wt % of Products :									
Hydrocarbons	22.29	21.36	22.58	20.57	21.88	20.29	19.75	22.02	20.02
CO2	68.11	68.48	64.88	67.46	66.50	67.90	55.56	59.04	61.14
H2O	1.15	1.33	1.63	1.32	1.16	1.42	1.64	1.41	0.90
H2	0.82	0.87	0.92	0.93	0.90	0.92	1.24	1.06	0.72
CO	7.63	7.96	9.99	9.72	9.56	9.47	21.82	16.48	17.23
Total	100	100	100	100	100	100	100	100	100
Bal Recovery, Wt % of Charge:	104.28	101.94	105.62	103.01	103.48	101.59	103.14	105.87	104.40
g HC/Nm3 (H2+CO) conv.:	215	200	227	199	214	192	220	236	203
Selectivities, Wt % of HC :									
Methane	7.30	7.87	7.27	9.51	8.71	9.63	10.98	9.99	9.66
Ethene	1.29	1.43	0.96	0.51	0.56	0.78	1.05	0.96	1.04
Ethane	3.15	3.35	3.27	3.81	3.61	4.04	4.76	4.59	3.83
Propene	4.46	5.10	0.87	2.08	2.28	3.07	3.78	3.29	3.58
Propane	9.02	9.40	8.54	6.81	5.57	5.91	6.29	6.65	7.72
Butenes	5.27	5.86	1.37	3.23	4.45	5.22	5.52	4.68	4.62
i-Butane	8.73	8.69	10.64	8.51	6.86	7.22	7.54	7.81	8.95
n-Butane	7.41	7.59	8.35	7.19	6.24	6.20	5.96	6.23	6.99
C5 - C11	45.23	42.99	49.34	50.24	54.70	51.00	49.98	50.65	47.48
C12+ (Excl. Rx. Wax)	0.94	0.57	3.83	2.94	2.19	2.41	1.73	1.91	2.00
Slurry Rx. Wax	7.22	6.96	5.56	5.17	4.83	4.52	2.41	3.24	4.13
Total	100	100	100	100	100	100	100	100	100
i-C4/(C3= + C4=) Molar	0.75	0.68	4.07	1.37	0.88	0.75	0.69	0.83	0.92
(C3/C3=) Molar Ratio :	1.93	1.76	9.42	3.12	2.33	1.83	1.59	1.93	2.06
Alkylate, Wt % of HC :	16.36	16.79	4.85	11.53	12.94	13.74	14.38	14.64	16.58
Cat-Poly, Wt % of HC :	2.09	3.06	0.00	0.00	0.65	1.76	2.46	1.14	0.57
C5 - C11 PONA, Wt % :									
Paraffins	42.89	43.15	49.96	49.38	50.78	39.93	44.67	43.11	43.71
Olefins	16.38	15.98	8.70	12.78	20.57	17.26	22.21	18.02	16.36
Naphthenes	7.63	8.60	8.13	6.44	5.55	6.79	6.70	7.86	7.97
Aromatics	33.10	32.28	33.22	31.40	23.10	36.02	26.42	31.02	31.96

(1) All MB's except MB # 6 are adjusted for inter-reactor sampling

Table A-7 (Contd.)
Second-Stage Fixed-Bed ZSM-5 Reactor
Operating Conditions and Material Balances
Run CT-256-3

(Nitrogen-Free Basis)							
M.B. No.	3- 58	3- 59	3- 60	3- 61	3- 62	3- 63	3- 64
Days On-stream	68.5	70.5	72.5	74.5	76.5	78.5	80.5
First-Stage Conditions:							
Charge H2/CO (Molar)	0.601	0.601	0.607	0.596	0.600	0.634	0.603
Temperature, oC	265	266	265	266	266	264	265
Pressure, MPa	1.825	2.170	2.170	2.515	2.515	2.515	2.515
Feed Sup. Vel., cm/s	2.605	2.564	2.593	2.537	2.207	1.365	2.548
Space Vel., NL/gFe-hr	2.186	2.587	2.616	3.014	2.612	1.602	3.028
N2 in Feed, Mol %	5.6	4.4	4.5	2.8	3.3	4.4	2.9
Second-Stage Conditions:							
Temp., Inlet, oC	354	361	370	377	392	399	408
Outlet, oC	402	412	418	424	439	442	442
Pressure, MPa	1.646	2.032	2.032	2.390	2.384	2.370	2.515
GHSV, hr	2717	3061	3216	3677	2761	1665	3707
Days On-stream	15.7	17.7	19.7	21.7	23.7	25.7	27.7
Conversions, Mol % :							
H2	82.99	81.91	80.32	78.83	88.78	91.38	75.18
CO	82.45	80.54	79.26	76.54	87.41	90.55	76.52
H2+CO	82.65	81.05	79.66	77.40	87.92	90.87	76.02
Yields, Wt % of Products :							
Hydrocarbons	19.55	20.70	19.01	18.31	19.94	21.41	16.60
CO2	62.71	59.08	59.69	58.02	66.50	68.38	58.16
H20	1.10	1.13	1.28	1.08	0.92	0.90	1.51
H2	0.67	0.74	0.80	0.84	0.47	0.37	1.04
CO	15.97	18.35	19.22	21.74	12.17	8.94	22.68
Total	100	100	100	100	100	100	100
Bal Recovery, Wt % of Charge:	104.87	101.50	103.10	103.23	99.13	100.98	99.16
g HC/Nm3 (H2+CO) conv.:	209	218	206	206	189	197	184
Selectivities, Wt % of HC :							
Methane	9.46	8.39	9.14	8.81	8.51	7.70	7.72
Ethene	0.92	0.91	1.16	1.27	1.26	1.29	2.77
Ethane	4.17	3.97	4.31	4.10	4.29	4.08	3.25
Propene	2.99	3.24	3.92	4.45	4.01	4.17	9.46
Propane	8.71	8.41	9.11	8.86	10.22	9.60	7.44
Butenes	4.17	4.20	4.70	5.39	4.70	4.59	11.72
i-Butane	9.01	8.61	8.56	8.11	8.11	7.34	4.94
n-Butane	7.14	7.17	7.15	7.05	7.28	6.85	4.61
C5 - C11	48.78	49.05	45.30	45.12	43.36	32.48	40.36
C12+ (Excl. Rx. Wax)	0.88	2.01	2.05	2.26	2.64	9.37	1.41
Slurry Rx. Wax	3.76	4.04	4.59	4.59	5.62	12.23	6.31
Total	100	100	100	100	100	100	100
i-C4/(C3= + C4=) Molar :	1.07	0.98	0.83	0.69	0.78	0.70	0.20
(C3/C3=) Molar Ratio :	2.78	2.48	2.22	1.90	2.43	2.20	0.75
Alkylate, Wt % of HC :	15.60	15.90	15.94	15.33	15.15	13.81	9.71
Cat-Poly, Wt % of HC :	0.00	0.15	1.25	2.62	1.67	2.29	16.41
C5 - C11 PONA, Wt % :							
Paraffins	42.84	40.40	39.06	38.62	37.95	39.77	32.14
Olefins	13.34	17.85	14.31	16.53	15.10	12.19	32.04
Naphthenes	7.97	7.50	7.98	7.49	7.62	7.49	5.87
Aromatics	35.86	34.25	38.65	37.36	39.33	40.55	29.95

(1) All MB's except MB # 6 are adjusted for inter-reactor sampling

TABLE A-8

SECOND-STAGE ZSM-5 REACTOR
RAW GASOLINE[1] PROPERTIES

(Run CT-256-3)

H.B. No.	7	8	9	11	19	20	21	22	26	32	53	54	57	58	59	60	64
DOS	9.3	10.3	11.3	13.4	20	21	22	23	27	33.5	57.5	59.5	66.5	68.5	70.5	72.5	80.5
Second-Stage Severity:																	
$i\text{-}C_4/C_3^{=} + C_4^{=}$)	0.76	0.42	0.23	0.16	2.56	2.03	1.5	0.92	0.51	1.07	0.88	0.75	0.92	1.07	0.98	0.83	0.20
$C_3/C_3^{=}$	1.91	1.27	1.02	0.75	5.61	4.64	3.39	2.72	1.42	2.53	2.33	1.83	2.06	2.77	2.48	2.32	0.75
Sp. Gr.	.760	.757	.744	.729	.726	.769	.771	.763	.759	.782	.767	.765	.784	.781	.770	.769	.702
Acid No. (Unwashed) mg KOH/mg	0.15	0.15	0.15	-	-	-	-	-	-	0.04	0.15	0.4	0.1	0.04	0.05	0.13	0.11
PONA, Wt %:																	
Paraffins	-	33.2	27.5	24.4	30.4	34.9	34.9	36.8	32.5	27.6	33.2	25.9	29.1	-	28.6	30.2	22.4
Olefins	-	32.3	43.8	50.2	4.6	7.8	10.3	21.5	28.0	11.9	21.2	16.8	14.1	-	10.1	13.9	32.0
Naphthenes	-	11.6	12.8	10.9	10.2	11.0	11.4	11.7	11.0	12.2	13.1	12.2	11.8	-	10.1	10.8	6.8
Aromatics	-	22.9	15.9	14.5	54.8	46.3	43.4	30.0	28.5	48.3	32.5	45.1	45.0	-	43.2	45.1	35.8
Octane Numbers:																	
R+O	90.5	89.3	85.4	85.1	89.6	92.0	89.3	86.9	87.4	93.9	87.6	87.9	94.0	92.3	92.7	92.0	91.1
M+O	80.8	80.1	75.6	83.4	83.4	82.8	80.4	70.4	79.0	83.5	79.7	79.5	81.8	82.5	82.7	82.8	80.7
ASTM Distillation, °C:																	
IBP	36	35	39	33	36	32	37	39	35	36	39	37	42	37	31	33	32
50 Vol %	120	122	126	120	130	125	128	127	128	130	130	128	133	128	124	123	123
90 Vol %	184	182	187	189	192	184	185	184	187	189	186	185	184	184	185	183	183
95 Vol %	218	214	231	232	245	238	224	212	232	236	218	219	222	220	237	236	238
EP	240	239	250	247	263	251	253	245	248	255	246	242	249	243	241	238	238
Residue, Vol %	3	3	1.1	1.1	0.9	0.7	1.2	1.1	1.0	1.3	1.4	1.3	0.9	1.0	0.9	1.0	1.0
Loss, Wt %	0	0	0	1.9	2.6	2.3	1.8	0.9	2.0	1.7	1.1	1.2	1.1	2.0	3.1	2.5	3.0

[1] Collected in ambient and chilled condensers. Hydrocarbons collected in hot condenser was very small.

Table A-9
Composition of Hydrocarbon Products from
Two-Stage Slurry F-T/ZSM-5 Syngas Conversion
Run CT-25e-3

M.B.No.	3-6	3-7	3-8	3-9	3-10	3-11	3-12	3-13	3-19
Days On Stream	8.3	9.3	10.3	11.3	12.4	13.4	14.4	15.4	20.0
METHANE	8.10	6.57	6.98	6.90	5.38	7.13	7.44	6.05	7.18
ETHENE	0.90	0.75	0.82	1.07	2.13	1.45	1.50	1.15	0.55
ETHANE	3.76	3.07	3.18	3.17	2.63	3.30	3.32	2.87	3.08
PROPENE	3.32	2.89	3.46	3.53	2.78	4.72	6.24	4.32	1.54
PROPANE	7.06	5.78	4.60	3.78	1.93	3.69	5.83	7.38	9.05
I-BUTANE	7.73	6.70	5.13	3.24	0.24	2.75	5.67	6.79	10.66
1-BUTENE+2-METHYLPROPENE	2.99	2.83	4.41	5.40	3.68	6.50	5.60	3.47	1.19
N-BUTANE	6.16	5.60	5.29	4.18	2.04	3.76	5.23	5.81	8.22
TRANS-2-BUTENE	1.10	1.07	1.68	2.04	2.33	2.49	2.14	1.38	0.47
CIS-2-BUTENE	0.74	0.73	1.15	1.37	1.50	1.68	1.49	0.98	0.32
3-METHYL-1-BUTENE	0.08	0.08	0.16	0.22	0.20	0.27	0.18	0.11	0.03
I-PENTANE	4.35	4.68	4.82	3.92	0.40	2.35	3.49	4.76	7.52
1-PENTENE	0.09	0.10	0.20	0.27	0.27	0.33	0.22	0.16	0.04
2-METHYL-1-BUTENE	0.45	0.00	1.18	1.74	1.84	2.10	1.20	0.78	0.22
N-PENTANE	2.66	3.20	4.12	3.37	1.88	2.89	2.82	3.48	4.44
TRANS-2-PENTENE	0.28	0.36	0.79	1.14	1.38	1.41	0.82	0.57	0.15
CIS-2-PENTENE	0.13	0.17	0.39	0.55	0.64	0.69	0.41	0.29	0.07
2-METHYL-2-BUTENE	0.99	1.32	3.05	4.77	5.74	5.68	2.80	1.37	0.54
C5-DIOLEFINS (DIENES)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2,2-DIMETHYLBUTANE	0.00	0.04	0.04	0.03	0.00	0.03	0.07	0.06	0.02
CYCLOPENTANE	0.04	0.06	0.08	0.03	0.00	0.12	0.07	0.26	0.19
HEXENES + ISO-HEXANES	0.07	0.07	0.04	0.26	0.66	0.00	0.24	0.06	0.00
2,3-DIMETHYLBUTANE	0.04	0.07	0.11	0.17	0.00	0.21	0.10	0.11	0.17
2-METHYLPENTANE	0.91	1.66	2.65	1.87	0.42	1.33	1.00	1.30	2.73
3-METHYLPENTANE	0.31	0.60	0.82	0.63	0.17	0.43	0.39	0.65	1.17
HEXENES	0.00	0.00	1.53	2.45	4.07	3.05	0.00	1.01	0.19
1-HEXENE	0.05	0.09	0.56	0.30	0.45	0.26	0.22	0.09	0.02
N-HEXANE	0.59	1.39	1.40	1.00	1.99	1.09	0.90	2.12	1.81
2,4-DIMETHYLPENTANE	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.01	0.01
METHYLCYCLOPENTANE	0.14	0.33	0.22	0.07	0.03	0.07	0.00	1.18	0.39
3,3-DIMETHYLPENTANE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CYCLOHEXANE	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.03	0.02
HEPTENES + ISO-HEPTANES	0.20	0.68	0.00	0.00	4.86	0.00	0.00	0.68	0.20
1-HEPTENE	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2-METHYLHEXANE	0.09	0.46	0.79	0.55	0.25	0.44	0.00	0.60	0.35
2,3-DIMETHYLPENTANE	0.00	0.03	0.08	0.04	0.01	0.04	0.00	0.19	0.18
3-METHYLHEXANE	0.07	0.38	0.70	0.46	0.22	0.37	0.00	0.58	0.84
1-CIS-3-DIMETHYL-N5	0.02	0.10	0.14	0.05	0.00	0.05	0.00	0.37	0.29
1-TRANS-3-DIMETHYL-N5	0.00	0.00	0.19	0.05	0.01	0.05	0.00	0.26	0.21
1-TRANS-2-DIMETHYL-N5	0.02	0.10	0.00	0.03	0.00	0.03	0.00	0.30	0.25
3-ETHYL-PENTANE	0.00	0.55	0.00	0.00	0.00	0.00	0.00	0.00	0.00
N-HEPTANE	0.11	0.59	1.35	1.27	1.88	1.30	0.00	1.34	0.68
C7-OLEFINS	0.00	0.00	2.21	3.08	5.12	3.93	0.00	1.14	0.24
METHYLCYCLOHEXANE	0.00	0.07	0.15	0.07	0.01	0.06	0.00	0.19	0.15
C8-OLEFINS + ISO-P	0.05	0.75	0.00	0.00	0.96	0.00	0.00	0.51	0.49
1-OCTENE	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MONOMETHYL-ISO-C8-P	0.00	0.00	1.22	0.97	0.35	0.72	0.00	0.48	0.67
OTHER ISO-C8-P	0.00	0.00	0.10	0.05	0.01	0.04	0.00	0.15	0.12
C8-OLEFINS	0.00	0.00	4.20	4.70	4.61	5.47	0.00	1.66	0.33
C9-NAPHTHENES (N5+N6)	0.00	0.00	0.74	0.30	0.03	0.28	0.00	1.12	1.01
N-OCTANE	0.03	0.13	1.10	1.25	1.36	1.29	0.00	0.72	0.22
C9-OLEFINS + ISO-P	0.39	0.70	0.00	0.00	0.12	0.00	0.00	0.55	0.36
MONOMETHYL-ISO-C9-P	0.00	0.00	0.76	0.69	0.32	0.48	0.00	0.27	0.30
OTHER ISO-C9-P	0.00	0.00	0.15	0.02	0.02	0.08	0.00	0.12	0.13
C9-OLEFINS	0.00	0.00	1.97	2.57	2.02	2.93	0.00	0.63	0.13
C9-NAPHTHENES (N5+N6)	0.00	0.00	0.39	0.25	0.02	0.15	0.00	0.31	0.26
N-NONANE	0.00	0.00	0.64	0.96	1.08	1.04	0.00	0.30	0.05
ISO-C10-P + O + N5 + N6,	0.00	0.00	2.49	3.61	7.33	3.24	0.00	1.11	0.37
BENZENE	0.09	0.25	0.31	0.27	0.21	0.33	0.00	0.80	0.69
TOLUENE	0.07	0.38	0.99	0.42	0.12	0.42	0.00	2.90	3.74
ETHYLBENZENE	0.00	0.14	0.30	0.11	0.07	0.09	0.00	1.10	1.52
P-XYLENE	0.00	0.00	0.37	0.13	0.02	0.10	0.00	0.86	0.00
M-XYLENE	0.00	0.00	1.03	0.51	0.07	0.37	0.00	2.10	3.26
O-XYLENE	0.00	0.00	0.40	0.46	0.07	0.73	0.00	1.03	1.01
ISOPROPYLBENZENE	0.00	0.00	0.00	0.00	0.00	0.15	0.00	0.00	0.00
N-PROPYLBENZENE	0.00	0.00	0.18	0.12	0.04	0.10	0.00	0.16	0.11
1-METHYL-3-ETHYL-BENZENE	0.00	0.00	1.59	0.88	0.02	0.62	0.00	2.21	2.31
1,3,5-TRIMETHYL-BENZENE	0.00	0.00	0.07	0.16	0.00	0.14	0.00	0.08	0.08
1-METHYL-2-ETHYLBENZENE	0.00	0.00	0.05	0.00	0.00	0.00	0.00	0.13	0.00
ISO-C4-BENZENE	0.00	0.00	0.00	0.05	0.00	0.04	0.00	0.00	0.20
SEC-C4-BENZENE	0.00	0.00	0.00	0.17	0.00	0.20	0.00	0.00	0.00
1,2,4-TRIMETHYLBENZENE	0.00	0.00	0.86	0.48	0.07	0.71	0.00	1.53	1.52
1-METHYL-2-ISO-C3-BENZENE	0.00	0.00	0.13	0.10	0.00	0.03	0.00	0.03	0.07
1,3-DIETHYLBENZENE	0.00	0.00	0.00	0.00	0.00	0.10	0.00	0.43	0.07
1-METHYL-3-N-C3-BENZENE	0.00	0.00	0.52	0.33	0.00	0.00	0.00	0.11	0.41
N-C4-BENZENE	0.00	0.00	0.19	0.16	0.00	0.00	0.00	0.11	0.00
1,2,3-TRIMETHYLBENZENE	0.00	0.00	0.02	0.04	0.00	0.01	0.00	0.08	0.13
1,2-DIETHYLBENZENE	0.00	0.00	0.00	0.00	0.00	0.06	0.00	0.00	0.11
1-METHYL-2-N-C3-BENZENE	0.00	0.00	0.02	0.02	0.00	0.03	0.00	0.00	0.00
C10-ALKYLBENZENES	0.00	0.00	0.70	0.09	0.04	0.29	0.00	0.64	0.67
1,2,4,5-TETRAMETHYLBENZENE	0.00	0.00	0.05	0.01	0.01	0.03	0.00	0.07	0.09
1,2,3,5-TETRAMETHYLBENZENE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.07
1,2,3,4-TETRAMETHYLBENZENE	0.00	0.00	0.00	0.03	0.00	0.01	0.00	0.01	0.02
C11-ALKYLBENZENES	0.00	0.00	0.30	1.09	0.19	0.65	0.00	0.88	1.07
METHYL-NAPHTHALENES	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00
UNKNOWNS (HC AROMATICS)	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.06
METHANOL	0.00	0.00	0.00	0.00	0.04	0.00	0.00	0.00	0.00
DIMETHYL ETHER	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
I-PROPANOL	0.00	0.00	0.00	0.00	0.12	0.00	0.00	0.00	0.00
UNKNOWN LITE HYDRO-CARB LIQ (1)	23.01	32.31	0.00	0.00	0.00	0.00	28.99	0.00	0.00
UNKNOWN C12+	2.05	0.92	3.06	6.49	13.31	3.11	1.71	1.73	2.72
SLURRY REACTOR WAX	10.68	10.43	10.43	10.26	10.20	9.89	9.80	9.60	9.26

(1) Collected in Ambient and Chilled Condensers

Table A-9 (Contd.)
Composition of Hydrocarbon Products from
Two-Stage Slurry F-T/ZSM-5 Syngas Conversion
Run CT-256-2

M.B.No.	3-20	3-21	3-22	3-23	3-24	3-25	3-26	3-27	3-28
Days On Stream	21	22	23	24	25	26	27	28	29
METHANE	7.83	7.46	6.77	7.27	8.20	7.37	8.00	7.33	7.21
ETHENE	0.53	0.55	0.95	0.60	0.74	0.71	0.86	0.81	0.81
ETHANE	3.34	3.11	2.99	2.97	3.27	3.17	3.29	3.01	3.00
PROPENE	1.76	1.98	1.96	2.53	3.09	3.13	3.57	3.28	3.30
PROPANE	8.55	7.04	5.60	4.92	4.93	5.01	5.29	5.27	5.72
I-BUTANE	10.12	8.96	6.74	5.95	5.76	5.85	6.07	6.75	7.28
1-BUTENE+2-METHYLPROPENE	1.50	1.90	2.70	3.37	3.76	4.25	4.09	3.40	3.26
N-BUTANE	7.83	7.37	6.28	5.81	5.54	5.65	5.43	5.79	6.07
TRANS-2-BUTENE	0.58	0.73	1.03	1.29	1.40	1.61	1.53	1.31	1.27
CIS-2-BUTENE	0.39	0.50	0.70	0.88	0.93	1.08	1.03	0.89	0.87
3-METHYL-1-BUTENE	0.03	0.05	0.09	0.12	0.12	0.15	0.13	0.11	0.11
I-PENTANE	6.64	7.00	5.87	5.27	4.34	4.82	4.37	5.39	5.66
1-PENTENE	0.04	0.06	0.11	0.16	0.15	0.18	0.15	0.14	0.14
2-METHYL-1-BUTENE	0.26	0.44	0.71	0.97	0.92	1.13	0.89	0.81	0.78
N-PENTANE	4.12	5.10	4.86	4.71	3.71	4.20	3.45	4.11	4.21
TRANS-2-PENTENE	0.19	0.29	0.47	0.65	0.59	0.74	0.58	0.55	0.53
CIS-2-PENTENE	0.09	0.14	0.23	0.32	0.28	0.37	0.28	0.27	0.26
2-METHYL-2-BUTENE	0.67	1.13	1.87	2.65	2.34	2.95	2.21	2.07	2.00
2,2-DIMETHYLBUTANE	0.01	0.02	0.03	0.03	0.02	0.03	0.05	0.04	0.04
CYCLOPENTANE	0.14	0.11	0.09	0.08	0.04	0.05	0.04	0.08	0.09
HEXENES + ISO-HEXANES	0.00	0.03	0.08	0.13	0.04	0.04	0.08	0.08	0.03
2,3-DIMETHYLBUTANE	0.13	0.15	0.09	0.11	0.08	0.10	0.08	0.09	0.15
2-METHYLPENTANE	2.48	3.31	3.18	3.04	2.08	2.54	1.95	2.56	2.55
3-METHYLPENTANE	1.01	1.27	1.11	1.02	0.70	0.88	0.69	0.93	0.95
HEXENES	0.35	0.42	0.89	1.18	1.42	2.07	1.20	0.90	0.80
1-HEXENE	0.02	0.05	0.08	0.15	0.07	0.08	0.06	0.10	0.10
N-HEXANE	1.86	2.76	3.10	3.26	2.27	2.79	2.05	2.59	2.56
2,4-DIMETHYLPENTANE	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
METHYLCYCLOPENTANE	0.58	0.41	0.26	0.20	0.27	0.27	0.19	0.56	0.62
3,3-DIMETHYLPENTANE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CYCLOHEXANE	0.03	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.02
HEPTENES + ISO-HEPTANES	0.02	0.00	0.11	0.24	0.37	0.24	0.74	0.66	0.70
2-METHYLHEXANE	0.84	0.82	0.92	0.87	0.99	0.98	0.82	1.00	0.96
2,3-DIMETHYLPENTANE	0.17	0.13	0.09	0.08	0.08	0.09	0.09	0.12	0.13
3-METHYLHEXANE	0.81	0.76	0.78	0.72	0.80	0.80	0.73	0.85	0.84
1-CIS-3-DIMETHYL-N5	0.27	0.22	0.15	0.12	0.13	0.14	0.17	0.23	0.25
1-TRANS-3-DIMETHYL-N5	0.27	0.21	0.15	0.09	0.13	0.20	0.11	0.18	0.17
1-TRANS-2-DIMETHYL-N5	0.20	0.15	0.10	0.00	0.09	0.00	0.01	0.07	0.21
N-HEPTANE	0.82	0.94	1.31	1.38	1.61	1.55	1.44	1.64	1.58
C7-OLEFINS	0.42	0.58	1.29	1.85	2.01	2.41	1.97	1.34	1.12
METHYLCYCLOHEXANE	0.21	0.19	0.19	0.16	0.16	0.16	0.17	0.22	0.22
C8-OLEFINS + ISO-P	0.00	0.00	0.51	0.00	0.04	0.00	0.12	0.85	0.69
MONOMETHYL-ISO-C8-P	1.01	1.09	1.33	1.29	0.79	1.14	1.11	0.52	0.83
OTHER ISO-C8-P	0.16	0.14	0.11	0.09	0.07	0.10	0.11	0.09	0.12
C8-OLEFINS	1.00	1.07	2.88	3.56	4.18	4.01	3.73	2.63	3.02
C8-NAPHTHENES (N5+N6)	1.32	1.19	0.85	0.84	1.27	0.66	0.83	1.24	0.85
N-OCTANE	0.00	0.52	0.93	1.08	1.17	1.02	1.00	0.92	0.17
C9-OLEFINS + ISO-P	0.00	0.00	0.00	0.00	0.02	0.00	0.37	0.36	0.49
MONOMETHYL-ISO-C9-P	0.48	0.58	0.81	0.81	0.81	0.19	0.66	0.51	0.46
OTHER ISO-C9-P	0.17	0.17	0.16	0.08	0.15	0.12	0.20	0.14	0.16
C9-OLEFINS	0.33	0.73	2.11	2.09	2.19	1.87	2.03	1.51	1.29
C9-NAPHTHENES (N5+N6)	0.41	0.44	0.37	0.34	0.39	0.74	0.37	0.38	0.37
N-NONANE	0.10	0.17	0.07	0.60	0.67	0.55	0.55	0.39	0.36
ISO-C10-P + O + N5 + N6	0.83	1.11	2.17	2.69	3.00	2.19	2.47	1.84	1.37
BENZENE	0.44	0.31	0.41	0.26	0.39	0.40	0.40	0.52	0.51
TOLUENE	2.91	2.24	1.30	0.99	0.97	0.95	1.26	1.61	1.77
ETHYLBENZENE	1.04	0.82	0.51	0.37	0.38	0.30	0.59	0.93	0.92
P-XYLENE	1.05	0.85	0.57	0.44	0.42	0.36	0.55	0.56	0.62
M-XYLENE	2.62	2.15	1.59	1.30	1.33	1.04	1.38	1.47	1.53
O-XYLENE	1.10	0.89	0.66	0.60	0.66	0.50	0.54	0.66	0.69
ISOPROPYLBENZENE	0.00	0.00	0.00	0.00	0.00	0.00	0.11	0.00	0.00
N-PROPYLBENZENE	0.17	0.22	0.26	0.26	0.24	0.18	0.25	0.24	0.22
1-METHYL-3-ETHYL-BENZENE	3.00	2.91	2.53	2.02	2.02	1.53	2.18	2.10	2.22
1,3,5-TRIMETHYL-BENZENE	0.07	0.07	0.09	0.13	0.14	0.10	0.11	0.08	0.08
1-METHYL-2-ETHYLBENZENE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02
ISO-C4-BENZENE	0.04	0.05	0.00	0.06	0.06	0.04	0.04	0.05	0.05
SEC-C4-BENZENE	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.00
1,2,4-TRIMETHYLBENZENE	1.72	1.51	1.21	1.02	1.05	0.77	1.05	1.10	1.15
1-METHYL-2-ISO-C3-BENZENE	0.06	0.04	0.05	0.05	0.05	0.02	0.15	0.19	0.17
1,3-DIETHYLBENZENE	0.00	0.00	0.00	0.69	0.70	0.50	0.00	0.00	0.00
1-METHYL-3-N-C3-BENZENE	0.57	0.67	0.76	0.24	0.25	0.19	0.66	0.59	0.57
N-C4-BENZENE	0.16	0.10	0.20	0.18	0.18	0.12	0.21	0.18	0.17
1,2,3-TRIMETHYLBENZENE	0.00	0.05	0.04	0.03	0.03	0.01	0.02	0.00	0.00
1,2-DIETHYLBENZENE	0.10	0.14	0.23	0.00	0.00	0.00	0.00	0.00	0.00
1-METHYL-2-N-C3-BENZENE	0.12	0.04	0.04	0.03	0.03	0.02	0.03	0.07	0.06
C10-ALKYLBENZENES	0.21	0.17	0.12	0.77	0.80	0.59	0.79	0.10	0.13
1,2,4,5-TETRAMETHYLBENZENE	0.10	0.09	0.08	0.07	0.07	0.05	0.10	0.07	0.06
1,2,3,5-TETRAMETHYLBENZENE	0.00	0.00	0.00	0.02	0.02	0.00	0.05	0.00	0.00
1,2,3,4-TETRAMETHYLBENZENE	0.13	0.10	0.08	0.01	0.00	0.06	0.15	0.06	0.07
C11-ALKYLBENZENES	1.82	1.76	1.58	0.85	0.83	0.60	0.57	1.32	1.38
NAPHTHALENE	0.00	0.00	0.03	0.00	0.02	0.02	0.00	0.01	0.00
METHYL-NAPHTHALENES	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00
UNKNOWNS (HC AROMATICS)	0.06	0.01	0.00	0.00	0.00	0.00	0.04	0.00	0.00
UNKNOWN C12+	2.56	2.12	2.47	2.27	2.50	2.71	2.81	2.81	2.41
SLURRY REACTOR WAX	9.08	9.00	8.91	8.68	8.62	8.54	8.47	8.32	8.46

Table A-9 (Contd.)
Composition of Hydrocarbon Products from
Two-Stage Slurry F-T/ZSM-5 Syngas Conversion
Run CT-256-3

M.B.No.	3-29	3-30	3-31	3-32	3-33	3-34	3-35	3-36	3-37
Days On Stream	30.5	31.5	32.5	33.5	34.5	35.5	36.5	37.5	38.5
METHANE	7.73	7.93	7.91	7.68	8.08	7.69	7.43	8.44	7.54
ETHENE	0.94	0.93	0.97	1.01	1.10	1.06	1.15	1.39	1.24
ETHANE	3.05	3.30	3.34	3.31	3.45	3.25	3.21	3.62	3.21
PROPENE	3.43	3.33	3.32	3.35	3.59	3.90	3.91	4.62	4.31
PROPANE	6.64	7.62	8.39	8.89	9.46	9.03	9.08	10.23	9.08
I-BUTANE	8.36	8.84	9.32	9.45	9.53	9.26	9.02	9.63	8.87
1-BUTENE+2-METHYLPROPENE	2.96	2.71	2.54	2.42	2.54	2.62	2.71	3.03	3.04
N-BUTANE	6.59	6.94	7.35	7.58	7.59	7.61	7.46	7.73	7.38
TRANS-2-BUTENE	1.18	1.06	1.00	0.95	1.00	1.03	1.07	1.17	1.19
CIS-2-BUTENE	0.83	0.73	0.69	0.66	0.69	0.72	0.75	0.81	0.83
3-METHYL-1-BUTENE	0.09	0.08	0.07	0.07	0.07	0.07	0.08	0.08	0.08
I-PENTANE	6.76	6.16	6.29	6.28	5.92	6.12	6.02	5.28	5.61
1-PENTENE	0.13	0.10	0.10	0.09	0.09	0.10	0.11	0.10	0.11
2-METHYL-1-BUTENE	0.69	0.55	0.50	0.46	0.46	0.50	0.52	0.47	0.56
N-PENTANE	4.40	3.95	4.03	3.99	3.77	4.02	4.01	3.30	3.74
TRANS-2-PENTENE	0.49	0.38	0.35	0.32	0.33	0.36	0.38	0.33	0.40
CIS-2-PENTENE	0.24	0.18	0.17	0.16	0.16	0.18	0.19	0.16	0.19
2-METHYL-2-BUTENE	1.76	1.33	1.21	1.09	1.07	1.18	1.24	1.06	1.29
C5-DIOLEFINS (DIENES)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2,2-DIMETHYLBUTANE	0.06	0.04	0.04	0.04	0.03	0.04	0.04	0.03	0.04
CYCLOPENTANE	0.20	0.19	0.22	0.24	0.25	0.28	0.29	0.15	0.17
HEXENES + ISO-HEXANES	0.07	0.02	0.02	0.02	0.00	0.05	0.02	0.00	0.05
2,3-DIMETHYLBUTANE	0.16	0.16	0.15	0.14	0.13	0.13	0.16	0.11	0.12
2-METHYLPENTANE	2.69	2.23	2.14	2.09	1.91	2.04	2.06	1.40	1.81
3-METHYLPENTANE	1.14	0.96	0.94	0.96	0.90	0.94	0.96	0.66	0.84
HEXENES	0.45	0.48	0.46	0.42	0.67	0.43	0.44	0.58	0.58
1-HEXENE	0.11	0.06	0.05	0.05	0.02	0.05	0.07	0.03	0.06
N-HEXANE	2.31	2.01	1.93	1.96	1.79	1.97	2.05	1.37	1.87
2,4-DIMETHYLPENTANE	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00
METHYLCYCLOPENTANE	1.02	0.95	1.00	1.12	1.08	1.20	1.23	0.88	1.11
3,3-DIMETHYLPENTANE	0.00	0.00	0.00	0.00	0.01	0.03	0.00	0.00	0.00
CYCLOHEXANE	0.02	0.02	0.03	0.03	0.04	0.02	0.02	0.03	0.00
HEPTENES + ISO-HEPTANES	0.59	0.36	0.30	0.30	0.07	0.25	0.40	0.14	0.38
2-METHYLHEXANE	0.77	0.75	0.70	0.69	0.61	0.67	0.62	0.43	0.57
2,3-DIMETHYLPENTANE	0.17	0.18	0.18	0.19	0.20	0.20	0.19	0.15	0.18
3-METHYLHEXANE	0.73	0.72	0.68	0.67	0.62	0.67	0.61	0.44	0.57
1-CIS-3-DIMETHYL-N5	0.32	0.33	0.33	0.35	0.34	0.38	0.34	0.28	0.34
1-TRANS-3-DIMETHYL-N5	0.32	0.33	0.33	0.35	0.34	0.38	0.35	0.28	0.34
1-TRANS-2-DIMETHYL-N5	0.25	0.26	0.27	0.28	0.27	0.30	0.28	0.22	0.27
N-HEPTANE	1.08	1.10	1.01	0.98	0.89	1.09	0.97	0.76	1.02
C7-OLEFINS	0.61	0.64	0.57	0.52	0.67	0.50	0.54	0.61	0.63
METHYLCYCLOHEXANE	0.24	0.25	0.23	0.24	0.19	0.25	0.19	0.16	0.20
C8-OLEFINS + ISO-P	0.69	0.52	0.41	0.40	0.01	0.50	0.40	0.01	0.42
MONOMETHYL-ISO-C8-P	0.57	0.61	0.56	0.51	0.57	0.44	0.43	0.46	0.43
OTHER ISO-C8-P	0.12	0.13	0.13	0.13	0.16	0.12	0.12	0.15	0.19
C8-OLEFINS	1.11	1.10	1.30	1.17	1.27	0.83	0.58	0.81	0.84
C8-NAPHTHENES (N5+N6)	1.03	1.10	1.11	1.05	1.26	0.99	0.97	1.10	0.87
N-OCTANE	0.52	0.51	0.06	0.06	0.00	0.42	0.42	0.42	0.49
C9-OLEFINS + ISO-P	0.98	0.56	0.35	0.41	0.08	0.37	0.38	0.04	0.42
MONOMETHYL-ISO-C9-P	0.29	0.32	0.29	0.25	0.27	0.23	0.22	0.26	0.29
OTHER ISO-C9-P	0.13	0.14	0.13	0.12	0.13	0.11	0.02	0.09	0.14
C9-OLEFINS	0.68	0.67	0.54	0.41	0.45	0.40	0.54	0.26	0.33
C9-NAPHTHENES (N5+N6)	0.34	0.35	0.32	0.29	0.32	0.27	0.29	0.37	0.39
N-NONANE	0.17	0.17	0.14	0.14	0.15	0.14	0.19	0.22	0.23
ISO-C10-P + O + N5 + N6	0.98	0.85	0.71	0.70	0.72	0.52	0.53	0.61	0.55
BENZENE	0.64	0.64	0.68	0.76	0.75	0.81	0.82	0.61	0.74
TOLUENE	2.49	2.87	3.10	3.33	3.24	3.02	3.52	3.37	3.44
ETHYLBENZENE	1.31	1.24	1.16	1.32	0.91	1.25	1.27	0.95	1.38
P-XYLENE	0.62	0.73	0.71	0.88	0.99	2.90	2.91	0.84	0.79
M-XYLENE	1.61	1.91	2.06	2.11	2.43	0.00	0.00	2.43	2.12
O-XYLENE	0.70	0.79	0.88	0.93	1.07	0.92	0.90	1.01	0.91
N-PROPYLBENZENE	0.15	0.15	0.14	0.12	0.13	0.12	0.12	0.13	0.13
1-METHYL-3-ETHYL-BENZENE	1.98	2.14	2.13	2.14	2.31	1.98	2.00	2.23	2.05
1,3,5-TRIMETHYL-BENZENE	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.07	0.06
1-METHYL-2-ETHYLBENZENE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05
ISO-C4-BENZENE	0.04	0.03	0.03	0.00	0.03	0.03	0.03	0.03	0.03
1,2,4-TRIMETHYLBENZENE	1.21	1.32	1.37	1.46	1.60	1.40	1.43	1.61	1.46
1-METHYL-2-ISO-C3-BENZENE	0.11	0.11	0.10	0.04	0.04	0.12	0.03	0.04	0.03
1,3-DIETHYLBENZENE	0.00	0.00	0.00	0.00	0.40	0.00	0.36	0.39	0.37
1-METHYL-3-N-C3-BEIZENE	0.42	0.43	0.40	0.38	0.08	0.34	0.07	0.08	0.08
N-C4-BENZENE	0.09	0.09	0.00	0.09	0.10	0.00	0.09	0.10	0.09
1,2,3-TRIMETHYLBENZENE	0.04	0.03	0.03	0.00	0.06	0.00	0.08	0.09	0.05
1,2-DIETHYLBENZENE	0.00	0.00	0.08	0.08	0.00	0.07	0.00	0.00	0.00
1-METHYL-2-N-C3-BENZENE	0.07	0.07	0.08	0.08	0.03	0.08	0.00	0.00	0.03
C10-ALKYLBENZENES	0.61	0.64	0.61	0.61	0.64	0.15	0.57	0.64	0.59
1,2,4,5-TETRAMETHYLBENZENE	0.06	0.07	0.07	0.07	0.08	0.07	0.07	0.08	0.07
1,2,3,5-TETRAMETHYLBENZENE	0.00	0.00	0.00	0.05	0.05	0.00	0.04	0.05	0.04
1,2,3,4-TETRAMETHYLBENZENE	0.09	0.09	0.09	0.01	0.11	0.10	0.10	0.11	0.10
C11-ALKYLBENZENES	0.69	0.76	0.75	0.77	0.67	1.11	0.75	0.76	0.72
NAPHTHALENE	0.06	0.07	0.00	0.07	0.08	0.07	0.00	0.09	0.00
METHYL-NAPHTHALENES	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00
UNKNOWNS (HC AROMATICS)	0.00	0.00	0.01	0.02	0.00	0.00	0.06	0.01	0.07
UNKNOWN C12+	1.46	1.83	1.99	0.59	0.75	1.70	1.77	1.94	1.84
SLURRY REACTOR WAX	8.45	8.34	8.30	8.99	7.97	7.66	7.63	7.47	7.31

Table A-9 (Contd.)
Composition of Hydrocarbon Products from
Two-Stage Slurry F-T/ZSM-5 Syngas Conversion
Run CT-256-3

M.B.No.	3-38	3-39	3-51	3-52	3-53	3-54	3-55	3-56	3-57
Days On Stream	39.5	40.5	53.5	55.5	57.5	59.5	62.5	64.5	66.5
METHANE	7.30	7.87	7.27	9.51	8.71	9.63	10.98	9.99	9.66
ETHENE	1.29	1.43	0.96	0.51	0.56	0.78	1.05	0.95	1.04
ETHANE	3.15	3.35	3.27	3.81	3.61	4.04	4.76	4.59	3.83
PROPENE	4.46	5.10	0.87	2.08	2.28	3.07	3.78	3.29	3.53
PROPANE	9.02	9.40	8.54	6.81	5.57	5.91	6.29	6.65	7.72
I-BUTANE	8.73	8.89	10.64	8.51	6.86	7.22	7.54	7.81	8.95
1-BUTENE+2-METHYLPROPENE	3.15	3.52	0.85	1.99	2.73	3.21	3.35	2.80	2.78
N-BUTANE	7.41	7.59	8.35	7.19	6.24	6.20	5.96	6.23	6.99
TRANS-2-BUTENE	1.24	1.37	0.31	0.74	1.03	1.20	1.30	1.11	1.08
CIS-2-BUTENE	0.88	0.96	0.21	0.50	0.69	0.81	0.88	0.77	0.76
3-METHYL-1-BUTENE	0.09	0.10	0.03	0.05	0.09	0.09	0.10	0.08	0.08
I-PENTANE	5.89	5.62	7.74	6.14	5.86	5.18	5.90	5.96	6.21
1-PENTENE	0.13	0.14	0.33	0.08	0.11	0.11	0.13	0.12	0.11
2-METHYL-1-BUTENE	0.63	0.65	0.16	0.40	0.68	0.66	0.74	0.63	0.55
N-PENTANE	4.07	3.87	4.76	4.40	4.71	3.69	3.88	3.85	3.88
TRANS-2-PENTENE	0.46	0.46	0.11	0.27	0.45	0.42	0.50	0.27	0.39
CIS-2-PENTENE	0.23	0.23	0.06	0.13	0.21	0.20	0.24	0.25	0.18
2-METHYL-2-BUTENE	1.50	1.49	0.41	1.04	1.83	1.63	1.96	1.60	1.39
UNKNOWN C5-MONOOLEFINS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.14	0.00
2,2-DIMETHYLBUTANE	0.05	0.05	0.04	0.02	0.03	0.03	0.05	0.04	0.04
CYCLOPENTANE	0.22	0.20	0.04	0.02	0.05	0.06	0.12	0.12	0.14
HEXENES + ISO-HEXANES	0.06	0.05	0.11	0.03	0.07	0.04	0.09	0.05	0.02
2,3-DIMETHYLBUTANE	0.13	0.12	0.16	0.10	0.09	0.08	0.12	0.12	0.13
2-METHYLPENTANE	1.96	1.75	2.98	2.58	3.10	1.94	2.65	2.45	2.28
3-METHYLPENTANE	0.89	0.81	1.19	0.93	1.04	0.75	1.05	1.06	0.94
HEXENES	0.58	0.64	0.38	0.59	0.79	0.81	0.58	0.82	0.60
1-HEXENE	0.07	0.07	0.65	0.03	0.08	0.05	0.13	0.07	0.06
N-HEXANE	2.00	1.87	2.20	2.25	2.99	1.76	2.33	2.23	2.01
2,4-DIMETHYLPENTANE	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.01	0.01
METHYLCYCLOPENTANE	1.15	1.10	0.69	0.48	0.46	0.58	0.79	0.97	0.99
3,3-DIMETHYLPENTANE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CYCLOHEXANE	0.00	0.02	0.02	0.03	0.02	0.03	0.02	0.03	0.03
HEPTENES + ISO-HEPTANES	0.42	0.39	0.18	0.14	0.53	0.23	0.80	0.38	0.35
2-METHYLHEXANE	0.55	0.49	0.97	1.12	1.34	0.74	0.99	0.90	0.79
2,3-DIMETHYLPENTANE	0.18	0.17	0.15	0.12	0.11	0.15	0.17	0.21	0.18
3-METHYLHEXANE	0.55	0.50	0.91	0.97	1.09	0.70	0.86	0.85	0.73
1-CIS-3-DIMETHYL-N5	0.34	0.32	0.26	0.23	0.21	0.27	0.29	0.36	0.36
1-TRANS-3-DIMETHYL-N5	0.34	0.32	0.75	0.24	0.17	0.26	0.30	0.35	0.32
1-TRANS-2-DIMETHYL-N5	0.28	0.26	0.51	0.23	0.06	0.19	0.25	0.28	0.28
N-HEPTANE	1.06	1.01	0.66	1.23	1.82	1.03	1.32	1.26	0.99
C7-OLEFINS	0.64	0.67	0.48	0.81	1.37	1.14	0.85	0.95	0.72
METHYLCYCLOHEXANE	0.23	0.23	0.25	0.20	0.22	0.32	0.34	0.33	0.36
C8-OLEFINS + ISO-P	0.52	0.43	0.55	0.01	0.25	0.01	0.87	0.70	0.56
MONOMETHYL-ISO-C8-P	0.25	0.38	0.89	1.41	0.76	0.94	0.69	0.72	0.63
OTHER ISO-C8-P	0.19	0.12	0.13	0.14	0.08	0.16	0.11	0.15	0.13
C8-OLEFINS	1.34	0.97	0.55	1.88	2.96	2.24	1.95	1.36	1.13
C8-NAPHTHENES (N5+N6)	0.61	0.91	1.10	1.25	1.48	1.24	0.84	1.12	0.98
N-OCTANE	0.51	0.49	0.46	0.75	1.02	0.60	0.54	0.55	0.44
C9-OLEFINS + ISO-P	0.33	0.32	0.20	0.00	0.55	0.00	1.36	0.86	0.99
MONOMETHYL-ISO-C9-P	0.22	0.26	0.42	0.79	0.77	0.51	0.39	0.13	0.33
OTHER ISO-C9-P	0.03	0.13	0.16	0.20	0.16	0.18	0.14	0.28	0.13
C9-OLEFINS	0.47	0.30	0.21	0.99	1.37	1.22	0.87	0.90	0.67
C9-NAPHTHENES (N5+N6)	0.29	0.34	0.39	0.56	0.36	0.51	0.42	0.41	0.32
N-NONANE	0.23	0.24	0.08	0.25	0.45	0.26	0.18	0.18	0.15
ISO-C10-P + O + N5 + N6	0.59	0.62	0.74	1.39	2.28	1.63	0.85	0.92	0.73
BENZENE	0.75	0.71	0.48	0.36	0.45	0.48	0.61	0.69	0.69
TOLUENE	3.46	3.22	3.15	2.09	1.56	2.65	2.27	3.06	3.43
ETHYLBENZENE	1.30	1.17	1.12	0.74	0.72	0.88	1.19	1.55	1.65
P-XYLENE	0.76	0.73	0.81	0.76	0.54	1.00	0.57	0.79	0.79
M-XYLENE	2.05	1.94	2.20	2.07	1.51	2.34	1.52	1.91	2.27
O-XYLENE	0.87	0.82	0.87	0.78	0.55	0.98	0.60	0.80	0.93
N-PROPYLBENZENE	0.13	0.12	0.16	0.30	0.29	0.29	0.19	0.19	0.19
1-METHYL-3-ETHYL-BENZENE	1.96	1.83	2.71	3.13	2.37	3.26	2.14	2.41	2.57
1,3,5-TRIMETHYL-BENZENE	0.06	0.05	0.10	0.09	0.10	0.11	0.06	0.06	0.07
1-METHYL-2-ETHYLBENZENE	0.04	0.00	0.00	0.03	0.03	0.08	0.10	0.10	0.13
ISO-C4-BENZENE	0.03	0.02	0.04	0.06	0.06	0.00	0.01	0.02	0.00
1,2,4-TRIMETHYLBENZENE	1.40	1.30	1.52	1.53	1.17	1.93	1.23	1.41	1.29
1-METHYL-2-ISO-C3-BENZENE	0.03	0.03	0.07	0.06	0.05	0.09	0.08	0.03	0.03
1,3-DIETHYLBENZENE	0.35	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.43
1-METHYL-3-N-C3-BENZENE	0.07	0.33	0.54	0.84	0.76	0.80	0.53	0.51	0.09
N-C4-BENZENE	0.09	0.08	0.15	0.22	0.19	0.23	0.14	0.13	0.12
1,2,3-TRIMETHYLBENZENE	0.08	0.07	0.12	0.11	0.04	0.17	0.04	0.05	0.06
1,2-DIETHYLBENZENE	0.00	0.07	0.09	0.19	0.24	0.18	0.12	0.11	0.00
1-METHYL-2-N-C3-BENZENE	0.05	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.00
C10-ALKYLBENZENES	0.51	0.53	0.83	1.04	0.39	1.23	0.77	0.77	0.19
1,2,4,5-TETRAMETHYLBENZENE	0.07	0.07	0.11	0.11	0.08	0.17	0.09	0.09	0.02
1,2,3,5-TETRAMETHYLBENZENE	0.04	0.04	0.10	0.06	0.03	0.08	0.03	0.05	0.01
1,2,3,4-TETRAMETHYLBENZENE	0.09	0.08	0.11	0.10	0.08	0.12	0.08	0.10	0.02
C11-ALKYLBENZENES	0.71	0.63	1.04	1.08	0.89	1.29	0.80	0.87	0.20
NAPHTHALENE	0.00	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.00
UNKNOWNS (HC AROMATICS)	0.05	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UNKNOWN C12+	0.94	0.57	3.83	2.94	2.19	2.41	1.73	1.91	2.00
SLURRY REACTOR WAX	7.22	6.96	5.56	5.17	4.83	4.52	2.41	3.24	4.13

Table A-9 (Contd.)
Composition of Hydrocarbon Products from
Two-Stage Slurry F-T/ZSM-5 Syngas Conversion
Run CT-256-3

M.B.No.	3-58	3-59	3-60	3-61	3-62	3-63	3-64
Days On Stream	68.5	70.5	72.5	74.5	76.5	78.5	80.5
METHANE	9.46	8.39	9.14	8.81	9.51	7.70	7.72
ETHENE	0.92	0.91	1.16	1.27	1.26	1.29	2.77
ETHANE	4.17	3.97	4.31	4.10	4.39	4.08	3.25
PROPENE	2.99	3.24	3.92	4.45	4.01	4.17	9.46
PROPANE	9.71	9.41	9.11	9.86	10.22	9.60	7.44
I-BUTANE	9.01	8.61	8.56	8.11	8.11	7.34	4.94
1-BUTENE+2-METHYLPROPENE	2.51	2.51	2.82	3.22	2.79	2.76	6.77
N-BUTANE	7.14	7.17	7.15	7.05	7.28	6.85	4.61
TRANS-2-BUTENE	0.98	0.99	1.10	1.27	1.12	1.06	2.86
CIS-2-BUTENE	0.68	0.70	0.77	0.90	0.80	0.76	2.10
3-METHYL-1-BUTENE	0.07	0.08	0.08	0.10	0.09	0.07	0.21
I-PENTANE	6.06	6.29	5.39	5.12	4.35	4.28	3.04
1-PENTENE	0.10	0.10	0.11	0.13	0.13	0.11	0.28
2-METHYL-1-BUTENE	0.50	0.53	0.53	0.61	0.57	0.46	1.23
N-PENTANE	3.39	4.01	3.46	3.28	3.38	3.01	2.44
TRANS-2-PENTENE	0.36	0.38	0.38	0.44	0.41	0.33	0.87
CIS-2-PENTENE	0.17	0.19	0.19	0.22	0.21	0.17	0.45
2-METHYL-2-BUTENE	1.25	1.26	1.23	1.35	1.24	0.95	2.55
2,2-DIMETHYLBUTANE	0.04	0.03	0.03	0.03	0.03	0.02	0.05
CYCLOPENTANE	0.19	0.13	0.10	0.12	0.13	0.11	0.15
HEXENES + ISO-HEXANES	0.03	0.03	0.00	0.01	0.01	0.00	0.07
2,3-DIMETHYLBUTANE	0.10	0.13	0.12	0.11	0.11	0.08	0.06
2-METHYLPENTANE	2.17	2.18	1.70	1.62	1.52	1.18	0.93
3-METHYLPENTANE	0.96	0.42	0.81	0.79	0.77	0.60	0.47
HEXENES	0.54	2.98	0.87	0.94	0.95	0.67	1.61
1-HEXENE	0.06	0.05	0.03	0.04	0.04	0.03	0.09
N-HEXANE	1.98	1.93	1.61	1.62	1.65	1.22	1.36
2,4-DIMETHYLPENTANE	0.01	0.01	0.01	0.01	0.01	0.00	0.01
METHYLCYCLOPENTANE	1.00	1.03	0.91	0.86	0.96	0.79	0.63
3,3-DIMETHYLPENTANE	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CYCLOHEXANE	0.03	0.03	0.03	0.00	0.03	0.02	0.02
HEPTENES + ISO-HEPTANES	0.32	0.27	0.14	0.14	0.14	0.06	0.32
2-METHYLHEXANE	0.75	0.69	0.56	0.55	0.48	0.30	0.28
2,3-DIMETHYLPENTANE	0.19	0.19	0.17	0.16	0.17	0.12	0.11
3-METHYLHEXANE	0.73	0.68	0.58	0.57	0.50	0.34	0.31
1-CIS-3-DIMETHYL-N5	0.35	0.33	0.30	0.28	0.28	0.20	0.20
1-TRANS-3-DIMETHYL-N5	0.35	0.32	0.30	0.28	0.29	0.20	0.19
1-TRANS-2-DIMETHYL-N5	0.27	0.26	0.25	0.22	0.24	0.17	0.14
N-HEPTANE	1.04	0.91	0.83	0.89	0.89	0.51	0.91
C7-OLEFINS	0.65	0.65	0.80	0.95	0.77	0.44	1.74
METHYLCYCLOHEXANE	0.27	0.21	0.21	0.18	0.17	0.09	0.10
C8-OLEFINS + ISO-P	0.41	0.31	0.04	0.06	0.16	0.05	0.00
MONOMETHYL-ISO-C8-P	0.64	0.57	0.57	0.57	0.42	0.28	0.34
OTHER ISO-C8-P	0.14	0.14	0.15	0.15	0.13	0.10	0.11
C8-OLEFINS	1.05	1.00	1.26	1.23	0.88	0.40	2.61
C8-NAPHTHENES (N5+N6)	1.11	1.06	1.11	1.12	0.98	0.71	0.77
N-OCTANE	0.43	0.38	0.42	0.47	0.42	0.23	0.63
C9-OLEFINS + ISO-P	0.36	0.56	0.30	0.55	0.77	0.06	0.03
MONOMETHYL-ISO-C9-P	0.30	0.28	0.29	0.29	0.21	0.13	0.21
OTHER ISO-C9-P	0.13	0.12	0.04	0.12	0.10	0.02	0.11
C9-OLEFINS	0.67	0.42	0.53	0.70	0.21	0.13	0.97
C9-NAPHTHENES (N5+N6)	0.32	0.30	0.40	0.31	0.21	0.13	0.17
N-NONANE	0.15	0.14	0.18	0.22	0.16	0.09	0.46
ISO-C10-P + O + N5 + N6	1.15	0.69	0.79	0.75	0.66	0.41	1.08
BENZENE	0.71	0.72	0.69	0.65	0.78	0.71	0.59
TOLUENE	3.59	3.44	3.36	3.10	3.80	3.38	1.86
ETHYLBENZENE	1.35	1.38	1.15	1.25	1.48	0.72	0.59
P-XYLENE	0.87	0.97	1.02	0.99	0.99	0.82	0.73
M-XYLENE	2.37	2.30	2.57	2.42	2.51	2.20	1.66
O-XYLENE	1.01	0.97	1.10	1.07	1.09	0.93	0.75
N-PROPYLBENZENE	0.18	0.15	0.18	0.19	0.14	0.08	0.17
1-METHYL-3-ETHYL-BENZENE	2.59	2.49	2.66	2.58	2.19	1.47	1.93
1,3,5-TRIMETHYL-BENZENE	0.07	0.06	0.07	0.07	0.07	0.06	0.08
1-METHYL-2-ETHYLBENZENE	0.14	0.00	0.02	0.02	0.01	0.01	0.03
ISO-C4-BENZENE	0.02	0.03	0.04	0.04	0.03	0.02	0.10
1,2,4-TRIMETHYLBENZENE	1.67	1.63	1.81	1.74	1.64	1.19	1.27
1-METHYL-2-ISO-C3-BENZENE	0.03	0.03	0.04	0.03	0.04	0.03	0.02
1,3-DIETHYLBENZENE	0.62	0.00	0.49	0.00	0.39	0.00	0.09
1-METHYL-3-N-C3-BENZENE	0.00	0.46	0.11	0.48	0.08	0.22	0.39
N-C4-BENZENE	0.02	0.12	0.13	0.12	0.09	0.05	0.09
1,2,3-TRIMETHYLBENZENE	0.07	0.09	0.10	0.09	0.09	0.07	0.06
1,2-DIETHYLBENZENE	0.14	0.09	0.00	0.11	0.00	0.04	0.11
1-METHYL-2-N-C3-BENZENE	0.00	0.00	0.00	0.00	0.00	0.00	0.03
C10-ALKYLBENZENES	0.74	0.76	0.81	0.80	0.67	0.43	0.62
1,2,4,5-TETRAMETHYLBENZENE	0.13	0.10	0.12	0.10	0.09	0.04	0.08
1,2,3,5-TETRAMETHYLBENZENE	0.01	0.05	0.06	0.05	0.05	0.01	0.04
1,2,3,4-TETRAMETHYLBENZENE	0.02	0.11	0.12	0.10	0.10	0.06	0.08
C11-ALKYLBENZENES	1.14	0.76	0.90	0.79	0.69	0.55	0.68
NAPHTHALENE	0.02	0.06	0.00	0.00	0.00	0.01	0.01
METHYL-NAPHTHALENES	0.00	0.00	0.00	0.00	0.02	0.02	0.00
UNKNOWNS (HC AROMATICS)	0.00	0.00	0.00	0.02	0.00	0.06	0.00
DIMETHYL ETHER	0.00	0.00	0.00	0.00	0.00	0.30	0.00
UNKNOWN C12+	0.88	2.01	2.05	2.26	2.64	9.37	1.41
SLURRY REACTOR WAX	3.76	4.04	4.59	4.59	5.62	12.23	6.31