LIQUID PHASE FISCHER-TROPSCH (III & IV) DEMONSTRATION IN THE LAPORTE ALTERNATIVE FUELS DEVELOPMENT UNIT

Topical Report

FINAL

(Volume I/II: Main Report)

Task 1: Engineering Modifications (Fischer-Tropsch III & IV Demonstration)

and

Task 2: AFDU Shakedown, Operations, Deactivation (Shut-down) and Disposal (Fischer-Tropsch III & IV Demonstration)

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EXECUTIVE SUMMARY

Slurry phase Fischer-Tropsch technology was successfully demonstrated in DOE's Alternative Fuels Development Unit (AFDU) at LaPorte, Texas. Earlier work at LaPorte, with iron catalysts in 1992 and 1994, had established proof-of-concept status for the slurry phase process. The third campaign (Fischer-Tropsch III), in 1996, aimed at aggressively extending the operability of the slurry reactor using a proprietary cobalt catalyst. Due to an irreversible plugging of catalyst-wax separation filters as a result of unexpected catalyst fines generation, the operations had to be terminated after seven days on-stream. Following an extensive post-run investigation by the participants, the campaign was successfully completed in March-April 1998, with an improved proprietary cobalt catalyst.

These runs were sponsored by the U. S. Department of Energy (DOE), Air Products & Chemicals, Inc., and Shell Synthetic Fuels, Inc. (SSFI). A productivity of approximately 140 grams (gm) of hydrocarbons (HC)/ hour (hr)-liter (lit) of expanded slurry volume was achieved at reasonable system stability during the second trial (Fischer-Tropsch IV). The productivity ranged from 110-140 at various conditions during the 18 days of operations. The catalyst/wax filters performed well throughout the demonstration, producing a clean wax product. For the most part, only one of the four filter housings was needed for catalyst/wax filtration. The filter flux appeared to exceed the design flux. A combination of use of a stronger catalyst and some innovative filtration techniques were responsible for this success. There was no sign of catalyst particle attrition and very little erosion of the slurry pump was observed, in contrast to the Fischer-Tropsch III operations.

The reactor operated hydrodynamically stable with uniform temperature profile and gas hold-ups. Nuclear density and differential pressure measurements indicated somewhat higher than expected gas hold-up (45 - 50 vol%) during Fischer-Tropsch IV operations. The high gas hold-up was confirmed by a dynamic gas disengagement test conducted at the end of the run. Heat transfer in the reactor was better than expected. Heat, mass and elemental balance calculations indicated excellent closure. After the initial learning curve with system dynamics, the plant was restarted very quickly (24 hours and 17 hours) following two plant trips. This demonstrates the ease and flexibility of the slurry technology.

In-situ reduction of catalyst pre-cursor was completed successfully during F-T IV operations. Water measurements proved to be inaccurate due to wax/oil contamination of the analytical system. However, the reduction appeared to proceed well as close to expected syngas conversion was obtained at the beginning of the run. The selectivity to wax was lower than expected, with higher methane selectivity. Returning to the baseline condition indicated a productivity decline from 135-140 to 125-130 gm HC/hr-lit. of reactor volume in two weeks of operation. This may be a result of some catalyst loss from the reactor as well as initial catalyst deactivation.

Significant quantities of product and samples were collected for further processing and analysis by the participants. Gas, liquid and solid phase mixing were studied as planned at two operating conditions using radioactive materials. A large amount of data were collected by ICI Tracerco using 43 detectors around the reactor. The data are being analyzed by Washington University as part of the Hydrodynamic Program with DOE.

INTRODUCTION

Domestic development of a slurry-phase Fischer-Tropsch (F-T) process is of considerable interest to Department of Energy's Indirect Liquefaction program. The Federal Energy Technology Center (FETC) sponsors the Indirect Liquefaction program as part of its Coal Liquefaction program. The overall goal of the Coal Liquefaction program is to develop a scientific and engineering knowledge base with which industry can bring economically competitive and environmentally acceptable advanced technology for the manufacture of synthetic liquid fuels from coal into the marketplace when needed. In addition, several industrial companies have an interest in developing the technology for remote gas conversion.

During October 1996, operations were carried out at DOE's Alternative Fuels Development Unit (AFDU) in LaPorte, Texas, to evaluate further improvements to the slurry process for Fischer-Tropsch synthesis. Earlier work at LaPorte in 1992 and 1994, had established proof-of-concept status for the slurry phase process. The first campaign in 1992 was a 19-day demonstration of the technology at 1 T/D product scale and addressed scale-up issues such as catalyst activation, catalyst performance and hydrodynamics (1). The scale-up of the technologies involves demonstration in a 22.5" (ID) diameter slurry bubble column reactor based on laboratory bench scale investigations. The chemistry of Fischer-Tropsch Synthesis as well as advantages of conducting F-T in a slurry phase were discussed in a report on the initial F-T demonstration (2). A very high level of reactor productivity (more than five times the F-T I productivity) was demonstrated for slurry phase Fischer-Tropsch synthesis in 1994 (3). Reactor productivity of 136 grams of HC/hr - liter of slurry volume was achieved, which was within the target of 120-150. The productivity was constrained by mass transfer limitations, due to slurry thickening. With an improved catalyst, if carbon formation can be avoided, there appeared to be significant room for further improvements.

The third campaign, in 1996, aimed at aggressively extending the operability of the slurry reactor using a SSFI proprietary catalyst. This demonstration had significant industrial backing. In addition to DOE, this run was sponsored by Air Products and Chemicals and Shell Synthetic Fuels, Inc. Preliminary results from this run were presented earlier at a DOE’s Contractors Review Conference and an AIChE meeting (4, 5). Due to an irreversible plugging of catalyst-wax separation filters as a result of unexpected catalyst fines generation, the operations had to be terminated after seven days on-stream. Following an extensive post-run investigation by the participants, the campaign was successfully completed with an improved SSFI proprietary catalyst in March-April 1998 (Fischer-Tropsch IV). A paper discussing the evolution of the technology through the four pilot plant campaigns was presented at the 1998 International Pittsburgh Coal Conference (6). Key issues such as catalyst-wax separation, reactor productivity improvements, reactor temperature control, and in-situ activation were addressed. The paper only included preliminary results from the F-T III and IV, as detailed analysis was pending. This report provides details and final analysis for the two runs.

OBJECTIVES

The principal objective of these runs was to conduct Fischer-Tropsch synthesis in a large diameter bubble column and demonstrate:

(1) Sustainable high productivity - a space time yield of 150 grams hydrocarbon per hour per liter of reactor volume;
(2) Activity and selectivity of SSFI's proprietary catalyst;
(3) Catalyst-wax separation by external cross-flow filtration; and
(4) In-situ reduction of catalyst pre-cursor.

The runs would also allow the participants to study other issues such as:

(1) Large scale fluid dynamics,
(2) Erosion,
(3) Catalyst stability, and
(4) Catalyst attrition.

ENGINEERING AND MODIFICATIONS (F-T III)

Process Description

Simplified process flow diagrams for Fischer-Tropsch III are given in Figures 1 and 2. The operation of the AFDU for Fischer-Tropsch is described as follows (refer to Fig. 1): Carbon monoxide, hydrogen and nitrogen are blended and compressed using the 01.10 compressor to obtain desired fresh synthesis gas composition and flow. The fresh feed is then mixed with recycle feed from the 01.20 recycle compressor. High pressure hydrogen is used to supplement the fresh feed. The high pressure hydrogen may be compressed using the recycle compressor if its pressure is not adequate. The combined feed gas is preheated in the 21.38 feed/product economizer and the 02.61 feed gas steam heater. The preheated feed gas is introduced to the bottom of the slurry reactor, 27.10. The synthesis gas flows upward through the slurry and is partially converted to hydrocarbons, water and carbon dioxide. The heat of reaction is absorbed by the slurry medium and then rejected to an internal heat exchanger. Heavier hydrocarbon fraction of the product (heavy wax) is liquid at reaction conditions and accumulates in the reactor. The reactor effluent is first sent through the 27.11 cyclone separator to remove entrained slurry and then cooled using the 21.38 economizer to condense light waxes which are separated in the 22.14 separator. The reactor effluent is subsequently chilled against cooling water in the 21.65 hairpin exchangers. Condensed hydrocarbon and water are separated from the vapor phase in the 22.10 separator. After analysis, part of the uncondensed vapor is sent to the flare as a purge stream, most of this stream is recycled using the 01.20 recycle compressor. The liquids from the 22.10 are de-pressurized and sent to vessels 22.11, 22.15 and 22.16 in sequence. The product from the 22.16 is sent to a tank trailer in batches, periodically.

The excess slurry from the reactor is drained into the 27.15 slurry degasser. Following degassing, the slurry is cooled by about 36°F in the 21.70 catalyst-wax slurry cooler. The slurry is then pumped using the 10.62 catalyst-wax circulation pump to the 22.62 cross flow filter for wax removal. The product wax from the filter is collected in the 28.30 prep tank and then drained into trailer or drums and sampled periodically. After filtration, the concentrated slurry is sent back to the reactor. The liquid level in the reactor is measured by the nuclear density gauge DIC-585 and is controlled by position of the control valve which directly controls wax withdrawal from the filters. In the reactor, particles are kept fully suspended by the upward liquid flow (also in the absence of gas flow), as the liquid velocity is well beyond the particle settling velocity.

A liquid level is maintained in the 27.12 slurry carryover surge tank which receives slurry from the 27.11 cyclone separator. Excess liquid from the 27.12 is sent to the 27.10 reactor using the 10.52.02 carryover oil pump. The light wax from the 22.14 separator is de-pressurized into the 27.13 tank. Light wax in the 27.13 tank is circulated around using the 10.60 pump and kept warm by flowing it through the 21.85 heat exchanger. Heavy wax in the 28.30 prep tank is circulated around by the 10.52.01 pump. The pressurized wax is used to back-flush the 22.62 filters when needed. Waxes from the 27.13 and the 28.30 are drained into trailer or drums.

Flows and compositions are measured at various strategic points in the process including feed and product gas.

Bubble Column Reactor

The 27.10 bubble column reactor is 28.3' top to bottom and 22.5" inside diameter. The maximum slurry level is about 20' with the remainder being vapor disengagement space. A goal of 150 grams HC/liter reactor vol - hr of HC productivity, which was same as F-T II, was set. The heat exchanger, which was installed prior to F-T II (3), was evaluated for F-T III and found adequate. The heat exchanger consists of 22 vertical 3/4" U-tubes with an internal header. Twelve of the U-tubes are near the wall and ten are near the center. Detailed drawings of the heat exchanger were included in the Fischer-Tropsch II topical report (3). The external surface area of the U-tubes is 217.7 ft^2 based on 36 ft length. The heat exchanger occupies 9.6% of the reactor cross-section. The reactor is fitted with a number of thermocouples, located at various elevations. A nuclear density gauge is mounted on an external track and spans the space occupied by the internal heat exchanger. The maximum temperature for the reactor is 315^{o}C at the maximum pressure of 1000 psig. Operations at higher temperature are feasible by lowering the operating pressure.

Analytical Set-up

Two of the AFDU gas chromatographs (GCs) are set up with two flame ionization detectors (FIDs) each, for both hydrocarbon and alcohol analysis. The hydrocarbon analysis uses DOE-FETC's methods (7). Both the GCs are dedicated to product gas analysis, measuring concentrations of C_1-C_8 hydrocarbons. Two other GCs are set up with two thermal conductivity detectors (TCDs) each. These GCs measure H_2, CO, N_2, and CO_2 in both feed and product gas streams. Liquid (C_5-C_{20}) and wax (C_{12}-C_{50}) analysis were performed by SSFI. Samples from 22.11 and 22.16 liquid (HC + aqueous phase), 22.14 light wax, 28.30 heavy wax as well as spent slurry from 27.10 were taken and shipped to SSFI.

Water analyzers were added to measure water production during the reduction of catalyst pre-cursor. This included adsorbent tubes for periodic analysis and Panametric instruments for instantaneous measurements.

Catalyst-wax Separation System

The catalyst-wax separation has been recognized as a challenge. No single proven technology exists in the public domain. An external system of tangential (cross) flow filters was used at LaPorte based on SSFI's pilot plant experience. Filtration was preferred at reactor pressure to avoid catalyst attrition that may occur if a control valve is used to reduce the pressure. The existing filtration system at LaPorte was designed for low pressure, with limited capacity. So, the entire filtration system was redesigned and replaced. The new system was rated at higher pressure (1000 psig) and higher temperature (600°F), with significantly higher capacity. It included four new cross-flow filters in series, a catalyst-wax slurry circulation pump, a slurry cooler and a slurry degasser. A layout of the filtration system is shown in Figure 3. The sketch is not to scale but does show an approximate elevation of the equipment. The degasser was installed close to the top of the reactor to obtain almost the same liquid level in the two vessels. The slurry cooler was located at a level near the bottom of the reactor. The pump and the filters were installed at the ground level. There was no back-up system for filtration. If the filtration did not work as designed, the reactor would have to be shut down. An extra charge of catalyst was available on site for another start-up if the problem could be identified and addressed.

27.15 Slurry Degasser

The degasser was used to separate gas and solid-liquid from the three-phase reactor slurry. The degasser would protect the slurry pump from gas and minimize any further reaction in the loop. The degasser diameter was based on the liquid velocity to be half the bubble rise velocity. A tubular vessel with 8" internal diameter and 8 ft tall was specified. A sketch of the vessel is shown in Figure 4. The instrumentation on the vessel included three thermocouples and a differential pressure transmitter to measure the liquid level, which was maintained at 5 ft level. A cone head was used for the bottom to avoid slurry accumulation. The layout of the degasser was very important (see Figure 3). Liquid level in the degasser was maintained at the same level as the reactor through nozzle T1 and a 3" pipe. A new nozzle was installed and used to return the gas back to the reactor. In case of gas shut down, valve NV-1752-S on nozzle T1 will close and valve NV-1751-S on nozzle P will open to provide continuous liquid flow to the pump. The bypass line with two shut-off valves (NV-1756-S and 3553-S) was provided for start-up. If the degasser does not degas adequately, the pump and filter will see gas in the slurry which could affect their performance.

21.70 Slurry Cooler

Slurry cooling of 36°F was desired to significantly lower the reaction rate. Utility oil exiting from the reactor heat exchanger was used on the shell side to cool the slurry (Figure 2). Use of cooler oil going into the reactor heat exchanger was avoided so that the reactor temperature stability will not be impacted. HTRI (Heat Transfer Research Institute) heat exchanger simulations were performed for the slurry cooler. Oil temperatures based on realistic calculations (2.14 MMBtu/hr heat load) for the reactor heat exchanger were specified. A conservative heat load (2.50 MMBtu/hr) on the reactor heat exchanger would lead to an under-design of this heat exchanger. If the reactor heat exchanger worked much better than designed, the oil would be hotter than expected. In that case, the cooler would not have adequate capacity. The cooler was not substantially over-designed to keep slurry inventory/residence time in the filtration system to a minimum. A horizontal multi-pass flow heat exchanger with segmental baffles on the shell side was specified. It contained 8" internal diameter single pass shell with 6 cross passes and 10 tubes with 3 passes, 11.5 ft long and 0.527" internal diameter.

10.62 Slurry Pump

Due to an anticipated long delivery time for the slurry pump, a process specification for the pump was quickly issued. A centrifugal pump was chosen based on SSFI's experience. The centrifugal pump is more reliable in operation compared to a disc type pump considered which has lower catalyst attrition rate. SSFI's testing showed acceptable level of catalyst attrition. The high temperature, high pressure service was considered severe. There was no back-up for this pump. In case of mechanical problems, the reactor would have to be shut down and the pump repaired on site. A design flow rate of 26 gpm was specified with a head of 107.5 psi. A variable speed motor was utilized to allow flow rate changes during the run.

22.62 Cross-flow Filters

The cross flow filter system consisted of four 10' filters (four parallel elements in each) in series. The elements were 1/2" ID, 5/8" OD, 1 micron grade stainless steel. A tangential velocity of 9 ft/sec would be maintained through the elements. The elements would be back-flushed with clear wax, as needed. The filters were designed for 62 gph of filtrate wax which was the anticipated maximum production rate. The design flux through the elements was 0.059 gpm/ft^2, which was a conservative number based on SSFI's experimental work. The total filtration area of the system was 20.9 ft^2, about 20% higher than required. The filtration performance depended on the catalyst strength. Laboratory testing at SSFI indicated that the catalyst was much harder than those used in F-T I and II. The F-T III catalyst was a supported catalyst which is typically more resistant to attrition. Differential pressure measurements capabilities were installed for individual filter housings. This was necessary to control pressure drop across each filter separately as significant pressure drop was expected for the 40 ft of total length due to the slurry flow through the inside of the elements. The trans-membrane pressure drop would be controlled by throttling manual valves.

Miscellaneous Modifications

Preliminary heat and mass balance calculations indicated that at high conversion (~80%) and high pressure (750 psig), the dew point for water (~235°C) was very close to the operating temperature (240-250°C). The heat exchanger tubes were expected to be significantly colder (170°C), where water could condense out. Water condensation would be an obvious problem for catalyst activity. Hence, it was decided to reduce per-pass conversion to 40% with a recycle of unconverted syngas. The Fischer-Tropsch train was connected to the existing 01.20 recycle compressor to allow the recycle. It was decided not to modify the system for light HC/water separation due to funding limitations.

Miscellaneous changes include:

(1) Differential Pressure (DP) taps and transmitters on the 27.10 Reactor,
(2) Radial thermocouples in the reactor,
(3) Erosion test pieces,
(4) Removal of once -thru connections for the reduction of catalyst pre-cursor.
(5) Relocation of water analysis sample port for catalyst activation from the reactor outlet to the 22.14 vapor-liquid separator outlet to avoid significant hydrocarbon condensation in the water analyzer which could cause interference.

The reactor was modified to accommodate SSFI’s proprietary sparger and optical fiber probe. The probe was installed to measure radial bubble size distribution. A number of signals were connected to SSFI's high speed data acquisition system.

Mass balances were generated using ASPEN simulator based proprietary kinetic and mass balance information available from SSFI. Close agreement was obtained with SSFI's gross predictions and more detailed mass balance information was generated for design purpose.

New instrumentation needing specification included slurry/wax flow meters, differential pressure transmitters, and automatic shut-off valves. In addition, specifications were developed for two new relief valves (PSV-236A/B and PSV-1766) and a rupture disc (PSE-1769).

Hazards Reviews

A Preliminary Hazards Review (PHR) was conducted on February 15, 1996. Mass and energy balances were performed in preparation for the examination of various safety devices and a review of existing relief devices was initiated. Operability reviews were conducted both internally and with SSFI personnel. Automatic shutdown and flush scenarios were developed and engineered.

A Design Hazards Review (DHR) was conducted on May 10, 1996, following completion of P&ID (Piping & Instrumentation Diagram) development. The modifications were divided into six different nodes, and a HAZOP was conducted on each node. The review of existing relief devices was also completed. For a 100% hydrogen case during reduction, two relief devices were found to be inadequate for this run. The reduction outlet gas was rerouted to bypass one vessel, while the other device was replaced.

A number of issues identified during the Design Hazards Review were followed up:

(1) A deadhead condition in the 10.62 pump would result in over-pressure of downstream piping and the 22.62 filters. It was confirmed that the speed control for the pump will not increase the deadhead pressure beyond 150 psi differential. Due to power limitations, the pump speed can only be increased to a maximum of 110% of the current design, which would result in a deadhead pressure differential of 142.5 psi. With PSV-1766 on the 27.15 Slurry Degasser set at 850 psig, the deadhead pressure of the 10.62 pump will not exceed the design pressure of 1000 psig. PSV-1766 is rated for a fire case on the filtration system as well as line blockage on reactor outlet requiring relief of all feed gases (fresh feed compressor, recycle feed compressor and high pressure H_2) at 850 psig.

(2) Three failure cases were considered for PSE-335A/B on the 28.30 Slurry Prep Tank: Vapor passing through fully open LV-203, valve 3611, and liquid flowing through failed open PV-644. The existing disks were found to be sufficiently sized for all three cases.

(3) The relief case for PSV-749A/B on the 27.13 Tank when LV-688 fails open was considered. The relief valves were found to be insufficiently sized for the maximum flow allowed by the existing trim on LV-688. It was decided to purchase a new trim for LV-688 to restrict the flow to the level the relief valves could handle.

A Design Verification Review (DVR) was held on September 10, 1996. All Process hazard review items were completed prior to the review and no new action items resulted. Following the meeting, OSHA PSM safety documentation was issued. Operator training was conducted by process and plant personnel on September 24 and an Operational Readiness Inspection (ORI) was conducted on the 25th of September, prior to the start-up. The scope of the ORI included review of the equipment, piping and instrumentation to be used for the run. The plant was found in satisfactory condition. Open items were completed before commencement of the October demonstration and an approval was given for start-up.

Metallurgical Review

A metallurgical review was conducted to discuss material compatibility for F-T III. A concern was raised about hydrogen attacking carbon in the carbon-steel particularly at H_2 partial pressures higher than 100 psig and temperature higher than 500°F. It was confirmed that stainless steel is being used in the reactor area where these conditions may be reached. Another concern was presence of acids in the water phase corroding the liquid product vessels (22.10, 22.11, 22.15 and 22.16), which are all carbon-steel. SSFI provided the following water phase pH and corrosion rate data:

(1) Analysis of the water produced in the autoclave unit with the SSFI proprietary catalyst yielded pH values ranging from 3.37 to 3.43. Acid corrosion rates at this pH range and at temperatures below 50°C are considered negligible for the total run time.

(2) For the 22.10 vessel, the acid corrosion rate will be negligible due to the low temperature (38°C). In addition, the presence of carbon monoxide will inhibit corrosion at this low temperature.

(3) For the 22.11, 22.15, and 22.16 vessels, on the basis of the low temperature maintained in these vessels (38°C), the acid corrosion rate can be neglected relative to the total run time anticipated.

It was decided to monitor the pH of the liquid while it was temporarily stored in these vessels.

Environmental Reviews

The planned modifications were documented and sent to Radian Corporation to evaluate their impact on air emission. Radian evaluated the proposed modifications and operation to check if we needed a new exemption for this run or a letter documenting these changes was sufficient. Emission calculations were completed for a material balance case corresponding to maximum production and emissions. Both exemption and non-attainment estimates were made and transmitted to Radian. Although there was a net decrease in emissions compared to F-T II, there were instances of individual increases in component emissions. For example, F-T III had higher hourly CO emissions from process equipment because the CO concentration was higher in the reactor effluent due to lower conversion. Also, Volatile Organic Components (VOCs) were higher for hydrocarbon (HC) loading fugitives due to the catalyst selectivity difference. Upon recommendation from Radian, an exemption application for the air emission permit was drafted. Now that the AFDU was an independent facility for air emissions purposes, a significant margin was added to each component for future flexibility, while staying below the exemption limitations. The exemption application was completed and submitted to TNRCC (Texas Natural Resource Conservation Commission). An approval for the exemption was received from TNRCC in July 1996.

Reactor Cleaning

Some heat exchanger tube fouling was noticed through opened nozzles in the 27.10 reactor. There appeared to be a thin coating of the Fischer-Tropsch II catalyst on some spots. It was not known how widely the coating was spread. Industrial cleaning vendors were contacted and proposals obtained from two companies. Rust Industrial Cleaning Services was chosen to run lab tests on the spent slurry from F-T II. Tests indicated successful break down of the slurry using alkaline degreasing solution. On August 15, 1996, the 27.10 reactor was cleaned by Rust. Alkaline degreasing solution was used followed by a water rinse. Limited success was achieved cleaning the tubes. While the degreasing solution drained from the reactor appeared dirty, visible fouling remained on the tube. More cleaning was expected to occur when the reactor was exposed to hot oil during the "carbonyl burnout" before the start of the run.

DEMONSTRATION RUN PLAN (F-T III)

A run plan was developed by the participants to achieve the objectives discussed earlier. A summary of the plan is shown in Table 1. The plan included a process variable scan at nine different conditions. Key parameters to be studied were feed compositions, recycle ratio, and conversion levels. The fresh feed range was from a H_2/CO ratio of 1.72 to 2.07. The recycle ratio varied from 0.8 to 3.3, resulting in a wide range of H_2/CO ratios between 0.65 and 2.07 in the reactor feed. Operating pressure was to be held constant at 710 psig for all but one condition (Run 15.6), when it would be reduced to 520 psig to achieve a high velocity of 0.85 ft/sec. A high productivity of 150 gm HC/lit-hr was targeted at all conditions except the start-up condition (Run 15.1). Reactor temperature levels were chosen to achieve CO conversions per pass in the range of 17-57 %. The target plant CO conversion was 80% at all the conditions with the exception of one (Run 15.7) for which the target was 90%. This matrix of process variables spanned through a large range and approached the plant limits of recycle compression and heat removal capacity. In addition, a high catalyst loading of 42.6 wt% perhaps pushed the slurry F-T technology to its limit. An activity check (Run 15.10) was planned at the end of the process variable scan. A 3-day tracer study would follow to look at gas, liquid, and possibly solid phase mixing at two different conditions. This would be followed by a 2-day dynamic gas disengagement study. At the end of the 30-day operating campaign, a 3-day filter study was planned without syngas operations. The objective of the filter study was to evaluate effects of operating parameters such as trans-membrane differential pressure, slurry velocity, slurry viscosity, and catalyst concentration on filtrate flux. It was decided to use a heavier medium as start-up fluid. Shell's commercial Callista 158 wax would be used.

PRE-RUN SET-UP AND TESTING (F-T III)

All new equipment (27.15 Slurry Degasser, 21.70 Slurry Cooler, 10.62 Catalyst/Wax Slurry Pump, 22.62A/D Cross-Flow Filters and associated instrumentation) was installed and tested. The optical fiber probe and the high-speed data logger provided by SSFI were installed and function tested. The 27.10 Reactor was pressure-tested to check the nozzle installed for the vapor return from the 27.15. Instrumentation check-out and calibration was complete. The gas sampling system was modified to the Fischer-Tropsch mode of operation. A significant amount of time and effort was spent in troubleshooting a data transfer problem between the distributed control system (DCS) and the data acquisition system (DAS). Replacement hardware was installed for the DAS, and new DCS software was put in place so that signals will be available at the minimum frequency needed for process analysis. Nuclear density gauge calibration was completed on 10/4/96, and a nitrogen plant test was performed. Following maintenance on the 10.62 pump, synthesis gas was introduced on 10/8/96 as part of a hot function test (carbonyl burn-out) and final plant check-out.

RESULTS AND DISCUSSION (F-T III)

Start-up wax (Callista-158) was charged to and melted in the slurry preparation tank on 10/10/96. SSFI's proprietary catalyst precursor (CMT-25) was loaded to the slurry preparation tank to make a 41.2 wt% slurry, and the slurry was then transferred to the reactor. A Run Chronology for F-T III is included in Appendix A.

Catalyst Activation

Please note that the word “catalyst” is conveniently used in this report both for the inactive pre-cursor as loaded in the reactor and its activated form. The calculation basis for mass balance purposes is the oxide form unless otherwise indicated.

Catalyst drying began at 20:00 hours on 10/11/96. Reactor temperature was ramped up with a flow of 100% nitrogen to drive the physical water out of the catalyst. Water concentrations were monitored in the system and drying was essentially complete at 23:00 hours on 10/12/96. At that point, hydrogen was brought in to begin catalyst activation using SSFI’s proprietary procedure. In-situ catalyst activation was well controlled using gas recycle. The water concentration level was maintained below the maximum allowed at all times. Water concentrations were monitored using both instantaneous Panametric instruments and accumulated measurements via P_2O_5 tubes. At 07:00 hours on 10/14/96, about 80% of the reduction appeared to be complete based on both the measurement techniques. The activation was considered complete at 12:00 hours on 10/14/96 and the reactor was cooled down to set up for hydrocarbon synthesis.

Further analysis of the activation results indicated an error in the calculations of the accumulated water amount in the P_2O_5 tubes. Applying the correction resulted in significant disagreement between the Panametric and the adsorption measurements. At the end of the activation period, the Panametric indicated 90% completion while the P_2O_5 suggested only 40% completion (see Figure 5). In addition to the calculation error in accumulated water quantity, increasing methane production was also responsible for a decision to terminate activation which may have been premature. Estimated water partial pressures during activation are shown in Figure 6. A multiplier of 0.44 was used to correct the Panametric data based on P_2O_5 data.

Process Variable Study

The filter system was brought on-line prior to introduction of CO. After initial start-up challenges, the filters operated normally through the night. CO was brought in at 20:00 hours on 10/14/96 and, adjustments were made to bring the plant to the conditions of run AF-R15.1. This was a low productivity condition, designed to allow streamlining of the system. As the productivity appeared to be lower than expected at the target reactor temperature of 211°C, temperature was increased during the night. During the temperature adjustment, a sharp rise in temperature was experienced. Reactor temperature reached 275° C for a short time and the reactor was quickly cooled down. The reactor was then brought back in control at about 225°C. Precise reactor temperature control was a challenge initially with temperature swinging between 220 and 230°C. It appeared that the reactor was extremely temperature sensitive and difficult to hold stable at low conversion levels of 10-12%. The control improved somewhat later as the plant operators became more familiar with the system dynamics, and the catalyst apparently lost some of its initial activity.

We had to delay moving to the next, higher productivity condition until a product stewardship issue was resolved. It appeared that neither SSFI nor Air Products could accommodate the aqueous and light hydrocarbon product cut, and output of this product could not increase until this issue was resolved. The product stewardship issue was subsequently resolved, with SSFI agreeing to accommodate the aqueous and light hydrocarbon product cut. The initial condition, AF-R15.1, was completed at 10:00 on 10/19/96. Preliminary heat and mass balances for two data periods during this condition indicated hydrocarbon productivity of about 45 gm HC/lit reactor vol. - hr at a reactor temperature of 227°C compared to an expected productivity of 75. Due to low conversion levels, the data were not very accurate. However, it appeared that the alpha of the catalyst was lower than expected (high methane, low wax).

The next condition, AF-R15.2, was begun at 13:00 on 10/19/96. As the temperature rose, productivity increased significantly. There was also evidence of additional CO_2 evolution at higher temperature. It is not clear as to the source of the additional CO_2. With significant rise in productivity, there was a large increase in the pressure drop across the filters and the filters were not able to keep up with the wax production. Backflushing the system seemed to increase the pressure drop further. The reactor temperature was reduced to lower the productivity. It was assumed that catalyst fines, perhaps created by the slurry pump, were gradually plugging the filter elements. The longitudinal as well as membrane differential pressures (DP) had been rising since two days on-stream. The longitudinal DPs are shown in Figure 7. The longitudinal DPs for each pair of filters increased from about 12 psi to 25-30 psi for a slurry circulation flow in approximately the same range. The membrane DPs for each filter are shown in Figures 8 and 9. The membrane DPs started in 0-20 psi range and ended up in the 30-70 psi range for the same flux. A membrane DP of about 100 psi was required to get a slightly higher flux. The unit was held on a stand-by until filter issues could be resolved. Mott Metallurgical was contacted to see if arrangements could be made to replace the current elements with a smaller filter grade (i.e. 0.2 microns instead of 1 micron). In addition, Sundstrand was contacted to see if modifications could be made so that the slurry velocity through the discharge throat of the pump could be reduced.

Several attempts were made to backflush the catalyst/wax filters without a significant improvement in filter performance. As the plant could not run without filtering the product wax out of the reactor slurry, it was shut down after being on a stand-by for a day. Immediately prior to that, a shut down test was performed on the reactor to look at dynamic gas disengagement and axial catalyst concentration profile. The nuclear density readings were constant along the length of the reactor in the two phase slurry, indicating axial uniformity. The plant was cooled, purged, and partially drained overnight on 10/21/96 so that the filters could be examined internally. Examination of the filters could provide some clues about the cause of the plugging problem. If the plugging was caused by a buildup of the filter cake, and particle size distribution tests confirmed that catalyst attrition was not a problem, we would have some hope of mechanically cleaning the filters and restarting. However, if the catalyst had broken down, penetrated into the annular region of the filter, and plugged, a replacement filter with a smaller micron grade was not available within the current time window.

After cooling down, the reactor slurry was drained and the reactor was flushed with oil. Flush oil from the filter system was also drained; it did not show significant solid content. The filters were taken apart on 10/23/96. Although no plugging was visible, backflushing with steam pushed out significant quantities of solids. It was difficult to judge whether the solids came from a cake on the slurry side (inside) of the filters or from the filter membrane annulus. Overnight, the filters were kept on a longitudinal steam flush through the slurry side. A nitrogen purge was maintained from the clean wax (shell) side. Mechanical cleaning was attempted on 10/24/96 with a nylon brush to clean the filter elements from inside. Looking inside through a boroscope showed that the brush action was only scraping the layer partially and just moving the material around. We returned to steam backflushing, as it was the only method that had worked. High pressure steam and nitrogen were used to get higher temperature and pressure on the elements. Backflushing of filters C and D continued overnight. With limited steam supply, having all four on line at the same time at lower steam flow and pressure was not desirable. Filters A & B were backflushed with steam and nitrogen overnight on 10/25/96. Inspection of the filters with boroscope indicated that most of the filter cake was flushed out.

The system was put together and a hot oil flush was conducted late on 10/26/96 to remove residual water from the system. Some of the stickiness observed with the solids could be due to agglomeration of particles caused by condensate from steam. The flush oil was then replaced with clean oil and a flux test was conducted on all the filters. The test revealed a significantly higher pressure drop across the membranes than expected. The pressure drop was in the range of 10 to 40 psi at a flux of 1 lb/min compared to an expectation of 0.1 psi for a new clean element. The longitudinal pressure drops were lower than observed during the run. It seemed that while the filter cake was removed, the membrane remained blocked with particles. Samples taken from the clean wax side appeared to contain fines indicating breakthrough.

Particle size distribution results on various samples from the filter system were received from SSFI laboratories on 10/26/96. The analysis showed a bi-modal distribution indicating particle breakdown. The particle size ranged from 0.5 to 100 micron with peaks at 3 and 35 microns. This compares with the fresh catalyst particle size range of 10 to 100 micron with a single peak at 35 microns. According to Mott Metallurgical, a 1 micron membrane can only retain 100% of the particles above ~3 micron particles.

The clean oil test clearly showed that the existing elements did not have adequate capacity for a high productivity condition. The particle size distribution provided an explanation of membrane blockage due to smaller than expected particle size. With replacement filters not immediately available, the participants decided to terminate the run at that point and regroup for a second trial later.

The data gathered during the Fischer-Tropsch III run were analyzed in detail. Even though, the run had to be terminated after seven days on-stream, significant achievements were accomplished to advance the learning process for the F-T slurry technology as discussed in the following sections.

Mass Balance

Some simplifying assumptions were made for mass and elemental balance. The 22.10 Separator hydrocarbon to aqueous phase ratio was assumed to be constant during the run. The value of the ratio was determined to be 0.256 HC/Aqueous by volume based on density measurements during transfer of liquid from the 22.16 day tank to the liquid trailer. Nitrogen was used as an internal standard to correct less accurate gas flow meter measurements. Nitrogen balance across the reactor was used to correct the product flow rate first. Plant nitrogen balance was then used to adjust the purge-1 flow rate. The 01.20 Compressor discharge flow was finally corrected using either feed nitrogen or product nitrogen balance (redundant).

A run-time table, which summarizes the cross-reference between run numbers, actual times and on-stream times, is given in Table 2. Mass balance was performed for two data periods during the run AF-R15.1. A summary of the results is given in Table 3. Heat and mass balances as well as flow correction factors are summarized in Table 4, elemental balances are shown in Table 5. The closures are considered adequate for the pilot scale, considering the fact that the conversion levels were low. Detailed data for each period are included in Appendix B.

When conditions were changed to high productivity (run AF-R15.2), significantly higher conversions and heat of reaction were observed. Although accurate calculations were difficult, as conditions were transient during this two hour period, productivities in the range 100 to 200 gm HC/lit reactor vol. - hr were estimated. Also, heat of reaction consistent with the above productivities (1.8 to 3.1 MMBtu/hr) was observed during the period.

Catalyst Inventory

Catalyst inventory in the reactor throughout the run was estimated. The details are given in Table 6. The initial catalyst load was 1043 lbs. With several reasonable assumptions made for catalyst loss as shown in the table, an end of the run catalyst inventory of 852 lbs was calculated for the reactor. This was higher than a catalyst inventory of 792 lbs estimated from the dynamic gas disengagement test conducted at the end of the run.

Catalyst Concentration and Gas Hold-up Estimates

Catalyst concentrations in the reactor were estimated based on nuclear density gauge (NDG) and differential pressure (DP) readings as well as slurry and wax density measurements in the filter loop. The comparison between the three methods is shown in Table 7 and Figure 10. The concentrations were estimated to be in 38-44 wt% range during Run AF-R15.1.

The average gas hold-up, calculated from the DP readings, was in the range of 36 to 37 vol% during run 15.1. The gas hold-up calculated from the NDG readings was somewhat higher (41-43 vol%), as expected (see Table 7 and Figure 11). Gas hold-up was also measured using the optical fiber probe during catalyst drying and early activation. Gas hold-up indicated by the probe was generally lower than that estimated by the other methods. Unfortunately, the probe stopped functioning in the middle of the activation, perhaps because of excessive slurry thickening due to inadequate maintenance of slurry level. Gas hold-up profile based on NDG data at different reactor height is shown in Figure 12. The gas hold-up appeared uniform axially in the reactor.

Dynamic Gas Disengagement and Reactor Temperature Control

Differential pressure data were acquired on the SSFI proprietary fast data logger during the dynamic gas disengagement (DGD) test conducted at the end of the run. The variation of the gas hold-up as a function of time during the test is shown in Figure 13. The curves do not show two distinct slopes that may be associated with two classes of bubbles. With a high initial liquid level and a low gas hold-up, the final liquid level was above the top-mid section at 18.2 ft reactor height. This resulted in nearly zero final gas hold-ups in both the sections. The gas hold-up and catalyst concentration at the end of the run were also verified. The DGD results indicated somewhat lower gas hold-up and catalyst concentration (see Table 7 and Figures 10-11). Nuclear density readings taken in the two phase slurry during the dynamic gas disengagement test were fairly constant along the length of the reactor, indicating the catalyst was uniformly distributed axially.

Measurements were also made to evaluate the response time of the revised reactor temperature control system. With the re-alignment of the utility oil system carried out prior to the run, the control system was judged to be adequate for the high productivity condition of run AF-R15.2.

Heat Balance and Heat Transfer in the Reactor

Heat loss from the reactor was estimated at about 35,000 Btu/hr from data obtained during drying. Heat balance during the run AF-R15.1 was in the 96 to 97% range based on the heat of reaction. Heat transfer coefficients were calculated based on the data obtained for the run AF-R15.1. The measured overall coefficient (U) was estimated to be 94 Btu/hr-ft2-°F as compared to the prediction of 90. Measured slurry-side coefficient was estimated at 305 Btu/hr-ft2-°F compared with the prediction of 264. The predicted slurry-side coefficient is based on Deckwer correlations (8). The results are tabulated in Table 8 and plotted in Figure 14. The heat transfer in the reactor was better than expected.

Reactor Performance

The reactor showed excellent temperature uniformity and even gas and catalyst distribution. Axially, the temperatures ranged from 225 to 228°C during the operations at the start-up condition (Run # AF-R15.1). The radial variation was only 0.4°C. SSFI's proprietary sparger appeared to work well. There was only a small amount of catalyst sedimentation on the reactor bottom and no catalyst was found in the gas feed line. Also, no erosion was evident in the reactor as indicated by erosion pieces.

Filtration Loop

The degasser functioned as designed. It effectively removed gas from the slurry going to the slurry pump when proper level in the reactor was maintained. The slurry cooler provided sufficient cooling; there was no evidence of any reaction in the filter loop. The slurry pump provided steady head and flow in the filtration loop. No erosion was found in the loop. However, an inspection of the pump showed erosion marks and browning on the surface of the bowl suggesting that perhaps higher temperatures were reached on the surface. Also, part of the wall separating the discharge throat and the bowl was eroded away resulting in retreat and sharpening of the so called "cut water" wall. The filters under-performed during the run. A filtrate flux of only 0.0045 gpm/ft^2 was achieved during Run 15.1 compared to the design flux of 0.059 gpm/ft^2.

Catalyst Stability

The actual CO conversion rate per unit of catalyst (gmole CO converted / liter of catalyst particle volume / hr) was calculated for the two mass balance periods. Autoclave data obtained by SSFI under kinetically limited conditions were used to generate a kinetic expression based on hot reactor outlet gas phase composition. Continuous Stirred Tank Reactor (CSTR) behavior was assumed for the autoclave. The pre-exponential term was made run-hour dependent as to reflect initial deactivation. Predictions of the CO conversion rate in the LaPorte reactor were derived in the same way as for the autoclave. The ratio of actual / predicted CO conversion rate is shown in Figure 15. The data indicate lower than expected initial activity for the catalyst. The catalyst appeared stable during the short period of condition AF-R15.1. Catalyst productivities were calculated at 200°C based on an activation energy calculated from autoclave data. A reference temperature was used to compare activities obtained at different temperatures. The results are shown in Table 9. After correcting for CO_2 selectivity, a stable productivity is observed expressed in Normal liter CO/liter catalyst/hr at 200°C.

Liquid/Wax/Slurry Analysis

A number of liquid, wax and slurry samples were collected during the run for various analyses. The analytical work, including corresponding data analysis, was performed by SSFI.

1. Product Water:

The results of the water phase analysis are given in Table 10. The pH of about 3 is normal for cobalt catalyst and is caused by small amounts of organic acids dissolved in the water. Cobalt was not detectable by the method applied (ICP). The trailer sample showed some iron, probably a result of corrosion by organic acids. The Total Organic Content (TOC) of about 0.96%w carbon is mainly caused by lower alcohols dissolved in the water. Ethanol can be considered as an average in terms of alcohol carbon number.

2. Hydrocarbons:

The results of the hydrocarbon analysis are summarized in Table 11, details are included in Appendix C. In the light and heavy wax, no cobalt was detectable by the ICP method. The H/C ratio was as expected. The light wax does not have an impact on the mass balance as very small quantity of light wax was produced during the run.

3. Slurry:

The results of the slurry sample analysis are summarized in Table 12. SSFI proprietary Pyrolysis Combustion Mass-spectrometric Elemental (PCME) analysis was conducted to estimate free carbon or carbon as coke on the catalyst. Samples #9-12 show high residue content in PCME analysis, suggesting that the sedimented part of the original sample was used for the analysis. Samples #13-15 show residue content close to expectation. The particle size distribution data are plotted in Figure 16 and show a substantial reduction in average particle size accompanied by high fines formation right from the first sample. This is fully in line with the observed filter plugging during the run.

4. Light Hydrocarbon Product:

The carbon distribution of the light hydrocarbon product is shown in Figure 17. A relatively light product with a heavy tail is observed. The two shoulders between C_{20} and C_{30} are probably caused by presence of some flush oil, Ethylflo-164 (now known as Durasyn-164). The type distribution of the light hydrocarbon product is shown in Figure 18. The high 1-alcohol content of C_4-C_6 is caused by flashing effects. The boiling point of the corresponding alkanes and alkenes is lower, causing these to end up to a larger extent in the gas phase. Olefinicity goes through a maximum at C_8 and decreases at higher carbon numbers. The 1-Alcohols above C_{16} were below the detection limit. Iso-alkanes increase with increasing carbon number. Apart from a natural increase of branching with carbon number, this can be caused by both attributing all unidentified GC peaks to iso-alkanes and the presence of some of the light components of Ethylflo-164. The calculated elemental oxygen content from alcohols is 0.52%w.

5. Wax Products:

The carbon distribution of the wax samples is shown in Figure 19. The light and heavy wax show a clear difference in carbon distribution reflecting the "overhead" character of the light wax. The presence of Ethylflo-164, as witnessed by the sharp peaks at C_{27} and C_{34}, is very clear. The Ethylflo peaks influence the overall product distribution, the physical properties of the waxes and the alpha values. Reliable alpha values can only be determined at carbon numbers below 20 and above 40.

6. Carbon Distribution for Total Product:

The flow and gas composition data for the mass balance period AF-R15.1C were used in combinations with carbon distributions of heavy wax and light hydrocarbon product (trailer) to estimate carbon distribution of the total product. The results are shown in Figure 20. As expected, the Ethylflo peaks are clearly visible. The AFS (Anderson-Flory-Schulz) alpha plot is shown in Figure 21. It shows a valley around C_{20}. This might be caused by light wax still building up in the separators (the light wax shows a maximum around C_{20}). The plot shows low alpha (0.8) up to C_{20} and higher alpha from C_{40} onwards (0.91-0.95).

POST FISCHER-TROPSCH III INVESTIGATIONS

A plan of action described below was developed and followed prior to a second trial:

- Investigate catalyst particle breakdown in laboratory. While it was suspected that the particle breakdown occurred in the pump, it needed to be proven. Based on the findings, the slurry pump design may need re-evaluation.

- Conduct additional filter tests. It was suggested the F-T III spent slurry be tested with 0.2 micron elements. Future run plan should include back-up filter elements.

- Improve catalyst activation procedure. While the activation was controlled well, there was evidence that it was not complete. Better water measurement techniques were required to decide when the activation is complete.

Spent slurry and a filter element bundle were shipped to SSFI for testing. The slurry pump was shipped to the manufacturer (Sundstrand) for evaluation.

Slurry Pump

A meeting was held with Sundstrand personnel on January 9, 1997 to discuss their post Fischer-Tropsch III run observations of the slurry pump and develop a plan to improve its performance. Following is a summary of the discussion:

- The throat could be opened up from 0.328" to a maximum of 0.446". This would reduce the throat velocity by almost a factor of 2: from 83.5 ft/sec to 45.2 ft/sec at 22 gpm (9 ft/sec in the filter element). We could reduce the throat velocity further to 30.1 ft/sec by operating at 14.7 gpm (6 ft/sec in the filter element). Higher throat diameter would mean we would have to operate at lower pump speed which would decrease the efficiency. This was not a problem at LaPorte, as we had enough horsepower. According to Sundstrand, our application involved too low a flow for the head requirement. Scale-up to a higher flow for commercial application would improve the efficiency.

- There was no need to increase the impeller clearances at the top or the bottom from bowl erosion point of view. The clearance between the impeller and the bottom bowl was measured at 0.055", which was within specification. The clearance may have opened up about 0.004". The clearance between the impeller and the top cover was measured at 0.050", which was within the normal range of 0.040-0.060".

- Sundstrand suggested considering alternative harder materials for pump internals instead of the current 316 SS (ASTM A351 grade CF8M - both bowl and impeller were made of this material): Duplex steel (CD4MCU) or heat treated carbon-steel. The current pump had no coating on the internals. Sundstrand did not favor coating because if the coating is broken through, it leaves a rough surface for significant erosion.

- Sundstrand suggested use of bellow seals in the lower position to prevent leakage during the operation. Other suggestions included use of differential pressure regulator to maintain the seal pressure 50 psi above the suction pressure; pressure rating of the lower seal at the full pressure; and use of a block valve to stop process fluid from going into the buffer system. The valve can trip on a buffer pump trip or a differential pressure trip. A normally closed solenoid valve connected with the pump circuit could be used. We already had a check valve to prevent pressure on the buffer pump.

- There was no evidence of damage in the largest diameter of the bottom bowl. All the damage was on the angled portion where it was close to the spinning impeller. Sundstrand was surprised at the extent of damage on the bottom bowl and only one scratch on the top cover. Typically, they see a lot more damage at the top compared to the bottom.

Testing at SSFI

SSFI followed up several possible causes of filter problems during F-T III: (1) Strength of their proprietary catalyst used in F-T III vs. strength of their improved proprietary catalyst. (2) Effect of liquid medium on catalyst attrition. (3) Effect of pumping velocity on attrition. (4) Use of different type of filter elements. The initial laboratory test results were inconclusive for (1), (2) and (3). The improved catalyst appeared to be stronger when slurried with water. However, in oil, the two catalysts showed similar attrition. Also, surprisingly, no effect of pumping velocity on attrition was evident. For filtration, the plan was to test three types of filter elements (sintered metal, ceramic membrane and woven metal) in parallel with activated improved catalyst in wax. A Sundstrand centrifugal pump would be used in these tests to evaluate erosion.

Commissioning of the filter loop in SSFI's pilot plant was completed and slurry pump/filtration tests started during May 97. SSFI's improved proprietary catalyst was activated in-situ in wax. Initially, the slurry circulation was started at high pump velocity to generate fines and test the pump for erosion. A more erosion resistant material - manganese alloy was utilized for pump internals. Reliable and steady operation was obtained with only a small sign of erosion. Also, very limited catalyst attrition was observed.

For filtration, woven metal filter elements were tested. These elements were most promising as they are uniform. Successful filtration was achieved with flux rate at twice the design rate at low membrane and longitudinal differential pressures.

ENGINEERING AND MODIFICATIONS (F-T IV)

As a result of successful filtration tests, the F-T IV modifications were kicked-off. The modifications included new filter elements, new element bundle arrangement, rebuilding the slurry pump and individualizing the filtration control. A simplified process flow diagram for Fischer-Tropsch IV is given in Figure 22. Other improvements included purchase of significant hardware and software to the Bailey control system to fix the data acquisition glitch and upgrade the system, and a cooling water pump to boost the cooling water pressure. In preparation of installing alternate filter elements, four filter housings from LaPorte were shipped to SSFI.

10.62 Slurry Pump

The slurry pump modification involved new internals (diffuser and cover plate) made up of manganese alloy, opening the throat to 0.446”, use of a differential pressure regulator to maintain proper differential pressure between process and buffer fluid, and installation of a shut-off valve on the buffer system.

22.62 Cross-flow Filters

The cross flow filter system consisted of four 10' filters (four parallel elements in each) in series. The new filter elements were woven metal elements, 14 mm ID, 10 ft long, 10 micron grade stainless steel. A tangential velocity of 8.7 ft/sec, corresponding to 26 gpm of pump flow, would be maintained through the elements. The elements would be back-flushed with clear wax, as needed. For 61 gph of filtrate wax production rate, the design flux through the elements required would be 0.044 gpm/ft^2. The total filtration area of the system was 23.1 ft^2. With expectation of lower wax production associated with the new catalyst and higher filter capacity as measured by SSFI, it appeared that there was a 100% spare capacity. So it was decided to put only two housings on-line initially, and withdraw wax from only one of them. For additional back-up, 16 extra elements were purchased and constructed into 4 additional bundles. The new bundle arrangement would allow easier on-site replacements of bundles, if the four bundles in service got plugged. Four control valves were installed on the product wax line to improve filtration control by achieving an individual control of each housing. These valves replaced the existing manual throttle valves. The single existing larger control valve (LV-203) was also removed.

Other miscellaneous items addressed in preparation for F-T IV are described below:

- A hazard review was conducted in January 98. Safety analysis and documentation were completed to support the Flowsheet Change Notices (FCNs) required for the process hazards review.

- A meeting was held between ICI Tracerco, Air Products and Washington University personnel to discuss improvements in tracer techniques and plan for a study during F-T IV. Tracerco agreed to several suggestions to improve the quantitative methods.

- An alternate oil was evaluated for the utility oil system to improve heat transfer. Better heat transfer in the reactor tubes translates into improved reactor temperature control. Therminol-59, a heat transfer fluid used in the Kingsport reduction vessel, was found to be superior to the current Drakeol-10. The log mean delta T (LMTD) reduced by about ~15%. The improvement is due to better heat transfer properties: higher thermal conductivity, lower viscosity and higher density. The only negative effect is due to lower heat capacity. After consultation with SSFI, it was decided to switch the oil at the cost of ~$9,000.

- Proprietary kinetic information was received from SSFI and the LaPorte flow sheet was simulated to generate mass balances.

DEMONSTRATION RUN PLAN (F-T IV)

Meetings were held between the participants to define scope and develop a run plan consistent with available funding for the second trial. The run plan was similar to the Fischer-Tropsch III plan. It consisted of 18-days on syngas including four process conditions, a baseline check-back, a tracer study at two conditions and a day on dynamic gas disengagement (see Table 13). Slurry concentration of approximately 25 wt% was planned compared to the F-T III concentration of about 40 wt%. Lower concentration was chosen to improve slurry transport and filterability. Also, the improved catalyst had a somewhat lower density than the F-T III catalyst. A space-time yield of 150 was targetted throughout the run.

PRE-RUN SET-UP AND TESTING (F-T IV)

Initial set-up and calibration activities for the F-T IV demonstration began at LaPorte in February 98. This included the analytical set-up, the data-acquisition system and the nuclear density measurements. Final preparations were completed in March. The new DCS control stations were programmed, and communications between the distributed control system (DCS) and the data acquisition system (DAS) were successfully tested. Nuclear density gauge calibration on the reactor was completed, and calibration of a radial nuclear density device for chordal scans was performed by ICI Tracerco. A hot function test of the unit without catalyst was performed on 21-22 March. This test was performed with both nitrogen and synthesis gas at the conditions for reactor operation. This provided a final check of the equipment and instrumentation systems.

RESULTS AND DISCUSSION (F-T IV)

SSFI's improved proprietary catalyst (MDC), start-up wax (Callista-158) as well as some flush Durasyn-164 oil were mixed in the prep tank to make a 26.8 wt% slurry. The slurry was then transferred to the reactor and catalyst drying began at 19:00 hours on 03/23/98. A Run Chronology is included in Appendix D.

Catalyst Activation

The reactor temperature was ramped up with a flow of 100% nitrogen to drive the physical water out of the catalyst. Water concentrations were monitored in the system using both instantaneous Panametric instruments and accumulated measurements via zeolite-5A tubes. Initially, plugging was experienced at a pressure regulator on the sample line for the reactor off-gas. Start-up wax was found in the regulator upon cleaning. The problem was addressed by inserting a knock-out pot up-stream of the regulator as well as increasing the reactor operating pressure.

The drying was essentially complete at 22:00 hours on 3/24/98. At that point, hydrogen was brought in to begin catalyst activation using SSFI’s proprietary improved activation procedure. Monitoring of the water concentration continued, but water measurements proved to be difficult due to wax/oil contamination of the analytical system. The contamination problem may have been associated with higher operating pressure compared to F-T III. The activation, however, appeared to proceed well, as the expected methane production was observed. The activation procedure was completed at 14:00 hours on 3/28/98. The activation was terminated after exceeding the on-stream time required in the autoclave at the activation conditions.

The calculated extent of reduction is given in Figure 23. The zeolite tubes show a 1200% reduction which is obviously erroneous due to wax/oil contamination. The panametric measurements indicate about 40% reduction. Estimated water partial pressures during activation are shown in Figure 24. A multiplier of 2.05 was used to correct the panametric data based on expectations from a typical 80% activation.

Process Variable Study

The filter system was brought on-line with the reactor and a slurry sample taken through from the filter system. CO was then introduced to the process at 14:15 on 3/28/98. The start-up with syngas included a series of intermediate steps to reach the first operating condition (Run AF-R16.1). Over Day 1 of the start-up, the plant was stabilized at approximately half the target productivity. Temperature control was satisfactory at stable operating conditions and low productivity, but proved challenging during transient moves to higher productivity conditions. As a result, we relied on the automatic temperature control scheme, with some tuning modifications, and made a series of small steps to the operating conditions. During this period, the productivity increased from about 65 gm HC/hr-lit. of reactor volume to above 120 gm HC/hr-lit. of reactor volume. The reactor operated hydrodynamically stable with uniform temperature and gas hold-ups. The catalyst/wax filters performed well, producing a clean wax product. For the most part, only one of the four filter housings was needed for catalyst/wax separation. The plant lined out at condition AF-R16.1 at midnight on 01 April with a productivity of approximately 140 gm HC/hr-lit. of reactor volume. At that point the heat load in the reactor caused the automatic temperature control to oscillate significantly (see Figures 25 and 26). As more than 90% of the productivity goal was achieved, and the productivity was within the success criteria of 120-150, it was decided not to push any further and risk unacceptable system instability. As a result, the baseline condition was defined, and a steady data collection period began.

On 02 April, the plant tripped out due to high temperature on a vapor-liquid separator. A cooling water exchanger in the product separation area vapor-locked, causing the high gas temperature which tripped the compressor. Gas flows to the reactor were re-established shortly thereafter, but the resulting upset in pressure and temperature had already quenched the reaction. In addition, the upset caused some plugging problems in the catalyst/wax circulation system which were rectified after a few hours of troubleshooting. In the restart, we still needed only one of the four filter housings, demonstrating the robust character of the new filter design. We returned to the sequence of startup steps to get back to the baseline condition. However, we were able to move much more quickly through the sequence because of the confidence gained in the system stability during the initial startup. The baseline condition was reached within 24 hours after the plant trip. Stable operation was achieved and the conditions were held constant for about two days to collect data. The productivity was approximately 135-140 gm HC/hr-lit. of reactor volume during this period. By bringing the plant back to the high productivity condition within 24 hours, another significant milestone for the slurry phase technology was achieved. The automatic temperature control oscillations were smaller than during the previous 6 hour operating period at this condition on 02 April. The filter system operations continued with one filter housing, yielding clean wax product. Close to expected catalyst productivity obtained at the beginning of the run indicated successful in-situ catalyst activation. The wax selectivity appeared to be lower than expected while the methane production was slightly higher.

As the start-up had taken longer than expected, several discussions were held between the representatives of the participants on-site to modify the run plan. The goal was to get quality information from this run in the on-stream time available while making sure that the important needs of each participant were met. It was decided to skip the operating condition AF-R16.2 and spend the same amount of time originally planned at the rest of the conditions.

At 05:00 on 05 April, the transition to high velocity condition (AF-R16.3) began. The recycle ratio was gradually increased ratio from 1.2 to 3.0. During the transition to condition AF-R16.3 on 06 April, operating limitations were encountered that required redefinition of the test condition. It appeared that wax loss from the reactor was exceeding the wax production, resulting in decreasing slurry level in the reactor. To correct this situation, the reactor temperature was reduced by 8°F, and the recycle flow was reduced to maintain the high productivity target. The final recycle ratio for the redefined AF-R16.3 was approximately 2:1. On 07 April, gamma scans were conducted by ICI Tracerco to get flow profile information at the high velocity condition. At 08:45 on 07 April the GC computer stopped communicating with the overall data acquisition computer because of a memory limitation on the acquisition computer. No data were lost, except during brief troubleshooting periods, but the data reduction process required hand input of the GC data for a 15 hour period. The operating time at AF-R16.3 was extended to have 12 hours of continuous data after the restoration of communication between the GC and the acquisition computers. Stable data for a 36 hour period was obtained. The productivity was approximately 130 gm HC/hr-lit. of reactor volume during this period.

At 13:00 on 08 April, the transition to run condition AF-R16.4 began. This test applied a high fresh feed H2/CO ratio of 2.18 which is approximately equal to the consumption ratio and was expected to result in more difficult plant control. Therefore, the target reactor productivity was reduced to 120 gm HC/hr-lit. of reactor volume. The condition was reached at 08:00 on 09 April. However, an upset in the high pressure H_2 supply caused a reactor temperature excursion to 518°F at 13:45. By 18:00, condition AF-R16.4 was reached again. Data collection continued until 07:00 on 10 April. A stable productivity of 110-115 gm HC/hr-lit. of reactor volume was achieved at this condition.

Transition to the baseline condition (AF-R16.5) was smooth and quick, as the new condition was reached in 7 hours. The plant operations were stable during 33 hours of data collection period. The catalyst activity as well as selectivity to wax showed some decline relative to the initial catalyst performance two weeks earlier, as the productivity dropped about 7% (from 135-140 range to 125-130 range) while the methane selectivity increased. A suspected restriction in a slurry line caused the plant to shut down in the morning of 4/12/98. After performing maintenance on the slurry pump, the plant was brought back on-stream at the baseline condition in 17 hours. The quick re-start demonstrates the ease and flexibility of the slurry technology.

Tracer Study

After the process variable scan, gas, liquid and solid phase mixing were studied at two operating conditions using radioactive materials. ICI Tracerco set up 43 detectors around the reactor during the last day of the process variable study. The first tracer run was conducted on April 14 at the baseline condition (AF-R16.6). Argon-41 was injected into the inlet gas line for the vapor residence time distribution study. In addition, two injections of radioactive manganese oxide were made in the reactor slurry to study liquid phase mixing. Solid injections were also done with radioactive manganese doped catalyst support to evaluate solid mixing. The first tracer runs were completed at midnight on April 14.

After switching to the high velocity condition (AF-R16.7) overnight, the second tracer runs were conducted on April 15. The injections began at 19:20 on April 15 and concluded at 01:20 on April 16. The large amount of data collected by ICI Tracerco are being analyzed by Washington University as part of the Hydrodynamic Program with DOE. After the second tracer runs, a dynamic gas disengagement test was conducted at the high velocity condition (AF-R16.8) to estimate the gas and solid hold-up as well as extract bubble size information.

Immediately after the dynamic gas disengagement test, syngas was purged from the plant with N_2, and shutdown activities commenced. ICI Tracerco returned onsite in the afternoon of April 16 to insure that the radioactive levels were low enough to begin draining the system.

Mass Balance

Assumptions similar to F-T III data analysis were made for mass and elemental balance. The 22.10 Separator hydrocarbon to aqueous phase ratio was assumed to be constant during the run. The value of the ratio was determined to be 0.722 HC/Aqueous by volume based on density measurements during transfers of liquid from the 22.16 day tank to the liquid trailer. Nitrogen was used as an internal standard to correct less accurate gas flow meter measurements similar to F-T III. With the wax flow meter not operating properly due to degassing at low pressure, instantaneous wax production data were not available. The average production rate was calculated based on amount of wax drained from the system for operation during a particular length of time.

A run-time table, which summarizes the cross-reference between run numbers, actual times and on-stream times, is given in Table 14. Mass balance was performed for twelve different data periods during the run. A summary of the results is given in Table 15. Heat and mass balances as well as flow correction factors are summarized in Table 16, elemental balances are shown in Table 17. The closures are quite good for the pilot scale, given the number of components involved in some of the streams. Detailed data for each period are included in Appendix E.

Catalyst Inventory

Catalyst inventory in the reactor throughout the run was estimated. The details are given in Table 18. The initial catalyst load was 501 lbs. With several reasonable assumptions made for catalyst loss as shown in the table, an end of the run catalyst inventory of 337 lbs was calculated for the reactor. This was higher than a catalyst inventory of 304 lbs estimated from the dynamic gas disengagement test conducted at the end of the run.

Catalyst Concentration and Gas Hold-up Estimates

Catalyst concentrations in the reactor were estimated based on nuclear density gauge (NDG) and differential pressure (DP) readings as well as slurry density measurements in the filter loop. The comparison between the three methods is shown in Table 19 and Figure 27. The concentrations were estimated to be in 24-30 wt% range.

The average gas hold-up, calculated from the DP readings, was in the range of 41 to 49 vol% during the run. The gas hold-up calculated from the NDG readings was somewhat higher (45-53 vol%), as expected (see Table 19 and Figure 28).

Dynamic Gas Disengagement

Differential pressure data were acquired on the SSFI proprietary fast data logger during the dynamic gas disengagement test conducted at the end of the run. The variation of the gas hold-up as a function of time during the test is shown in Figure 29. The curve does not show two distinct slopes that may be associated with two classes of bubbles. With a relatively higher gas hold-up compared to F-T III, the final liquid level was in the top-mid section at 11.3 ft reactor height. As a result, the gas hold-up in that section leveled of at a positive value after going through a dip. The gas hold-up and catalyst concentration at the end of the run were verified. The DGD results indicated somewhat lower gas hold-up and catalyst concentration (see Table 19 and Figures 27-28). The NDG readings taken along the length of the reactor during the DGD test showed only a small variation suggesting fairly uniform axial distribution of the catalyst.

Heat Balance and Heat Transfer in the Reactor

Heat loss from the reactor was estimated at about 50,000 Btu/hr from data obtained during the 2-phase hot function test. Heat balance during the run was in the 96 to 102% range based on the heat of reaction. Heat transfer coefficients were calculated based on the data obtained during the run. The results are tabulated in Table 20 and plotted in Figure 30. The heat transfer in the reactor was significantly better than expected.

Reactor Performance

The reactor operated hydrodynamically stable with uniform temperature profile and even gas and catalyst distribution. Nuclear density and differential pressure measurements indicated somewhat higher than expected gas hold-up (45 - 50 vol%). The high gas hold-up was confirmed by the DGD test conducted at the end of the run. SSFI's proprietary sparger appeared to work well. The reactor bottom was found to be clear of large amount of catalyst sedimentation upon inspection following the shut-down.

Catalyst-wax Separation

The catalyst/wax filters performed well throughout the demonstration, producing a clean wax product. For the most part, only one of the four filter housings was needed for filtration. The filter flux appeared to exceed the design flux. An average filtrate flux of 0.031 gpm/ft^2 was demonstrated during Run 16.1, compared to the design flux of 0.044 gpm/ft^2. However, the system showed significant higher capacity, as the filtrate was withdrawn intermittently during the run. The average flux was calculated based on amount of wax drained from the system, since instantaneous flux data were not available. With the slurry being recycled back from the filtration loop, the upward liquid velocity through the reactor was about 0.024 ft/sec.

Catalyst Stability

The actual CO conversion rate per unit of catalyst (gmole CO converted / liter of catalyst particle volume / hr) was calculated for the twelve mass balance periods. As in the case with the F-T III data analysis, kinetic expressions based on autoclave data obtained by SSFI were used for comparison. The ratio of actual / predicted CO conversion rate is shown in Figure 31. It appears that conditions 16.1, 16.4 and 16.5 have a similar ratio indicating that the initial catalyst deactivation rate in the LaPorte reactor was similar to that in the autoclave. The ratio is about 0.76-0.77, which is much higher than the F-T III value of 0.43-0.44. The ratio being lower than 1.0 can be explained by either a less than optimal activation of the catalyst precursor in the LaPorte reactor vs in the autoclave or presence of some mass transfer limitation.

For the high gas velocity condition (16.3), the ratio of actual vs predicted CO conversion rate dropped to 0.63. This can be explained by an increase in mass transfer limitation or more back-mixing.

Catalyst productivities were calculated at 200°C based on an activation energy calculated from autoclave data. The results are shown in Table 21. The results are corrected for CO_2 selectivity, and the productivity is expressed in Normal liter CO/liter catalyst/hr at 200°C. The productivities reflect the effect of the actual H_2 and CO concentration. This is apparent in the results of condition 16.4, where high H_2/CO ratio results in highest productivity. Conditions 16.1 and 16.5 (check-back) give activities in the same range indicating the absence of fast deactivating. These data are not corrected for initial deactivation.

<u>Liquid/Wax/Slurry Analysis</u>

An estimated 1,875 gallons of wax, 16,915 gallons of light hydrocarbon liquids and 23,428 gallons of water were made during the run. Significant quantities of the product were collected for further processing by the participants. In addition, a number of liquid, wax, and slurry samples were taken for analysis. The analytical work, including corresponding data analysis, was performed by SSFI. An overview of the samples chosen for analysis is given in Table 22.

1. Product Water:

The results of the water phase analysis are given in Table 23. Like F-T III, a pH of about 3 was obtained, which is normal for cobalt catalyst. The Total Organic Content (TOC) of about 1.69%w carbon is mainly caused by lower alcohols dissolved in the water. Ethanol is considered as an average in terms of alcohol carbon number.

2. Hydrocarbons:

The results of the light hydrocarbon analysis are summarized in Table 24, details are included in Appendix F. The oxygen content is mainly caused by 1-alcohols. The calculated oxygen content from GC was 0.62%w. The results of the wax analysis are summarized in Table 25, with details included in Appendix F. The wax density shows little variation over the samples. The cobalt content of 3 ppm is considered low.

3. Slurry:

The results of the slurry sample analysis are summarized in Table 26. The PCME data show no fixed carbon, in other words, no free carbon or carbon as coke on the catalyst. Taking a separate sample from the slurry samples appeared difficult in view of the residue contents which strongly deviated from the expected 25%w. The larger sub-samples taken for de-waxing showed solids contents which are much closer to 25%w. The samples taken from the reactor after shutdown indicate high solids contents for both methods, which is not surprising since these samples were already highly concentrated and further sedimentation is not possible.

The particle size distribution data are plotted in Figure 32. The particle size of the catalyst in the slurry samples is hardly different from that of the fresh catalyst precursor and, more importantly, constant in time. Moreover, the production of fines is very limited and seems to occur mainly at the start-up. These data suggest very good mechanical properties of the catalyst, which is consistent with the excellent filtration performance observed and represents a large improvement over F-T III. The relatively large particle size of the reactor bottom sample suggests sedimentation during the shutdown phase when the slurry recycle was not operating.

4. Light Hydrocarbon Product:

The carbon distribution of the light hydrocarbon product is shown in Figure 33. There is very little difference between the products of the various conditions. The products show a heavy tail, which is also reflected by the deposits in the product and the greasy character of some samples. The heavy tail is related to an ineffective phase separation in the reactor, probably accompanied with some entrainment. Due to the heavy tail, capillary column analysis was not possible for all samples except for the drum sample. As a result, high temperature GC (HT-GC) had to be applied. The fraction less than C_{10} is not correctly measured by HT-GC. Therefore, some reconstruction of data was carried out using the $<C_{10}$ fraction of the drum sample. The Samples 22.11-18 and 22.11-19 show presence of some Durasyn-164 oil. This is probably a result of the Durasyn additions to the filtration loop on April 12, 1998, following operational problems.

The type distribution of the light hydrocarbon product is shown in Figure 34. The high alcohol content of the C_3-C_6 fraction is caused by flashing effects. The boiling point of the corresponding alkanes and alkenes is lower causing these to end up to a larger extent in the gas phase. Olefinicity passes through a maximum at C_6 and decreases at higher carbon numbers. Alcohols above C_{17} were below the detection limit. Iso-alkanes increase with increasing carbon number. Apart from a real increase of branching with increasing carbon number, this can also be caused by attributing all unidentified GC-peaks to iso-alkanes.

5. Wax Products:

The carbon distribution of the wax samples is shown in Figure 35. The alpha-values for the waxes as such are not reliable at carbon numbers below 40 due to separation effects. A carbon distribution for the Durasyn-164 oil could not be generated due to the high degree of branching. Direct information from the chromatogram (not shown) indicated a sharp maximum around C_{27} and a smaller maximum around C_{34}. The Callista-158 start-up wax has a broad maximum around C_{34}. The waxes are relatively light F-T waxes with hardly any material above C_{90}. During the run, a small shift to heavier wax is observed, as indicated by a shift in the maximum of the carbon distribution as well as the generation of more material in the C_{70} range. Sample 22.62-27 (condition 16.6, 14 April 1998) seems to contain a relatively large amount of Durasyn-164 oil. This is consistent with the observation in the light HC product discussed above and probably due to the same Durasyn-164 additions on April 12, 1998, following operational problems. Alpha values of 0.88-0.90 are observed in the C_{40}-C_{80} range.

6. Carbon Distribution for Total Product:

Carbon distributions for the following separate samples were available:

- Wax: HT GC (short column) for samples 22.62-14, 22.62-20, 22.62-22, 22.62-25 and 22.62-27.
- Light Hydrocarbons: HT GC (short column) for samples drum sample, 22.11-12, 22.11-18, 22-11-19.
- Light hydrocarbons after removal of heavy tail: capillary column for drum sample.

The light hydrocarbon samples all had a heavy tail, which did not allow capillary column analysis. The samples were greasy, not allowing removal of the heavy tail by sedimentation in a refrigerator. The exception was the drum sample, where removal of the heavy tail appeared possible. The HT-GC method does not produce correct concentrations for the C_9- fraction. However, the distributions of the light hydrocarbons as determined by HT-GC seemed very much alike for the four light hydrocarbons samples. It was, therefore, decided to correct the carbon distributions of the light hydrocarbons samples by imposing the C_9- fraction as determined for the drum sample on each of the four samples. This was done by using the C_{10} concentration as a scaling factor, followed by re-normalization.

The total carbon distributions were then calculated by combining:

- hydrocarbon concentrations in the purge gas and purge gas flow,
- corrected carbon distribution of the light hydrocarbon product and production rate of light hydrocarbon product, and,
- carbon distribution of the wax and production rate of the wax.

The total carbon distributions thus obtained were re-normalized. Subsequently, the AFS (Anderson-Flory-Schulz) plots were constructed and alpha values (chain growth probability) were determined. Also, a product based C_5+ selectivity was calculated which can deviate slightly from the gas phase derived C_5+ selectivity. Since the carbon distributions of the light hydrocarbon product were all very similar, it was decided to use the results of adjacent condition where no analysis was available.

This lead to the following combinations:

F-T IV Condition #	Wax sample used	Light HC sample used
16.1C	22.62-14	drum sample
16.3D	22.62-20	22.11-12
16.4A	22.62-22	22.11-12
16.5C	22.62-25	22.11-18

The total product carbon distribution results as well as the AFS alpha plots are shown Figures 36-43. Apart from the high methane production, the carbon numbers with the largest weight fractions were C_5 and C_6. Condition 16.1C (Figure 37) shows a single alpha with the usual undershoot for C_2 and overshoot for C_1. The average alpha value for C_{10}-C_{80} was 0.865. Condition 16.3D alpha plot (Figure 39) shows a slight bend at around C_{35} with alpha values of about 0.82 below C_{35} and about 0.88 above C_{35}. The average alpha value for C_{10}-C_{80} was 0.858. Condition 16.4A alpha plot (Figure 41) is straight with a hump at C_{60}-C_{90}. The wax concentrations in this range are very low; the hump may, therefore, be an artifact. The average alpha value for C_{10}-C_{80} was 0.880. Both the total carbon distribution and the alpha plots for condition 16.5C (Figures 42-43) show a hump at C_{27-28} caused by the presence of some Durasyn. The average alpha value for C_{10}-C_{80} is 0.890.

The above analysis was performed on the overall plant basis. The alpha values and the selectivities presented here are slightly different than shown in the run reports (Appendix E), which were calculated based on the reactor balance. However, since the mass balance closures were excellent, the differences are negligible.

CONCLUSIONS AND RECOMMENDATIONS

The slurry phase Fischer-Tropsch technology was successfully demonstrated:

- A productivity of approximately 140 gm HC/hr-lit. of reactor volume was achieved at reasonable system stability during the second trial. As this was more than 90% of the goal of 150, and within the success criteria of 120-150, it was decided not to push any further and risk unacceptable system instability. The productivity ranged from 110-140 at various conditions during the 18 days of F-T IV operations.

- The catalyst/wax filters performed well throughout the F-T IV demonstration, producing a clean wax product. For the most part, only one of the four filter housings was needed for catalyst/wax filtration. The filter flux appeared to exceed the design flux. A combination of use of a stronger catalyst and some innovating filtration techniques were responsible for this success. There was no sign of catalyst particle attrition and very little erosion of the slurry pump was observed. This was in contrast to the F-T III operations, when the run had to be terminated after seven days on-stream, as the filter membranes apparently plugged with catalyst fines.

- The reactor operated hydrodynamically stable with uniform temperature profile and gas hold-ups. Nuclear density and differential pressure measurements indicated somewhat higher than expected gas hold-up (45 - 50 vol%) during F-T IV operations. The high gas hold-up was confirmed by a dynamic gas disengagement test conducted at the end of the run.

- Heat transfer in the reactor was better than expected. Heat, mass and elemental balance calculations indicated excellent closure.

- After the initial learning curve with system dynamics, the plant was restarted very quickly (24 hours and 17 hours) following two plant trips. This demonstrates the ease and flexibility of the slurry technology.

- In-situ catalyst activation was completed successfully during F-T IV operations. Water measurements by the zeolite tube system proved to be inaccurate due to wax/oil contamination. However, the activation appeared to proceed well as close to expected syngas conversion was obtained at the beginning of the run. The selectivity to wax was lower than expected, with higher methane selectivity. Calculation error in accumulated water quantity as well as increasing methane production lead to a decision to terminate activation prematurely during F-T III operations. The results confirmed that the P_2O_5 adsorption is a better water measurement technique than Panametric measurements.

- Returning to the baseline condition indicated a productivity decline from 135-140 to 125-130 gm HC/hr-lit. of reactor volume in two weeks of operation. This may be a result of some catalyst loss from the reactor as well as initial catalyst deactivation.

- Significant quantities of product and samples were collected for further processing and analysis by the participants.

- Gas, liquid and solid phase mixing were studied as planned at two operating conditions using radioactive materials. A large amount of data were collected by ICI Tracerco using 43 detectors around the reactor. The data are being analyzed by Washington University as part of the Hydrodynamic Program with DOE.

Although the technology was successfully demonstrated, it is worthwhile to recommend actions that would improve the operations at the LaPorte facility:

- More accurate water measurement using P_2O_5 adsorption is needed to improve the monitoring of catalyst activation step.

- To improve the reactor temperature control for the existing LaPorte reactor would require significant modifications in the utility oil loop, including a larger capacity heater and a larger capacity cooler. This is particularly true because there is no room to add significantly more heat transfer area in the LaPorte reactor. Alternately, a boiling water system can be used. However, it will add significant complexity to the operations.

- The interruption in data communication was an isolated event, which can be prevented in future. However, it should be noted that the data acquisition system needs upgrading to catch up with technological advances in this area. The current system was installed in 1992 and is extremely primitive.

- Plant trips and upsets are incidental occurrences in this type of demonstration unit. Facility upgrading can certainly reduce some of these interruptions.

ACKNOWLEDGMENTS

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TABLE 1

FISCHER-TROPSCH III DEMONSTRATION RUN PLAN

SSFI Proprietary Catalyst Pre-cursor: 1043 lbs
Callista-158 Wax 1489 lbs

Pressure Range: 520 - 710 psig
Temperature Range: 210 - 250 deg C

Run No.	Description	H2/CO in Reactor Feed	Sup. Gas Vel (in), ft/sec	Plant CO Conv. mole%	Reactor Prod., g HC/lit-hr	Wax Production gpd	Days on-stream
AF-A11	Activation		0.31				1
AF-R15.1	Start-up	1.18	0.41	80	75	664	2.5
AF-R15.2	Baseline	1.44	0.34	80	150	1327	2.5
AF-R15.3 to AF-R15.9	Process Variables	0.65 to 2.07	0. 32 to 0.85	80 to 90	150	1327	17.5
AF-R15.10	Baseline Repeat	1.44	0.34	80	150	1327	2.5
AF-R15.11 to AF-R15.12	Tracer Studies	1.19 to 01.44	0.34 to 0.73	80	150	1327	3
AF-R15.13 to AF-R15.14	Dynamic Gas Disengagement Tests	1.19 to	0.34 to 0.73	80	150	1327	2
AF-R15.15	Filter Tests w/o Syngas						3

TABLE 2

Run Time Table								
	F-T III:		Drying Started Activation Started Syngas Started		11-Oct-96 12-Oct-96 14-Oct-96	20:00 23:00 20:00		
Run No.	**Avg. Time On-stream, Hrs.**	**Start Date**	**Start Time**	**Time On-stream, Hrs.**	**End Date**	**End Time**	**Time On-stream, Hrs.**	**Time Period, Hrs.**
R15.1B	58	17-Oct	0:00	52	17-Oct	12:00	64	12
R15.1C	76	17-Oct	12:00	64	18-Oct	12:00	88	24

TABLE 3 (page 1/3)

SUMMARY OF RESULTS FOR FT-III DEMONSTRATION RUN AT LAPORTE

Run No.	On-stream Time, Hrs.	Temperature (average) deg F	Pressure psig	Space Velocity sL/kg-hr	Recycle Ratio	Superficial Gas Vel. Inlet, ft/sec	Catalyst in Reactor lbs	CO Conv. per pass mole%	H2 Conv. per pass mole%	CO+H2 Conv. per pass mole%	CO Conv. plant mole%	H2 Conv. plant mole%
AF-R15.1B	58	440.2	706.9	7444	3.24	0.43	862	9.5	12.1	11.0	39.2	55.9
AF-R15.1C	76	440.1	710.0	7612	3.20	0.43	860	9.1	15.8	13.0	36.8	54.7

TABLE 3 (page 2/3)

SUMMARY OF RESULTS FOR FT-III DEMONSTRATION RUN AT LAPORTE

Run No.	CO+H2 Conv. plant mole%	CO Conv. Rate gmole/kg-hr	HC Prodtn. Rate grams/kg-hr	Reactor Productivity (STY) grams HC/lit. react. vol.-hr	H2/CO in Fresh Feed mole/mole	H2/CO in Reactor Feed mole/mole	H2/CO Usage Ratio mole/mole	H2/CO in Outlet mole/mole	C02 Select. mole%
AF-R15.1B	49.7	12.3	171.3	45.9	1.73	1.32	1.69	1.28	1.30
AF-R15.1C	48.4	11.6	163.4	43.9	1.82	1.41	2.43	1.30	0.41

TABLE 3 (page 3/3)

SUMMARY OF RESULTS FOR FT-III DEMONSTRATION RUN AT LAPORTE

Run No.	CH4	<------- HC Selectivity (CO2 free) wt% --------->							< ----- PRODUCT DISTRIBUTION, WT% ----- >					HC Prodtn Rate based on liquid data grams HC/kg-hr	Alpha C3-C9	Alpha C10-C50
		C2H6	C2H4	C3H8	C3H6	C4H10 Sum	C4H8 Sum	C5H11 Sum	METHANE C1	GAS C2-C4	GASOLINE C5-C11	DIESEL C12-C18	WAX C19+			
AF-Rl5.lB	26.3 1	3.07	1.13	4.48	7.44	4.77	7.85	8.25								
AF-Rl5.lC	13.8 8	1.50	1.01	1.90	3.57	2.57	3.40	5.47	15.6	17.9	24.3	11.5	30.6	138.5	0.74	0.90

TABLE 4

Heat and Mass Balance Summary for F-T III									
Run No.	**Prod Gas Flow Factor**	**Purge1 Flow Factor**	**01.20 Discharge Flow Factor**	**Water/Oxygen Balance, %**	**Reactor Balance, %**	**Plant Balance, %**	**Feed Balance, %**	**Prod Gas Balance, %**	**Heat Balance, %**
AF-R15.1B	1.067	1.215	0.940	98.3	101.7	104.8	99.9	99.3	97.1
AF-R15.1C	1.046	1.194	0.915	101.0	99.8	104.2	100.5	100.5	96.3
Average	1.057	1.205	0.928	99.6	100.8	104.5	100.2	99.9	96.7

TABLE 5

Elemental Balance (Reactor) Summary for F-T III					
Run No.	**Total, %**	**C, %**	**H, %**	**O, %**	**N, %**
AF-Rl5.lC	98.7	97.6	96.9	100.0	99.0

TABLE 6

Catalyst Inventory in the Reactor During F-T III

Assumptions:

Catalyst lost to prep tank and piping during transfer	15	lbs
Catalyst lost in nozzles and dead legs	15	lbs
Physical Water in the Catalyst	30	lbs
Catalyst Loss Rate with Gas Flow	2	lb/day
Catalyst Loss Rate with Product Wax	0.01	lb/day
Catalyst Loss due to sampling	0.5	lb/sample

Date	Days in the Reactor	Run	Assumed Gas Hold-up, vol%	Estimated Catalyst Amount in the Reactor	No. of Slurry Samples	Comments
10/11/1996	0	Drying		1043		As Loaded
10/12/1996	1	Drying/Activating		981		Catalyst lost in transfer, dead legs and loss of physical water
10/13/1996	2	Activating		979		
10/14/1996	3	Activating/Syngas Start-up	40	868		Filtration brought on-stream
10/15/1996	4	Start-up	40	866		
10/16/1996	5	Start-up	40	864	1	
10/17/1996	6	R15.1	40	861	1	
10/18/1996	7	R15.1	40	859		
10/19/1996	8	Transition	40	857		
10/20/1996	9	Transition	40	854	2	
10/21/1996	10	Transition	40	852		Shut Down

TABLE 7

Catalyst Concentration and Gas Hold-up Estimates for F-T III

Run No.	Time On-stream, Hours	Cat Conc. by NDG, wt%	Cat Conc. by DP, wt%	Cat Conc. by 2-Phase Density, wt%	Reduced Cat Conc. by 2-Phase Density, wt%	Assumed Cat. Inventory in Reactor, lbs	Gas Hold-up by NDG, vol%	Gas Hold-up by DP, vol%	2-Phase Density, g/cc	Cat Conc. by DGD, wt%	Gas Hold-up by DGD, vol%	Calculated Cat. Inventory in Reactor based on DGD data
AF-R15.1B	58	43.87	40.48	39.04	36.04	862	43.43	37.39	1.001			
AF-R15.1C	76	42.38	39.87	38.43	35.46	860	41.36	35.83	0.995			
	165	33.12	31.77			852	29.66	24.90		29.60	22.53	792

TABLE 8

Heat Transfer Coefficient Estimates for F-T III									
Run No.	**Time On-stream, Hours**	**Cat Conc. by DP, wt%**	**Gas Hold-up by DP, vol%**	**Superficial Gas Vel. (In), ft/sec**	**Reactor Heat Duty, BTU/hr**	**Log Mean Temp. Diff., deg F**	**Overall HT Coeff., BTU/hr-ft2-deg F**	**Measured Slurry Side HT Coeff., BTU/hr-ft2-deg F**	**Predicted Slurry Side HT Coeff., BTU/hr-ft2-deg F**
AF-Rl5.lB	58	40.48	37.39	0.43	502,470	24.1	96	324	263
AF-Rl5.lC	76	39.87	35.83	0.43	453,211	22.5	92	286	264

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TABLE 9

Catalyst Productivity data extrapolated to 200°C for F-T III		
Applied activation energy	121.6	kJ/gmole
Run No.	15.1B	15.1C
Average Reactor Temperature (T), °C	226.8	226.7
CO Conversion Rate, rCO, mol/l cat/h	18.3	17.3
C02 selectivity, %mol	1.300	0.410
CO Conversion Rate for Hydrocarbon Synthesis only, rCO*, mol/l cat/h	18.1	17.3
productivity @T°C, NI CO/l cat/h	405.5	386.8
productivity @200°C, NI CO/lcat/h	77.2	74.1
* Fischer-Tropsch only		

TABLE 10

Analysis of F-T III product water samples					
Sample ID (SSFI)	#1	#2	#3	#4	#5
Date	10/16/1996 4:00	10/17/1996 3:25	10/18/1996 2:40	10/18/1996 14:00	11/4/1996 0:00
Condition	15.1	15.1	15.1	15.1	from trailer
pH	3.7	2.9	2.8	2.8	2.9
Inorganics (ICP):					
Co, ppmw					<10
Fe, ppmw					40-45
Total Organic Content (TOC), ppmw carbon			9564		

TABLE 11

Analysis of F-T III product hydrocarbon samples

Sample ID (SSFI)	#6	#7	#8
Date	11/4/96	10/18/1996 9:15	10/16/1998 9:30
Type	light hydrocarbon	light wax from sep. 27.13	heavy wax from sep. 28.30
Condition	from trailer	15.1	15.1
C-distribution (HT-GC)	see Appendix C	see Appendix C	see Appendix C
alpha C40-59			0.916
alpha C60-79			0.952
Avg. carbon no. (GC)	12	24	33
Olefins Content	see Appendix C		
Alcohols Content	see Appendix C		
lnorganics (ICP):			
Co, ppmw		<10	<10
Fe, ppmw		15-20	<10
C/H (PCME)			
C, %w		85.25	85.46
H, %w		15.04	15.27
H/C, at/at		2.12	2.14
Fixed Carbon, %w		0.07	0.16

TABLE 12

Analysis of F-T III slurry samples

Sample	fresh catalyst	#9	#10	#11	#12	#13	#14	#15
Date/time	10/15/1996 0:00	10/16/1996 17:30	10/17/1996 14:00	10/20/1996 00:25	10/20/1996 15:00	10/23/1996 15:30	10/29/1996	10/29/1996
Comment		from pump 10.62	from pump 10.62	from pump 10.62	from pump 10.62	end reactor drain	from reactor fibre probe nozzle	from reactor bottom
PCME								
fixed C, %w		1.13	1.22	1.26	0.37	0.12	0.36	0.52
residue, %w		63.3	64.9	94.9	69.1	22.2	59.9	60.6
Particle Size Distribution:								
diameter (vol. avg)/ diameter (vol. avg) fresh	1	0.44	0.32	0.39	0.17	0.56		
fines, %w	3.7	66.4	77.2	51.7	83.4	61.8		

TABLE 13

FISCHER-TROPSCH IV DEMONSTRATION RUN PLAN

SSFI Proprietary Catalyst Pre-cursor:	500	lbs		**Plant CO Conv:**	80	mole%
Callista-158 Wax + Durasyn-164 Oil:	1350	lbs		**Reactor Productivity:**	150	g HC/lit-hr
				Total Production:		
Reactor Pressure:	710	psig	strm 1	**Heavy Wax (C14+)**	11500	gallons
Reactor Temp:	250-260	deg C	strm 1	**Light Wax (C11-C26)**	2600	gallons
Slurry Conc.:	24-25	wt%	strm 2	**Hydrocarbons (C4-C21)**	14900	gallons
Slurry Height:	20	ft	strm 2	**Water:**	31100	gallons

Run No.	Description	H2/CO in Fresh Feed	H2/CO in Reactor Feed	Recycle Ratio	Space Velocity sl/hr-kg cat	Days on-stream	Sup. Gas Vel (in), ft/sec	CO Conv. per Pass mole%
AF-R16.1	Mid H2/CO in Fresh Feed, Low Recycle (Baseline)	1.85	1.21	1.19	13460	4	0.41	33.7
AF-R16.2	Low H2/CO in Fresh Feed, Low Recycle	1.78	1.01	1.20	13103	3	0.40	31.7
AF-R16.3	Low H2/CO in Fresh Feed, High Recycle	1.80	0.81	3.01	23950	3	0.72	17.0
AF-R16.4	High H2/CO in Fresh Feed, Mid Recycle	2.18	2.11	1.99	20346	2	0.62	31.2
AF-R16.5	Activity Check, Repeat Baseline (AF-R16.1)	1.85	1.21	1.19	13460	2	0.41	33.7
AF-R16.6	Tracer Study at Low Velocity (AF-R16.1)	1.85	1.21	1.19	13460	1.5	0.41	33.7
AF-R16.7	Tracer Study at High Velocity (AF-R16.3)	1.8	0.81	3.01	23950	1.5	0.72	17.0
AF-R16.8	Dynamic Gas Disengagement Test at High Velocity (AF-R16.3)	1.8	0.81	3.01	23950	1	0.72	17.0
	TOTAL					**18**		

RunPlan3.xls BLB 2/5/1999

TABLE 14

Run Time Table

F-T IV:	Drying Started	23-Mar-98	19:00
	Activation Started	24-Mar-98	22:00
	Syngas Started	28-Mar-98	14:00

Run No.	Avg. Time On-stream, Hrs-.	Start Date	Start Time	Time On-stream, Hrs.	End Date	End Time	Time On-stream, Hrs.	Time Period, Hrs.
R16.1A	109	2-Apr	0:00	106	2-Apr	6:00	112	6
R16.1B	152	3-Apr	12:00	142	4-Apr	8:00	162	20
R16.1C	172	4-Apr	8:00	162	5-Apr	4:00	182	20
R16.3A	229.5	6-Apr	23:00	225	7-Apr	8:00	234	9
R16.3B	237.5	7-Apr	8:00	234	7-Apr	15:00	241	7
R16.3C	247	7-Apr	18:00	244	8-Apr	0:00	250	6
R16.3D	257.5	8-Apr	2:00	252	8-Apr	13:00	263	11
R16.4A	284.5	9-Apr	8:00	282	9-Apr	13:00	287	5
R16.4B	298.5	9-Apr	18:00	292	10-Apr	7:00	305	13
R16.5A	323	10-Apr	14:00	312	11 -Apr	12:00	334	22
R16.5B	339.5	11-Apr	12:00	334	11 -Apr	23:00	345	11
R16.5C	392	13-Apr	9:00	379	14-Apr	11:00	405	26

TABLE 15 (page 1/3)

SUMMARY OF RESULTS FOR FT-IV DEMONSTRATION RUN AT LAPORTE												
Run No.	**On-stream Time, Hrs.**	**Temperature (average) deg F**	**Pressure psig**	**Space Velocity sL/kg-hr**	**Recycle Ratio**	**Superficial Gas Vel. Inlet ft/sec**	**Catalyst in Reactor lbs**	**CO Conv. per pass mole%**	**H2 Conv. per pass mole%**	**CO +H2 Conv. per pass mole%**	**CO Conv. plant mole%**	**H2 Conv. plant mole%**
AF-R16.1A	109	495.5	710.0	15487	1.23	0.42	390	29.6	59.7	45.7	75.6	91.4
AF-R16.1B	152	498.1	710.0	14925	1.14	0.41	390	33.1	59.9	47.6	76.8	91.3
AF-R16.1C	172	498.0	710.0	14975	1.11	0.41	388	33.2	60.5	48.4	75.7	90.4
AF-R16.3A	230	502.2	710.1	22223	2.12	0.60	383	20.2	43.0	32.2	70.2	87.2
AF-R16.3B	237	502.1	710.1	22115	2.08	0.60	383	20.9	43.5	32.8	70.6	87.2
AF-R16.3C	247	502.1	710.2	22210	2.13	0.60	383	20.1	42.3	31.7	69.3	86.5
AF-R16.3D	257	502.1	710.0	22364	2.12	0.60	380	20.1	41.9	31.6	69.1	86.2
AF-R16.4A	284	479.8	709.9	17594	1.64	0.46	377	34.5	39.6	38.0	78.8	81.7
AF-R16.4B	298	480.0	710.0	18278	1.79	0.48	377	32.1	39.7	37.2	79.1	83.5
AF-R16.5A	323	498.3	710.1	15530	1.11	0.41	376	31.7	56.4	45.8	71.3	87.1
AF-R16.5B	339	497.7	710.0	15601	1.10	0.41	373	31.2	54.1	44.5	69.4	85.1
AF-R16.5C	392	498.2	710.0	17567	1.15	0.42	340	30.1	52.2	43.0	68.7	84.2

TABLE 15 (page 2/3)

SUMMARY OF RESULTS FOR FT-IV DEMONSTRATION RUN AT LAPORTE									
Run No.	**CO+H2 Conv. plant mole%**	**CO Conv. Rate gmole/kg-hr**	**HC Prodtn. Rate grams/kg-hr**	**Reactor Productivity (STY) grams HC/lit. react. vol.-hr**	**H2/CO in Fresh Feed mole/mole**	**H2/CO in Reactor Feed mole/mole**	**H2/CO Usage Ratio mole/mole**	**H2/CO in Outlet mole/mole**	**C02 Select. mole%**
AF-R16.1A	85.9	78.2	1088.1	131.2	1.87	1.15	2.32	0.66	1.33
AF-R16.1B	86.3	83.0	1155.1	139.2	1.88	1.17	2.13	0.70	1.33
AF-R16.1C	85.3	81.5	1132.6	135.8	1.88	1.26	2.30	0.75	1.41
AF-R16.3A	81.2	76.9	1067.3	126.1	1.82	1.10	2.34	0.78	1.55
AF-R16.3B	81.4	78.6	1093.1	129.3	1.83	1.11	2.31	0.79	1.37
AF-R16.3C	80.4	76.6	1063.5	126.1	1.82	1.11	2.33	0.80	1.47
AF-R16.3D	80.1	77.1	1070.1	125.5	1.81	1.12	2.33	0.81	1.54
AF-R16.4A	80.8	69.5	971.0	113.4	2.27	2.12	2.44	1.96	0.96
AF-R16.4B	82.2	69.6	972.3	113.5	2.23	1.98	2.45	1.76	0.89
AF-R16.5A	81.6	79.8	1109.9	129.7	1.88	1.33	2.37	0.85	1.37
AF-R16.5B	79.6	78.3	1088.9	125.2	1.88	1.38	2.39	0.92	1.35
AF-R16.5C	78.8	84.1	1172.0	123.6	1.90	1.40	2.43	0.96	1.15

SUMMARY OF RESULTS FOR FT-IV DEMONSTRATION RUN AT LAPORTE

Run No.	< --------- HC Selectivity (CO2 free) wt% --------- >								< ----- PRODUCT DISTRIBUTION, WT% ----- >					HC Prodtn Rate based on liquid data grams HC/kg-hr	Alpha C3-C9	Alpha C10-C50
	CH4	C2H6	C2H4	C3H8	C3H6	C4Hl0 Sum	C4H8 Sum	C5H11 Sum	METHANE C1	GAS C2-C4	GASOLINE C5-C11	DIESEL C12-C18	WAX C19+			
AF-R16.1A	13.14	2.19	0.23	2.38	1.53	1.88	1.11	1.38								
AF-R16.1B	13.95	2.05	0.08	2.40	1.46	1.89	1.24	1.06								
AF-R16.1C	14.61	2.42	0.15	2.51	1.69	1.90	1.21	1.02	14.2	15.2	34.4	19.6	16.6	1187.4	0.86	0.87
AF-R16.3A	17.67	2.48	0.00	2.64	1.73	1.55	1.45	1.63								
AF-R16.3B	16.63	2.62	0.13	2.62	1.69	1.27	1.83	0.57								
AF-R16.3C	18.89	3.16	0.00	3.97	1.94	2.76	1.67	2.27								
AF-R16.3D	20.43	3.31	0.00	3.53	2.12	2.21	1.59	1.88	19.1	17.3	34.2	18.8	10.6	1164.5	0.83	0.83
AF-R16.4A	25.12	3.70	0.10	4.51	1.52	2.94	0.84	2.00	22.2	17.2	31.3	17.7	11.6	1125.4	0.81	0.85
AF-R16.4B	23.21	5.86	0.32	7.73	2.31	4.60	1.82	2.67								
AF-R16.5A	22.22	3.16	0.17	3.44	2.27	2.28	1.55	1.40								
AF-R16.5B	23.06	3.40	0.17	3.63	2.32	2.55	1.76	2.06								
AF-R16.5C	22.30	3.54	0.15	4.07	2.57	3.11	2.06	2.72	19.2	18.3	32.3	16.3	13.8	1393.0	0.79	0.87

TABLE 16

Heat and Mass Balance Summary for F-T IV									
Run No.	**Prod Gas Flow Factor**	**Purgel Flow Factor**	**01.20 Discharge Flow Factor**	**Water/Oxygen Balance, %**	**Reactor Balance, %**	**Plant Balance, %**	**Feed Balance, %**	**Prod Gas Balance, %**	**Heat Balance, %**
AF-R16.1A	1.085	1.247	1.062	105.4	100.8	102.0	99.9	99.9	102.2
AF-R16.1B	1.126	1.145	1.068	97.7	99.2	99.5	100.5	100.2	96.3
AF-R16.1C	1.119	1.146	1.060	96.1	99.0	97.6	100.2	100.0	97.7
AF-R16.3A	1.031	1.194	1.046	102.7	99.8	100.1	100.3	100.0	99.6
AF-R16.3B	1.025	1.182	1.043	98.0	99.2	98.3	100.5	100.0	97.0
AF-R16.3C	1.049	1.198	1.049	99.1	100.0	99.2	99.8	100.0	98.2
AF-R16.3D	1.035	1.189	1.049	100.5	100.0	99.8	99.9	100.1	98.9
AF-R16.4A	1.060	1.224	1.020	100.0	100.3	101.6	100.1	100.0	102.4
AF-R16.4B	1.049	1.227	1.040	95.9	100.4	98.9	99.3	100.0	101.5
AF-R16.5A	1.180	1.178	1.054	99.0	100.3	100.7	99.9	100.1	99.2
AF-R16.5B	1.185	1.185	1.046	99.7	100.8	101.8	99.8	100.0	99.0
AF-R16.5C	1.050	1.167	1.034	98.0	100.6	101.2	99.8	100.0	98.2
Average	1.083	1.190	1.048	99.3	100.0	100.1	100.0	100.0	99.2

TABLE 17

Elemental Balance (Reactor) Summary for F-T IV					
Run No.	**Total, %**	**C, %**	**H, %**	**O, %**	**N, %**
AF-R16.1C	99.0	99.9	96.2	98.3	100.0
AF-R16.3D	100.0	100.5	98.7	99.8	100.0
AF-R16.4A	100.3	101.5	98.7	99.5	100.0
AF-R16.5C	100.6	102.7	98.4	99.0	100.0
Average	100.0	101.2	98.0	99.1	100.0

TABLE 18

Catalyst Inventory in the Reactor during FT IV

Assumptions:		
Catalyst lost to prep tank and piping during transfer	10	lbs
Catalyst lost in nozzles and dead legs	10	lbs
Physical Water in the Catalyst	15	lbs
Catalyst Loss Rate with Gas Flow	1.5	lb/day
Catalyst Loss Rate with Product Wax	0.01	lb/day
Catalyst Loss due to sampling	0.5	lb/sample
Plant Trip on 4/12/98	30	lbs

Date	Days in the Reactor	Run	Assumed Gas Hold up, vol%	Estimated Catalyst Amount in the Reactor	No. of Slurry Samples	Comments
03/23/1998	0	Drying		501		As Loaded
03/24/1998	1	Drying/Activating		464.5		Catalyst lost in transfer, dead legs and loss of physical water
03/25/1998	2	Activating		463		
03/26/1998	3	Activating		461.5		
03/27/1998	4	Activating		460		
03/28/1998	5	Activating/Syngas Start-up	45	402	3	Filtration brought on-stream
03/29/1998	6	Start-up	45	400	1	
03/30/1998	7	Start-up	45	397	2	
03/31/1998	8	Start-up	45	395	1	
04/01/1998	9	Start-up	45	394		
04/02/1998	10	R16.1	45	392	1	
04/03/1998	11	R16.1	45	390		
04/04/1998	12	R16.1	45	388	1	
04/05/1998	13	Transition	45	387		
04/06/1998	14	Transition	45	385		
04/07/1998	15	R16.3	45	383	1	
04/08/1998	16	R16.3	45	380	3	
04/09/1998	17	R16.4	45	377	3	
04/10/1998	18	R16.5	45	376		
04/11/1998	19	R16.5	45	373	3	
04/12/1998	20	R16.5	45	341		Plant Trip
04/13/1998	21	R16.5	45	340		
04/14/1998	22	R16.6	45	338		
04/15/1998	23	R16.7	45	337		
04/16/1998	24	R16.8			3	Shut Down

TABLE 19

Catalyst Concentration Estimates for F-T IV												
Run No.	**Time On-stream, Hours**	**Cat Conc. by NDG, wt%**	**Cat Conc. by DP, wt%**	**Cat Conc. by 2-Phase Density, wt%**	**Reduced Cat Conc. by 2-Phase Density, wt%**	**Assumed Cat. Inventory in Reactor, lbs**	**Gas Hold-up by NDG, vol%**	**Gas Hold-up by DP, vol%**	**2-Phase Density, g/cc**	**Cat Conc. by DGD, wt%**	**Gas Hold-up DGD, vol%**	**Calculated Cat. Inventory in Reactor based on DGD data**
AF-R16.1A	109	28.52	27.99	29.71	27.12	390	50.29	48.05	0.824			
AF-R16.1B	152	28.84	27.69	28.26	25.75	390	50.52	47.29	0.820			
AF-R16.1C	172	28.60	27.58	28.36	25.84	388	50.09	47.32	0.821			
AF-R16.3A	230	28.63	27.25	29.57	26.98	383	50.18	47.19	0.826			
AF-R16.3B	237	28.61	26.96	29.34	26.76	383	50.69	46.40	0.824			
AF-R16.3C	247	28.74	27.33	29.48	26.89	383	50.74	47.21	0.825			
AF-R16.3D	257	28.26	25.28	29.54	26.95	380	49.87	45.28	0.826			
AF-R16.4A	284	25.98	24.59	27.32	24.86	377	45.14	41.40	0.820			
AF-R16.4B	298	26.45	24.92	27.50	25.02	377	46.61	42.40	0.821			
AF-R16.5A	323	26.83	25.58	27.32	24.86	376	47.19	43.59	0.814			
AF-R16.5B	339	26.47	25.53	26.99	24.54	373	46.81	44.37	0.812			
AF-R16.5C	392	26.98	25.68	24.63	22.33	340	52.94	49.36	0.795			
AF-R16.8	445	26.42	25.81	23.98	21.72	337	52.27	48.84	0.813	22.2	44.94	304

TABLE 20

Heat Transfer Coefficient Estimates for F-T IV									
Run No.	**Time On-stream, Hours**	**Cat Conc. by DP, wt%**	**Gas Hold-up by DP, vol%**	**Superficial Gas Vel. (In), ft/sec**	**Reactor Heat Duty, BTU/hr**	**Log Mean Temp. Diff., deg F**	**Overall HT Coeff., BTU/hr-ft2-deg F**	**Measured Slurry Side HT Coeff., BTU/hr-ft2-deg F**	**Predicted Slurry Side HT Coeff., BTU/hr-ft2-deg F**
AF-R16.1A	109	27.99	48.05	0.42	1,787,544	60.2	136	533	243
AF-R16.1B	152	27.69	47.29	0.41	1,781,024	59.6	137	545	242
AF-R16.1C	172	27.58	47.32	0.41	1,762,756	58.7	138	554	241
AF-R16.3A	230	27.25	47.19	0.60	1,608,490	53.2	139	565	273
AF-R16.3B	237	26.96	46.40	0.60	1,605,273	53.3	138	557	273
AF-R16.3C	247	27.33	47.21	0.60	1,571,700	52.3	138	551	273
AF-R16.3D	257	25.28	45.28	0.60	1,585,463	52.6	138	556	276
AF-R16.4A	284	24.59	41.40	0.46	1,532,551	51.5	137	540	257
AF-R16.4B	298	24.92	42.40	0.48	1,521,470	51.0	137	544	259
AF-R16.5A	323	25.58	43.59	0.41	1,691,316	57.1	136	524	245
AF-R16.5B	339	25.53	44.37	0.41	1,625,940	55.1	136	516	245
AF-R16.5C	392	25.68	49.36	0.42	1,611,510	53.6	138	555	247

TABLE 21

Catalyst Productivity data extrapolated to 200°C for F-T IV												
Applied activation energy					121.6	kJ/gmole (based on autoclave data)						
Run No.	16.1A	16.1B	16.1C	16.3A	16.3B	16.3C	16.3D	16.4A	16.4B	16.5A	16.5B	16.5C
Average Reactor Temperature (T), °C	257.5	259	258.9	261.2	261.2	261.1	261.2	248.8	248.9	259.1	258.7	259
CO Conversion Rate, rCO, mol/l cat/h	71.8	76.7	75.1	70.7	72.5	70.6	71.1	64.1	64.2	74.0	72.2	77.5
CO2 selectivity, %mol	1.330	1.330	1.410	1.550	1.37	1.47	1.54	0.96	0.89	1.37	1.35	1.15
CO Conversion Rate for Hydrocarbon Synthesis only, rCO*, mol/l cat/h	70.8	75.7	74.1	69.6	71.5	69.5	70.0	63.5	63.6	73.0	71.2	76.6
productivity @T°C, N1 CO/l cat/h	1586.7	1696.3	1658.9	1559.1	1601.0	1557.7	1567.4	1422.2	1424.3	1634.2	1594.7	1716.0
productivity @200°C, Nl CO/l cat/h	55.6	55.0	54.0	45.1	46.3	45.3	45.4	78.9	78.6	52.7	52.5	55.6
*Fischer -Tropsch only												

TABLE 22

Analysis Plan FT-IV Samples						
Condition	**Description**	**Water**	**Wax**	**Light HC**	**Slurry**	**Misc.**
startup					10.62-4 10.62-7	Durasyn 164 Callista 158
R16-1	baseline	22.11-9	drum sample 22.62-14	drum sample	10.62-9	
R16-3	high velocity	22.11-13	22.62-20	22.11-12	10.62-11	
R16-4	high feed ratio	22.11-14	22.62-22		10.62-12	
R16-5	checkback		22.62-25		10.62-13	
R16-6	tracer 1 (=R16-1)		22.62-27	22.11-18		
R16-7	tracer 2 (= R16-3)			22.11-19		
shutdown					10.62-14 27.10-1 (rx btm) 27.10-2 (rx nzl)	

TABLE 23

Analysis of F-T IV product water samples			
Sample ID (SSFI)	22.11.9	22.11.13	22.11.14
Date	4/4/1998 22:15	4/8/1998 11:30	4/9/1998 20:30
Condition	16.1	16.3	16.4
pH	2.95	2.85	3.08
Total Organic Content (TOC), ppmw carbon	16936		

TABLE 24

Analysis of Light HC Product Samples for F-T IV				
Sample ID (SSFI)	22.11-12	22.11-18	22.11-19	Drum
Date	4/7/1998 1:00	4/14/1998 11:00	4/15/1998 13:30	4/4/1998 8:30
Condition	16.3	16.6	16.7	16.1
Oxygen content, %w				
Total (FNA)				0.598
Organic (IR)				0.319
Water (calc.)				0.279

TABLE 25

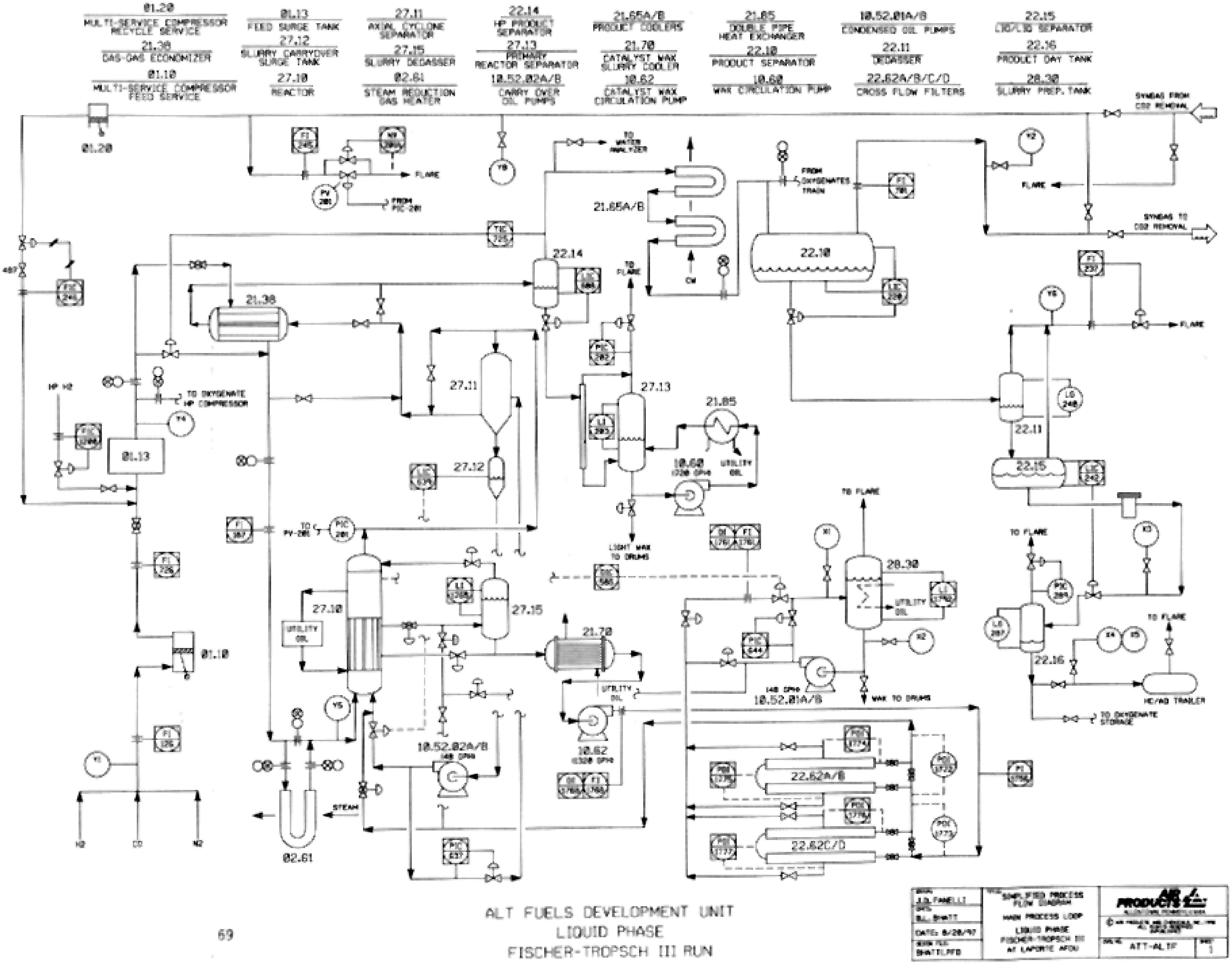
Analysis of Product Wax Samples for F-T IV						
Sample ID (SSFI)	22.62-14	22.62-20	22.62-22	22.62-25	22.62-27	Drum Sample
Date	4/4/1998 23:15	4/8/1998 11:20	4/9/1998 20:30	4/11/1998 15:00	4/14/1998 2:15	4/4/1998 0:00
Condition	16.1	16.3	16.4	16.5	16.6	16.1
Density 150°C, kg/m3	730.5	734.9	735.6	730.9	740.6	730
Density 175°C, kg/m3	714.7	720.7	716.6	714.9	715.1	713.7
Inorganics (ICP)						
Co, ppmw						3
Olefins (NMR)						
total olefins, mol%						12.7
alpha olefins, mol%						1.1
Oxygen						
Total (FNA), %w						0.172
Organic (IR), %w						0.145
Water (calc.), %w						0.027
C/H						
C, %w						85.29
H, %w						14.71
H/C, at/at						2.05

TABLE 26

Analysis of Slurry Samples for F-T IV

PCME										
Sample ID (SSFI)	Fresh cat. precursor	10.62-4	10.62-7	10.62-9	10.62-11	10.62-12	10.62-13	10.62-14	27.10-1	27.10-2
Date	3/28/98 14:15	3/29/98 3:15	3/31/98 8.20	4/4/98 3:10	8/4/98 11:15	9/4/98 20:30	11/4/98 3:30	4/16/98 15:30	5/21/98 0:00	4/21/98 0:00
Comment		Startup, 13 h on syngas	Startup, 66 h on syngas	Condition 16.1	Condition 16.3	Condition 16.4	Condition 16.5	@ shutdown	Reactor Bottom	Reactor Nozzle
PCME on slurry samp.										
fixed C, %w		0.1	0.1	0.1	0.1	0	0	0	0.2	0.2
inorganic residue, %w		4.5	1.1	0.8	13.6	2.7	0.5	0	52.6	50.9
PCME on recovered cat.										
fixed C, %w		0.5	1	1	0.5	0.5	0.5	1.2	0.5	0.2
Dewaxing and Particle Size Distribution										
diameter (vol. avg)/ diameter (vol. avg) fresh	1	0.89	0.94	0.92	0.94	0.86	0.93	0.94	1.26	0.77
fines, %w	0.8	2.2	1.7	1.4	1.4	3	2.1	1.4	0.1	2.1
solids content*, %w	-	24.3	22.5	24.5	25.1	22.7	21.1	19.0	52.6	56.8
*corrected for remaining wax in dewaxed sample										

Figure 1



ALT FUELS DEVELOPMENT UNIT
LIQUID PHASE
FISCHER-TROPSCH III RUN

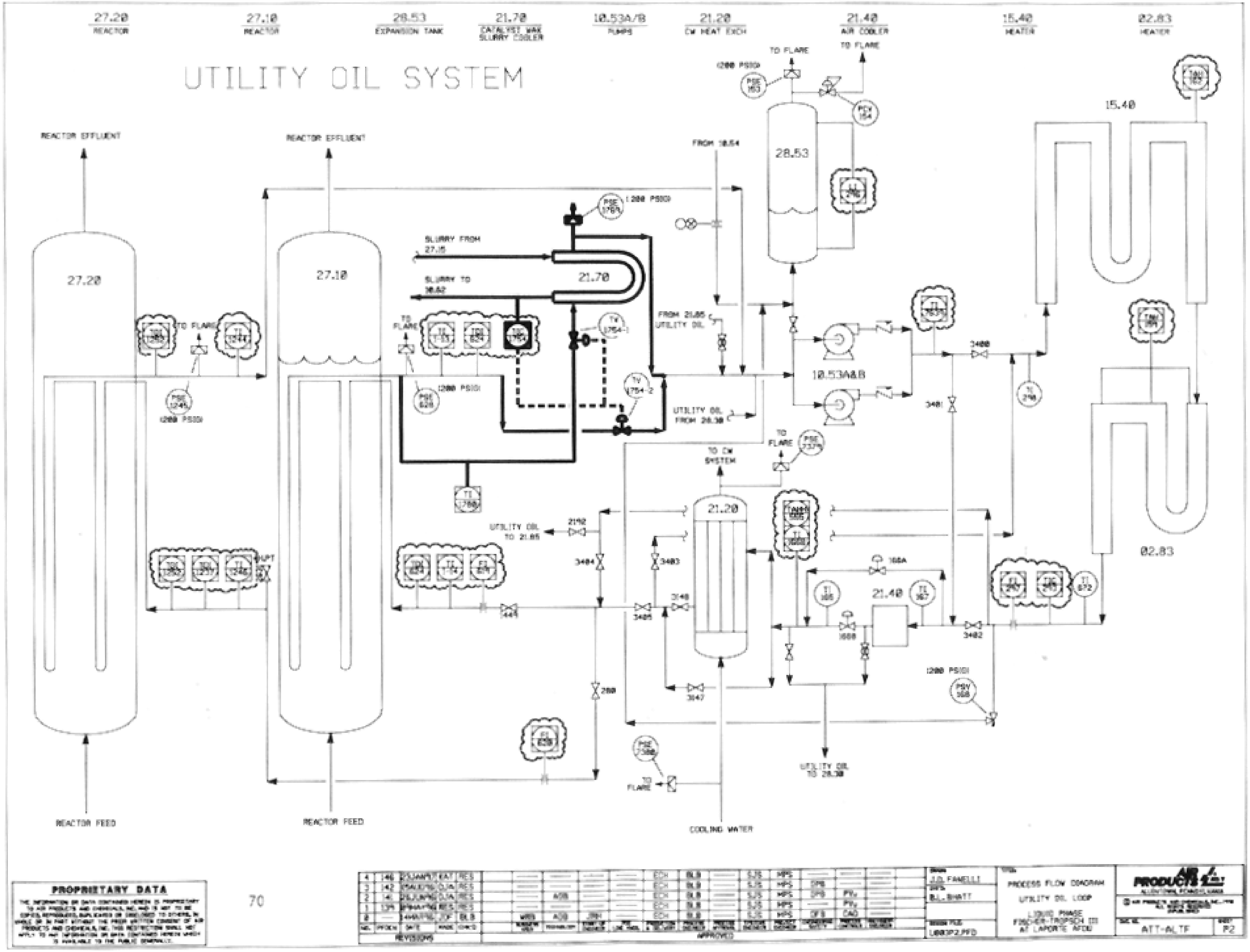

27.20 REACTOR
27.10 REACTOR
28.53 EXPANSION TANK
21.70 CATALYST WAX SLURRY COOLER
10.53A/B PUMPS
21.20 CW HEAT EXCH
21.40 AIR COOLER
15.40 HEATER
02.83 HEATER
UTILITY OIL SYSTEM
REACTOR EFFLUENT
REACTOR EFFLUENT
TO FLARE
TO FLARE
SLURRY FROM 27.15
SLURRY TO 10.62
FROM 10.54
FROM 21.85 UTILITY OIL
UTILITY OIL FROM 20.30
10.53A&B
TO CW SYSTEM
UTILITY OIL TO 21.85
UTILITY OIL TO 20.30
COOLING WATER
REACTOR FEED
REACTOR FEED
PROPRIETARY DATA
PROCESS FLOW DIAGRAM
UTILITY OIL LOOP
LIQUID PHASE FISCHER-TROPSCH III AT LAPORTE AFDU
ATT-ALTF
P2
REVISIONS
APPROVED
AIR PRODUCTS

Figure 2

Figure 3

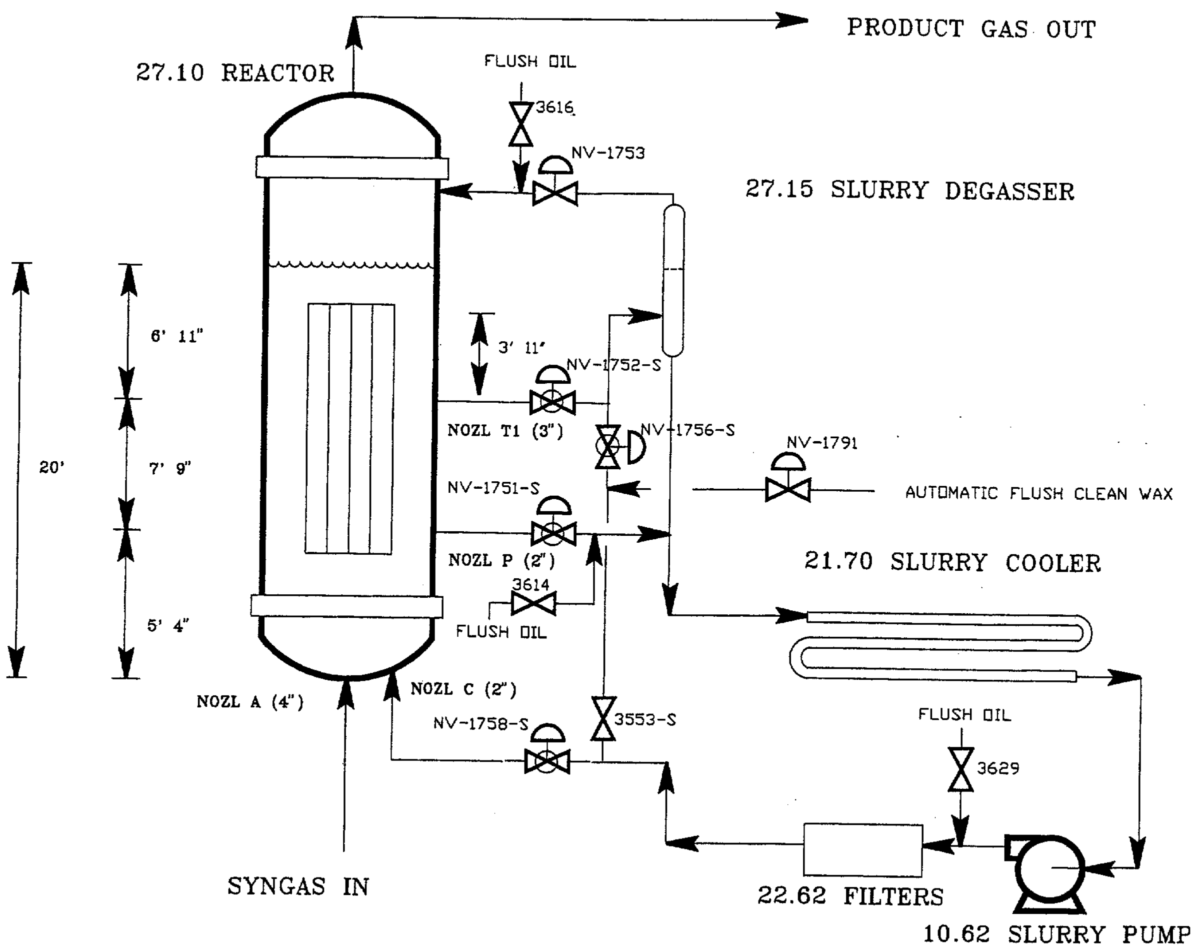
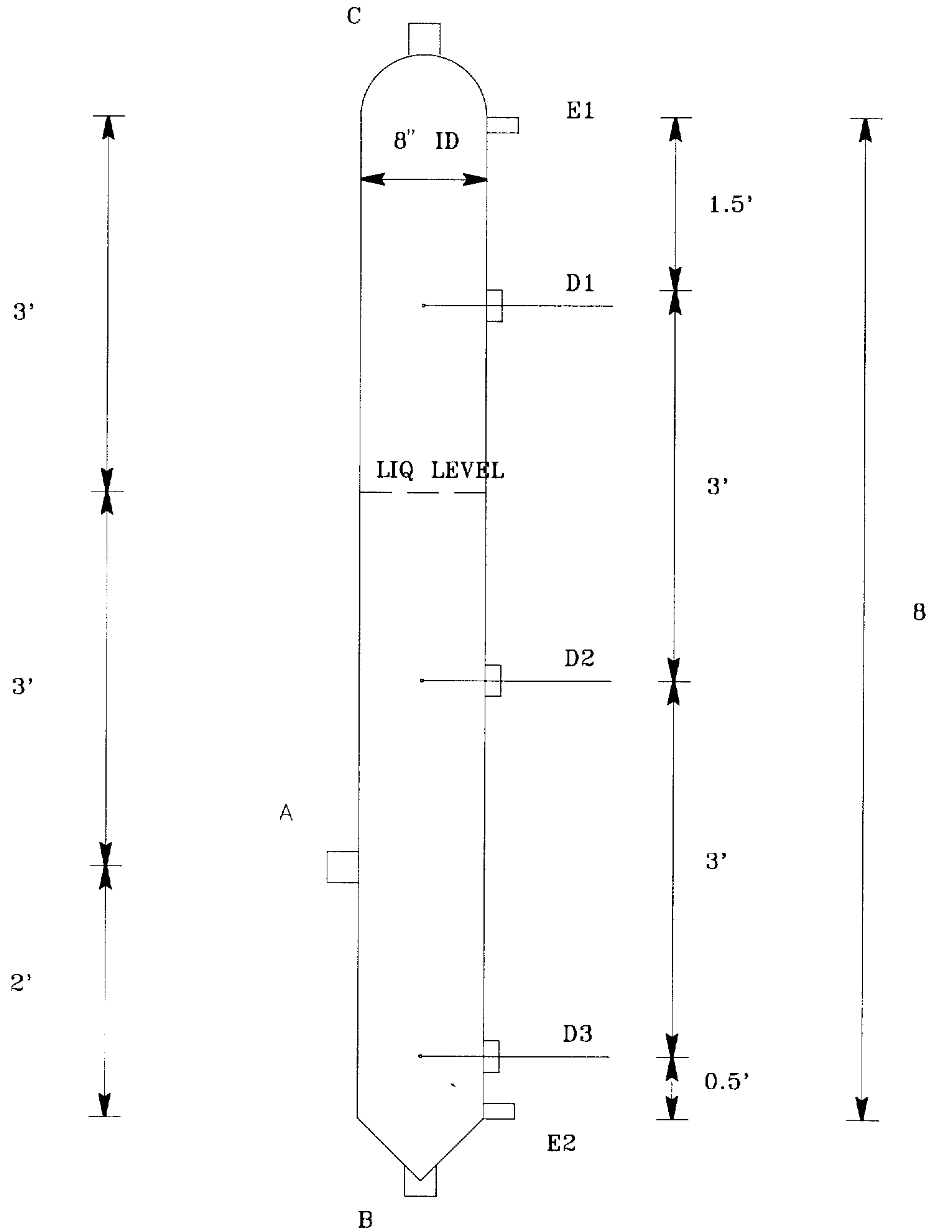

FISCHER-TROPSCH III FILTRATION SYSTEM LAYOUT
(NOT TO SCALE)
PRODUCT GAS OUT
27.10 REACTOR
FLUSH OIL
3616
NV-1753
27.15 SLURRY DEGASSER
6' 11"
3' 11'
NV-1752-S
NOZL T1 (3")
NV-1756-S
NV-1791
20'
7' 9"
NV-1751-S
AUTOMATIC FLUSH CLEAN WAX
NOZL P (2")
21.70 SLURRY COOLER
3614
5' 4"
FLUSH OIL
NOZL C (2")
NOZL A (4")
NV-1758-S
3553-S
FLUSH OIL
3629
SYNGAS IN
22.62 FILTERS
10.62 SLURRY PUMP

FIGURE 4

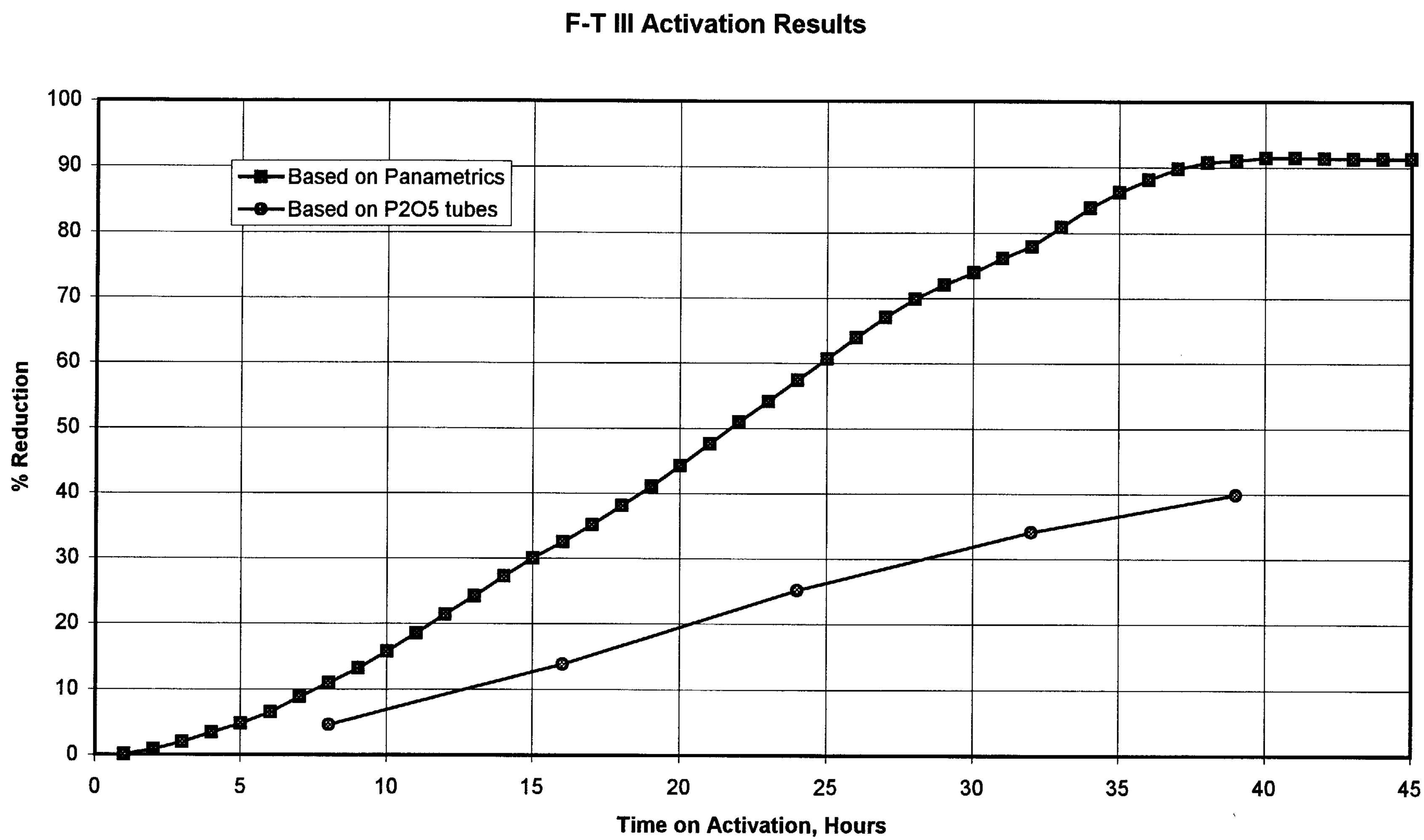
27.15 SLURRY DEGASSER

NOT TO SCALE



NOZZLES	SERVICE
A	3-PHASE SLURRY INLET
B	2-PHASE SLURRY OUTLET
C	GAS OUTLET
D	THERMOCOUPLES
E	DP TAPS

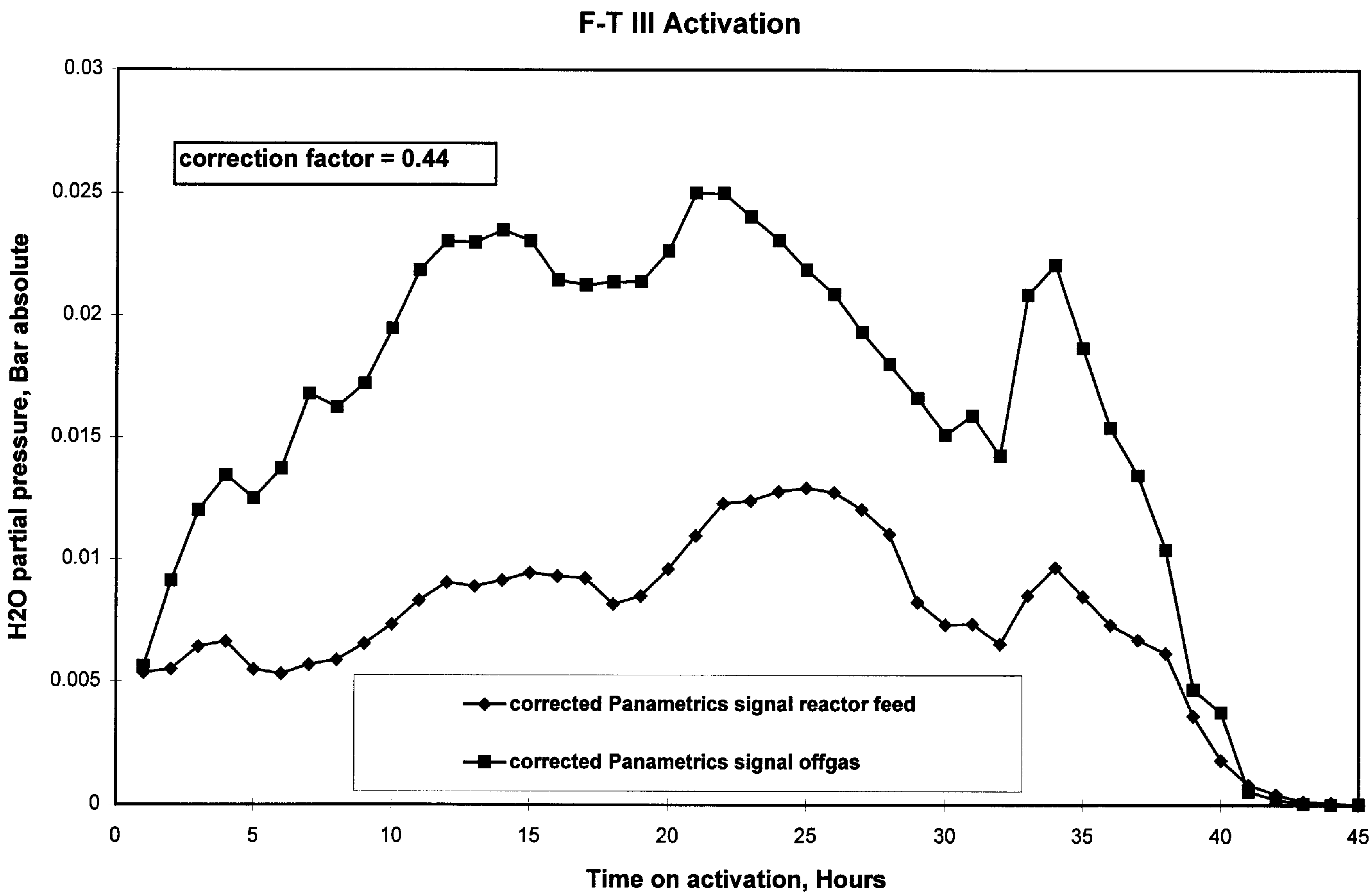
FIGURE 5



Ft3_red.sht1 Chart 1

BLB 2/2/1999

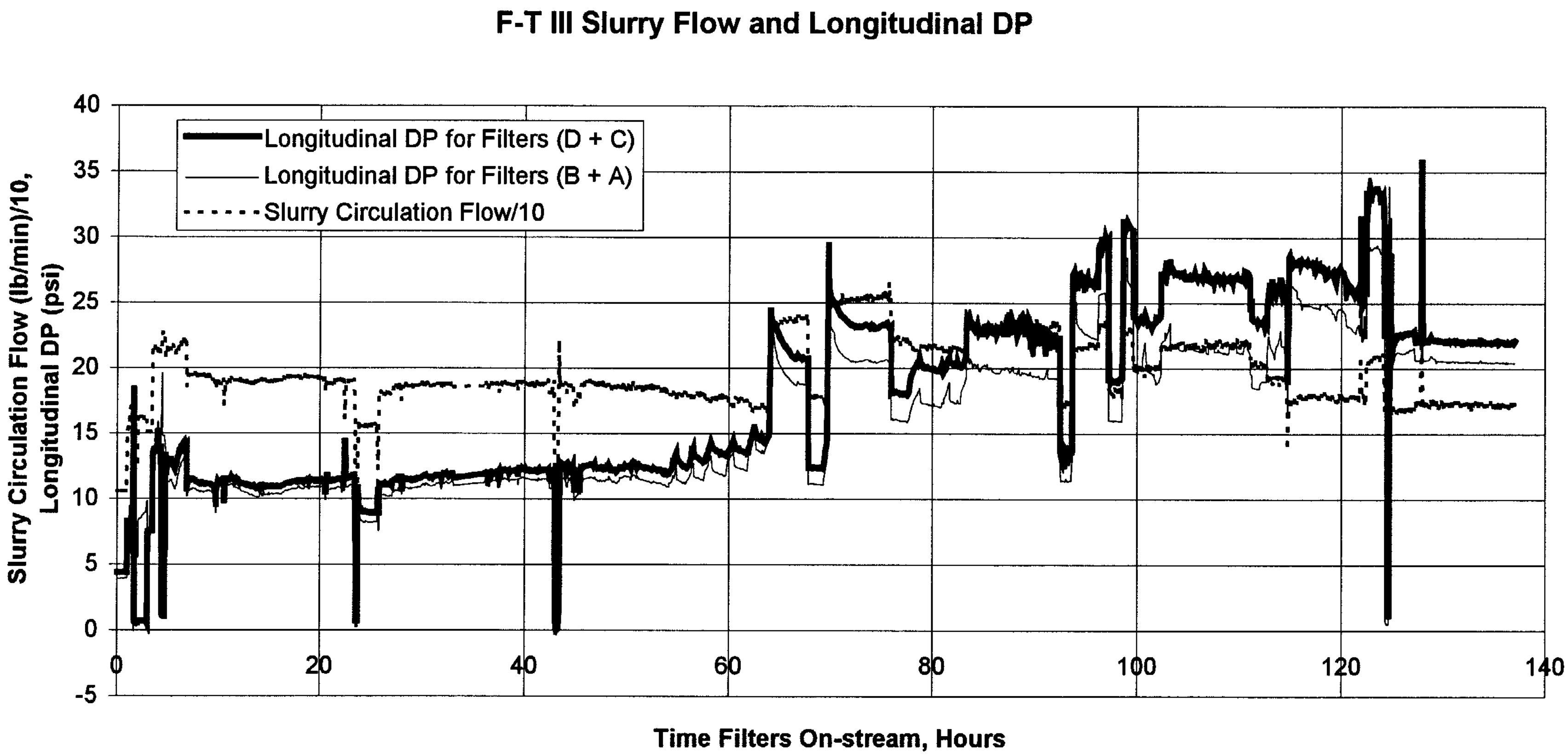
FIGURE 6



Ft3red2.xls

BLB 2/2/1999

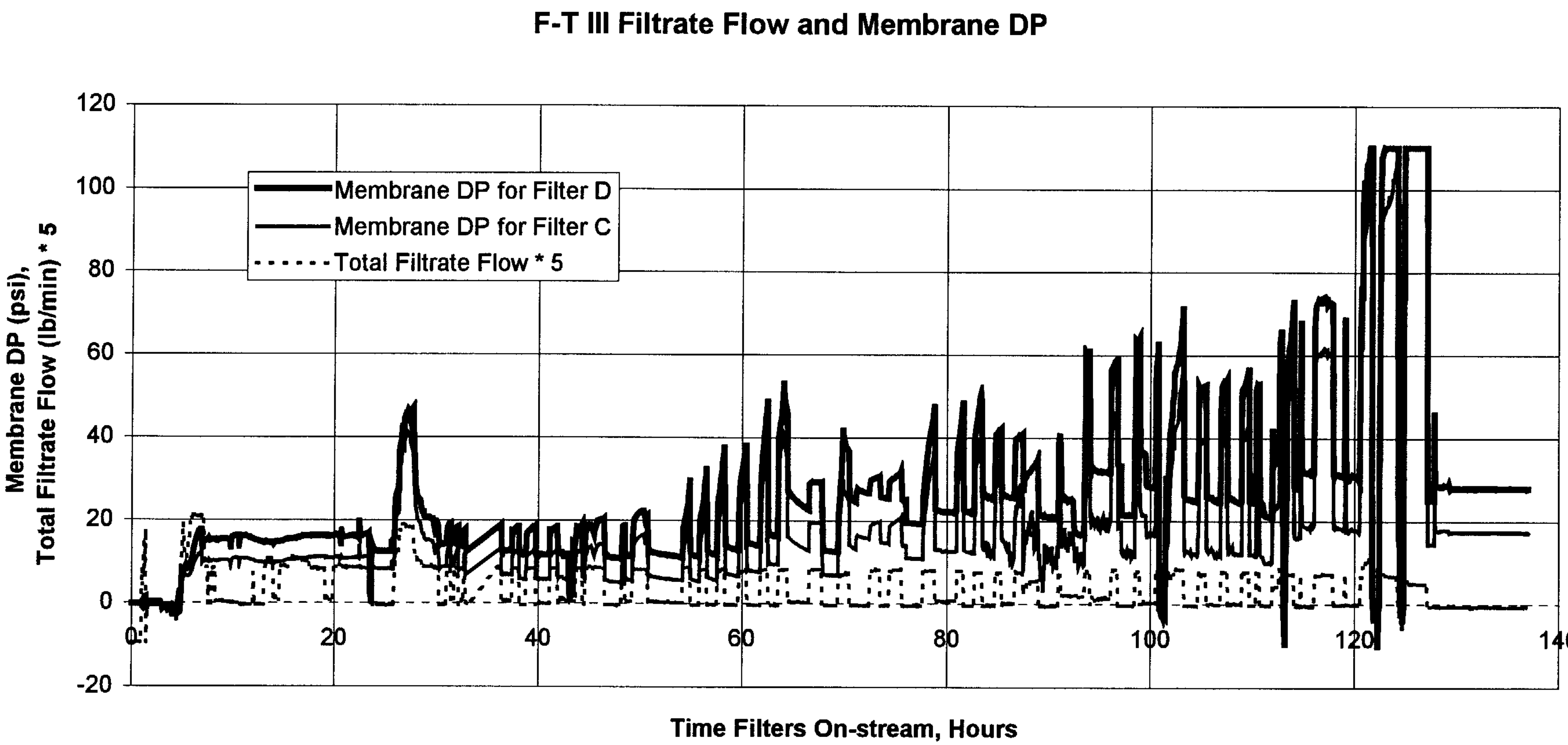
FIGURE 7



Q496fg22.xlc

BLB 2/3/1999

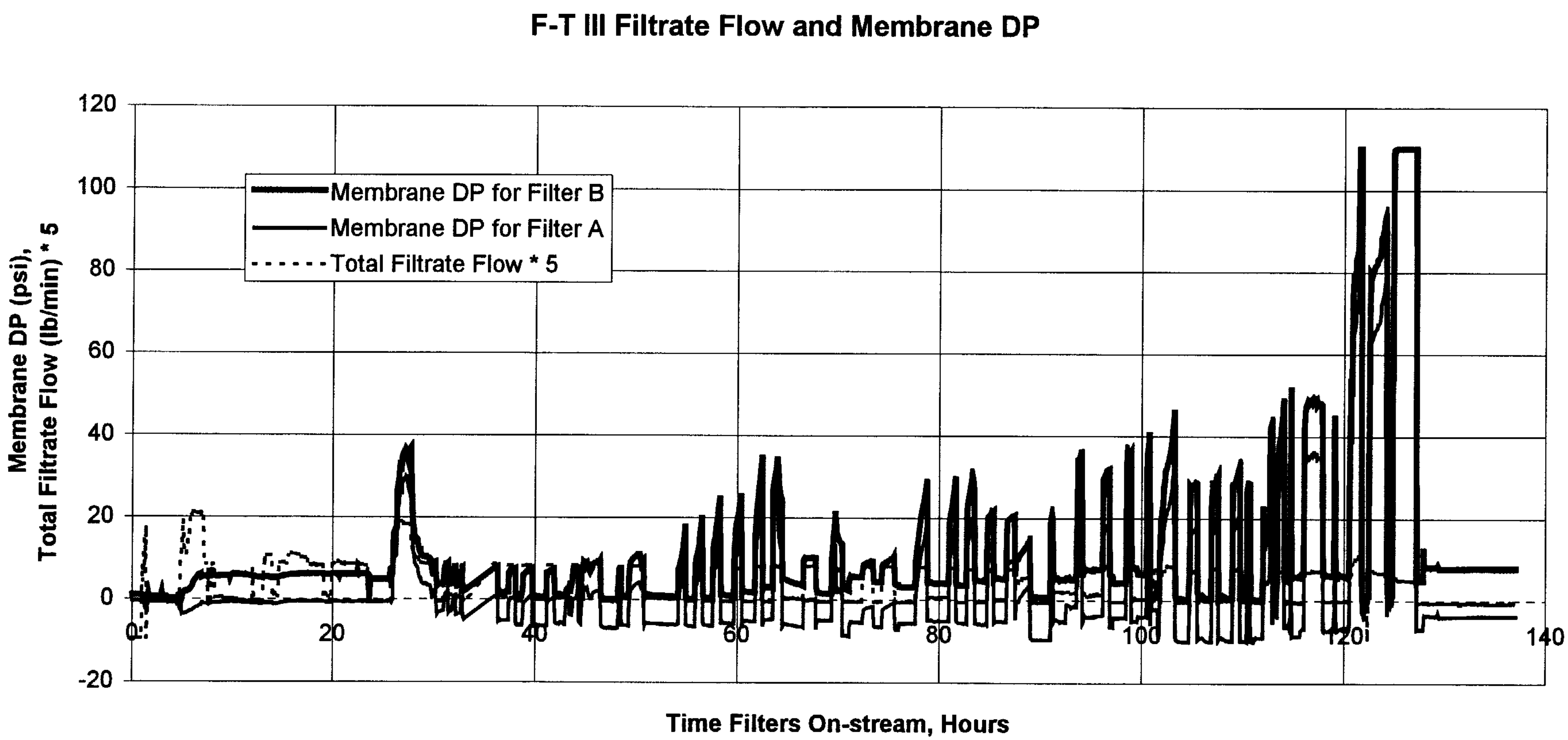
FIGURE 8



Q496fg23.xlc

BLB 2/3/1999

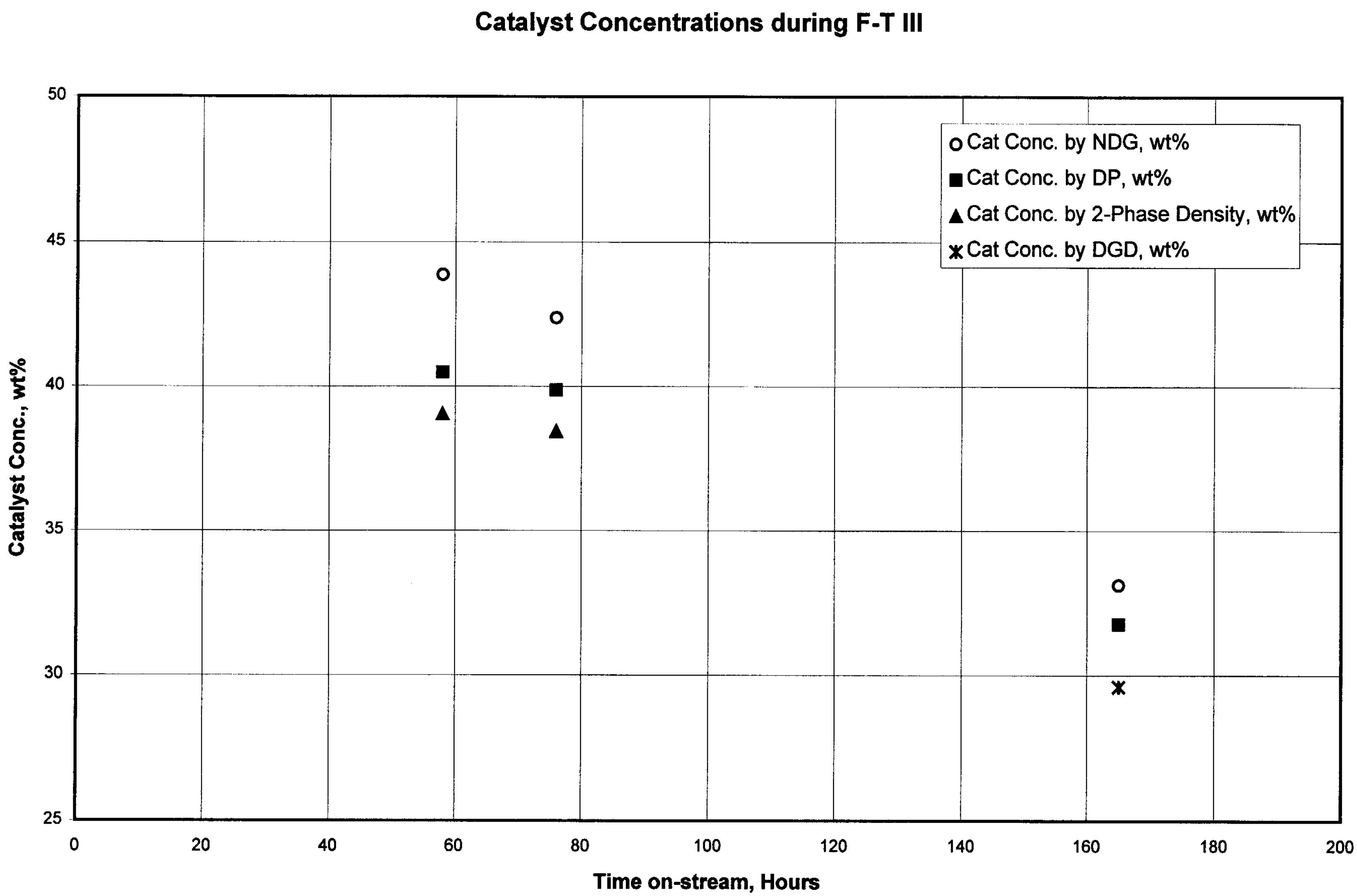
FIGURE 9



Q496fg24.xlc

BLB 2/3/1999

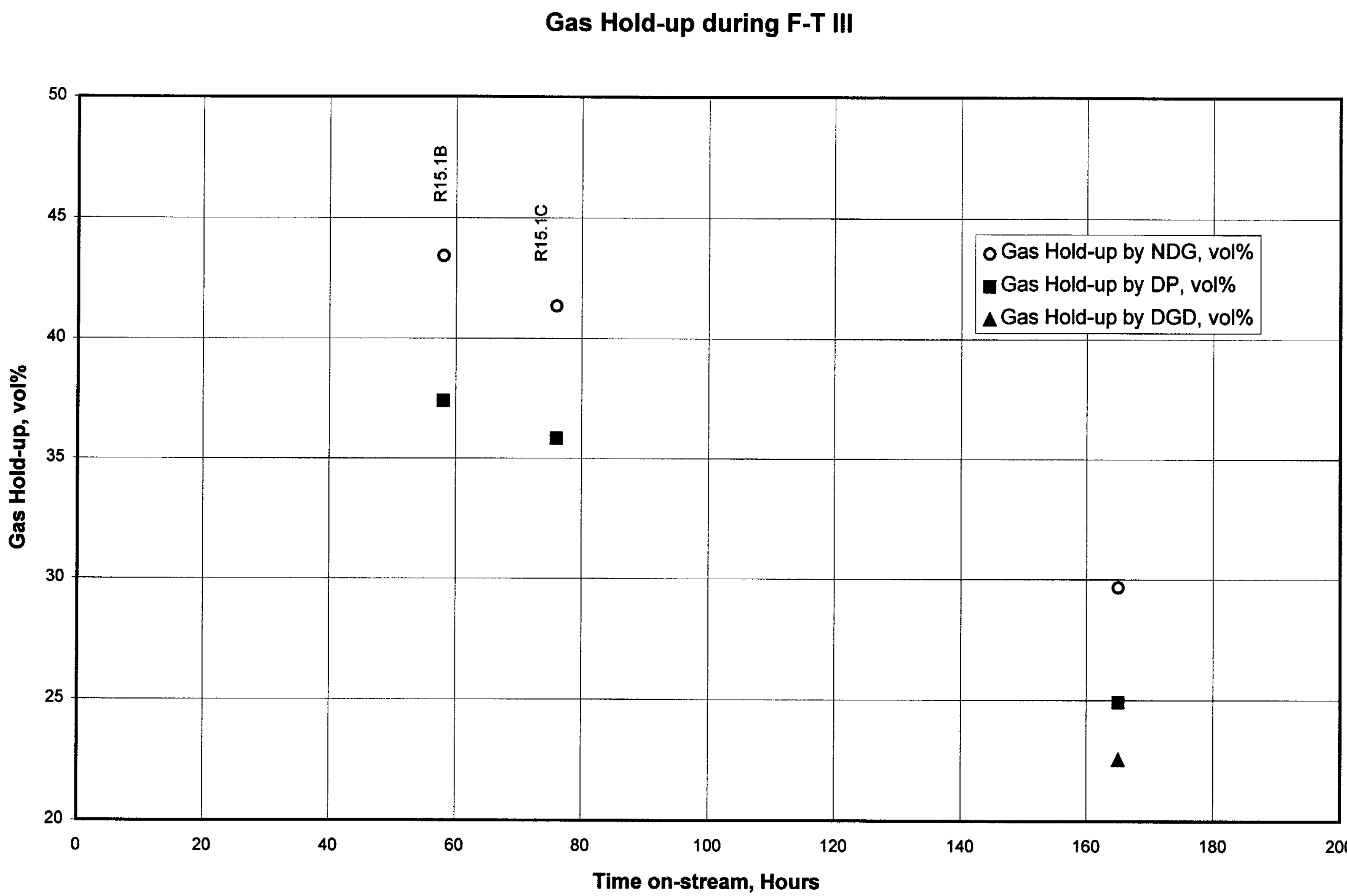
FIGURE 10



concft31.xls Chart 1

BLB 2/4/1999

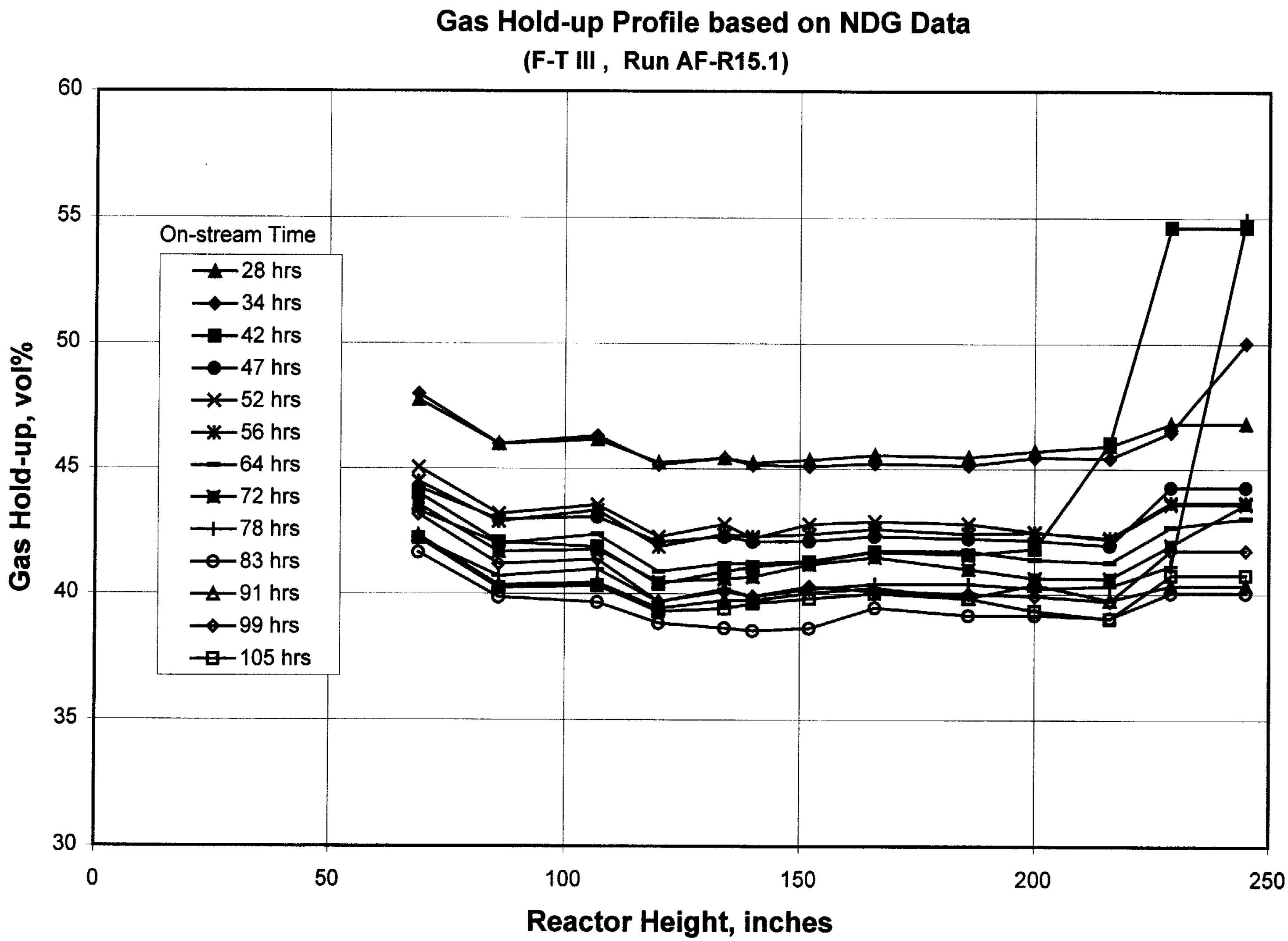
FIGURE 11



concft31.xls Chart 2

BLB 2/4/1999

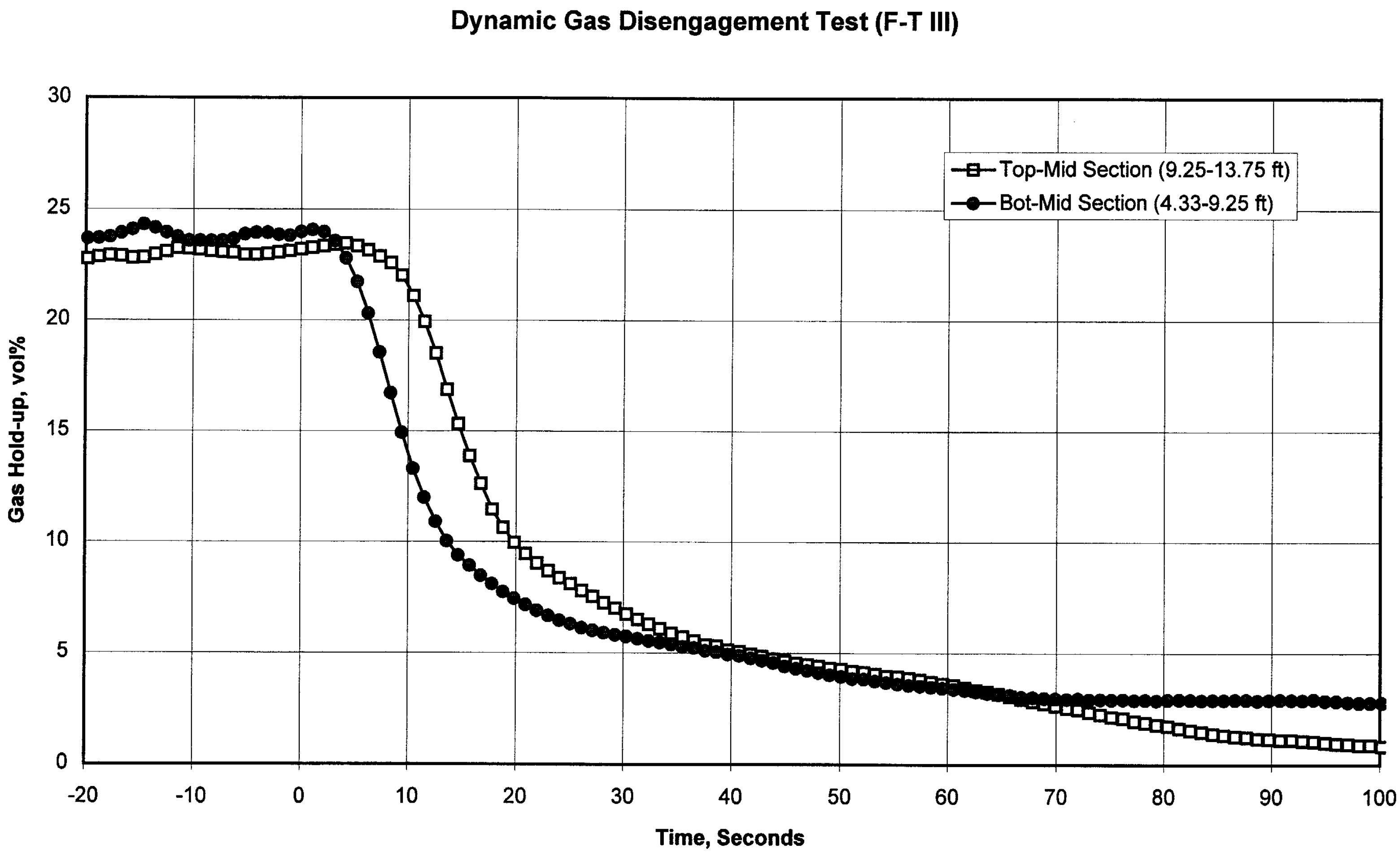
FIGURE 12



AXPROF03 Chart 1

BLB 2/3/1999

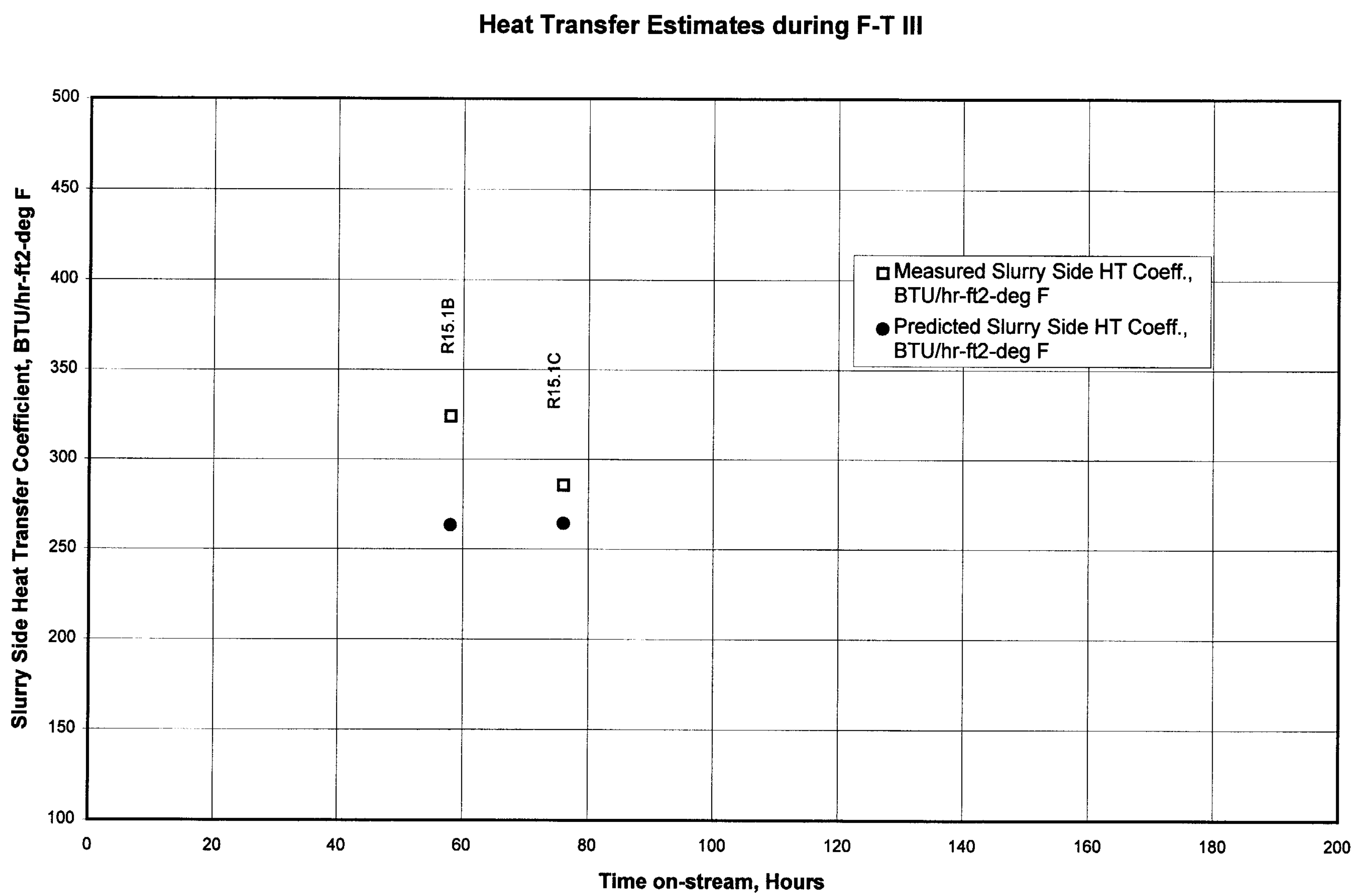
FIGURE 13



FT3SD01.xls Chart 1

BLB 2/3/1999

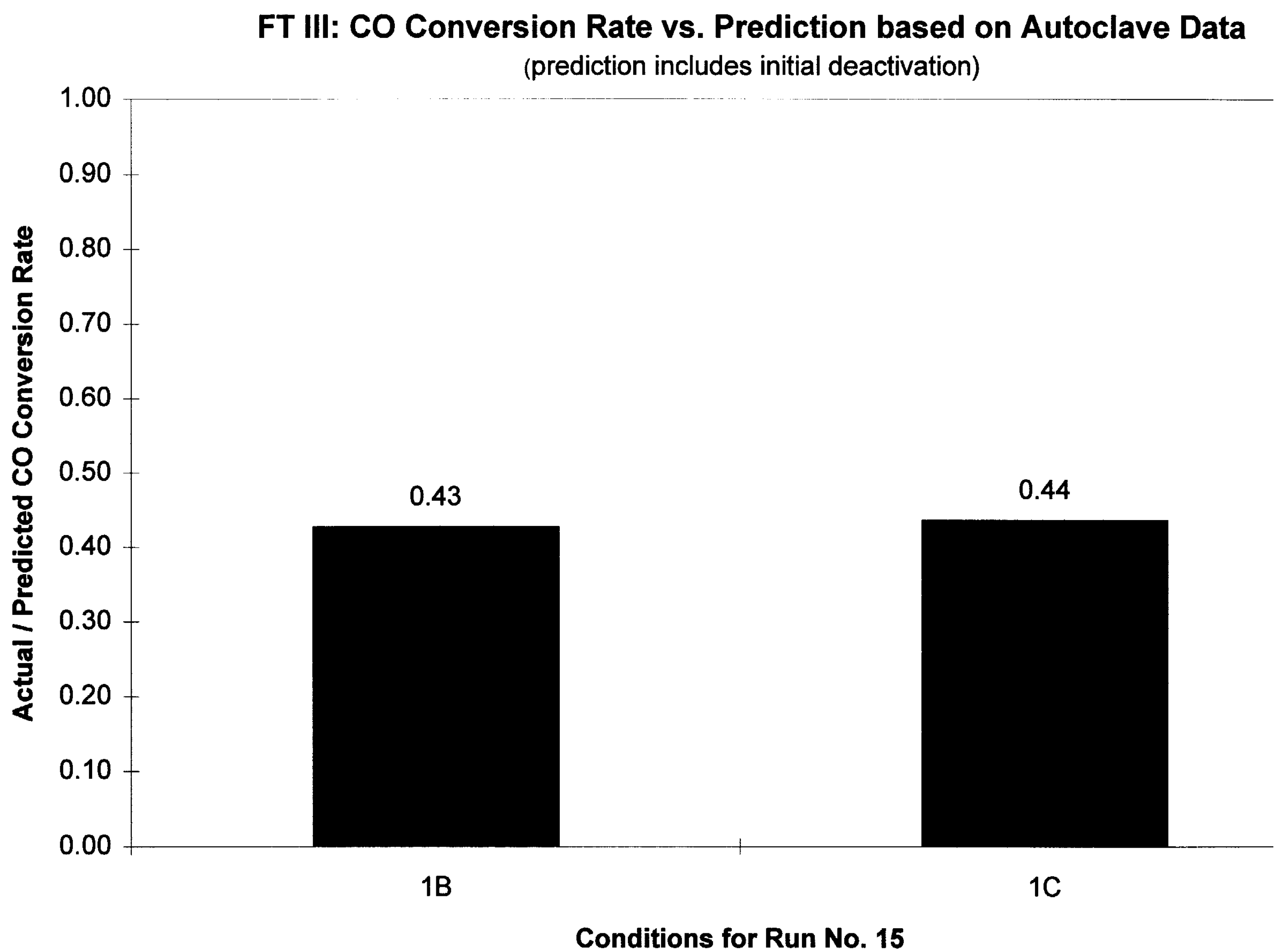
FIGURE 14



httrft31.xls Chart 1

BLB 2/3/1999

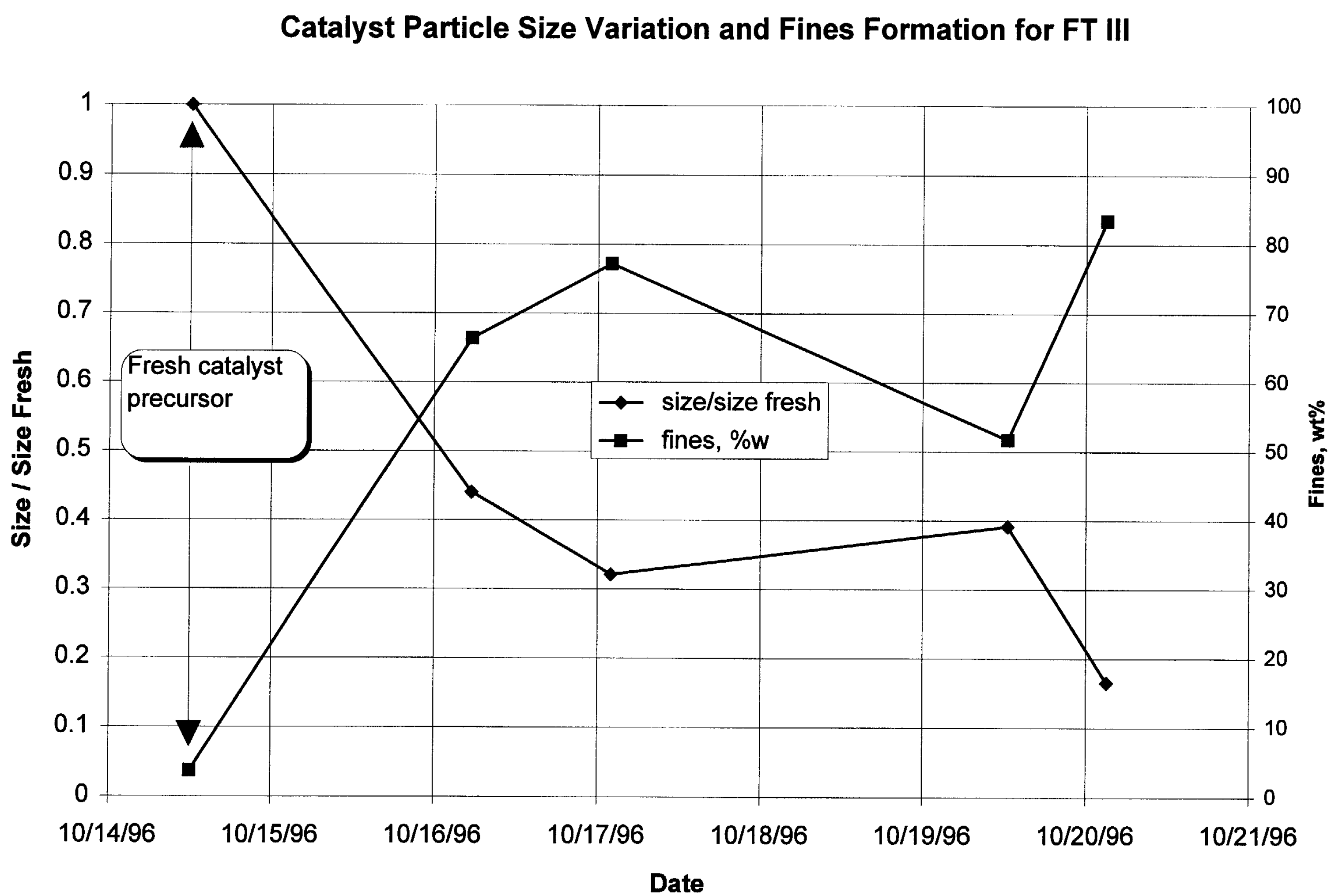
FIGURE 15



ft3actvs2.xls

BLB 2/3/1999

FIGURE 16



FT3SSFIA2.xls

BLB 2/3/1999

FIGURE 17

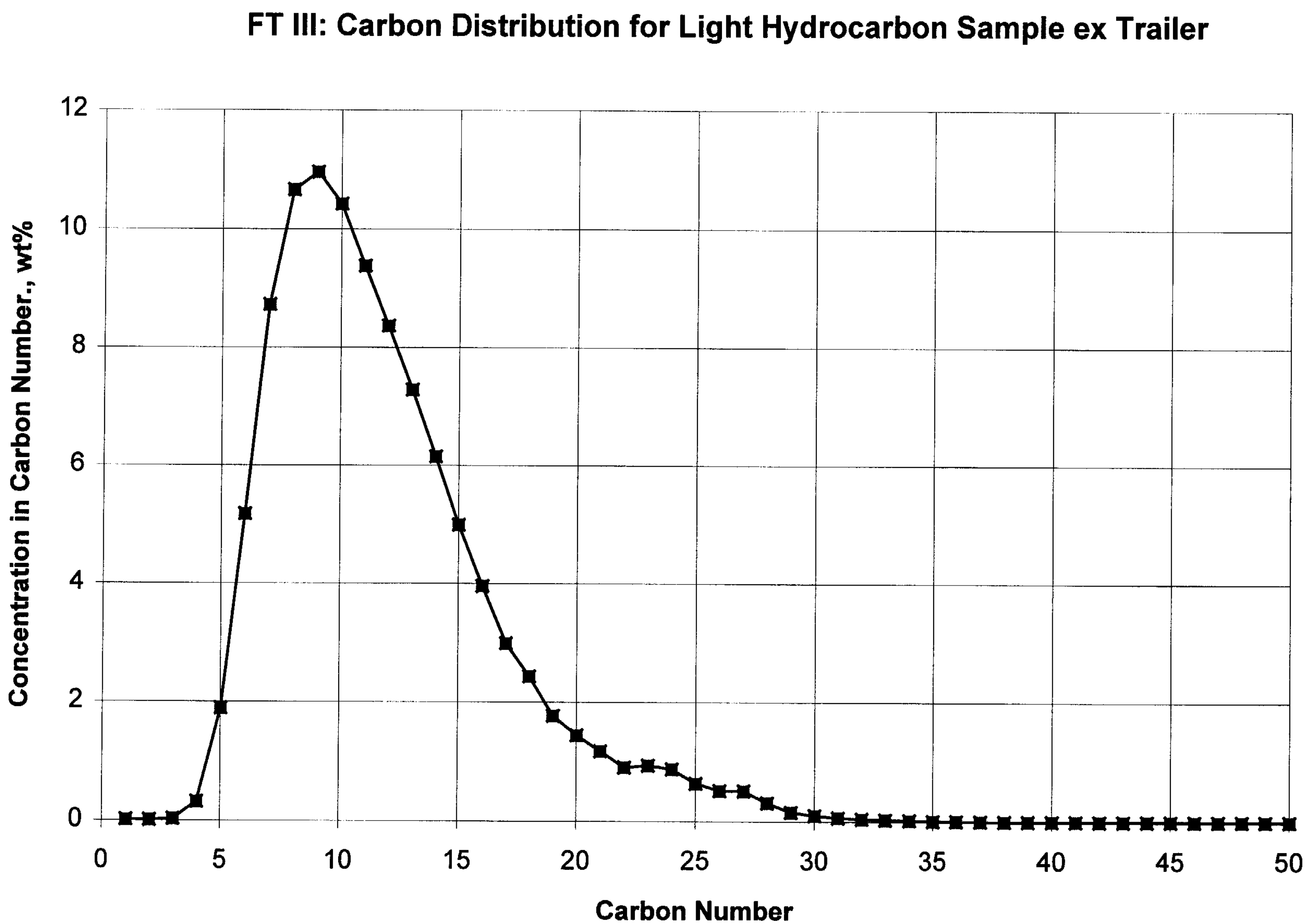
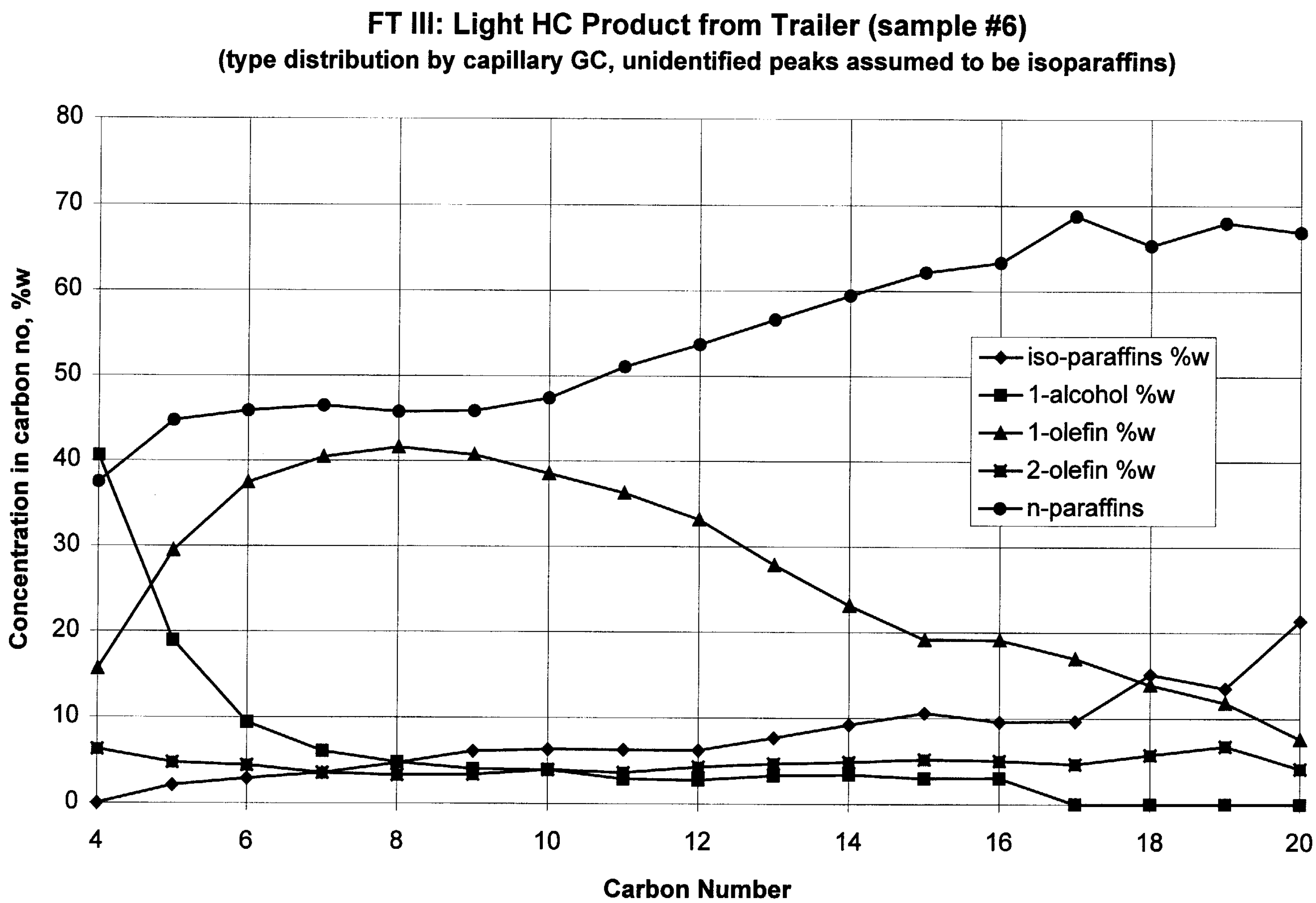

FT III: Carbon Distribution for Light Hydrocarbon Sample ex Trailer
12
10
8
6
4
2
0
0
5
10
15
20
25
30
35
40
45
50
Concentration in Carbon Number., wt%
Carbon Number

FIGURE 18



FT III: Light HC Product from Trailer (sample #6)
(type distribution by capillary GC, unidentified peaks assumed to be isoparaffins)
80
70
60
50
40
30
20
10
0
Concentration in carbon no, %w
4
6
8
10
12
14
16
18
20
Carbon Number
iso-paraffins %w
1-alcohol %w
1-olefin %w
2-olefin %w
n-paraffins

FIGURE 19

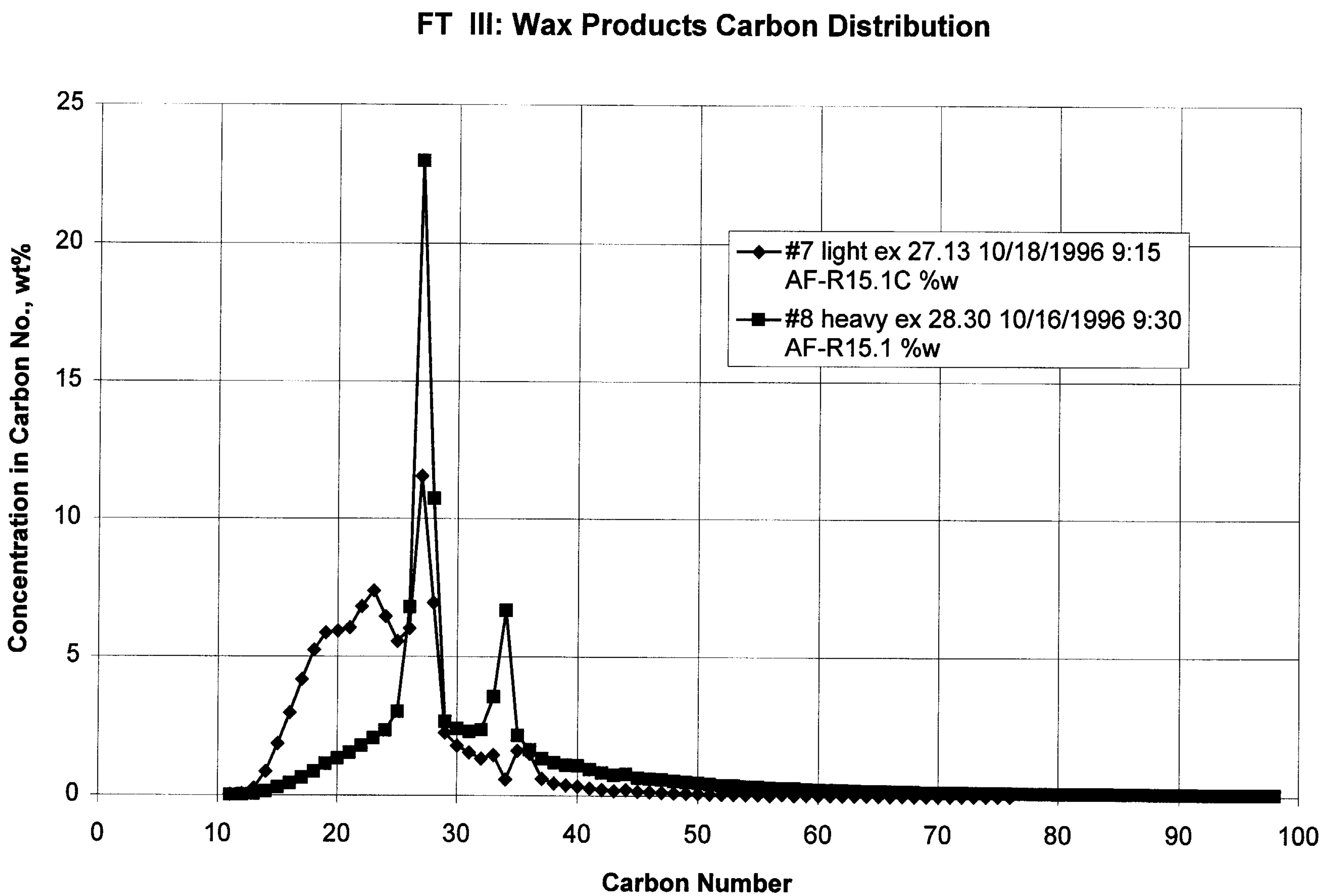
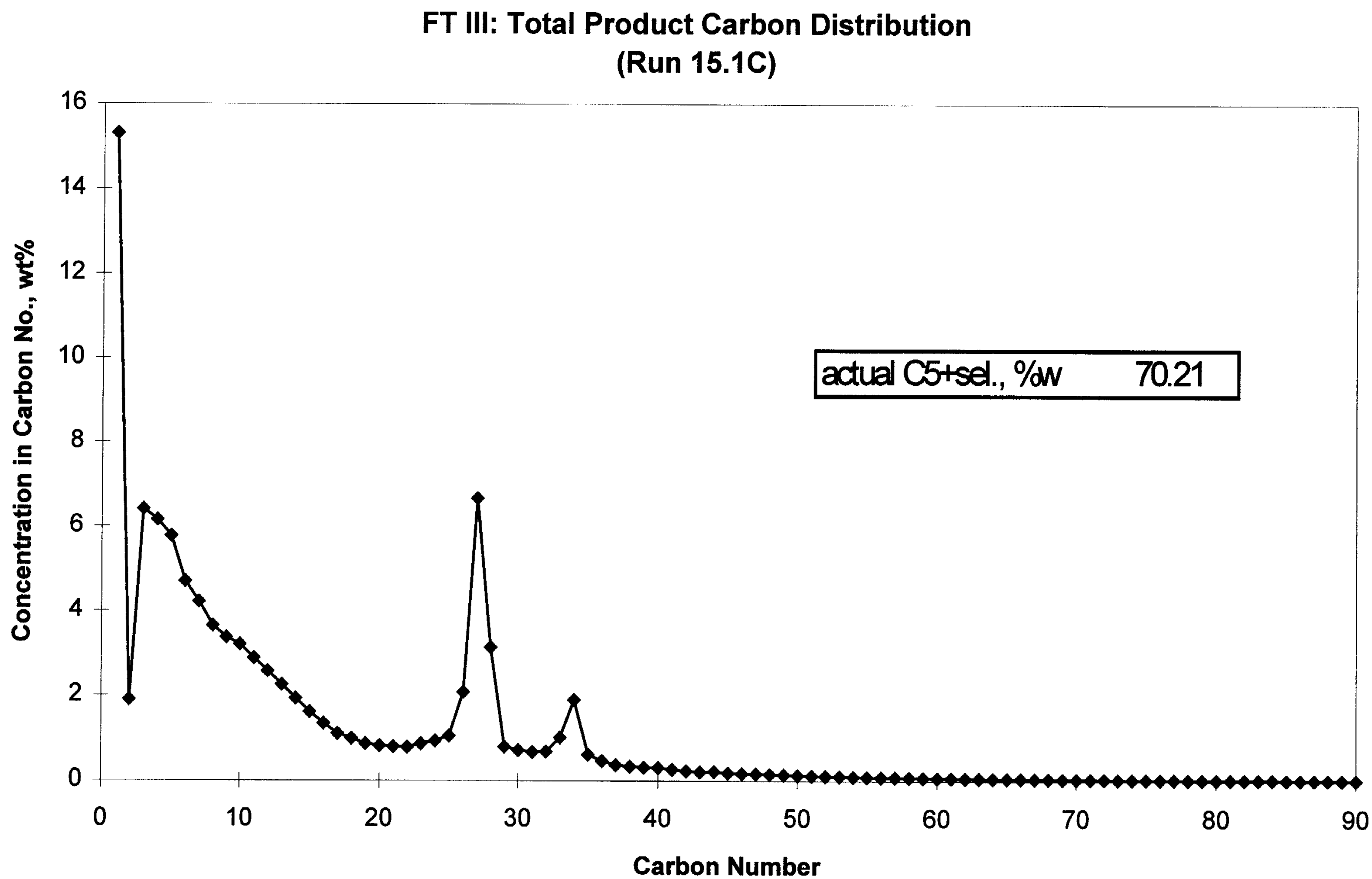

FT III: Wax Products Carbon Distribution
Concentration in Carbon No., wt%
25
20
15
10
5
0
0
10
20
30
40
50
60
70
80
90
100
Carbon Number
#7 light ex 27.13 10/18/1996 9:15 AF-R15.1C %w
#8 heavy ex 28.30 10/16/1996 9:30 AF-R15.1 %w

FIGURE 20



FT III: Total Product Carbon Distribution
(Run 15.1C)
16
14
12
10
8
6
4
2
0
Concentration in Carbon No., wt%
actual C5+sel., %w 70.21
0
10
20
30
40
50
60
70
80
90
Carbon Number

FIGURE 21

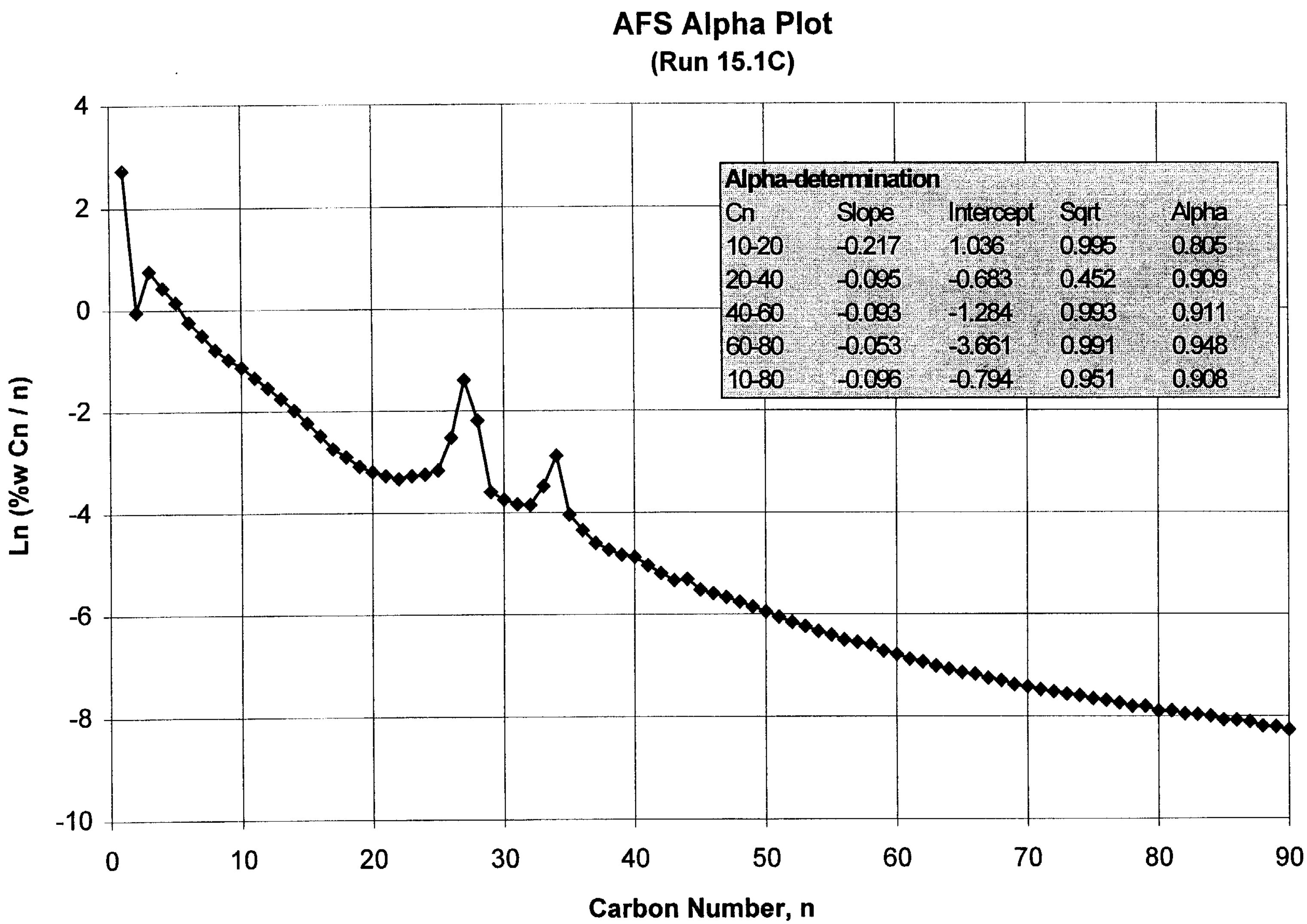
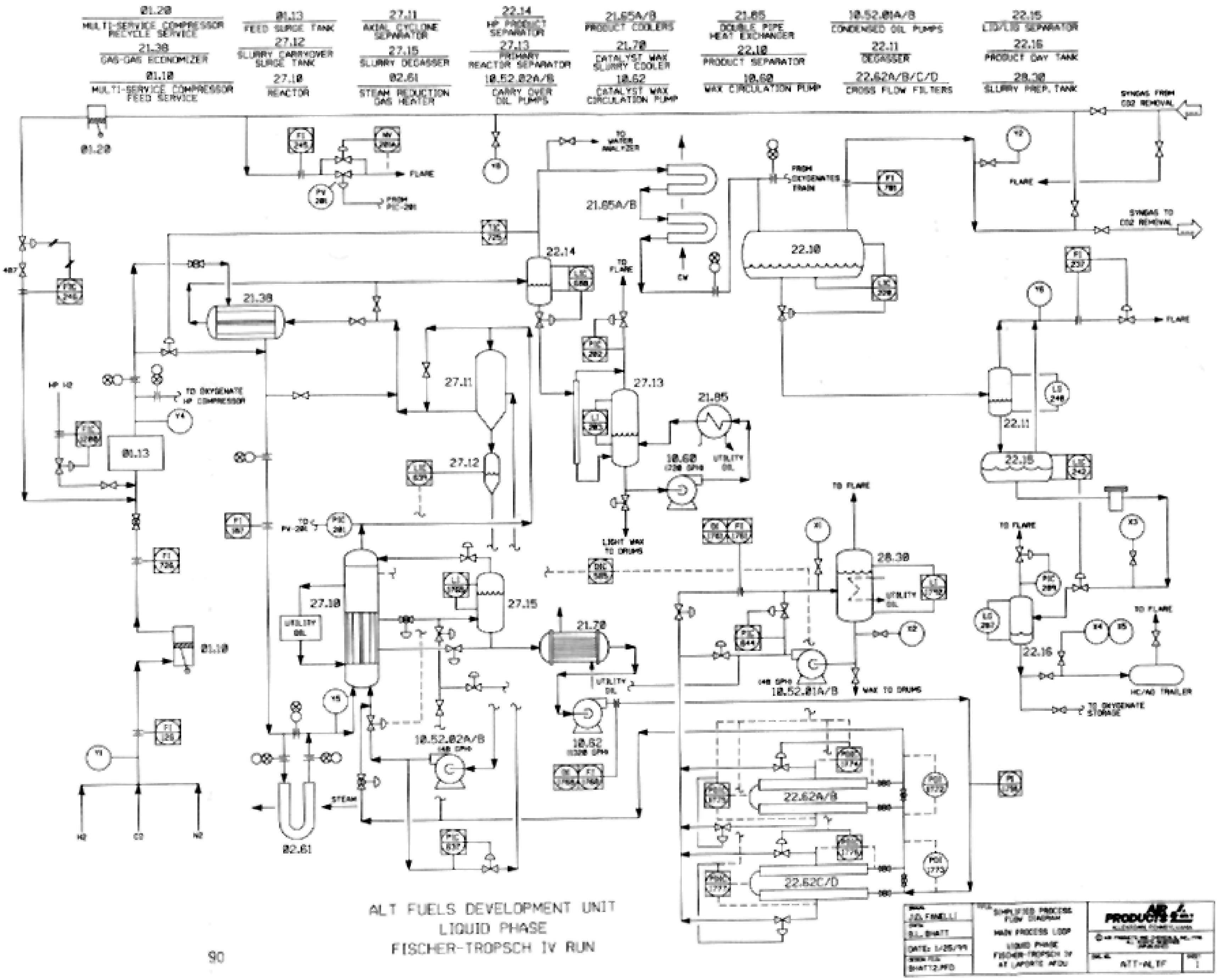
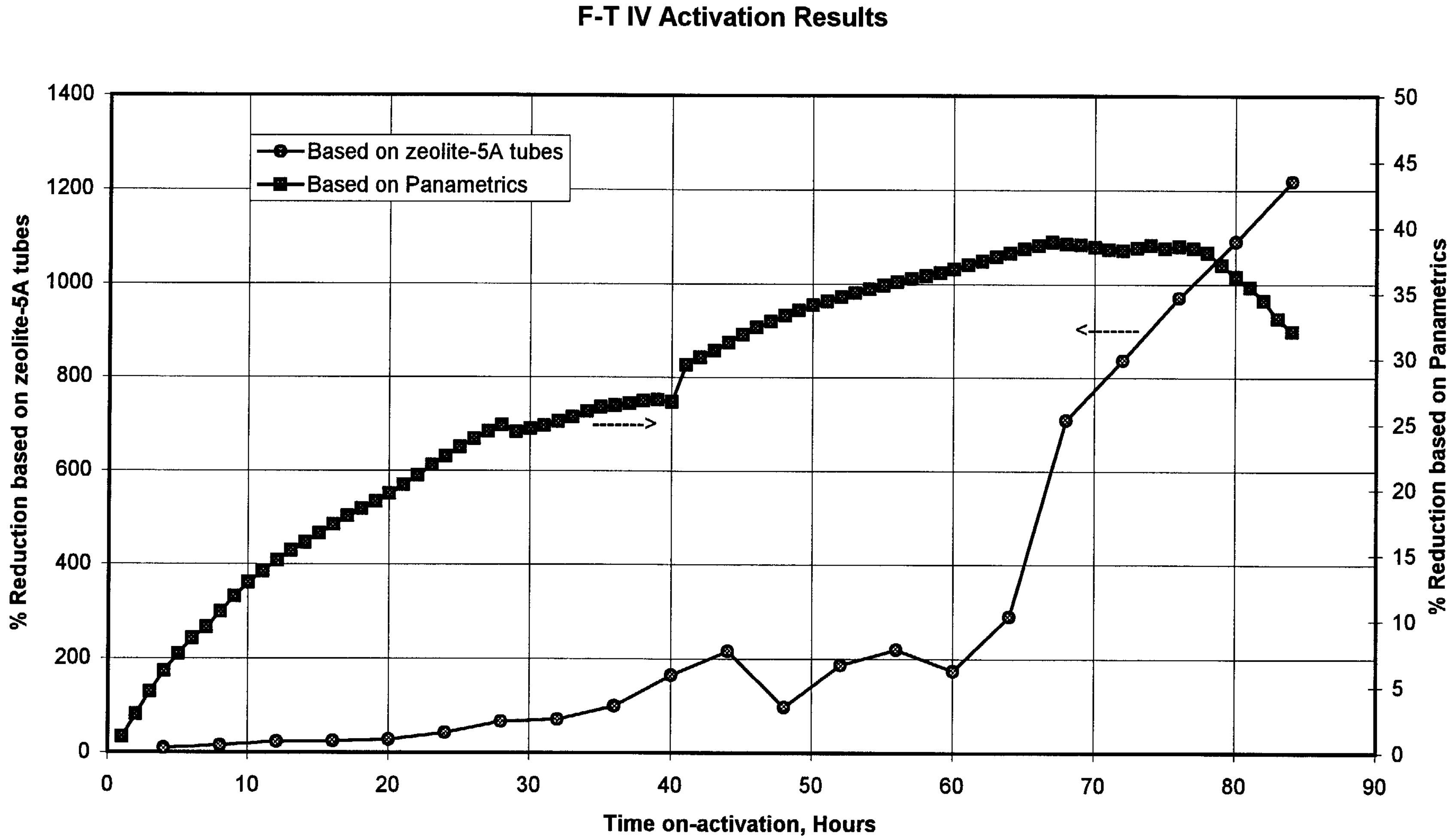

AFS Alpha Plot
(Run 15.1C)
Alpha-determination
Cn Slope Intercept Sqrt Alpha
10-20 -0.217 1.036 0.995 0.805
20-40 -0.095 -0.683 0.452 0.909
40-60 -0.093 -1.284 0.993 0.911
60-80 -0.053 -3.661 0.991 0.948
10-80 -0.096 -0.794 0.951 0.908
Ln (%w Cn / n)
4
2
0
-2
-4
-6
-8
-10
0
10
20
30
40
50
60
70
80
90
Carbon Number, n

Figure 22



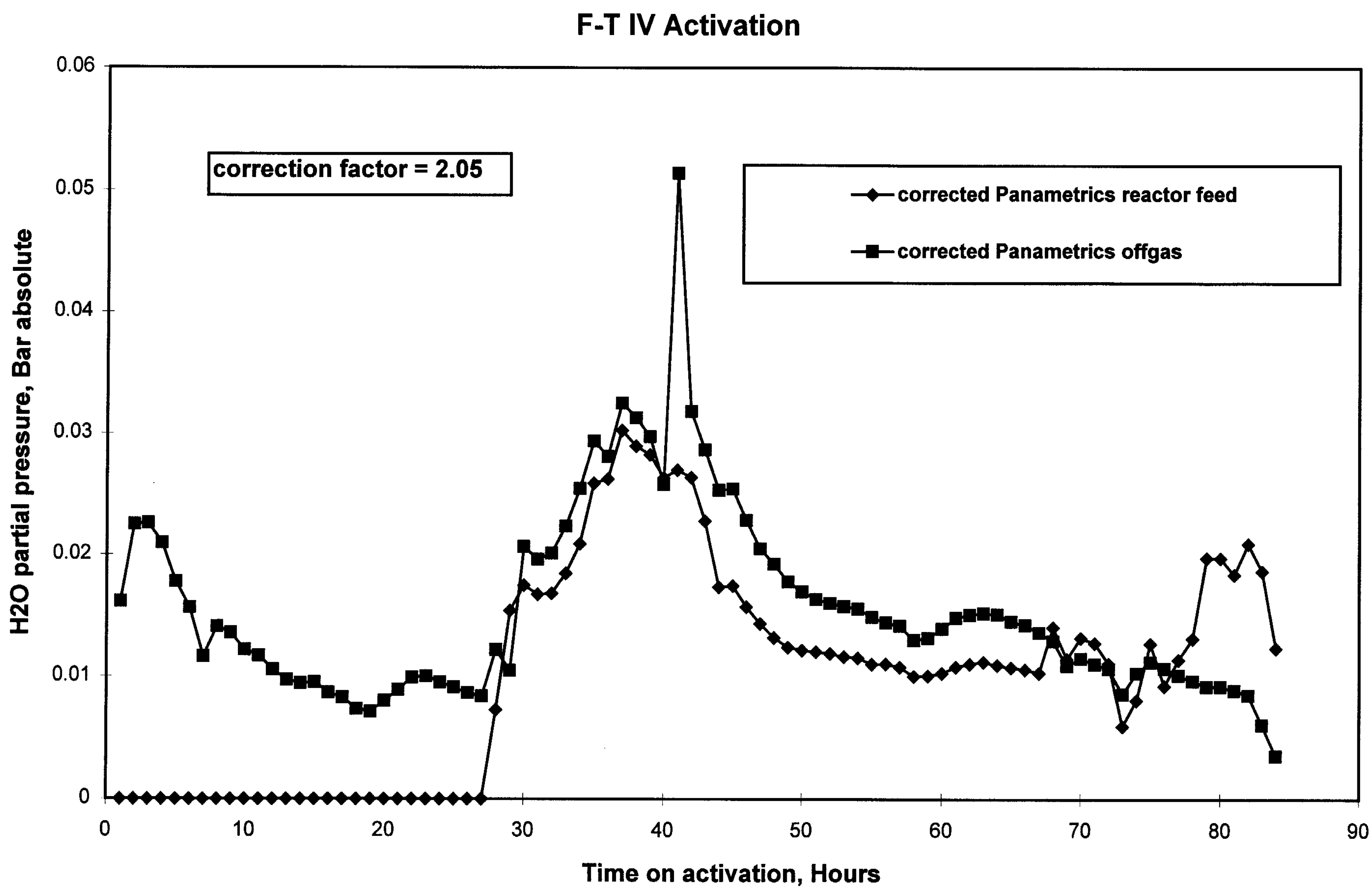
ALT FUELS DEVELOPMENT UNIT
LIQUID PHASE
FISCHER-TROPSCH IV RUN

FIGURE 23



F-T IV Activation Results
Based on zeolite-5A tubes
Based on Panametrics
% Reduction based on zeolite-5A tubes
% Reduction based on Panametrics
Time on-activation, Hours
0
200
400
600
800
1000
1200
1400
0
5
10
15
20
25
30
35
40
45
50
0
10
20
30
40
50
60
70
80
90

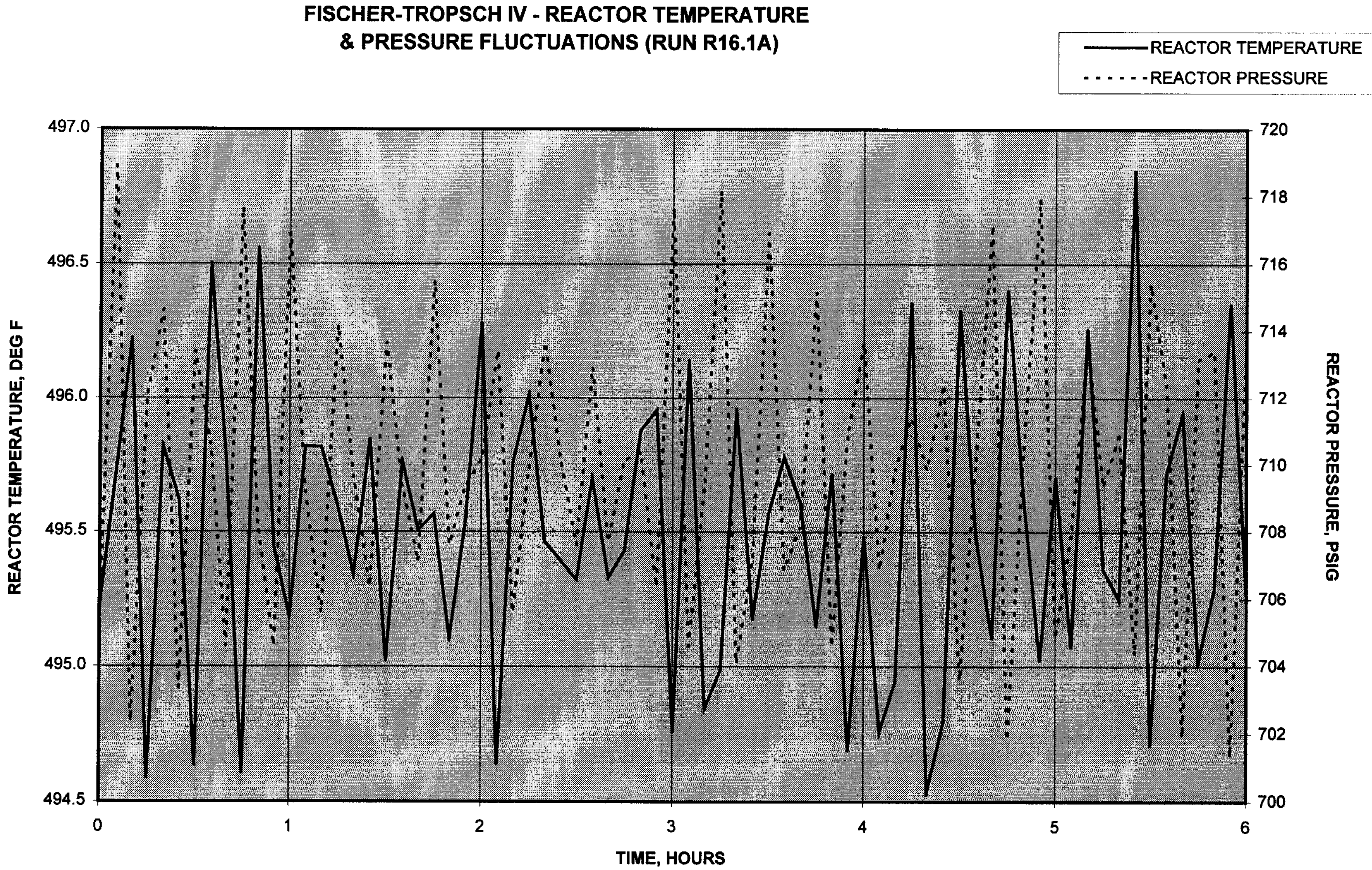
FIGURE 24



Ft4_red2.xlw

BLB 2/5/1999

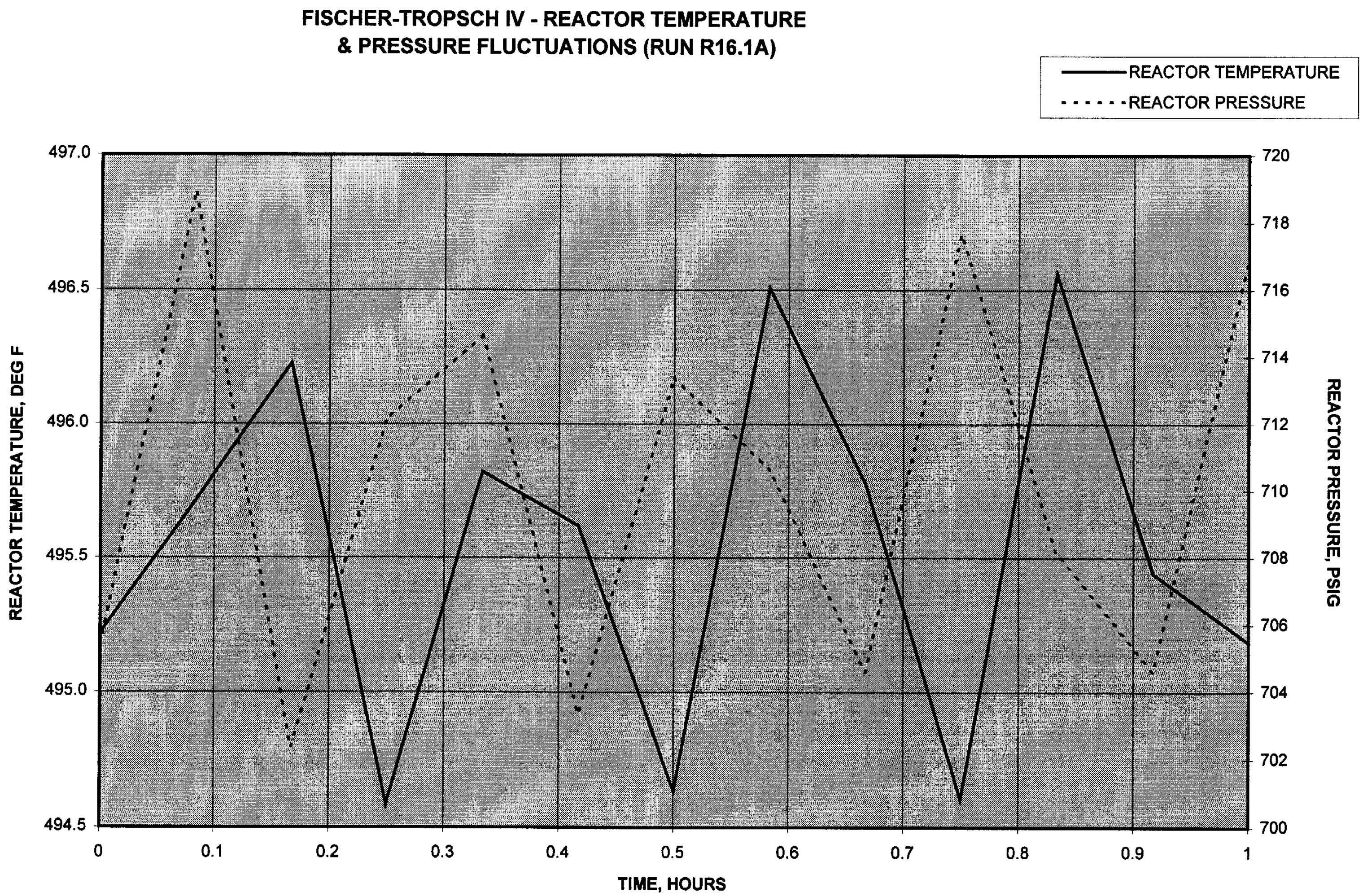
FIGURE 25



R161IA Chart 1

BLB 2/5/1999

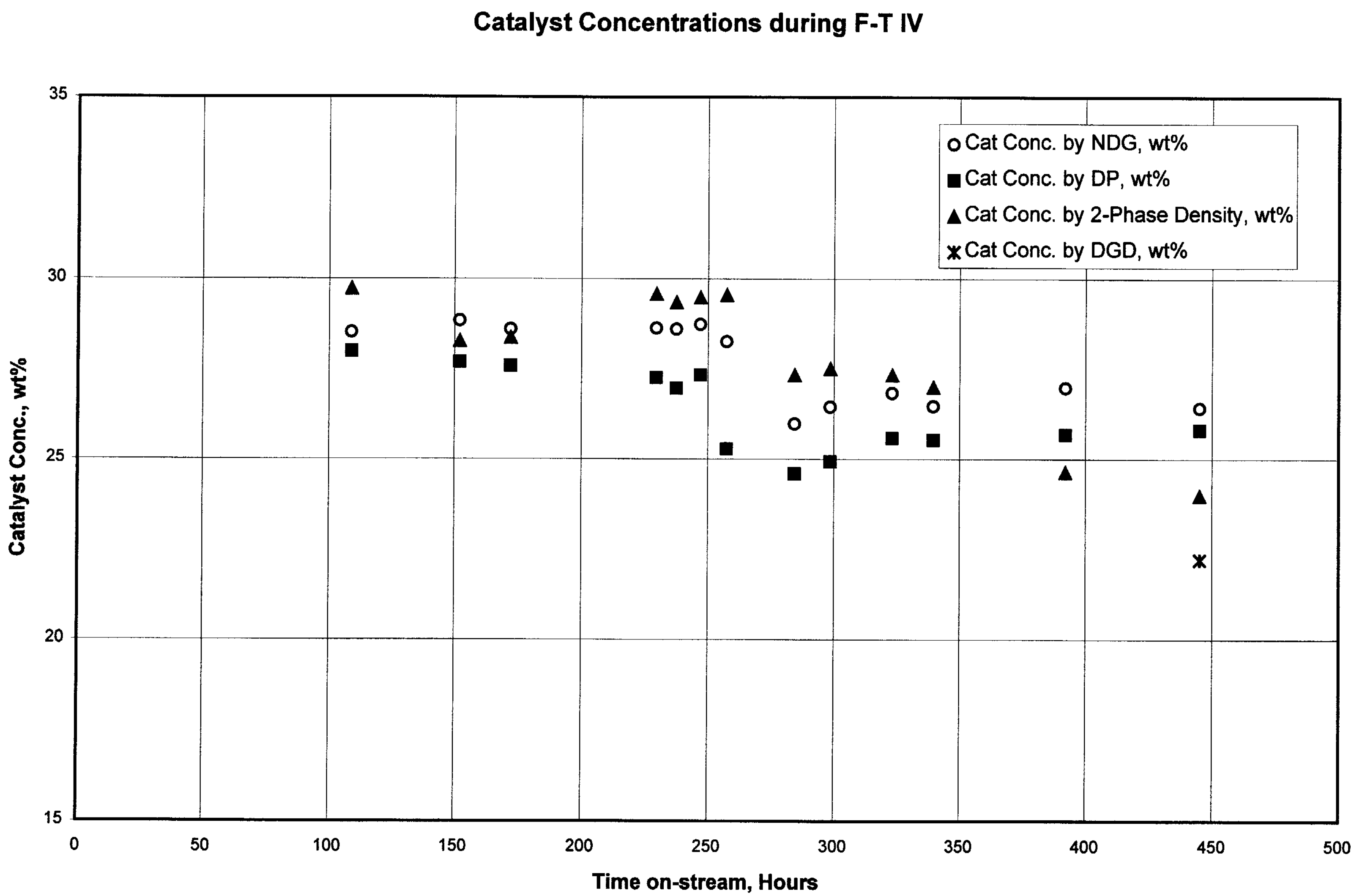
FIGURE 26



R161IA Chart 2

BLB 2/5/1999

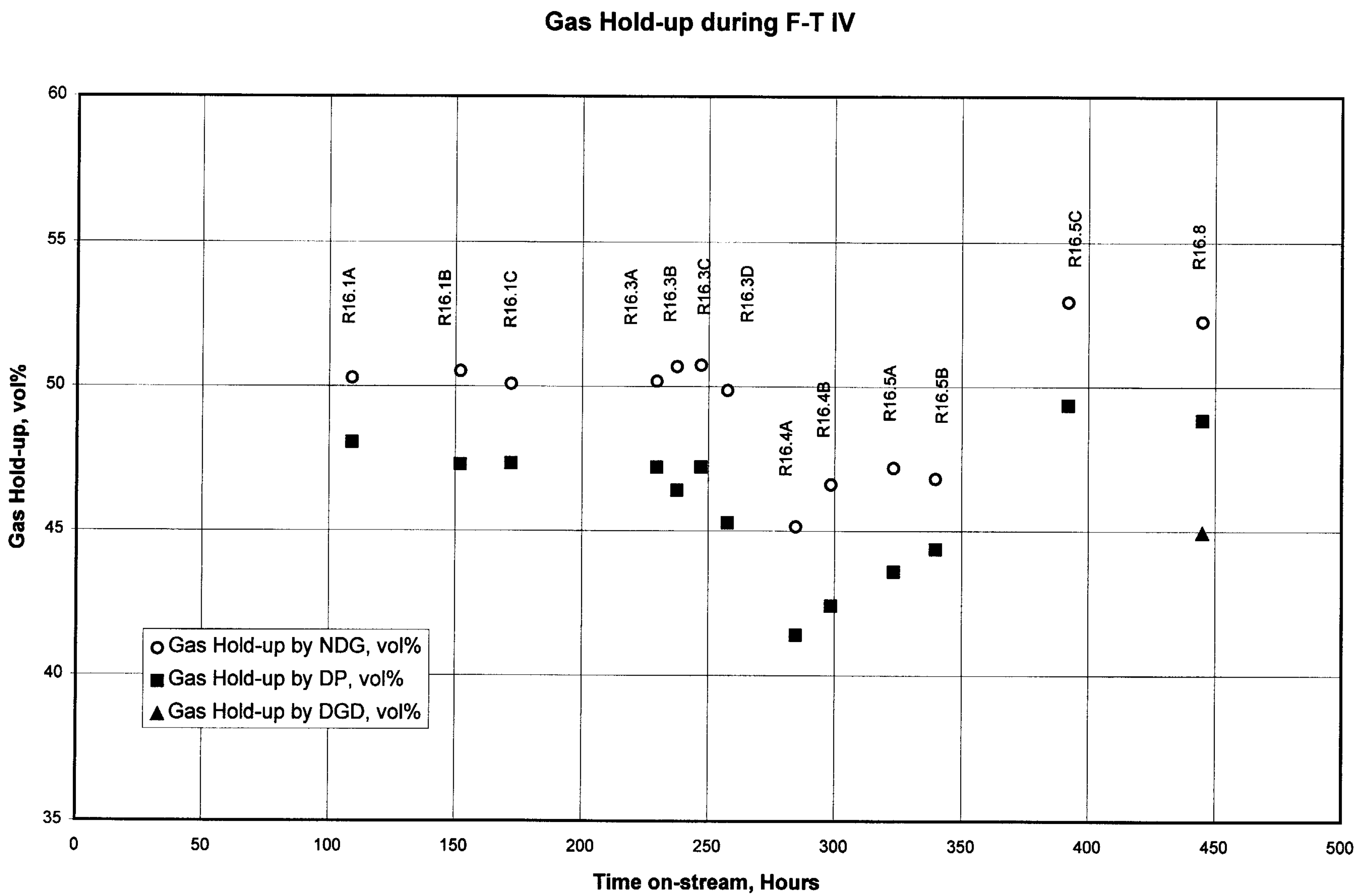
FIGURE 27



catconc3.xls Chart 1

BLB 2/5/1999

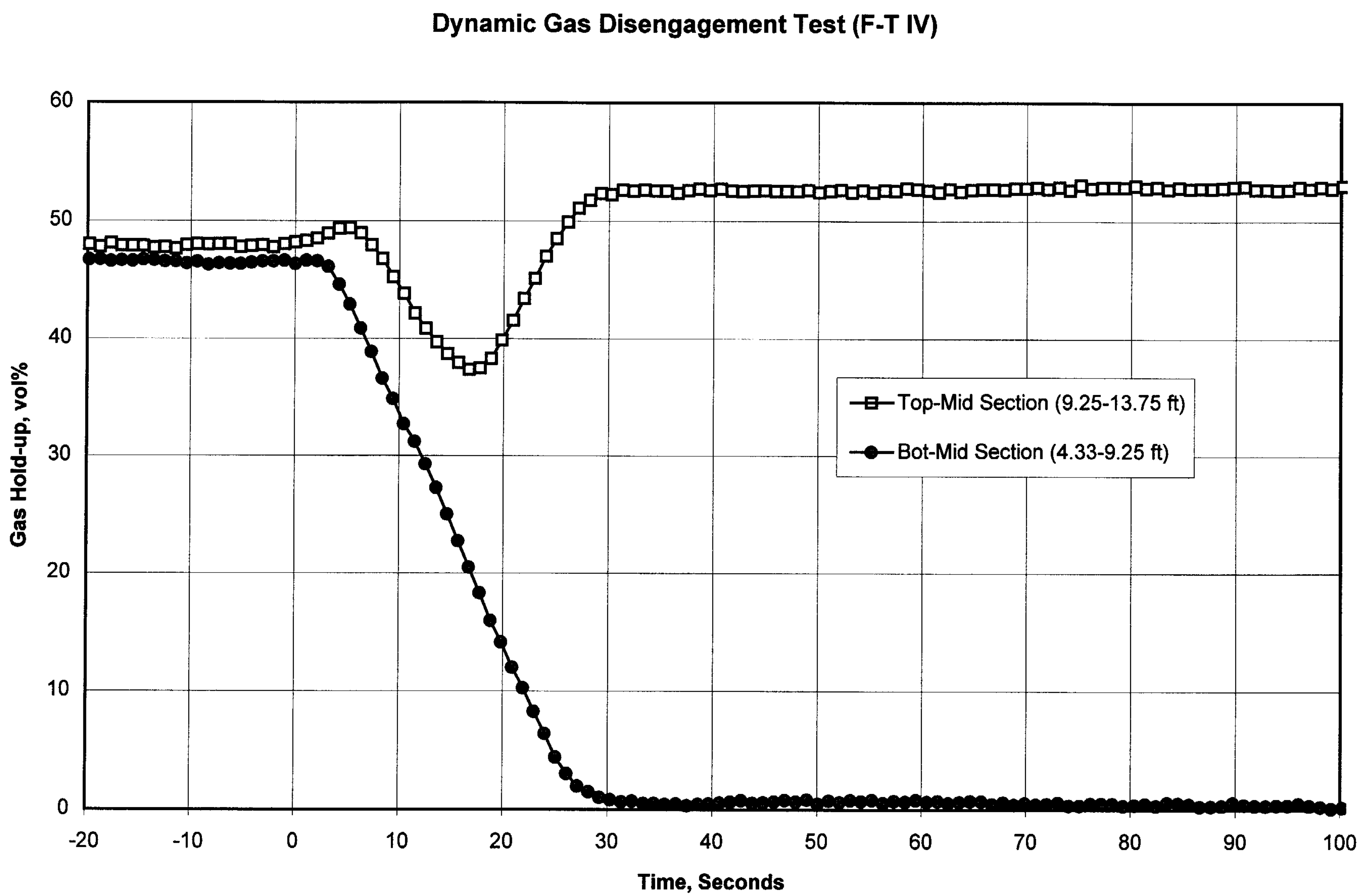
FIGURE 28



catconc3.xls Chart 2

BLB 2/5/1999

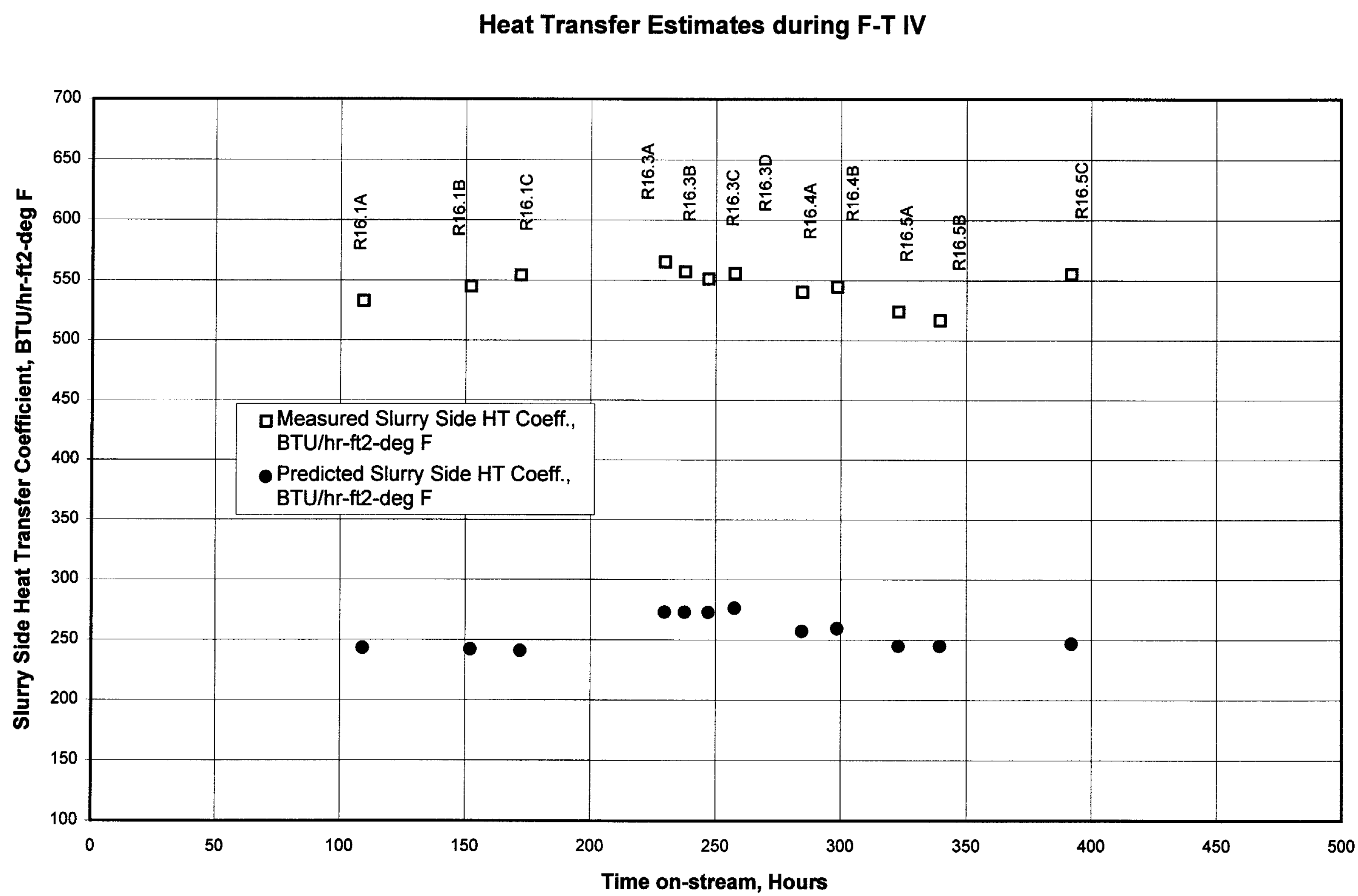
FIGURE 29



ft4sdt03.xls Chart 1

BLB 2/5/1999

FIGURE 30



httrft42.xls Chart 1 BLB 2/5/1999

FIGURE 31

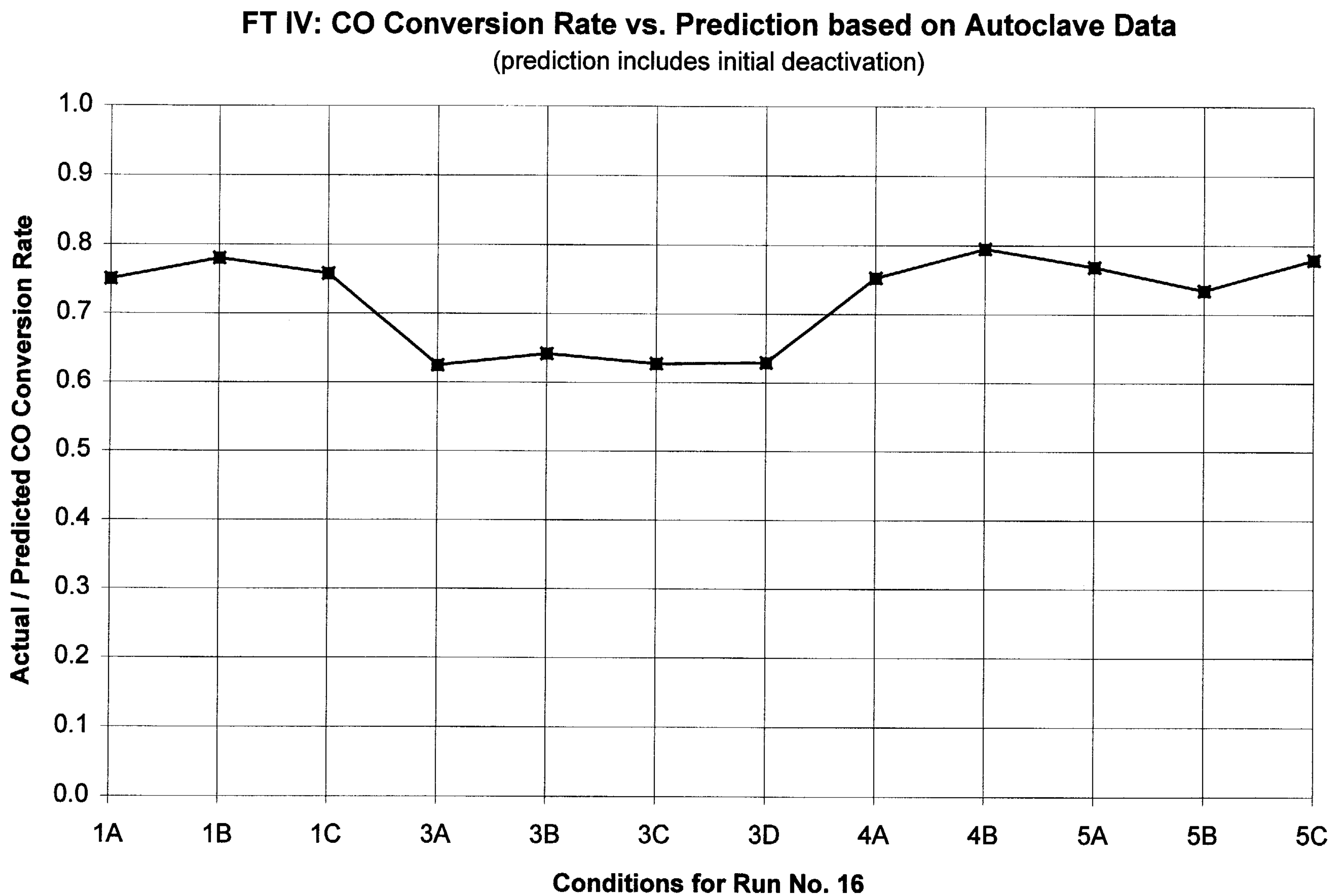
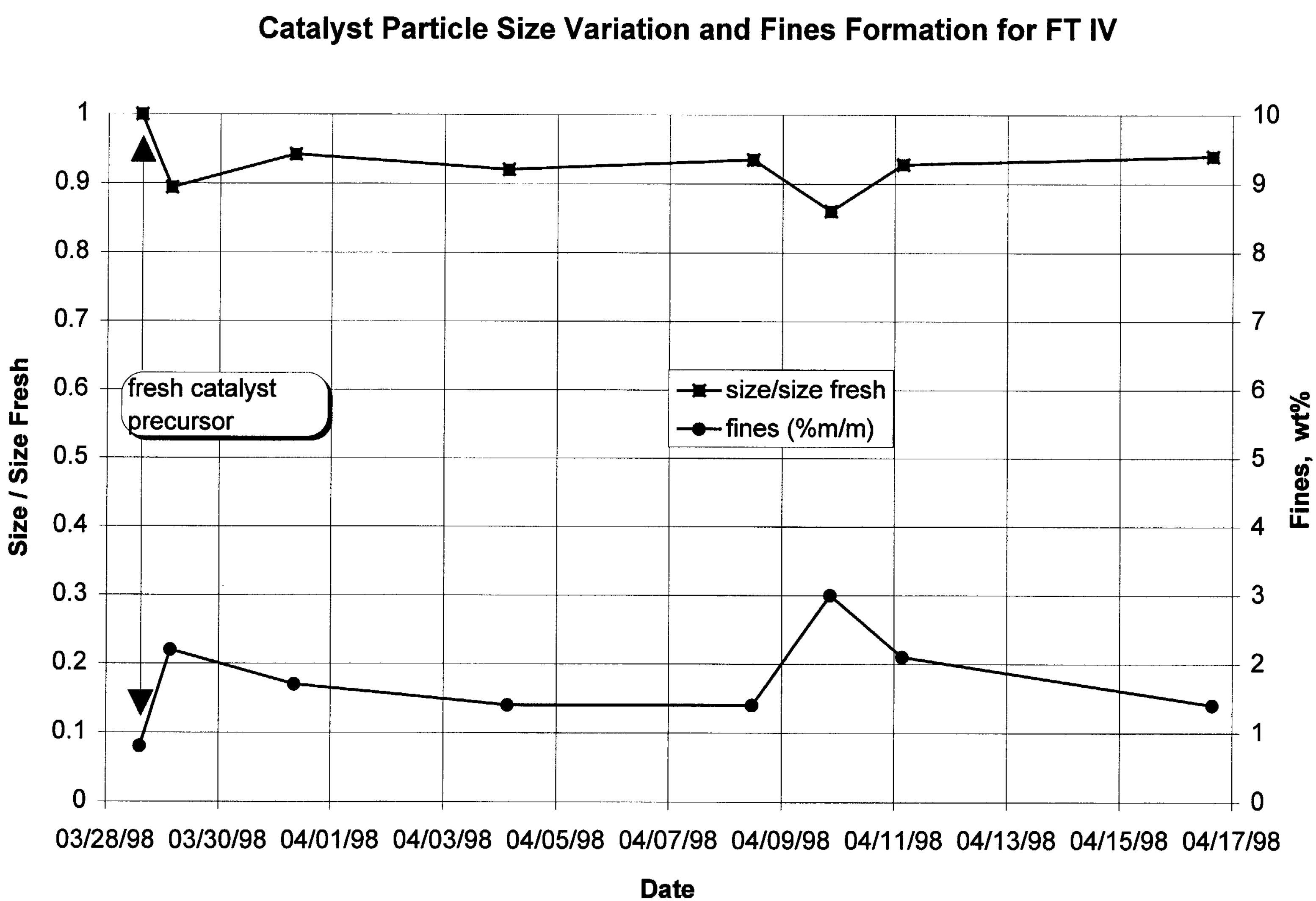

FT IV: CO Conversion Rate vs. Prediction based on Autoclave Data
(prediction includes initial deactivation)
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
Actual / Predicted CO Conversion Rate
1A
1B
1C
3A
3B
3C
3D
4A
4B
5A
5B
5C
Conditions for Run No. 16

FIGURE 32



FT4SSFIA2.xls

BLB 2/8/1999

FIGURE 33

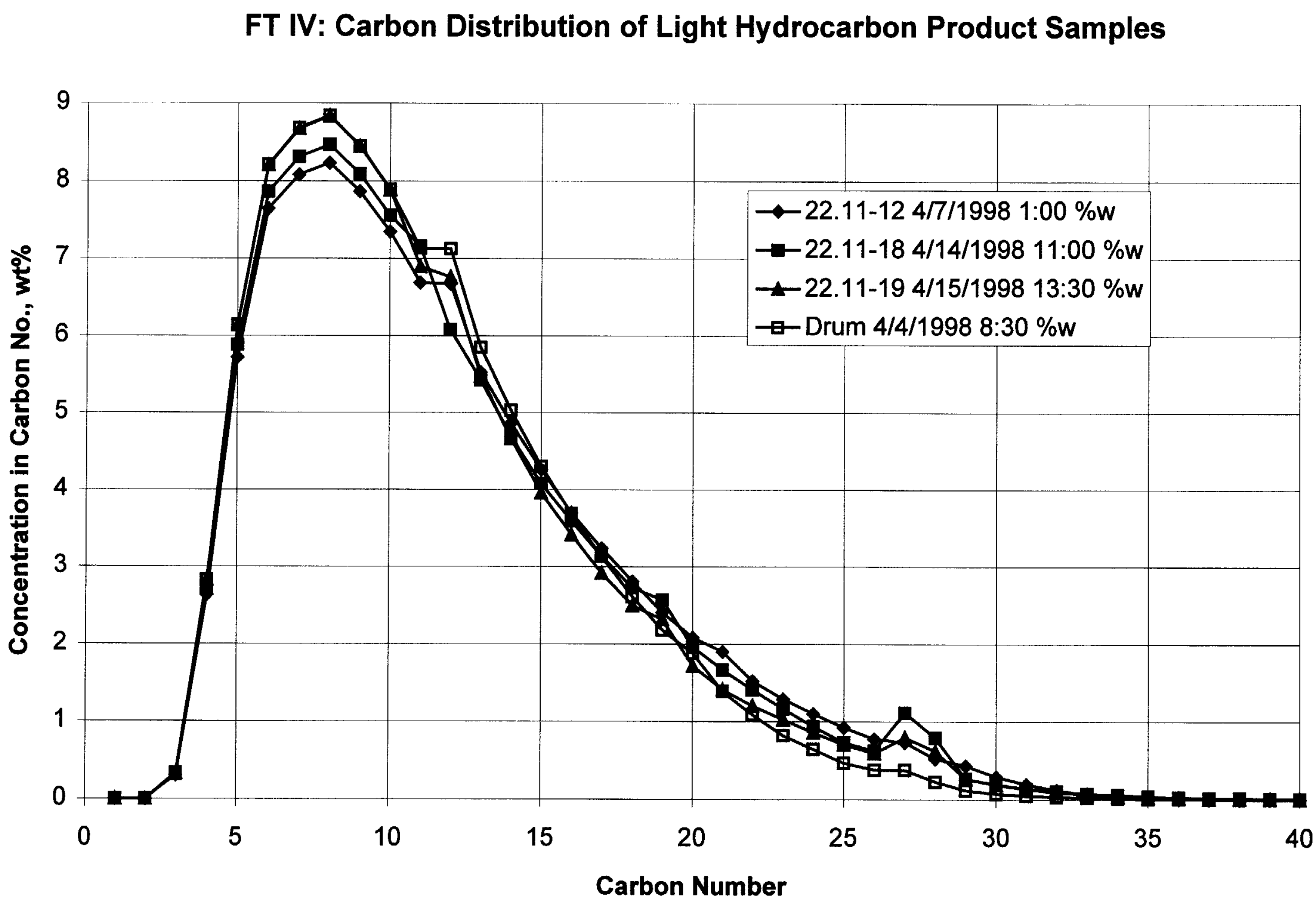
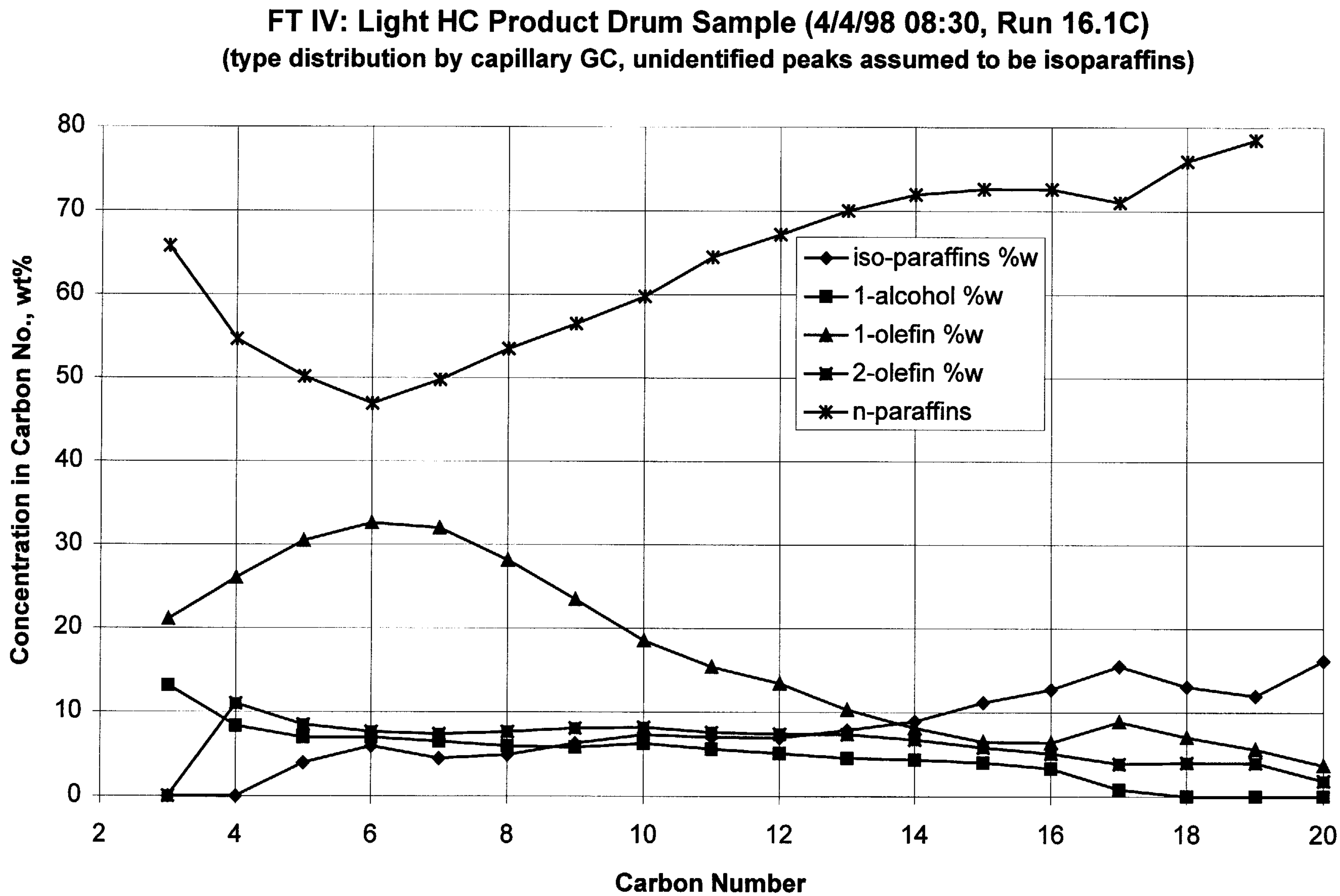
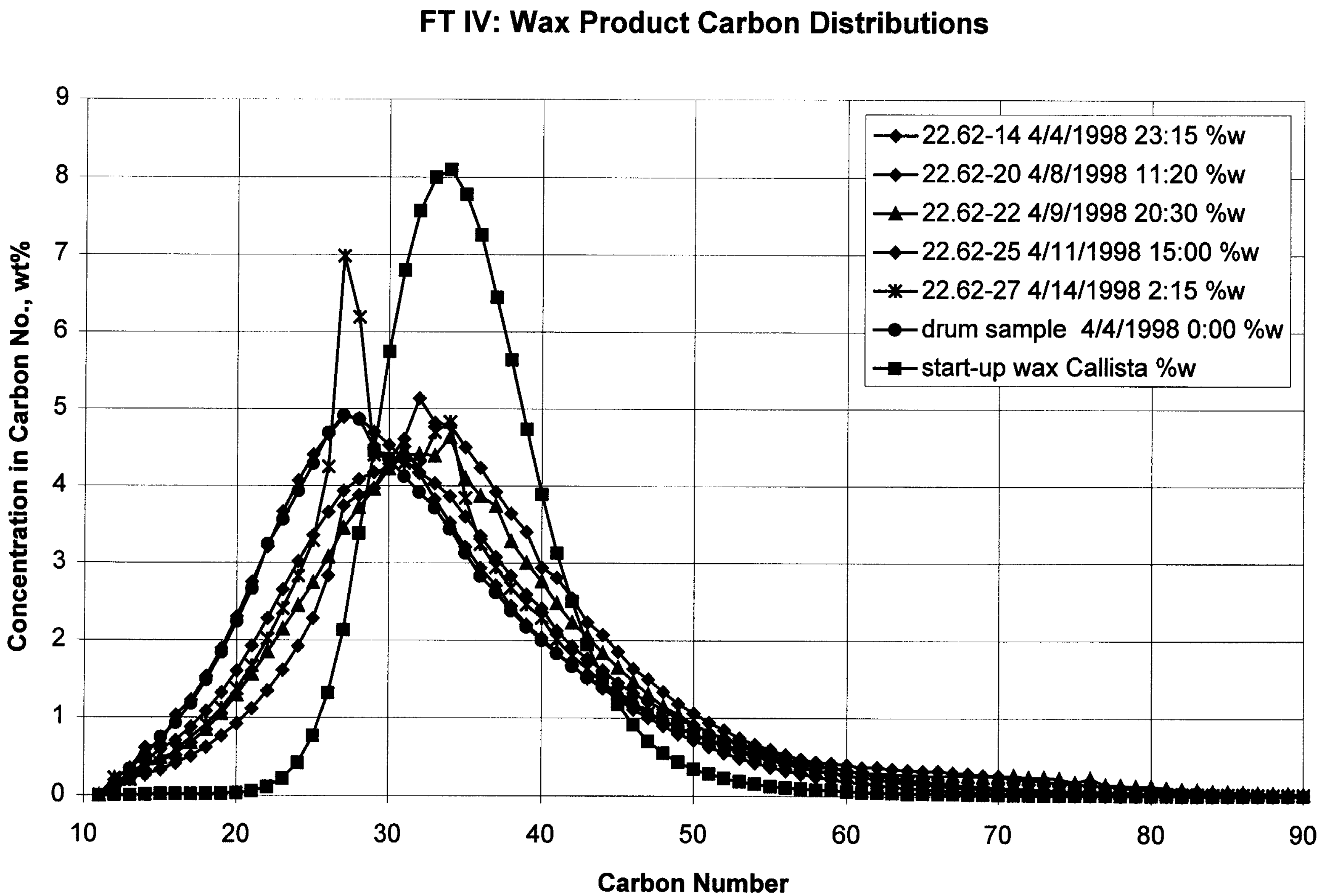

FT IV: Carbon Distribution of Light Hydrocarbon Product Samples
Concentration in Carbon No., wt%
Carbon Number
22.11-12 4/7/1998 1:00 %w
22.11-18 4/14/1998 11:00 %w
22.11-19 4/15/1998 13:30 %w
Drum 4/4/1998 8:30 %w
0
1
2
3
4
5
6
7
8
9
0
5
10
15
20
25
30
35
40

FIGURE 34



FT IV: Light HC Product Drum Sample (4/4/98 08:30, Run 16.1C)
(type distribution by capillary GC, unidentified peaks assumed to be isoparaffins)
80
70
60
50
40
30
20
10
0
Concentration in Carbon No., wt%
2
4
6
8
10
12
14
16
18
20
Carbon Number
iso-paraffins %w
1-alcohol %w
1-olefin %w
2-olefin %w
n-paraffins

FIGURE 35



FT4SSFIA2.xls

BLB 2/9/1999

FIGURE 36

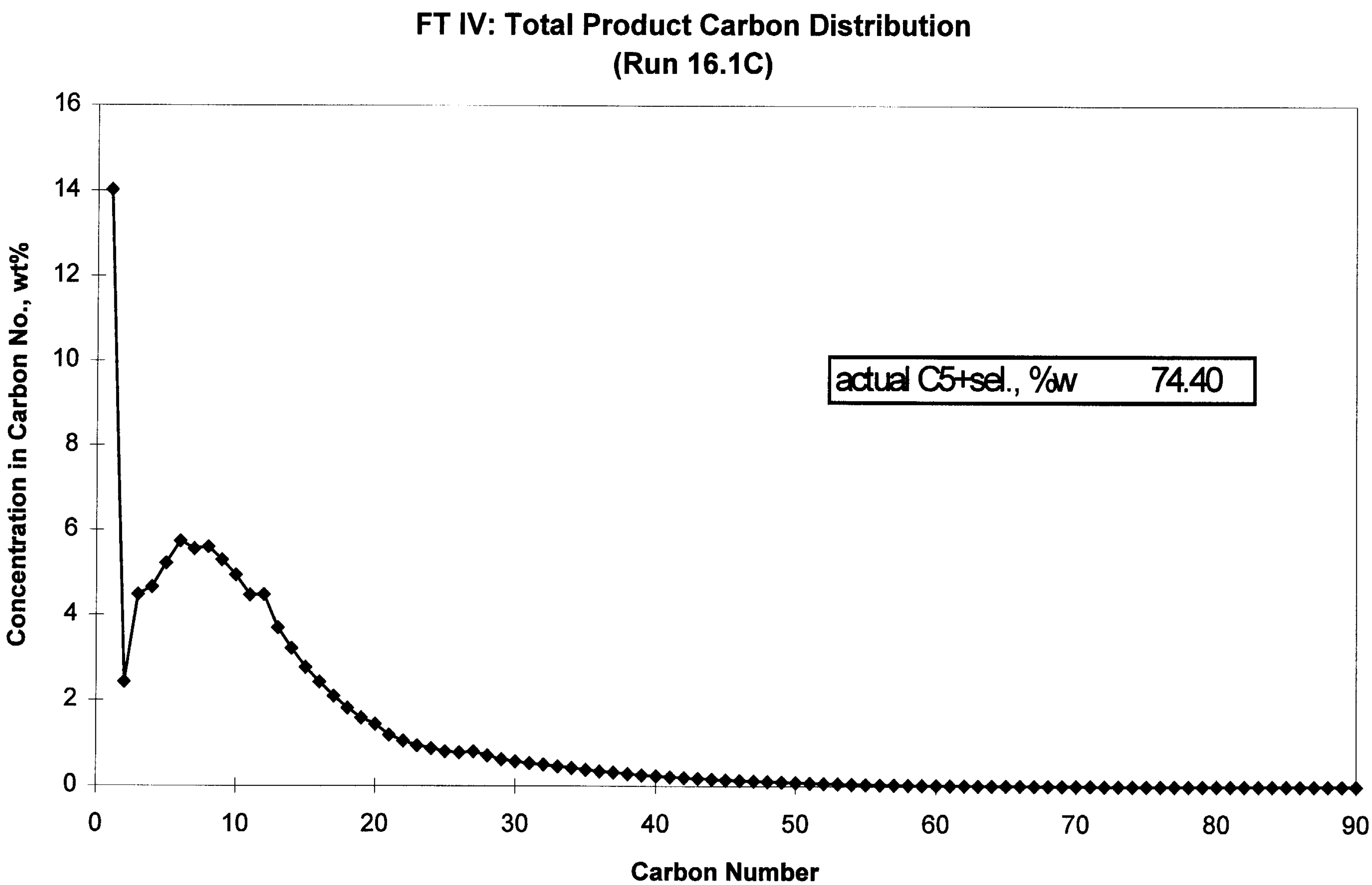
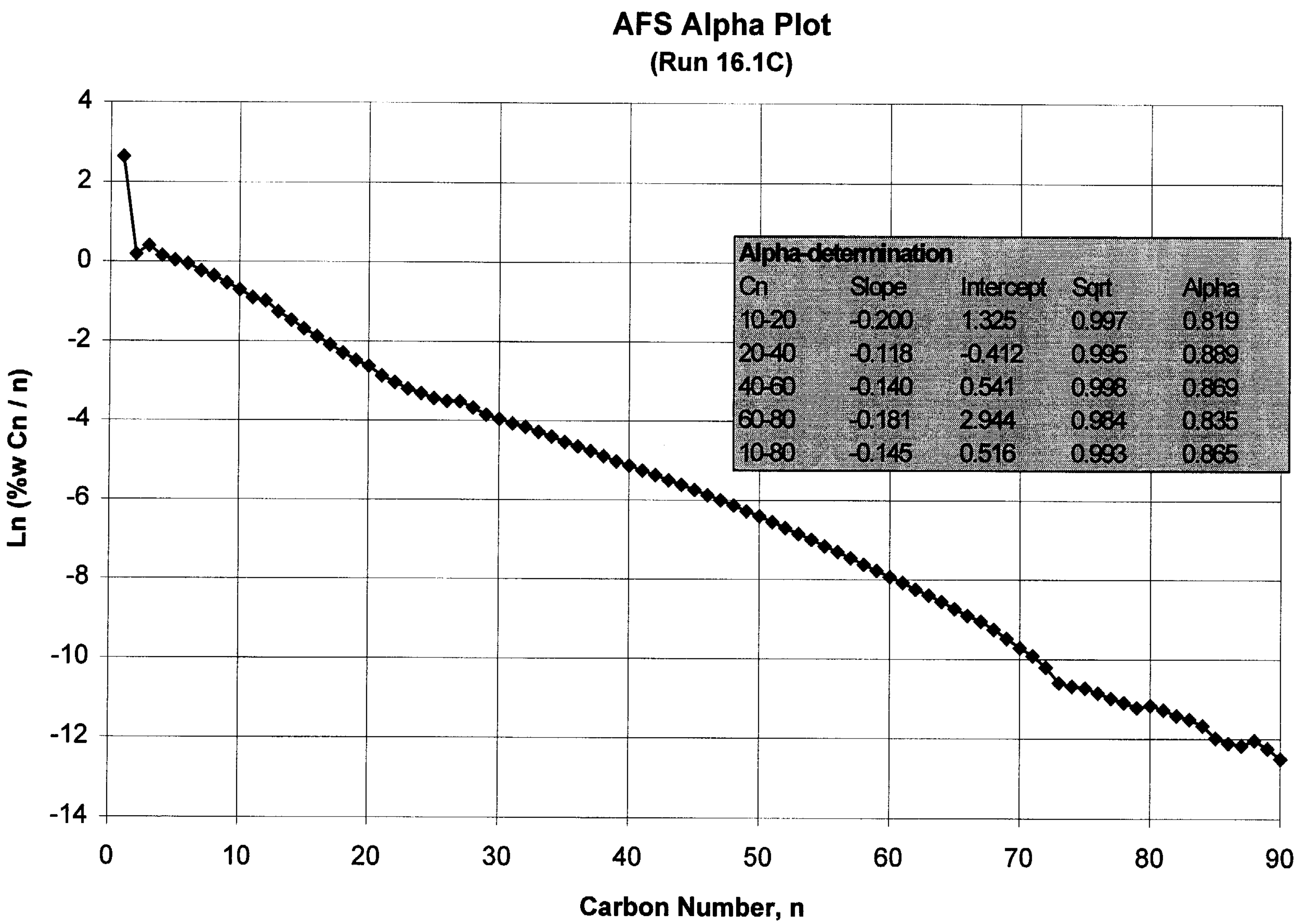

FT IV: Total Product Carbon Distribution
(Run 16.1C)
Concentration in Carbon No., wt%
16
14
12
10
8
6
4
2
0
actual C5+sel., %w 74.40
0
10
20
30
40
50
60
70
80
90
Carbon Number

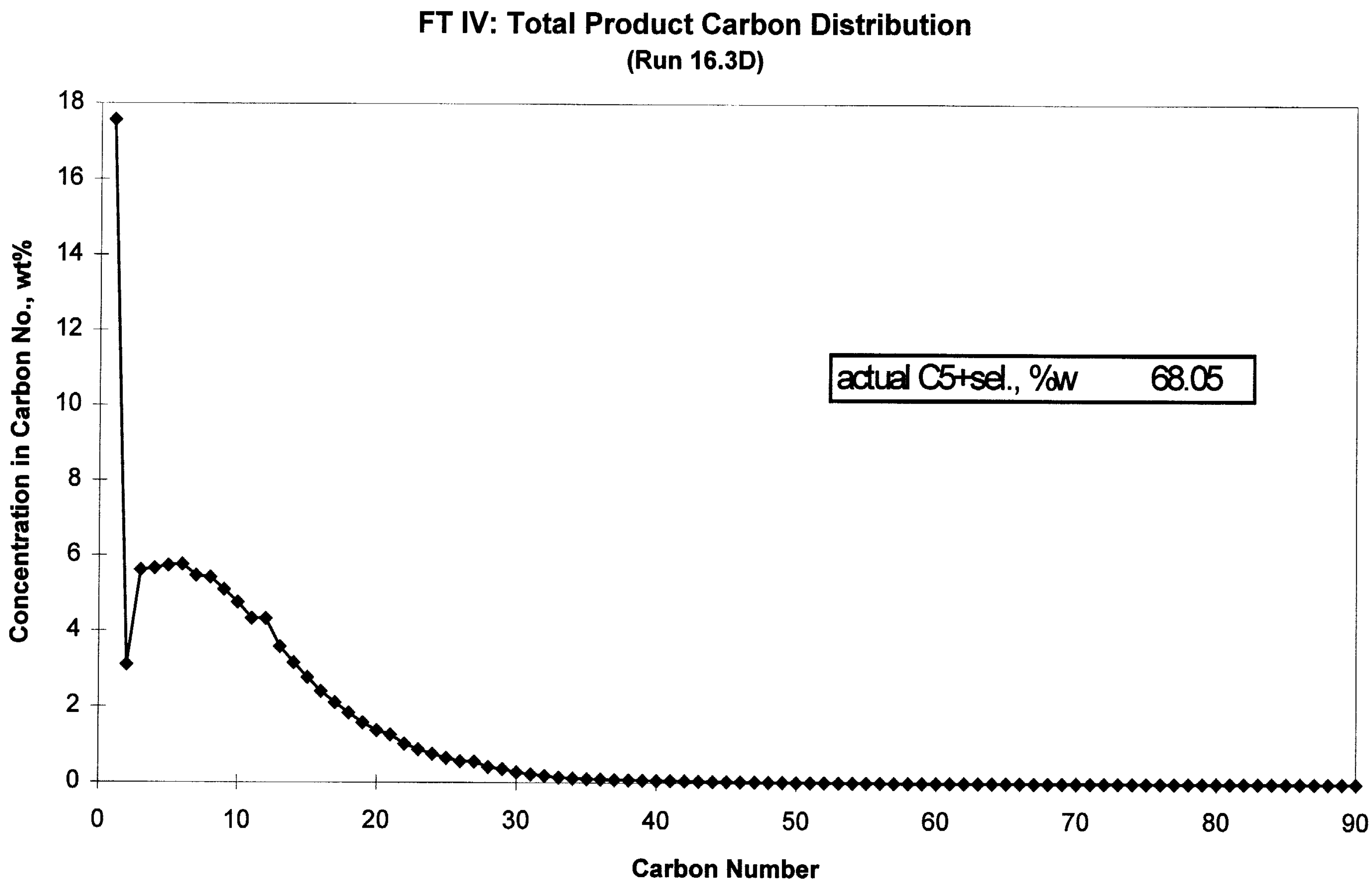
FIGURE 37



Alpha-determination

Cn	Slope	Intercept	Sqrt	Alpha
10-20	-0.200	1.325	0.997	0.819
20-40	-0.118	-0.412	0.995	0.889
40-60	-0.140	0.541	0.998	0.869
60-80	-0.181	2.944	0.984	0.835
10-80	-0.145	0.516	0.993	0.865

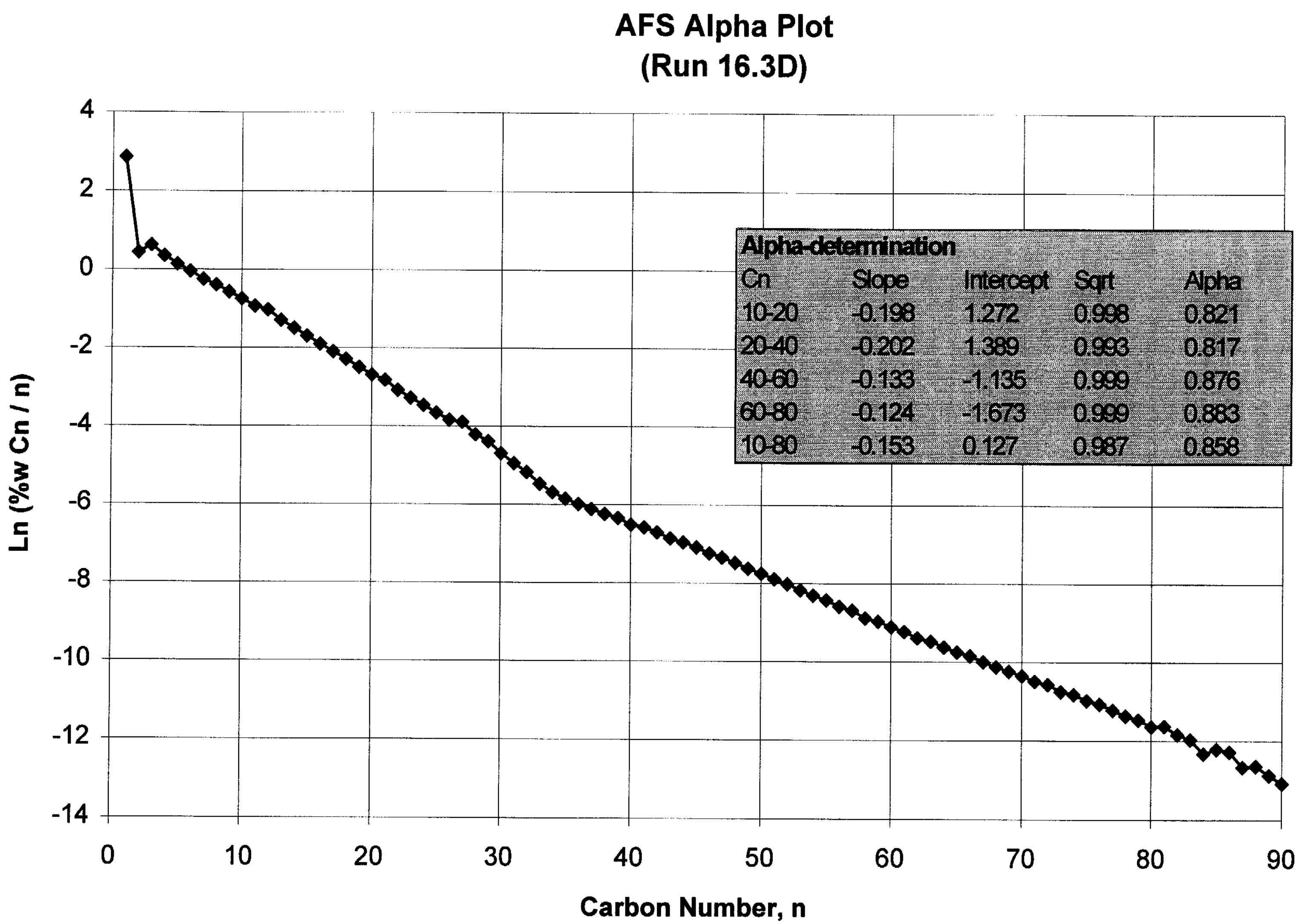
FIGURE 38



FT4SS13.xls

BLB 2/9/1999

FIGURE 39



AFS Alpha Plot
(Run 16.3D)
Ln (%w Cn / n)
Carbon Number, n
4
2
0
-2
-4
-6
-8
-10
-12
-14
0
10
20
30
40
50
60
70
80
90
Alpha-determination
Cn Slope Intercept Sqrt Alpha
10-20 -0.198 1.272 0.998 0.821
20-40 -0.202 1.389 0.993 0.817
40-60 -0.133 -1.135 0.999 0.876
60-80 -0.124 -1.673 0.999 0.883
10-80 -0.153 0.127 0.987 0.858

FIGURE 40

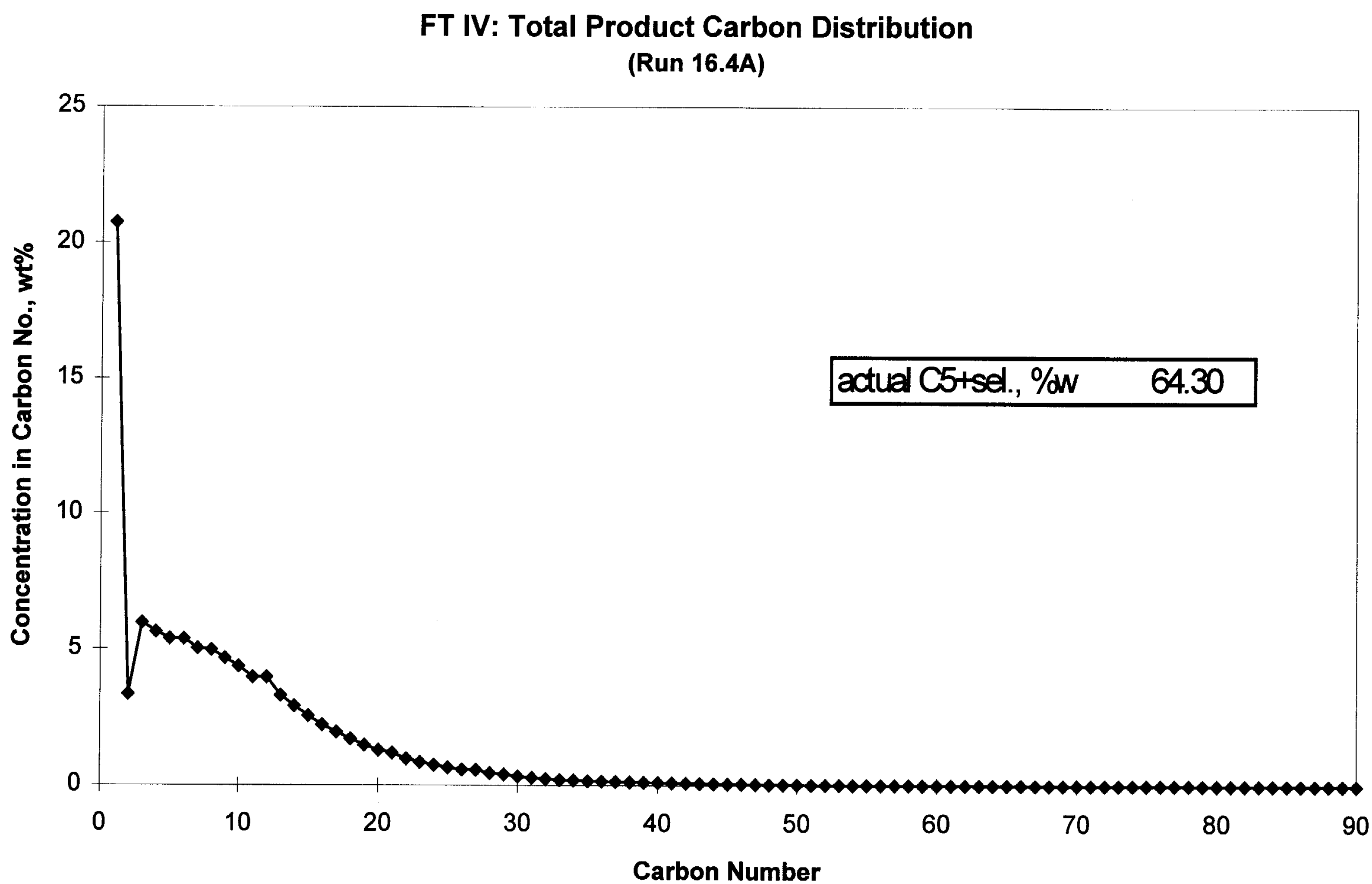

FT IV: Total Product Carbon Distribution
(Run 16.4A)
Concentration in Carbon No., wt%
25
20
15
10
5
0
0
10
20
30
40
50
60
70
80
90
Carbon Number
actual C5+sel., %w 64.30

FIGURE 41

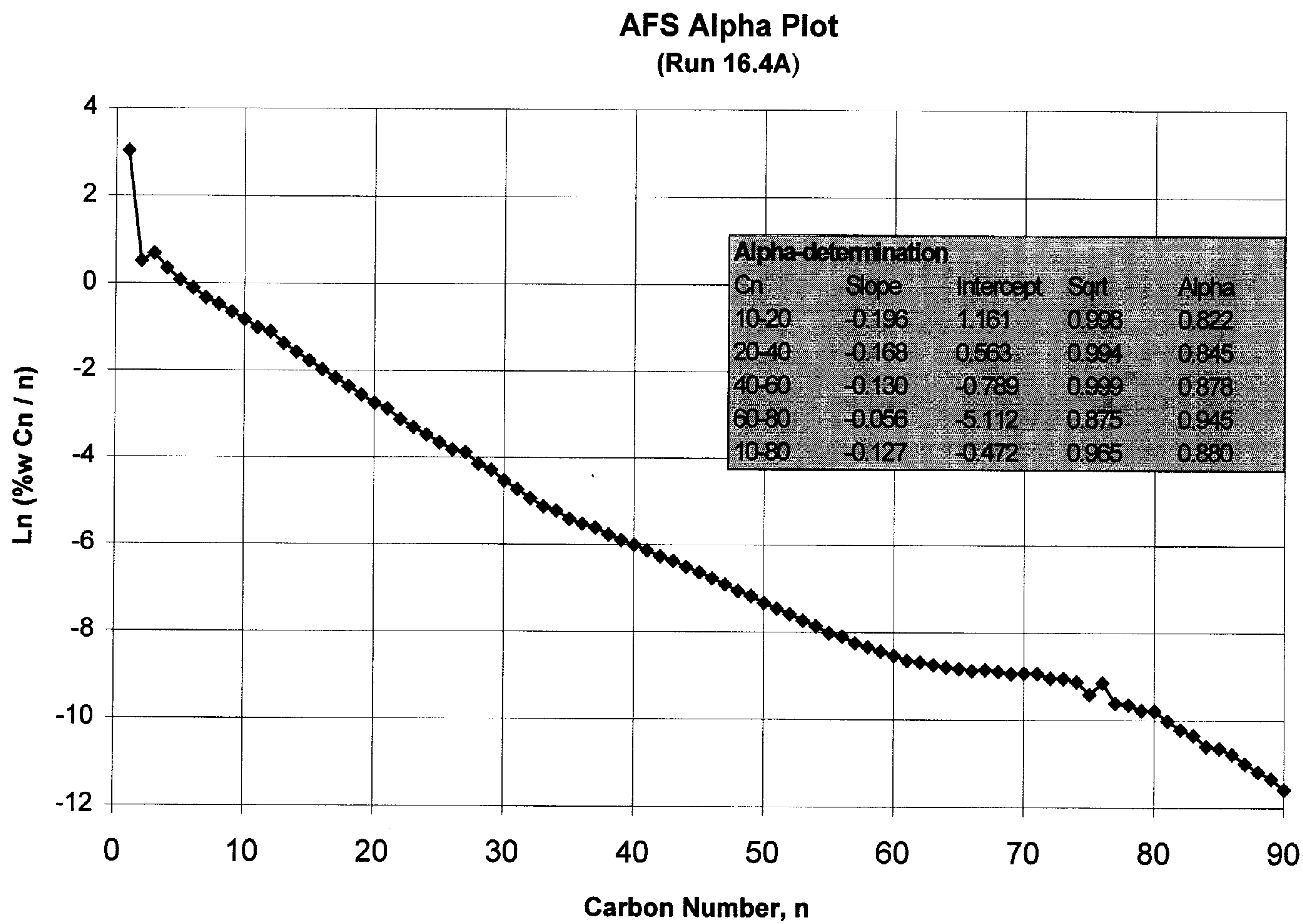
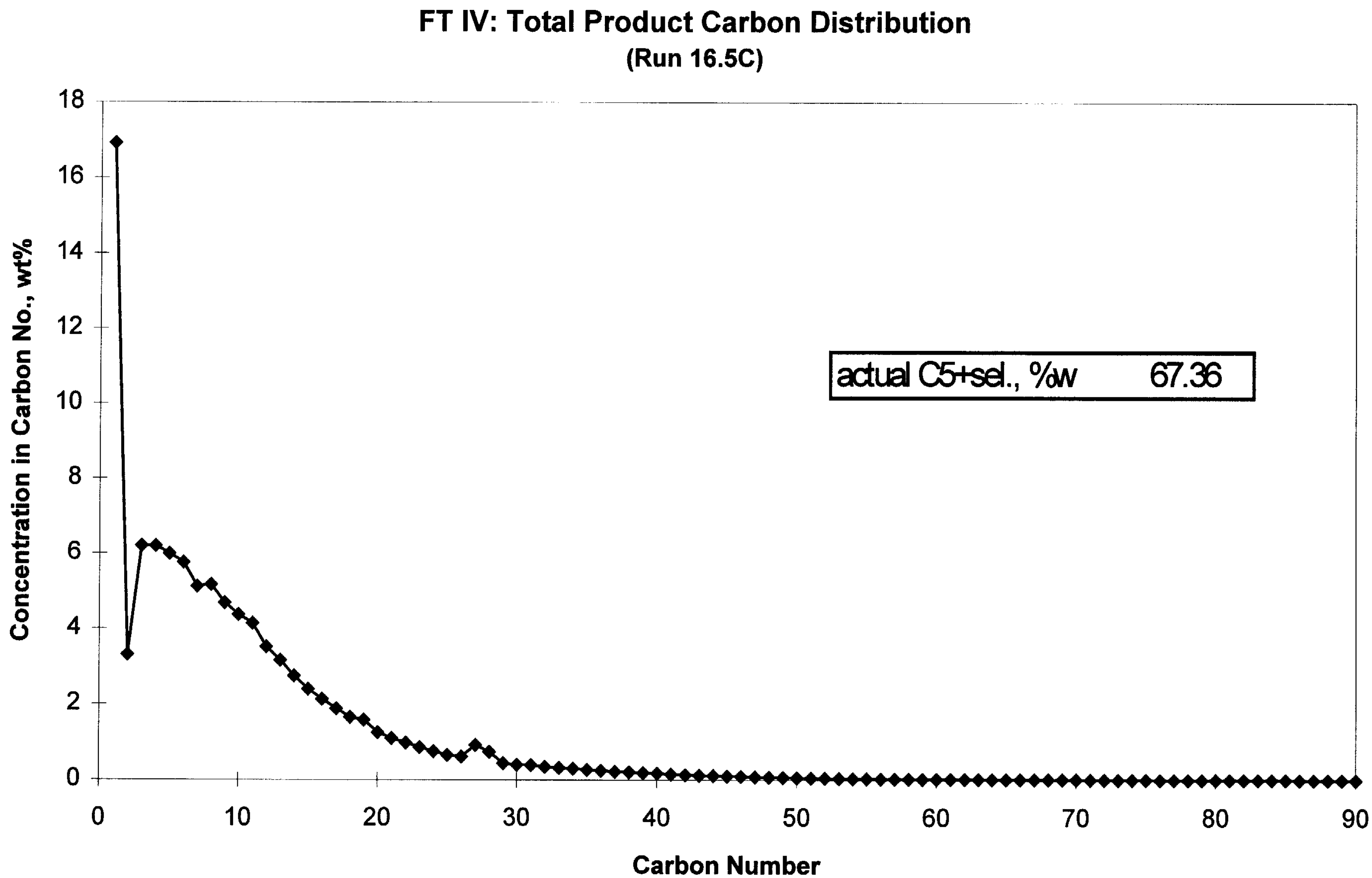

AFS Alpha Plot
(Run 16.4A)
Alpha-determination
Cn Slope Intercept Sqrt Alpha
10-20 -0.196 1.161 0.998 0.822
20-40 -0.168 0.563 0.994 0.845
40-60 -0.130 -0.789 0.999 0.878
60-80 -0.056 -5.112 0.875 0.945
10-80 -0.127 -0.472 0.965 0.880
Ln (%w Cn / n)
Carbon Number, n
4
2
0
-2
-4
-6
-8
-10
-12
0
10
20
30
40
50
60
70
80
90

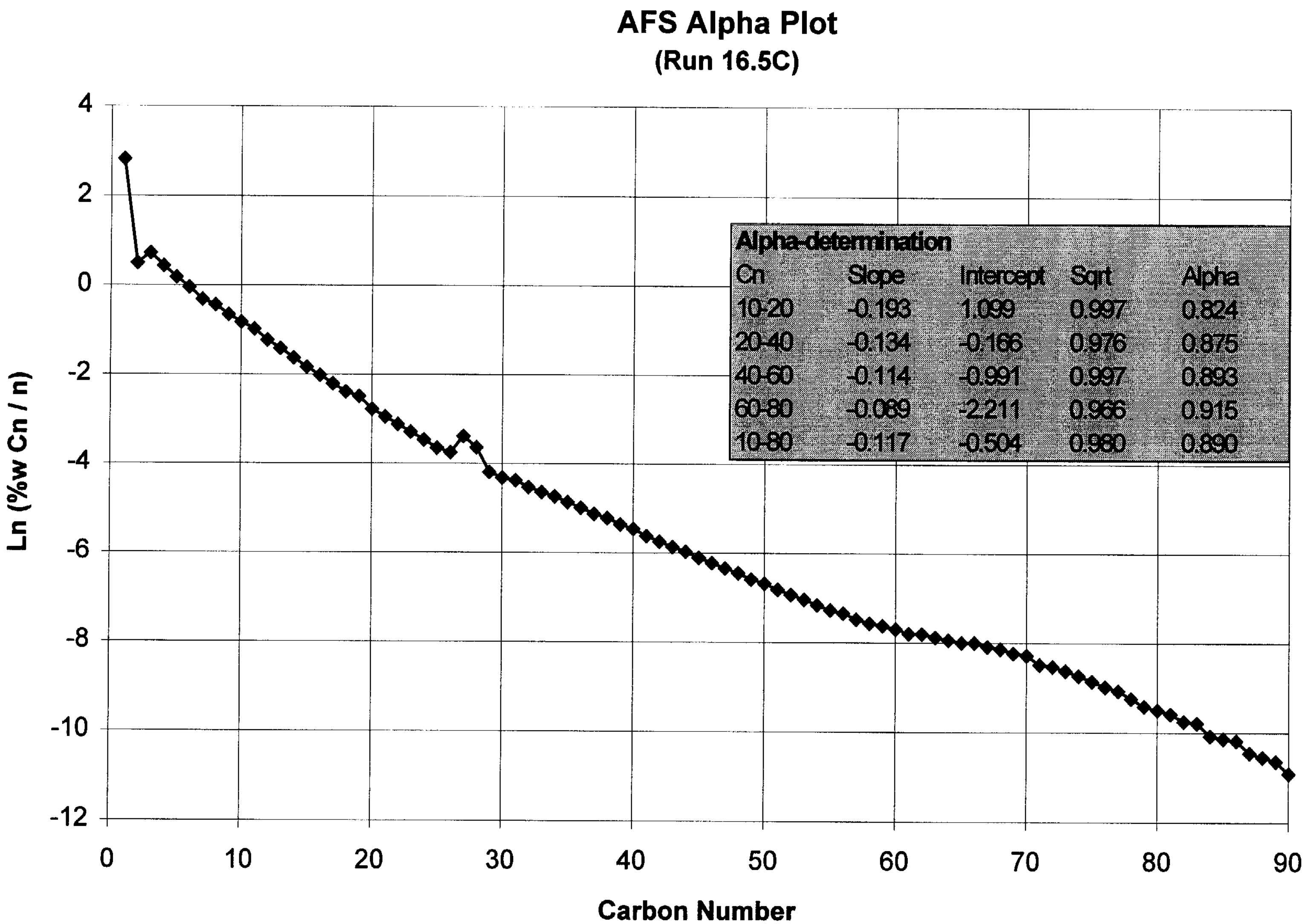
FIGURE 42



FT4SS13.xls

BLB 2/9/1999

FIGURE 43



Alpha-determination				
Cn	Slope	Intercept	Sqrt	Alpha
10-20	-0.193	1.099	0.997	0.824
20-40	-0.134	-0.166	0.976	0.875
40-60	-0.114	-0.991	0.997	0.893
60-80	-0.089	-2.211	0.966	0.915
10-80	-0.117	-0.504	0.980	0.890

LIQUID PHASE FISCHER-TROPSCH (III & IV) DEMONSTRATION IN THE LAPORTE ALTERNATIVE FUELS DEVELOPMENT UNIT

Topical Report

FINAL

(Volume II / II : Appendix)

Task 1: Engineering Modifications (Fischer-Tropsch III & IV Demonstration)

and

Task 2 : AFDU Shakedown, Operations, Deactivation (Shut-down) and Disposal (Fischer-Tropsch III & IV Demonstration)

Contractor:

AIR PRODUCTS AND CHEMICALS
Allentown, PA 18195

Bharat L. Bhatt*
June 1999

Prepared for the United States Department of Energy
Under Contract No. DE-FC22-95PC93052
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APPENDIX A

Fischer-Tropsch III Run Chronology

Fischer-Tropsch III Run - October/November 1996

4 October 1996

6:00 Loaded the reactor with oil: 80" Rxt ht, 48" on tape. Started nitrogen flow and heating up. The 10.62 pump not running overnight.

5 October 1996

8:00 Reached reactor temp of ~ 450ºF. N_2 flow (Rxt feed FI-187) set @ 90,000 SCFH. Reactor level set at 210" on tape.
DEC is having communication problems with Bailey. TI-687-1 had wrong block location, fixed. No more errors in DEC, but communication problems continue. Some signals are "zero" when they should have some values, DEC gives OK signal. The obvious signal not working is PIC-201, many others. PIC-201 was working overnight, but stopped working when Nextgen was rebooted. The rebooting was done because TI-1781 A and C were not working before. They are working now!

14:30 10.62 pump seal failed. Leaked seal oil into the process oil. Will need new seals. Overnight the pump is cooling, the reactor will be de-pressurized tomorrow.

6 October 1996

16:30 New seals/parts for 10.62 received and installed. Clarification: seal was rebuilt. Began operating 10.62 pump and slowly raising temperature.

7 October 1996

6:00 10.62 pump still running, temp @~ 250ºC and degasser is being bypassed. Nuke scan taken.

10:00 Attempts are being made to get flow thru the degasser loop; However, they have been unable to maintain stability.
Temperature has been reduced, filtration loop has been isolated, additional oil has been brought in to raise level in the filters.

12:50 Level in Rx = value in degasser
187 flow = 40000 scfh, temp 240ºC

13:00 CH4 in Plant

13:25 Nuke scan

15:00 Flare is lit...NOMEX!

23:00 Decreased gas flow to reactor to decrease level to 211". (50,000 scfh - 46,000 scfh). Level in 27.15 runs about 22%. At 211" in reactor. Gas holdup dropped from 43% to 39%.

9 October 1996

21:30 Felt the steam traced piping to make sure that they're hot:

- Piping around 10.62 pump NOT hot ***
- Piping around 22.62 A-D filters hot
- Piping around 27.15 degasser hot
- Piping around 28.30 tank hot
- Didn't check piping expand to light wax (e.g. 22.14, 27.13)

10 October 1996

11:30 Piping around 22.14 and 27.13 checked and hot
(DURASYN - 164 = ETHYLFLO-164)

~13:00 Loaded 46.2 lb oil into 28.30 prep tank. Drum before filling = 206.2 lb. Drum after filling = 160.0 lb.
13:50 Loaded 5 bags of wax.
15:05 Loaded 14 bags of wax. Weight of amount loaded after 19 bags = 973 lbs.
16:15 Finished loading last 10 bags and a bucket containing 17 pounds. Total amount of wax loaded to 28.30. Prep tank = 1489 lbs.

Wax Loading

Tank T = 155º

Wax Bag #	Weight of Bag	Weight -50	Total Deviation
1	50	0	-
2	50	0	-
3	56	+6	+6
4	54	+4	+10
5	48	-2	+8
6	48	-2	+6
7	50	0	+6
8	52	+2	+8
9	48	-2	+6
10	55	+5	+11
11	52	+2	+13
12	54	+4	+17
13	52	+2	+19
14	50	0	+19
15	50	0	+19
16	50	0	+19
17	56	6	+25
18	50	0	+25
19	59	9	+34
20	48	-2	+32
21	54	+4	+36
22	50	0	+36
23	47	-3	+33
24	52	+2	+35
25	48	-2	+33
26	51	+1	+34
27	51	+1	+35
28	50	0	+35
29	54	+4	+39
30			

Weight of first 19 empty bags = 11 lbs
Weight of last 9 empty bags = 6 lbs
Amount loaded after 19 bags:
19 (50) +34-11 = 973 lb
Weight of 9 bags left to add
10 (50) = 500 +5 = 505 lb
Amount of 20 bags
Weight = 1478 lb
Added bucket containing 17 lbs extra

Total including bucket full = 1495
Subtract weight of empty 10 bags -6
Amount added = 1489

11 October 1996

16:30 Catalyst loading - start (Shells' CMT-25 Fischer-Tropsch Cat).
17:15 Finish catalyst loading.

1. 1st drum
   Weight catalyst, drum, funnel = 406 lb
   Weight drum funnel = 127 lb
   À Weight catalyst = 279 lb
2. 2nd drum
   Weight catalyst, drum, funnel = 510 lb
   Weight drum, funnel = 128 lb
   À Weight catalyst = 382 lb
3. 3rd drum
   Weight catalyst, drum, funnel = 509 lb
   Weight drum, funnel = 127 lb
   À Weight catalyst = 382 lb
4. Total catalyst loaded
   Weight catalyst (1st drum) = 279 lb
   Weight catalyst (2nd drum) = 382 lb
   Weight catalyst (3rd drum) = 382 lb
   TOTAL catalyst loaded = 1043 lb

18:00 Filled drum with lb of flush oil. [Weight of drum and oil = 368 lb.]
19:05 Begin transferring oil/catalyst slurry from 28.30 to 27.10.
19:35 Finish transferring oil/catalyst slurry.
Looked inside 28.30 slurry tank and saw a lot of catalyst at the bottom.
19:50 Weight of drum (no oil) = 115 lb
À Flush oil weight = 253 lb oil
20:00 Weight of 2nd oil drum & oil = 362 lb
20:20 Weight of 2nd oil drum - no oil = 115 lb
À Weight of 2nd oil = 247 lb
20:45 Currently in the catalyst drying step in the 27.10 reactor. Will begin heating the reactor to get an additional 40ºF in the next 2 hours.
21:35 PIC-201 Rxt Pr = 505 psig
Rxt Avg temp = 243ºF
Rxt feed flow (N_2 100%) = 44.69 MSCFH
23:30 Plant conditions steady for last couple of hours on dry out step.

Nuke Scan:	Fresh feed flow 10,500 SCFH
	Reactor feed flow 42,000 SCFH
	Reactor pressure 505 psig
	Reactor temperature 268ºF (and climbing slowly)
	Level is still high (seems to be right at the top of nuke)
	Gas holdup corrected later 21.8%
PDI - 1778	46 PSID
PDI - 1779	51 PSID
Sparger PDI	Unstable between 10 and 25 PSID

01.10 discharge pressure 533 PSIG (À total reactor ΔP = 28 PSID including piping and equipment downstream of 01.10).
It seems like the PDI values are off by a factor of 10??? No - Bailey shows units of "H_2O. PDI-631 across the reactor isn't reading anything - probably plugged up (although it spikes occasionally).

12 October 1996

00:20 Moisture probes are showing steady baselines at about 870 and 1370 PPM. But with spikes (+300 - 400 PPM) every 10 - 15 minutes.

00:30 Utility oil heaters tripped at about midnight. Reactor temperature lost above 5°F and then come back in about 10 minutes.
Reactor average temperature is now 283°R and we will continue heating at 60°/hr.

01:30 Looks like sparger PDI has plugged up. But essentially at the same time PDI-631 across the reactor seems to have come back.

03.20 Nuke scan:

Fresh feed	10,500 SCFH
Reactor feed	41,400 SCFH
Reactor pressure	506 PSIG
Reactor temp	410°F (still climbing)

Level still over top of nuke
Still expanding but no carryover in 22.14
Gas holpup corrected later 35.2%
This seems very high. 33% calculated from ΔP measurements.
Sparger PDI has shown 0.5 - 0.7 PSID for about the past hour. This may actually be accurate.

04:15 AI-1796A spiked from about 1000 PPM to about 2500 PPM (greater than reactor outlet (2000 PPM) which must be bogus) and held there.

04:50 Reactor temperature at 489°F. AJ cutting back to level out right at 500°F.
ΔP measurements seem to be reasonable (including sparger and total reactor).
AI-1796B at about 2000 PPM and still climbing.
AI-1796A at about 2400 PPM and stable (doesn't make sense).

05:20 Reactor T at 500°F and holding.

06:00 Nuke Scan

Fresh feed	10,500 SCFH
Reactor feed	40.84 MSCFH
Reactor pressure	506.52 psig
Reactor temp	501°F

Level over top of nuke
Gas holdup corrected later 36.0%

06:35 Dave and Ray opened CW to 21.20 a little to maintain flow and avoid vapor lock.
Reactor T dipped to about 485°F before recovering.

07:35 Reactor T back up to 500°F. Put N_2 to Panametrics and readings dropped to <100 PPM.

07:50 Went out to purge with N_2 again, readings went up again.

08:20 NDG detector position @ 4933. Checked in field and this position corresponds 214 inches. This inconsistent with calibration height.

09:00 A_2214_ACTVTN_GASOUT_H_2OCONC_A ~2800 PPM (27.13 Rxt In)
A_2214_ACTVTN_GASOUT_H_2OCONC_B ~1700 PPM (22.14 Out)

10:00 10:53 PI's fluctuating a lot, difficult to get reading.

09:35 01.10/01.20 flow adjusted to bring in 20-21 MSCFH (Increasing purge to aid reduction of H_2O concentration in Panametrics).

15:15 Nuke Scan

Fresh feed	(FI-126)	204.35 SCFH
Reactor feed	(FI-187)	40.68 MSCFH
Reactor pressure	(PIC-201)	508.77 PSIG
Reactor temp	(DEC avg)	501.9°F
Level over top of nuke		
Gas holdup		34.56

17:05 27.10 inlet = 1200 ppmv H_2O
22.14 outlet = 1350 ppmv H_20

For tonight:

1. Our target for water in 27.10 and 22.14 is about 500 ppmv H2O. Call Bharat when this happens. He wants to be here when we start to add H2.
2. Until the DEC software has been installed by A. Agrawal, we need to take the Bailey readings every hour.
3. For the bold items in the field readings, we need to take them every two hours. This means readings at 18:00, 20:00 and 22:00......
4. All the rest of the items in the field readings have to be taken every four hours. This means readings at 18:00, 22:00 tomorrow at 02:00......
5. Nuke scans every four hours. This means readings at 19:15, 23:15, tomorrow at 03:15......

19:17 Nuke Scan

Fresh Feed	(FI-1260	= 20619 SCFH
Reactor feed	(FI-187)	= 40.92 MSCFH
Reactor pressure	(PIC-201)	= 508.66 psig
Reactor temp	(DEC)	= 502°F
Level over top of nuke		
Gas holdings		= 33.95

17:05 Stopped Nextgen to remove debug lines from driver to save disk space.
17:15 Started Nextgen. Came up almost same as previously. Actually gained 2 data points!
21:00 Drying complete. Decreasing reactor temp from 500°F to 446°F.
23:00 Reactor level still higher than 215" on tape.
React average temp = 448.57°F
271°F react feed in (A) = 304.20 ppmv
22.14 offgas (B) = 286.39 ppmv
23:20 Bringing in H_2 for reduction. At about 2000 SCFH.
N_2 flow is about 20,000 SCFH.

13 October 1996

00:35 GC's show 3.5% H_2
Increasing FI-101 to 3 MSCFH - 3.3 MSCFH

01:15 H_2 in Rxt = 9%
Increasing FI-101 to 4.3 MSCFH (gal 14.1 H_2)

02:05 G04001 up to 14.38% H_2

02:15 Moving on toward 18% H_2.

02:45 G04001 up to 18.52% H_2. Moving on towards 25% H_2.

03.20 G04001 up to 25.95% H_2. Moving on toward 33% H_2.

03:50 Holding 33% H2 and increasing reactor T by 5°F to 451°F.
Stopped temperature increase after 2°F. Moisture concentration in 22.14 had risen from about 740 to 840 PPM. Then topped out in very direct response to the temperature hold. Increased another 2°F at 04:10, H2 in feed topping out at about 35%.

04:30 Not much action on the last temperature ramp. Moving up 3°F to 453°F very slowly.

04:50 Moving on toward 455°F. Moisture at 22:14 increasing nicely up to 935 PPM.

05:10 At about 453.5°F, moisture spiked up to 1200 ppm! And held.

06:25 Still creeping up slowly on temperature. 456.5°F right now.

07:55 Reactor temperature at 464°F. Continuing on to 467°F.

09:15 Reactor temperature raised to 473°F.

09:20 Gas holdup from Nuke Scan 27.31%, level still over top of Nuke.

10:30 Reactor temp raised to 476°F.

10:45 Increasing H_2 from 7.3 to 10 MSCFH (35.5% to 50% H_2)
22.14 off gas ⇒ ~1500 ppmv

12:40 Reactor level is visible! ⇒ 215" m type
NDG count = 133

16:24 Reactor temp is being increased in 2°F increments.

1:56 pm	up 2 deg.	to 481°F
2:22 pm	up 2 deg.	to 483°F
4:20 pm	up 2 deg	to 485°F

19:40 Raised feed flow to 50000 SCFH to the reactor to maintain the reactor level. Ceis approved to move.

19:45 Blocked in methane to the flare.

20:25 Raised flow to reactor to 53000 SCFH again to raise reactor level again. Ceis approved the move because the reactor is stable.

20:45 Completed the set up for INFI-90 (Bailey data collection) to take the 134 (?) hourly readings and the fifteen 5-minute readings. Please have Al Agrawal check the work to make sure it's set up OK.
The set-up files are found in:
C:/INFIVIEW/SETUP

1. AFDUFT3.STP - the original file that has all the possible Bailey points.
2. FT3TAG5.STP - the set up file for the hourly readings.
   As instructed, I have changed the block numbers for the 17 measurements that were listed.
3. FT35MIN.STP - the set up file for the fifteen readings taken every five minutes.

The collected data is found in: C:/INFIVIEW/DATA

1. FT3HR1.DAT - the data file for the hourly readings.
2. FT3MIN1.DAT - the data file for the fifteen points taken every five minutes.

I think the software is collecting data now, and the results can be seen in the trend data.

23:30 AJ still bumping up recycle flow to maintain level between 211" and 215". Now at 74 KSCFH total flow. Moisture level in outlet still drifting down slowly (about 80 ppm/hr). Now at 1380 ppm. Reactor temperature holding at 500°F. All we can do now is watch and wait.

14 October 1996

02:30 Reactor level is down below 197" and seems to be falling faster at the higher flow rate. (We've been at the target rate of 87 KSCFH since 0100.) We might be stripping out wax faster at the higher gas velocity, so we will reduce the recycle rate. We can't find carryover anywhere - 22.14 still seems to be empty, but we could be building level below the sight glass. Dave's last nuke scan at 01:50 was quite uniform and steady - seems to be well-mixed.

03:20 50 KSCFH on FI-187 to reactor. Level is down to <166". (Interfering down to 157".)
Nuke scan was steady and uniform.

04:00 Level dropping through 157".

04:20 Level dropping through 154".

04:45 Called Ed, then Bharat.
Concluded we should:
Add ethyflo to reactor
Drop gas rates to 40 KSCFH
Maintain temperature at 500°F

12:25 Begin cooling step for end of reduction.

12:41 Temp dropped from 480°F - 450°F in ~5 min.

13:40 Starting to heat up the 28.30 --- tank by cracking open oil to 28.30.

13:50 TI-1-14B dropped about 30°F pretty quickly the last few minutes.

Ref: Test Authorization #52 - meeting to discuss procedure

Filters: NV-1760 is just open/close, actually
LV-203 will throttle
3.3 m 3/h (14.7 gpm) or (126 lb/min)
(density = 1.03 g/cm3)
Eventually want to transfer control to the control valve.
Want backflush pressure higher than the pump discharge pressure.
Want to evenly distribute flow flux thru the filters.
It will be hard to control at these low rates, but we'll keep velocities low.
Possible ΔP is 10 - 60 psi, we're guessing it will be 10 psi
A 770 psi - 760 psi
B 780 psi - 770 psi
700 psi - 30 psi
C 790 psi - 780 psi
D 800 psi - 790 psi
Will establish flows thru the filters with clean fluid (ethylflo)

15:10 Raise 27.10 reactor pressure to 710 psig.

15:50 Finished setting up 10.52.01.
Losing level in 27.12.

15:55 Opening NV-1760 to begin to line up filters. Going to start sending clean liquid thru filters. Start with bottom filter (D). Watching PDI-1777 (1.35 psi).

16:25 Now sending slurry from 27.10 to reactor to filters. Watching 10.62 pump. Pumps have failed (10.52? 10.54?).
16:55 27.10 reactor level is dropping.
17:00 10.62 pump: 128 lb/min, 40% speed, raised it to 60% speed. Line from 28.30 Prep. Tank to 10.52.01 pump is plugged. Can't remove the plug even with 300 psi N_2.
17:07 10:54 pump fuse has been replaced. 10.54 restated. Sending 800 psi N_2 to try to send plug bark into 28.30 prep tank.
17:58 UNPLUGGED - used 1500 psi N_2 thru the back flush line to remove the plug.
18:28 Will begin re-pressuring reactor to 710 psig.
18:34 Start taking flow thru 21.38 economizer.
18:40 Filter ΔP = 7 psi, which is good.
19:10 Valve for "D" filter (V-3574) is messed up. Will try to use "C" filter.
19:20 V-3574 is glassed wide open. Will back flush "C" and "D" filters. Will need to replace this valve. Closed NV-1760
19:26 Opening LV-203 slowly to de-pressure "C" and "D" filters.
19:38 Valve V-3574 already replaced.
20:15 Bringing CO into plant. Watch for temp. increase in reactor. Keeping total flow same (cutting back N_2). Reactor temp start at 355°, 694 psig.
20:20 Bring more H_2
20:25 Reactor temp 370°. Reacting much of CO. Bring more H2 7000 MSCFH.
CO - can't get flow read.
20:35 H_2 8.33 MSCFH
CO 4.34 MSCFH
Reactor 392°, 668 psig
20:50 Lowering reactor level by removing wax.
Level current over nuke.
Reactor 726 psig, 383°
H_2 12,000 MSCFH
CO 6.0 MSCFH
As level drops - increasing recycle to reactor.
21:15 Recycle 89 MSCFH
Reactor 715 psig, 360°
H_2 10.7 MSCFH
CO 5.8 MSCFH
21:25 Turn off fin fan to raise reactor temperature. Reactor 359° before. Goal is 410°.
21:35 Adding more CO - 6/7 MSCFH
H_2 - 10.9 MSCFH

Filters	D	PDI-1777	17 PSID
	C	PDI-1776	11.4 PSID
	B	PDI-1775	5.6 PSID
	A	PDI-1774	-2 backflush

21:40 First product GC spec in.
21:55 Reducing the pump 10.62 speed down from 70% to 61.5% to bring flow down to 190 lb/min.
23:15 Bringing reactor temp up 405° now

Filters	D	15	PSID
	C	10	PSID
	B	5.5	PSID
	D	-1	PSID

Allowing temp to rise to aid in CO conversion to produce more wax.
Due to small wax production - bringing down recycle ratio.

15 October 1996

00:35 21:20 bypass which was open to get reactor temp up is being closed.
00:45 Starting fin fan.
Temp. in reactor shooting through roof, 490°F
Fin fan 50% ý 100% still climbing rapidly
Reactor temp. peaked at about 530°F ý 790 psig
00:45 Compressor tripped SD-1. Low suction pressure.
00:50 Compressor restarted. Add N_2 to try to stabilize reactor.
00:55 Temperature dropping fast. Full cooling on fin fan.
01:45 Feed to reactor stabilized.
Temperature reactor 358°F
02:10 We are going to run at very dilute H_2/CO to N_2 ratio. This hopefully will allow us to control the temperature spike. Adding N_2 with Big Joe.
03:00 33.5% N_2 in reactor feed. Make another move on Big Joe.
02:30 To increase temperature on reactor (we were stuck at 360°F). Opened more 21.20 bypass so less cooling on oil. Want to get to 420°F then start backing down on N2.
05:00 Reactor 428°F. Oil now cooling with fan. Fan ~50%. Temp appears stable - controllable with fin fan.
05:05 Temperature drop slightly - increase H2 flow.
Feed 14% H2
20% CO
React temp 411°F
710 psig
05:10 Hit with too much cooling - temperature bottomed out at 408°F. Move reactor temperature back toward 420°F.
05:35 As control reactor continue to move back towards 2.1 H_2/CO
25% H_2
17% CO in reactor feed.
07:05 Slowly backing out N_2 in the feed and establishing ΔT between oil system and reactor temps.
07:30 Draining prep tank (Dave and Ray). Raising temperature in 22.14. Still no level in 22.14 or 22.10??
09:30 Still no level in 22.14 or 22.10. Working to back out N_2 in the fresh feed and maintain a steady temperature. N2 is being replaced with H_2.
13:00 Transfer from 28.30 prep tank to tank trailer.
- Ran N_2 through line to make sure it was clear
- Pressured up 28.30 prep tank to 50 psig
- Turned agitator off
- Changed valves so product would go to the tank trailer
- Opened top of trailer
- Opened HIC 512 valve
- Emptied tank until gas came out
- Shut HIC valve
Level was ~38
Level seen in 22.10. Height/level ≅ 3 bolts (5 1/2")
22.10 site glass full.

Product carried over to 22.15 and then to the 22.16 product day tank.
The balls in the site glasses seem to be stuck. Steve Cochran is working to fix them.

15:00 Shut LV-203 because we are not making product.
16:35 Temperature has dropped form 421 to 416°F over the past few minutes.
16:45 Re-establish flow thru filters.
19:45 Reactor up to 443°F. Controls back in automatic. Operation is pretty warm and pretty stable.
19:48 Transferring liquid from 22:10 degasser to 22.16 day tank.
19:52 Trying cascade control on 27.10 reactor temp to see if it works. Target temp 443°F (TI-190-3B).

16 October 1996

00:25 Power loss in control bldg.
Bailey power stayed on.
Only partial power loss. Lost lights first, then DEC.
Powered down all unnecessary equipment to conserve.
GC's apparently lost no power.
Rocco timer not affected so we assume they all stayed on.
00:45 Gadget trying to remedy situation.
GC's still functioning.
DEC still down.
Bailey Operating.
Try to reboot when power restored.
01:45 Power back up
02:00 DEC rebooted. NG_START
Trend collector and HPGC_DRIVER are running
(GC's never went down)
Points seem to be coming back in OK. Now need to get window view going again.
02:30 Window view seems to be working again and logging data.
Will get Wendyann to check at 06:00.
03:05 Forgot to power-up the DEC printer until now. No snapshots printed since midnight.
Some points seem to be "invalid" in the DEC - correction, we were looking at 22.60 filtrate parameters instead of 22.62 parameters. All seems to be well.
At current wax production rates the wax take-off (via LIC-203) tends to be all or nothing (1.7 lb/min or 0.1 lb/min), so level control ends up being on/off to build from 211" and drop from 215". The period is about one hour for 4" change in level.
04:30 Tried to access data point FIC-101 on laptop monitor. On hour longer.
Error: Subject out of range
Crashed. VES got running again.
Note: tracker after power loss was after this crash
B51ns4.dat
B51ins5.dat
04:00 Henry took a liquid sample off 22.11. Looks like skim milk.
06:15 Window checked and is running. It was shut down momentarily to load file with 134 pts.
07:30 Trying to maintain temp ~435°F
D04/B04 - Rx feed - Make sure total 100, they are close.

D02/B02 - Prod gas - Look at 4 hour trend and one hour trend of individual components to see if steady or changing (H_2 & CO). H_2/CO ratio
G04 Time scan questionable, but comp is OK. Can also compare with B04 to see if reading values are close.
A_2262_ Filtrate flow: small ü in 203 (smallest move) goes to 1.6
When level gets up to 215, tell operator to close small amt. (~1 hr cycle). Once level gets down below 211, bring back up again.
Watch filter DP values
Watch HMBFLO1. Ration of 126A/701A
Compare it with 109/606 expected ration from ASPEN.

10:00 Compressor trip
Level dropped to ~188
Temp increased to ~ 443.6
Resetting H_2 at 12.8 mol.%
10:05 Level brought back to ~215.
10:10 Temp @ 426 and dropping slowly.
10:13 Level >215, temperature @ 424.
10:30 Raising temperature to 435-440 range with H_2 feed of 13 mol%.
12:20 Temp increased still climbing. Max of 469 reached.
12:25 Temp coming back down.
13:00 Temp leveled off ≅440.
15:10 High 27.10 reactor level. Open LV-203 to transfer wax from 27.10 reactor to 28.30 prep tank.
Initial NDG reading of 30 at voltage of 4863.
Final NDG reading of 230 at voltage of 4863 (finished at 15:25).
Measured wax level/volume in trailer 5692.
- Lowered tubing to top of wax without sticking it into was.
- Marked height in pencil at bottom of metal band.
- Measured length from end of tube to pencil mark
Max capacity height = 77.75"
Empty height = 61"
Height of = 16.75" or 1'4 8/10"
Loaded wax
(wax loaded 10/15/96)
Volume loaded =1022 gal.
21:10 Liquid level in 27.10 reactor above 215" transferring a load of wax from 27.10 reactor to 28.30 prep tank.
21:50 Completed wax transfer.
16:30 Day tank transfer to #5390 (6251 gallon capacity @ 90%)
49 1/2" 762.5
20" <u>240.0</u>
515.5 transferred

17 October 1996

03:25 Henry took a liquid sample off 22.11. A little clearer than last night's sample.
12:45 Transferred heat product from 27.10 reactor to 28.30 prep tank.
14:00 Took a slurry sample.
14:40 Wax transfer from 28.30 prep tank to trailer.
Volume transferred = 547 gal. wax (54 inch from wax level to top target line.)

15:20 Transferred wax product from 27.10 reactor to 28.30 prep tank.
16:25 Completed wax transfer from 27.10 to 28.30.
16:45 Transferred H_2O/HC from 22.16 day tank to trailer. Starting level in 22.16 = 64.5 inches.
Ending level = 20"
density = 0.45 till 21".
then density = 0
17:10 Completed water/HC transfer from 22.16 to trailer. Ending level in 22.16 = 20 inches. 784 gallons transferred (total in #5390 is 1299.5 gallons).
17:15 Transferred wax product from 27.10 reactor to 28.30 prep tank.
18:30 Finished transferring wax from 27.10 to 28.30.
Reactor temp has been stable all day.
20:00 Transfer light wax from 22.14 to 27.13.
High level alarm keeps ringing.
20:35 Transfer wax for 27.10 reactor to 28.30 prep tank.

18 October 1996
02:00 Wind shifted. Cold front coming through. Heaters firing higher to maintain temperature.
02:45 Henry grabbed a liquid sample off 22.11.
12:30 Stopped data acquisition on Bailey window view to load a file that collects 5 data pts every 10 sec. to study response time. File name: XAVPTS.STP.
12:40 Restarted above file with FT3TAGS.STP (hourly data).
15:00 Transferred wax form 27.13 to wax trailer.
90.83% to 24.61% in 27.13
______ gal transferred.
18:30 Begin to backflush all filters.
A
B
C
D
18:40 Needed to divert some utility oil to heat 28.30. Caused drop in reactor temp. took off cascade control till stabilized.
18:45 Downloaded data. This required stopping Bailey data acquisition.
19:13 Restarted Bailey data acquisition (134 tags every hour & 24 every hour).
19:45 Started back-flushing (28.30 ~280°F)
21:50 GC Dennis is showing bad compositions in just the last sequence (<1 hour). Rob is on his way in to troubleshoot. Need to exclude data from 2100 - 2400. It looks like D04 at about 2110 was the first shot to go bad.
21:15 Rob has fixed Dennis. His first comparison against G02 showed Dennis about 1% high on H2 and CO, but he will wait until morning to re-calibrate.

19 October 1996
02:15 AJ grabbed a liquid sample off 22.11.
08:00 Back-flushing filters.
10:05 Stopped Bailey data collection to run test.
10:08 Started hourly Bailey data collection and 10 sec data.
10:13 10 min test began
45.4 from 65.4 on TIC-293

440.6°F starting T avg on Rx
190-3B unit. Temp = 440°F
10:18 Tavg on Rx = 438.58.
10:20 Test stopped
Tavg = 437.16°F
190 - 3B = 436.2°F
11:45 Bailey data acquisition resumed.
B152AVG1.DAT
B152INS1.DAT
10:30 Changing cond. to R15.2.
12:30 Transferred 22.16 HC/H_2O to trailer.
22.16 starting level = 90.75"
density = 2.0
22.16 level @ density change = 31"
density = + 0.65
22.16 ending level = 20"
12:55 Switching over to HP H_2, attempt 1
13:00 A_2710_AVG_TEMP dropped from 460.04 to ~443.
13:07 Went back to LP H2
13:45 Trying HP H_2 again
14:40 NP N_2 caused big deviation high 482°F - low 420°F
Trying to line out again.
16:30 Going to backflush filters with N_2
All DP's are high 80-100 psi
Wax level high. 2.4 filtrate flow
19:30 Still trying to clear filters.
Pressurize filters to ~900-1000 psi and then pop open ball valves.
20:00 Mildly successful. Keep running at this condition ~410°F till level drops - then raise T to around 440°F.
20:30 Filters not filtering very well.
Keep T down ~390
Lower level as much as can. Wait till tomorrow.

20 October 1996

00:25 Henry grabbed a slurry sample off 10.62.
08:00 Turned off Bailey collection to install mouse and reconverted files B151AVG5.DAT ý B151AVG9.DAT
08:17 Re-started Bailey data collection.
09:40 Back-flushed filters with N_2 and now trying flow through them again.
09:50 dP increasing in D = 110
in C = 95 @ avg RxT = 395.9
in B = 81.6
in A = 66.23
Stopped test ý Mtg.
12:15 Attempt made to back contents into reactor and run clean wax through filters. Couldn't re-establish flow.
13:00 22.16 transfer complete
22.16 starting level = 50.5"
22.16 ending level = 20"

density varied ~0.6
Volume transferred 537.5 gal
Ending amt. in trailer = 3083.75

14:00 Dropping H_2 and CO feeds.

15:00 Slurry sample taken.

21 October 1996

16:45 Preparing for a shut-down test.
Rxt avg temp = 396°F
Rxt pressure = 702 psig
(187A) Rxt feed --- = 56.85 MSCFH SP4MW = 12.3
(701A) 22.10 Outlet -- = 45.72 MSCFH SP2MW = 12.38
22.10 outlet : H_2 = 60.14 -1.
(D02) N_2 = 6.18 -1.
CO = 33.36 -1
CH4 = 0.27 01.
Rxt feed --- H_2 = 60.86
N_2 = 5.95
CO = 33.14
CH4 = 0.08

Shut-down Test

17:14 Shut down gas flow
7.52 total test time
PDI 1778 ~39.7 ý~51 psi
PDI 1779 ~44 ý 56 psi

18:30 Clean liquid in filters

PDI				Product withdrawal valves shut	Back flush w/10.54		
1772	22.16	22.31	22.28			21.21	21.21
73	18.85	18.97	19.08			18.28	18.29
74	53.67	21.78	-4.01	-6.76	-15	-0.75	28.74
75	70.64	33.09	7.21	0.7	-13	10.21	39.40
76	79.15	42.85	15.66	-	-18	18.17	47.68
77	88.01	51.92	26.13	-	-20	28.63	58.08
LV-203	8.1y	5.0y	4.9y			7 -1.	11y
DI-1761	0.74	0.73	0.73			0.76	0.74
DI-1768	0.76	0.77	0.77			0.75	0.75
FI-1768	163	164	162			162	162
FI-1761	1.38	0.89	-0.11			1.39	1.8

	19:15	19:30	19:40
PDI	Backflush w/ 10.54		

1772		20.37	20.32
73		18.5	18.43
74	-19.8	01.71	-.3
75	-13.47	9.51	10.86
76	-19.08	17.32	18.77
77	-24.13	27.28	28.74
LV-203		7%	10%
DI-1761		.76	.75
DI-1768		.73	.73
FI - 1768		157.03	157.05
FI - 1761		1.67	1.89

22 October 1996

07:30 Transferred 28.30 to trailer. Ending amt in trailer = 2438 gal. Amt added was 201 gal.

09.38 22.62 contents transferred to 27.10.

12:00 Drained 27.10 contents into drums.

Drum #	Empty Wt (lb)	Full Wt (lb)	Δ (lb)
1	45	461	416
2	46	316.5	270.5
3	46	321	275
4	46	319	273
5	46	293	247
6	46	310	264
7	46	418	372
8	46	355	309
9	46	346	350
10	46	103	57

12:15 Nextgen stopped
13:00 Filled 27.10/22.62 for flush
15:00 Draining 22.62 filters
16:00 Draining 27.10

23 October 1996
Drum height (total = 33 1/4" (from inside of cap bottom edge to ground)
Drum Diameter = 23"
Empty height within each drum:

Drum #	Height (in)	
1	5 1/8	5.125
2	15	50.0
3	13 7/8	13.879
4	14 1/2	14.5
5	16 1/2	16.25
6	15 1/2	15.5
7	7 3/4	7.75
8	12 1/4	12.25
9	12 3/4	12.75
10	29 1/2	29.5

Height of Catalyst in Heavy Fischer-Tropsch Wax:

Drum #	Height (in)
1	28.125
2	16.75
3	19.375
4	18.75
5	17.0
6	17.75
7	25.5
8	21.0
9	20.5
10	3.75

Density Calcs

Drum	Mass(g)	Vol (cm3)	Density (g/cc)
1	188693.44	191486.06	0.99
2	122696.1	114040.59	1.08
3	124737.25	131912.62	0.95
4	123830.07	127657.38	0.97
5	112036.73	115742.69	0.97
6	119747.76	120848.98	0.99
7	168735.48	173614.03	0.97
8	140159.31	142976.26	0.98
9	136077	139572.06	0.97
10	25854.63	25531.48	1.01

Average density = 0.99 g/cm^3

26 October 1996

Seal oil was leaking out of 10.62 pump
Maintenance done on 10.62 from ~1500 to ~2200
Note: Changed back clock early for end of daylight savings.
22:15: 10.62 Running and operating procedure for hot oil filter flush and clean oil flux test commenced. Began heating up filter loop at a rate of 87°F/hr.
23.25 Adding new oil to maintain level in 10.62. This is done frequently and seems to keep temp rate at ~78°F/hr.

27 October 1996

00:15 Raised reactor pressure to ~117 psig in order to maintain seal oil level.
00:35 TIC-293 opened 100% and temp ramp at 75°F/hr and dropping slowly.
00:45 Reactor P at 120 psig and level is holding steady.
03:00 Oil transferred from degasser to 28.30 prep tank LI-1765 reduced to 6.72%.
03:45 Back flush of filters began.
06:25 Reactor temperature peaked at 487.48 and temperature started cooling down to 300°F.
08:30 Flushing 22.62 logs.
08:49 Filter loop at 300°F, system flushed.
FI - 1761 = -6.36
FI - 1768 = 186.77
PI - 1756 = 181.56
PDI 1772 = 15.82
PDI - 1773 = 18.48
PDI - 1773 = 18.48
PDI - 1774 = -4.51
PDI - 1775 = -0.65
PDI - 1776 = -2.26
PDI - 1777 = -2.96
08:52 PDI-1777 = 38.65 D filter
FI - 1761 = 0.92
08:54 FI - 1761 = 0.93 D filter
PDI - 1777 = 40.45
08:59 PDI - 1776 = 20.22 C filter
FI - 1761 = 1.07

09:00 PDI-1776 = 23.63 C filter
FI - 1761 = 1.06
09:03 PDI - 1776 = 34.29 C filter
FI - 1761 = 1.04
09:04 PDI - 1775 = 15.47 B filter
FI - 1761 = 1.05
09:08 PDI - 1775 = 22.67 B filter
FI - 1761 = 0.99
09:10 PDI - 1775 = 24.73 B filter
FI - 1761 = 0.98
09:12 PDI-1775 = 26.43/27.18 B filter
FI - 1761 = 0.98
09:15 PDI - 1774 = 1.25 A filter (flow 1)
FI - 1761 = 1.07
09:18 PDI - 1774 = 4.15 A filter (flow 1)
FI - 1761 = 1.04
09:23 PDI - 1774 = 7.6 A filter (flow 1)
FI - 1761 = 1.03
09:26 PDI - 1774 = 19.17 A filter (flow 2)
FI - 1761 = 1.98
09:27 PDI - 1774 = 27.23 A filter (flow 2)
FI - 1761 = 1.90
009:32 PDI - 1774 = 43.3 A filter (flow 2)
FI - 1761 = 1.68

5 November 1996

Wt of impeller (10.62)
After the run = 1403.32 g

APPENDIX B

Fischer-Tropsch III Mass Balances

RUN NO.: AF-R15.1B **TITLE: LIQUID PHASE FISCHER-TROPSCH (III) SYNTHESIS IN LAPORTE AFDU**

Start Date / Time	10/17/1996	0.00
End Date / Time	10/17/1996	12.00

On-stream Time From Start-up (hr)	
Start	52.00
End	64.00

Reaction Conditions:					
Temperature average		deg F	440.2	deg C	226.8
Pressure	PIC-201	psig	706.9	bara	49.75
Space Velocity		sL/kg-hr	7444		
Superficial Gas Vel. - Inlet		ft/sec	0.43	cm/sec	12.98
(based on average reactor temp)					
Recycle Ratio			3.24		

Slurry Data:				
Catalyst Oxide Wt (Reactor)	lbs	862	kg	391.0
Slurry Concentration by NDG	wt%	43.9		
Slurry Concentration by DP	wt%	40.5		
Slurry Level by NDG	% NDG Span	95.8		
Slurry Height	ft	20.66	meters	6.30
Average Gas Holdup by NDG	Vol%	43.4		
Average Gas Holdup by DP	Vol%	37.4		

Performance Results	
CO Conversion per pass, mole %	9.5
H2 Conversion per pass, mole %	12.1
CO + H2 Conversion per pass, mole %	11.0
Plant CO Conversion, mole%	39.2
Plant H2 Conversion, mole%	55.9
Plant CO+H2 Conversion, mole%	49.7
CO Conversion Rate,	12.3
gmole CO converted/kg cat oxide-hr	
HC Production Rate,	171.3
grams of HC (CH2.1) produced/kg cat oxide-hr	
Reactor Productivity (STY)	45.88
grams of H C (CH2.1)/lit of reactor vol. - hr	
H2/CO in Fresh Feed, mole/mole	1.73
H2/CO in Reactor Feed, mole/mole	1.32
H2/CO Usage Ratio, mole/mole	1.69
H2/CO in Outlet, mole/mole	1.28
CO2 Selectivity, mole %	1.30
HC Selectivity (CO2 free) wt%:	
CH4	26.31
C2H6	3.07
C2H4	1.13
C3H8	4.48
C3H6	7.44
SUM C4H10	4.77
SUM C4H8	7.85
SUM C5H11	8.25

Reactor Heat Balance	**Btu/hr**	**kW**
Chemical Heat Production by Reaction	746477	218.77
Sensible Gas Heat	-102535	-30.05
Sensible Oil Heat	-502539	-147.28
Sensible Wax Heat	-85097	-24.94
Estimate of Heat Loss from Catalyst Drying Data	-35000	-10.26
% Heat Balance based on Reaction Heat	97.15	

Mass Balance	**Reactor lb/hr**	**Plant lb/hr**	**Feed lb/hr**	**Prod Gas lb/hr**
Fresh Feed		832	832	
HP H2 Feed				
Recycle Feed			3345	3345
Reactor Feed	4173		4173	
Total In	4173	832		
Prod Gas	3892			3892
Main Purge		520		520
22.11 Purge	70.6	70.6		
HC Phase	38.3	38.3		
AQ Phase	208.2	208.2		
Heavy Wax	34.0	34.0		
Light Wax				
Total Out	4243	871		
Mass Balance, %	101.7	104.8	99.9	99.3

Compositions (mole%):		LP FRESH FEED	HP FRESH FEED (H2)	RECYCLE FEED	REACTOR FEED GAS	PRODUCT GAS	MAIN (22.10) PURGE	22.11 PURGE	REACTOR OUTLET (estimated)
Components									
1	H2	61.10	100.00	49.79	51.67	49.79	49.79	37.40	47.57
2	N2	3.49	0.00	6.94	6.18	6.94	6.94	6.35	6.63
3	CO	35.41	0.00	38.74	39.17	38.74	38.74	40.31	37.01
4	CH4	0.00	0.00	3.09	2.04	3.09	3.09	5.72	2.95
5	CO2	0.00	0.00	0.14	0.08	0.14	0.14	0.57	0.13
6	ETHANE	0.00	0.00	0.17	0.11	0.17	0.17	0.85	0.16
7	ETHYLENE	0.00	0.00	0.02	0.00	0.02	0.02	0.11	0.02
8	PROPANE	0.00	0.00	0.16	0.11	0.16	0.16	1.10	0.15
9	PROPYLENE	0.00	0.00	0.28	0.19	0.28	0.28	2.09	0.27
10	ISOBUTANE	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00
11	N-BUTANE	0.00	0.00	0.14	0.10	0.14	0.14	1.12	0.13
12	T-BUTENE-2	0.00	0.00	0.01	0.00	0.01	0.01	0.09	0.01
13	BUTENE-1	0.00	0.00	0.16	0.11	0.16	0.16	1.34	0.15
14	ISOBUTYLENE	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00
15	C-BUTENE-2	0.00	0.00	0.01	0.00	0.01	0.01	0.07	0.01
16	SUM C5	0.00	0.00	0.19	0.13	0.19	0.19	1.60	0.18
17	SUM C6	0.00	0.00	0.10	0.08	0.10	0.10	0.99	0.10
18	SUM C7	0.00	0.00	0.05	0.03	0.05	0.05	0.23	0.05
19	SUM C8	0.00	0.00	0.01	0.01	0.01	0.01	0.00	0.01
20	SUM C9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
21	SUM C10	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00
	H2O								4.35
	He								0.10
	LIGHT WAX								0.000
	TOTAL	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Mole Wt	lb/lb mole	12.13	2.02	15.07	14.58	15.07	15.07	20.39	15.32
Flows	SCFH	26510.97	0.00	85839.92	110631.77	99873.85	13347.86	1338.98	104527.63
	lb mole/hr	68.57	0.00	222.01	286.13	258.31	34.52	3.46	270.35
	lb/hr	831.78	0.00	3345.10	4172.97	3891.99	520.15	70.62	4142.36
	Nm3/hr	697.67	0.00	2258.98	2911.41	2628.30	351.26	35.24	2750.77
	kgmol/hr	31.10	0.00	100.70	129.79	117.17	15.66	1.57	122.63
	kg/hr	377.30	0.00	1517.33	1892.85	1765.39	235.94	32.03	1878.96
Temperature	deg F	284.6	84.9	127.7	260.4	88.5	86.5	79.2	
	deg C	140.3	29.4	53.2	126.9	31.4	30.3	26.2	
Pressure	psig	762.2	781.4	814.6	749.2	663.7	672.1	17.3	
	bara	53.56	54.89	57.18	52.67	46.77	47.35	2.21	

Reactor Heat Balance

		deg F	deg C			lb/hr	kg/hr		Btu/lb-deg F	J/gm-deg C		lb/ft3	kg/m3
Gas:													
Inlet Temp	TI-1-12A	391.6	199.8	Inlet Flow	RXT FEED	4173	1892.8	Inlet Ht Cap.	0.506	2.116			
Outlet Temp	RXT AVG	440.2	226.8	Outlet Flow	RXT FEED-WAXPROD	4139	1877.4	Outlet Ht Cap.	0.500	2.091			
Oil:													
Inlet Temp	TI-1-14B	407.5	208.6	Inlet Flow	*FI-619	49874	22622.9	Inlet Ht Cap.	0.657	2.749	Inlet Density	45.39	727.06
Outlet Temp	TI-1780	423.0	217.2	Outlet Flow	*FI-619	49874	22622.9	Outlet Ht Cap.	0.665	2.784			
Slurry:													
Inlet Temp	TI-1783	425.5	218.6	Inlet Flow	*FI-1768-61	11625	5273.0	Inlet Ht Cap.	0.500	2.092			
Outlet Temp	RXT AVG	440.2	226.8	Outlet Flow	*FI-1768	11659	5288.4	Outlet Ht Cap.	0.500	2.092			
					*based on								

Reactor Differential Pressures

	DP NOZZLES		Differential Pressures: psi	mbar	Heights: ft (based on flange loc.)	meters	Density - 3 Phase: lb/ft3	kg/m3	Gas Hold-up vol%
Reactor Height:									
13.75 to 9.25 ft	Kl -K3	PDI-1778	1.30	89.9	4.56	1.391	41.14	659.1	36.92
9.25 ft to 4.33 ft	K3-K5	PDI-1779	1.43	98.7	5.08	1.549	40.54	649.4	37.87
Total Reactor	K6-OUT	PDI-631	4.87	335.8	95.80	29.200	8.07	129.3	88.97
Sparger	K6-IN	PDI-633	4.04	278.4					

DEGASSER

Temperatures:			deg F		deg C	
6.5 ft Height	TI-1762		314.1		156.7	
3.5 ft Height	TI-1763		412.2		211.2	
0.5 ft Height	TI-1764		435.6		224.2	
Liquid Level:						
% Level	LI-1765		17.5			
Slurry Height		ft	2.26		meters	0.688

SLURRY PUMP

			deg F	deg C
Temperature:	Slurry Inlet	TI-1755	434.0	223.4
	Seal Oil Outlet	TI-1795	119.8	48.8
			psig	bara
Pressure:	Seal Oil Outlet	PI-1794	870.7	61.05
			lb/hr	kg/hr
Flow Rate:	Slurry Outlet	FI-1768	11658.9	5288.7
			g/cc	
Density:	Slurry Outlet	DI-1768	1.001	

SLURRY COOLER

Temperatures:		deg F	deg C
Slurry Outlet	TIC-1754	431.3	221.8

Oil Inlet	TI-1780	423.0	217.2

FILTERS

			deg F	**deg C**				**lb/hr**	**kg/hr**
Temperature:	Slurry Outlet	TI-1783	425.5	218.6	Flow Rate:	Wax	FI-1761	34.044	15.442
			psig	**bara**				**g/cc**	
Pressure:	Slurry Inlet	PI-1756	752.4	52.89	Density:	Wax	DI-1761	0.718	
Diff. Press.:	Longitudinal		**psi**	**mbar**				**ft/sec**	**m/sec**
	Thru D & C	PDI-1772	16.2	1117	Linear Vel.:	Slurry thru	Calculated	9.50	2.896
	Thru B & A	PDI-1773	14.9	1025		Each Element			
	Trans-membrane							**ft/sec**	**mm/sec**
	Membrane A	PDI-1774	0.4	26	Superfic. Vel.:	Liquid Upflow	Calculated	0.21	6.302
	Membrane B	PDI-1775	8.8	607		thru Reactor			
	Membrane C	PDI-1776	15.9	1096					
	Membrane D	PDI-1777	23.5	1622					

Reactor Temperatures

	Reactor Ht, Ft		**Deg F**	**Deg C**
Nozzle N1	24.25	TI-626-1	433.6	223.1
Nozzle N2	20.25	TI-626-2	441.0	227.2
Nozzle N3	18.25	TI-190-2A	440.9	227.2
Nozzle N4	16.25	TI-626-3	440.4	226.9
Nozzle N5	14.25	TI-190-3	439.9	226.6
Nozzle N7	10.25	TI-1781A	441.0	227.2
		TI-1781B	440.8	227.1
		TI-1781C	440.7	227.0
		TI-1781D	440.6	227.0
Nozzle N8	8.083	TI-626-5	436.2	224.6
Nozzle K4	7.75	TI-190-4	443.1	228.4
Nozzle O	4.792	TI-626-6	438.3	225.7
Reactor Temp. Avg. (Noz N3 thru Noz O)			440.2	226.8

Product Separation

			deg F	**deg C**
Temperatures	27.11 In	TI-1-08	-22.0	-30.0
	2138 Tube In	TI-723	415.7	213.2
	22.14 Out	TIC-725	281.9	138.8
	21.65 Out	TIC-1-11A	74.6	23.7
	27.13 Lt Wax	TI-744	109.9	43.3
	28.30 Hv Wax	TI-515	309.7	154.3
			%	
Levels	27.12	LIC-639	5.1	
	22.14	LIC-688	26.2	
	22.10	LIC-220	40.0	
	22.15	LIC-242	43.8	
	27.13	LI-203	64.9	
	28.30	LI-1792	28.1	
			psig	**bara**
Pressure	27.13	PIC-202	16.50	2.15

Miscellaneous Data

Overall Plant Material Balance		%	104.75
100*(22.10 Purge+22.11 Purge+Heavy Wax+Light Wax+Light HC+Water)/ (LP Fresh Feed+HP H2)			
Reactor GHSV	Nm3 Rxt Feed/m3 3-phase slurry volume/hr		1994
Catalyst GHSV	Nm3 Rxt Feed/m3 particle volume/hr		11092
Catalyst Volume in the Reactor		litres particle volume	262.4
Inlet Superfic. Vel. based on Avg Reactor Temp.		cm/sec	12.98
Inlet Sup. Vel. based on Rxt Inlet Temp (TI-1-12A)		cm/sec	12.28
CO Conversion Rate, gmole CO converted/lit particle volume/hr			18.34
grams of HC (CH2.1) produced/lit particle volume/hr			255.21

N2 Balance Across Reactor	Plant N2 Balance	Feed N2 Balance
(vary prod gas flow factor-step1)	(vary purge1 flow factor-step2)	(vary 01.20 discharge flow factor-step3)
101.35	100.03	99.35
		(Redundancy converges both to 100%)
Water/Oxygen Balance		**Prod. Gas N2 Balance**
		(vary 01.20 discharge flow factor-step3)
98.30		99.31

Wax/Liquid Production Rates

	lbs/hr	kg/hr
Heavy Wax (27.10/28.30, Reactor Temp. Cut)	34.04	15.44
Light Wax (22.14/27.13, 392 deg F Cut)	0.00	0.00
Light HCs (22.10/22.16, 100 deg F Cut)	38.34	17.39
Water (22.10/22.16, 100 deg F Cut)	208.16	94.42

Slurry Conc. Based on Density Measurements

2-Phase Slurry Concentration	reduced particle vol %	25.51
	catalyst wt%	36.04

Water Saturation Calculations for the Reactor

	Based on CO, CO2 Meas.:		Based on Water Production:	
	psia	**mbara**	**psia**	**mbara**
Calculated Water Partial Pressure @ Reactor Outlet	30.76	2121	30.26	2086
Saturated Water Pressure @ Reactor Outlet	382.9	26403	382.9	26403
Water Partial Pressure as % of Sat. Pressure @ Reactor Outlet	8.03%		7.90%	
	deg F	**deg C**	**deg F**	**deg C**
Saturated Water Temperature @ Reactor Outlet	251.4	121.9	250.4	121.3

RUN NO.: AF-R15.1C **TITLE: LIQUID PHASE FISCHER-TROPSCH (III) SYNTHESIS IN LAPORTE AFDU**

Start Date / Time	10/17/1996	12.00
End Date / Time	10/18/1996	12.00

On-stream Time From Start-up (hr)	
Start	64.00
End	88.00

Reaction Conditions:					
Temperature	average	deg F	440.1	deg C	226.7
Pressure	PIC-201	psig	710.0	bara	49.97
Space Velocity		sL/kg-hr	7612		
Superficial Gas Vel. - Inlet		ft/sec	0.43	cm/sec	13.18
(based on average reactor temp)					
Recycle Ratio			3.20		

Slurry Data:				
Catalyst Oxide Wt (Reactor)	lbs	860	kg	390.1
Slurry Concentration by NDG	wt%	42.4		
Slurry Concentration by DP	wt%	39.9		
Slurry Level by NDG	% NDG Span	95.2		
Slurry Height	ft	20.57	meters	6.27
Average Gas Holdup by NDG	Vol%	41.4		
Average Gas Holdup by DP	Vol%	35.8		

Performance Results	
CO Conversion per pass, mole %	9.1
H2 Conversion per pass, mole %	15.8
CO + H2 Conversion per pass, mole %	13.0
Plant CO Conversion, mole%	36.8
Plant H2 Conversion, mole%	54.7
Plant CO+H2 Conversion, mole%	48.4
CO Conversion Rate,	11.6
gmole CO converted/kg cat oxide-hr	
HC Production Rate,	163.4
grams of HC (CH2.1) produced/kg cat oxide-hr	
Reactor Productivity (STY)	43.85
grams of H C (CH2.1)/lit of reactor vol. - hr	
H2/CO in Fresh Feed, mole/mole	1.82
H2/CO in Reactor Feed, mole/mole	1.41
H2/CO Usage Ratio, mole/mole	2.43
H2/CO in Outlet, mole/mole	1.30
CO2 Selectivity, mole %	0.41
HC Selectivity (CO2 free) wt%:	
CH4	13.88
C2H6	1.50
C2H4	1.01
C3H8	1.90
C3H6	3.57
SUM C4H10	2.57
SUM C4H8	3.40
SUM C5H11	5.47

Reactor Heat Balance	**Btu/hr**	**kW**
Chemical Heat Production by Reaction	708882	207.75
Sensible Gas Heat	-114281	-33.49
Sensible Oil Heat	-453176	-132.81
Sensible Wax Heat	-80173	-23.50
Estimate of Heat Loss from Catalyst Drying Data	-35000	-10.26
% Heat Balance based on Reaction Heat	96.30	

Mass Balance	**Reactor lb/hr**	**Plant lb/hr**	**Feed lb/hr**	**Prod Gas lb/hr**
Fresh Feed		823	823	
HP H2 Feed				
Recycle Feed			3317	3317
Reactor Feed	4162		4162	
Total In	4162	823		
Prod Gas	3839			3839
Main Purge		541		541
22.11 Purge	45.7	45.7		
HC Phase	36.9	36.9		
AQ Phase	200.1	200.1		
Heavy Wax	34.0	34.0		
Light Wax				
Total Out	4156	857		
Mass Balance, %	99.8	104.2	100.5	100.5

RUN NO.: AF-R15.1C **TITLE: LIQUID PHASE FISCHER-TROPSCH (III) SYNTHESIS IN LAPORTE AFDU**

Compositions (mole%):		**LP FRESH FEED**	**HP FRESH FEED (H2)**	**RECYCLE FEED**	**REACTOR FEED GAS**	**PRODUCT GAS**	**MAIN (22.10) PURGE**	**22.11 PURGE**	**REACTOR OUTLET (estimated)**
Components									
1	H2	62.08	100.00	50.14	52.89	50.14	50.14	48.34	48.04
2	N2	3.71	0.00	7.12	6.32	7.12	7.12	6.93	6.82
3	CO	34.20	0.00	38.47	37.62	38.47	38.47	38.24	36.85
4	CH4	0.00	0.00	2.93	2.18	2.93	2.93	3.12	2.81
5	CO2	0.00	0.00	0.12	0.09	0.12	0.12	0.16	0.11
6	ETHANE	0.00	0.00	0.17	0.13	0.17	0.17	0.23	0.16
7	ETHYLENE	0.00	0.00	0.02	0.00	0.02	0.02	0.03	0.02
8	PROPANE	0.00	0.00	0.15	0.11	0.15	0.15	0.29	0.14
9	PROPYLENE	0.00	0.00	0.27	0.20	0.27	0.27	0.51	0.26
10	ISOBUATNE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11	N-BUTANE	0.00	0.00	0.13	0.10	0.13	0.13	0.38	0.13
12	T-BUTENE-2	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00
13	BUTENE-1	0.00	0.00	0.15	0.12	0.15	0.15	0.20	0.15
14	ISOBUTYLENE	0.00	0.00	0.00	0.00	0.00	0.00	0.24	0.00
15	C-BUTENE-2	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00
16	SUM C5	0.00	0.00	0.19	0.13	0.19	0.19	0.63	0.18
17	SUM C6	0.00	0.00	0.08	0.08	0.08	0.08	0.51	0.08
18	SUM C7	0.00	0.00	0.04	0.03	0.04	0.04	0.14	0.04
19	SUM C8	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01
20	SUM C9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
21	SUM C10	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00
	H2O								4.11
	HC								0.10
	LIGHT WAX								0.000
	TOTAL	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Mole Wt	lb/lb mole	11.87	2.02	14.96	14.26	14.96	14.96	16.15	15.21
Flows	SCFH	26798.58	0.00	85721.03	112858.42	99218.39	13971.76	1093.39	103576.37
	lb mole/hr	69.31	0.00	221.70	291.89	256.61	36.14	2.83	267.88
	lb/hr	823.03	0.00	3316.81	4162.20	3839.06	540.61	45.68	4074.36
	Nm3/hr	705.24	0.00	2255.85	2970.01	2611.05	367.68	28.77	2725.74
	kgmol/hr	31.44	0.00	100.56	132.40	116.40	16.39	1.28	121.51
	kg/hr	373.32	0.00	1504.49	1887.96	1741.39	245.22	20.72	1848.12
Temperature	deg F	277.9	86.7	124.9	247.0	85.0	83.2	79.3	
	deg C	136.6	30.4	51.6	119.5	29.4	28.5	26.3	
Pressure	psig	762.5	780.5	818.1	749.6	662.2	671.6	26.9	
	bara	53.59	54.83	57.42	52.69	46.67	47.32	2.86	

Reactor Heat Balance

		deg F	deg C			lb/hr	kg/hr		Btu/lb-deg F	J/gm-deg C		lb/ft3	kg/m3
Gas:													
Inlet Temp	TI-1-12A	387.1	197.3	Inlet Flow	RXT FEED	4162	1888.0	Inlet Ht Cap.	0.518	2.168			
Outlet Temp	RXT AVG	440.1	226.7	Outlet Flow	RXT FEED-WAXPROD	4128	1872.6	Outlet Ht Cap.	0.501	0.098			
Oil:													
Inlet Temp	TI-1-14B	409.9	210.0	Inlet Flow	*FI-619	50224	22781.5	Inlet Ht Cap.	0.658	2.754	Inlet Density	45.34	726.22
Outlet Temp	TI-1780	423.8	217.7	Outlet Flow	*FI-619	50224	22781.5	Outlet Ht Cap.	0.666	2.786			
Slurry:													
Inlet Temp	TI-1783	428.4	220.2	Inlet Flow	*FI-1768-61	13737	6230.9	Inlet Ht Cap.	0.500	2.092			
Outlet Temp	RXT AVG	440.1	226.7	Outlet Flow	*FI-1768	13771	6246.3	Outlet Ht Cap.	0.500	2.092			
					*based on								

Reactor Differential Pressures

	DP NOZZLES		Differential Pressures: psi	mbar	Heights: ft	meters	Density - 3 Phase: lb/ft3	kg/m3	Gas Hold-up vol%
					(based on flange loc.)				
Reactor Height:									
13.75 to 9.25 ft	Kl -K3	PDI-1778	1.33	91.5	4.56	1.391	41.88	670.9	35.43
9.25 ft to 4.33 ft	K3-K5	PDI-1779	1.46	100.7	5.08	1.549	41.38	662.8	36.23
Total Reactor	K6-OUT	PDI-631	5.77	398.1	95.23	29.026	9.48	151.9	86.69
Sparger	K6-IN	PDI-633	1.38	95.0					

DEGASSER

Temperatures:			deg F	deg C	
6.5 ft Height	TI-1762		322.6	161.4	
3.5 ft Height	TI-1763		420.0	215.5	
0.5 ft Height	TI-1764		436.0	224.4	
Liquid Level:					
% Level	LI-1765		18.1		
Slurry Height		ft	2.29	meters	0.698

SLURRY PUMP

			deg F	deg C
Temperature:	Slurry Inlet	TI-1755	435.1	224.0
	Seal Oil Outlet	TI-1795	116.4	46.9
			psig	bara
Pressure:	Seal Oil Outlet	PI-1794	878.2	61.56
			lb/hr	kg/hr
Flow Rate:	Slurry Outlet	FI-1768	13770.6	6246.6
			g/cc	
Density:	Slurry Outlet	DI-1768	0.995	

SLURRY COOLER

Temperatures:		deg F	deg C
Slurry Outlet	TIC-1754	431.9	222.2

Oil Inlet	TI-1780	423.8	217.7

FILTERS

			deg F	**deg C**				**lb/hr**	**kg/hr**
Temperature:	Slurry Outlet	TI-1783	428.4	220.2	Flow Rate:	Wax	FI-1761	33.954	15.401
			psig	**bara**				**g/cc**	
Pressure:	Slurry Inlet	PI-1756	762.3	53.57	Density:	Wax	DI-1761	0.718	
Diff. Press.:	Longitudinal		**psi**	**mbar**				**ft/sec**	**m/sec**
	Thru D & C	PDI-1772	21.5	1485	Linear Vel.:	Slurry thru Each Element	Calculated	11.29	3.442
	Thru B & A	PDI-1773	18.9	1300					
	Trans-membrane							**ft/sec**	**mm/sec**
	Membrane A	PDI-1774	-1.5	-105	Superfic. Vel.:	Liquid Upflow thru Reactor	Calculated	0.025	7.495
	Membrane B	PDI-1775	8.6	593					
	Membrane C	PDI-1776	17.3	1191					
	Membrane D	PDI-1777	28.0	1931					

Reactor Temperatures

	Reactor Ht, Ft		Deg F	Deg C
Nozzle N1	24.25	TI-626-1	432.7	222.6
Nozzle N2	20.25	TI-626-2	440.8	227.1
Nozzle N3	18.25	TI-190-2A	440.9	227.2
Nozzle N4	16.25	TI-626-3	440.3	226.8
Nozzle N5	14.25	TI-190-3	439.9	226.6
Nozzle N7	10.25	TI-1781A	440.9	227.2
		TI-1781B	440.8	227.1
		TI-1781C	440.3	226.8
		TI-1781D	440.5	226.9
Nozzle N8	8.083	TI-626-5	436.2	224.5
Nozzle K4	7.75	TI-190-4	443.1	228.4
Nozzle O	4.792	TI-626-6	438.3	225.7
Reactor Temp. Avg. (Noz N3 thru Noz O)			440.1	226.7

Product Separation

			deg F	**deg C**
Temperatures	27.11 In	TI-1-08	73.6	23.1
	2138 Tube In	TI-723	412.9	211.6
	22.14 Out	TIC-725	290.0	143.3
	21.65 Out	TIC-1-11A	77.8	25.4
	27.13 Lt Wax	TI-744	110.4	43.5
	28.30 Hv Wax	TI-515	231.3	110.7
			%	
Levels	27.12	LIC-639	5.5	
	22.14	LIC-688	41.2	
	22.10	LIC-220	49.8	
	22.15	LIC-242	50.0	
	27.13	LI-203	76.1	
	28.30	LI-1792	12.2	
			psig	**bara**
Pressure	27.13	PIC-202	17.00	2.19

Miscellaneous Data

Overall Plant Material Balance 100*(22.10 Purge+22.11 Purge+Heavy Wax+Light Wax+Light HC+Water)/ (LP Fresh Feed+HP H2)	%	104.15
Reactor GHSV	Nm3 Rxt Feed/m3 3-phase slurry volume/hr	2043
Catalyst GHSV	Nm3 Rxt Feed/m3 particle volume/hr	11341
Catalyst Volume in the Reactor	litres particle volume	261.8
Inlet Superfic. Vel. based on Avg Reactor Temp.	cm/sec	13.18
Inlet Sup. Vel. based on Rxt Inlet Temp (TI-1-12A)	cm/sec	12.41
CO Conversion Rate, gmole CO converted AR particlevolume/hr		17.34
grams of HC (CH2.1) produced/Ift particle volume/hr		243.44

N2 Balance Across Reactor (vary prod gas flow factor-step1)	**Plant N2 Balance** (vary purgel flow factor-step2)	**Feed N2 Balance** (vary 01.20 discharge flow factor-step3)
99.01	99.97	100.51 (Redundancy converges both to 100%)
Water/Oxygen Balance		**Prod. Gas N2 Balance** (vary 01.20 discharge flow factor-step3)
100.97		100.48

Wax/Liquid Production Rates

	lbs/hr	**kg/hr**
Heavy Wax (27.10/28.30, Reactor Temp. Cut)	33.95	15.40
Light Wax (22.14/27.13, 392 deg F Cut)	0.00	0.00
Light HCs (22.10/22.16, 100 deg F Cut)	36.86	16.72
Water (22.10/22.16, 100 deg F Cut)	200.09	90.76

Slurry Conc. Based on Density Measurements

2-Phase Slurry Concentration	reduced particle vol %	24.95
	catalyst wt%	35.46

Water Saturation Calculations for the Reactor

	Based on CO, CO2 Meas.:		**Based on Water Production:**	
	psia	**mbara**	**psia**	**mbara**
Calculated Water Partial Pressure @ Reactor Outlet	29.18	2012	29.45	2031
Saturated Water Pressure @ Reactor Outlet	382.7	26383	382.7	26383
Water Partial Pressure as % of Sat. Pressure @ Reactor Outlet	7.63%		7.70%	
	deg F	**deg C**	**deg F**	**deg C**
Saturated Water Temperature @ Reactor Outlet	248.3	120.2	248.9	120.5

	Compositions, wt%				Light HC Phase	
Carbon No.	1-Alcohols wt%	2-Olefins wt%	n-Paraffins wt%	1-Olefins wt%	iso-Paraffins wt%	Total wt%
1						0.00
2						0.00
3	0.01	0.00	0.01	0.00	0.00	0.03
4	0.13	0.02	0.12	0.05	0.00	0.31
5	0.35	0.09	0.82	0.54	0.04	1.83
6	0.47	0.22	2.30	1.88	0.14	5.02
7	0.51	0.30	3.93	3.42	0.30	8.45
8	0.49	0.34	4.73	4.29	0.48	10.33
9	0.42	0.36	4.87	4.32	0.65	10.62
10	0.39	0.39	4.78	3.89	0.64	10.10
11	0.26	0.33	4.64	3.29	0.57	9.09
12	0.22	0.35	4.35	2.69	0.50	8.11
13	0.23	0.33	4.00	1.96	0.54	7.06
14	0.20	0.29	3.54	1.38	0.55	5.96
15	0.14	0.25	3.00	0.92	0.51	4.83
16	0.12	0.19	2.43	0.73	0.37	3.83
17	0.00	0.13	1.99	0.49	0.28	2.90
18	0.00	0.13	1.54	0.33	0.36	2.36
19	0.00	0.12	1.16	0.20	0.23	1.71
20	0.00	0.06	0.93	0.11	0.30	1.40
21			1.14			1.14
22			0.88			0.88
23			0.90			0.90
24			0.84			0.84
25			0.61			0.61
26			0.50			0.50
27			0.49			0.49
28			0.30			0.30
29			0.15			0.15
30			0.10			0.10
> 30			0.17			0.17
Total	3.95	3.89	55.23	30.49	6.44	100.00

Composition, Wt% Compound	Aqueous Phase
Ethanol	1.82
Water by diff.	98.18
Total	100.00

	Composition, wt%
Carbon No.	Reactor Wax
12	0.02
13	0.05
14	0.15
15	0.28
16	0.45
17	0.64
18	0.86
19	1.14
20	1.33
21	1.53
22	1.79
23	2.05
24	2.34
25	3.02
26	6.79
27	22.97
28	10.73
29	2.65
30	2.40
31	2.30
32	2.36
33	3.55
34	6.68
35	2.16
36	1.64
37	1.31
38	1.18
39	1.10
40	1.08
41	0.93
42	0.82
43	0.73
44	0.77
45	0.64
46	0.61
47	0.58
48	0.54
49	0.50
50	0.46
> 50	8.89
Total	100.00

RUN NO.: AF-R15.1C

TITLE: LIQUID PHASE FISCHER-TROPSCH (III) SYNTHESIS IN LAPORTE AFDU

Elemental Balance:

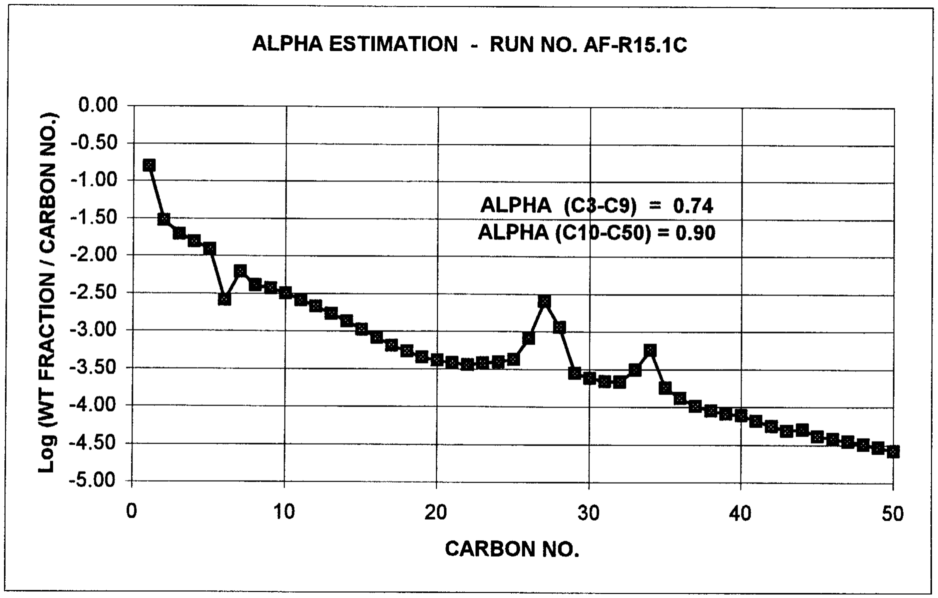
	Total lb/hr	C lb/hr	H lb/hr	O lb/hr	N lb/hr
Reactor Feed Gas	4162.30	1519.81	360.72	1765.13	516.63
Main Gas Outlet	3838.67	1421.47	316.71	1588.98	511.52
27.10 Reactor Wax	33.95	28.96	4.99	0.00	0.00
22.14 Light Wax	0.00	0.00	0.00	0.00	0.00
22.18 HC Phase	36.86	31.17	5.51	0.18	0.00
22.18 AQ Phase	200.09	1.90	22.30	175.89	0.00
Total Out	4109.57	1483.50	349.51	1765.05	511.52
% Balance	98.7	97.6	96.9	100.0	99.0

Product Distribution: Selectivity (wt%)

Methane (C1)	15.6
Gas (C2 - C4)	17.9
Gasoline (C5 - C11)	24.3
Diesel (C12 - C18)	11.5
Wax (C19+)	30.6
Total	100.0
HC Production Rate based on Liquid Data, grams HC produced/kg-cat oxide hr	138.5

Alpha Estimate:

C3 - C9	1	0.74
C10-C50	2	0.90



APPENDIX C

Fischer-Tropsch III Product Hydrocarbon Analysis

F-T III Light HC Product Analysis			
Sample ID (SSFI)	#6		
Date	11/04/96		
Condition	from trailer		
(Carbon distribution by capillary GC)			
Carbon No.	**%w**	**Carbon No**	**%w**
1	0.020	26	0.513
2	0.010	27	0.509
3	0.030	28	0.310
4	0.318	29	0.156
5	1.888	30	0.100
6	5.178	31	0.060
7	8.726	32	0.043
8	10.664	33	0.030
9	10.962	34	0.021
10	10.425	35	0.007
11	9.382	36	0.007
12	8.368	37	0.005
13	7.285	38	0.002
14	6.152	39	0.000
15	4.989	40	0.000
16	3.955	41	0.000
17	2.991	42	0.000
18	2.435	43	0.000
19	1.769	44	0.000
20	1.441	45	0.000
21	1.173	46	0.000
22	0.904	47	0.000
23	0.934	48	0.000
24	0.871	49	0.000
25	0.632	50	0.000

F-T III Light HC Product Analysis						
Sample ID (SSFI)	#6					
Date	11/04/96					
Condition	from trailer					
(Olefins and alcohols content per carbon number by capillary GC)						
Assumption: all unidentified GC peaks are assumed iso-paraffins						
Type	**n-paraffins**	**iso-paraffins**	**1-alcohol**	**1-olefin**	**2-olefin**	**total**
Carbon No.	**%w**	**%w**	**%w**	**%w**	**%w**	**%w**
4	37.5	0.0	40.6	15.6	6.3	100.0
5	44.7	2.1	18.9	29.5	4.7	100.0
6	45.9	2.9	9.4	37.4	4.4	100.0
7	46.5	3.5	6.0	40.4	3.5	100.0
8	45.8	4.7	4.8	41.6	3.3	100.0
9	45.9	6.1	4.0	40.7	3.4	100.0
10	47.4	6.3	3.9	38.5	3.9	100.0
11	51.1	6.3	2.9	36.2	3.6	100.0
12	53.7	6.2	2.7	33.1	4.3	100.0
13	56.6	7.6	3.3	27.8	4.6	100.0
14	59.5	9.2	3.4	23.1	4.8	100.0
15	62.2	10.6	3.0	19.1	5.2	100.0
16	63.3	9.5	3.0	19.1	5.0	100.0
17	68.8	9.6	0.0	16.9	4.7	100.0
18	65.3	15.1	0.0	13.9	5.7	100.0
19	68.0	13.5	0.0	11.8	6.7	100.0
20	66.9	21.4	0.0	7.6	4.1	100.0

F-T III Product Wax Analysis

(Carbon distribution of wax samples by high temp. GC)

Sample ID (SSFI)	#7	#8		Sample ID (SSFI)	#7	#8
Date	10/18/1996 9:15	10/16/1996 9:30		Date	10/18/1996 9:15	10/16/1996 9:30
Type	light ex 27.13	heavy ex 28.30		Type	light ex 27.13	heavy ex 28.30
Condition	15.1	15.1		Condition	15.1	15.1
Carbon No.	**%w**	**%w**		Carbon No.	**%w**	**%w**
11	0.0292	0.0016		56	0.0226	0.2959
12	0.0592	0.0156		57	0.0576	0.2872
13	0.2536	0.0549		58	0.0169	0.2786
14	0.8522	0.1487		59	0.0326	0.2493
15	1.8564	0.2805		60	0.0257	0.2378
16	2.9731	0.4455		61	0.0296	0.2206
17	4.1722	0.6375		62	0.0194	0.2129
18	5.241	0.8575		63	0.0161	0.1991
19	5.8694	1.1388		64	0.0138	0.1906
20	5.9348	1.3266		65	0.0135	0.181
21	6.0465	1.5325		66	0.0029	0.1776
22	6.8166	1.7861		67	0.0052	0.1663
23	7.3826	2.0485		68	0.004	0.1616
24	6.4555	2.3427		69	0.0039	0.1508
25	5.5545	3.019		70	0.0037	0.1468
26	6.018	6.7933		71	0.003	0.1405
27	11.5451	22.9744		72	0.0018	0.137
28	6.9542	10.7298		73	0.0027	0.133
29	2.2515	2.649		74	0.0026	0.1306
30	1.7879	2.4019		75	0.0017	0.1245
31	1.5409	2.3021		76	0.0012	0.1224
32	1.3263	2.3587		77		0.1174
33	1.455	3.549		78		0.1115
34	0.5816	6.6754		79		0.1128
35	1.6085	2.1632		80		0.1043
36	1.503	1.6353		81		0.106
37	0.6079	1.3106		82		0.1011
38	0.4422	1.1821		83		0.1013
39	0.3741	1.0967		84		0.0995
40	0.3294	1.0783		85		0.0932
41	0.2665	0.9347		86		0.0936
42	0.219	0.821		87		0.092
43	0.1783	0.7332		88		0.0851
44	0.2174	0.7701		89		0.0854
45	0.1545	0.64		90		0.081
46	0.1398	0.6078		91		0.0785
47	0.122	0.5752		92		0.0769
48	0.1054	0.5362		93		0.0762
49	0.0937	0.4958		94		0.0754
50	0.0784	0.4585		95		0.0707
51	0.0688	0.4217		96		0.0707
52	0.0551	0.3897		97		0.0692
53	0.0533	0.365		98		0.0601
54	0.0449	0.337		99+		1.1527
55	0.0431	0.3195		Total	99.9431	99.9999

F-T III Total Carbon Distribution (Combined purge gas, light hydrocarbon and wax in production ratio)				
Condition	15.1C			15.1C
Light HC	Sample #6			Sample #6
Heavy Wax	Sample #8			Sample #8
Carbon No.	**%w**		**Carbon No.**	**%w**
1	15.318		51	0.120
2	1.906		52	0.110
3	6.411		53	0.103
4	6.157		54	0.096
5	5.776		55	0.091
6	4.702		56	0.084
7	4.221		57	0.081
8	3.652		58	0.079
9	3.373		59	0.071
10	3.208		60	0.067
11	2.887		61	0.063
12	2.579		62	0.060
13	2.257		63	0.056
14	1.935		64	0.054
15	1.615		65	0.051
16	1.343		66	0.050
17	1.101		67	0.047
18	0.992		68	0.046
19	0.867		69	0.043
20	0.819		70	0.042
21	0.795		71	0.040
22	0.784		72	0.039
23	0.868		73	0.038
24	0.932		74	0.037
25	1.050		75	0.035
26	2.083		76	0.035
27	6.668		77	0.033
28	3.136		78	0.032
29	0.799		79	0.032
30	0.712		80	0.030
31	0.671		81	0.030
32	0.682		82	0.029
33	1.015		83	0.029
34	1.898		84	0.028
35	0.615		85	0.026
36	0.466		86	0.027
37	0.373		87	0.026
38	0.336		88	0.024
39	0.311		89	0.024
40	0.306		90	0.023
41	0.265		91	0.022
42	0.233		92	0.022
43	0.208		93	0.022
44	0.218		94	0.021
45	0.181		95	0.020
46	0.172		96	0.020
47	0.163		97	0.020
48	0.152		98	0.017
49	0.141		99+	0.327
50	0.130		total	100.000

APPENDIX D

Fischer-Tropsch IV Run Chronology

Fischer-Tropsch IV Run - March/April 1998

2 March 1998

10:30 Installed shell's sparger and 5 erosion pieces (4 on ht exch. tubes, 1 on sparger)

9 March 1998

15:00 Nuke scan completed at 4 different N_2 pressures (calibration).

11 March 1998

12:00 Tracers completed gamma scan with low pressure N_2 and cold oil (2 scans at 90°for each condition).

13 March 1998

Operated unit at reduction flows and pressures.

21 March 1998

9:00 Started N_2 flow and heat-up.
17:30 Started Syngas for carbon burnout.

22 March 1998

11:30 Syngas stopped.
Tracerco condensing hot oil gamma scan.
cooled under N_2, drained the system.

23 March 1998

11:30	Durasyn-166 loading = 50 lbs	
	Wax loading:	Drum 1 = 201 lbs (4 bags)
	(callista-158)	Drum 2 = 198 lbs (4 bags)
	Wax temp = 95°F	Drum 3 = 199 lbs (4 bags)
		Drum 4 = 211 lbs (4 bags)
		Drum 5 = 201 lbs (4 bags)
		Drum 6 = 102 lbs (2 bags)
		Total = 1112 lbs (22 bags)
15:45	Catalyst loading:	Drum #5 = 235 lbs
	Wax temp = 173°F)	Drum #1 = 252 lbs
		Drum #2 = 14 lbs
		Total = 501 lbs

18:00 Transferred slurry to reactor
N_2 on at Rxt bottom
Rxt slurry level = 111~ 118" on tape
Loaded flash Durasyn - 164 = 210 lbs
18:40 Transferred flash oil to 2710
Rxt level now @ 142-154" on tape
19:00 Loaded 347 lbs of Durasyn -164 ~28.30 to prepare for product receiving.
Inspection of 28.30 after the flush indicated clean wall, thin film coating on the bottom but no lumps.
19:00 Drying started
20:00 Rxt @ 285°F, 145 psig
Rxt level = 157 - 166"

N_2 flow = 22,000 scfh

21:00 Reactor @ 284.5F, 132,1 psi, Nuke scan done
Reactor level → 157” - 166”

21:30 Zeolite tubes in place

22:00 Reactor 285 F 132 psi
level → 157-166”
Temp ramp started

23:00 Reactor level at 180”. Temperature at 345°F. 128 psig panametrics on reactor outlet at 390 ppmv and climbing.

24 March 1998

00:00 Reactor level above 199”. Temperature at 405°F. 134 psig panametrics on reactor outlet has leveled off at about 470 ppm_v.

01:00 Reactor level above 199”. Temperature at 465°F. 128 psig panametrics on reactor outlet at 380 ppmv and drifting down.

01.30 Took zeolite tubes off-line for weighing.

02:00 Reactor level about 211”. Temperature at 503°F. 126 psig panametrics on reactor outlet at 390 ppm_v and pretty steady.

03:00 Reactor level <211”. Temperature at 512°F. 123 psig panametrics on reactor outlet at 370 ppmv.

03:30 Nuke scan. AJ swapped U.O. pumps because 10.53A seal was leaking oil, but 10.53B is smoking like crazy now, too. At 03:50, decided to drop temperature to 480°F to prolong seal life on 10:53B long enough to fix 10.53A in the morning.

05:00 Reactor temperature at 480°F. Pump seal leak has definitely improved. Reactor level <197”. Panametrics on reactor outlet at 330 ppm_v and steady over the last ½ hour.

05:40 Weighed zeolite tubes. W.T.M. on 22.14 isn’t working. Regulator plugged at 22.14.

06:00 Reactor level at 199”. Panametrics on reactor outlet at 275 ppm_v.

07:30 Rxt level @ 190-197”
Rxt temp @ 479°F, Rxt Pr = 133.1
FI-187A = 21.75 mscfh, FI-126A = 21.73
SP1MW = 25, SP2MW = 27.8 now set to, SP4MW = 27.8 now set to 28

09:30 Rxt level @ 190”

11:00 Rxt level @ 186”
Increasing pressure (Rxt) to 203 psig to reduce wax loss.

13:30 Rxt level @180”, nuke scan done at 14:10. Dropping 22.16 temp to 194°F.

15:00 Rxt level @ 174”

15:40 Rxt level @ 170”

16:00 (22.14) Regulator cleared after 3 attempts
Both 27.10 and 22.14 samples now flowing @ 288 lit/hr

18:00 Zeolite tubes weighed
Download data from DEC 16:00 - 18:00
File: FT4DRTI1.TXT
Panametric average conc. From 16:00 - 18:00 → 90.71 for 22.14
Zeolite tube weight for 22.14 @16:00 @ 16:00 1718.89g
@ 18:00 @ 18:00 1718.97g
Δ = 0.08 g
flow meter @ 16:00 671.168 = 0.004444 grade H_2O
@ 18:00 671.628
460 lit. → 20.536 gmole gas

$$conc = \frac{0.004444\ gmole\ H2O}{20.536\ gmol\ gas}\ x10^6$$
$$= 216\ ppmv$$

216. x $\frac{531}{492}$ = 233 ppmv (temp correction for 71F)

Correction factor = $\frac{233}{90.7}$ = 2.57

target = 100 ppmv

corrected target (for panametrics) = <u>40 ppmv</u>

20:00 Zeolite tubes weighed T = 66.5F

22.14 Δ weight = 0.13g between 18:00 and 20:00
Δ flow = 247 L

27.10 Δ weight = 0.12g
Δ flow = 631L

Regulators being cleared.

20:20 Reactor level @ 174-180" T=429

21:40 Zeolite tubes lined up.

21:50 Bringing in H_2. Very slow going at the start.

22:25 Rxt level at 182".

22:45 Panametrics on 22.14 at 695 ppm and appears to be topping out. H_2 analyses coming thru at 3.5 - 4.0% H_2.

23:15 Reactor level at 181". Panametrics on 22.14 at 730 ppm.

25 March 1998

00:15 Reactor level at 180". Panametrics on 22.14 at 770 ppm.

00:50 Drained 22.14 to prep tank 21 nuts to 16 ½ nuts. Also returned some inventory from 27.12 to reactor. Reactor level up to 190".

01:00 Did a brief test on N_2 to check panametrics response. Looks Good.

01:40 Weighed zeolite tubes:

22.14 flow = 675,700 - 674,545 = 1155 l with 1.05 g accumulation = 0.0583 gal H_2O

$$conc_{avg} = \frac{0.0583\ g\ mol\ H2O}{51.56\ g\ mol\ gas}\ x\ 10^6\ \ X\ \frac{524}{492} = 1200\ PPM$$

02:00 Panametrics response has been dropping for about an hour. Now down to 685 ppm. Reactor level >199".

02:50 Nuke scan. Reactor level at 212"!

03:10 Increasing H_2 flow. Panametrics responded in <10 minutes. Minimum was about 510 ppm.

03:35 Panametrics peaked out at about 565 ppm. H_2 concentration at about 8%, so still increasing slightly to try to get 10%.

04:00 H_2 concentration at 10.5%. Panametrics at 530 ppm and dropping.

04:15 Checked flows on panametrics. 27.10 is still just >5 l/min.
22.14 is still just <4 l/min.

04.30 Panametric down to 410 ppm. Increasing H_2 to 25%.

05:00 Panametrics reading finally bottomed out at 320 ppm. H_2 concentration up to 22.7%.

05:30 Panametrics topping out at about 550 ppm.

05:45 Weighed zeolite tubes:

22.14 flow = 1028 l w/ 0.51 g accumulation = 0.0283 gmol H_2O

$$conc_{avg} = \frac{0.0283\ gmol\ H2O}{45.89\ gmol\ gas} x10^6\ x \frac{525}{492} = 660\ ppm$$

(Panametric avg. = 518.6 ppmv)
Flows are still good thru the panametrics. H_2 contraction actually topped out at 29%.
06:30 Panametrics reading at 500 ppm and easing down slowly.
07:45 Rxt level @ 199 - 211" on tape
Rxt pressure drifted to 180 psig, increasing to 203 psig.
09:00 Rxt level @ 199-211" on tape
09:45 Weighed zeolite tube
22.14 wt gain = 1721.30 - 1720.30 - 1720.66 = 0.64g
22.14 vol. of gas = 677,809 - 676,757 = 1052 ft

$\therefore$ H_2O conc. by tube = $$\frac{0.64/18}{(1052\ x \frac{492}{531.1})/22.4} x\ 10^6$$
$$= 817.2\ ppmv$$

22.14 Avg. H_2O conc. by panametric = (491.2 + 434.3 + 376.3 + 343)/4 = 411.2 ppmv
11:10 Rxt level @ 199 - 211" on tape.
11:15 Increasing H_2 conc. from ~30% to 50%.
13:00 H_2 conc. @ 55%.
13:30 Reactor level between 190" and 197" on tape. T = 430, P = 204.6
14:00 Zeolite tubes weighed.
22.14 Δ weight = 1721.42 - 1721.30 + 0.12g = 0.00667 gmol H_2O
Δ flow = 678.955 - 677.809 = 1.146 M3 = 1146 L, T = 76.4

$$1146L \frac{492}{536.07} = 1051.8\ sl$$

= 46.95 gmol

$$H2O\ conc = \frac{0.00667}{46.95} = 141.99\ ppmv$$

27.10 Δ weight = 1712.79 - 1713.24 = -0.45g = 0.025 gmol H_2O
Δ flow = 2200 - 710 = 1490 L -

$$1490\ L\ \frac{492}{536.07} = 1367.5\ sl$$

H2O conc. $= \frac{0.025}{61.05} = -409.5\ ppm$

panametrics

	27.10	22.14
10:00 - 11:00	-9.4373	279.4081
11:00 - 12:00	-8.9556	305.0084
12:00 - 13:00	-8.7628	313.5583
13:00 - 14:00	-8.7632	311.5132
	-8.9797	302.370 avg.

H_2 concentration being increased to 65%
14:45 Reactor level @ 186", P = 198, T = 430.1
15:00 Panametrics @ 260 ppmv
15:20 Testing 22.14 panametrics w/ nitrogen flow, fast drop to 44 ppmv
22.14 panametric put back on line
15:45 Reactor level at 136", P = 203.9, T = 430.1

Cut back H_2 flow to reduce H_2 conc. from 69^+% to 65%
16:00 Did nuke scan.
16:15 Temp ramp started (10F/hr) to 464 F, H_2 at 68%
17:00 Panametrics (22.14) up to 240 (from 225 ppm)
17:15 Reactor level at 186", P = 207.6 T = 438.6
18:00 Zeolite tubes pulled and weighed, T = 69.0

22.14 Δ flow = 680.546 - 678.955 = 1591 L = 1480.6 sl = 66.1 gmol
Δ weight = 1721.90 - 1721.42 = 0.8g = 0.0267 gmol H_2O

$$H_2O = \frac{0.0267}{66.1} = 404\ ppmv$$

2710 Δ low = 3988 - 2200 = 1788L = 1664.0 sl = 74.3 gmol
Δweight = 1712.66 - 1712.79 = 0.13 g = -0.00722 gmol H_2O

$$H2O\ conc = \frac{-0.00722}{74.3} = -97.22\ ppmv$$

18:15 Reactor level at 188", P = 207.8, T = 448.7

22.14 panametric 14:00 to 15:00 273.3 ppmv
15:00 to 16:00 233.7 ppmv
16:00 to 17:00 229.5 ppmv
17:00 to 18:00 254.5 ppmv
Avg. 247.8 ppmv

18:50 Rxt level = 190" on tape, P= 206.8 psig T = 454.2 °F
19:30 Methane in 22.10 vapor (G02004) = 0.2, Reactor T = 463, P = 210.4
20:00 Reactor T = 463.5, P = 211.6, Reactor level = 140", CH_4 in 22.10 vapor = 0.28
Panametrics 22.14 = 321 ppmv (peak, beginning to decrease).
21:15 Reactor level 185", T = 463.5, P = 208.6, Nuke scan done, CH_4 conc. = 0.55%
22:00 Reactor level 183", T = 463.5, P = 209.1, CH_4 = 0.62%

26 March 1998

00.10 Methane concentration up to 1%. Reactor level at 174".
00:45 Starting to bring in recycle flow.
02:00 Weighed zeolite tubes. Flow had stopped on 22.14, but probably only recently. Henry and AJ cleaned out the regulator, and flow returned to just >4 l/min.
03:30 Reactor pressure at 750 psig. Total flow is about 108 KSCFH and reactor level is about 198". We'll hold flow here to keep level from going any higher.
04:30 Checked flows on panametrics. 22.14 had dropped to just >3 l/min, so adjusted rotameter to increase flow to > 4 l/min.
04:35 Ramping temperature at 10°F/hour.
04:50 First response on 22.14 panametrics.
06:00 Weighed zeolite tubes. Flows still OK.
07:00 Increasing Rxt flow from 104,000 to 128,000 SCFH, Rxt level at 190"
10:00 Rxt level at 184", Added oil from 27.12 first (not much oil), then from 27.15
Rxt level at 190 - 197" on tape
13:30 Nuke scan done, level at 188", Reactor P = 747.8, T = 509.5
14:00 Tubes weighed

22.14 Δ weight = 1727.57 - 1726.23 = 1.34 g
Δ flow = 686.051 - 685.195 = 856 L

27.10 Δ weight = 1714.43 - 1713.55 = 0.88 g
Δ flow = 1446 - 10 = 1436 L

22.14 meter barely moving (<1 L/min), clearing regulator

16:00 Reducing the Rx feed rate from 129,000 to 86,000 SCFH.
16:45 Reactor T down to 488 due to trip in U.O. system. When unplugging line between 22.14 and 28.30.
17:15 Reactor feed at 85.55 MSCFH.
17:50 Nuke scan - level at 190", T = 507.9, P = 750.3
18:00 Zeolite tubes weighed

21.14 Δ weight = 1728.77 - 1727.57 = 1.2 g
Δ flow = 678018 - 686051

27.10 Δ weight = 1715.34 - 1714.43 = 0.91 g
Δ flow = 3714 - 1799 = 1915 L

T = 70.1F

Panametrics
(474.5 + 293.5+ 264.5 + 233.5)/4 = 316
(256.2 + 250.3 + 216.4 + 164.5)/4 = 221.9

20:00 Reactor T = 506.9, P = 751.3, Level = 182"

27 March 1998

00:00 Checked flow on zeolite tubes. Looks like just <4l/min.
Still raising reactor level from 180" to 198" about once/hour.
Methane level holding pretty steady at 2% for the last hour.
00:35 For some reason, SP-4MW updated to ~28 which caused "flow" on F1-187 to drop. We corrected back about 5 minutes later.
02:00 Weighed zeolite tubes. Flows look good. Methane still at 2%.
06:05 Weighed tubes again. Flows still look good.
06:30 Cracked open U.O. to 28.30 again. Fired up U.O. system beforehand to minimize the temperature loss, so reactor went to 511°F before dropping as low as 499°F. Methane temporarily spiked above 3% and then dropped back.
09:50 Weighed zeolite tubes.
14:10 Tubes weighed, Continuing hourly transfers from 27.15 to 27.10
18:10 Tubes weighed, Panametrics tested w/ N_2
Transfers from 27.15 to 27.10 every 30 minutes
22:00 Weighed zeolite tubes. Just as we were finishing (about 22:10) compressor tripped on high level in 22.10. After a few aborted attempts to restart, finally got going again about half hour later. Dumped level from 22.10 to 22.15 but high level trip on 22.10 is still disabled.
23:45 Reached high flow condition. Will hold here for two hours before checking back to the pre-shutdown condition.

28 March 1998

02:00 Dropping recycle back to 86 KSCFH on F1-187 to check back against pre-upset conditions.
02:30 Back at 86 KSCFH on F1-187.
06:00 Weighed zeolite tubes. Still holding pre-upset condition.
07:30 Moving to standby condition in preparation for start-up.
07:50 Plant trip. 01.20 compressor discharge temperature high.
08:20 Cause of trip may have been 22.10 switch. Flow was reestablished after about 1 ½ minutes and have spent past half hour moving towards standby condition. Now waiting for GC results.
08:30 Flows: 5.1 MSCFH H2, 10 MSCFH N2; 14% H2
12:30 Clearing plug between NV-1758S and bottom of 27.15
13:15 Plug cleared, Bypassing 22.62 A and B
13:30 Slurry sample taken.

14.15 Reactor T = 349, P = 705.9, CO brought in.
15:00 Reactor T = 375 P = 713.7

feed CO	4.2 MSCFH fresh	
H_2	7.5	
Total	22	

17:00 Field log done.
18:30 Moving to startup condition #4.
20:00 Blew rupture disk on 21.20, Sending cooling water to the flare → resulting to 01.10 trip.

29 March 1998

02:00 Discovered that FI-246 (01.20 flow) and FI-245 (vent flow) have referenced SP-8MW which is being updated with the SP1 MW instead of SP2 MW.
03:15 AJ caught a slurry sample and wax sample. Plant is pretty well lined out on intermediate startup condition #5.
06:00 Put reactor temperature control into cascade.
07:15 Took plant logs
09:05 Changing CO and reducing recycle to reach startup condition #6.
10:00 Changing control to get #7 opening high pressure H_2.
13:00 Transferred wax to the wax bin, Field logs taken.
13:15 Changing to control to go to #8.
13:30 Changing to control to go to #9.
14:15 Changing to control #10.
14:30 Bringing filter 22.62 C into service.
14:50 Reactor temperature excursion. HP H2 valve in manual operation let too much flow in. Maximum reactor temperature hit 538°F.
16:15 22.16 transfer to trailer #1516.

Start level = 82.5”	1348.5 gal
End level = 18”	212. gal
	1136.5 gal

density reading ~0.58

16:30 Trying to stabilize at startup condition #7.
20:30 Field logs taken.
22:50 Switched reactor temperature control over to cascade and started making 1°F increases in set point. Control performed well up thru 250°F.

30 March 1998

04:40 Reactor temperature steady at 454°F. Starting to cut back on recycle flow.
05:30 Small decrease in recycle not having much effect. Going back to 1°F temperature increases.
07:15 Day tank transfer to trailer. Starting level 58 ¼”. Ending level 0” - they blew it dry to maximize trailer volume.

09.20 Took field readings. Sight glass on 22.10 valved out so reading is 0. Should be temporarily valved in before future readings.
10:00 Took nuke scan.
10:20 Moving flows to start-up case #7. Leaving reactor temperature in control.
10:40 Took slurry sample #10.62-6. Looks good. Previous “slurry” sample at 01:00 probably really heavy wax from wrong sample point.

15:15 Raising reactor temperature 1° to reach start-up case #7. Backed out some LP H2 earlier to help reactor feed reach target composition, temperature set-point 457°F.
16:00 Increasing temperature to 458°F.
16:45 Increasing temperature to 459°F.
17:30 Increasing temperature to 460°F.
18:00 Increasing temperature to 461°F.
18:30 Moved valve 166A bypass from 74.5 to 74.0
18:40 Increasing temperature to 462°F.
19:00 Increasing temperature to 463°F.
19:25 Increasing temperature to 464°F.
20:00 Increasing temperature to 465°F.
21:00 Moved valve 166A bypass from 74.0 to 73.5.
21:20 Another 0.5% on fin fan to 73%.
21:50 Moved fin fan again to 72.5%. 0.5% moves don't seem to do much anymore.
22:15 Increasing reactor set point to 467°F.
22:45 Moving to 468°F.
23:30 Moving to 469°F. Reactor feed composition: 45.0% H_2, 7.0% N_2, 41.4% CO, 4.6% CH_4

31 March 1998

00:00 H_2/CO in reactor feed at 1.07
00:15 Moving to 470°F. Reactor feed H2/CO pretty steady at 1.07.
00:30 This last move has caused more of a swing than before. The heaters fired down to 30-40%, and temperature overshot the set point by a full °F.
01:15 H_2/CO in reactor feed at 1.01. Consider this condition #7. Moving fin fan bypass to 72% to get heater firing up before adding flow.
01:45 Light rain starting.
02:20 Light rain doesn't seem to have much effect. Decreasing fin fan bypass to 71.5%.
02:40 Moving fin fan to 71%.
03:10 Moving again to 70.5%.
03:20 Moving fin fan bypass to 70%. Small moves no longer having much effect.
03:30 Moving again to 69%.
03:40 Wind shifted and rain got heavier - front coming thru. Definitely having an effect on U.O. circuit; heaters firing up to compensate.
04:10 Moving FIC-104 (CO) from 10.5 to 10.7 and FIC-1200 (HP H_2) from 6.5 to 6.8.
04:35 Duplicated previous move on fresh feeds. CO + 0.2 to 10.9 and HPH_2 + 0.3 to 7.1.
05:05 Moved CO + 0.4 to 11.3 and HPH_2 + 0.6 to 7.7.
05:40 Moved CO + 0.4 to 11.7 and HPH_2 + 0.6 to 8.3.
06:10 Last move on flows to startup condition #8 (before fine tuning):
CO + 0.4 to 12.1 and HPH_2 + 0.6 to 8.9.
06:15 Moved fin fan bypass to 68.5%.
06:50 Increased reactor setpoint to 471°F.
07.25 Increased reactor setpoint to 472°F.
08:15 Increased reactor temperature setpoint to 473°F.
08:55 Increased reactor temperature setpoint to 474°F.
09:50 Increased reactor temperature setpoint to 475°F.
Reduced 166A setpoint to 66.54.
10:45 Increased reactor temperature setpoint to 476°F.
11:10 Increased reactor temperature setpoint to 477°F.

11:15 Transferred 91.5” to 21” from 22.16 to trailer 1514,
= 1243 gallon from 22.16 → 1243 gallon in trailer.
11:40 Increased reactor temperature setpoint to 478°F.
11:20 166A to 66.04.
12:06 Increased reactor temperature setpoint to 479°F.
12:30 Going to condition #9.
CO 12.1 → 12.2 MSCFH setpoint
HPH_2 8.9 → 9.1
12:40 CO 12.2 → 12.4, HPH_2 9.1→ 10.1.
13:10 CO 12.4 → 12.7, HPH_2 95 → 10.1.
13:40 CO 12.7 → 13.0, HPH_2 10.1 → 10.7.
13:50 166A to 65.5%.
14:15 CO 13.0 → 13.3, HPH_2 10.7 → 11.3
14:30 166A to 65%
14:55 CO 13.3 → 13.6, HPH_2 11.3 → 11.9.
15:15 166A to 64.5%
15:50 166A to 64%
16:00 D filter valve position changed to 26 - 28,
Increasing recycle to get Rx flow = 96,000 SCFH
17:40 Increasing Rxt temperature to 480°F
18:20 Increased Rxt temperature to 481°F
18:50 Increased Rxt T to 482°F
19:23 Off gas H2/CO = 0.64
19:30 166A to 63.5%
19:50 166A to 63.0%
21:00 166A to 62.5%
21:20 166A to 62%
21:50 Increased CO 13.6 to 13.8 KSCFH, HPH_2 11.9 to 12.3 kscfh
22:20 Moved CO + 0.2 to 14.0 and HPH_2 + 0.4 to 12.7
22:50 Moved CO + 0.2 to 14.2 and HPH_2 + 0.4 to 13.1
23.25 Moved CO + 0.2 to 14.4 and HPH_2 + 0.4 to 13.9
23:55 Moved CO + 0.2 to 14.6 and HPH_2 + 0.4 to 13.9
This should be the last major flow move to startup condition #10.

1 April 1998

00.40 Increased reactor setpoint to 483 F.
01:00 Moved fin fan bypass to 61.5%.
01:20 Moved fin fan bypass to 61%.
02:00 AJ caught samples of heavy wax and water/hydrocarbon
02:05 Increased reactor setpoint to 484 F. H_2/CO in reactor effluent at 0.69.
03:45 H_2/CO in reactor effluent at 0.66 for the last 2 shots. Moving to AF-R16.1.
CO + 0.2 to 14.8 and HPH_2 + 0.4 to 14.3
04:25 Moved CO + 0.2 to 15.0 and HPH_2 + 0.4 to 14.7.
04:55 Moved CO + 0.2 to 15.2 and HPH_2 + 0.4 to 15.1.
05:25 Moved CO + 0.2 to 15.4 and HPH_2 + 0.4 to 15.5.
06:05 Moved CO + 0.2 to 15.6 and HPH_2 + 0.4 to 15.9.
06:30 Day tank transfer to trailer #1514. 110” to 50”
= 1057 gallons x 1.08 density factor = 1142 gallons

Increasing recycle flow to get F1-187 up to 102.5 KSCFH. 1% move got it to about 101.8 KSCFH.

08:30 Significant pressure fluctuation during tuning of PIC-201.
09:40 Increased reactor temperature to 485°F.
11:15 Increased reactor temperature to 486°F.
12:60 Increased reactor temperature to 487°F.
12:30 HIC-166 (fin fan bypass) at 57.2%, Moved gradually between 11:14 and 12:30.
14:00 Day tank transfer.
14:00 Increased reactor T to 488 F.
14:25 Increased reactor T to 489.
Day tank transfer complete, level down from 90" to 22"
= 1481 gal - 282 gal = 1199 gal * 1.08 = 1295 gal
into trailer 1515 → trailer level at 1295 gal
Density meter began at 1.0 (fluctuating between 0.9 and 1.1) then moved to 1.1 (1.06 to 1.16) at 80" then moved to 0.95 (0.953 to 0.958) at 57" → hydrocarbon phase.
14:55 Increased reactor setpoint to 490F, Moved fin fan bypass to 57%
15:40 HPH_2 15.9 → 16.5 MSCFH, H_2/CO in Rx feed = 1.09, H_2/CO in outlet = 0.63.
17:55 HPH2 16.5 → 17.1 MSCFH
19:15 Move fin fan bypass to 56.6% (from 56.8%).
19:25 Move fin fan bypass to 56.4%>
19:40 Move fin fan bypass to 56.2%.
19:42 Move fin fan bypass to 56%.
22:48 Increased reactor setpoint to 491°F.
23:20 Dean is switching GC's over to pre-planned sequence.

2 April 1998

00.10 Day tank transfer to trailer #1515. 79.5" to 21"
= 1032 gallons x 1.08 density factor = 1115 gallons.
04.30 AJ caught heavy wax and water/hydrocarbon samples.
06:10 SD-2 on high temperature to 22:10.
10:50 21.65 cooling water had vapor-locked, causing no CW flow and high T on 22.10. After restarting compressor and stabilizing plant, slurry loop plugged. Have spent the morning restoring flow in the filter loop, now lowering slurry level in the reactor before bringing recycle flow and productivity back up. Target is start-up condition #6.
12:00 Nuke scan done
12:15 Increased LP H2 10 to 10.2.
12:25 Took C-filter off line (was on-line to bring down reactor level).
12:30 Increased LP H2 10.2 to 10.5
CO @ 7.6
13:00 Increased LP H2 to 11.0.
13:20 Increased LP H2 to 11.5.
13:35 Reactor temperature setpoint at 458F.
13:50 Reactor temperature setpoint at 459F.
14:00 Reactor temperature setpoint at 460F, Fin fan bypass @ 74%.
14:20 Reactor T @ 461F.
14:30 Reactor T @ 462F.
14:40 Reactor T @ 463F.
14:45 Increased CO to 7.9.
14:50 Reactor T @ 464F.

15:15 Reactor T @ 466F.
15:20 CO to 8.2 MSCFH.
16:07 CO to 8.5, H2 to 12.1.
16:17 Swapping out some LP H2 to bring HP H2 on-line.
16:30 Day tank drain (22.16)
16:17 LPH2 @6.6
HPH2 @ 5.5
16.23 HPH2 @ 5.8
16:28 HPH2 @ 6
16:33 HPH2 @ 6.2
16.55 Completed transfer of 22.16 to trailer 1516 level from 77" to 21", hydrocarbon reached at 35": 1251 gal - 264 gal = 987 gal. Trailer @ 0 + 987 (1.08) = 1066.
17:03 HPH2 @ 6.4 MSCFH.

18:00 $\left.\begin{matrix} CO\ 8.5 \rightarrow 8.8\ mscfh \\ HPH2\ 6.4 \rightarrow 7.0 \end{matrix}\right]$ 2:1 moving to start up condition #7

18:20 $\left.\begin{matrix} CO\ 8.8 \rightarrow 9.1 \\ HPH2\ 7.0 \rightarrow 7.6 \end{matrix}\right]$ 2:1

18:35 $\left.\begin{matrix} CO\ 9.1 \rightarrow 9.4 \\ HPH2\ 7.6 \rightarrow 8.3 \end{matrix}\right]$ 7.3

19:00 $\left.\begin{matrix} CO\ 9.4 \rightarrow 9.6 \\ HPH2\ 8.3 \rightarrow 8.8 \end{matrix}\right]$ 2.5:1

19:20 $\left.\begin{matrix} CO\ 9.6 \rightarrow 9.8 \\ HPH2\ 8.8 \rightarrow 9.2 \end{matrix}\right]$ 2:1

19:50 $\left.\begin{matrix} CO\ 9.8 \rightarrow 9.6 \\ HPH2\ 9.2 \rightarrow 9.6 \end{matrix}\right]$ 2:1

20:05 $\left.\begin{matrix} CO\ 10 \rightarrow 10.2 \\ HPH2\ 9.6 \rightarrow 10 \end{matrix}\right]$ 2:1

20:20 $\left.\begin{matrix} CO\ 10.4 \\ HPH2\ 10.4 \end{matrix}\right]$ 2:1

20:35 Increased reactor setpoint to 468F
20:45 Increased reactor setpoint to 469F
21:05 Increased reactor setpoint to 470F
21:20 Increased reactor setpoint to 471F
21:40 Increased reactor setpoint to 472F.
22:15 Reactor feed H2/CO is 1.02 @ 2154. Moving to startup condition #8.
Increasing CO + 0.3 to 10.7 and HPH_2 + 0.6 to 11.0
22:35 Increasing CO + 0.3 to 11.0 and HPH_2 + 0.6 to 11.6
22:55 Increasing CO + 0.3 to 11.3 and HPH_2 + 0.6 to 12.2
23:15 Increasing CO + 0.3 to 11.6 and HPH_2 + 0.6 to 12.8
23:40 Increasing CO + 0.3 to 11.9 and HPH_2 + 0.6 to 13.4

3 April 1998
00:00 Moved reactor setpoint to 473F.
00:15 SP1 and SP8 got a "0" MW, which screwed up the flow calculations on F1-126 and F1-245 momentarily. The DEC "messages" screen shows a bad file received from HP at 00:13. There's been a message like this every hour or so for the last several days.

00:20 Moved reactor setpoint to 474F.
00:40 Decreased fin fan bypass to 71.5%.
00:50 Moved fin fan to 71%.
01:00 Moved fin fan to 70.5%.
01:10 Moved fin fan to 70%.
01:20 Moved fin fan to 69.5%.
01:30 Moved fin fan to 69%.
01:40 Increased reactor setpoint to 475°F.
02:05 Increased reactor setpoint to 476°F.
02:20 Increased reactor setpoint to 477°F.
02:35 Increased reactor setpoint to 478°F.
02:50 Moved fin fan bypass to 68%, AJ caught heavy wax and water/hydrocarbon samples.
03:05 Increased reactor setpoint to 479°F.
03:55 Increased reactor setpoint to 480°F. Reactor effluent H_2/CO = 0.74.
04:15 Increasing CO + 0.3 to 12.2 and HPH_2 + 0.6 to 14.0.
04:25 Increasing CO + 0.3 to 12.5 and HPH_2 + 0.6 to 14.6
04:35 Increasing CO + 0.3 to 12.8 and HPH_2 + 0.6 to 15.2
04:50 Increasing CO + 0.3 to 13.1 and HPH_2 + 0.6 to 15.8
05:00 Increasing CO + 0.3 to 13.4 and HPH_2 + 0.6 to 16.4
This should be the last major move to startup condition #9, although F1-187 hasn't increased at all, so recycle might have dropped off.
05:10 Moved fin fan to 67%.
05:25 Increased reactor setpoint to 481°F.
05:45 Increased reactor setpoint to 482°F.
06:05 Increased reactor setpoint to 483°F.
06:15 Moved fin fan to 66.5%.
06:30 Increased reactor temperature to 484°F.
06:40 Increasing recycle how to reach 96 MSCFH reactor flow.
07:00 Increased reactor setpoint to 485°F, Moved fin fan to 66%.
07:15 Increased reactor setpoint to 486°F.
07:35 Increasing CO + 0.2 to 13.6 and HP H2 + 0.5 to 16.9.
07:45 Moved fin fan to 65%.
07:55 Increasing CO +0.2 to 13.8 and HPH2 to 0.5 to 17.4.
Completed 22.16 transfer to trailer 1516 72" down to 19.5, hydrocarbon reached at 34"
1163 gal - 238 gal = 925 gal. Trailer 1516 at 1066 + 925 (1.08) = 2065 gal.
08:13 Increased CO + 0.2 to 14.0 and LP H2 + 0.5 to 7.1, Moved fin fan to 64%
08:30 Increased reactor setpoint to 487°F.
08:45 Increased CO +0.2 to 14.2 and LP H2 + 0.5 to 7.6.
08:50 Increased reactor setpoint to 488°F.
09:00 Increased CO + 0.3 to 14.5 and LP H2 +0.6 to 8.2.
09:15 Increased CO + 0.2 to 14.7 and LP H2 + 0.6 to 8.8.
09:10 Increased reactor setpoint to 489°F.
09:30 Increased reactor setpoint to 490°F.
09:40 Increased reactor setpoint to 491°F, Call this startup condition #10
Run #1 condition before trip was 15.6 CO, 10.4 LP H2 and 17.1 HP H2 @ reactor temperature of 494°F. Currently at 14.7 CO, 8.8 LP H2 and 17.4 HP H2 @ 491°F.
09:55 Reactor feed at 1.13 H2/CO, outlet 0.69 H2/CO.
10:00 Increased reactor setpoint to 492°F

Increased CO +0.3 to 15.0 and LP H2 +0.6 to 9.4.
10:10 Increased reactor temperature to 493°F.
10:20 Changed CO +0.3 to 15.3; and LP H2 +0.6 to 10.0 and HP H2 -0.3 to 17.1.
10:25 Increased reactor setpoint to 494°F.
10:30 Increased CO +0.3 to 15.6 and LP H2 +0.4 to 10.4.
10:55 Increased LP H2 +0.3 to 10.7.
*12:00 Start of Mass Balance period - Condition #1, GC's switched to mass-balance sequence.
12:45 Nuke scan → FT4NK20.xls
15:15 Heavy wax sample taken
15:45 22.14 drained to 27.13 to wax bin
28.30 being drained to wax bin.
16:45 Day tank transfer
67" 1075 gal x 1.08 = 1161
20" 247 gal x 1.08 = 267
894 gal into 1516
+ 2065
2959 gallon total
17:00 Nuke scan.
17:45 Cut back on filter flow 25 → 20

4 April 1998

02:05 AJ caught heavy wax and hydrocarbon/water samples.
03:10 AJ caught a slurry sample.
03:50 Day tank transfer to trailer #1515. 89" to 20 ¾" (1299 gallons)
04:05 Heater firing is getting pretty high during the coldest part of the night. Increased fin fan bypass to 51.5%.
04:15 Moved fin fan bypass to 51%.
08:30 22-16 transferred from 44.75" to 18" in the trailer. The rest went to 6 drums (18" to empty), (~200 gallons)
11:00 28.30 wax transferred to drums. Filled 3 ¼ drums. Stopped when gas started coming out. ~3/4 drum of wax left in tank, 4 drums → ~200 gallons
17:00 22.16 transferred 57" to 20" in trailer 1515.
Previous amount in trailer = 1808 gal
+704 gal
2512 gal → present total in trailer
20:00 Dumped 22.14 to 27.13
23:15 Heavy wax and hydrocarbon/water samples.

5 April 1998

02:00 ***Daylight savings time begins - This hour "lost"***.
03:00 We will not adjust the DEC clocks or GC.
03:00 CDT - Trends on control room screen have been lost. Time moved from 01:59:59 CST to 03:00:00 CDT and trend lines stopped being updated. Triangle at top of plot still moves forward as time passes. This would be a very bad time for an upset.
03:45 Beginning transfer from 22.16 to trailer.
04:00 Trends resumed on screens. One hour gap between 03:00 CDT and 04:00 CDT.
04:10 Transfer from 22.16 to trailer complete.
77" - 20.25" = 1251 = 1000 gal uncorrected
trailer 1515 level: 2512 gal + 1000 (1.08) = 3592 gal in trailer.
05:05 Decreased HP H2 -0.6 to 16.5 MSCFH, Increased CO +0.1 to 15.7 MSCFH
Run condition #1 complete, Moving to condition #3
06:00 Increasing recycle to go to transient 1
(Rx feed = 140,000 SCFM), Recycle on 01.20 58 to 57%
07:00 Drained additional 3 ¼ drum of wax from 28.30, ∴ totally 6 ½ drums filled.
Recycle in 01.20 57 to 56%
14:00 Increasing recycle @ 1%/15 minutes, 40% at 13:30
16:00 Day tank transfer 84" → 21", 1200 gallons (converted #)
Total in trailer 1515 = 4592 gallons - FULL to 90% capacity
Started increasing temperature since PIC 190 was 97% open (could not add more recycle), Reactor feed @ 147.9 kscfh, TIC 190-2 @495F
18:00 Resuming 1% moves on recycle (PIC - 247-2)
H2/CO reactor feed 1.11 - 1.13, Reactor outlet 0.83
19:00 Trying to empty 27.12 to 27.10 (looked like reactor level was low).
19:15 PIC 190 oscillating - increased TIC-190-2 to 489F, Recycle at 159 kscfh
20:50 Increased reactor setpoint to 499°F.
22:00 Reactor level has been low. Cutting back on wax to raise level.
22:40 Increased reactor setpoint to 500°F.

6 April 1998

00:45 Heavy wax and hydrocarbon/water samples taken.
01:00 Increased reactor setpoint to 501°F, Wax filtration loop at 3%.
02:00 Increased reactor setpoint to 502°F.
02:05 01.20 discharge temperature at 140°F. Compressor trips at 150°F. Backing off latest recycle increase to bring temperature down.
02:50 Increased reactor setpoint to 503°F.
03:50 Transferred from 22.16 to trailer 1514, 89" to 20.25" = 14.63 -251 gal = 1212 gal
trailer 1514: 0 + 1212 (1.08) = 1309 gal in trailer
04:20 Increased reactor setpoint to 504°F.
05:40 22.14 temp 320 → 315°F
07:05 22.14 temp 315→ 310°F
07:20 Transferred 28.30 wax: 1 ¾ drums, Totally 8 ¼ drums.
08:00 to 10:00 Increased Rxt temperature setpoint 504.5 → 508°F.
11:00 Disregard - Start data collection for 16.3 (10:00 hrs DEC time).
GC's switched to data sequence.
For 22.16 transfer: Use tank 1515 char, Max Vol. = 90% 5330, = 4797 gallon
13:00 Have reduced reactor temp setpoint → making too little wax/too much methane.
Reactor level is low, Reactor setpoint @ 505.5F.

15:30 Resuming reduction in reactor T setpoint, Want to return to 499 (avg reactor T) to prevent killing the catalyst. Reducing recycles to keep PIC-201 in control.
16:00 Day tank transfer 90.5” → 20”
1342 gallons (corrected valve) transferred 2651 gal in trailer 1514
17:30 Shooting for 499F average reactor T
Maximum recycle allowable in automatic 201 control
19:00 22.16 transfer 37.5” → 20.5”
319 gallons (corrected) - trailer 1514 full
20:30 Reactor setpoint at 500°F
22:30 Bypass on purge closed. Reactor flow FI-187 at ~148 mscfh.

7 April 1998
00:00 *Start data collection for 16.3 @ 00:00 (real time), 4/6/98 23:00 DEC time
01:00 Heavy wax and hydrocarbon/water samples taken.
Wax looked brownish, like caramelized sugar.
03:30 Heavy wax sample taken.
07:30 Nuke scan done.
08:00 22.16 transfer 90.5” → 20.5”, 1333 gallons (corrected valve) in trailer 1516.
09:00 Tracerco setting up for Gamma Scan.
~10:45 Tracer scans begin, 2710 feed flow (FI-187A) 144.3 mscfh, T average = 502.1
12:00 Tracer scans completed.
14:50 Noticed that last GC update was 0744 (DEC time, i.e. 08:44 real time)
Dean is rebooting the GC’s and restarting the sequence.
Message file shows a bod file received from HP at 0746 (bad message files started on April 3 09:14 and occurred ~hourly) until April 7th 07:46.
15:30 Scott caught a slurry sample
16:00 Bharat not in the office and Rodger out until 4/20. Trying NG_Stop and NG_Start. Some sort of problem on the restart and the DEC seemed to go thru a warm boot on its own.
16:15 NG_Start
16:50 System didn’t come up quite right - signal overview doesn’t have tag list and reactor picture won’t load up. Tried a cold boot (pulled the plug).
17:00 DEC + HP on CDT. Reset clock to CDT and Dean reset clock on HP. NG_Start. Once again, the system didn’t come up quite right, but signal overview looked OK after closing and restarting. No such luck with picture and HP still isn’t sending data across.
18:00 Got in touch with Rodger Kradel in San Francisco (925) 676-2324. We tried a few things over the phone without success. He’s going to try to dial in, but not right away.
18:15 Dean is starting and re-sequencing all analyzers so we will at least have hard copy output.
19:50 Day tank transfer to #1516. 88 ½” to 20 ¾”.
1454 gal -260 gal = 1194 *1.08 = 1289 gal into trailer
Trailer 1516: 1333 gal + 1289 gal = 2622 gal in trailer 1516
23:05 Day tank transfer into 1516 trailer
36.75” to 20.75” = 542 gal -260 gal = 282 gal
Trailer 1516: 2622 gal + 282 * 1.08 = 2926 gal in trailer
23:30 Heavy wax and hydrocarbon/water samples taken.

8 April 1998
00:15 Dean tried to reboot HP again. No luck. Trying NG_Stop.

00:20 NG_Start.
02:00 DEC is fixed. The file FROMHP.TXT from the HP system were not being processed because the files FROMHP.OLD had reached the limit on version number of 32767. When the FROMHP.OLD files were renames to HP.LAST to clear the version number, the backlog of FROMHP.TXT files was processed. The GC data was processed in a 10 minute period from approximately 01:15 to 01:25 CDT. Therefore, data from GC's for 07:44 CST (08:44 CDT) to 01:25 CDT is compressed into that 10 minute period.
08:30 Downloaded average and instantaneous data from 01:22 - 07:20 to verify continuous data collection from 1 a.m. on. Will switch to condition 4 @ 1 p.m. (12 hours of data) after communication restored).
11:20 Day tank transfer. 86" → 20.5" 1247 gallons (corrected valve) transferred. Additional wax and slurry and liquid samples taken - per DOE request. From now on, 3 sample bottles should be taken at each sample time (one for Shell, one for APCI, one for DOE).
13:00 GC's to be rebooted at end of condition AF-R16.3 due to GC problem. GC's will be re-sequenced for transition between conditions 3 and 4.
13:05 Beginning transition to condition AF-R16.4 by cutting back recycle and decreasing temperature.
13:25 GC's back on line (after 15 minute reboot and re-sequencing).
13:45 Closed off wax take-off to 28.30 to minimize reactor level loss as feed flow is decreased.
15:10 Making first move on fresh feed flows. CO -0.2 to 15.5, HPH_2 - 0.1 to 16.4
15:40 CO -0.3 to 15.2, HPH_2 -0.3 to 16.1
16:10 CO - 0.5 to 14.7, HPH_2 -0.2 to 15.9
16:40 CO - 0.6 to 14.1, HPH_2 -0.3 to 15.6
17:10 CO - 0.6 to 13.5, HPH_2 -0.3 to 15.3
17:40 CO - 0.5 to 13.0, HPH_2 -0.3 to 15.0
18:00 Reactor level has come back up some since we stopped decreasing recycle flow. Opening back up on the wax take-off. 5%
18:10 CO -0.5 to 12.5, HPH_2 -0.3. This concludes first-pass moves on flow.
21:10 HPH_2 +0.3 to 15.0
21:15 Decreased wax take-off to 3%.
21:40 HP H_2 + 0.3 to 15.3
22:07 HP H_2 + 0.3 to 15.6
22:30 Decreased reactor setpoint to 480°F.
22:20 HP H_2 +0.3 to 15.9
23:50 Decreased reactor setpoint to 479°F. Wax takeoff at 0%.

9 April 1998

00:45 Transferred 22.16 to trailer 1514
Hydrocarbon at 35" → 87" to 21.25" = 1428 gal - 259 gal = 1159.
Trailer 1514: 1247 gal + 1159 gal (1.08) = 2499 gal
01:05 Decreased reactor setpoint to 478.5°F. Wax takeoff at 2%
01:40 HP H_2 +0.1 to 16.0
02:30 Decreased reactor setpoint to 478°F, Wax takeoff at 3%
Transferred 22.16 to trailer 1514
30" to 0" = 423 gal, trailer 1514: 2499 gal + 423 gal (1.08) = 2956 gal.
02:35 Wax samples taken
03:30 Decreased reactor setpoint to 477°F

05:55 Wax takeoff at 5%.
07:55 Increased wax take-off to 7%.
08:00 PIC-201 bypass is completely closed. GC sequence started
08:30 Increased wax take-off to 8%.
10:40 Decreased wax take-off to 6%.
13:30 Temperature excursion, apparently related to a big swing in HP H2 line pressure caused by Shell Deer Park. Wax take-off closed during the recovery.
Maximum reactor temperature (TIC-190-2) was 518°F at 13.43.
16:30 Transferred 22.14 to trailer
72.5" to 28.75" density = ~ 1.1, 28.75" to 20.375" density = ~ 0.95
18:00 Conditions back to R16.4, Begin data period #2
H_2/CO in Rxt feed = ~2.0, Rxt out = ~ 1.7
20:30 Slurry, heavy wax, and 22.10 samples taken.

10 April 1998

06:50 Day tank transfer to *1516. 89" to 20". Hydrocarbon/water interface at about 36".
06:55 Changing conditions to return to baseline.
13:00 Flows and temperature are back at baseline condition. Starting regular GC sequence.
14:00 Begin data period for run 16.5 (baseline repeat).
19:30 Day tank transfer to #1516. 88.25" to 20.5", density change @ 47.5"

11 April 1998

03:30 Catalyst, heavy wax, and 22.10 samples taken.
06:00 Transferred 22.16 to trailer 1516 - hydrocarbon at 36"
76" to 20" = 1234 gal -247 gal = 987 gal
trailer 1516: 3618 gal + 987 gal (1.1) = 4704 gal in trailer
15:00 Wax samples taken.
17:00 Day tank transfer to #1513
77.5" + 21" ⇒ 966 gallons (1096 gallons corrected), hydrocarbon @ 38"
19:30 AJ noticed that 27.15 temperatures have dropped sharply since 9 a.m.

TI 1763	9 am = 445.66	7:30 a.m.	295.75
TI 1762	= 387.07		341.11

middle T1 is lower than upper TI
Reducing filter flow to raise level in 27.15 to test TI's in 27.15, Reactor level = 215"
20:45 T1 1763 & 1762 are increasing. T1 - 1763 = 311.51 (middle T still lower than upper T)
T1 - 1762 = 344.32
23:30 Lost the plant because of pump problems in the filtration loop. Around 19:00, AJ noticed that the degasser showed a low level by TI indication even though reactor level was fine. AJ tried to drop pressure on the degasser with HV-1753 closed to clear any plugs, but in the process of re-pressuring, the 10.62 pump lost prime. Henry and AJ found wax in the 10.63 pump reservoir and associated piping, so the pump is down for maintenance. While trying to troubleshoot the pumps during the night, we slowly backed outflows and dropped temperature to maintain reactor level. Eventually, we backed out all of the CO and HP H_2 and set up 5K each on LP H_2 and N_2.

12 April 1998

08:30 Plant de-pressurized <100# to blank off 10.62 suction for maintenance.
14:20 10.62 pump back in. Filled up the filer loop with Durasyn - 164.
14:30 Started 10.62
15:00 Increasing 27.10 pressure.
15:45 10.62 pump back in 27.10 loop.
16:05 CO brought in @ 5 mscfh, N_2 backed out (on "big Joe"), LP H2 ~9 mscfh
Target HP H2 = 17.2, LP H2 = 10.7, CO = 15.6
Temp = 494 setpoint, Rx feed = 103
16:35 Swapped 10 LP H2 for 5 HP/5 LP H2
17:00 LPH2 @7.7 mscfh, CO @7.5, HP H2 @6.8
17:30 LPH2 @ 10.7 @ target, CO @ 9.5, HP H2 @6.8, T setpoint on reactor 455F
18:20 HPH2 @ 9.9, LPH2 @ 10.7, CO @ 11.2
19:15 HP H2 @ 12.3, CO @12.7
19:30 Latest moves made system swing, Backed at HPH2, letting system equilibrate
Next move will be increasing recycle so 27.10 feed ~91000 (start up condition #3)
21:00 Tank transfer. 87.25" → 20.5" in 22.16
Transferred 1294 gallons (corrected) into trailer #1513.

13 April 1998

04:20 AJ caught heavy wax and water/hydrocarbon samples.
06:40 Have been slowly returning to baseline condition all night. Last flow move AJ 06:25, last temperature move at 06:40.
08:45 GC's switched data mode.
09:00 Data period R16.5C begins.
13:30 Transferred 22.16 to trailer #1513. 89.75" → 20.5". density change @ 44"
Tracerco set up for tracer studies.
22:40 Day tank transfer to trailer #1513. 73 ¾" to 20 ¼".
Density transition at 38".

14 April 1998

02:15 AJ caught heavy wax and water/hydrocarbon samples.
08:00 Tracerco here for first tracer study (AF-R16.5)
11:00 Day tank transfer 85" → 20.5" 1250 gallons (corrected)m in #1514
Collected 3 hydrocarbon samples from end of transfer
(previous 22.11 samples have been all water, collect samples at each future 22.16 transfer).
11:00 GC shutdown for tracer injection studies.
14:00 22.16 transfer prior to tracer study
35 ¼ → 20.5" 286 gallons (corrected), total in trailer #1514 = 1536 gal.
15:06 First Ar-41 Injection
15:40 Second Ar-41 Injection w/liquid out defector plugged
16:15 Third Ar-41 Injection w la out and liquid defector plugged
17:50 MnO_2 Injected thru top nozzle (wall). (all detectors unplugged)
Significant radioactive remaining in the slurry line between reactor and degasser.
DO NOT TAKE ANY ACTION
We will monitor the radioactivity and barricade the area if necessary.
18:56 Catalyst support injected thru top nozzle (wall)
22:25 MnO_2 injection thru bottom nozzle. (center)

23:30 Catalyst support injection thru bottom nozzle. (center)

15 April 1998

00:15 Tracerco off-site. GC's on-line. Moving to high flow condition.
00:40 Nuke shutter open.
03:50 Day tank transfer to trailer #1514. 94" to 20 ½", Density transition at 44".
06:40 Last recycle and temp. move to reach high flow condition (AF-R16.7)
08:50 Decreased reactor T setpoint to 499F. (reactor level was dropping w/ no wax take off)
09:00 Switched GC's to full cycle.
10:22 HPH2 decreased from 16.5 to 16 mscfh
10:40 HPH2 decreased from 16 to 15.5
10:54 CO increased from 15.7 to 16.0
11:00 Reactor T setpoint down to 489F.
11:45 Reactor T setpoint @ 485F
Level in reactor still low (can't see where it is since nuke is racked out).
Adding durasyn (10-15 gallons) because flow through 10.62 pump was "struggling"
Reactor T dropped down to 476F
12:15 Reactor level still low → added wax from prep tank.
14:00 Adjusted Rxt temp set print to 485°F.
15:00 22.16 transferred to trailer #1514. 71.5" to 20.5". GC's turned off
17:15 22.16 transferred to trailer #1514. 33" to 20.5"
19:00 Added some durasyn-164 from 28.30 to 27.15 to bring reactor level up.
19:20 First argon injection.
20:07 Second argon injection (liquid out and liquid in detectors plugged)
21:15 Mn_20_3 injected thru top nozzle (wall)
22:18 Catalyst support injected thru top nozzle (wall)
23:43 Mn_20_3, injected thru bottom nozzles (center)

16 April 1998

00:36 Catalyst support injected thru bottom nozzle (center)
01:16 Repeat Mn_20_3, injected thru bottom nozzle (center)
03:15 Tracerco off-site. Nuke is racked in with shutter open. Bharat is doing a nuke scan.
03:35 Isolating filtration for shutdown test.
03:38 Tripping HV-150. PIC-201 closed manually. Blocking in feeds.
Starting slurry level = 215" on tape. Slurry level after gas shut down = 104" on tape.
08:00 Day tank transfer. 73" → 0", 1181 gallons → 1299 corrected gallons.
08:50 Filling 27.10 w/ 10.54
09:00 Flare out of service.
10:05 Flushed filter loop connections to 27.10.
10:30 27.10 filled w/ durasyn to top thermocouple.
12:30 GC's turned off → reading all N2.

APPENDIX E

Fischer-Tropsch IV Mass Balance

Start Date / Time	10/21/1998	0.00
End Date / Time	10/21/1998	6.00

On-stream Time From Start-up (hr)

Start	106.00
End	112.00

Reaction Conditions:

Temperature	average	deg F	495.5	deg C	257.6
Pressure	PIC-201	psig	710.0	bara	49.96
Space Velocity		sL/kg-hr	15487		
Superficial Gas Vel. - Inlet		ft/sec	0.42	cm/sec	12.91
(based on average reactor temp)					
Recycle Ratio			1.23		

Slurry Data:

Catalyst Oxide Wt (Reactor)	lbs	390	kg	176.9
Slurry Concentration by NDG	wt%	28.5		
Slurry Concentration by DP	wt%	28.0		
Slurry Level by NDG	% NDG Span	96.5		
Slurry Height	ft	20.76	meters	6.33
Average Gas Holdup by NDG	Vol%	50.3		
Average Gas Holdup by DP	Vol%	48.1		

Performance Results

CO Conversion per pass, mole %	29.6
H2 Conversion per pass, mole %	59.7
CO + H2 Conversion per pass, mole %	45.7
Plant CO Conversion, mole%	75.6
Plant H2 Conversion, mole%	91.4
Plant CO+H2 Conversion, mole%	85.9
CO Conversion Rate,	78.2
gmole CO converted/kg cat oxide-hr	
HC Production Rate,	1088.1
grams of HC (CH2.1) produced/kg cat oxide-hr	
Reactor Productivity (STY)	131.21
grams of H C (CH2.1)/lit of reactor vol. - hr	
H2/CO in Fresh Feed, mole/mole	1.87
H2/CO in Reactor Feed, mole/mole	1.15
H2/CO Usage Ratio, mole/mole	2.32
H2/CO in Outlet, mole/mole	0.66
CO2 Selectivity, mole %	1.33
HC Selectivity (CO2 free) wt%:	
CH4	13.14
C2H6	2.19
C2H4	0.23
C3H8	2.38
C3H6	1.53
SUM C4H10	1.88
SUM C4H8	1.11

Reactor Heat Balance

	Btu/hr	kW
Chemical Heat Production by Reaction	746477	218.77
Sensible Gas Heat	-102535	-30.05
Sensible Oil Heat	-502539	-147.28
Sensible Wax Heat	-85097	-24.94
Estimate of Heat Loss from Catalyst Drying Data	-35000	-10.26
% Heat Balance based on Reaction Heat	97.15	

Mass Balance	Reactor lb/hr	Plant lb/hr	Feed lb/hr	Prod Gas lb/hr
Fresh Feed		1293	1293	
HP H2 Feed				
Recycle Feed		89	89	
Reactor Feed			3064	3064
Total In	4443		4443	
Prod Gas	4443	1383		
Main Purge		496		496
22.11 Purge	0.0	0.0		
HC Phase	292.4	292.4		
AQ Phase	562.9	562.9		
Heavy Wax	59.2	59.2		
Light Wax				
Total Out	4478	1411		
Mass Balance, %	100.8	102.0	99.9	99.9

SUM C5H11	1.38		

RUN NO.: AF-R16.1A **TITLE: LIQUID PHASE FISCHER-TROPSCH (IV) SYNTHESIS IN LAPORTE AFDU**

Compositions (mole%):		**LP FRESH FEED**	**HP FRESH FEED (H2)**	**RECYCLE FEED**	**REACTOR FEED GAS**	**PRODUCT GAS**	**MAIN (22.10) PURGE**	**22.11 PURGE**	**REACTOR OUTLET (estimated)**
Components									
1	H2	43.17	100.00	27.62	44.00	27.62	27.62	10.89	23.34
2	N2	3.12	0.00	9.97	6.41	9.97	9.97	5.76	8.43
3	CO	53.71	0.00	41.82	38.19	41.82	41.82	32.26	35.34
4	CH4	0.00	0.00	14.08	7.73	14.08	14.08	22.20	11.90
5	CO2	0.00	0.00	1.68	0.93	1.68	1.68	7.34	1.42
6	ETHANE	0.00	0.00	1.29	0.71	1.29	1.29	4.41	1.09
7	ETHYLENE	0.00	0.00	0.02	0.00	0.02	0.02	0.06	0.02
8	PROPANE	0.00	0.00	0.99	0.55	0.99	0.99	5.10	0.83
9	PROPYLENE	0.00	0.00	0.66	0.36	0.66	0.66	3.35	0.56
10	ISOBUATNE	0.00	0.00	0.01	0.00	0.01	0.01	0.06	0.01
11	N-BUTANE	0.00	0.00	0.47	0.26	0.47	0.47	2.71	0.40
12	T-BUTENE-2	0.00	0.00	0.04	0.02	0.04	0.04	0.21	0.03
13	BUTENE-1	0.00	0.00	0.26	0.14	0.26	0.26	1.51	0.22
14	ISOBUTYLENE	0.00	0.00	0.03	0.02	0.03	0.03	0.16	0.03
15	C-BUTENE-2	0.00	0.00	0.05	0.03	0.05	0.05	0.28	0.04
16	SUM C5	0.00	0.00	0.35	0.19	0.35	0.35	1.86	0.29
17	SUM C6	0.00	0.00	0.12	0.08	0.12	0.12	0.60	0.10
18	SUM C7	0.00	0.00	0.34	0.24	0.34	0.34	0.97	0.29
19	SUM C8	0.00	0.00	0.21	0.13	0.21	0.21	0.25	0.18
20	SUM C9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
21	SUM C10	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00
	H2O								14.49
	HC								1.01
	LIGHT WAX								0.000
	TOTAL	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Mole Wt	lb/lb mole	16.79	2.02	20.59	16.50	20.59	20.59	28.59	21.44
Flows	SCFH	29784.74	17095.50	57552.93	104137.00	66922.63	9316.93	0.00	79198.31
	lb mole/hr	77.03	44.21	148.85	269.33	173.09	24.10	0.00	204.83
	lb/hr	1293.32	89.31	3064.42	4443.17	3563.31	496.08	0.00	4391.97
	Nm3/hr	783.82	449.89	1514.57	2740.49	1761.15	245.19	0.00	2084.20
	kgmoVhr	34.94	20.06	67.52	122.17	78.51	10.93	0.00	92.91
	kg/hr	586.65	40.51	1390.01	2015.41	1616.31	225.02	0.00	1992.19
Temperature	deg F	278.2	81.8	109.9	257.0	88.4	84.9	69.7	
	deg C	136.8	27.6	43.3	125.0	31.3	29.4	20.9	
Pressure	psig	771.8	806.0	766.2	737.9	674.3	670.4	33.3	
	bara	54.23	56.59	53.84	51.89	47.50	47.23	3.31	

Reactor Heat Balance

		deg F	deg C			lb/hr	kg/hr		Btu/lb-deg F	J/gm-deg C		lb/ft3	kg/m3
Gas:													
Inlet Temp	TI-1-12A	442.0	227.8	Inlet Flow	RXT FEED	4443	2015.4	Inlet Ht Cap.	0.486	2.033			
Outlet Temp	RXT AVG	495.5	257.5	Outlet Flow	RXT FEED-WAXPROD	4384	1988.6	Outlet Ht Cap.	0.433	1,810			
Oil:													
Inlet Temp	TI-1-14B	406.1	207.9	Inlet Flow	*FI-619	66472	30151.3	Inlet Ht Cap.	0.542	2.268	Inlet Density	51.98	832.62
Outlet Temp	TI-1780	457.3	236.3	Outlet Flow	*FI-619	66472	30151.3	Outlet Ht Cap.	0.564	2.361			
Slurry:													
Inlet Temp	TI-1783	458.9	237.2	Inlet Flow	*FI-1768-61	10843	4918.2	Inlet Ht Cap.	0.606	2.537			
Outlet Temp	RXT AVG	495.5	257.5	Outlet Flow	*FI-1768	10902	4945.0	Outlet Ht Cap.	0.606	2.537			
					*based on								

Reactor Differential Pressures

	DP NOZZLES		Differential Pressures: psi	mbar	Heights: ft (based on flange loc.)	meters	Density - 3 Phase: lb/ft3	kg/m3	Gas Hold-up vol%
Reactor Height:									
13.75 to 9.25 ft	Kl -K3	PDI-1778	0.84	58.2	4.56	1.391	26.64	426.7	48.1
9.25 ft to 4.33 ft	K3-K5	PDI-1779	0.94	64.7	5.08	1.549	26.60	426.0	48.10
Total Reactor	K6-OUT	PDI-631	3.94	271.5	96.47	29.404	6.81	109.0	88.72
Sparger	K6-IN	PDI-633	1.36	93.5					

DEGASSER

Temperatures:			deg F		deg C	
6.5 ft Height	TI-1762		388.1		197.8	
3.5 ft Height	TI-1763		432.6		222.6	
0.5 ft Height	TI-1764		497.8		258.8	
Liquid Level:						
% Level	LI-1765					
Slurry Height		ft	3.32	meters		1.013

SLURRY PUMP

			deg F	deg C
Temperature:	Slurry Inlet	TI-1755	465.7	240.9
	Seal Oil Outlet	TI-1 795	109.7	43.2
			psig	**bara**
Pressure:	Seal Oil Outlet	PI-1794	743.5	52.28
			lb/hr	**kg/hr**
Flow Rate:	Slurry Outlet	FI-1768	10901.8	4945.3
			g/cc	
Density:	Slurry Outlet	DI-1768	0.824	

SLURRY COOLER

Temperatures:		deg F	deg C
Slurry Outlet	TIC-1754	461.3	238.5

Oil Inlet	TI-1780	457.3	236.3

FILTERS

			deg F	**deg C**				**lb/hr**	**kg/hr**
Temperature:	Slurry Outlet	TI-1783	458.9	237.2	Flow Rate:	Wax	FI-1761	59.166	26.837
			psig	**bara**				**g/cc**	
Pressure:	Slurry Inlet	PI-1756	728.8	51.26	Density:	Wax	DI-1761	0.67	
Diff. Press.:	Longitudinal		**psi**	**mbar**				**ft/sec**	**msec**
	Thru D & C	PDI-1772	9.3	638	Linear Vel.:	Slurry thru	Calculated	10.80	3.291
	Thru B & A	PDI-1773	0.2	14		Each Element			
	rans-membrane							**ft/sec**	**msec**
	Membrane A	PDI-1774	0.9	0	Superfic. Vel.:	Liquid Upflow	Calculated	0.023	7.144
	Membrane B	PDI-1775	1.3	92		thru Reactor			
	Membrane C	PDI-1776	-0.9	-62					
	Membrane D	PDI-1777	0.9	65					

Reactor Temperatures

	Reactor Ht, Ft		**Deg F**	**Deg C**
Nozzle N1	24.25	TI-626-1	478.0	247.8
Nozzle N2	20.25	TI-626-2	493.2	256.2
Nozzle N3	18.25	TI-190-2A	493.3	256.3
Nozzle N4	16.25	TI-626-3	492.0	255.6
Nozzle N5	14.25	TI-190-3	491.1	255.1
Nozzle N7	10.25	TI-1781A	497.8	258.8
		TI-1781B	496.6	258.1
		TI-1781C	498.3	259.1
		TI-1781D	497.0	258.3
Nozzle N8	8.083	TI-626-5	493.2	256.2
Nozzle K4	7.75	TI-190-4	500.8	260.5
Nozzle O	4.792	TI-626-6	494.8	257.1
Reactor Temp. Avg. (Noz N3 thru Noz O)				495.5
	257.5			

Product Separation

			deg F	**deg C**
Temperatures	27.11 In	TI-1-08	-25.0	-31.7
	2138 Tube In	TI-723	461.0	238.3
	22.14 Out	TIC-725	325.5	163.0
	21.65 Out	TIC-1-11A	87.2	30.7
	27.13 Lt Wax	TI-744	119.8	48.8
	28.30 Hv Wax	TI-515	210.8	99.3
			%	
Levels	27.12	LIC-639	0.0	
	22.14	LIC-688	142.4	
	22.10	LIC-220	18.9	
	22.15	LIC-242	32.8	
	27.13	LI-203	19.5	
	28.30	LI-1792	105.0	
			psig	**bara**
Pressure	27.13	PIC-202	-0.15	1.00

Miscellaneous Data

Overall Plant Material Balance	%	102.2
100*(22.10 Purge 22.11 Purge+Heavy Wax+Light Wax+Light HC+Water)/ (LP Fresh Feed+HP H2)		
Reactor GHSV	Nm3 Rxt Feed/m3 3-phase slurry volume/hr	1867
Catalyst GHSV	Nm3 Rxt Feed/m3 particle volume/hr	14279
Catalyst Volume in the Reactor	litres particle volume	191.9
Inlet Superfic. Vel. based on Avg Reactor Temp.	cm/sec	12.91
Inlet Sup. Vel. based on Rxt Inlet Temp (TI-1-12A)	cm/sec	12.19
CO Conversion Rate, gmole CO converted AR particl volume/hr		72.11
grams of HC (CH2.1) produced/lft particle volume/hr	1003.24	

N2 Balance Across Reactor	Plant N2 Balance	Feed N2 Balance
(vary prod gas flow factor-step1)	(vary purgel flow factor-step2)	(vary 01.20 discharge flow factor-step3)
99.96	99.95	100.11
		(Redundancy converges both to 100%)
Water/Oxygen Balance		**Prod. Gas N2 Balance**
		(vary 01.20 discharge flow factor-step3)
105.38		99.92

Wax/Liquid Production Rates

	lbs/hr	kg/hr
Heavy Wax (27.10/28.30, Reactor Temp. Cut)	59.17	26.84
Light Wax (22.14/27.13, 392 deg F Cut)	0.00	0.00
Light HCs (22.10/22.16, 100 deg F Cut)	292.44	132.65
Water (22.10/22.16, 100 deg F Cut)	562.90	255.33

Slurry Conc. Based on Density Measurements

2-Phase Slurry Concentration reduced	particle vol %	24.22
	catalyst wt%	27.12

Water Saturation Calculations for the Reactor

	Based on CO, CO2 Meas.:		Based on Water Production:	
	psia	**mbara**	**psia**	**mbara**
Calculated Water Partial Pressure @ Reactor Outlet	102.86	70.92	107.56	7416
Saturated Water Pressure @ Reactor Outlet	655.2	45173	655.2	45173
Water Partial Pressure as % of Sat. Pressure @ Reactor Outlet	15.70%		16.42%	
	deg F	**deg C**	**deg F**	**deg C**
Saturated Water Temperature @ Reactor Outlet	329.6	165.3		167.1

RUN NO.: AF-R16.1B **TITLE: LIQUID PHASE FISCHER-TROPSCH (IV) SYNTHESIS IN LAPORTE AFDU**

Start Date / Time	04/03/1998	12.00
End Date / Time	04/04/1998	8.00

On-stream Time From Start-up (hr)	
Start	142.00
End	162.00

Reaction Conditions:					
Temperature	average	deg F	498.1	deg C	259.0
Pressure	PIC-201	psig	710.0	bara	49.97
Space Velocity		sL/kg-hr	14925		
Superficial Gas Vel. - Inlet		ft/sec	0.41	cm/sec	12.48
(based on average reactor temp)					
Recycle Ratio			1.14		

Slurry Data:				
Catalyst Oxide Wt (Reactor)	lbs	390	kg	176.9
Slurry Concentration by NDG	wt%	28.8		
Slurry Concentration by DP	wt%	27.7		
Slurry Level by NDG	% NDG Span	96.5		
Slurry Height	ft	20.77	meters	6.33
Average Gas Holdup by NDG	Vol%	50.5		
Average Gas Holdup by DP	Vol%	47.3		

Performance Results	
CO Conversion per pass, mole %	33.1
H2 Conversion per pass, mole %	59.9
CO + H2 Conversion per pass, mole %	47.6
Plant CO Conversion, mole%	76.8
Plant H2 Conversion, mole%	91.3
Plant CO+H2 Conversion, mole%	86.3
CO Conversion Rate,	83.0
gmole CO converted/kg cat oxide-hr	
HC Production Rate,	1155.1
grams of HC (CH2.1) produced/kg cat oxide-hr	
Reactor Productivity (STY)	139.23
grams of H C (CH2.1)/lit of reactor vol. - hr	
H2/CO in Fresh Feed, mole/mole	1.88
H2/CO in Reactor Feed, mole/mole	1.17
H2/CO Usage Ratio, mole/mole	2.13
H2/CO in Outlet, mole/mole	0.70
CO2 Selectivity, mole %	1.33
HC Selectivity (CO2 free) wt%:	
CH4	13.95
C2H6	2.05
C2H4	0.08
C3H8	2.40
C3H6	1.46
SUM C4H10	1.89
SUM C4H8	1.24

Reactor Heat Balance	**Btu/hr**	**kW**
Chemical Heat Production by Reaction	2277851	667.57
Sensible Gas Heat	-118507	-34.73
Sensible Oil Heat	-1781173	-522.01
Sensible Wax Heat	-244482	-71.65
Estimate of Heat Loss from Catalyst Drying Data	-50000	-14.65
% Heat Balance based on Reaction Heat	96.33	

Mass Balance	**Reactor lb/hr**	**Plant lb/hr**	**Feed lb/hr**	**Prod Gas lb/hr**
Fresh Feed		1300	1300	
HP H2 Feed		89	89	
Recycle Feed			2790	2790
Reactor Feed	4202		4202	
Total In	4202	1390		
Prod Gas	3266			3266
Main Purge		481		481
22.11 Purge	0.0	0.0		
HC Phase	287.8	287.8		
AQ Phase	554.0	554.0		
Heavy Wax	59.2	59.2		
Light Wax				
Total Out	4167	1382		
Mass Balance, %	99.2	99.5	100.5	100.2

SUM C5H11	1.06		

Compositions (mole%):		LP FRESH FEED	HP FRESH FEED (H2)	RECYCLE FEED	REACTOR FEED GAS	PRODUCT GAS	MAIN (22.10) PURGE	22.11 PURGE	REACTOR OUTLET (estimated)
Components									
1	H2	43.59	100.00	28.14	44.25	28.14	28.14	8.18	23.35
2	N2	3.04	0.00	9.83	6.20	9.83	9.83	4.82	8.15
3	CO	53.37	0.00	40.06	37.72	40.06	40.G6	24.11	33.24
4	CH4	0.00	0.00	15.62	8.33	15.62	15.62	23.27	12.96
5	CO2	0.00	0.00	1.83	0.99	1.83	1.83	7.57	1.52
6	ETHANE	0.00	0.00	1.39	0.76	1.39	1.39	7.11	1.16
7	ETHYLENE	0.00	0.00	0.02	0.01	0.02	0.02	0.10	0.02
8	PROPANE	0.00	0.00	1.02	0.55	1.02	1.02	7.96	0.84
9	PROPYLENE	0.00	0.00	0.67	0.36	0.67	0.67	5.27	0.56
10	ISOBUATNE	0.00	0.00	0.01	0.00	0.01	0.01	0.09	0.01
11	N-BUTANE	0.00	0.00	0.46	0.24	0.46	0.46	4.03	0.38
12	T-BUTENE-2	0.00	0.00	0.04	0.02	0.04	0.04	0.31	0.03
13	BUTENE-1	0.00	0.00	0.26	0.12	0.26	0.26	2.33	0.22
14	ISOBUTYLENE	0.00	0.00	0.03	0.04	0.03	0.03	0.26	0.02
15	C-BUTENE-2	0.00	0.00	0.05	0.02	0.05	0.05	0.40	0.04
16	SUM C5	0.00	0.00	0.32	0.18	0.32	0.32	2.69	0.27
17	SUM C6	0.00	0.00	0.11	0.06	0.11	0.11	0.85	0.09
18	SUM C7	0.00	0.00	0.11	0.12	0.11	0.11	0.62	0.09
19	SUM C8	0.00	0.00	0.04	0.04	0.04	0.04	0.01	0.03
20	SUM C9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
21	SUM C10	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00
	H2O								15.98
	HC								1.04
	LIGHT WAX								0.000
	TOTAL	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Mole Wt	lb/lb mole	16.68	2.02	19.97	16.19	19.97	19.97	30.75	20.92
Flows	SCFH	30138.70	17101.00	54031.22	100355.33	63249.80	9314.22	0.00	76219.29
	lb mole/hr	77.95	44.23	139.74	259.55	163.59	24.09	0.00	197.13
	lb/hr	1300.26	89.34	2790.32	4201.68	3266.39	481.01	0.00	4123.30
	Nm3/hr	793.14	450.03	1421.90	2640.97	1664.49	245.11	0.00	2005.80
	kgmol/hr	35.36	20.06	63.39	117.73	74.20	10.93	0.00	89.42
	kg/hr	589.79	40.53	1265.68	1905.87	1481.62	218.19	0.00	1870.32
Temperature	deg F	266.7	82.5	98.2	238.1	75.5	74.4	73.4	
	deg C	130.4	28.0	36.8	114.5	24.2	23.5	23.0	
Pressure	psig	768.1	779.2	760.3	734.4	686.4	682.3	33.5	
	bara	53.97	54.74	53.43	51.65	48.34	48.06	3.32	

Reactor Heat Balance

		deg F	deg C			lb/hr	kg/hr		Btu/lb-deg F	J/gm-deg C		lb/ft3	kg/m3
Gas:													
Inlet Temp	TI-1-12A	440.7	227.0	Inlet Flow	RXT FEED	4202	1905.9	Inlet Ht Cap.	0.491	2.054			
Outlet Temp	RXT AVG	498.1	259.9	Outlet Flow	RXT FEED-WAXPROD	4143	1879.0	Outlet Ht Cap.	0.443	1.853			
Oil:													
Inlet Temp	TI-1-14B	409.4	207.7	Inlet Flow	*FI-619	66218	30036.7	Inlet Ht Cap.	0.543	2.274	Inlet Density	51.89	831.14
Outlet Temp	TI-1780	460.5	238.0	Outlet Flow	*FI-619	66218	30036.7	Outlet Ht Cap.	0.566	2.366			
Slurry:													
Inlet Temp	TI-1783	461.6	238.7	Inlet Flow	*FI-1768-61	11011	4994.5	Inlet Ht Cap.	0.608	2.544			
Outlet Temp	RXT AVG	498.1	259.0	Outlet Flow	*FI-1768	11070	5021.4	Outlet Ht Cap.	0.608	2.544			
					*based on								

Reactor Differential Pressures

	DP NOZZLES		Differential Pressures: psi	mbar	Heights: ft (based on flange loc.)	meters	Density - 3 Phase: lb/ft3	kg/m3	Gas Hold-up vol%
Reactor Height:									
13.75 to 9.25 ft	Kl -K3	PDI-1778	0.85	58.4	4.56	1.391	26.75	428.5	47.56
9.25 ft to 4.33 ft	K3-K5	PDI-1779	0.95	65.7	5.08	1.549	27.01	432.6	47.03
Total Reactor	K6-OUT	PDI-631	3.94	271.5	20.77	6.331	26.83	429.7	47.40
Sparger	K6-IN	PDI-633	1.15	79.5					

DEGASSER

Temperatures:			**deg F**	**deg C**	
6.5 ft Height	TI-1762		397.2	202.9	
3.5 ft Height	TI-1763		455.6	235.3	
0.5 ft Height	TI-1764		502.8	261.6	
Liquid Level:					
% Level	LI-1765		2.9		
Slurry Height		ft	0.75	meters	0.229

SLURRY PUMP

			deg F	**deg C**
Temperature:	Slurry Inlet	TI-1755	469.1	242.8
	Seal Oil Outlet	TI-1 795	98.9	37.2
			psig	**bara**
Pressure:	Seal Oil Outlet	PI-1794	762.7	53.60
			lb/hr	**kg/hr**
Flow Rate:	Slurry Outlet	FI-1768	11070.1	5021.6
			g/cc	
Density:	Slurry Outlet	DI-1768	0.820	

SLURRY COOLER

Temperatures:	**deg F**	**deg C**

Slurry Outlet	TIC-1754	464.3	240.2
Oil Inlet	TI-1780	460.5	238.0

FILTERS

			deg F	**deg C**				**lb/hr**	**kg/hr**
Temperature:	Slurry Outlet	TI-1783	461.6	238.7	Flow Rate:	Wax	FI-1761	59.173	26.841
			psig	**bara**				**g/cc**	
Pressure:	Slurry Inlet	PI-1756	717.4	50.47	Density:	Wax	DI-1761	0.67	
Diff. Press.:	Longitudinal		**psi**	**mbar**				**ft/sec**	**msec**
	Thru D & C	PDI-1772	6.8	467	Linear Vel.:	Slurry thru Each Element	Calculated	11.01	3.356
	Thru B & A	PDI-1773	0.2	13					
	rans-membrane							**ft/sec**	**msec**
	Membrane A	PDI-1774	-0.6	-41	Superfic. Vel.:	Liquid Upflow thru Reactor	Calculated	0.024	7.285
	Membrane B	PDI-1775	1.3	90					
	Membrane C	PDI-1776	-1.3	-87					
	Membrane D	PDI-1777	0.2	15					

Reactor Temperatures

	Reactor Ht, Ft		**Deg F**	**Deg C**
Nozzle N1	24.25	TI-626-1	480.3	249.0
Nozzle N2	20.25	TI-626-2	497.1	258.4
Nozzle N3	18.25	TI-190-2A	496.7	258.1
Nozzle N4	16.25	TI-626-3	495.4	257.5
Nozzle N5	14.25	TI-190-3	494.0	256.7
Nozzle N7	10.25	TI-1781A	500.7	260.4
		TI-1781B	499.5	259.7
		TI-1781C	501.0	260.6
		TI-1781D	499.7	259.9
Nozzle N8	8.083	TI-626-5	493.3	256.3
Nozzle K4	7.75	TI-190-4	503.7	262.1
Nozzle O	4.792	TI-626-6	497.4	258.6
Reactor Temp. Avg. (Noz N3 thru Noz O)				498.1
	259.0			

Product Separation

			deg F	**deg C**
Temperatures	27.11 In	TI-1-08	-25.0	-31.7
	2138 Tube In	TI-723	460.6	238.1
	22.14 Out	TIC-725	335.4	168.5
	21.65 Out	TIC-1-11A	74.1	23.4
	27.13 Lt Wax	TI-744	102.7	39.3
	28.30 Hv Wax	TI-515	217.9	103.3
			%	
Levels	27.12	LIC-639	0.0	
	22.14	LIC-688	90/6	
	22.10	LIC-220	30.0	
	22.15	LIC-242	27.8	
	27.13	LI-203	26.8	
	28.30	LI-1792	33.4	
			psig	**bara**
Pressure	27.13	PIC-202	12.41	1.87

Miscellaneous Data

Overall Plant Material Balance		%	99.46
100*(22.10 Purge 22.11 Purge+Heavy Wax+Light Wax+Light HC+Water)/ (LP Fresh Feed+HP H2)			
Reactor GHSV	Nm3 Rxt Feed/m3 3-phase	slurry volume/hr	1799
Catalyst GHSV	Nm3 Rxt Feed/m3	particle volume/hr	13761
Catalyst Volume in the Reactor		litres particle volume	191.9
Inlet Superfic. Vel. based on Avg Reactor Temp.		cm/sec	12.48
Inlet Sup. Vel. based on Rxt Inlet Temp (TI-1-12A)		cm/sec	11.73
CO Conversion Rate, gmole CO converted AR particle volume/hr			76.55
grams of HC (CH2.1) produced/Ift particle volume/hr		1065	

N2 Balance Across Reactor	**Plant N2 Balance**	**Feed N2 Balance**
(vary prod gas flow factor-step1)	(vary purgel flow factor-step2)	(vary 01.20 discharge flow factor-step3)
99.94	100.01	99.91
		(Redundancy converges both to 100%)
Water/Oxygen Balance		**Prod. Gas N2 Balance**
		(vary 01.20 discharge flow factor-step3)
97.71		100.15

Wax/Liquid Production Rates

	lbs/hr	kg/hr
Heavy Wax (27.10/28.30, Reactor Temp. Cut)	59.17	26.84
Light Wax (22.14/27.13, 392 deg F Cut)	0.00	0.00
Light HCs (22.10/22.16, 100 deg F Cut)	287.84	130.56
Water (22.10/22.16, 100 deg F Cut)	554.05	251.31

Slurry Conc. Based on Density Measurements

2-Phase Slurry Concentration reduced	particle vol %	22.90
	catalyst wt%	25.75

Water Saturation Calculations for the Reactor

	Based on CO, CO2 Meas.:		Based on Water Production:	
	psia	mbara	psia	mbara
Calculated Water Partial Pressure @ Reactor Outlet	113.47	7823	111.27	7672
Saturated Water Pressure @ Reactor Outlet	671.1	46273	671.1	46273
Water Partial Pressure as % of Sat. Pressure @ Reactor Outlet	16.91%		16.58%	
	deg F	deg C	deg F	deg C
Saturated Water Temperature @ Reactor Outlet	336.8	169.3	335.4	168.5

RUN NO.: AF-R16.1C **TITLE: LIQUID PHASE FISCHER-TROPSCH (IV) SYNTHESIS IN LAPORTE AFDU**

Start Date / Time	04/04/1998	8.00
End Date / Time	04/05/1998	4.00

On-stream Time From Start-up (hr)

Start	162.00
End	182.00

Reaction Conditions:

Temperature	average	deg F	498.0	deg C	258.9
Pressure	PIC-201	psig	710.0	bara	49.97
Space Velocity		sL/kg-hr	14975		
Superficial Gas Vel. - Inlet		ft/sec	0.41	cm/sec	12.45
(based on average reactor temp)					
Recycle Ratio			1.11		

Slurry Data:

Catalyst Oxide Wt (Reactor)	lbs	388	kg	176.0
Slurry Concentration by NDG	wt%	28.6		
Slurry Concentration by DP	wt%	27.6		
Slurry Level by NDG	% NDG Span	96.5		
Slurry Height	ft	20.77	meters	6.33
Average Gas Holdup by NDG	Vol%	50.1		
Average Gas Holdup by DP	Vol%	47.3		

Performance Results

CO Conversion per pass, mole %	33.2
H2 Conversion per pass, mole %	60.5
CO + H2 Conversion per pass, mole %	48.4
Plant CO Conversion, mole%	75.7
Plant H2 Conversion, mole%	90.4
Plant CO+H2 Conversion, mole%	85.3
CO Conversion Rate, gmole CO converted/kg cat oxide-hr	81.5
HC Production Rate, grams of HC (CH2.1) produced/kg cat oxide-hr	1132.6
Reactor Productivity (STY) grams of H C (CH2.1)/lit of reactor vol. - hr	135.79
H2/CO in Fresh Feed, mole/mole	1.88
H2/CO in Reactor Feed, mole/mole	1.26
H2/CO Usage Ratio, mole/mole	2.30
H2/CO in Outlet, mole/mole	0.75
CO2 Selectivity, mole %	1.41
HC Selectivity (CO2 free) wt%:	
CH4	14.61
C2H6	2.42
C2H4	0.15
C3H8	2.51
C3H6	1.69
SUM C4H10	1.90
SUM C4H8	1.21

Reactor Heat Balance

	Btu/hr	kW
Chemical Heat Production by Reaction		
Sensible Gas Heat		
Sensible Oil Heat		
Sensible Wax Heat		
Estimate of Heat Loss from Catalyst Drying Data		
% Heat Balance based on Reaction Heat		

Mass Balance	Reactor lb/hr	Plant lb/hr	Feed lb/hr	Prod Gas lb/hr
Fresh Feed		1301	1301	
HP H2 Feed		89	89	
Recycle Feed			2641	2641
Reactor Feed	4039		4039	
Total In	4039	1390		
Prod Gas	3138			3138
Main Purge		498		498
22.11 Purge	0.0	0.0		
HC Phase	275.8	275.8		
AQ Phase	531.0	531.0		
Heavy Wax	52.7	52.7		
Light Wax				
Total Out	3997	1357		
Mass Balance, %	99.0	97.6	100.2	100.0

SUM C5H11	1.02

RUN NO.: AF-R16.1C

TITLE: LIQUID PHASE FISCHER-TROPSCH (IV) SYNTHESIS IN LAPORTE AFDU

Compositions (mole%):		LP FRESH FEED	HP FRESH FEED (H2)	RECYCLE FEED	REACTOR FEED GAS	PRODUCT GAS	MAIN (22.10) PURGE	22.11 PURGE	REACTOR OUTLET (estimated)
Components									
1	H2	43.54	100.00	29.59	46.37	29.59	29.59	9.41	24.58
2	N2	3.07	0.00	9.39	5.82	9.39	9.39	4.57	7.80
3	CO	53.39	0.00	39.71	36.78	39.71	39.71	25.39	32.99
4	CH4	0.00	0.00	15.15	7.81	15.15	15.15	21.44	12.59
5	CO2	0.00	0.00	1.73	0.90	1.73	1.73	6.67	1.44
6	ETHANE	0.00	0.00	1.38	0.71	1.38	1.38	7.24	1.15
7	ETHYLENE	0.00	0.00	0.02	0.00	0.02	0.02	0.11	0.02
8	PROPANE	0.00	0.00	1.01	0.53	1.01	1.01	8.18	0.84
9	PROPYLENE	0.00	0.00	0.67	0.34	0.67	0.67	5.28	0.55
10	ISOBUATNE	0.00	0.00	0.01	0.00	0.01	0.01	0.10	0.01
11	N-BUTANE	0.00	0.00	0.47	0.24	0.47	0.47	4.31	0.39
12	T-BUTENE-2	0.00	0.00	0.04	0.02	0.04	0.04	0.31	0.03
13	BUTENE-1	0.00	0.00	0.26	0.13	0.26	0.26	2.38	0.22
14	ISOBUTYLENE	0.00	0.00	0.03	0.02	0.03	0.03	0.28	0.03
15	C-BUTENE-2	0.00	0.00	0.05	0.02	0.05	0.05	0.41	0.04
16	sum C5	0.00	0.00	0.33	0.18	0.33	0.33	2.88	0.28
17	SUM C6	0.00	0.00	0.12	0.07	0.12	0.12	0.90	0.10
18	SUM C7	0.00	0.00	0.02	0.02	0.02	0.02	0.14	0.02
19	SUM C8	0.00	0.00	0.01	0.02	0.01	0.01	0.02	0.01
20	SUM C9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
21	SUM C10	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00
	H2O								15.90
	HC								1.01
	LIGHT WAX								0.000
	TOTAL	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Mole Wt	lb/lb mole	16.69	2.02	19.56	15.59	19.56	19.56	30.43	20.55
Flows	SCFH	30132.03	17104.10	52207.22	100178.56	62030.75	9842.83	0.00	74659.86
	lb mole/hr	77.93	44.24	135.03	259.10	160.43	25.46	0.00	193.10
	lb/hr	1301.01	89.36	2640.99	4039.26	3137.93	497.92	0.00	3968.45
	Nm3/hr	792.96	450.12	1373.90	2636.32	1632.41	259.03	0.00	1964.76
	kgmol/hr	35.35	20.07	61.25	117.53	72.77	11.55	0.00	87.59
	kg/hr	590.13	40.53	1197.94	1832.20	1423.36	225.85	0.00	1800.08
Temperature	deg F	272.0	85.2	104.2	238.7	83.8	81.3	69.3	
	deg C	133.4	29.6	40.1	114.8	28.8	27.4	20.7	
Pressure	psig	766.0	792.3	758.4	733.1	685.8	682.0	33.4	

bara	53.82	55.64	53.30	51.56	48.30	48.03	3.31

RUN NO.: AF-R16.1C **TITLE: LIQUID PHASE FISCHER-TROPSCH (IV) SYNTHESIS IN LAPORTE AFDU**

Reactor Heat Balance

Gas:		**deg F**	**deg C**			**lb/hr**	**kg/hr**		**Btu/lb-deg F**	**J/gm-deg C**			
Inlet Temp	TI-1-12A	440.3	226.8	Inlet Flow	RXT FEED	4039	1832.2	Inlet Ht Cap.	0.505	2.112			
Outlet Temp	RXT AVG	498.0	258.9	Outlet Flow	RXT FEED-WAXPROD	3987	1808.3	Outlet Ht Cap.	0.448	1.875			
Oil:												**lb/ft3**	**kg/m3**
Inlet Temp	TI-1-14B	410.5	210.3	Inlet Flow	*FI-619	66226	30040.1	Inlet Ht Cap.	0.544	2.276	Inlet Density	51.86	830.65
Outlet Temp	TI-1780	461.0	238.3	Outlet Flow	*FI-619	66226	30040.1	Outlet Ht Cap.	0.566	2.367			
Slurry:													
Inlet Temp	TI-1783	462.3	239.0	Inlet Flow	*FI-1768-61	11011	4994.7	Inlet Ht Cap.	0.609	2.546			
Outlet Temp	RXT AVG	498.0	258.9	Outlet Flow	*FI-1768	11064	5018.6	Outlet Ht Cap.	0.609	2.546			
					*based on								

Reactor Differential Pressures

	DP NOZZLES		**Differential Pressures:**		**Heights:**		**Density - 3 Phase:**		**Gas Hold-up**
			psi	**mbar**	**ft**	**meters**	**lb/ft3**	**kg/m3**	**vol%**
					(based on flange loc.)				
Reactor Height:									
13.75 to 9.25 ft	Kl -K3	PDI-1778	0.85	58.6	4.56	1.391	26.83	429.7	47.34
9.25 ft to 4.33 ft	K3-K5	PDI-1779	0.95	65.3	5.08	1.549	26.85	430.0	47.30
Total Reactor	K6-OUT	PDI-631	3.93	271.0	20.77	6.332	26.78	429.0	47.43
Sparger	K6-IN	PDI-633	1.12	77.2					

DEGASSER

Temperatures:		**deg F**	**deg C**		
6.5 ft Height	TI-1762	403.4	206.4		
3.5 ft Height	TI-1763	457.8	236.5		
0.5 ft Height	TI-1764	502.7	261.5		
Liquid Level:					
% Level	LI-1765	4.3			
Slurry Height	ft	1.01		meters	0.307

SLURRY PUMP

			deg F	**deg C**
Temperature:	Slurry Inlet	TI-1755	469.7	243.2
	Seal Oil Outlet	TI-1 795	104.0	40.0
			psig	**bara**
Pressure:	Seal Oil Outlet	PI-1794	762.7	53.60
			lb/hr	**kg/hr**
Flow Rate:	Slurry Outlet	FI-1768	11064.1	5018.9
			g/cc	
Density:	Slurry Outlet	DI-1768	0.821	

SLURRY COOLER

Temperatures:		**deg F**	**deg C**
Slurry Outlet	TIC-1754	465.1	240.6
Oil Inlet	TI-1780	461.0	238.3

RUN NO.: AF-R16.1C TITLE: LIQUID PHASE FISCHER-TROPSCH (IV) SYNTHESIS IN LAPORTE AFDU

FILTERS

			deg F	**deg C**				**lb/hr**	**kg/hr**
Temperature:	Slurry Outlet	TI-1783	462.3	239.0	Flow Rate:	Wax	FI-1761	52.672	23.892
			psig	**bara**				**g/cc**	
Pressure:	Slurry Inlet	PI-1756	721.7	50.77	Density:	Wax	DI-1761	0.67	
Diff. Press.:	Longitudinal		**psi**	**mbar**				**ft/sec**	**msec**
	Thru D & C	PDI-1772	8.7	598	Linear Vel.:	Slurry thru	Calculated	11.00	3.353
	Thru B & A	PDI-1773	0.2	14		Each Element			
	rans-membrane							**ft/sec**	**msec**
	Membrane A	PDI-1774	-0.1	-10	Superfic. Vel.:	Liquid Upflow	Calculated	0.024	7.283
	Membrane B	PDI-1775	1.3	87		thru Reactor			
	Membrane C	PDI-1776	-1.1	-74					
	Membrane D	PDI-1777	0.5	33					

Reactor Temperatures

	Reactor Ht, Ft		**Deg F**	**Deg C**
Nozzle N1	24.25	TI-626-1	480.2	249.0
Nozzle N2	20.25	TI-626-2	497.5	258.6
Nozzle N3	18.25	TI-190-2A	496.9	258.3
Nozzle N4	16.25	TI-626-3	495.7	257.6
Nozzle N5	14.25	TI-190-3	494.0	256.7
Nozzle N7	10.25	TI-1781A	500.4	260.2
		TI-1781B	499.3	259.6
		TI-1781C	500.9	260.5
		TI-1781D	499.6	259.8
Nozzle N8	8.083	TI-626-5	492.9	256.1
Nozzle K4	7.75	TI-190-4	503.4	261.9
Nozzle O	4.792	TI-626-6	497.0	258.4
Reactor Temp. Avg. (Noz N3 thru Noz O)			498.0	258.9

Product Separation

			deg F	**deg C**
Temperatures	27.11 In	TI-1-08	-25.0	-31.9
	2138 Tube In	TI-723	457.1	236.1
	22.14 Out	TIC-725	335.3	168.5
	21.65 Out	TIC-1-11A	82.5	28.0
	27.13 Lt Wax	TI-744	96.2	35.6
	28.30 Hv Wax	TI-515	240.8	116.0
			%	
Levels	27.12	LIC-639	0.0	
	22.14	LIC-688	57.4	
	22.10	LIC-220	30.0	
	22.15	LIC-242	31.5	
	27.13	LI-203	38.9	
	28.30	LI-1792	42.6	
			psig	**bara**
Pressure	27.13	PIC-202	10.84	1.76

Miscellaneous Data

Overall Plant Material Balance	%	97.63
100*(22.10 Purge 22.11 Purge+Heavy Wax+Light Wax+Light HC+Water)/ (LP Fresh Feed+HP H2)		
Reactor GHSV Nm3 Rxt Feed/m3 3-phase slurry volume/hr		1795
Catalyst GHSV Nm3 Rxt Feed/m3 particle volume/hr		13807
Catalyst Volume in the Reactor	litres particle volume	190.9
Inlet Superfic. Vel. based on Avg Reactor Temp.	cm/sec	12.45
Inlet Sup. Vel. based on Rxt Inlet Temp (TI-1-12A)	cm/sec	11.70
CO Conversion Rate, gmole CO converted AR particle volume/hr		75.12
grams of HC (CH2.1) produced/lft particle volume/hr		1044.25

N2 Balance Across Reactor	Plant N2 Balance	Feed N2 Balance
(vary prod gas flow factor-step1)	(vary purgel flow factor-step2)	(vary 01.20 discharge flow factor-step3)
99.98	100.04	99.99
		(Redundancy converges both to 100%)
Water/Oxygen Balance		**Prod. Gas N2 Balance**
		(vary 01.20 discharge flow factor-step3)
96.06		100.03

Wax/Liquid Production Rates

	lbs/hr	kg/hr
Heavy Wax (27.10/28.30, Reactor Temp. Cut)	52.67	23.89
Light Wax (22.14/27.13, 392 deg F Cut)	0.00	0.00
Light HCs (22.10/22.16, 100 deg F Cut)	275.84	125.12
Water (22.10/22.16, 100 deg F Cut)	530.96	240.84

Slurry Conc. Based on Density Measurements

2-Phase Slurry Concentration reduced	particle vol %	23.00
	catalyst wt%	25.84

Water Saturation Calculations for the Reactor

	Based on CO, CO2 Meas.:		Based on Water Production:	
	psia	**mbara**	**psia**	**mbara**
Calculated Water Partial Pressure @ Reactor Outlet	112.91	7785	109.14	7525
Saturated Water Pressure @ Reactor Outlet	670.4	46224	670.4	46224
Water Partial Pressure as % of Sat. Pressure @ Reactor Outlet			16.28%	
	deg F	**deg C**	**deg F**	**deg C**
Saturated Water Temperature @ Reactor Outlet	336.4	169.1	333.9	167.7

RUN NO.: AF-R16.1C

TITLE: LIQUID PHASE FISCHER-TROPSCH (IV) SYNTHESIS IN LAPORTE AFDU

Carbon No.	Compositions, wt% 1-Alcohols wt%	2-Olefins wt%	n-Paraffins wt%	Light HC Phase 1-Olefins wt%	iso-Parafins wt%	Total wt%
1						0.00
2						0.00
3	0.04	0.00	0.22	0.07	0.00	0.33
4	0.24	0.31	1.55	0.74	0.00	2.83
5	0.43	0.52	3.08	1.87	0.24	6.14
6	0.57	0.63	3.85	2.68	0.49	8.21
7	0.56	0.64	4.32	2.77	0.39	8.68
8	0.52	0.67	4.73	2.48	0.43	8.84
9	0.49	0.68	4.77	1.98	0.53	8.45
10	0.49	0.65	4.72	1.46	0.57	7.89
11	0.40	0.54	4.60	1.10	0.50	7.13
12	0.36	0.53	4.79	0.96	0.49	7.12
13	0.26	0.43	4.09	0.60	0.46	5.85
14	0.22	0.34	3.62	0.41	0.45	5.03
15	0.17	0.25	3.12	0.28	0.48	4.30
16	0.12	0.19	2.68	0.23	0.47	3.69
17	0.03	0.12	2.22	0.28	0.48	3.13
18	0.00	0.10	1.98	0.18	0.34	2.61
19	0.00	0.09	1.71	0.12	0.26	2.18
20	0.00	0.03	1.47	0.07	0.30	1.88
21			1.39			1.39
22			1.09			1.09
23			0.82			0.82
24			0.64			0.64
25			0.47			0.47
26			0.38			0.38
27			0.37			0.37
28			0.23			0.23
29			0.11			0.11
30			0.07			0.07
> 30			0.13			013
Total	4.91	6.71	63.22	18.28	6.88	100.00

Composition, Wt% Compound	Aqueous Phase
Ethanol	3.20
Water by diff.	96.80
Total	100.0

Composition, wt% Carbon No.	Reactor Wax
12	0.19
13	0.35
14	0.61
15	0.65
16	1.03
17	1.23
18	1.54
19	1.90
20	2.31
21	2.75
22	3.21
23	3.67
24	4.07
25	4.40
26	4.67
27	4.89
28	4.88
29	4.70
30	4.53
31	4.33
32	4.16
33	3.82
34	3.52
35	3.21
36	2.94
37	2.71
38	2.45
39	2.20
40	2.03
41	1.84
42	1.68
43	1.51
44	1.38
45	1.24
46	1.11
47	1.00
48	0.90
49	0.80
50	0.72
> 50	4.85
Total	100.00

Elemental Balance:

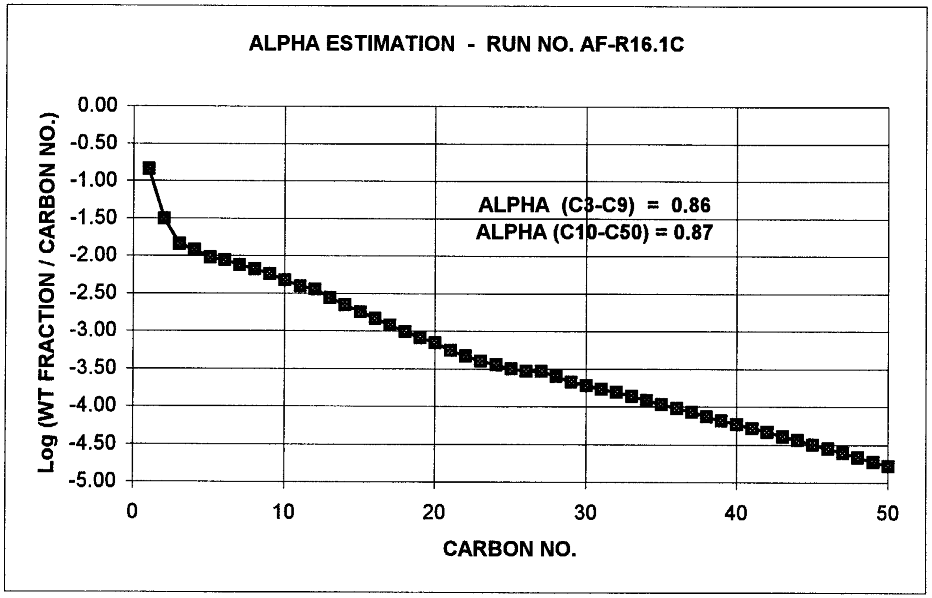
	Total lb/hr	C lb/hr	H lb/hr	O lb/hr	N lb/hr
Reactor Feed Gas	4039.54	1645.97	371.71	1599.69	422.17
Main Gas Outlet	3137.88	1358.64	248.78	1108.38	422.08
27.10 Reactor Wax	52.67	44.92	7.75	0.00	0.00
22.14 Light Wax	0.00	0.00	0.00	0.00	0.00
22.18 HC Phase	275.84	232.51	41.67	1.66	0.00
22.18 AQ Phase	530.96	8.85	59.32	462.78	0.00
Total Out	3997.35	1644.93	357.51	1572.84	422.08
% Balance	99.0	99.9	96.2	98.3	100.0

Product Distribution: Selectivity (wt%)

Methane (C1)	14.2
Gas (C2 - C4)	15.2
Gasoline (C5 - C11)	34.4
Diesel (C122 - C18)	19.6
Wax (C19+)	16.6
Total	100.0
HC Production Rate based on Liquid Data, grams HC produced/kg-cat oxide hr	1187.4

Alpha Estimate:

C3 - C9	1	0.86
C10-C50	2	0.87



RUN NO.: AF-R16.3A **TITLE: LIQUID PHASE FISCHER-TROPSCH (IV) SYNTHESIS IN LAPORTE AFDU**

Start Date / Time	0/06/1998	23.00
End Date / Time	04/07/1998	8.00

On-stream Time From Start-up (hr)	
Start	225.00
End	234.00

Reaction Conditions:

Temperature	average	deg F	502.2	deg C	261.2
Pressure	PIC-201	psig	710.1	bara	49.98
Space Velocity		sL/kg-hr	22223		
Superficial Gas Vel. - Inlet		ft/sec	0.60	cm/sec	18.32
(based on average reactor temp)					
Recycle Ratio			2.12		

Slurry Data:

Catalyst Oxide Wt (Reactor)	lbs	383	kg	173.7
Slurry Concentration by NDG	wt%	28.6		
Slurry Concentration by DP	wt%	27.3		
Slurry Level by NDG	% NDG Span	96.8		
Slurry Height	ft	20.81	meters	6.34
Average Gas Holdup by NDG	Vol%	50.2		
Average Gas Holdup by DP	Vol%	47.2		

Performance Results

CO Conversion per pass, mole %	20.2
H2 Conversion per pass, mole %	43.0
CO + H2 Conversion per pass, mole %	32.2
Plant CO Conversion, mole%	70.2
Plant H2 Conversion, mole%	87.2
Plant CO+H2 Conversion, mole%	81.2
CO Conversion Rate,	76.9
gmole CO converted/kg cat oxide-hr	
HC Production Rate,	1067.3
grams of HC (CH2.1) produced/kg cat oxide-hr	
Reactor Productivity (STY)	126.07
grams of H C (CH2.1)/lit of reactor vol. - hr	
H2/CO in Fresh Feed, mole/mole	1.82
H2/CO in Reactor Feed, mole/mole	1.10
H2/CO Usage Ratio, mole/mole	2.34
H2/CO in Outlet, mole/mole	0.78
CO2 Selectivity, mole %	1.55
HC Selectivity (CO2 free) wt%:	
CH4	17.67
C2H6	2.48
C2H4	-0.05
C3H8	2.64
C3H6	1.73
SUM C4H10	1.55
SUM C4H8	1.45

Reactor Heat Balance

	Btu/hr	kW
Chemical Heat Production by Reaction	2068071	606.09
Sensible Gas Heat	-178235	-52.24
Sensible Oil Heat	-1608608	-471.43
Sensible Wax Heat	-222668	-65.26
Estimate of Heat Loss from Catalyst Drying Data	-50000	-14.65
% Heat Balance based on Reaction Heat	99.59	

Mass Balance	Reactor lb/hr	Plant lb/hr	Feed lb/hr	Prod Gas lb/hr
Fresh Feed		1312	1312	
HP H2 Feed		86	86	
Recycle Feed			4882	4882
Reactor Feed	6296		6296	
Total In	6296	1398		
Prod Gas	5472			5472
Main Purge		590		590
22.11 Purge	0.0	0.0		
HC Phase	274.0	274.0		
AQ Phase	527.4	527.4		
Heavy Wax	8.6	8.6		
Light Wax				
Total Out	6282	1400		
Mass Balance, %	99.8	100.1	100.3	100.0

SUM C5H11	1.63		

RUN NO.: AF-R16.3A TITLE: LIQUID PHASE FISCHER-TROPSCH (IV) SYNTHESIS IN LAPORTE AFDU

Compositions (mole%):		LP FRESH FEED	HP FRESH FEED (H2)	RECYCLE FEED	REACTOR FEED GAS	PRODUCT GAS	MAIN (22.10) PURGE	22.11 PURGE	REACTOR OUTLET (estimated)
Components									
1	H2	43.25	100.00	31.65	42.08	31.65	31.65	10.91	28.62
2	N2	3.06	0.00	7.73	5.86	7.73	7.73	4.08	6.99
3	CO	53.69	0.00	40.33	38.30	40.33	40.33	27.97	36.47
4	CH4	0.00	0.00	14.57	9.83	14.57	14.57	19.11	13.18
5	CO2	0.00	0.00	1.45	0.98	1.45	1.45	5.05	1.31
6	ETHANE	0.00	0.00	1.30	0.90	1.30	1.30	7.26	1.18
7	ETHYLENE	0.00	0.00	0.02	0.02	0.02	0.02	0.10	0.02
8	PROPANE	0.00	0.00	0.98	0.88	0.98	0.98	8.24	0.89
9	PROPYLENE	0.00	0.00	0.59	0.40	0.59	0.59	4.84	0.54
10	ISOBUATNE	0.00	0.00	0.01	0.01	0.01	0.01	0.10	0.01
11	N-BUTANE	0.00	0.00	0.48	0.33	0.48	0.48	4.53	0.44
12	T-BUTENE-2	0.00	0.00	0.05	0.03	0.05	0.05	0.42	0.04
13	BUTENE-1	0.00	0.00	0.24	0.16	0.24	0.24	2.20	0.22
14	ISOBUTYLENE	0.00	0.00	0.03	0.02	0.03	0.03	0.30	0.03
15	C-BUTENE-2	0.00	0.00	0.08	0.04	0.06	0.06	0.52	0.05
16	SUM C5	0.00	0.00	0.36	0.25	0.36	0.36	3.16	0.33
17	SUM C6	0.00	0.00	0.13	0.09	0.13	0.13	1.05	0.11
18	SUM C7	0.00	0.00	0.02	0.01	0.02	0.02	0.15	0.01
19	SUM C8	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.00
20	SUM C9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
21	SUM C10	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00
	H2O								8.97
	HC								0.61
	LIGHT WAX								0.000
	TOTAL	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Mole Wt	lb/lb mole	16.77	2.02	19.04	16.59	19.04	19.04	30.30	19.69
Flows	SCFH	30245.09	16504.40	99154.37	148743.26	111147.37	11978.68	0.00	122926.70
	lb mole/hr	78.22	42.69	256.45	379.53	287.47	30.98	0.00	317.93
	lb/hr	1311.76	86.23	4881.66	6296.36	5472.11	589.75	0.00	6261.44
	Nm3/hr	795.94	434.33	2609.37	3861.73	2924.98	315.23	0.00	3234.96
	kgmol/hr	35.48	19.36	116.32	172.15	130.39	14.05	0.00	144.21
	kg/hr	595.01	39.11	2214.31	2856.01	2482.13	267.51	0.00	2840.17
Temperature	deg F	279.1	80.1	122.8	295.2	85.2	82.7	73.2	
	deg C	137.3	26.7	50.4	146.2	29.6	28.2	22.9	
Pressure	psig	815.1	812.4	824.8	770.9	640.5	633.4	33.3	
	bara	57.21	57.02	57.88	54.17	45.17	44.68	3.31	

Reactor Heat Balance

Gas:		**deg F**	**deg C**			**lb/hr**	**kg/hr**		**Btu/lb-deg F**	**J/gm-deg C**			
Inlet Temp	TI-1-12A	443.8	228.8	Inlet Flow	RXT FEED	6296	2856.0	Inlet Ht Cap.	0.485	2.030			
Outlet Temp	RXT AVG	502.2	261.2	Outlet Flow	RXT FEED-WAXPROD	6288	2852.1	Outlet Ht Cap.	0.458	1.918			
Oil:												**lb/ft3**	**kg/m3**
Inlet Temp	TI-1-14B	422.8	217.1	Inlet Flow	*FI-619	65579	29746.6	Inlet Ht Cap.	0.549	2.298	Inlet Density	51.51	825.12
Outlet Temp	TI-1780	468.7	242.6	Outlet Flow	*FI-619	65579	29746.6	Outlet Ht Cap.	0.569	2.381			
Slurry:													
Inlet Temp	TI-1783	469.0	242.8	Inlet Flow	*FI-1768-61	10978	4979.7	Inlet Ht Cap.	0.610	2.554			
Outlet Temp	RXT AVG	502.2	261.2	Outlet Flow	*FI-1768	20987	4983.5	Outlet Ht Cap.	0.610	2.554			
					*based on								

Reactor Differential Pressures

	DP NOZZLES		**Differential Pressures:** psi	mbar	**Heights:** ft (based on flange loc.)	meters	**Density - 3 Phase:** lb/ft3	kg/m3	**Gas Hold-up** vol%
Reactor Height:									
13.75 to 9.25 ft	Kl -K3	PDI-1778	0.84	57.9	4.56	1.391	26.52	424.9	47.66
9.25 ft to 4.33 ft	K3-K5	PDI-1779	0.95	65.7	5.08	1.549	26.97	432.1	46.73
Total Reactor	K6-OUT	PDI-631	3.77	259.9	20.81	6.344	25.63	410.5	49.51
Sparger	K6-IN	PDI-633	2.57	177.2					

DEGASSER

Temperatures:			**deg F**		**deg C**
6.5 ft Height	TI-1762		397.0		202.8
3.5 ft Height	TI-1763		444.1		228.9
0.5 ft Height	TI-1764		507.2		264.0
Liquid Level:					
% Level	LI-1765		52.0		
Slurry Height		ft	9.36	meters	2.851

SLURRY PUMP

			deg F	**deg C**
Temperature: Slurry Inlet		TI-1755	476.3	246.8
	Seal Oil Outlet	TI-1 795	103.8	39.9
			psig	**bara**
Pressure:	Seal Oil Outlet	PI-1794	766.6	53.87
			lb/hr	**kg/hr**
Flow Rate:	Slurry Outlet	FI-1768	10986.7	4983.8
			g/cc	
Density:	Slurry Outlet	DI-1768	0.826	

SLURRY COOLER

Temperatures:		**deg F**	**deg C**
Slurry Outlet	TIC-1754	471.5	244.2
Oil Inlet	TI-1780	468.7	242.6

FILTERS

			deg F	**deg C**				**lb/hr**	**kg/hr**
Temperature:	Slurry Outlet	TI-1783	469.0	242.8	Flow Rate:	Wax	FI-1761	8.574	3.889
			psig	**bara**				**g/cc**	
Pressure:	Slurry Inlet	PI-1756	729.6	51.31	Density:	Wax	DI-1761	0.67	
Diff. Press.:	Longitudinal		**psi**	**mbar**				**ft/sec**	**msec**
	Thru D & C	PDI-1772	10.0	690	Linear Vel.:	Slurry thru	Calculated	10.85	3.308
	Thru B & A	PDI-1773	0.2	15		Each Element			
	rans-membrane							**ft/sec**	**msec**
	Membrane A	PDI-1774	0.0	-2	Superfic. Vel.:	Liquid Upflow	Calculated	0.024	7.221
	Membrane B	PDI-1775	1.3	89		thru Reactor			
	Membrane C	PDI-1776	-1.1	-77					
	Membrane D	PDI-1777	-0.3	-21					

Reactor Temperatures

	Reactor Ht, Ft		Deg F	Deg C
Nozzle N1	24.25	TI-626-1	494.3	256.8
Nozzle N2	20.25	TI-626-2	502.1	261.2
Nozzle N3	18.25	TI-190-2A	501.5	260.8
Nozzle N4	16.25	TI-626-3	500.2	260.1
Nozzle N5	14.25	TI-190-3	500.1	260.1
Nozzle N7	10.25	TI-1781A	504.4	262.5
		TI-1781B	503.7	262.0
		TI-1781C	504.5	262.5
		TI-1781D	503.6	262.0
Nozzle N8	8.083	TI-626-5	497.6	258.7
Nozzle K4	7.75	TI-190-4	506.3	263.5
Nozzle O	4.792	TI-626-6	500.1	260.1
Reactor Temp. Avg. (Noz N3 thru Noz O)				502.2
	261.2			

Product Separation

			deg F	**deg C**
Temperatures	27.11 In	TI-1-08	-25.0	-31.7
	2138 Tube In	TI-723	472.5	244.7
	22.14 Out	TIC-725	310.0	154.5
	21.65 Out	TIC-1-11A	84.0	28.9
	27.13 Lt Wax	TI-744	97.3	36.3
	28.30 Hv Wax	TI-515	214.3	101.3
			%	
Levels	27.12	LIC-639	0.0	
	22.14	LIC-688	80.6	
	22.10	LIC-220	30.0	
	22.15	LIC-242	27.9	
	27.13	LI-203	-7.1	
	28.30	LI-1792	53.7	
			psig	**bara**
Pressure	27.13	PIC-202	18.12	2.26

Miscellaneous Data

Overall Plant Material Balance	%	100.12
100*(22.10 Purge 22.11 Purge+Heavy Wax+Light Wax+Light HC+Water)/ (LP Fresh Feed+HP H2)		
Reactor GHSV	Nm3 Rxt Feed/m3 3-phase slurry volume/hr	2625
Catalyst GHSV	Nm3 Rxt Feed/m3 particle volume/hr	20489
Catalyst Volume in the Reactor	litres particle volume	188.4
Inlet Superfic. Vel. based on Avg Reactor Temp.	cm/sec	18.32
Inlet Sup. Vel. based on Rxt Inlet Temp (TI-1-12A)	cm/sec	17.21
CO Conversion Rate, gmole CO converted AR particle volume/hr		70.89
grams of HC (CH2.1) produced/lft particle volume/hr		984.07

N2 Balance Across Reactor	Plant N2 Balance	Feed N2 Balance
(vary prod gas flow factor-step1)	(vary purgel flow factor-step2)	(vary 01.20 discharge flow factor-step3)
100.00	100.01	100.02
		(Redundancy converges both to 100%)
Water/Oxygen Balance		**Prod. Gas N2 Balance**
		(vary 01.20 discharge flow factor-step3)
102.72		99.99

Wax/Liquid Production Rates

	lbs/hr	kg/hr
Heavy Wax (27.10/28.30, Reactor Temp. Cut)	8.57	3.89
Light Wax (22.14/27.13, 392 deg F Cut)	0.00	0.00
Light HCs (22.10/22.16, 100 deg F Cut)	273.98	124.28
Water (22.10/22.16, 100 deg F Cut)	527.37	239.21

Slurry Conc. Based on Density Measurements

2-Phase Slurry Concentration reduced	particle vol %	24.17
	catalyst wt%	26.98

Water Saturation Calculations for the Reactor

	Based on CO, CO2 Meas.:		Based on Water Production:	
	psia	**mbara**	**psia**	**mbara**
Calculated Water Partial Pressure @ Reactor Outlet	63.71	4392	65.28	4501
Saturated Water Pressure @ Reactor Outlet	696.2	47999	696.2	47999
Water Partial Pressure as % of Sat. Pressure @ Reactor Outlet	9.15%		9.38%	
	deg F	**deg C**	**deg F**	**deg C**
Saturated Water Temperature @ Reactor Outlet	296.3	146.8	297.9	147.7

RUN NO.: AF-R16.3B

TITLE: LIQUID PHASE FISCHER-TROPSCH (IV) SYNTHESIS IN LAPORTE AFDU

Start Date / Time	04/07/1998	8.00
End Date / Time	04/07/1998	15.00

On-stream Time From Start-up (hr)

Start	234.00
End	241.00

Reaction Conditions:

Temperature	average	deg F	502.01	deg C	261.2
Pressure	PIC-201	psig	710.1	bara	49.97
Space Velocity		sL/kg-hr	22115		
Superficial Gas Vel. - Inlet		ft/sec	0.60	cm/sec	18.23
(based on average reactor temp)					
Recycle Ratio			2.08		

Slurry Data:

Catalyst Oxide Wt (Reactor)	lbs	383	kg	173.7
Slurry Concentration by NDG	wt%	28.6		
Slurry Concentration by DP	wt%	27.0		
Slurry Level by NDG	% NDG Span	96.6		
Slurry Height	ft	20.78	meters	6.33
Average Gas Holdup by NDG	Vol%	50.7		
Average Gas Holdup by DP	Vol%	46.4		

Performance Results

CO Conversion per pass, mole %	20.9
H2 Conversion per pass, mole %	43.5
CO + H2 Conversion per pass, mole %	32.8
Plant CO Conversion, mole%	70.6
Plant H2 Conversion, mole%	87.2
Plant CO+H2 Conversion, mole%	81.4
CO Conversion Rate,	78.6
gmole CO converted/kg cat oxide-hr	
HC Production Rate,	1093.1
grams of HC (CH2.1) produced/kg cat oxide-hr	
Reactor Productivity (STY)	129.30
grams of H C (CH2.1)/lit of reactor vol. - hr	
H2/CO in Fresh Feed, mole/mole	1.83
H2/CO in Reactor Feed, mole/mole	1.11
H2/CO Usage Ratio, mole/mole	2.31
H2/CO in Outlet, mole/mole	0.79
CO2 Selectivity, mole %	1.37
HC Selectivity (CO2 free) wt%:	
CH4	16.63
C2H6	2.62
C2H4	0.13
C3H8	2.62
C3H6	1.69
SUM C4H10	1.27
SUM C4H8	1.83
SUM C5H11	0.57

Reactor Heat Balance

	Btu/hr	kW
Chemical Heat Production by Reaction	2117056	620.45
Sensible Gas Heat	-176759	-51.80
Sensible Oil Heat	-1604523	-470.24
Sensible Wax Heat	-223114	-65.39
Estimate of Heat Loss from Catalyst Drying Data	-50000	-14.65
% Heat Balance based on Reaction Heat	97.04	

Mass Balance	Reactor lb/hr	Plant lb/hr	Feed lb/hr	Prod Gas lb/hr
Fresh Feed		1318	1318	
HP H2 Feed		86	86	
Recycle Feed			4808	4808
Reactor Feed	6242		6242	
Total In	6242	1404		
Prod Gas	5396			5396
Main Purge		587		587
22.11 Purge	0.0	0.0		
HC Phase	268.2	268.2		
AQ Phase	516.2	516.2		
Heavy Wax	8.6	8.6		
Light Wax				
Total Out	6189	1380		
Mass Balance, %	99.2	98.3	100.5	100.0

Compositions (mole%):		**LP FRESH FEED**	**HP FRESH FEED (H2)**	**RECYCLE FEED**	**REACTOR FEED GAS**	**PRODUCT GAS**	**MAIN (22.10) PURGE**	**22.11 PURGE**	**REACTOR OUTLET (estimated)**
Components									
1	H2	43.60	100.00	31.84	42.36	31.84	31.84	10.24	28.69
2	N2	2.90	0.00	7.40	5.56	7.40	7.40	3.66	6.67
3	CO	53.50	0.00	40.18	38.18	40.18	40.18	25.95	36.21
4	CH4	0.00	0.00	14.75	9.92	14.75	14.75	22.87	13.29
5	CO2	0.00	0.00	1.45	0.98	1.45	1.45	5.17	1.30
6	ETHANE	0.00	0.00	1.32	0.90	1.32	1.32	6.79	1.19
7	ETHYLENE	0.00	0.00	0.02	0.01	0.02	0.02	0.09	0.02
8	PROPANE	0.00	0.00	1.00	0.69	1.00	1.00	7.93	0.90
9	PROPYLENE	0.00	0.00	0.60	0.40	0.60	0.60	4.62	0.54
10	ISOBUATNE	0.00	0.00	0.01	0.01	0.01	0.01	0.10	0.01
11	N-BUTANE	0.00	0.00	0.51	0.35	0.51	0.51	4.57	0.46
12	T-BUTENE-2	0.00	0.00	0.05	0.03	0.05	0.05	0.42	0.05
13	BUTENE-1	0.00	0.00	0.24	0.16	0.24	0.24	2.17	0.22
14	ISOBUTYLENE	0.00	0.00	0.03	0.02	0.03	0.03	0.31	0.03
15	C-BUTENE-2	0.00	0.00	0.06	0.04	0.06	0.06	0.51	0.05
16	SUM C5	0.00	0.00	0.37	0.27	0.37	0.37	3.26	0.34
17	SUM C6	0.00	0.00	0.14	0.09	0.14	0.14	1.13	0.13
18	SUM C7	0.00	0.00	0.01	0.03	0.01	0.01	0.17	0.01
19	SUM C8	0.00	0.00	0.02	0.00	0.02	0.02	0.01	0.02
20	SUM C9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
21	SUM C10	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00
	H2O								9.29
	HC								0.60
	LIGHT WAX								0.000
	TOTAL	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Mole Wt	lb/lb mole	16.68	2.02	19.00	16.53	19.00	19.00	30.07	19.65
Flows	SCFH	30559.08	16521.20	97828.01	146035.34	109796.36	11953.76	0.00	121847.00
	lb mole/hr	79.04	42.73	253.02	377.70	283.97	30.92	0.00	315.14
	lb/hr	1318.18	86.31	4807.98	6242.01	5396.19	587.50	0.00	6193.04
	Nm3/hr	804.20	434.78	2574.46	3843.10	2889.42	314.58	0.00	3206.55
	kgmol/hr	35.85	19.38	114.77	171.32	128.81	14.02	0.00	142.95
	kg/hr	597.92	39.15	2180.89	2831.36	2447.70	266.49	0.00	2809.14
Temperature	deg F	286.6	95.6	128.5	303.6	86.8	85.7	84.7	
	deg C	141.4	35.3	53.6	150.9	30.5	29.9	29.3	
Pressure	psig	817.8	796.2	824.8	770.0	642.7	634.8	33.5	
	bara	57.40	55.91	57.88	54.10	45.33	44.78	3.32	

Reactor Heat Balance

		deg F	deg C			lb/hr	kg/hr		Btu/lb-deg F	J/gm-deg C		lb/ft3	kg/m3
Gas:													
Inlet Temp	TI-1-12A	444.1	229.0	Inlet Flow	RXT FEED	6242	2831.4	Inlet Ht Cap.	0.488	2.042			
Outlet Temp	RXT AVG	502.1	261.2	Outlet Flow	RXT FEED-WAXPROD	6233	2827.5	Outlet Ht Cap.	0.461	1.929			
Oil:													
Inlet Temp	TI-1-14B	422.7	217.0	Inlet Flow	*FI-619	65443	29684.7	Inlet Ht Cap.	0.549	2.298	Inlet Density	51.52	825.19
Outlet Temp	TI-1780	468.6	242.5	Outlet Flow	*FI-619	65443	29684.7	Outlet Ht Cap.	0.569	2.381			
Slurry:													
Inlet Temp	TI-1783	468.9	242.7	Inlet Flow	*FI-1768-61	10957	4970.0	Inlet Ht Cap.	0.612	2.561			
Outlet Temp	RXT AVG	502.1	261.2	Outlet Flow	*FI-1768	10966	4973.9	Outlet Ht Cap.	0.612	2.561			
					*based on								

Reactor Differential Pressures

	DP NOZZLES		Differential Pressures: psi	mbar	Heights: ft (based on flange loc.)	meters	Density - 3 Phase: lb/ft3	kg/m3	Gas Hold-up vol%
Reactor Height:									
13.75 to 9.25 ft	Kl -K3	PDI-1778	0.85	58.4	4.56	1.391	26.72	428.0	47.12
9.25 ft to 4.33 ft	K3-K5	PDI-1779	0.97	66.7	5.08	1.549	27.42	439.2	45.68
Total Reactor	K6-OUT	PDI-631	3.93	271.1	20.78	6.335	26.79	429.2	46.97
Sparger	K6-IN	PDI-633	2.65	182.9					

DEGASSER

			deg F		deg C	
Temperatures:						
6.5 ft Height	TI-1762		395.4		201.9	
3.5 ft Height	TI-1763		450.9		232.7	
0.5 ft Height	TI-1764		506.5		263.6	
Liquid Level:						
% Level	LI-1765		37.4			
Slurry Height		ft	6.73	meters		2.050

SLURRY PUMP

			deg F	**deg C**
Temperature:	Slurry Inlet	TI-1755	476.3	246.8
	Seal Oil Outlet	TI-1 795	107.9	42.2
			psig	**bara**
Pressure:	Seal Oil Outlet	PI-1794	764.0	53.69
			lb/hr	**kg/hr**
Flow Rate:	Slurry Outlet	FI-1768	10965.5	4974.2
			g/cc	
Density:	Slurry Outlet	DI-1768	0.824	

SLURRY COOLER

Temperatures:	deg F	deg C

Slurry Outlet	TIC-1754	471.7	244.3
Oil Inlet	TI-1780	468.6	242.5

FILTERS

			deg F	**deg C**				**lb/hr**	**kg/hr**
Temperature:	Slurry Outlet	TI-1783	468.9	242.7	Flow Rate:	Wax	FI-1761	8.578	2.891
			psig	**bara**				**g/cc**	
Pressure:	Slurry Inlet	PI-1756	729.3	51.30	Density:	Wax	DI-1761	0.67	
Diff. Press.:	Longitudinal		**psi**	**mbar**				**ft/sec**	**msec**
	Thru D & C	PDI-1772	10.0	687	Linear Vel.:	Slurry thru Each Element	Calculated	10.85	3.307
	Thru B & A	PDI-1773	0.2	13					
	rans-membrane							**ft/sec**	**msec**
	Membrane A	PDI-1774	0.0	-2	Superfic. Vel.:	Liquid Upflow thru Reactor	Calculated	0.024	7.220
	Membrane B	PDI-1775	1.3	90					
	Membrane C	PDI-1776	-1.0	-69					
	Membrane D	PDI-1777	-0.4	-29					

Reactor Temperatures

	Reactor Ht, Ft		**Deg F**	**Deg C**
Nozzle N1	24.25	TI-626-1	494.6	257.0
Nozzle N2	20.25	TI-626-2	502.7	261.5
Nozzle N3	18.25	TI-190-2A	501.5	260.8
Nozzle N4	16.25	TI-626-3	500.2	260.1
Nozzle N5	14.25	TI-190-3	500.0	260.0
Nozzle N7	10.25	TI-1781A	504.4	262.5
		TI-1781B	503.7	262.1
		TI-1781C	504.4	262.4
		TI-1781D	503.5	262.0
Nozzle N8	8.083	TI-626-5	497.5	258.6
Nozzle K4	7.75	TI-190-4	506.2	263.4
Nozzle O	4.792	TI-626-6	500.0	260.0
Reactor Temp. Avg. (Noz N3 thru Noz O)			502.1	261.2

Product Separation

			deg F	**deg C**
Temperatures	27.11 In	TI-1-08	-25.0	-31.7
	2138 Tube In	TI-723	474.5	245.8
	22.14 Out	TIC-725	310.00	154.5
	21.65 Out	TIC-1-11A	85.6	29.8
	27.13 Lt Wax	TI-744	100.8	38.2
	28.30 Hv Wax	TI-515	199.6	93.1
			%	
Levels	27.12	LIC-639	0.0	
	22.14	LIC-688	85.2	
	22.10	LIC-220	30.0	
	22.15	LIC-242	40.0	
	27.13	LI-203	0.0	
	28.30	LI-1792	-0.6	
			psig	**bara**
Pressure	27.13	PIC-202	19.73	2.37

Miscellaneous Data

Overall Plant Material Balance		%	98.29
100*(22.10 Purge 22.11 Purge+Heavy Wax+Light Wax+Light HC+Water)/ (LP Fresh Feed+HP H2)			
Reactor GHSV	Nm3 Rxt Feed/m3 3-phase	slurry volume/hr	2616
Catalyst GHSV	Nm3 Rxt Feed/m3	particle volume/hr	20390
Catalyst Volume in the Reactor		litres particle volume	0.0
Inlet Superfic. Vel. based on Avg Reactor Temp. cm/sec			18.23
Inlet Sup. Vel. based on Rxt Inlet Temp (TI-1-12A)cm/sec			17.13
CO Conversion Rate, gmole CO converted AR particle volume/hr			72.47
grams of HC (CH2.1) produced/lft particle volume/hr		1007.82	

N2 Balance Across Reactor (vary prod gas flow factor-step1)	Plant N2 Balance (vary purgel flow factor-step2)	Feed N2 Balance (vary 01.20 discharge flow factor-step3)
99.97	99.97	100.4 (Redundancy converges both to 100%)
Water/Oxygen Balance		**Prod. Gas N2 Balance** (vary 01.20 discharge flow factor-step3)
97.99		99.99

Wax/Liquid Production Rates

	lbs/hr	kg/hr
Heavy Wax (27.10/28.30, Reactor Temp. Cut)	8.58	3.89
Light Wax (22.14/27.13, 392 deg F Cut)	0.00	0.00
Light HCs (22.10/22.16, 100 deg F Cut)	268.17	121.64
Water (22.10/22.16, 100 deg F Cut)	516.18	234.14

Slurry Conc. Based on Density Measurements

2-Phase Slurry Concentration reduced	particle vol %	23.93
	catalyst wt%	26.76

Water Saturation Calculations for the Reactor

	Based on CO, CO2 Meas.:		Based on Water Production:	
	psia	**mbara**	**psia**	**mbara**
Calculated Water Partial Pressure @ Reactor Outlet	65.94	4547	64.74	4463
Saturated Water Pressure @ Reactor Outlet	695.9	47980	695.9	47980
Water Partial Pressure as % of Sat. Pressure @ Reactor Outlet	9.48%		9.30%	
	deg F	**deg C**	**deg F**	**deg C**
Saturated Water Temperature @ Reactor Outlet	298.6	148.1	297.4	147.4

RUN NO.: AF-R16.3C **TITLE: LIQUID PHASE FISCHER-TROPSCH (IV) SYNTHESIS IN LAPORTE AFDU**

Start Date / Time	04/07/1998	18.00
End Date / Time	04/07/1998	24.00

On-stream Time From Start-up (hr)	
Start	244.00
End	250.00

Reaction Conditions:					
Temperature	average	deg F	502.1	deg C	261.1
Pressure	PIC-201	psig	710.2	bara	49.98
Space Velocity		sL/kg-hr	22210		
Superficial Gas Vel. - Inlet		ft/sec	0.60	cm/sec	18.31
(based on average reactor temp)					
Recycle Ratio			2.13		

Slurry Data:				
Catalyst Oxide Wt (Reactor)	lbs	383	kg	173.7
Slurry Concentration by NDG	wt%	28.7		
Slurry Concentration by DP	wt%	27.3		
Slurry Level by NDG	% NDG Span	96.4		
Slurry Height	ft	20.74	meters	6.32
Average Gas Holdup by NDG	Vol%	50.7		
Average Gas Holdup by DP	Vol%	47.2		

Performance Results	
CO Conversion per pass, mole %	20.1
H2 Conversion per pass, mole %	42.3
CO + H2 Conversion per pass, mole %	31.7
Plant CO Conversion, mole%	69.3
Plant H2 Conversion, mole%	86.5
Plant CO+H2 Conversion, mole%	80.4
CO Conversion Rate,	76.6
gmole CO converted/kg cat oxide-hr	
HC Production Rate,	1063.5
grams of HC (CH2.1) produced/kg cat oxide-hr	
Reactor Productivity (STY)	126.05
grams of H C (CH2.1)/lit of reactor vol. - hr	
H2/CO in Fresh Feed, mole/mole	1.82
H2/CO in Reactor Feed, mole/mole	1.11
H2/CO Usage Ratio, mole/mole	2.33
H2/CO in Outlet, mole/mole	0.80
CO2 Selectivity, mole %	1.47
HC Selectivity (CO2 free) wt%:	
CH4	18.89
C2H6	3.16
C2H4	-0.12
C3H8	3.97
C3H6	1.94
SUM C4H10	2.76
SUM C4H8	1.67
SUM C5H11	2.27

Reactor Heat Balance	**Btu/hr**	**kW**
Chemical Heat Production by Reaction	2060303	603.81
Sensible Gas Heat	-178849	-52.42
Sensible Oil Heat	-1572237	-460.78
Sensible Wax Heat	-222491	-65.21
Estimate of Heat Loss from Catalyst Drying Data	-50000	014.65
% Heat Balance based on Reaction Heat	98.22	

Mass Balance	**Reactor lb/hr**	**Plant lb/hr**	**Feed lb/hr**	**Prod Gas lb/hr**
Fresh Feed		1310	1310	
HP H2 Feed		86	86	
Recycle Feed			4859	4859
Reactor Feed	6246		6246	
Total In	6246	1396		
Prod Gas	5463			5463
Main Purge		605		605
22.11 Purge	0.0	0.0		
HC Phase	263.6	263.6		
AQ Phase	507.5	507.5		
Heavy Wax	8.6	8.6		
Light Wax				
Total Out	6243	1385		
Mass Balance, %	100.0	99.2	99.8	100.0

RUN NO.: AF-R16.3C **TITLE: LIQUID PHASE FISCHER-TROPSCH (IV) SYNTHESIS IN LAPORTE AFDU**

Compositions (mole%):		**LP FRESH FEED**	**HP FRESH FEED (H2)**	**RECYCLE FEED**	**REACTOR FEED GAS**	**PRODUCT GAS**	**MAIN (22.10) PURGE**	**22.11 PURGE**	**REACTOR OUTLET (estimated)**
Components									
1	H2	43.16	100.00	32.26	42.52	32.26	32.26	10.77	29.19
2	N2	2.96	0.00	7.21	5.48	7.21	7.21	3.67	6.52
3	CO	53.89	0.00	40.34	38.44	40.34	40.34	27.33	36.51
4	CH4	0.00	0.00	14.45	9.71	14.45	14.45	23.67	13.08
5	CO2	0.00	0.00	1.40	0.95	1.40	1.40	2.34	1.27
6	ETHANE	0.00	0.00	1.31	0.88	1.31	1.31	7.11	1.18
7	ETHYLENE	0.00	0.00	0.02	0.02	0.02	0.02	0.09	0.02
8	PROPANE	0.00	0.00	0.99	0.66	0.99	0.99	8.01	0.90
9	PROPYLENE	0.00	0.00	0.60	0.40	0.60	0.60	4.77	0.54
10	ISOBUATNE	0.00	0.00	0.01	0.01	0.01	0.01	0.11	0.01
11	N-BUTANE	0.00	0.00	0.50	0.32	0.50	0.50	4.47	0.45
12	T-BUTENE-2	0.00	0.00	0.05	0.03	0.05	0.05	0.41	0.05
13	BUTENE-1	0.00	0.00	0.24	0.16	0.24	0.24	2.18	0.22
14	ISOBUTYLENE	0.00	0.00	0.03	0.02	0.03	0.03	0.29	0.03
15	C-BUTENE-2	0.00	0.00	0.05	0.04	0.05	0.05	0.49	0.05
16	SUM C5	0.00	0.00	0.36	0.24	0.36	0.36	3.13	0.33
17	SUM C6	0.00	0.00	0.13	0.08	0.13	0.13	1.01	0.12
18	SUM C7	0.00	0.00	0.04	0.02	0.04	0.04	0.14	0.04
19	SUM C8	0.00	0.00	0.01	0.00	0.01	0.01	0.00	0.01
20	SUM C9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
21	SUM C10	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00
	H2O								8.91
	HC								0.59
	LIGHT WAX								0.000
	TOTAL	100.00	100.00	100.00	100.00	I GO.00	100.00	100.00	100.00
Mole Wt	lb/lb mole	16.79	2.02	18.92	16.47	18.92	18.92	29.22	19.56
Flows	SCFH	30164.22	16492.80	99297.87	146661.90	111644.67	12369.23	0.00	123365.10
	lb mole/hr	78.02	42.66	256.82	379.32	288.75	31.99	0.00	319.07
	lb/hr	1310.17	86.17	4858.93	6245.74	5463.09	605.26	0.00	6240.58
	Nm3/hr	793.81	434.03	2613.14	3859.58	2938.06	325.51	0.00	3246.50
	kgmol/hr	35.39	19.35	116.49	172.06	130.98	14.51	0.00	144.73
	kg/hr	594.29	39.08	2203.99	2833.05	2478.04	274.54	0.00	2830.71
Temperature	deg F	281.0	84.3	124.2	295.4	84.4	82.2	75.6	
	deg C	138.3	29.0	51.2	146.4	29.1	27.9	24.2	
Pressure	psig	815.4	749.1	824.3	770.5	641.3	634.0	33.4	
	bara	57.23	52.66	57.85	54.14	45.23	44.72	3.32	

Reactor Heat Balance

		deg F	deg C			lb/hr	kg/hr		Btu/lb-deg F	J/gm-deg C		lb/ft3	kg/m3
Gas:													
Inlet Temp	TI-1-12A	443.3	228.5	Inlet Flow	RXT FEED	6246	2833.0	Inlet Ht Cap.	0.488	2.041			
Outlet Temp	RXT AVG	502.1	261.1	Outlet Flow	RXT FEED-WAXPROD	6237	2829.2	Outlet Ht Cap.	0.462	1.932			
Oil:													
Inlet Temp	TI-1-14B	424.1	217.9	Inlet Flow	*FI-619	65420	29674.2	Inlet Ht Cap.	0.550	2.300	Inlet Density	51.48	824.53
Outlet Temp	TI-1780	469.0	242.8	Outlet Flow	*FI-619	65420	29674.2	Outlet Ht Cap.	0.569	2.382			
Slurry:													
Inlet Temp	TI-1783	468.8	242.7	Inlet Flow	*FI-1768-61	10981	4980.8	Inlet Ht Cap.	0.610	2.552			
Outlet Temp	RXT AVG	502.1	261.1	Outlet Flow	*FI-1768	10989	4984.7	Outlet Ht Cap.	0.610	2.552			
					*based on								

Reactor Differential Pressures

	DP NOZZLES		Differential Pressures: psi	mbar	Heights: ft (based on flange loc.)	meters	Density -3 Phase: lb/ft3	kg/m3	Gas Hold-up vol%
Reactor Height:									
13.75 to 9.25 ft	Kl -K3	PDI-1778	0.84	58.0	4.56	1.391	26.54	425.2	47.65
9.25 ft to 4.33 ft	K3-K5	PDI-1779	0.95	65.6	5.08	1.549	26.97	431.9	46.77
Total Reactor	K6-OUT	PDI-631	1.49	102.6	20.74	6.323	9.89	158.4	82.08
Sparger	K6-IN	PDI-633	272	187.4					

DEGASSER

Temperatures:		deg F	deg C	
6.5 ft Height	TI-1762	389.4	198.5	
3.5 ft Height	TI-1763	437.4	225.2	
0.5 ft Height	TI-1764	505.6	263.1	
Liquid Level:				
% Level	LI-1765	26.8		
Slurry Height	ft	4.93	meters	1.503

SLURRY PUMP

			deg F	deg C
Temperature:	Slurry Inlet	TI-1755	476.5	247.0
	Seal Oil Outlet	TI-1 795	106.6	41.4
			psig	bara
Pressure:	Seal Oil Outlet	PI-1794	761.0	53.48
			lb/hr	kg/hr
Flow Rate:	Slurry Outlet	FI-1768	10989.2	4984.9
			g/cc	
Density:	Slurry Outlet	DI-1768	0.825	

SLURRY COOLER

Temperatures:		deg F	deg C
Slurry Outlet	TIC-1754	471.2	244.0

Oil Inlet	TI-1780	469.0	242.8

FILTERS

			deg F	**deg C**				**lb/hr**	**kg/hr**
Temperature:	Slurry Outlet	TI-1783	468.8	242.7	Flow Rate:	Wax	FI-1761	8.574	3.889
			psig	**bara**				**g/cc**	
Pressure:	Slurry Inlet	PI-1756	729.7	51.32	Density:	Wax	DI-1761	0.67	
Diff. Press.:	Longitudinal		**psi**	**mbar**				**ft/sec**	**msec**
	Thru D & C	PDI-1772	10.0	693	Linear Vel.:	Slurry thru Each Element	Calculated	10.86	3.311
	Thru B & A	PDI-1773	0.3	20					
	rans-membrane							**ft/sec**	**msec**
	Membrane A	PDI-1774	-1.1	-73	Superfic. Vel.:	Liquid Upflow thru Reactor	Calculated	0.024	7.228
	Membrane B	PDI-1775	1.2	82					
	Membrane C	PDI-1776	-1.0	-70					
	Membrane D	PDI-1777	-1.8	-122					

Reactor Temperatures

	Reactor Ht, Ft		**Deg F**	**Deg C**
Nozzle N1	24.25	TI-626-1	494.4	256.9
Nozzle N2	20.25	TI-626-2	502.5	261.4
Nozzle N3	18.25	TI-190-2A	501.7	261.0
Nozzle N4	16.25	TI-626-3	500.3	260.2
Nozzle N5	14.25	TI-190-3	500.0	260.0
Nozzle N7	10.25	TI-1781A	504.3	262.4
		TI-1781B	503.6	262.0
		TI-1781C	504.2	262.4
		TI-1781D	503.3	261.9
Nozzle N8	8.083	TI-626-5	497.5	258.6
Nozzle K4	7.75	TI-190-4	506.0	263.3
Nozzle O	4.792	TI-626-6	499.7	259.8
Reactor Temp. Avg. (Noz N3 thru Noz O)			502.1	261.1

Product Separation

			deg F	**deg C**
Temperatures	27.11 In	TI-1-08	-25.0	-31.7
	2138 Tube In	TI-723	471.5	244.2
	22.14 Out	TIC-725	310.0	154.4
	21.65 Out	TIC-1-11A	82.9	28.3
	27.13 Lt Wax	TI-744	105.1	40.6
	28.30 Hv Wax	TI-515	201.0	93.9
			%	
Levels	27.12	LIC-639	0.0	
	22.14	LIC-688	102.9	
	22.10	LIC-220	30.0	
	22.15	LIC-242	26.6	
	27.13	LI-203	-7.0	
	28.30	LI-1792	-0.6	
			psig	**bara**
Pressure	27.13	PIC-202	18.84	2.31

Miscellaneous Data

Overall Plant Material Balance	%	99.19
100*(22.10 Purge 22.11 Purge+Heavy Wax+Light Wax+Light HC+Water)/ (LP Fresh Feed+HP H2)		
Reactor GHSV Nm3 Rxt Feed/m3 3-phase	slurry volume/hr	2632
Catalyst GHSV Nm3 Rxt Feed/m3	particle volume/hr	20478
Catalyst Volume in the Reactor	litres particle volume	188.4
Inlet Superfic. Vel. based on Avg Reactor Temp.	cm/sec	18.31
Inlet Sup. Vel. based on Rxt Inlet Temp (TI-1-12A)	cm/sec	17.19
CO Conversion Rate, gmole CO converted AR particle volume/hr		70.58
grams of HC (CH2.1) produced/lft particle volume/hr	980.56	

N2 Balance Across Reactor	Plant N2 Balance	Feed N2 Balance
(vary prod gas flow factor-step1)	(vary purgel flow factor-step2)	(vary 01.20 discharge flow factor-step3)
100.02	99.98	99.96
		(Redundancy converges both to 100%)
Water/Oxygen Balance		**Prod. Gas N2 Balance**
		(vary 01.20 discharge flow factor-step3)
99.12		100.02

Wax/Liquid Production Rates

	lbs/hr	kg/hr
Heavy Wax (27.10/28.30, Reactor Temp. Cut)	8.57	3.89
Light Wax (22.14/27.13, 392 deg F Cut)	0.00	0.00
Light HCs (22.10/22.16, 100 deg F Cut)	263.64	119.59
Water (22.10/22.16, 100 deg F Cut)	507.48	230.19

Slurry Conc. Based on Density Measurements

2-Phase Slurry Concentration reduced	particle vol %	24.07
	catalyst wt%	26.89

Water Saturation Calculations for the Reactor

	Based on CO, CO2 Meas.:		Based on Water Production:	
	psia	**mbara**	**psia**	**mbara**
Calculated Water Partial Pressure @ Reactor Outlet	63.31	4365	62.80	4330
Saturated Water Pressure @ Reactor Outlet	695.3	47939	695.3	47939
Water Partial Pressure as % of Sat. Pressure @ Reactor Outlet	9.11%		9.03%	
	deg F	**deg C**	**deg F**	**deg C**
Saturated Water Temperature @ Reactor Outlet	295.9	146.6	295.4	146.3

RUN NO.: AF-R16.3D **TITLE: LIQUID PHASE FISCHER-TROPSCH (IV) SYNTHESIS IN LAPORTE AFDU**

Start Date / Time	04/08/1998	2.00
End Date / Time	04/08/1998	13.00

On-stream Time From Start-up (hr)	
Start	252.00
End	263.00

Reaction Conditions:					
Temperature	average	deg F	502.01	deg C	261.2
Pressure	PIC-201	psig	710.0	bara	49.97
Space Velocity		sL/kg-hr	22364		
Superficial Gas Vel. - Inlet		ft/sec	0.60	cm/sec	18.29
(based on average reactor temp)					
Recycle Ratio			2.12		

Slurry Data:				
Catalyst Oxide Wt (Reactor)	lbs	380	kg	172.4
Slurry Concentration by NDG	wt%	28.3		
Slurry Concentration by DP	wt%	25.3		
Slurry Level by NDG	% NDG Span	96.7		
Slurry Height	ft	20.79	meters	6.34
Average Gas Holdup by NDG	Vol%	49.9		
Average Gas Holdup by DP	Vol%	45.3		

Performance Results	
CO Conversion per pass, mole %	20.1
H2 Conversion per pass, mole %	41.9
CO + H2 Conversion per pass, mole %	31.6
Plant CO Conversion, mole%	69.1
Plant H2 Conversion, mole%	86.2
Plant CO+H2 Conversion, mole%	80.1
CO Conversion Rate,	77/1
gmole CO converted/kg cat oxide-hr	
HC Production Rate,	1070.1
grams of HC (CH2.1) produced/kg cat oxide-hr	
Reactor Productivity (STY)	125.54
grams of H C (CH2.1)/lit of reactor vol. - hr	
H2/CO in Fresh Feed, mole/mole	1.81
H2/CO in Reactor Feed, mole/mole	1.12
H2/CO Usage Ratio, mole/mole	2.33
H2/CO in Outlet, mole/mole	0.81
CO2 Selectivity, mole %	1.54
HC Selectivity (CO2 free) wt%:	
CH4	20.43
C2H6	3.31
C2H4	-0.12
C3H8	3.53
C3H6	2.12
SUM C4H10	2.21
SUM C4H8	1.59
SUM C5H11	1.88

Reactor Heat Balance	**Btu/hr**	**kW**
Chemical Heat Production by Reaction	2057135	602.88
Sensible Gas Heat	-176262	-51.66
Sensible Oil Heat	-1584541	-464.38
Sensible Wax Heat	-224140	-65.69
Estimate of Heat Loss from Catalyst Drying Data	-50000	-14.65
% Heat Balance based on Reaction Heat	98.92	

Mass Balance	**Reactor lb/hr**	**Plant lb/hr**	**Feed lb/hr**	**Prod Gas lb/hr**
Fresh Feed		1312	1312	
HP H2 Feed		86	86	
Recycle Feed			4834	4834
Reactor Feed	6225		6225	
Total In	6225	1339		
Prod Gas	5438			5438
Main Purge		607		607
22.11 Purge	0.0	0.0		
HC Phase	266.6	266.6		
AQ Phase	513.2	513.2		
Heavy Wax	8.6	8.6		
Light Wax				
Total Out	6227	1396		
Mass Balance, %	100.0	99.8	99.9	100.1

Compositions (mole%):		LP FRESH FEED	HP FRESH FEED (H2)	RECYCLE FEED	REACTOR FEED GAS	PRODUCT GAS	MAIN (22.10) PURGE	22.11 PURGE	REACTOR OUTLET (estimated)
Components									
1	H2	43.15	100.00	32.69	42.88	32.69	32.69	11.90	29.59
2	N2	3.01	0.00	7.30	5.56	7.30	7.30	4.03	6.61
3	CO	53.83	0.00	40.32	38.45	40.32	40.32	29.62	36.50
4	CH4	0.00	0.00	14.01	9.28	14.01	14.01	25.54	12.68
5	CO2	0.00	0.00	1.39	0.94	1.39	1.39	6.50	1.26
6	ETHANE	0.00	0.00	1.30	0.87	1.30	1.30	5.07	1.18
7	ETHYLENE	0.00	0.00	0.02	0.02	0.02	0.02	0.07	0.02
8	PROPANE	0.00	0.00	0.97	0.65	0.97	0.97	5.46	0.88
9	PROPYLENE	0.00	0.00	0.60	0.40	0.60	0.60	3.32	0.54
10	ISOBUATNE	0.00	0.00	0.01	0.01	0.01	0.01	0.07	0.01
11	N-BUTANE	0.00	0.00	0.48	0.32	0.48	0.48	3.05	0.44
12	T-BUTENE-2	0.00	0.00	0.05	0.03	0.05	0.05	0.28	0.04
13	BUTENE-1	0.00	0.00	0.24	0.16	0.24	0.24	1.51	0.22
14	ISOBUTYLENE	0.00	0.00	0.03	0.02	0.03	0.03	0.20	0.03
15	C-BUTENE-2	0.00	0.00	0.06	0.04	0.06	0.06	0.34	0.05
16	SUM C5	0.00	0.00	0.36	0.24	0.36	0.36	2.18	0.32
17	SUM C6	0.00	0.00	0.12	0.09	0.12	0.12	0.73	0.11
18	SUM C7	0.00	0.00	0.03	0.02	0.03	0.03	0.11	0.02
19	SUM C8	0.00	0.00	0.01	0.00	0.01	0.01	0.01	0.01
20	SUM C9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
21	SUM C10	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00
	H2O								8.90
	HC								0.59
	LIGHT WAX								0.000
	TOTAL	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Mole Wt	lb/lb mole	16.79	2.02	18.84	16.43	18.84	18.84	27.40	19.49
Flows	SCFH	30217.14	16478.40	99215.79	146517.65	111625.67	12468.27	0.00	123327.62
	lb mole/hr	78.15	42.62	256.61	378.95	288.70	32.25	0.00	318.97
	lb/hr	1312.50	86.09	4833.65	6225.23	5438.24	607.44	0.00	6217.48
	Nm3/hr	795.20	433.65	2610.98	3855.79	2937.56	328.12	0.00	3245.52
	kgmol/hr	35.45	19.33	116.40	171.89	130.95	14.63	0.00	144.68
	kg/hr	595.35	39.05	2192.53	2823.75	2466.77	275.53	0.00	2820.23
Temperature	deg F	282.9	88.0	124.8	299.8	84.0	82.2	78.8	
	deg C	139.4	31.1	51.6	148.8	28.9	27.9	26.0	
Pressure	psig	815.4	738.6	823.9	769.8	640.7	633.2	33.4	
	bara	57.23	51.94	57.82	54.09	45.19	44.67	3.32	

Reactor Heat Balance

Gas:		**deg F**	**deg C**			**lb/hr**	**kg/hr**		**Btu/lb-deg F**	**J/gm-deg C**			
Inlet Temp	TI-1-12A	444.1	228.9	Inlet Flow	RXT FEED	6225	2823.7	Inlet Ht Cap.	0.488	2.041			
Outlet Temp	RXT AVG	502.1	261.2	Outlet Flow	RXT FEED-WAXPROD	6217	2819.9	Outlet Ht Cap.	0.462	1.933			
Oil:												**lb/ft3**	**kg/m3**
Inlet Temp	TI-1-14B	423.7	217.6	Inlet Flow	*FI-619	65465	29694.9	Inlet Ht Cap.	0.550	2.299	Inlet Density	51.49	824.74
Outlet Temp	TI-1780	468.9	242.7	Outlet Flow	*FI-619	65465	29694.9	Outlet Ht Cap.	0.569	2.382			
Slurry:													
Inlet Temp	TI-1783	469.3	242.9	Inlet Flow	*FI-1768-61	10984	4982.5	Inlet Ht Cap.	0.622	2.601			
Outlet Temp	RXT AVG	502.1	261.2	Outlet Flow	*FI-1768	10993	2986.4	Outlet Ht Cap.	0.622	2.601			
					*based on								

Reactor Differential Pressures

	DP NOZZLES		Differential Pressures: psi	mbar	Heights: ft (based on flange loc.)	meters	Density - 3 Phase: lb/ft3	kg/m3	Gas Hold-up vol%
Reactor Height:									
13.75 to 9.25 ft	Kl -K3	PDI-1778	0.85	58.8	4.56	1.391	26.92	431.1	45.97
9.25 ft to 4.33 ft	K3-K5	PDI-1779	0.97	67.1	5.08	1.549	27.58	441.7	44.58
Total Reactor	K6-OUT	PDI-631	3.78	260.5	20.79	6.337	25.73	412.2	48.47
Sparger	K6-IN	PDI-633	2.68	184.8					

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DEGASSER

Temperatures:			**deg F**	**deg C**	
6.5 ft Height	TI-1762		401.5	205.3	
3.5 ft Height	TI-1763		439.4	226.3	
0.5 ft Height	TI-1764		504.9	262.7	
Liquid Level:					
% Level	LI-1765		33.3		
Slurry Height		ft	5.98	meters	1.821

SLURRY PUMP

			deg F	**deg C**
Temperature:	Slurry Inlet	TI-1755	476.6	247.0
	Seal Oil Outlet	TI-1 795	105.8	41.0
			psig	**bara**
Pressure:	Seal Oil Outlet	PI-1794	764.3	53.71
			lb/hr	**kg/hr**
Flow Rate:	Slurry Outlet	FI-1768	10993.0	4986.6
			g/cc	
Density:	Slurry Outlet	DI-1768	0.826	

SLURRY COOLER

Temperatures:		**deg F**	**deg C**
Slurry Outlet	TIC-1754	471.9	244.4
Oil Inlet	TI-1780	468.9	242.7

FILTERS

			deg F	**deg C**				**lb/hr**	**kg/hr**
Temperature:	Slurry Outlet	TI-1783	469.3	242.9	Flow Rate:	Wax	FI-1761	8.575	3.890
			psig	**bara**				**g/cc**	
Pressure:	Slurry Inlet	PI-1756	729.3	51.30	Density:	Wax	DI-1761	0.67	
Diff. Press.:	Longitudinal		**psi**	**mbar**				**ft/sec**	**msec**
	Thru D & C	PDI-1772	10.0	690	Linear Vel.:	Slurry thru	Calculated	10.86	3.311
	Thru B & A	PDI-1773	0.2	16		Each Element			
	rans-membrane							**ft/sec**	**msec**
	Membrane A	PDI-1774	-0.5	-32	Superfic. Vel.:	Liquid Upflow	Calculated	0.024	7.227
	Membrane B	PDI-1775	1.0	67		thru Reactor			
	Membrane C	PDI-1776	-1.0	-70					
	Membrane D	PDI-1777	-0.5	-35					

Reactor Temperatures

	Reactor Ht, Ft		**Deg F**	**Deg C**
Nozzle N1	24.25	TI-626-1	493.8	256.6
Nozzle N2	20.25	TI-626-2	501.8	261.0
Nozzle N3	18.25	TI-190-2A	501.4	260.8
Nozzle N4	16.25	TI-626-3	500.1	260.0
Nozzle N5	14.25	TI-190-3	500.1	260.0
Nozzle N7	10.25	TI-1781A	504.3	262.4
		TI-1781B	503.7	262.0
		TI-1781C	504.4	262.4
		TI-1781D	503.6	262.0
Nozzle N8	8.083	TI-626-5	497.7	258.7
Nozzle K4	7.75	TI-190-4	506.1	263.4
Nozzle O	4.792	TI-626-6	500.1	260.0
Reactor Temp. Avg. (Noz N3 thru Noz O)			502.1	261.2

Product Separation

			deg F	**deg C**
Temperatures	27.11 In	TI-1-08	-25.0	-31.7
	2138 Tube In	TI-723	474.2	245.7
	22.14 Out	TIC-725	310.0	154.5
	21.65 Out	TIC-1-11A	82.9	28.3
	27.13 Lt Wax	TI-744	101.9	28.8
	28.30 Hv Wax	TI-515	201.3	94.1
			%	
Levels	27.12	LIC-639	0.0	
	22.14	LIC-688	92.8	
	22.10	LIC-220	30.0	
	22.15	LIC-242	28.4	
	27.13	LI-203	-7.0	
	28.30	LI-1792	46.5	
			psig	**bara**
Pressure	27.13	PIC-202	13.82	1.97

Miscellaneous Data

Overall Plant Material Balance		%	99.80
100*(22.10 Purge 22.11 Purge+Heavy Wax+Light Wax+Light HC+Water)/ (LP Fresh Feed+HP H2)			
Reactor GHSV	Nm3 Rxt Feed/m3 3-phase	slurry volume/hr	2623
Catalyst GHSV	Nm3 Rxt Feed/m3	particle volume/hr	20619
Catalyst Volume in the Reactor		litres particle volume	186.9
Inlet Superfic. Vel. based on Avg Reactor Temp.		cm/sec	18.29
Inlet Sup. Vel. based on Rxt Inlet Temp (TI-1-12A)		cm/sec	17.19
CO Conversion Rate, gmole CO converted AR particle volume/hr			71.07
grams of HC (CH2.1) produced/lft particle volume/hr		986.61	

N2 Balance Across Reactor	**Plant N2 Balance**	**Feed N2 Balance**
(vary prod gas flow factor-step1)	(vary purgel flow factor-step2)	(vary 01.20 discharge flow factor-step3)
99.97	100.0	99.98
		(Redundancy converges both to 100%)
Water/Oxygen Balance		**Prod. Gas N2 Balance**
		(vary 01.20 discharge flow factor-step3)
100.48		100.05

Wax/Liquid Production Rates

	lbs/hr	**kg/hr**
Heavy Wax (27.10/28.30, Reactor Temp. Cut)	8.57	3.89
Light Wax (22.14/27.13, 392 deg F Cut)	0.00	0.00
Light HCs (22.10/22.16, 100 deg F Cut)	266.61	120.93
Water (22.10/22.16, 100 deg F Cut)	513.18	232.78

Slurry Conc. Based on Density Measurements

2-Phase Slurry Concentration reduced	particle vol %	24.13
	catalyst wt%	26.95

Water Saturation Calculations for the Reactor

	Based on CO, CO2 Meas.:		Based on Water Production:	
	psia	**mbara**	**psia**	**mbara**
Calculated Water Partial Pressure @ Reactor Outlet	61.16	4355	63.44	4374
Saturated Water Pressure @ Reactor Outlet	695.7	47969	695.7	47969
Water Partial Pressure as % of Sat. Pressure @ Reactor Outlet	9.08%		9.12%	
	deg F	**deg C**	**deg F**	**deg C**
Saturated Water Temperature @ Reactor Outlet	295.7	146.5	296.0	146.7

Carbon No.	1-Alcohols wt%	2-Olefins wt%	n-Paraffins wt%	1-Olefins wt%	iso-Parafins wt%	Total wt%
					Light HC Phase	
1						0.00
2						0.00
3	0.04	0.00	0.20	0.06	0.00	0.31
4	0.22	0.29	1.44	0.69	0.00	2.64
5	0.40	0.49	2.87	1.74	0.23	5.72
6	0.53	0.58	3.59	2.49	0.45	7.64
7	0.52	0.59	4.02	2.58	0.36	8.08
8	0.49	0.63	4.40	2.31	0.40	8.23
9	0.45	0.63	4.44	1.84	0.49	7.87
10	0.46	0.60	4.39	1.36	0.53	7.35
11	0.37	0.51	4.31	1.03	0.47	6.69
12	0.34	0.49	4.48	0.89	0.46	6.67
13	0.25	0.40	3.87	0.57	0.43	5.53
14	0.21	0.33	3.50	0.39	0.43	4.86
15	0.17	0.25	3.09	0.28	0.47	4.26
16	0.12	0.19	2.69	0.23	0.47	3.70
17	0.03	0.13	2.30	0.29	0.50	3.24
18	0.00	0.11	2.13	0.20	0.37	2.81
19	0.00	0.10	1.89	0.13	0.29	2.41
20	0.00	0.04	1.63	0.08	0.34	2.08
21			1.90			1.90
22			1.52			1.52
23			1.29			1.29
24			1.10			1.10
25			0.92			0.92
26			0.77			0.77
27			0.73			0.73
28			0.52			0.52
29			0.43			0.43
30			0.29			0.29
> 30			0.44			0.44
Total	4.61	6.35	65.17	17.17	6.70	100.00

Composition, Wt% Compound	Aqueous Phase
Ethanol	3.20
Water by diff.	96.80
Total	100.00

Composition, wt%	
Carbon No.	Reactor Wax
12	0.09
13	0.22
14	0.26
15	0.33
16	0.41
17	0.51
18	0.62
19	0.77
20	0.92
21	1.12
22	1.35
23	1.62
24	1.92
25	2.28
26	2.84
27	3.74
28	3.88
29	3.97
30	4.33
31	4.61
32	5.14
33	4.82
34	4.79
35	4.50
36	4.23
37	3.92
38	3.64
39	3.40
40	2.94
41	2.81
42	2.55
43	2.23
44	2.07
45	1.86
46	1.64
47	1.50
48	1.34
49	1.18
50	1.06
> 50	8.62
Total	100.00

RUN NO.: AF-R16.3D **TITLE: LIQUID PHASE FISCHER-TROPSCH (IV) SYNTHESIS IN LAPORTE AFDU**

Elemental Balance:

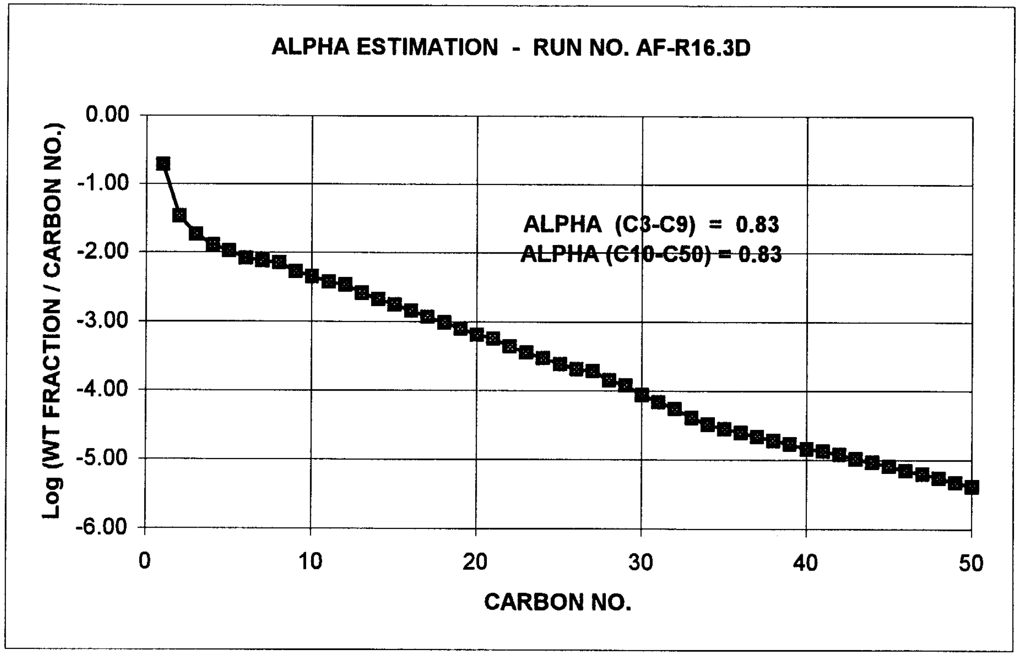
	Total lb/hr	C lb/hr	H lb/hr	O lb/hr	N lb/hr
Reactor Feed Gas	6225.72	2633.57	556.30	2445.18	590.67
Main Gas Outlet	5438.10	2405.95	450.46	1991.19	590.50
27.10 Reactor Wax	8.57	7.32	1.26	0.00	0.00
22.14 Light Wax	0.00	0.00	0.00	0.00	0.00
22.18 HC Phase	266.61	224.88	40.22	1.51	0.00
22.18 AQ Phase	513.18	8.56	57.34	447.29	0.00
Total Out	6226.47	2646.71	549.28	2439.98	590.50
% Balance	100.0	100.5	98.7	99.8	100.0

Product Distribution: Selectivity (wt%)

Methane (C1)	19.1
Gas (C2 - C4)	17.3
Gasoline (C5 - C11)	34.2
Diesel (C122 - C18)	18.8
Wax (C19+)	10.6
Total	100.0
HC Production Rate based on Liquid Data, grams HC produced/kg-cat oxide hr	1164.5

Alpha Estimate:

C3 - C9	1	0.83
C10-C50	2	0.83


ALPHA ESTIMATION - RUN NO. AF-R16.3D
ALPHA (C3-C9) = 0.83
ALPHA (C10-C50) = 0.83
Log (WT FRACTION / CARBON NO.)
0.00
-1.00
-2.00
-3.00
-4.00
-5.00
-6.00
0
10
20
30
40
50
CARBON NO.

RUN NO.: AF-R16.4A TITLE: LIQUID PHASE FISCHER-TROPSCH (IV) SYNTHESIS IN LAPORTE AFDU

Start Date / Time	04/09/98	8.00
End Date / Time	04/09/98	13.00

On-stream Time From Start-up (hr)	
Start	282.00
End	287.00

Reaction Conditions:					
Temperature average		deg F	479.8	deg C	248.8
Pressure	PIC-201	psig	709.9	bara	49.96
Space Velocity		sL/kg-hr	17594		
Superficial Gas Vel. - Inlet		ft/sec	0.46	cm/sec	13.95
(based on average reactor temp)					
Recycle Ratio					

Slurry Data:				
Catalyst Oxide Wt (Reactor)	lbs	377	kg	171.0
Slurry Concentration by NDG	wt%	26.0		
Slurry Concentration by DP	wt%	24,6		
Slurry Level by NDG	% NDG Span	96.2		
Slurry Height	ft	20.72	meters	6.31
Average Gas Holdup by NDG	Vol%	45.1		
Average Gas Holdup by DP	Vol%	41.4		

Performance Results	
CO Conversion per pass, mole %	34.5
H2 Conversion per pass, mole %	39.6
CO + H2 Conversion per pass, mole %	38.0
Plant CO Conversion, mole%	78.8
Plant H2 Conversion, mole%	81.7
Plant CO+H2 Conversion, mole%	80.8
CO Conversion Rate,	69.5
gmole CO converted/kg cat oxide-hr	
HC Production Rate,	971.0
grams of HC (CH2.1) produced/kg cat oxide-hr	
Reactor Productivity (STY)	113.42
grams of H C (CH2.1)/lit of reactor vol. - hr	
H2/CO in Fresh Feed, mole/mole	2.27
H2/CO in Reactor Feed, mole/mole	2.12
H2/CO Usage Ratio, mole/mole	2.44
H2/CO in Outlet, mole/mole	1.96
CO2 Selectivity, mole %	0.96
HC Selectivity (CO2 free) wt%:	
CH4	25.12
C2H6	3.70
C2H4	0.10
C3H8	4.51
C3H6	1.52
SUM C4H10	2.94
SUM C4H8	0.84
SUM C5H11	2.00

Reactor Heat Balance	Btu/hr	kW
Chemical Heat Production by Reaction	1849190	541.94
Sensible Gas Heat	-94614	-28.02
Sensible Oil Heat	-1532948	-449.26
Sensible Wax Heat	-215625	-63.19
Estimate of Heat Loss from Catalyst Drying Data	-50000	-14.65
% Heat Balance based on Reaction Heat	102.43	

Mass Balance	Reactor lb/hr	Plant lb/hr	Feed lb/hr	Prod Gas lb/hr
Fresh Feed		1070	1070	
HP H2 Feed		83	83	
Recycle Feed			2746	2746
Reactor Feed	3905		3905	
Total In	3905	1153		
Prod Gas	3199			3199
Main Purge		454		454
22.11 Purge	0.0	0.0		
HC Phase	240.3	240.3		
AQ Phase	462.5	462.5		
Heavy Wax	15.0	15.0		
Light Wax				
Total Out	3916	1172		
Mass Balance, %	1--/3	101.6	100.1	100.0

Compositions (mole%):		**LP FRESH FEED**	**HP FRESH FEED (H2)**	**RECYCLE FEED**	**REACTOR FEED GAS**	**PRODUCT GAS**	**MAIN (22.10) PURGE**	**22.11 PURGE**	**REACTOR OUTLET (estimated)**
Components									
1	H2	48.90	100.00	45.74	54.57	45.74	45.74	13.37	40.53
2	N2	3.45	0.00	7.97	5.74	7.97	7.97	3.65	7.07
3	CO	47.66	0.00	23.37	25.69	23.37	23.37	20.71	20.70
4	CH4	0.00	0.00	17.38	10.53	17.38	17.38	25.34	15.40
5	CO2	0.00	0.00	0.82	0.50	0.82	0.82	3.38	0.72
6	ETHANE	0.00	0.00	1.48	0.91	1.48	1.48	7.43	1.31
7	ETHYLENE	0.00	0.00	0.01	0.00	0.01	0.01	0.06	0.01
8	PROPANE	0.00	0.00	1.31	0.81	1.31	1.31	10.13	1.16
9	PROPYLENE	0.00	0.00	0.45	0.28	0.45	0.45	3.38	0.40
10	ISOBUATNE	0.00	0.00	0.01	0.01	0.01	0.01	0.11	0.01
11	N-BUTANE	0.00	0.00	0.66	0.41	0.66	0.66	5.76	0.58
12	T-BUTENE-2	0.00	0.00	0.03	0.02	0.03	0.03	0.26	0.03
13	BUTENE-1	0.00	0.00	0.17	0.11	0.17	0.17	1.55	0.15
14	ISOBUTYLENE	0.00	0.00	0.03	0.02	0.03	0.03	0.27	0.03
15	C-BUTENE-2	0.00	0.00	0.04	0.03	0.04	0.04	0.35	0.04
16	SUM C5	0.00	0.00	0.37	0.23	0.37	0.37	3.08	0.33
17	SUM C6	0.00	0.00	0.13	0.09	0.13	0.13	0.98	0.11
18	SUM C7	0.00	0.00	0.03	0.02	0.03	0.03	0.16	0.03
19	SUM C8	0.00	0.00	0.01	0.03	0.01	0.01	0.02	0.01
20	SUM C9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
21	SUM C10	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00
	H2O								10.69
	HC								0.71
	LIGHT WAX								0.000
	TOTAL	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Mole Wt	lb/lb mole	15.30	2.02	15.02	13.20	15.02	15.02	28.78	16.24
Flows	SCFH	27030.60	15980.00	70701.18	114357.35	82357.27	11686.45	0.00	92951.97
	lb mole/hr	69.91	41.33	182.86	295.77	213.00	30.23	0.00	240.41
	lb/hr	1069.78	83.49	2745.96	3904.90	3198.67	453.89	0.00	3903.22
	Nm3/hr	711.34	420.53	1860.59	3009.45	2167.33	307.54	0.00	2446.14
	kgmol/hr	31.71	18.75	82.94	134.16	96.62	13.71	0.00	109.05
	kg/hr	485.25	37.87	1245.56	1771.25	1450.91	205.88	0.00	1770.49
Temperature	deg F	270.3	89.0	109.1	255.2	86.7	84.7	69.5	
	deg C	132.4	31.7	42.8	124.0	30.4	29.3	20.8	
Pressure	psig	767.8	757.0	765.8	735.5	671.9	667.1	33.3	
	bara	53.95	53.20	53.82	51.72	47.34	47.01	3.31	

Reactor Heat Balance

		deg F	deg C			lb/hr	kg/hr		Btu/lb-deg F	J/gm-deg C		lb/ft3	kg/m3
Gas:													
Inlet Temp	TI-1-12A	440.4	226.9	Inlet Flow	RXT FEED	3906	1771.2	Inlet Ht Cap.	0.622	2.604			
Outlet Temp	RXT AVG	479.8	248.8	Outlet Flow	RXT FEED-WAXPROD	3890	1764.5	Outlet Ht Cap.	0.579	2.424			
Oil:													
Inlet Temp	TI-1-14B	403.5	206.4	Inlet Flow	*FI-619	66886	30339.3	Inlet Ht Cap.	0.541	2.263	Inlet Density	52.06	833.82
Outlet Temp	TI-1780	447.0	230.5	Outlet Flow	*FI-619	66886	30339.3	Outlet Ht Cap.	0.560	2.342			
Slurry:													
Inlet Temp	TI-1783	448.1	231.2	Inlet Flow	*FI-1768-61	10884	4937.0	Inlet Ht Cap.	0.626	2.617			
Outlet Temp	RXT AVG	479.8	248.8	Outlet Flow	*FI-1768	10899	4943.8	Outlet Ht Cap.	0.626	2.617			
					*based on								

Reactor Differential Pressures

	DP NOZZLES		Differential Pressures: psi	mbar	Heights: ft (based on flange loc.)	meters	Density - 3 Phase: lb/ft3	kg/m3	Gas Hold-up vol%
Reactor Height:									
13.75 to 9.25 ft	Kl -K3	PDI-1778	0.91	63.0	4.56	1.391	28.83	461.7	42.15
9.25 ft to 4.33 ft	K3-K5	PDI-1779	1.04	71.9	5.08	1.549	29.55	473.4	40.64
Total Reactor	K6-OUT	PDI-631	4.17	287.3	20.72	6.314	28.60	458.1	42.62
Sparger	K6-IN	PDI-633	1.32	90.9					

DEGASSER

Temperatures:			deg F		deg C	
6.5 ft Height	TI-1762		380.5		193.6	
3.5 ft Height	TI-1763		442.7		228.2	
0.5 ft Height	TI-1764		483.8		251.0	
Liquid Level:						
% Level	LI-1765		7.0			
Slurry Height		ft	1.37	meters		0.418

SLURRY PUMP

			deg F	deg C
Temperature:	Slurry Inlet	TI-1755	455.3	235.2
	Seal Oil Outlet	TI-1 795	102.2	39.0
			psig	**bara**
Pressure:	Seal Oil Outlet	PI-1794	761.8	53.53
			lb/hr	**kg/hr**
Flow Rate:	Slurry Outlet	FI-1768	10899.1	4944.0
			g/cc	
Density:	Slurry Outlet	DI-1768	0.820	

SLURRY COOLER

Temperatures:		deg F	deg C
Slurry Outlet	TIC-1754	450.4	232.4
Oil Inlet	TI-1780	447.0	230.5

FILTERS

			deg F	**deg C**				**lb/hr**	**kg/hr**
Temperature:	Slurry Outlet	TI-1783	448.1	231.2	Flow Rate:	Wax	FI-1761	14.959	6.785
			psig	**bara**				**g/cc**	
Pressure:	Slurry Inlet	PI-1756	728.3	51.23	Density:	Wax	DI-1761	0.68	
Diff. Press.:	Longitudinal		**psi**	**mbar**				**ft/sec**	**msec**
	Thru D & C	PDI-1772	9.8	676	Linear Vel.:	Slurry thru Each Element	Calculated	10.85	3.307
	Thru B & A	PDI-1773	0.2	17					
	rans-membrane							**ft/sec**	**msec**
	Membrane A	PDI-1774	-1.4	-100	Superfic. Vel.:	Liquid Upflow thru Reactor	Calculated	0.024	7.213
	Membrane B	PDI-1775	0.7	45					
	Membrane C	PDI-1776	-1.0	-67					
	Membrane D	PDI-1777	0.1	4					

Reactor Temperatures

	Reactor Ht, Ft		**Deg F**	**Deg C**
Nozzle N1	24.25	TI-626-1	469.2	242.9
Nozzle N2	20.25	TI-626-2	479.4	248.6
Nozzle N3	18.25	TI-190-2A	478.4	248.0
Nozzle N4	16.25	TI-626-3	477.2	247.4
Nozzle N5	14.25	TI-190-3	477.1	247.3
Nozzle N7	10.25	TI-1781A	482.0	250.0
		TI-1781B	481.2	249.6
		TI-1781C	482.0	250.0
		TI-1781D	481.2	249.6
Nozzle N8	8.083	TI-626-5	475.5	246.4
Nozzle K4	7.75	TI-190-4	484.4	251.3
Nozzle O	4.792	TI-626-6	478.6	248.1
Reactor Temp. Avg. (Noz N3 thru Noz O)			479.8	248.8

Product Separation

			deg F	**deg C**
Temperatures	27.11 In	TI-1-08	-25.0	-31.7
	2138 Tube In	TI-723	447.4	230.8
	22.14 Out	TIC-725	310.1	154.5
	21.65 Out	TIC-1-11A	85.1	29.5
	27.13 Lt Wax	TI-744	93.4	34.1
	28.30 Hv Wax	TI-515	205.3	96.3
			%	
Levels	27.12	LIC-639	0.0	
	22.14	LIC-688	62.1	
	22.10	LIC-220	30.0	
	22.15	LIC-242	25.0	
	27.13	LI-203	-7.0	
	28.30	LI-1792	99.7	
			psig	**bara**
Pressure	27.13	PIC-202	7.41	1.52

Miscellaneous Data

Overall Plant Material Balance		%	101.60
100*(22.10 Purge 22.11 Purge+Heavy Wax+Light Wax+Light HC+Water)/ (LP Fresh Feed+HP H2)			
Reactor GHSV	Nm3 Rxt Feed/m3 3-phase	slurry volume/hr	2055
Catalyst GHSV	Nm3 Rxt Feed/m3	particle volume/hr	16221
Catalyst Volume in the Reactor		litres particle volume	185.5
Inlet Superfic. Vel. based on Avg Reactor Temp.		cm/sec	13.95
Inlet Sup. Vel. based on Rxt Inlet Temp (TI-1-12A)		cm/sec	13.36
CO Conversion Rate, gmole CO converted AR particle volume/hr			64.10
grams of HC (CH2.1) produced/lft particle volume/hr			895.22

N2 Balance Across Reactor (vary prod gas flow factor-step1)	Plant N2 Balance (vary purgel flow factor-step2)	Feed N2 Balance (vary 01.20 discharge flow factor-step3)
100.00	100.00	99.96 (Redundancy converges both to 100%)
Water/Oxygen Balance		**Prod. Gas N2 Balance** (vary 01.20 discharge flow factor-step3)
100.00		100.04

Wax/Liquid Production Rates

	lbs/hr	kg/hr
Heavy Wax (27.10/28.30, Reactor Temp. Cut)	14.96	6.79
Light Wax (22.14/27.13, 392 deg F Cut)	0.00	0.00
Light HCs (22.10/22.16, 100 deg F Cut)	240.29	109.00
Water (22.10/22.16, 100 deg F Cut)	462.53	209.80

Slurry Conc. Based on Density Measurements

2-Phase Slurry Concentration reduced	particle vol %	22.10
	catalyst wt%	24.86

Water Saturation Calculations for the Reactor

	Based on CO, CO2 Meas.:		Based on Water Production:	
	psia	**mbara**	**psia**	**mbara**
Calculated Water Partial Pressure @ Reactor Outlet	75.89	52.32	75.88	52.32
Saturated Water Pressure @ Reactor Outlet	566.1	39031	566.1	39031
Water Partial Pressure as % of Sat. Pressure @ Reactor Outlet	13.40%		13.40%	
	deg F	**deg C**	**deg F**	**deg C**
Saturated Water Temperature @ Reactor Outlet	308.1	153.4	308.1	153.4

Carbon No.	Compositions, wt% 1-Alcohols wt%	2-Olefins wt%	n-Paraffins wt%	1-Olefins wt%	Light HC Phase iso-Parafins wt%	Total wt%
1						0.00
2						0.00
3	0.04	0.00	0.20	0.06	0.00	0.31
4	0.22	0.29	1.44	0.69	0.00	2.64
5	0.40	0.49	2.87	1.74	0.23	5.72
6	0.53	0.58	3.59	2.49	0.45	7.64
7	0.52	0.59	4.02	2.58	0.36	8.08
8	0.49	0.63	4.40	2.31	0.40	8.23
9	0.45	0.63	4.44	1.84	0.49	7.87
10	0.46	0.60	4.39	1.36	0.53	7.35
11	0.37	0.51	4.31	1.03	0.47	6.69
12	0.34	0.49	4.48	0.89	0.46	6.67
13	0.25	0.40	3.87	0.57	0.43	5.53
14	0.21	0.33	3.50	0.39	0.43	4.86
15	0.17	0.25	3.09	0.28	0.47	4.26
16	0.12	0.19	2.69	0.23	0.47	3.70
17	0.03	0.13	2.30	0.29	0.50	3.24
18	0.00	0.11	2.13	0.20	0.37	2.81
19	0.00	0.10	1.89	0.13	0.29	2.41
20	0.00	0.04	1.63	0.08	0.34	2.08
21			1.90			1.90
22			1.52			1.52
23			1.29			1.29
24			1.10			1.10
25			0.92			0.92
26			0.77			0.77
27			0.73			0.73
28			0.52			0.52
29			0.43			0.43
30			0.29			0.29
> 30			0.44			0.44
Total	4.61	6.35	65.17	17.17	6.70	100.00

Composition, Wt% Compound	Aqueous Phase
Ethanol	3.20
Water by diff.	96.80
Total	100.00

Carbon No.	Composition, wt% Reactor Wax
12	0.22
13	0.21
14	0.37
15	0.48
16	0.54
17	0.68
18	0.85
19	1.05
20	1.29
21	1.56
22	1.85
23	2.14
24	2.45
25	2.74
26	3.08
27	3.45
28	3.72
29	3.96
30	4.22
31	4.40
32	4.41
33	4.39
34	4.63
35	4.09
36	3.87
37	3.74
38	3.28
39	3.00
40	2.76
41	2.48
42	2.23
43	2.05
44	1.84
45	1.65
46	1.47
47	1.30
48	1.15
49	1.05
50	0.92
> 50	10.46
Total	100.00

Elemental Balance:

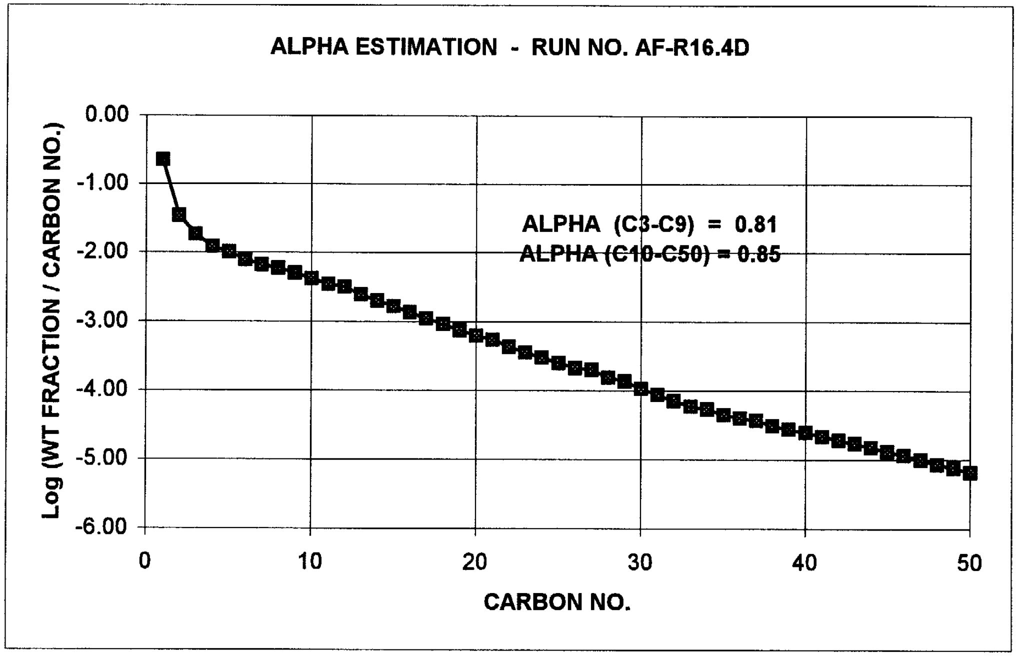
	Total lb/hr	C lb/hr	H lb/hr	O lb/hr	N lb/hr
Reactor Feed Gas	3905.32	1643.53	522.79	1263.25	475.75
Main Gas Outlet	3198.44	1444.90	425.70	852.09	475.75
27.10 Reactor Wax	14.96	12.76	2.19	0.00	0.00
22.14 Light Wax	0.00	0.00	0.00	0.00	0.00
22.18 HC Phase	240.29	202.69	36.25	1.36	0.00
22.18 AQ Phase	462.53	7.71	51.68	403.14	0.00
Total Out	3916.23	1668.06	515.82	1256.59	475.75
% Balance	100.3	101.5	98.7	99.5	100.0

Product Distribution: Selectivity (wt%)

Methane (C1)	22.2
Gas (C2 - C4)	17,2
Gasoline (C5 - C11)	31.3
Diesel (C122 - C18)	17.7
Wax (C19+)	11.6
Total	100.0
HC Production Rate based on Liquid Data, grams HC produced/kg-cat oxide hr	1125.4

Alpha Estimate:

C3 - C9	1	0.81
C10-C50	2	0.85


ALPHA ESTIMATION - RUN NO. AF-R16.4D
ALPHA (C3-C9) = 0.81
ALPHA (C10-C50) = 0.85
Log (WT FRACTION / CARBON NO.)
0.00
-1.00
-2.00
-3.00
-4.00
-5.00
-6.00
0
10
20
30
40
50
CARBON NO.

RUN NO.: AF-R16.4B **TITLE: LIQUID PHASE FISCHER-TROPSCH (IV) SYNTHESIS IN LAPORTE AFDU**

Start Date / Time	04/09/1998	18.00
End Date / Time	04/10/1998	7.00

On-stream Time From Start-up (hr)	
Start	292.00
End	305.00

Reaction Conditions:					
Temperature	average	deg F	480.0	deg C	248.9
Pressure	PIC-201	psig	710.0	bara	49.97
Space Velocity		sL/kg-hr	18278		
Superficial Gas Vel. - Inlet		ft/sec	0.48	cm/sec	14.49
(based on average reactor temp)					
Recycle Ratio			1.79		

Slurry Data:				
Catalyst Oxide Wt (Reactor)	lbs	377	kg	171.0
Slurry Concentration by NDG	wt%	26.4		
Slurry Concentration by DP	wt%	24.9		
Slurry Level by NDG	% NDG Span	96.3		
Slurry Height	ft	20.73	meters	6.32
Average Gas Holdup by NDG	Vol%	46.6		
Average Gas Holdup by DP	Vol%	42.4		

Performance Results	
CO Conversion per pass, mole %	32.1
H2 Conversion per pass, mole %	39.7
CO + H2 Conversion per pass, mole %	37.2
Plant CO Conversion, mole%	79.1
Plant H2 Conversion, mole%	83.5
Plant CO+H2 Conversion, mole%	82.2
CO Conversion Rate,	69.6
gmole CO converted/kg cat oxide-hr	
HC Production Rate,	972.3
grams of HC (CH2.1) produced/kg cat oxide-hr	
Reactor Productivity (STY)	113.50
grams of H C (CH2.1)/lit of reactor vol. - hr	
H2/CO in Fresh Feed, mole/mole	2.23
H2/CO in Reactor Feed, mole/mole	1.98
H2/CO Usage Ratio, mole/mole	2.45
H2/CO in Outlet, mole/mole	1.76
CO2 Selectivity, mole %	0.89
HC Selectivity (CO2 free) wt%:	
CH4	23.21
C2H6	5.86
C2H4	0.32
C3H8	7.73
C3H6	2.31
SUM C4H10	4.60
SUM C4H8	1.82
SUM C5H11	2.67

Reactor Heat Balance	**Btu/hr**	**kW**
Chemical Heat Production by Reaction	1851479	542.61
Sensible Gas Heat	-96722	-28.35
Sensible Oil Heat	-1522261	-446.13
Sensible Wax Heat	-210654	-61.74
Estimate of Heat Loss from Catalyst Drying Data	-50000	-14.65
% Heat Balance based on Reaction Heat	101.52	

Mass Balance	**Reactor lb/hr**	**Plant lb/hr**	**Feed lb/hr**	**Prod Gas lb/hr**
Fresh Feed		1063	1063	
HP H2 Feed		81	81	
Recycle Feed			3083	3083
Reactor Feed	4198		4198	
Total In	4198	1144		
Prod Gas	3525			3525
Main Purge		441		441
22.11 Purge	0.0	0.0		
HC Phase	231.0	231.0		
AQ Phase	444.6	444.6		
Heavy Wax	15.0	15.0		
Light Wax				
Total Out	4216	1132		
Mass Balance, %	100.4	98.9	99.3	100.0

RUN NO.: AF-R16.4B TITLE: LIQUID PHASE FISCHER-TROPSCH (IV) SYNTHESIS IN LAPORTE AFDU

Compositions (mole%):		**LP FRESH FEED**	**HP FRESH FEED (H2)**	**RECYCLE FEED**	**REACTOR FEED GAS**	**PRODUCT GAS**	**MAIN (22.10) PURGE**	**22.11 PURGE**	**REACTOR OUTLET (estimated)**
Components									
1	H2	48.93	100.00	43.45	52.67	43.45	43.45	12.76	38.73
2	N2	3.36	0.00	8.31	6.08	8.31	8.31	3.73	7.41
3	CO	47.71	0.00	24.64	26.55	24.64	24.64	19.77	21.96
4	CH4	0.00	0.00	17.52	11.04	17.52	17.52	25.32	15.62
5	CO2	0.00	0.00	0.82	0.53	0.82	0.82	3.06	0.73
6	ETHANE	0.00	0.00	1.65	0.97	1.65	1.65	7.81	1.47
7	ETHYLENE	0.00	0.00	0.02	0.00	0.02	0.02	0.06	0.02
8	PROPANE	0.00	0.00	1.45	0.85	1.45	1.45	10.82	1.29
9	PROPYLENE	0.00	0.00	0.52	0.32	0.52	0.52	3.63	0.47
10	ISOBUATNE	0.00	0.00	0.02	0.01	0.02	0.02	0.13	0.02
11	N-BUTANE	0.00	0.00	0.70	0.42	0.70	0.70	5.95	0.62
12	T-BUTENE-2	0.00	0.00	0.03	0.02	0.03	0.03	0.27	0.03
13	BUTENE-1	0.00	0.00	0.20	0.12	0.20	0.20	1.67	0.18
14	ISOBUTYLENE	0.00	0.00	0.04	0.02	0.04	0.04	0.30	0.03
15	C-BUTENE-2	0.00	0.00	0.04	0.03	0.04	0.04	0.36	0.04
16	SUM C5	0.00	0.00	0.40	0.24	0.40	0.40	3.19	0.35
17	SUM C6	0.00	0.00	0.14	0.09	0.14	0.14	1.01	0.13
18	SUM C7	0.00	0.00	0.03	0.03	0.03	0.03	0.15	0.02
19	SUM C8	0.00	0.00	0.02	0.02	0.02	0.02	0.01	0.02
20	SUM C9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
21	SUM C10	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00
	H2O								10.21
	HC								0.65
	LIGHT WAX								0.000
	TOTAL	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Mole Wt	lb/lb mole	15.29	2.02	15.69	13.66	15.69	15.69	29.20	16.74
Flows	SCFH	26875.19	15501.80	75980.21	118806.83	86884.17	10872.37	0.00	97473.96
	lb mole/hr	69.51	40.09	196.51	307.28	224.71	28.12	0.00	252.10
	lb/hr	1062.98	80.99	3082.62	4197.72	3525.01	441.11	0.00	4221.16
	Nm3/hr	707.25	407.95	1999.51	3126.55	2286.46	286.12	0.00	2565.14
	kgmol/hr	31.53	18.19	89.14	139.38	101.93	12.76	0.00	114.35
	kg/hr	482.17	36.74	1398.27	1904.07	1598.94	200.08	0.00	1914.71
Temperature	deg F	273.3	83.0	110.0	261.1	86.8	84.1	71.0	
	deg C	134.1	28.3	43.3	127.3	30.4	28.9	21.7	
Pressure	psig	772.9	776.6	772.2	740.0	668.7	663.9	33.5	
	bara	54.30	54.56	54.25	52.03	47.12	46.79	3.32	

Reactor Heat Balance

		deg F	deg C			lb/hr	kg/hr		Btu/lb-deg F	J/gm-deg C		lb/ft3	kg/m3
Gas:													
Inlet Temp	TI-1-12A	441.8	227.7	Inlet Flow	RXT FEED	4198	1904.1	Inlet Ht Cap.	0.604	2.526			
Outlet Temp	RXT AVG	480.0	248.9	Outlet Flow	RXT FEED-WAXPROD	4183	1897.3	Outlet Ht Cap.	0.562	2.352			
Oil:													
Inlet Temp	TI-1-14B	404.3	206.8	Inlet Flow	*FI-619	66849	30322.5	Inlet Ht Cap.	0.541	2.264	Inlet Density	52.03	833.44
Outlet Temp	TI-1780	447.5	230.8	Outlet Flow	*FI-619	66849	30322.5	Outlet Ht Cap.	0.560	2.343			
Slurry:													
Inlet Temp	TI-1783	449.0	231.7	Inlet Flow	*FI-1768-61	10902	4945.2	Inlet Ht Cap.	0.624	2.610			
Outlet Temp	RXT AVG	480.0	248.9	Outlet Flow	*FI-1768	10917	4952.0	Outlet Ht Cap.	0.624	2.610			
					*based on								

Reactor Differential Pressures

DP NOZZLES			Differential Pressures: psi	mbar	Heights: ft (based on flange loc.)	meters	Density - 3 Phase: lb/ft3	kg/m3	Gas Hold-up vol%
Reactor Height:									
13.75 to 9.25 ft	Kl -K3	PDI-1778	0.90	61.7	4.56	1.391	28.25	452.5	43.52
9.25 ft to 4.33 ft	K3-K5	PDI-1779	1.04	71.4	5.08	1.549	29.33	469.9	41.27
Total Reactor	K6-OUT	PDI-631	4.11	283.5	20.73	6.319	28.19	451.5	43.65
Sparger	K6-IN	PDI-633	1.50	103.3					

DEGASSER

Temperatures:		deg F	deg C	
6.5 ft Height	TI-1762	392.7	200.4	
3.5 ft Height	TI-1763	444.7	229.3	
0.5 ft Height	TI-1764	484.9	251.6	
Liquid Level:				
% Level	LI-1765	-5.5		
Slurry Height	ft	-0.64	meters	-0.194

SLURRY PUMP

			deg F	deg C
Temperature:	Slurry Inlet	TI-1755	455.8	235.4
	Seal Oil Outlet	TI-1 795	104.6	40.3
			psig	bara
Pressure:	Seal Oil Outlet	PI-1794	744.1	52.32
			lb/hr	kg/hr
Flow Rate:	Slurry Outlet	FI-1768	10917.2	4952.2
			g/cc	
Density:	Slurry Outlet	DI-1768	0.821	

SLURRY COOLER

Temperatures:	deg F	deg C

Slurry Outlet	TIC-1754	450.7	232.6
Oil Inlet	TI-1780	447.5	230.8

RUN NO.: **AF-R16.4B** TITLE: **LIQUID PHASE FISCHER-TROPSCH (IV) SYNTHESIS IN LAPORTE AFDU**

FILTERS

			deg F	**deg C**				**lb/hr**	**kg/hr**
Temperature:	Slurry Outlet	TI-1783	449.0	231.7	Flow Rate:	Wax	FI-1761	14.955	6.783
			psig	**bara**				**g/cc**	
Pressure:	Slurry Inlet	PI-1756	729.3	51.30	Density:	Wax	DI-1761	0.68	
Diff. Press.:	Longitudinal		**psi**	**mbar**				**ft/sec**	**msec**
	Thru D & C	PDI-1772	9.9	685	Linear Vel.:	Slurry thru Each Element	Calculated	10.85	3.308
	Thru B & A	PDI-1773	0.3	19					
	rans-membrane							**ft/sec**	**msec**
	Membrane A	PDI-1774	-1.6	-108	Superfic. Vel.:	Liquid Upflow thru Reactor	Calculated	0.024	7.217
	Membrane B	PDI-1775	0.4	26					
	Membrane C	PDI-1776	-1.0	-70					
	Membrane D	PDI-1777	-0.3	-24					

Reactor Temperatures

	Reactor Ht, Ft		**Deg F**	**Deg C**
Nozzle N1	24.25	TI-626-1	470.3	243.5
Nozzle N2	20.25	TI-626-2	479.4	248.6
Nozzle N3	18.25	TI-190-2A	478.5	248.1
Nozzle N4	16.25	TI-626-3	477.2	247.4
Nozzle N5	14.25	TI-190-3	477.0	247.2
Nozzle N7	10.25	TI-1781A	481.8	249.9
		TI-1781B	481.0	249.4
		TI-1781C	481.9	249.9
		TI-1781D	481.0	249.5
Nozzle N8	8.083	TI-626-5	478.2	247.9
Nozzle K4	7.75	TI-190-4	484.3	251.3
Nozzle O	4.792	TI-626-6	478.7	248.2
Reactor Temp. Avg. (Noz N3 thru Noz O)			480.0	248.9

Product Separation

			deg F	**deg C**
Temperatures	27.11 In	TI-1-08	-25.0	-31.7
	2138 Tube In	TI-723	450.1	232.3
	22.14 Out	TIC-725	310.0	154.4
	21.65 Out	TIC-1-11A	85.0	29.4
	27.13 Lt Wax	TI-744	100.5	38.1
	28.30 Hv Wax	TI-515	231.0	110.5
			%	
Levels	27.12	LIC-639	0.0	
	22.14	LIC-688	59.3	
	22.10	LIC-220	30.0	
	22.15	LIC-242	21.1	
	27.13	LI-203	-7.0	
	28.30	LI-1792	-0.6	
			psig	**bara**
Pressure	27.13	PIC-202	5.82	1.41

Miscellaneous Data

Overall Plant Material Balance	%	98.93
100*(22.10 Purge 22.11 Purge+Heavy Wax+Light Wax+Light HC+Water)/ (LP Fresh Feed+HP H2)		
Reactor GHSV	Nm3 Rxt Feed/m3 3-phase slurry volume/hr	2133
Catalyst GHSV	Nm3 Rxt Feed/m3 particle volume/hr	16853
Catalyst Volume in the Reactor	litres particle volume	185.5
Inlet Superfic. Vel. based on Avg Reactor Temp.	cm/sec	1449
Inlet Sup. Vel. based on Rxt Inlet Temp (TI-1-12A)	cm/sec	13.90
CO Conversion Rate, gmole CO converted AR particlevolume/hr		64.15
grams of HC (CH2.1) produced/lft particle volume/hr	896.47	

N2 Balance Across Reactor	Plant N2 Balance	Feed N2 Balance
(vary prod gas flow factor-step1)	(vary purgel flow factor-step2)	(vary 01.20 discharge flow factor-step3)
100.02	99.96	100.01
		(Redundancy converges both to 100%)
Water/Oxygen Balance		**Prod. Gas N2 Balance**
		(vary 01.20 discharge flow factor-step3)
95.93		99.96

Wax/Liquid Production Rates

	lbs/hr	kg/hr
Heavy Wax (27.10/28.30, Reactor Temp. Cut)	14.95	6.78
Light Wax (22.14/27.13, 392 deg F Cut)	0.00	0.00
Light HCs (22.10/22.16, 100 deg F Cut)	231.00	104.78
Water (22.10/22.16, 100 deg F Cut)	444.65	201.69

Slurry Conc. Based on Density Measurements

2-Phase Slurry Concentration reduced	particle vol %	22.27
	catalyst wt%	25.02

Water Saturation Calculations for the Reactor

	Based on CO, CO2 Meas.:		Based on Water Production:	
	psia	**mbara**	**psia**	**mbara**
Calculated Water Partial Pressure @ Reactor Outlet	72.52	5000	69.86	4817
Saturated Water Pressure @ Reactor Outlet	567.1	39098	567.1	39098
Water Partial Pressure as % of Sat. Pressure @ Reactor Outlet	12.79%		12.32%	
	deg F	**deg C**	**deg F**	**deg C**
Saturated Water Temperature @ Reactor Outlet	305.0	151.7	302.5	150.3

RUN NO.: AF-R16.5A **TITLE: LIQUID PHASE FISCHER-TROPSCH (IV) SYNTHESIS IN LAPORTE AFDU**

Start Date / Time	04/10/1998	14.00
End Date / Time	04/11/1998	12.00

On-stream Time From Start-up (hr)	
Start	312.00
End	334.00

Reaction Conditions:					
Temperature	average	deg F	498.3	deg C	259.1
Pressure	PIC-201	psig	710.1	bara	49.97
Space Velocity		sL/kg-hr	15530		
Superficial Gas Vel. - Inlet		ft/sec	0.41	cm/sec	12.52
(based on average reactor temp)					
Recycle Ratio			1.11		

Slurry Data:					
Catalyst Oxide Wt (Reactor)		lbs	376	kg	170.6
Slurry Concentration by NDG		wt%	26.8		
Slurry Concentration by DP		wt%	25.6		
Slurry Level by NDG	% NDG Span		95.8		
Slurry Height		ft	20.65	meters	629
Average Gas Holdup by NDG		Vol%	47.2		
Average Gas Holdup by DP		Vol%	43.6		

Performance Results	
CO Conversion per pass, mole %	31.7
H2 Conversion per pass, mole %	56.4
CO + H2 Conversion per pass, mole %	45.8
Plant CO Conversion, mole%	71.3
Plant H2 Conversion, mole%	87.1
Plant CO+H2 Conversion, mole%	81.6
CO Conversion Rate,	79.8
gmole CO converted/kg cat oxide-hr	
HC Production Rate,	1109.9
grams of HC (CH2.1) produced/kg cat oxide-hr	
Reactor Productivity (STY)	129.72
grams of H C (CH2.1)/lit of reactor vol. - hr	
H2/CO in Fresh Feed, mole/mole	1.88
H2/CO in Reactor Feed, mole/mole	1.33
H2/CO Usage Ratio, mole/mole	2.37
H2/CO in Outlet, mole/mole	0.85
CO2 Selectivity, mole %	1.37
HC Selectivity (CO2 free) wt%:	
CH4	22.22
C2H6	3.16
C2H4	0.17
C3H8	3.44
C3H6	2.27
SUM C4H10	2.28
SUM C4H8	1.55
SUM C5H11	1.40

Reactor Heat Balance	**Btu/hr**	**kW**
Chemical Heat Production by Reaction	2110254	618.45
Sensible Gas Heat	-113445	-33.25
Sensible Oil Heat	-1691725	-495.79
Sensible Wax Heat	-238515	-69.90
Estimate of Heat Loss from Catalyst Drying Data	-50000	-14.65
% Heat Balance based on Reaction Heat	99.21	

Mass Balance	**Reactor lb/hr**	**Plant lb/hr**	**Feed lb/hr**	**Prod Gas lb/hr**
Fresh Feed		1301	1301	
HP H2 Feed		89	89	
Recycle Feed			2560	2560
Reactor Feed	3946		3946	
Total In	3946	1391		
Prod Gas	3138			3138
Main Purge		580		580
22.11 Purge	0.0	0.0		
HC Phase	270.1	270.1		
AQ Phase	519.8	519.8		
Heavy Wax	31.2	31.2		
Light Wax				
Total Out	3959	1401		
Mass Balance, %	100.3	100.7	99.9	

RUN NO.: AF-R16.5A TITLE: LIQUID PHASE FISCHER-TROPSCH (IV) SYNTHESIS IN LAPORTE AFDU

Compositions (mole%):		LP FRESH FEED	HP FRESH FEED (H2)	RECYCLE FEED	REACTOR FEED GAS	PRODUCT GAS	MAIN (22.10) PURGE	22.11 PURGE	REACTOR OUTLET (estimated)
Components									
1	H2	43.73	100.00	32.78	48.29	32.78	32.78	10.20	27.64
2	N2	2.98	0.00	7.53	4.84	7.53	7.53	3.55	6.35
3	CO	53.29	0.00	38.68	36.36	38.68	38.68	24.06	32.62
4	CH4	0.00	0.00	14.94	7.32	14.94	14.94	23.32	12.59
5	CO2	0.00	0.00	1.32	0.69	1.32	1.32	5.12	1.12
6	ETHANE	0.00	0.00	1.44	0.75	1.44	1.44	7.31	1.21
7	ETHYLENE	0.00	0.00	0.03	0.01	0.03	0.03	0.11	0.03
8	PROPANE	0.00	0.00	1.05	0.54	1.05	1.05	8.17	0.88
9	PROPYLENE	0.00	0.00	0.71	0.37	0.71	0.71	5.40	0.60
10	ISOBUATNE	0.00	0.00	0.01	0.00	0.01	0.01	0.11	0.01
11	N-BUTANE	0.00	0.00	0.53	0.28	0.53	0.53	4.67	0.45
12	T-BUTENE-2	0.00	0.00	0.04	0.02	0.04	0.04	0.31	0.03
13	BUTENE-1	0.00	0.00	0.29	0.15	0.29	0.29	2.51	0.24
14	ISOBUTYLENE	0.00	0.00	0.04	0.02	0.04	0.04	0.32	0.03
15	C-BUTENE-2	0.00	0.00	0.05	0.03	0.05	0.05	0.42	0.04
16	SUM C5	0.00	0.00	0.38	0.21	0.38	0.38	3.21	0.32
17	SUM C6	0.00	0.00	0.14	0.07	0.14	0.14	1.04	0.12
18	SUM C7	0.00	0.00	0.03	0.01	0.03	0.03	0.16	0.03
19	SUM C8	0.00	0.00	0.01	0.02	0.01	0.01	0.02	0.01
20	SUM C9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
21	SUM C10	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00
	H2O								14.71
	HC								0.97
	LIGHT WAX								0.000
	TOTAL	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Mole Wt	lb/lb mole	16.64	2.02	18.77	15.15	18.77	18.77	30.16	19.85
Flows	SCFH	30231.00	17105.90	52737.92	100677.29	64645.94	11945.18	0.00	76665.25
	lb mole/hr	78.19	44.24	136.40	260.39	167.20	30.89	0.00	198.28
	lb/hr	1301.32	89.37	2560.19	3945.70	3138.28	579.89	0.00	3935.32
	Nm3/hr	795.57	450.16	1387.86	2649.44	1701.24	314.35	0.00	2017.54
	kgmol/hr	35.47	20.07	61.87	118.11	75.84	14.01	0.00	89.94
	kg/hr	590.27	40.54	1161.30	1789.76	1423.51	263.03	0.00	1785.05
Temperature	deg F	273.0	86.5	109.4	327.3	88.7	86.1	74.4	
	deg C	133.9	30.3	43.0	164.0	31.5	30.0	23.5	
Pressure	psig	768.9	780.7	761.3	733.3	677.3	673.2	33.5	
	bara	54.03	54.84	53.50	51.57	47.71	47.43	3.32	

Reactor Heat Balance

		deg F	deg C			lb/hr	kg/hr		Btu/lb-deg F	J/gm-deg C		lb/ft3	kg/m3
Gas:													
Inlet Temp	TI-1-12A	443.1	228.4	Inlet Flow	RXT FEED	3946	1789.8	Inlet Ht Cap.	0.521	2.178			
Outlet Temp	RXT AVG	498.3	259.1	Outlet Flow	RXT FEED-WAXPROD	3915	1775.6	Outlet Ht Cap.	0.466	1.949			
Oil:													
Inlet Temp	TI-1-14B	413.7	212.0	Inlet Flow	*FI-619	66080	29973.7	Inlet Ht Cap.	0.545	2.281	Inlet Density	51.77	829.24
Outlet Temp	TI-1780	462.0	238.9	Outlet Flow	*FI-619	66080	29973.7	Outlet Ht Cap.	0.566	2.369			
Slurry:													
Inlet Temp	TI-1783	462.9	239.4	Inlet Flow	*FI-1768-61	10853	4922.8	Inlet Ht Cap.	0.620	2.594			
Outlet Temp	RXT AVG	498.3	259.1	Outlet Flow	*FI-1768	10884	4937.0	Outlet Ht Cap.	0.620	2.594			
					*based on								

Reactor Differential Pressures

	DP NOZZLES		Differential Pressures: psi	mbar	Heights: ft (based on flange loc.)	meters	Density - 3 Phase: lb/ft3	kg/m3	Gas Hold-up vol%
Reactor Height:									
13.75 to 9.25 ft	Kl -K3	PDI-1778	0.88	60.8	4.56	1.391	27.83	445.9	44.30
9.25 ft to 4.33 ft	K3-K5	PDI-1779	1.01	59.4	5.08	1.549	28.51	456.6	42.89
Total Reactor	K6-OUT	PDI-631	3.98	274.5	20.65	6.294	27.31	437.4	45.40
Sparger	K6-IN	PDI-633	1.11	76.7					

DEGASSER

Temperatures:			**deg F**		**deg C**	
6.5 ft Height	TI-1762		393.7		201.0	
3.5 ft Height	TI-1763		440.2		226.8	
0.5 ft Height	TI-1764		498.2		259.0	
Liquid Level:						
% Level	LI-1765		-2.4			
Slurry Height		ft	-0.16		meters	-0.047

SLURRY PUMP

			deg F	**deg C**
Temperature:	Slurry Inlet	TI-1755	470.0	243.3
	Seal Oil Outlet	TI-1 795	107.2	41.8
			psig	**bara**
Pressure:	Seal Oil Outlet	PI-1794	755.7	53.12
			lb/hr	**kg/hr**
Flow Rate:	Slurry Outlet	FI-1768	10884.1	4937.2
			g/cc	
Density:	Slurry Outlet	DI-1768	0.814	

SLURRY COOLER

Temperatures:		**deg F**	**deg C**
Slurry Outlet	TIC-1754	465.3	240.7

Oil Inlet	TI-1780	462.0	238.9

FILTERS

			deg F	**deg C**				**lb/hr**	**kg/hr**
Temperature:	Slurry Outlet	TI-1783	462.9	239.4	Flow Rate:	Wax	FI-1761	31.189	14.147
			psig	**bara**				**g/cc**	
Pressure:	Slurry Inlet	PI-1756	729.1	51.28	Density:	Wax	DI-1761	0.67	
Diff. Press.:	Longitudinal		**psi**	**mbar**				**ft/sec**	**msec**
	Thru D & C	PDI-1772	9.7	667	Linear Vel.:	Slurry thru	Calculated	10.91	3.326
	Thru B & A	PDI-1773	0.2	13		Each Element			
	rans-membrane							**ft/sec**	**msec**
	Membrane A	PDI-1774	-0.5	-32	Superfic. Vel.:	Liquid Upflow	Calculated	0.024	7.241
	Membrane B	PDI-1775	0.6	44		thru Reactor			
	Membrane C	PDI-1776	-0.9	-65					
	Membrane D	PDI-1777	0.1	3					

Reactor Temperatures

	Reactor Ht, Ft		**Deg F**	**Deg C**
Nozzle N1	24.25	TI-626-1	480.8	249.3
Nozzle N2	20.25	TI-626-2	494.8	257.1
Nozzle N3	18.25	TI-190-2A	495.3	257.4
Nozzle N4	16.25	TI-626-3	494.0	256.7
Nozzle N5	14.25	TI-190-3	494.1	256.7
Nozzle N7	10.25	TI-1781A	500.9	260.5
		TI-1781B	499.8	259.9
		TI-1781C	500.8	260.4
		TI-1781D	500.3	260.2
Nozzle N8	8.083	TI-626-5	405.3	257.4
Nozzle K4	7.75	TI-190-4	504.4	262.4
Nozzle O	4.792	TI-626-6	498.4	259.1
Reactor Temp. Avg. (Noz N3 thru Noz O)				498.3
	259.1			

Product Separation

			deg F	**deg C**
Temperatures	27.11 In	TI-1-08	-25.0	-31.7
	2138 Tube In	TI-723	456.6	235.9
	22.14 Out	TIC-725	310.0	154.4
	21.65 Out	TIC-1-11A	87.1	30.6
	27.13 Lt Wax	TI-744	102.1	38.9
	28.30 Hv Wax	TI-515	233.9	112.2
			%	
Levels	27.12	LIC-639	0.0	
	22.14	LIC-688	85.6	
	22.10	LIC-220	30.0	
	22.15	LIC-242	24.7	
	27.13	LI-203	-7.0	
	28.30	LI-1792	-0.3	
			psig	**bara**
Pressure	27.13	PIC-202	3.64	1.26

Miscellaneous Data

Overall Plant Material Balance		%	100.74
100*(22.10 Purge 22.11 Purge+Heavy Wax+Light Wax+Light HC+Water)/ (LP Fresh Feed+HP H2)			
Reactor GHSV	Nm3 Rxt Feed/m3 3-phase	slurry volume/hr	1815
Catalyst GHSV	Nm3 Rxt Feed/m3	particle volume/hr	14319
Catalyst Volume in the Reactor		litres particle volume	185.0
Inlet Superfic. Vel. based on Avg Reactor Temp.		cm/sec	12.52
Inlet Sup. Vel. based on Rxt Inlet Temp (TI-1-12A)		cm/sec	11.80
CO Conversion Rate, gmole CO converted AR particlevolume/hr			73.58
grams of HC (CH2.1) produced/lft particle volume/hr		1023.28	

N2 Balance Across Reactor (vary prod gas flow factor-step1)	Plant N2 Balance (vary purgel flow factor-step2)	Feed N2 Balance (vary 01.20 discharge flow factor-step3)
99.94	99.96	99.99 (Redundancy converges both to 100%)

Water/Oxygen Balance	Prod. Gas N2 Balance (vary 01.20 discharge flow factor-step3)
99.00	100.06

Wax/Liquid Production Rates

	lbs/hr	kg/hr
Heavy Wax (27.10/28.30, Reactor Temp. Cut)	31.19	14.15
Light Wax (22.14/27.13, 392 deg F Cut)	0.00	0.00
Light HCs (22.10/22.16, 100 deg F Cut)	270.06	122.50
Water (22.10/22.16, 100 deg F Cut)	519.82	235.79

Slurry Conc. Based on Density Measurements

2-Phase Slurry Concentration reduced	particle vol %	21.94
	catalyst wt%	24.86

Water Saturation Calculations for the Reactor

	Based on CO, CO2 Meas.:		Based on Water Production:	
	psia	**mbara**	**psia**	**mbara**
Calculated Water Partial Pressure @ Reactor Outlet	104.46	7272	103.47	7141
Saturated Water Pressure @ Reactor Outlet	672.2	46344	672.2	46344
Water Partial Pressure as % of Sat. Pressure @ Reactor Outlet	15.54%		15.41%	
	deg F	**deg C**	**deg F**	**deg C**
Saturated Water Temperature @ Reactor Outlet	330.7	166.0	330.1	165.6

RUN NO.: AF-R16.5B **TITLE: LIQUID PHASE FISCHER-TROPSCH (IV) SYNTHESIS IN LAPORTE AFDU**

Start Date / Time	04/11/1998	12.00
End Date / Time	04/11/1998	23.00

On-stream Time From Start-up (hr)	
Start	334.00
End	345.00

Reaction Conditions:					
Temperature	average	deg F	497.7	deg C	258.7
Pressure	PIC-201	psig	710.0	bara	49.96
Space Velocity		sL/kg-hr	15601		
Superficial Gas Vel. - Inlet		ft/sec	0.41	cm/sec	12.47
(based on average reactor temp)					
Recycle Ratio			1.10		

Slurry Data:				
Catalyst Oxide Wt (Reactor)	lbs	373	kg	169.2
Slurry Concentration by NDG	wt%	26.5		
Slurry Concentration by DP	wt%	25.5		
Slurry Level by NDG	% NDG Span	96.8		
Slurry Height	ft	20.82	meters	6.35
Average Gas Holdup by NDG	Vol%	46.8		
Average Gas Holdup by DP	Vol%	44.4		

Performance Results	
CO Conversion per pass, mole %	31.2
H2 Conversion per pass, mole %	54.1
CO + H2 Conversion per pass, mole %	44.5
Plant CO Conversion, mole%	69.4
Plant H2 Conversion, mole%	85.1
Plant CO+H2 Conversion, mole%	79.6
CO Conversion Rate,	78.3
gmole CO converted/kg cat oxide-hr	
HC Production Rate,	1088.9
grams of HC (CH2.1) produced/kg cat oxide-hr	
Reactor Productivity (STY)	125.23
grams of H C (CH2.1)/lit of reactor vol. - hr	
H2/CO in Fresh Feed, mole/mole	1.88
H2/CO in Reactor Feed, mole/mole	1.38
H2/CO Usage Ratio, mole/mole	2.39
H2/CO in Outlet, mole/mole	0.92
CO2 Selectivity, mole %	1.35
HC Selectivity (CO2 free) wt%:	
CH4	23.06
C2H6	3.40
C2H4	0.17
C3H8	3.63
C3H6	2.32
SUM C4H10	2.55
SUM C4H8	1.76
SUM C5H11	2.06

Reactor Heat Balance	**Btu/hr**	**kW**
Chemical Heat Production by Reaction	2053707	601.88
Sensible Gas Heat	-115946	-33.98
Sensible Oil Heat	-1626599	-476.71
Sensible Wax Heat	-241330	-70.73
Estimate of Heat Loss from Catalyst Drying Data	-50000	-14.65
% Heat Balance based on Reaction Heat	99.03	

Mass Balance	**Reactor lb/hr**	**Plant lb/hr**	**Feed lb/hr**	**Prod Gas lb/hr**
Fresh Feed		1303	1303	
HP H2 Feed		89	89	
Recycle Feed			2470	2470
Reactor Feed	3854		3854	
Total In	3854	1392		
Prod Gas	3081			3081
Main Purge		611		611
22.11 Purge	0.0	0.0		
HC Phase	264.8	264.8		
AQ Phase	509.6	509.6		
Heavy Wax	31.2	31.2		
Light Wax				
Total Out	3886	1417		
Mass Balance, %	100.8	101.8	99.8	100.0

RUN NO.: AF-R16.5B **TITLE: LIQUID PHASE FISCHER-TROPSCH (IV) SYNTHESIS IN LAPORTE AFDU**

Compositions (mole%):		LP FRESH FEED	HP FRESH FEED (H2)	RECYCLE FEED	REACTOR FEED GAS	PRODUCT GAS	MAIN (22.10) PURGE	22.11 PURGE	REACTOR OUTLET (estimated)
Components									
1	H2	43.77	100.00	35.01	49.60	35.01	35.01	11.28	29.68
2	N2	2.98	0.00	6.99	4.54	6.99	6.99	3.44	5.92
3	CO	53.25	0.00	38.17	36.04	38.17	38.17	24.73	32.35
4	CH4	0.00	0.00	14.02	6.80	14.02	14.02	22.74	11.88
5	CO2	0.00	0.00	1.17	0.61	1.17	1.17	4.70	0.99
6	ETHANE	0.00	0.00	1.37	0.71	1.37	1.37	6.92	1.17
7	ETHYLENE	0.00	0.00	0.03	0.01	0.03	0.03	0.10	0.03
8	PROPANE	0.00	0.00	1.01	0.52	1.01	1.01	7.84	0.86
9	PROPYLENE	0.00	0.00	0.69	0.36	0.69	0.69	5.24	0.58
10	ISOBUATNE	0.00	0.00	0.01	0.00	0.01	0.01	0.11	0.01
11	N-BUTANE	0.00	0.00	0.53	0.28	0.53	0.53	4.72	0.45
12	T-BUTENE-2	0.00	0.00	0.03	0.02	0.03	0.03	0.30	0.03
13	BUTENE-1	0.00	0.00	0.28	0.15	0.28	0.28	2.49	0.24
14	ISOBUTYLENE	0.00	0.00	0.03	0.02	0.03	0.03	0.32	0.03
15	C-BUTENE-2	0.00	0.00	0.05	0.02	0.05	0.05	0.41	0.04
16	SUM C5	0.00	0.00	0.40	0.21	0.40	0.40	3.34	0.34
17	SUM C6	0.00	0.00	0.14	0.08	0.14	0.14	1.11	0.12
18	SUM C7	0.00	0.00	0.03	0.01	0.03	0.03	0.16	0.03
19	SUM C8	0.00	0.00	0.02	0.01	0.02	0.02	0.02	0.02
20	SUM C9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
21	SUM C10	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00
	H2O								14.28
	HC								0.94
	LIGHT WAX								0.000
	TOTAL	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Mole Wt	lb/lb mole	16.64	2.02	18.28	14.85	18.28	18.28	29.91	19.41
Flows	SCFH	30276.13	17113.20	52249.90	100329.21	65165.37	12933.28	0.00	76871.22
	lb mole/hr	78.30	44.26	135.14	259.49	168.54	33.45	0.00	198.82
	lb/hr	1302.60	89.41	2470.14	3854.02	3080.72	611.43	0.00	3858.51
	Nm3/hr	796.75	450.35	1375.02	2640.28	1714.91	340.35	0.00	2022.96
	kgmol/hr	35.52	20.08	61.30	117.70	76.45	15.17	0.00	90.18
	kg/hr	590.86	40.55	1120.45	1748.17	1397.40	277.34	0.00	1750.21
Temperature	deg F	272.2	87.7	109.3	307.0	88.6	85.7	72.8	
	deg C	133.4	30.9	43.0	152.8	31.4	29.8	22.7	
Pressure	psig	767.5	761.6	759.4	732.5	677.0	672.9	33.5	
	bara	53.93	53.53	53.37	51.52	47.69	47.41	3.32	

Reactor Heat Balance

		deg F	deg C			lb/hr	kg/hr		Btu/lb-deg F	J/gm-deg C		lb/ft3	kg/m3
Gas:													
Inlet Temp	TI-1-12A	440.8	227.1	Inlet Flow	RXT FEED	38.54	1748.2	Inlet Ht Cap.	0.529	2.213			
Outlet Temp	RXT AVG	497.7	258.7	Outlet Flow	RXT FEED-WAXPROD	3823	1734.0	Outlet Ht Cap.	0.474	1.984			
Oil:													
Inlet Temp	TI-1-14B	416.2	213.4	Inlet Flow	*FI-619	66004	29939.2	Inlet Ht Cap.	0.546	2.286	Inlet Density	51.70	828.12
Outlet Temp	TI-1780	462.6	239.2	Outlet Flow	*FI-619	66004	29939.2	Outlet Ht Cap.	0.566	2.370			
Slurry:													
Inlet Temp	TI-1783	461.8	238.8	Inlet Flow	*FI-1768-61	10834	4914.4	Inlet Ht Cap.	0.620	2.595			
Outlet Temp	RXT AVG	297.7	258.7	Outlet Flow	*FI-1768	10865	4928.5	Outlet Ht Cap.	0.620	2.595			
					*based on								

Reactor Differential Pressures

	DP NOZZLES		Differential Pressures: psi	mbar	Heights: ft (based on flange loc.)	meters	Density - 3 Phase: lb/ft3	kg/m3	Gas Hold-up vol%
Reactor Height:									
13.75 to 9.25 ft	Kl -K3	PDI-1778	0.88	60.4	4.56	1.391	27.66	443.1	44.63
9.25 ft to 4.33 ft	K3-K5	PDI-1779	0.99	67.9	5.08	1.549	27.91	447.1	44.10
Total Reactor	K6-OUT	PDI-631	0.76	52.3	20.82	6.346	4.82	77.1	92.41
Sparger	K6-IN	PDI-633	3.32	228.6					

DEGASSER

Temperatures:			deg F		deg C	
6.5 ft Height	TI-1762		343.7		173.2	
3.5 ft Height	TI-1763		313.5		156.4	
0.5 ft Height	TI-1764		494.1		256.7	
Liquid Level:						
% Level	LI-1765		-7.4			
Slurry Height		ft	-0.99	meters		-0.302

SLURRY PUMP

			deg F	**deg C**
Temperature:	Slurry Inlet	TI-1755	469.4	243.0
	Seal Oil Outlet	TI-1 795	107.9	42.2
			psig	**bara**
Pressure:	Seal Oil Outlet	PI-1794	749.6	52.70
			lb/hr	**kg/hr**
Flow Rate:	Slurry Outlet	FI-1768	10865.4	4928.7
			g/cc	
Density:	Slurry Outlet	DI-1768	0.812	

SLURRY COOLER

Temperatures:	deg F	deg C

Slurry Outlet	TIC-1754	464.2	240.1
Oil Inlet	TI-1780	462.6	239.2

FILTERS

			deg F	**deg C**				**lb/hr**	**kg/hr**
Temperature:	Slurry Outlet	TI-1783	461.8	238.8	Flow Rate:	Wax	FI-1761	31.191	14.148
			psig	**bara**				**g/cc**	
Pressure:	Slurry Inlet	PI-1756	729.2	51.29	Density:	Wax	DI-1761	0.67	
Diff. Press.:	Longitudinal		**psi**	**mbar**				**ft/sec**	**msec**
	Thru D & C	PDI-1772	9.7	667	Linear Vel.:	Slurry thru Each Element	Calculated	10.92	3.328
	Thru B & A	PDI-1773	0.3	20					
	rans-membrane							**ft/sec**	**msec**
	Membrane A	PDI-1774	-0.4	025	Superfic. Vel.:	Liquid Upflow thru Reactor	Calculated	0.024	7.246
	Membrane B	PDI-1775	0.0	63					
	Membrane C	PDI-1776	-1.0	-66					
	Membrane D	PDI-1777	-2.8	-190					

Reactor Temperatures

	Reactor Ht, Ft		**Deg F**	**Deg C**
Nozzle N1	24.25	TI-626-1	466.5	241.4
Nozzle N2	20.25	TI-626-2	495.8	257.7
Nozzle N3	18.25	TI-190-2A	495.7	257.6
Nozzle N4	16.25	TI-626-3	494.3	256.8
Nozzle N5	14.25	TI-190-3	494.9	256.7
Nozzle N7	10.25	TI-1781A	500.3	260.1
		TI-1781B	499.2	259.6
		TI-1781C	500.0	260.0
		TI-1781D	499.5	259.7
Nozzle N8	8.083	TI-626-5	493.5	256.4
Nozzle K4	7.75	TI-190-4	503.3	261.9
Nozzle O	4.792	TI-626-6	496.9	258.3
Reactor Temp. Avg. (Noz N3 thru Noz O)				497.7
	258.7			

Product Separation

			deg F	**deg C**
Temperatures	27.11 In	TI-1-08	-25.0	-31.7
	2138 Tube In	TI-723	446.4	230.2
	22.14 Out	TIC-725	309.9	154.4
	21.65 Out	TIC-1-11A	86.7	30.4
	27.13 Lt Wax	TI-744	97.6	36.4
	28.30 Hv Wax	TI-515	210.1	99.0
			%	
Levels	27.12	LIC-639	0.0	
	22.14	LIC-688	44.2	
	22.10	LIC-220	30.0	
	22.15	LIC-242	24.2	
	27.13	LI-203	-7.0	
	28.30	LI-1792	-0.6	
			psig	**bara**
Pressure	27.13	PIC-202	2.40	1.18

Miscellaneous Data

Overall Plant Material Balance		%	101.80
100*(22.10 Purge 22.11 Purge+Heavy Wax+Light Wax+Light HC+Water)/ (LP Fresh Feed+HP H2)			
Reactor GHSV	Nm3 Rxt Feed/m3 3-phase	slurry volume/hr	1794
Catalyst GHSV	Nm3 Rxt Feed/m3	particle volume/hr	14384
Catalyst Volume in the Reactor		litres particle volume	183.5
Inlet Superfic. Vel. based on Avg Reactor Temp.		cm/sec	12.47
Inlet Sup. Vel. based on Rxt Inlet Temp (TI-1-12A)		cm/sec	11.73
CO Conversion Rate, gmole CO converted AR particle volume/hr			72.17
grams of HC (CH2.1) produced/Ift particle volume/hr		1003.93	

N2 Balance Across Reactor	Plant N2 Balance	Feed N2 Balance
(vary prod gas flow factor-step1)	(vary purgel flow factor-step2)	(vary 01.20 discharge flow factor-step3)
99.99	100.03	99.99
		(Redundancy converges both to 100%)
Water/Oxygen Balance		**Prod. Gas N2 Balance**
		(vary 01.20 discharge flow factor-step3)
99.70		100.03

Wax/Liquid Production Rates

	lbs/hr	kg/hr
Heavy Wax (27.10/28.30, Reactor Temp. Cut)	31.19	14.15
Light Wax (22.14/27.13, 392 deg F Cut)	0.00	0.00
Light HCs (22.10/22.16, 100 deg F Cut)	264.76	120.09
Water (22.10/22.16, 100 deg F Cut)	509.62	231.16

Slurry Conc. Based on Density Measurements

2-Phase Slurry Concentration reduced	particle vol %	21.61
	catalyst wt%	24.54

Water Saturation Calculations for the Reactor

	Based on CO, CO2 Meas.:		Based on Water Production:	
	psia	**mbara**	**psia**	**mbara**
Calculated Water Partial Pressure @ Reactor Outlet	101.41	6992	101.15	6974
Saturated Water Pressure @ Reactor Outlet	668.2	46072	668.2	46072
Water Partial Pressure as % of Sat. Pressure @ Reactor Outlet	15.18%		15.14%	
	deg F	**deg C**	**deg F**	**deg C**
Saturated Water Temperature @ Reactor Outlet	328.6	164.8	328.4	164.6

RUN NO.: AF-R16.5C **TITLE: LIQUID PHASE FISCHER-TROPSCH (IV) SYNTHESIS IN LAPORTE AFDU**

Start Date / Time	04/13/1998	9.00
End Date / Time	04/14/1998	11.00

On-stream Time From Start-up (hr)	
Start	379.00
End	405.00

Reaction Conditions:					
Temperature	average	deg F	498.2	deg C	259.0
Pressure	PIC-201	psig	710.0	bara	49.96
Space Velocity		sL/kg-hr	17567		
Superficial Gas Vel. - Inlet		ft/sec	0.42	cm/sec	12.81
(based on average reactor temp)					
Recycle Ratio			1.15		

Slurry Data:				
Catalyst Oxide Wt (Reactor)	lbs	340	kg	154.2
Slurry Concentration by NDG	wt%	27.0		
Slurry Concentration by DP	wt%	25.7		
Slurry Level by NDG	% NDG Span	96.1		
Slurry Height	ft	20.70	meters	6.31
Average Gas Holdup by NDG	Vol%	52.9		
Average Gas Holdup by DP	Vol%	49.2		

Performance Results	
CO Conversion per pass, mole %	30.1
H2 Conversion per pass, mole %	52.2
CO + H2 Conversion per pass, mole %	43.0
Plant CO Conversion, mole%	68.7
Plant H2 Conversion, mole%	84.2
Plant CO+H2 Conversion, mole%	78.8
CO Conversion Rate,	
gmole CO converted/kg cat oxide-hr84.1	
HC Production Rate,	1172.0
grams of HC (CH2.1) produced/kg cat oxide-hr	
Reactor Productivity (STY)	123.57
grams of H C (CH2.1)/lit of reactor vol. - hr	
H2/CO in Fresh Feed, mole/mole	1.90
H2/CO in Reactor Feed, mole/mole	1.40
H2/CO Usage Ratio, mole/mole	2.43
H2/CO in Outlet, mole/mole	0.96
CO2 Selectivity, mole %	1.15
HC Selectivity (CO2 free) wt%:	
CH4	22.30
C2H6	3.54
C2H4	0.15
C3H8	4.07
C3H6	2.57
SUM C4H10	3.11
SUM C4H8	2.06
SUM C5H11	2.72

Reactor Heat Balance	**Btu/hr**	**kW**
Chemical Heat Production by Reaction	2014029	590.25
Sensible Gas Heat	-111837	-32.78
Sensible Oil Heat	-1611597	-472.31
Sensible Wax Heat	-205269	-60.16
Estimate of Heat Loss from Catalyst Drying Data	-60000	-14.65
% Heat Balance based on Reaction Heat	98.25	

Mass Balance	**Reactor lb/hr**	**Plant lb/hr**	**Feed lb/hr**	**Prod Gas lb/hr**
Fresh Feed		1299	1299	
HP H2 Feed		89	89	
Recycle Feed			2559	2559
Reactor Feed	3941		3941	
Total In	3941	1388		
Prod Gas	3185			3185
Main Purge		625		625
22.11 Purge	0.1	0.1		
HC Phase	255.8	255.8		
AQ Phase	492.4	492.4		
Heavy Wax	31.2	31.2		
Light Wax				
Total Out	3964	1405		
Mass Balance, %	100.6	101.2	99.8	100.0

RUN NO.: AF-R16.5C **TITLE: LIQUID PHASE FISCHER-TROPSCH (IV) SYNTHESIS IN LAPORTE AFDU**

Compositions (mole%):		**LP FRESH FEED**	**HP FRESH FEED (H2)**	**RECYCLE FEED**	**REACTOR FEED GAS**	**PRODUCT GAS**	**MAIN (22.10) PURGE**	**22.11 PURGE**	**REACTOR OUTLET (estimated)**
Components									
1	H2	44.10	100.00	36.13	49.97	36.13	36.13	11.70	30.91
2	N2	3.04	0.00	6.90	4.56	6.90	6.90	16.85	5.90
3	CO	52.86	0.00	37.63	35.59	37.63	37.63	22.81	32.19
4	CH4	0.00	0.00	13.52	6.80	13.52	13.52	19.60	11.57
5	CO2	0.00	0.00	0.94	0.50	0.94	0.94	3.32	0.80
6	ETHANE	0.00	0.00	1.38	0.73	1.38	1.38	4.95	1.18
7	ETHYLENE	0.00	0.00	0.03	0.01	0.03	0.03	0.08	0.02
8	PROPANE	0.00	0.00	1.06	0.56	1.06	1.06	6.06	0.91
9	PROPYLENE	0.00	0.00	0.69	0.36	0.69	0.69	3.80	0.59
10	ISOBUATNE	0.00	0.00	0.01	0.01	0.01	0.01	0.10	0.01
11	N-BUTANE	0.00	0.00	0.60	0.31	0.60	0.60	3.95	0.51
12	T-BUTENE-2	0.00	0.00	0.04	0.02	0.04	0.04	0.25	0.03
13	BUTENE-1	0.00	0.00	0.28	0.13	0.28	0.28	1.84	0.24
14	ISOBUTYLENE	0.00	0.00	0.04	0.04	0.04	0.04	0.27	0.03
15	C-BUTENE-2	0.00	0.00	0.05	0.03	0.05	0.05	0.34	0.04
16	SUM C5	0.00	0.00	0.46	0.24	0.46	0.46	2.86	0.39
17	SUM C6	0.00	0.00	0.18	0.10	0.18	0.18	1.01	0.15
18	SUM C7	0.00	0.00	0.04	0.03	0.04	0.04	0.17	0.03
19	SUM C8	0.00	0.00	0.03	0.01	0.03	0.03	0.01	0.02
20	SUM C9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
21	SUM C10	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00
	H2O								13.57
	HC								0.88
	LIGHT WAX								0.000
	TOTAL	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Mole Wt	lb/lb mole	16.55	2.02	18.10	14.80	18.10	18.10	28.70	19.18
Flows	SCFH	30340.69	17101.90	54684.69	102978.82	68044.68	13356.27	1.47	79541.69
	lb mole/hr	78.47	44.23	141.43	266.34	175.99	34.54	0.00	205.72
	lb/hr	1298.57	89.35	2559.34	3941.01	3184.61	625.10	0.11	3944.81
	Nm3/hr	798.45	450.06	1439.09	2710.01	1790.68	351.49	0.04	2093.24
	kgmoVhr	35.59	20.06	64.15	120.81	79.83	15.67	0.00	93.32
	kg/hr	589.03	40.53	1160.91	1787.63	1444.53	283.54	0.05	1789.35
Temperature	deg F	272.5	84.4	119.7	399.3	102.3	97.7	75.7	
	deg C	133.6	29.1	48.7	204.0	39.1	36.5	24.3	
Pressure	psig	772.2	791.8	765.3	734.3	632.4	627.9	33.8	
	bara	54.25	55.60	53.78	51.64	44.61	44.31	3.35	

Reactor Heat Balance

		deg F	deg C			lb/hr	kg/hr		Btu/lb-deg F	J/gm-deg C		lb/ft3	kg/m3
Gas:													
Inlet Temp	TI-1-12A	445.1	229.5	Inlet Flow	RXT FEED	3941	1787.6	Inlet Ht Cap.	0.534	2.235			
Outlet Temp	RXT AVG	498.2	259.0	Outlet Flow	RXT FEED-WAXPROD	3910	1773.5	Outlet Ht Cap.	0.480	2.007			
Oil:													
Inlet Temp	TI-1-14B	418.4	214.7	Inlet Flow	*FI-619	65812	29852.1	Inlet Ht Cap.	0.547	2.290	Inlet Density	51.64	827.11
Outlet Temp	TI-1780	464.4	240.2	Outlet Flow	*FI-619	65812	29852.1	Outlet Ht Cap.	0.567	2.374			
Slurry:													
Inlet Temp	TI-1783	467.1	241.7	Inlet Flow	*FI-1768-61	10647	4829.5	Inlet Ht Cap.	0.619	2.592			
Outlet Temp	RXT AVG	498.2	259.0	Outlet Flow	*FI-1768	10678	4843.6	Outlet Ht Cap.	0.619	2.592			
					*based on								

Reactor Differential Pressures

	DP NOZZLES		Differential Pressures: psi	mbar	Heights: ft	meters	Density - 3 Phase: lb/ft3	kg/m3	Gas Hold-up vol%
					(based on flange loc.)				
Reactor Height:									
13.75 to 9.25 ft	Kl -K3	PDI-1778	0.80	55.1	4.56	1.391	25.23	404.1	49.74
9.25 ft to 4.33 ft	K3-K5	PDI-1779	0.90	62.3	5.08	1.549	25.59	409.9	48.98
Total Reactor	K6-OUT	PDI-631	3.77	260.2	20.70	6.309	25.83	413.7	48.49
Sparger	K6-IN	PDI-633	1.33	92.0					

DEGASSER

Temperatures:			deg F		deg C	
6.5 ft Height	TI-1762		346.7		174.8	
3.5 ft Height	TI-1763		450.5		232.5	
0.5 ft Height	TI-1764		499.8		259.9	
Liquid Level:						
% Level	LI-1765		-7.4			
Slurry Height		ft	-1.11	meters		-0.340

SLURRY PUMP

			deg F	**deg C**
Temperature:	Slurry Inlet	TI-1755	474.2	245.7
	Seal Oil Outlet	TI-1 795	110.9	43.8
			psig	**bara**
Pressure:	Seal Oil Outlet	PI-1794	757.9	53.27
			lb/hr	**kg/hr**
Flow Rate:	Slurry Outlet	FI-1768	10678.2	4843.8
			g/cc	
Density:	Slurry Outlet	DI-1768	0.795	

SLURRY COOLER

Temperatures:		deg F	deg C
Slurry Outlet	TIC-1754	468.7	242.6

Oil Inlet	TI-1780	464.4	240.2

FILTERS

			deg F	**deg C**				**lb/hr**	**kg/hr**
Temperature:	Slurry Outlet	TI-1783	467.1	241.7	Flow Rate:	Wax	FI-1761	31.88	14.147
			psig	**bara**				**g/cc**	
Pressure:	Slurry Inlet	PI-1756	728.7	51.25	Density:	Wax	DI-1761	0.67	
Diff. Press.:	Longitudinal		**psi**	**mbar**				**ft/sec**	**msec**
	Thru D & C	PDI-1772	8.0	554	Linear Vel.:	Slurry thru	Calculated	10.95	3.338
	Thru B & A	PDI-1773	0.1	7		Each Element			
	rans-membrane							**ft/sec**	**msec**
	Membrane A	PDI-1774	-0.3	-18	Superfic. Vel.:	Liquid Upflow	Calculated	0.024	7.269
	Membrane B	PDI-1775	1.1	76		thru Reactor			
	Membrane C	PDI-1776	-1.0	-72					
	Membrane D	PDI-1777	0.2	11					

Reactor Temperatures

	Reactor Ht, Ft		**Deg F**	**Deg C**
Nozzle N1	24.25	TI-626-1	467.4	241.9
Nozzle N2	20.25	TI-626-2	499.5	259.7
Nozzle N3	18.25	TI-190-2A	497.1	258.4
Nozzle N4	16.25	TI-626-3	495.2	257.4
Nozzle N5	14.25	TI-190-3	494.0	256.6
Nozzle N7	10.25	TI-1781A	500.5	260.3
		TI-1781B	499.2	259.6
		TI-1781C	500.7	260.4
		TI-1781D	499.5	259.7
Nozzle N8	8.083	TI-626-5	495.6	257.6
Nozzle K4	7.75	TI-190-4	503.5	262.0
Nozzle O	4.792	TI-626-6	497.0	258.3
Reactor Temp. Avg. (Noz N3 thru Noz O)				498.2
	259.0			

Product Separation

			deg F	**deg C**
Temperatures	27.11 In	TI-1-08	-25.0	-31.7
	2138 Tube In	TI-723	469.2	242.9
	22.14 Out	TIC-725	290.0	143.3
	21.65 Out	TIC-1-11A	99.0	37.2
	27.13 Lt Wax	TI-744	97.6	36.5
	28.30 Hv Wax	TI-515	201.8	94.4
			%	
Levels	27.12	LIC-639	0.0	
	22.14	LIC-688	35.9	
	22.10	LIC-220	30.1	
	22.15	LIC-242	25.6	
	27.13	LI-203	-6.0	
	28.30	LI-1792	14.5	
			psig	**bara**
Pressure	27.13	PIC-202	0.49	1.05

Miscellaneous Data

Overall Plant Material Balance		%	101.20
100*(22.10 Purge 22.11 Purge+Heavy Wax+Light Wax+Light HC+Water)/ (LP Fresh Feed+HP H2)			
Reactor GHSV	Nm3 Rxt Feed/m3 3-phase	slurry volume/hr	1852
Catalyst GHSV	Nm3 Rxt Feed/m3	particle volume/hr	16197
Catalyst Volume in the Reactor		litres particle volume	167.3
Inlet Superfic. Vel. based on Avg Reactor Temp.		cm/sec	12.81
Inlet Sup. Vel. based on Rxt Inlet Temp (TI-1-12A)		cm/sec	12.10
CO Conversion Rate, gmole CO converted AR particle volume/hr			77.53
grams of HC (CH2.1) produced/Ift particle volume/hr		1080.62	

N2 Balance Across Reactor (vary prod gas flow factor-step1)	Plant N2 Balance (vary purgel flow factor-step2)	Feed N2 Balance (vary 01.20 discharge flow factor-step3)
99.98	99.98	100.02
		(Redundancy converges both to 100%)
Water/Oxygen Balance		**Prod. Gas N2 Balance** (vary 01.20 discharge flow factor-step3)
97.97		99.99

Wax/Liquid Production Rates

	lbs/hr	kg/hr
Heavy Wax (27.10/28.30, Reactor Temp. Cut)	31.19	14.15
Light Wax (22.14/27.13, 392 deg F Cut)	0.00	0.00
Light HCs (22.10/22.16, 100 deg F Cut)	255.80	116.03
Water (22.10/22.16, 100 deg F Cut)	492.38	223.34

Slurry Conc. Based on Density Measurements

2-Phase Slurry Concentration reduced	particle vol %
	catalyst wt%

Water Saturation Calculations for the Reactor

	Based on CO, CO2 Meas.:		Based on Water Production:	
	psia	**mbara**	**psia**	**mbara**
Calculated Water Partial Pressure @ Reactor Outlet	96.36	6644	94.67	6527
Saturated Water Pressure @ Reactor Outlet	671.7	46310	671.7	46310
Water Partial Pressure as % of Sat. Pressure @ Reactor Outlet	14.35%		14.09%	
	deg F	**deg C**	**deg F**	**deg C**
Saturated Water Temperature @ Reactor Outlet	324.9	162.7	323.6	162.0

	Compositions, wt%				Light HC Phase	
Carbon No.	1-Alcohols wt%	2-Olefins wt%	n-Paraffins wt%	1-Olefins wt%	iso-Parafins wt%	Total wt%
1						0.00
2						0.00
3	0.04	0.00	0.21	0.07	0.00	0.32
4	0.23	0.30	1.48	0.70	0.00	2.71
5	0.41	0.50	2.95	1.79	0.23	5.88
6	0.55	0.60	3.69	2.56	0.47	7.86
7	0.54	0.61	4.14	2.66	0.37	8.31
8	0.50	0.65	4.53	2.38	0.41	8.47
9	0.47	0.65	4.57	1.90	0.51	8.09
10	0.47	0.62	4.52	1.40	0.55	7.56
11	0.40	0.54	4.61	1.10	0.50	7.15
12	0.31	0.45	4.08	0.81	0.42	6.08
13	0.25	0.40	3.80	0.56	0.43	5.43
14	0.20	0.32	3.38	0.38	0.42	4.69
15	0.16	0.24	2.96	0.26	0.45	4.07
16	0.12	0.18	2.61	0.23	0.46	3.60
17	0.03	0.12	2.23	0.28	0.49	3.14
18	0.00	0.11	2.07	0.19	0.36	2.73
19	0.00	0.10	2.02	0.14	0.31	2.57
20	0.00	0.04	1.54	0.07	0.32	1.96
21			1.67			1.67
22			1.41			1.41
23			1.16			1.16
24			0.94			0.94
25			0.73			0.73
26			0.62			0.62
27			1.11			1.11
28			0.79			0.79
29			0.26			0.26
30			0.19			0.19
> 30			0.49			0.49
Total	4.67	6.41	64.74	17.48	6.68	99.98

Composition, Wt% Compound	Aqueous Phase
Ethanol	3.20
Water by diff.	96.80
Total	100.00

Composition, wt% Carbon No.	Reactor Wax
12	0.03
13	0.24
14	0.42
15	0.59
16	0.70
17	0.88
18	1.08
19	1.33
20	1.61
21	1.93
22	2.28
23	2.66
24	3.02
25	3.36
26	3.66
27	3.93
28	4.08
29	4.17
30	4.23
31	4.51
32	4.17
33	4.03
34	3.86
35	3.60
36	3.35
37	3.08
38	2.83
39	2.59
40	2.41
41	2.12
42	1.93
43	1.76
44	1.61
45	1.45
46	1.32
47	1.21
48	1.11
49	0.99
50	0.91
> 50	10.92
Total	100.00

RUN NO.: AF-R16.5C TITLE: LIQUID PHASE FISCHER-TROPSCH (IV) SYNTHESIS IN LAPORTE AFDU

Elemental Balance:

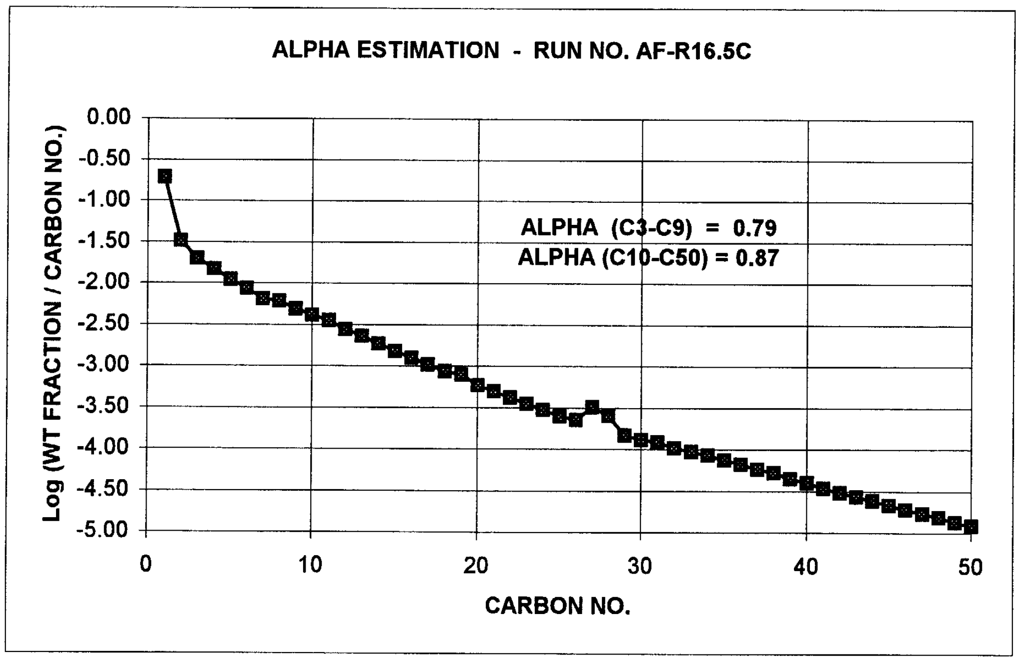
	Total lb/hr	C lb/hr	H lb/hr	O lb/hr	N lb/hr
Reactor Feed Gas	3941.28	1644.49	297.56	1558.91	340.32
Main Gas Outlet	3184.50	1439.11	292.98	1112.18	340.24
27.10 Reactor Wax	31.19	26.61	4.58	0.00	0.00
22.14 Light Wax	0.00	0.00	0.00	0.00	0.00
22.18 HC Phase	255.80	215.73	38.60	1.47	0.00
22.18 AQ Phase	492.38	8.21	55.01	429.16	0.00
Total Out	3963.87	1689.66	391.17	1542.80	340.24
% Balance	100.6	102.7	98.4	99.0	100.0

Product Distribution: Selectivity (wt%)

Methane (C1)	19.2
Gas (C2 - C4)	18.3
Gasoline (C5 - C11)	32.3
Diesel (C122 - C18)	16.3
Wax (C19+)	13.8
Total	100.0
HC Production Rate based on Liquid Data, grams HC produced/kg-cat oxide hr	1393.0

Alpha Estimate:

C3 - C9	1	0.79
C10-C50	2	0.87



APPENDIX F

Fischer-Tropsch IV Product Hydrocarbon Analysis

F-T IV Light HC Product Analysis

Sample ID (SSFI)	22.11-12	22.11-18	22.11-19	Drum
Date	4/7/1998 1:00	4/14/1998 11:00	4/15/1998 13:30	4/4/1998 8:30
Condition	16.3	16.6	16.7	16.1
Carbon No.	**%w**	**%w**	**%w**	**%w**
1	0.000	0.000	0.000	0.000
2	0.000	0.000	0.000	0.000
3	0.307	0.316	0.330	0.330
4	2.635	2.710	2.828	2.831
5	5.717	5.880	6.136	6.142
6	7.645	7.862	8.205	8.212
7	8.082	8.312	8.675	8.683
8	8.231	8.465	8.835	8.843
9	7.868	8.092	8.445	8.453
10	7.347	7.556	7.885	7.892
11	6.688	7.154	6.895	7.134
12	6.675	6.077	6.760	7.125
13	5.529	5.426	5.470	5.846
14	4.865	4.693	4.665	5.030
15	4.260	4.073	3.956	4.301
16	3.699	3.595	3.417	3.686
17	3.237	3.135	2.914	3.129
18	2.809	2.727	2.498	2.614
19	2.408	2.570	2.320	2.179
20	2.082	1.960	1.715	1.876
21	1.901	1.667	1.409	1.386
22	1.521	1.410	1.202	1.087
23	1.287	1.162	1.025	0.816
24	1.100	0.935	0.858	0.642
25	0.921	0.727	0.701	0.465
26	0.774	0.623	0.589	0.378
27	0.732	1.114	0.795	0.375
28	0.519	0.789	0.619	0.228
29	0.433	0.264	0.265	0.115
30	0.290	0.190	0.188	0.074
31	0.196	0.140	0.131	0.044
32	0.120	0.101	0.091	0.031
33	0.064	0.073	0.061	0.022
34	0.029	0.059	0.037	0.015
35	0.015	0.039	0.025	0.005
36	0.008	0.027	0.018	0.005
37	0.004	0.017	0.010	0.004
38	0.001	0.019	0.007	0.001
39	0.000	0.011	0.005	0.000
40	0.000	0.008	0.003	0.000

F-T IV Light HC Product Analysis						
Sample ID (SSFI)	Drum Sample					
Date	4/4/1998 8:30					
Condition	16.1					
(Olefins and alcohols content per carbon number by capillary GC)						
Assumption: all unidentified GC peaks are assumed iso-paraffins						
Type	**n-paraffins**	**iso-paraffins**	**1-alcohol**	**1 -olefin**	**2-olefin**	**total**
Carbon No.	**%w**	**%w**	**%w**	**%w**	**%w**	**%w**
3	65.8	0.0	13.2	21.1	0.0	100.0
4	54.7	0.0	8.3	26.0	11.0	100.0
5	50.2	3.9	7.0	30.5	8.5	100.0
6	46.9	5.9	6.9	32.6	7.6	100.0
7	49.8	4.5	6.5	32.0	7.3	100.0
8	53.5	4.9	5.9	28.1	7.6	100.0
9	56.5	6.3	5.8	23.4	8.1	100.0
10	59.8	7.3	6.3	18.5	8.2	100.0
11	64.5	7.0	5.6	15.4	7.6	100.0
12	67.2	6.9	5.1	13.4	7.4	100.0
13	70.0	7.8	4.5	10.3	7.3	100.0
14	71.9	8.9	4.3	8.1	6.7	100.0
15	72.6	11.1	4.0	6.5	5.8	100.0
16	72.6	12.7	3.3	6.3	5.1	100.0
17	71.0	15.5	0.8	8.8	3.9	100.0
18	75.9	13.0	0.0	7.0	4.0	100.0
19	78.5	12.0	0.0	5.6	4.0	100.0
20	78.3	16.1	0.0	3.7	1.8	100.0

F-T IV Product Wax Analysis
(Carbon distribution of wax samples by high temp. GC)

Sample ID (SSFI)	22.62-14	22.62-20	22.62-22	22.62-25	22.62-27	drum sample	start-up wax
Date	4/4/1998 23:15	4/8/1998 11:20	4/9/1998 20:30	4/11/1998 15:00	4/14/1998 2:15	4/4/1998 0:00	Callista
Condition	16.1	16.3	16.4	16.5	16.6	16.1	
Carbon No.	%w	%w	%w	%w	%w	%w	%w
11	0.000	0.000	0.000	0.000	0.000	0.000	0.000
12	0.195	0.093	0.218	0.027	0.220	0.023	0.000
13	0.348	0.215	0.208	0.242	0.199	0.339	0.000
14	0.613	0.264	0.368	0.424	0.388	0.511	0.009
15	0.652	0.329	0.481	0.594	0.402	0.749	0.018
16	1.030	0.412	0.542	0.705	0.585	0.931	0.017
17	1.229	0.505	0.676	0.880	0.740	1.183	0.015
18	1.535	0.620	0.845	1.084	0.912	1.486	0.019
19	1.896	0.765	1.051	1.326	1.121	1.842	0.025
20	2.305	0.921	1.290	1.606	1.370	2.245	0.034
21	2.753	1.117	1.559	1.928	1.666	2.666	0.057
22	3.213	1.347	1.847	2.284	2.015	3.244	0.112
23	3.667	1.616	2.143	2.656	2.408	3.564	0.220
24	4.070	1.923	2.446	3.020	2.831	3.932	0.422
25	4.404	2.283	2.744	3.357	3.292	4.290	0.764
26	4.668	2.835	3.076	3.660	4.248	4.693	1.320
27	4.894	3.744	3.451	3.934	6.982	4.920	2.130
28	4.876	3.876	3.718	4.084	6.189	4.866	3.384
29	4.703	3.966	3.957	4.175	4.402	4.489	4.453
30	4.531	4.328	4.219	4.231	4.353	4.350	5.743
31	4.331	4.609	4.396	4.511	4.294	4.122	6.795
32	4.165	5.136	4.411	4.174	4.238	3.915	7.564
33	3.824	4.821	4.389	4.033	4.695	3.713	7.996
34	3.522	4.790	4.630	3.863	4.828	3.440	8.095
35	3.209	4.502	4.094	3.602	3.843	3.130	7.775
36	2.935	4.232	3.867	3.351	3.241	2.830	7.255
37	2.708	3.920	3.736	3.078	2.941	2.618	6.445
38	2.445	3.640	3.281	2.833	2.680	2.384	5.633
39	2.203	3.404	3.002	2.592	2.461	2.175	4.739
40	2.033	2.939	2.761	2.413	2.288	2.001	3.892
41	1.840	2.809	2.478	2.124	2.007	1.831	3.126
42	1.685	2.546	2.227	1.925	1.801	1.666	2.501
43	1.512	2.234	2.055	1.764	1.634	1.523	1.948
44	1.382	2.071	1.835	1.614	1.451	1.402	1.528
45	1.244	1.856	1.651	1.448	1.324	1.275	1.175
46	1.111	1.636	1.470	1.320	1.214	1.166	0.914
47	1.005	1.498	1.305	1.210	1.064	1.054	0.701
48	0.900	1.339	1.149	1.109	0.977	0.960	0.550
49	0.795	1.183	1.045	0.988	0.877	0.882	0.435
50	0.715	1.061	0.915	0.913	0.790	0.792	0.342
51	0.629	0.943	0.819	0.814	0.706	0.723	0.284
52	0.551	0.846	0.733	0.742	0.642	0.660	0.226
53	0.485	0.741	0.644	0.679	0.565	0.593	0.187
54	0.426	0.659	0.580	0.612	0.519	0.529	0.155
55	0.369	0.595	0.506	0.558	0.459	0.477	0.126

F-T IV Product Wax Analysis
(Carbon distribution of wax samples by high temp. GC)

Sample ID (SSFI)	22.62-14	22.62-20	22.62-22	22.62-25	22.62-27	drum sample	start-up wax
Date	4/4/1998 23:15	4/8/1998 11:20	4/9/1998 20:30	4/11/1998 15:00	4/14/1998 2:15	4/4/1998 0:00	Callista
Condition	16.1	16.3	16.4	16.5	16.6	16.1	
Carbon No.	%w	%w	%w	%w	%w	%w	%w
56	0.328	0.516	0.476	0.528	0.413	.422	0.109
57	0.284	0.476	0.417	0.470	0.367	.383	0.097
58	0.246	0.396	0.387	0.438	0.330	0.334	0.079
59	0.215	0.373	0.356	0.422	0.293	0.304	0.079
60	0.186	0.330	0.329	0.398	0.260	0.266	0.058
61	0.163	0.297	0.298	0.366	0.246	0.240	0.051
62	0.140	0.257	0.293	0.370	0.212	0.215	0.046
63	0.123	0.239	0.280	0.347	0.194	0.189	0.040
64	0.106	0.210	0.269	0.333	0.175	0.168	0.034
65	0.090	0.187	0.263	0.319	0.159	0.150	0.036
66	0.077	0.173	0.257	0.324	0.147	0.134	0.030
67	0.068	0.151	0.267	0.301	0.128	0.118	0.025
68	0.056	0.135	0.260	0.291	0.118	0.105	0.024
69	0.046	0.122	0.251	0.268	0.106	0.094	0.024
70	0.036	0.111	0.257	0.260	0.093	0.084	0.020
71	0.030	0.098	0.259	0.214	0.088	0.073	0.017
72	0.023	0.091	0.237	0.208	0.078	0.068	0.017
73	0.016	0.078	0.239	0.192	0.073	0.061	0.014
74	0.015	0.073	0.225	0.174	0.062	0.050	0.013
75	0.014	0.063	0.170	0.155	0.058	0.047	0.011
76	0.013	0.059	0.226	0.140	0.052	0.042	0.011
77	0.011	0.051	0.143	0.129	0.046	0.037	0.009
78	0.010	0.045	0.140	0.110	0.047	0.031	0.008
79	0.009	0.041	0.125	0.094	0.036	0.029	0.007
80	0.010	0.035	0.125	0.088	0.041	0.026	0.006
81	0.009	0.036	0.101	0.082	0.036	0.024	0.005
82	0.008	0.029	0.084	0.070	0.029	0.020	0.004
83	0.007	0.026	0.074	0.068	0.026	0.019	0.003
84	0.006	0.019	0.058	0.052	0.024	0.015	0.003
85	0.005	0.021	0.056	0.049	0.023	0.014	0.001
86	0.004	0.020	0.050	0.048	0.023	0.011	0.002
87	0.004	0.014	0.041	0.037	0.020	0.009	0.001
88	0.004	0.014	0.034	0.034	0.017	0.008	0.001
89	0.004	0.011	0.029	0.031	0.017	0.005	0.001
90	0.003	0.009	0.023	0.024	0.017	0.005	0.000
91	0.003	0.009	0.022	0.019	0.016	0.004	0.000
92	0.002	0.005	0.016	0.017	0.014	0.004	0.000
93	0.001	0.003	0.010	0.012	0.015	0.002	0.000
94	0.010	0.002	0.006	0.010	0.011	0.002	0.000
95	0.007	0.001	0.004	0.008	0.011	0.002	0.000
96	0.000	0.001	0.001	0.005	0.008	0.001	0.000
97	0.000	0.000	0.000	0.005	0.005	0.001	0.000
98	0.000	0.000	0.001	0.002	0.004	0.001	0.000
99	0.000	0.000	.000	0.001	0.002	0.001	0.000
100	0.000	0.000	0.003	0.001	0.000	0.001	0.000

F-T IV Total Carbon Distributions I (Combined purge gas, light hydrocarbon-and wax in production ratio)				
Condition	**16.C**	**16.3D**	**16.4A**	**16.5C**
Light HC	**drum**	**22.11-12**	**22.11-12**	**22.11-18**
Wax	**22. 2-14**	**2.62-20**	**22.62-22**	**22.62-25**
Carbon No.	**%w**	**%w**	**%w**	**%w**
1	14.024	17.571	20.763	16.923
2	2.430	3.104	3.338	3.309
3	4.483	5.614	5.965	6.207
4	4.659	5.662	5.634	6.197
5	5.222	5.735	5.381	5.995
6	5.742	5.761	5.371	5.763
7	5.555	5.470	5.019	5.126
8	5.606	5.421	4.969	5.169
9	5.295	5.096	4.668	4.685
10	4.944	4.759	4.359	4.375
11	4.469	4.332	3.968	4.142
12	4.486	4.325	3.968	3.520
13	3.703	3.586	3.288	3.158
14	3.222	3.156	2.899	2.746
15	2.770	2.766	2.545	2.399
16	2.429	2.404	2.214	2.130
17	2.102	2.107	1.945	1.876
18	1.815	1.832	1.697	1.653
19	1.585	1.575	1.466	1.579
20	1.442	1.367	1.281	1.245
21	1.187	1.254	1.184	1.097
22	1.053	1.012	0.969	0.972
23	0.936	0.866	0.841	0.855
24	0.874	0.752	0.741	0.748
25	0.802	0.643	0.645	0.650
26	0.777	0.558	0.569	0.611
27	0.802	0.550	0.558	0.914
28	0.708	0.414	0.441	0.736
29	0.617	0.360	0.399	0.438
30	0.571	0.275	0.323	0.399
31	0.530	0.220	0.074	0.389
32	0.502	0.181	0.229	0.344
33	0.457	0.139	0.195	0.318
34	0.417	0.115	0.183	0.298
35	0.375	0.101	0.155	0.269
36	0.343	0.091	0.143	0.245
37	0.316	0.082	0.136	0.220
38	0.284	0.074	0.118	0.205
39	0.255	0.069	0.107	0.183
40	0.235	0.059	0.099	0.169

F-T IV Total Carbon Distributions I (Combined purge gas, light hydrocarbon-and wax in production ratio)				
Condition	**16.C**	**16.3D**	**16.4A**	**16.5C**
Light HC	**drum**	**22.11-12**	**22.11-12**	**22.11-18**
Wax	**22. 2-14**	**2.62-20**	**22.62-22**	**22.62-25**
Carbon No.	**%w**	**%w**	**%w**	**%w**
41	0.213	0.057	0.089	0.148
42	0.195	0.051	0.080	0.134
43	0.175	0.045	0.074	0.122
44	0.166	0.042	0.066	0.112
45	0.144	0.037	0.059	0.100
46	0.129	0.033	0.053	0.091
47	0.116	0.030	0.047	0.083
48	0.104	0.027	0.041	0.076
49	0.092	0.024	0.037	0.068
50	0.083	0.021	0.033	0.062
51	0.073	0.019	0.029	0.056
52	0.064	0.017	0.026	0.051
53	0.056	0.015	0.023	0.046
54	0.049	0.013	0.021	0.042
55	0.043	0.012	0.018	0.038
56	0.038	0.010	0.017	0.036
57	0.033	0.010	0.015	0.032
58	0.028	0.008	0.014	0.030
59	0.025	0.008	0.013	0.029
60	0.022	0.007	0.012	0.027
61	0.019	0.006	0.011	0.025
62	0.016	0.005	0.010	0.025
63	0.014	0.005	0.010	0.024
64	0.012	0.004	0.010	0.023
65	0.010	0.004	0.009	0.022
66	0.009	0.003	0.009	0.022
67	0.008	0.003	0.010	0.021
68	0.006	0.003	0.009	0.020
69	0.605	0.002	0.009	0.018
70	0.004	0.002	0.009	0.018
71	0.004	0.002	0.009	0.015
72	0.003	0.002	0.008	0.014
73	0.002	0.002	0.009	0.013
74	0.002	0.001	0.008	0.012
75	0.002	0.001	0.006	0.011
76	0.001	0.001	0.008	0.010
77	0.001	0.001	0.005	0.009
78	0.001	0.001	0.005	0.008
79	0.001	0.001	0.004	0.006
80	0.001	0.001	0.004	0.006

F-T IV Total Carbon Distributions I (Combined purge gas, light hydrocarbon-and wax in production ratio)				
Condition	**16.C**	**16.3D**	**16.4A**	**16.5C**
Light HC	**drum**	**22.11-12**	**22.11-12**	**22.11-18**
Wax	**22. 2-14**	**2.62-20**	**22.62-22**	**22.62-25**
Carbon No.	**%w**	**%w**	**%w**	**%w**
81	0.001	0.001	0.004	0.006
82	0.001	0.001	0.003	0.005
83	0.001	0.001	0.003	0.005
84	0.001	0.000	0.002	0.004
85	0.001	0.000	0.002	0.003
86	0.000	0.000	0.002	0.003
87	0.000	0.000	0.001	0.003
88	0.001	0.000	0.001	0.002
89	0.000	0.000	0.001	0.002
go	0.000	0000	0.001	0.002
91	0.000	0.000	0.001	0.001
92	0.000	0.000	0.001	0.001
93	0.000	0.000	0.001	0.001
94	0.001	0.000	0.000	0.001
95	0.001	0.000	0.000	0.001
96	0.000	0.000	0.000	0.000
97	0.000	0.000	0.000	0.000
98	0.000	0.000	0.000	0.000
99	0.000	0.000	0.000	0.000
100	0.000	0.000	0.000	0.000