Title

ANALYSIS OF FIELD PERFORMANCE DATA ON SHELL-AND-TUBE HEAT EXCHANGERS IN GEOTHERMAL SERVICE

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Analysis of Field-Performance Data on Shell-and-Tube Heat Exchangers in Geothermal Service

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DISCLAIMER

ABSTRACT

Analysis of field performance data from a binary cycle test loop using geothermal brine and a hydrocarbon working fluid is reported. Results include test loop operational problems, and shell-and-tube heat exchanger performance factors such as overall heat transfer coefficients, film coefficients, pinch points, and pressure drops.

Performance factors are for six primary heaters having brine in the tubes and hydrocarbon in the shells in counterflow, and for a condenser having cooling water in the tubes and hydrocarbon in the shell. Working fluids reported are isobutane, 90/10 isobutane/isopentane, and 80/20 isobutane/isopentane. Performance factors are for heating each working fluid at supercritical conditions in the vicinity of their critical pressure and temperature and condensing the same fluid.

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SECTION 1 - INTRODUCTION

A Rankine cycle using a secondary working fluid is ideally suited for converting the thermal energy of moderate-temperature hydrothermal-geothermal resources to electric power. A typical cycle configuration employs conventional shell-and-tube heat exchangers, a hydrocarbon working fluid, and supercritical working fluid conditions; yet performance data for such cycle configurations in actual geothermal service are scarce. Good performance data could form a basis for the design of a large pilot or commercial power plant. Consequently, a program to test and verify the performance of shell-and-tube heat exchangers in geothermal service was initiated.

The earlier portion of the program was a co-operative venture between the Electric Power Research Institute and the Lawrence Berkeley Laboratory (LBL). The results of that work are reported elsewhere.[1] The latter part of the program consists of three parts: Part I is the acquisition of heat exchanger performance data in the form of operating parameters, i.e., temperatures, pressures, flow rates, working fluid composition. Part II is the modeling of the data from Part I. Part III is a final report detailing the results of Part II and the experimental procedures. This report is the combination of Parts II and III, and as such serves as the program's final report. The results of Part I are reported elsewhere.[2]

To obtain the desired performance data, a test loop was constructed. The test loop was sited at the U. S. Department of Energy's Geothermal Test Facility (GTF) located at East Mesa in California's Imperial Valley. Figure 1-1 is a photo of the test loop layout.

Previous design studies[3,4] had indicated that a working fluid composed of isobutane and isopentane was the most promising for brine resource temperatures of ≈350°F. Consequently, the test program concentrated on three

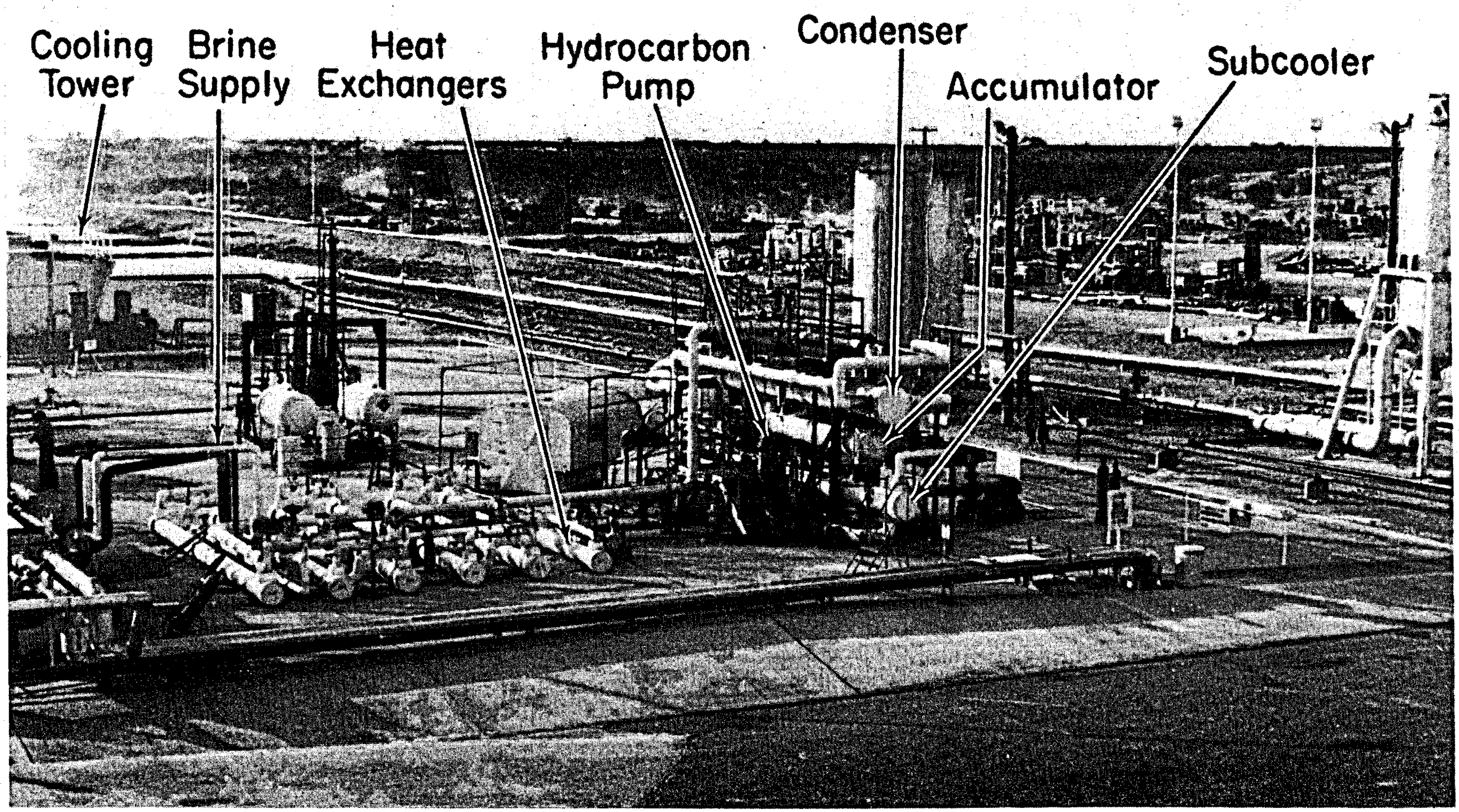

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Fig. 1-1 Supercritical Heat Exchange Test Loop different hydrocarbon compositions spanning the composition range of interest: commercial grade isobutane, 90/10 mole percent isobutane/isopentane, and 80/20 mole percent isobutane/isopentane. The program further incorporated test conditions (temperatures and pressures) proposed for a commerical installation. In effect, the test loop was built to mimic a 50 MW commerical system, only on a much smaller scale, while providing useful information on the geothermal binary process.

Supercritical Hydrocarbon Binary Process

The geothermal-binary⁺-power cycle involves heat exchange directly from a liquid geothermal brine to a hydrocarbon working fluid. In such a system, the brine is pumped from a well as a liquid through a series of heaters. If the heaters are shell-and-tube heat exchangers, the brine will usually pass through the tubes heating the hydrocarbon fluid flowing in the shell side. The hydrocarbon is pumped as a liquid at supercritical pressure to the cold heater and is heated by the brine as it passes through the heater train. At the exit of the heater train, the hydrocarbon has been heated beyond its critical temperature and leaves the train as a supercritical vapor.

The supercritical vapor drives a turbo-generator which extracts part of the energy imparted to the fluid by the brine. From the turbine exit the low pressure vapor is condensed in another shell-and-tube exchanger, giving up its latent heat to the atmosphere through a cooling tower. The fluid then passes to an accumulator where the cycle is complete. The hydrocarbon is recycled, allowing for the continuous extraction of energy from the brine and its conversion into electricity.

[+]In the geothermal industry, closed Rankine-cycle processes using a secondary working fluid are called binary cycles. Since the word binary is well entrenched in the geothermal literature, we embrace the terminology.

Unknown Areas in the Geothermal Binary Process

Although the binary cycle is conceptually simple, practical problems surround its implementation. These unknown areas fall into two broad catagories: those concerned with the design of the heat exchangers, and those concerned with the operation of the binary loop as a whole.

Primary Heat Exchangers

The unknown area in the design of the heat exchangers centers on the factors contributing to the accuracy of the design; i.e., for a set of conditions, the ability to predict the performance of the heaters within acceptable limits. The design of the primary heaters for the binary cycle represents a departure from the design of more conventional heat exchangers because the hydrocarbon is heated from a subcooled liquid to a supercritical vapor. (The prediction of the tube side (brine) performance is not suspect. Consequently, when we refer to "performance", we mean as dictated by the behavior of the hydrocarbon). At the cold end of the train the hydrocarbon is clearly a liquid whose thermodynamic and transport properties are predictable and which change nearly linearly with temperature. The hydrocarbon properties in the liquid region do not change dramatically throughout a temperature range and are not significantly dependent upon changes in the pressure and therefore the pressure drop. The liquid region is where conventionally accepted methods and correlations for heat transfer and pressure drop would be expected to apply with an acceptable level of accuracy. The current level of accuracy for predicting the surface area in the liquid region is approximately ± 15%.

As the hydrocarbon temperature increases, the hydrocarbon enters the "near-critical" region. The near-critical region lies above and to each side of the vapor-liquid dome, and extends out into the supercritical region astride the transposed critical line+ (TCL). In the near-critical region all the properties used in a heat transfer calculation, i.e., the heat capacity, thermal conductivity, viscosity, and density, show marked non-linear behavior as functions of temperature and pressure.

A practical consequence is that such design factors as the log-mean-temperature-difference can no longer be computed from an exchanger's terminal conditions since the temperature-pressure profile is nonlinear between the terminal conditions. One must then resort to a stepwise calculation along the exchanger. As a result, special design techniques are required, and an investigation of the validity of standard correlations as tested against actual performance is desireable.

The correlations required to properly analyze the heat exchanger performance include models for the thermodynamic properties of the fluids, their transport properties, the shell side pressure drop and the shell side heat transfer coefficient. In the analysis, each individual model becomes dependent upon the others. This integrated model then becomes the correlation to be tested.

The dependence of one model on another can be seen when the following points are considered. For a fixed exchanger geometry and mass flow rate:

1. The heat transfer coefficient is a function of the local fluid properties.

2. The local fluid properties are a function of the local temperature and pressure of the fluid.

3. The local temperature and pressure are functions of the amount of heat transferrred to the fluid and the pressure loss up to the point under consideration.

+The transposed critical line is the locus of points in the supercritical region where the heat capacity is a maximum.

4. The amount of heat transferred and the pressure loss are a function of the length traveled along the exchanger.

5. The length traveled along the exchanger is a function of the amount of heat transferred, i.e., the heat transfer coefficient.

The intent of the program was not to develop specific correlations but to select the standard forms of existing correlations for modeling the exchangers and to compare the modeling results with the observed performance.

Various parts of the integrated model adopted for this study are widely used by designers, the only exception might be the fluid property algorithms. Therefore, such comparisons provide a measure of the uncertainty a designer could expect for similar conditions.

The importance of understanding how the hydrocarbon behaves in the primary heaters can be viewed from the following prespective: The low level of fouling expected for candidate sites for geothermal binary power plants means the greater the effect of the individual film coefficients on the required surface area. In addition, the film coefficients for the brine side will likely be 50 to 100% higher than for the hydrocarbon. Thus, the film coefficient for the hydrocarbon is the major determining factor in fixing the required surface area. Therefore, correlations with reliable predictive ability for the hydrocarbon are important for a successful design.

Condenser

The other heat exchanger of interest is the condenser. To handle the hydrocarbon condenser loads envisioned for a commercial size plant requires a large device. Steam condenser technology is not applicable because the condensate volume change for the hydrocarbon is far smaller (about 30 to 1 compared to 3,000 to 1) than for steam. The result is a large volume of liquid that must be carried out of the tube bundle without flooding the bundle. Also, the condenser and its ability to condense the hydrocarbon at as low a temperature as possible is a major limiting factor on the overall power plant performance. Consequently, the test program included a series of tests to obtain performance data on the condenser that would be useful in the design of a commercial size unit.

Test Loop

The unknown areas concerning the binary cycle as a whole center on the fact that a complete binary loop had not heretofore been run in actual geothermal service, nor one the size of the test loop. Consequently, a goal was to observe and test the stability of the loop as a whole, particularly the hydrocarbon flow behavior when the heating was subcritical, supercritical, and when traversing from subcritical to supercritical conditions. The latter test is important in identifying potential problems for the startup of a commercial unit.

Another goal was to observe the performance of the other test loop equipment to help identify potential problem areas in design, reliability, and control.

SECTION 2 - EXPERIMENTAL

EQUIPMENT

The test loop was installed at the U.S. Department of Energy's Geothermal Test Facility (GTF) located on the East Mesa anomaly outside of Holtville, Imperial County, California. Construction of the test loop begin in March 1980 with testing in June 1980 through March 1981.

Brine for the test was provided by the GTF wells Mesa 8-1 and Mesa 6-2. Brine was pumped from the wells using a Reda downhole pump. Mesa 8-1 provided brine for the early testing, but the well temperatures proved too low. Consequently, the Reda pump was relocated to Mesa 6-2 which provided brine for the remainder of the testing. Located approximately 1/2 mile east of the test pad, Mesa 6-2 delivered brine to the pad at 350 psia at 340 to 345°F, with maximum flow of 220 gpm. Brine delivery lines to the pad were insulated.

A chemical profile of Mesa 6-2 is reported in Table 2-1. The brine is typical of East Mesa in that Mesa 6-2 has a low TDS and a high $CO_2(g)$ content making the brine a $CaCO_3(s)$ scaler. For this reason, the brine was pressurized well above its flash point from wellhead to final discharge. Also, brine exiting the test loop was maintained above 150°F to prevent fouling.

Test Loop:

The test loop is shown schematically in Figure 2-1. The unit consists of three fluid loops: brine, hydrocarbon, and cooling water. The three loops are interconnected through the primary brine/hydrocarbon heat exchanger train and condenser/subcooler train. The heat load is rejected to the atmosphere through a wet cooling tower. The high pressure (heater) portion of the hydrocarbon loop is separated from the low-pressure (condenser) portion by an expansion valve in lieu of a turbine.

Table 2-1

Chemical Profile of Well Mesa 6-2

pH	6.1 - 5.9
Conductivity	6000 - 5000 (μ mhos)
TDS	5000 - 4800 (ppm)
HCO_3^-	560 - 617
$CO_3^=$	0
Cl^-	2142 - 1778
SO_4	156 - 160
Silica	269 - 260
Na^+	1700 - 1650
K^+	150 - 120
Li^+	4
Ca^{++}	16 - 9
Fe	20.1 - 0.7
B	7

NOTES: Analysis preformed April 1977 by LBL at GTF site. Sample taken at wellhead at unflashed conditions. During test operations, TDS fell to ≈4000 ppm, and $CO_2(g)$ concentration increased.

SUPERCRITICAL HEAT EXCHANGE FIELD TEST (SHEFT)

TEST FACILITY SCHEMATIC DIAGRAM

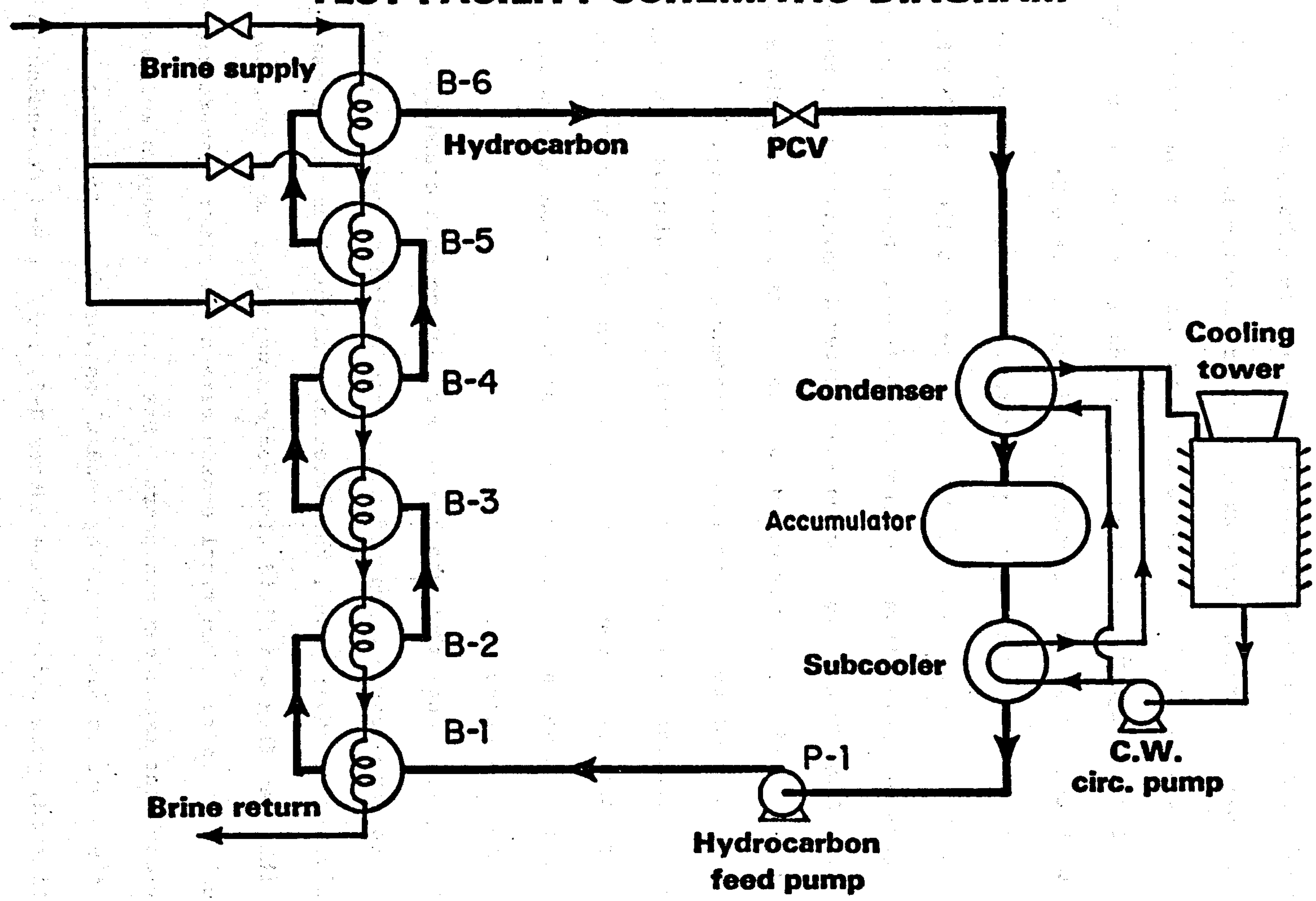

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Figure 2-1

The primary brine/hydrocarbon heat exchanger train consists of six exchangers, both sides in series, with brine in the tubes and hydrocarbon in the shells. The primary heat exchangers are labeled B-1 through B-6 in Figure 2-2 and 2-1. Table 2-2 lists the main features of the exchangers. Exchangers B-1 through B-5 are identical; exchanger B-6 has double-segmented baffles with all other specifications as listed in Table 2-2.

The final design of the primary heaters was a compromise between several factors. The hydrocarbon heating range spans 120°F to 320°F. The brine temperature falls from 340°F to 200 to 150°F. Because the brine exit temperature is below the hydrocarbon exit temperature, trying to complete the heating in a single heater would require a heater of unwieldly size. Several series connected exchangers were therefore necessary.

Next, to better explore the heat transfer and fluid flow behavior of the hydrocarbon required data points along the heating curve. The simplest solution was series connected exchangers with data stations located between exchangers.

Finally, to ensure that the heater performance data could be extrapolated with some degree of confidence to the design of units suitable for a commerical size power plant, the internal configuration was choosen so that the heat flux and fluid flow regimes were typical of proposed commerical size units. The final design came about after conversations with various heat exchanger designers. Six 24 ft. exchangers were necessary to span the 120°F to 320°F working conditions for the hydrocarbon.

Unflashed, pressurized brine enters B-6, B-5, or B-4 depending on the operation of the inlet valving. The exchangers B-4 through B-6 span the

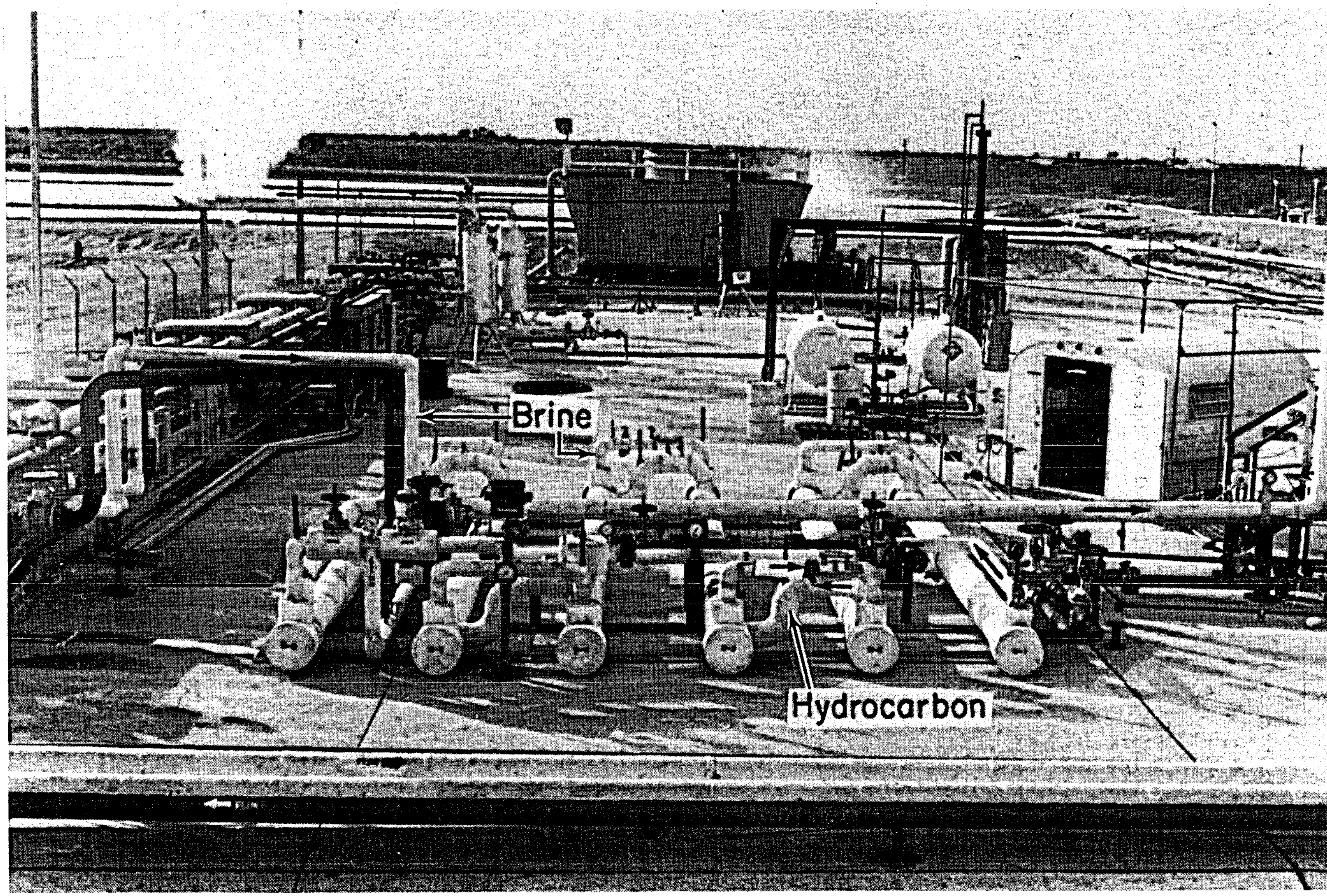

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Fig. 2-2 SHEFT Primary Heaters

Table 2-2. Primary heat exchanger details.

No. of tubes per exchanger: 62
No. of passes: 1 shell side, 1 tube side
Tube length: 24 ft
Tube size: 3/4 in O.D., 16 BWG.
Tube Material: carbon steel (SA-214)
Tube pitch: 15/16 in., triangular array
Shell I.D.: 8.625
Baffle spacing: 12 in.
Baffle cut: horizontal cut segmental baffles,
13/16 in. from center line
Area per exchanger: 292 ft^2
Number of exchangers: 6
Nominal dia. shell side nozzles: 6 in.
Nominal dia. tube side nozzles: 3 in.
TEMA type E shell

Exchangers: B-1 thru B-5
Flow orientation: 30°
Baffle cut: 13/16 in. from center line
Cross flow area: 20.3 sq. in.
Net window area: 11.8 sq. in.

Exchanger: B-6
Flow orientation: 60°
Vertical cut double segmental baffles
Center baffle cut: 2-11/32 in. from center line
Outer baffles cut: 1-13/32 in. from center line
Crossflow area: 20.3 sq. in.
Outer net window area: 10/6 sq. in.
Inner net window area: 9.9 sq. in.

near-critical region. The brine valving connecting these exchangers to the brine supply allows the temperature-pressure profile of the heating curve to be adjusted so that data may be more readily obtained throughout the near-critical region. Spent brine exits B-1 then flows to the GTF silencer were it was flashed to the atmosphere.

Superheated hydrocarbon exits B-6, flows through the pressure-reducing valve, then enters the condenser. The condenser is a two pass unit with vertical pass lanes and external valving that allows the tube bundle to be halved. Table 2-3 lists the main features of the condenser and Figure 2-3 shows the condenser/subcooler assembly. Cooling water for the condenser/ subcooler was supplied by the GTF cooling tower.

The condensed hydrocarbon is further cooled by the subcooler to about 120°F, then enters the hydrocarbon feed pump, P-1, where it is pressurized to supercritical pressure and discharged into B-1 to be heated upon passage to the exit of B-6.

Others features of the test loop include a hydrocarbon handling system, a hydrocarbon filtering loop, and a condenser cooling water recirculation loop. The hydrocarbon handling system consists of hydrocarbon storage tanks fitted to allow weighing to determine the amount of hydrocarbon added or removed from the system, high pressure pumps for adding or withdrawing hydrocarbon from the loop while it is operating, and the necessary valving. Figure 2-4 illustrates the arrangement.

The hydrocarbon filtering system consists of an inline filter in a slip-stream around pump P-1. The system can remove particulates down to 0.5 microns in size.

The condenser recirculation loop allows the cooling water flow through the condenser to be changed to alter the cooling water temperature profile.

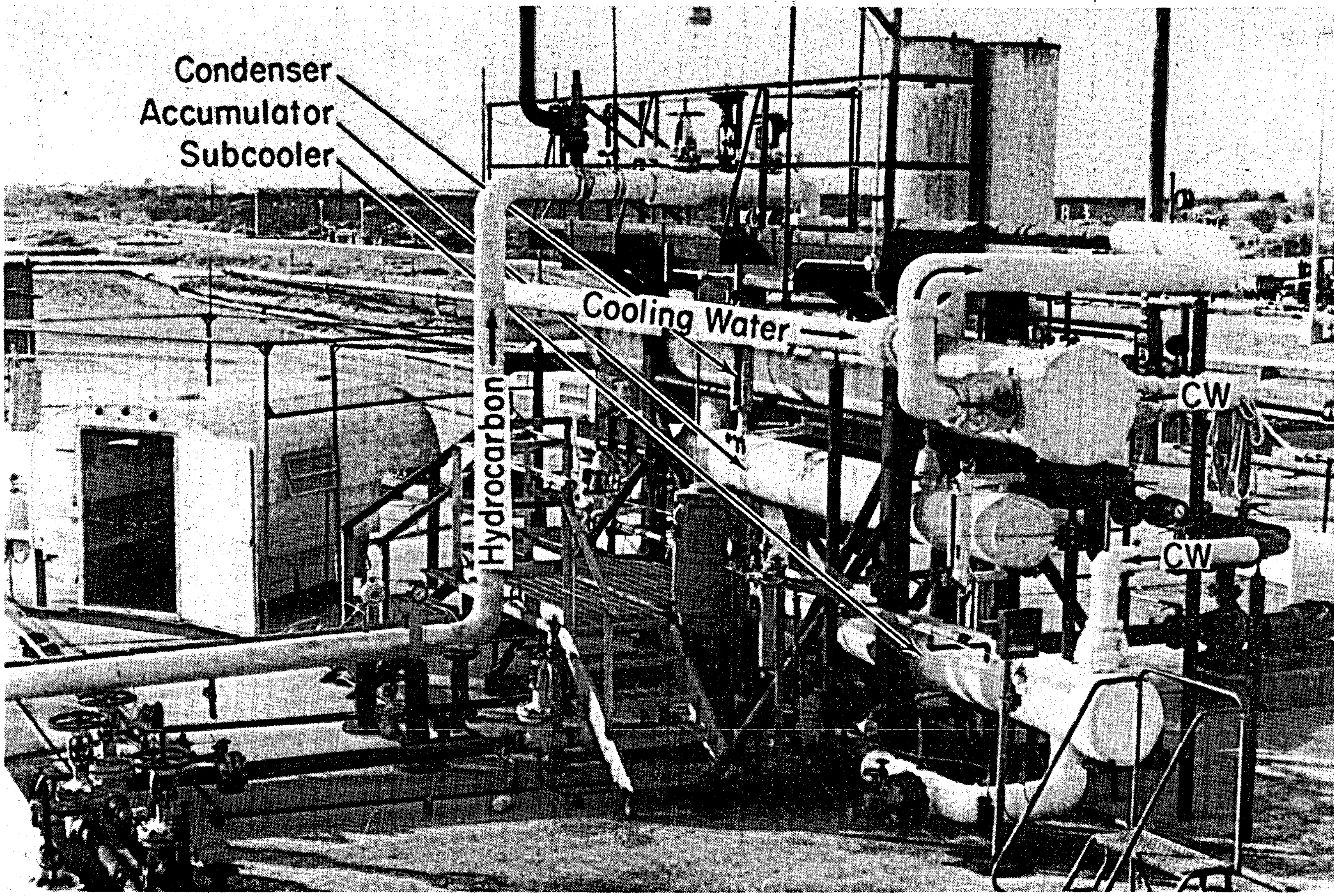

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Fig. 2-3 SHEFT Condenser/Subcooler

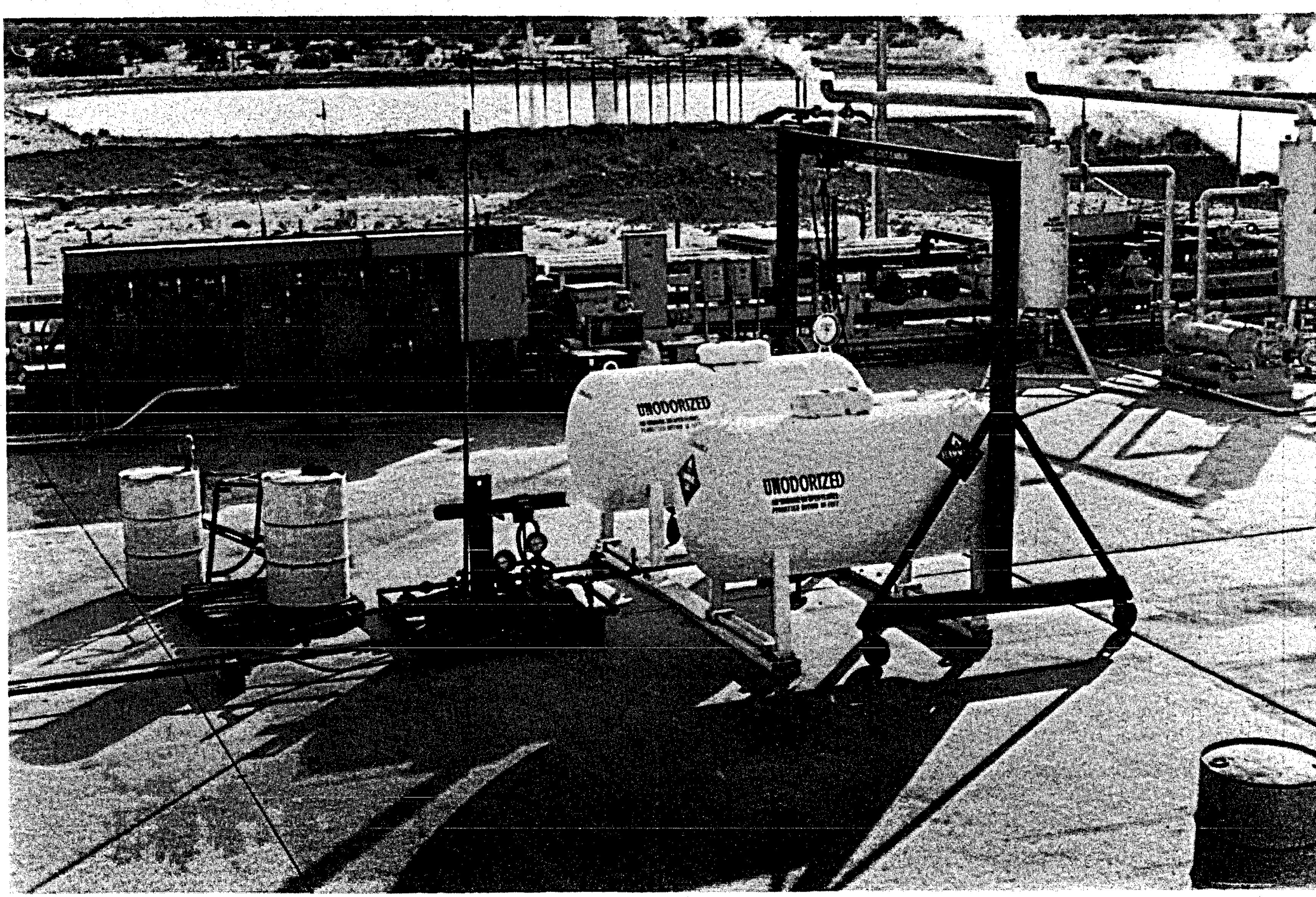

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Fig. 2-4 SHEFT Hydrocarbon Handling System

Table 2-3. Condenser details.

No. of tubes: 332
No. of passes: 1 shell side, 1 tube side[a]
Tube length: 24 ft
Tube size: 3/4 in O.D., 14 BWG.
Tube material: carbon steel (SA-214)
Tube pitch: 15/16 in., triangular array
shell I.D.: 22 in.
Baffles: Supports

[a]Side by side

All heat exchangers and interconnecting piping were constructed of carbon steel and were insulated.

The test loop was designed for a thermal heat load of 16 million BTU/hr., or about 1% of the thermal load for a 50 MW commerical installation. Table 2-4 lists the major design points for the test loop based upon isobutane as the working fluid.

Instruments:

Performance data on the heat exchangers consisted of temperatures, pressures, flow rates, and the hydrocarbon composition.

Temperatures:

Temperatures were recorded from mercury-in-glass thermometers. Thermometers were inserted into carbon steel thermowells having a minimum of 4 inch penetration depth. Thermowells were located where possible in regions of turbulent fluid flow, e.g., in elbows with the thermowell bottom pointing up-stream. Thermometer ranges were selected so that thermometers did not have to be withdrawn from the wells to be read. The thermometers were further enclosed in steel armour guards having a slit for viewing. Insulating sleeves were installed over the armoured guards. The net effect was to bring the entire thermometer to a uniform temperature and thereby reduce the thermometer temperature gradient to a point where stem corrections were unnecessary. The thermometers, depending on the range, were graduated in 0.1°F or 0.2°F increments.

Pressures:

Pressures were recorded on two types of Ashcroft precision gauges. Cooling water pressures were on individual gauges reading in psig. All other pressures were read from two Aschroft Digigauges reading in psia.

Table 2-4. Test Loop Design Points

Brine entrance temperature :	348°F
exit temperature :	150 to 200°F
Hydrocarbon entrance temperature:	120°F at 650 psia
exit temperature :	300°F at 600 psia
Condenser pressure :	245 psia
Hydrocarbon temperature :	197°F
Subcooler entrance temperature :	196°F
exit temperature :	105 to 110°F
Cooling water entrance temperature:	90°F
exit temperature :	120°F
Hydrocarbon flow rate:	84,000 lbs/hr
Brine flow rate :	98,300 lbs/hr
Heat load:	16 million BTU/hr
Hydrocarbon working fluid:	isobutane

Digigauges were factory calibrated and had an accuracy of 0.1% (0.1 psia). The remaining gauges were calibrated with a dead weight tester and had an accuracy of ±1.0 psi.

For the hydrocarbon and brine pressures, the pressure tap points were fed by individual fluid lines to valved manifolds at a central location. The manifolds were connected to the Digigauges, one gauge for the brine and one gauge for the hydrocarbon. Valving on the two gauges allowed them to be separately set to the prevailing atmospheric pressure. Output signals from each Digigauge were fed by separate coaxial cables to a central location where the signals were continuously monitored and recorded on a strip-chart.

Flow Rates:

Volumetric flow rates were measured by orifice plates, a venturi, and turbine flow meters. The brine flow was measured with a venturi and an orifice plate, the hydrocarbon flow was measured with an orifice plate and a turbine flow meter, and the cooling water flows were measured with turbine flow meters.

Orifice plates were supplied with factory calibration curves. The hydrocarbon orifice plate agreed with the turbine flow meter to within 1%. The brine orifice plate agreed with the venturi to within 1-2%.

The venturi was built by Flow-Dyne, and factory calibrated by Foxborough. Flows for the orifice plate and the venturi were indicated by differential pressure gauges located at each instrument (accuracy was ±0.1%).

The turbine flow meters were built by Flow-Technology. The units were constructed of stainless steel with ball bearings for the hydrocarbon meter, and tungsen-carbide bearings for the cooling water meters. The units employed magnetic pickups. Generated signals were fed by coaxial cable to a preamplifier, whose output was fed by coaxial cable to a central location for transcription to digital output in gpm. The hydrocarbon turbine flow meter output was also continuously monitored and recorded on a strip-chart.

Hydrocarbon Composition:

The methods of determining the hydrocarbon composition are detailed in the section on Operations.

Data Stations:

Temperatures, pressures, and flow rates were recorded at various data stations located throughout the test loop.

For the primary heaters, data station locations are: temperature of the tube side and the shell side fluids at the entrance and exit of each exchanger, shell side pressure at the entrance and exit of each exchanger, and tube side pressure at the entrance, midpoint, and exit of the heat exchanger train.

For the condenser-subcooler, data stations are temperature and pressure at the entrance and exit of each exchanger for both shell side and tube side.

Flow rate data stations are: venturi and orifice plate at the primary heat exchanger train exit for the tube side (brine), turbine flow meter and orifice plate at the primary heat exchanger train entrance for the shell side (hydrocarbon), and separate turbine flow meters for the cooling water at the entrance to the condenser and the subcooler.

Hydrocarbon sampling stations are the entrance and exit of the pump P-1 (hydrocarbon feed pump).

Data Taking:

Data was recorded by hand. Data scans covered all data stations. Three data takers were used, one for the primary heaters, one for the condenser/subcooler, and one for the pressures and flow rates. Data scans were every fifteen minutes during a test run. Six to eight data scans were taken per test run. After each data scan, the data was processed by the on-site computer. The computed heat balances were used to indicate whether or not the test data was acceptable. Test data was taken during daylight hours only. During the evening, the test loop was still operated, usually at the next test run conditions or the last completed test conditions.

OPERATIONS

Hydrocarbon Loop Cleaning:

An underlying assumption for the analysis of the heat exchanger and condenser data was that the shell side (hydrocarbon) fouling resistance was negilible (i.e., zero). To establish this condition required that the hydrocarbon loop be throughly cleaned prior to testing, and maintained in a clean state throughout the testing. This meant the shell side of the tubes had to be cleaned to a state free of scale, rust, and sludge.

The heaters and condenser/subcooler arrived at the site in a sorry condition. Large deposits of iron oxide were discovered in the exchanger shells. Cleaning of the shells was deferred until after the exchangers were placed and the interconnecting piping installed.

The only practical way to clean the shell side was chemically. The first attempts at cleaning the shells failed, not because the cleaning solution was lacking, but because the amount of rust and sludge exceeded the carry capacity of the cleaning solution. A decision was made to loosen and remove mechanically as much of the rust and sludge as possible before attempting another chemical cleaning. This was accomplished by vibrating the shell exteriors with a pneumatic hammer while the loop was flushed with water fed from a high-flow diesel-driven irrigation pump. Finally the loop was flushed with an emulsifying agent to wash out the last of the sludge. Thus prepared, the loop was chemically cleaned by recirculating through the loop a 5% HCl solution, with addition of ammonium biflouride to the HCl solution followed by further recirculation. After the shell side was determined to be clean by visual inspection of the shell interiors and interconnecting piping, the solution was dumped. To prevent the clean surfaces from oxidizing, they were treated with ammonium citrate solution which polishes the surfaces and inhibits oxidization. The loop was given a final rinse with a dilute inhibitor solution. The loop had been designed so that those pipe runs that would trap water had low point drains, or could be removed, flushed, and dried. The solution was drained and the loop dried by passing oil-free air through the primary heat exchanger shells with hot brine running through the tubes, and discharging the water-air mixture out the subcooler outlet. After several hours the loop was "bone-dry" as indicated by moisture sampling of the exiting air.

The pump pit for the hydrocarbon feed pump, P-1, was similarly cleaned prior to the testing. The pump was removed from the pump barrel for this operation. A dip tube was installed in the pit to aid in removing any water or sludge that might accumulate in the pump barrel during operation of the loop. No water or sludge was ever detected.

The resulting clean and dry system remained as such throughout the duration of the testing as verified by periodic visual inspections and analysis of the hydrocarbon. Figure 2-5 illustrates the clean condition of a section of the hydrocarbon loop.

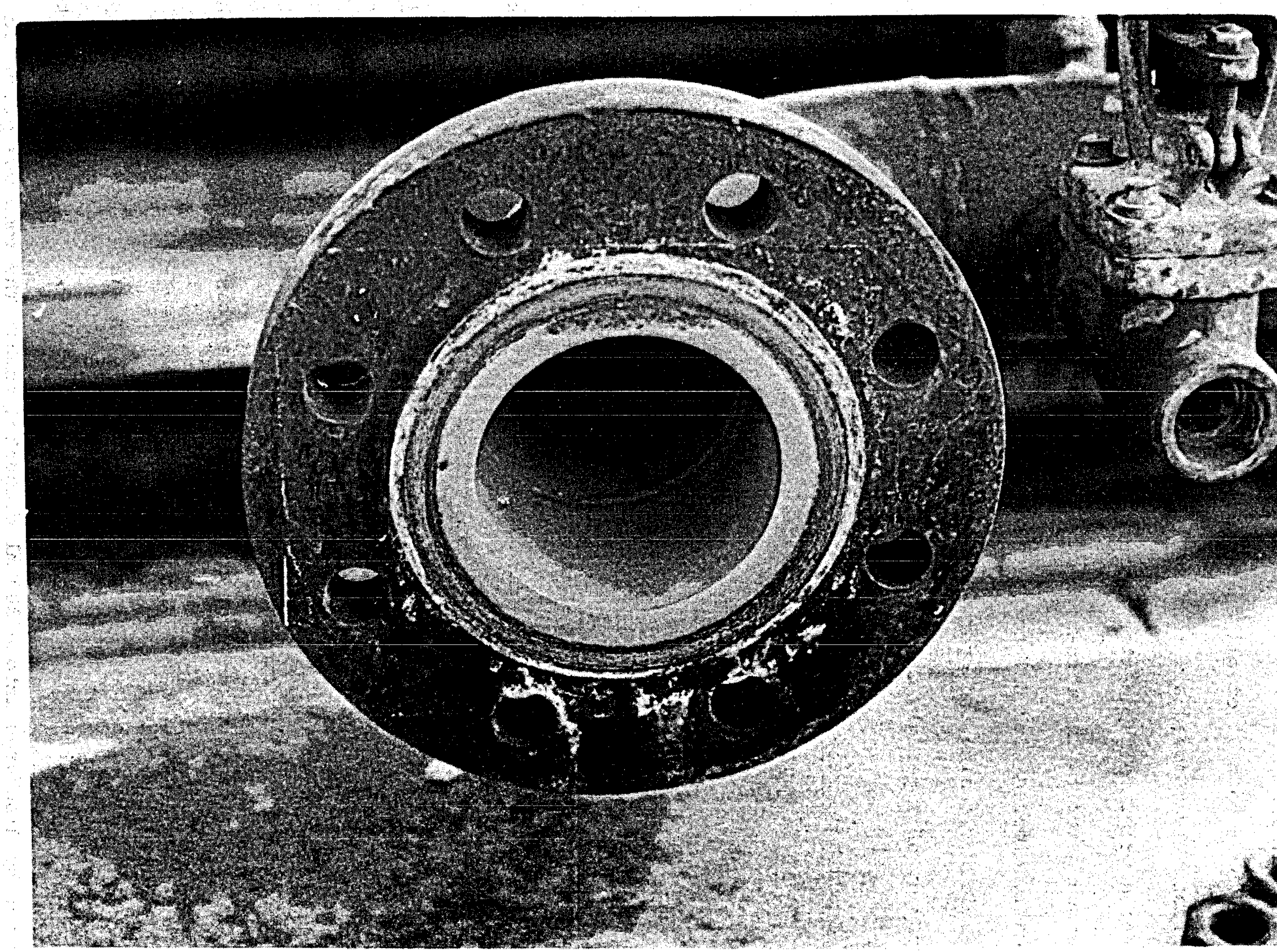

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Fig. 2-5 Section of Cleaned Test Loop

Tube Side Cleaning:

The tube side of all exchangers was cleaned by hydrolancing which effectively removed all rust and scale. The primary heater tubes were lanced prior to the heater tests. The condenser-subcooler tubes were lanced prior to the condenser tests. The cooling water piping was chemically cleaned with HCl to reduce the problem of metal flaking. All chemical cleaning and hydrolancing was performed by Southwest Chemical Company of Imperial, California.

Hydrocarbon Filtering:

The chemical cleaning left a thin, fine, gray colored film on the metal surfaces. This deposit was swept-up by the flowing hydrocarbon. To prevent the particulate matter from damaging the hydrocarbon turbine flow meter, or the seals on the hydrocarbon recirculation pump, a filter system was installed in a slip stream around the recirculation pump.

The filtering was effective and eventually discontinued when the one micron filters showed no visible fouling. This occurred after 200 hours of running. No pump seal problems, nor any failure of the hydrocarbon turbine flow meter were experienced.

Hydrocarbon Sampling and Analysis:

Hydrocarbon samples were taken on a regular basis and analyzed for hydrocarbon composition and water content. Analysis was performed on site by LBL personnel the same day of the sampling. Analysis was by gas chromatograph.

Four milliliter (ml) liquid samples were taken, then fully flashed to vapor by discharge into a 300 ml evacuated bomb. The bomb was placed in a thermostat held at 50 ± 1°C. Tubing wound with heat tape connected the bomb through appropriate valving to the gas-sampling injection-valve of the chromatograph. Gas samples could thus be injected into the chromatograph for analysis. All tubing, valving and bombs were of stainless steel.

The isobutane and isopentane as received were analyzed and the results checked against the manufacturer's supplied analysis. The results were in excellent agreement.

Cooling Water Treatment:

Scaling of the condenser/subcooler was a perennial problem. The condenser was designed to operate at high condensing pressures (≈245 psia), and high condensing temperatures (≈200°F). This was done to reduce the head requirements of the hydrocarbon recirculation pump. Since the higher condensing pressure means a higher condensing temperature, a smaller condenser could be built for the original heat load. However, this resulted in high tube wall temperatures and concomitantly a larger temperature rise (≈30°F) in the coooling water than is common practice (≈10-15°F). These factors exacerbated the fouling problem since most chemical treatments are designed for cooler water temperatures. In addition the makeup water had a TDS of 1400. As a result, the cooling water treatment was never really completely brought under control.

The selected treatment was to maintain the phosphate levels by addition of phosphinates, and control the pH at 7 by addition of sulfuric acid. Addition of the latter was controlled by continuous pH monitor/controller, and the former by a TDS controller set at 2000 TDS.

Instrument Performance:

No problems arose with the data acquisition instrumentation which performed faultlessly throughout the tests.

Performance of the process instrumentation was likewise faultless. Controllers performed equally well in manual or automatic mode once each controller was properly adjusted. No mechanical aids were required to trim the controllers.

Operating Plan:

The test plan for obtaining the performance data consisted of a series of separate runs for the primary heaters and the condenser. These series of tests were repeated for the three different hydrocarbon fluid compositions. Table 2-5 summarizes the test sequence adopted for the primary heaters. The idea was simply to run at a variety of exit conditions that span the region of commercial interest.

After completing the heater tests for a given hydrocarbon working fluid, the condenser tests were run. Table 2-6 summarizes the adopted condenser test sequence. The idea was to span a variety of tube loading conditions. The proposed conditions, though generally outside the range of commercial interest, are nonetheless important indicators of performance, especially as regards condensation of the hydrocarbon mixtures.

Once the test loop was cleaned and the operation of the equipment verified, approximately 3450 lbs of isobutane was loaded into the loop and the testing begun. As with most experiments, mother nature had her say. Events did not proceed as planned. Table 2-7 lists the significant events.

Because the GTF at the time of the experiment was hosting other experiments, and Mesa 6-2 was the only pumped well available, the test loop was allocated test time in two week blocks. Consequently, the time lapses in Table 2-7 are either for nonallocated time or from a downhole pump failure, two of which occurred during the test program.

Table 2-5

Heat Exchanger Test Sequence

Run #	m_{Hc} (%max)	T_{B-1} (°F)	P_{B-6} (psia)	T_{B-6} (°F)	$P_{cond.}$ (psia)
1*+	100	120	600	300	245
2	80	120	600		245
3	60	120	600		245
4	40	120	600		245
5*	100	120	600	300	245
6++	100	120	575	300	245
7	80	120	575		245
8	60	120	575		245
9	40	120	575		245
10*	100	120	575	300	245
11+++	100	120	550	300	245
12	80	120	550		245
13	60	120	550		245
14	40	120	550		245
15*	100	120	550	300	245

m_{Hc} = mass flow rate of hydrocarbon
T_{B-1} = temperature of hydrocarbon entering B-1
P_{B-6} = pressure of hydrocarbon exiting B-6
T_{B-6} = temperature of hydrocarbon exiting B-6
$P_{cond.}$ = pressure of hydrocarbon in the condenser
* = all state-points and flow-rates are the same as in Run 1
+ = brine flow-rate fixed Runs 1 thru 5
++ = brine flow-rate fixed Runs 6 thru 9
(not necessarily equal to brine flow rate in Run 1)
+++ = brine flow-rate fixed Runs 11 thru 14

Table 2-6

<u>Condenser Test Sequence</u>

Run #	m_{HC} (%max)	T_{B-1} (°F)	$P_{cond.}$ (psia)
1*+	100	120	245
2	80	120	
3	60	120	
4	40	120	
5*	100	120	
6	100	120	180
7	80	120	
8	60	120	
9	40	120	
10*	100	120	
11+++	100	120	Lowest possible $P_{cond.}$
12	80	120	" " "
13	60	120	" " "
14	40	120	" " "
15*	100	120	245
16*	100	120	245 (half bundle)

m_{HC} = mass flow rate of hydrocarbon
T_{B-1} = temperature of hydrocarbon entering B-1
$P_{cond.}$ = pressure of hydrocarbon in the condenser
* = all state-points and flow-rates are the same as in Run 1
\+ = brine flow-rate fixed Runs 1 thru 4
++ = brine flow-rate fixed Runs 7 thru 9
+++ = brine flow rate fixed Runs 12 thru 14

Table 2-7

Test Loop Events

4-Aug-80	System filled with isobutane, shake-down tests begin
14-Oct-80	Isobutane heater tests begin
20-Oct-80	Isobutane heater tests end, run time, ≈181 hrs.
22-Oct-80	Leaks in condenser/subcooler
14-Nov-80	Isobutane condenser tests begin
17-Nov-80	90/10 heater tests begin
21-Nov-80	90/10 condenser tests begin
23-Nov-80	80/20 heater tests begin
1-Dec-80	80/20 condenser test begin
3-Dec-80	Complete 80/20 testing, run time: ≈336 hrs.
21-Mar-81	Start isobutane condenser tests
29-Mar-81	Complete 90/10, and 80/20 condenser tests, run time: ≈198 hrs.

Total test loop run time during testing: ≈715 hrs.

The testing from 14 October 1980 through 3 December 1981 proceeded almost as planned. Close analysis of the condenser data, however, revealed unexplained deviations in the heat balance. The fluid properties were initially thought to be at fault, but the real culprit was vapor carry over into the subcooler caused by vortexing at the accumulator drain.

The vortexing arose from the accumulator being undersized, and the discharge from the hydrocarbon feed pump bypass entering the subcooler inlet in such a way as to act as an ejector helping to create and maintain the vortex.

These problems were corrected by relocating the pump bypass to the pump inlet and installing a view port in the pipe connecting the accumulator to the subcooler. By viewing the on-set of vapor carryover, we could readily set the maximum allowable hydrocarbon fluid flow, i.e., tube loading, for a given condenser pressure and inlet temperature. These modifications were in place for the final condenser tests and all went smoothly.

With the completion of the condenser tests in March 1981, the field test program concluded.

Unusual Operating Characteristics and Problems:

This section details the problems encountered during the operation of the test loop. Solutions employed are also discussed.

Leaks:

Before cleaning the hydrocarbon loop, a hydrotest was performed. The test pressure was held for twenty four hours. This approach was adopted because the viscosity of the hydrocarbon differed significantly from that of water, and consequently evidence of a leak took longer to appear with water than with the hydrocarbon. No leaks were discovered.

After cleaning, but before the final rinse solution was discarded, the hydrotest was repeated to insure that the cleaning had not created new leaks. None were found.

After completing the isobutane heater tests, the condenser/subcooler end plates were removed for hydrolancing. Several leaks were evident. The heater ends were then removed and the tube sheets checked. Several leaks among the six exchangers were found. All leaks were fixed by heli-arc welding. They included no leaks in B-1, one in B-2 which required plugging, three in B-3, one in B-4, two in B-5, and two in B-6. Thereafter, leaks in the primary heaters were not a serious problem.

The condenser and subcooler continued to leak off and on throughout the course of the testing. By the conclusion of testing, the subcooler had 43 leaks repaired at the cold end, with two tubes requiring plugs, and 24 at the hot end with two tubes requiring plugs. The condenser faired better, requiring six repairs with two plugs in the cold end and four repairs with no plugs in the return water box. Without exception, all leaks in the heaters, condenser, and subcooler were weld failures at the tube-sheet/tube joint. Inspection of the weld failures revealed gas pockets and debris in the welds.

The weld failures appear to be from faulty welds or induced by stress from thermal cycling. The heaters had shell side bellows to compensate for thermal expansion of the tubes and the shell. The bellows worked fautlessly with no leakage. The condenser and subcooler had no provision for thermal expansion. During testing, the condenser and subcooler experienced numerous temperature cycles from ambient to operating conditions which no doubt contributed to the weld failures.

None of the leaks were of such a magnitude as the effect the data. The test loop was operated with the hydrocarbon side the highest pressure, so that hydrocarbon leakage was presumed into the brine or cooling water.

Cleaning:

As mentioned above, the cleaning method adopted for the hydrocarbon loop worked quite well and produced excellent results. The hydrolancing of the tubes was effective, simple, and quick.

The tube side (brine) of the heaters was hydrolanced only once, just prior to the start of the isobutane tests, because visual inspection of the tubes indicated little or no fouling, making recleaning unnecessary.

The condenser tubes were hydrolanced prior to the start of the isobutane tests, but not prior to the 90/10 or 80/20 test runs, because it was felt the tests could be completed before serious fouling occurred. This point is discussed further in the section on the condenser test results.

Subcritical/Supercritical Behavior:

No system problems or imbalances were encountered when heating the hydrocarbon at subcritical conditions as occurred during the condenser tests, or when running supercritical, even at 550 psia exit pressure which is 5% above the critical point of isobutane and 4% above the 80/20 mixture critical point. No problems were encountered when transferring from either mode of heating.

SECTION 3 - TEST RESULTS

TEST RESULTS, HEATERS

Hydrocarbon Composition:

Hydrocarbons were from industrial suppliers in commercial grades used primarily as aerosol propellants. Mixtures were made at the test site by blending isobutane and isopentane. The resulting compositions were called "nominal" to indicate the mixtures that would result had pure isobutane and pure isopentane been mixed rather than their commercial grades. For example, a nominal 90/10 mixture was made by mixing 0.9 moles of commercial grade isobutane with 0.1 moles of commercial grade isopentane.

The mixtures were made by adding a known weight of isopentane to the isobutane circulating in the test loop. The resulting mixture was sampled and analyzed. When the composition did not change with time, the fluid mixture was assumed to be homogeneous. Homogeneity was usually obtained within several hours of introduction of the isopentane.

The as-received isobutane and isopentane were analyzed. The results agreed within 1% of the manufacturer's supplied analysis. Consequently, the commercial grade isobutane and isopentane were used as standards for the mixture analysis. The analysis for the primary heater mixtures are reported in Table 3-1. Those for the condenser are reported in the section on the condenser results. All entries in Table 3-1 are in mole percent. The listed compositions were used for the heater data analysis. Reported averages for the listed compositions are the result of 5 to 6 samples for each test fluid taken during the course of the testing (usually a daily sampling).

Data Analysis, Heaters:

As mentioned earlier, the intent of the program was not to develop new correlations but rather to use widely accepted correlations to predict

Table 3-1

Hydrocarbon Compositions for the Primary Heater Tests

Commercial Isobutane

Component	Mole %
Propane	0.60
n-Butane	2.56
i-Butane	96.84

Nominal 90/10 Isobutane/Isopentane

Component	Mole %
Propane	0.54 ± 0.00
n-Butane	2.30 ± 0.01
i-Butane	86.97 ± 0.19
n-Pentane	0.48 ± 0.01
i-Pentane	9.71 ± 0.19

Nominal 80/20 Isobutane/Isopentane

Component	Mole %
Propane	0.47 ± 0.00
n-Butane	2.00 ± 0.02
i-Butane	75.77 ± 0.16
n-Pentane	1.02 ± 0.04
i-Pentane	20.74 ± 0.16

the performance of the heat exchangers. Consequently, we now present the basic equations used in the data reduction without derivation or apology for their source. A certain familiarity of the reader with the equations is assumed. The nomenclature used in the following equations is listed in Table 3-2.

<u>Data Reduction - Primary Heaters, the Basic Equations:</u>

Heat Transfer:

The analysis of the energy transferred as heat within a heat exchanger begins with

$$Q = U \cdot A \cdot \Delta T_m \tag{3-1}$$

where Q is the duty, U is the overall heat transfer coefficient, A is the area perpendicular to the heat flux, and ΔT_m is the mean temperature difference in the direction of the heat flux.

For a shell-and-tube heat exchanger where the heat capacity at constant pressure, C_p, is constant for <u>both</u> fluids, and U is a constant, equation (3-1) may be rewritten as

$$Q = U \cdot A \cdot LMTD \tag{3-2}$$

where LMTD is the log-mean-temperature-difference,

$$LMTD = (T_a - T_b)/\ell n(T_a/T_b) \tag{3-3}$$

where for our case,

$$T_a = T_{Br,in} - T_{Hc,out} \tag{3-3a}$$

$$T_b = T_{Br,out} - T_{Hc,in} \tag{3-3b}$$

The overall heat transfer coefficient may be treated as a series of connected thermal resistances, i.e.,

Table 3-2

NOMENCLATURE

A	- Surface area, ft^2
C_p	- Heat capacity, Btu/lb_m-°F
d	- Diameter, ft.
f	- Friction factor, dimensionless
g	- Acceleration of gravity, ft/sec^2
G	- Mass velocity, $lb_m/hr-ft^2$
h	- Heat transfer coefficient, $Btu/hr-ft^2$-°F
k	- Thermal conductivity, $Btu/hr-ft^2$-°F
L	- Tube length, ft
LMTD	- Log mean temperature difference, °F
Nu	- Nusselt Number, dimensionless
P	- Pressure, lb_f/in^2
Pr	- Prandtl Number, dimensionless
ΔP	- Pressure drop, lb_f/in^2
Q	- Heat load, Btu/hr
r	- Thermal resistance (individual), $hr-ft^2$-°F/Btu
Re	- Reynolds Number, dimensionless
T	- Fluid temperature, °F
U	- Overall heat transfer coefficient, $Btu/hr-ft^2$-°F
u	- Viscosity, lbs/ft-sec
ρ	- Fluid density, lb_m/ft^3
ϕ	- Sieder-Tate correction

SUBSCRIPTS

b,w	- bulk property and tube wall surface property, respectively
i,o	- inside and outside areas, respectively
io	- inside value referred to outside surface area
m	- measured quantity
Br	- brine
Hc	- hydrocarbon
in	- inlet
out	- outlet
t	- tube side
x	- cross flow
ℓ	- long flow
foul	- tube side fouling
shell	- shell side
s	- shell side
wall	- tube interior wall

$$\frac{1}{U} = \frac{1}{h_{io}} + r_{foul} + r_{wall} + r_{shell} + \frac{1}{h_o} \tag{3-4}$$

where:

- h_{io} is the tube side film coefficient referred to the outside tube area,
- r_{foul} is the tube side fouling resistance,
- r_{wall} is the tube wall thermal resistance,
- r_{shell} is the shell side fouling resistance, and
- h_o is the shell side film coefficient referred to the outside tube area.

Each term in equation (3-4) is computed from correlations which are functions of the thermodynamic and transport properties of the fluids, and the geometry factors of the exchangers.

The equations selected to predict the tube side heat transfer coefficient, h_{io}, is the familiar Dittus-Boelter equation given as,

$$Nu = 0.022\ Re_t^{0.8} Pr^{0.4} \phi_t \tag{3-5}$$

where:

$$Nu_t = h_{io}\ d_o/k_b \tag{3-5a}$$

$$Re_t = G_t d_i/u_b \tag{3-5b}$$

$$Pr = C_P u_b/k_b \tag{3-5c}$$

$$\phi_t = (u_b/u_w)_t^{0.14} \tag{3-5d}$$

$$G_t = m_{Br}/(N_t A_t) \tag{3-5e}$$

d_o = outside tube diameter

d_i = inside tube diameter

k_b = thermal conductivity of the bulk fluid

u_b = viscosity of the bulk fluid

u_w = viscosity of the fluid at the tube wall

C_p = heat capacity of the bulk fluid

m_{Br} = mass flow rate of the brine

N_t = number of tubes in the heat exchanger

A_t = cross-sectional area of a single tube

In the absence of extensive data, the fouling resistances r_{foul} and r_{shell} are specified as constants independent of the fluid temperature and pressure, and the time.

The tube wall thermal resistance is calculated as

$$r_{wall} = d_o \, \ln(d_o/d_i)/(2\, k_{wall}) \tag{3-6}$$

where: k_{wall} = the tube wall thermal conductivity

The shell side heat transfer coefficient, h_o, may be obtained in one of two ways:

If all the terms of equation (3-4) are known except h_o, then a "measured" film coefficient, $h_{o,m}$ may be obtained from

$$\frac{1}{h_{o,m}} = \frac{1}{U} - r_{foul} - r_{wall} - r_{shell} - \frac{1}{h_{io}} \tag{3-7}$$

Equation (3-7) allows calculating a value for h_o, but says nothing about the component parts of h_o. The second method of obtaining h_o is from standard relationships for the shell side flow behavior. The shell side flow behavior may be envisioned as some combination of crossflow and longflow. Each flow can be characterized by a Dittus-Boelter type equation with the appropriate definitions. For the cross flow we selected:

$$Nu_x = 0.33\ Re_x^{0.6}\ Pr^{1/3}\ \phi_s \qquad (3\text{-}8)$$

where:

$$Nu_x = h_x d_o / k_b \qquad (3\text{-}8a)$$

$$Re_x = G_x d_o / u_b \qquad (3\text{-}8b)$$

$$G_x = (\text{percent cross flow}) \cdot (\text{Seg}) \cdot m_{Hc} / A_x \qquad (3\text{-}8c)$$

A_x = cross flow area

Seg = segmented baffle factor

m_{Hc} = mass flow of the hydrocarbon

For the long flow we selected,

$$Nu_\ell = 0.024\ Re_\ell^{0.8} Pr^{0.4} \phi_\ell \qquad (3\text{-}9)$$

where:

$$Nu_\ell = h_\ell\ d_h / k_b \qquad (3\text{-}9a)$$

$$Re_\ell = h_\ell\ d_h / k_b \qquad (3\text{-}9b)$$

$$G_\ell = m_{Hc} / A_\ell \qquad (3\text{-}9c)$$

A_ℓ = long flow area

d_h = hydraulic diameter

Equations (3-2) through (3-9) comprise the basic heat transfer equations used for the data reduction of the primary heat exchangers.

Pressure Drop:

The fluid's pressure drop is a good indicator of fluid flow behavior in the heat exchanger. For the tube side (brine) we resolved the pressure drop into three components: channel nozzle losses, tube entrance and exit losses, and the tube friction losses. Each component was calculated separately:

Nozzles:

$$\Delta P_N = \frac{(G_N/3600)^2\ k_N}{2\rho g 144} \qquad (3\text{-}10)$$

where: ΔP_N = nozzle pressure loss

k_N = nozzle coefficient in number of velocity heads

$G_N = m_{Br}/A_N$ (3-10a)

A_N = cross-sectional area of the nozzle

ρ = fluid density in the nozzle

g = acceleration of gravity

Tube entrance or exit:

$$\Delta P_E = \frac{(G_t/3600)^2\ k_E}{2\rho g 144} \qquad (3\text{-}11)$$

where: ΔP_E = pressure loss entering or exiting the tubes

k_E = entrance or exit coefficient in number of velocity heads

$G_t = m_{Br}/(N_t\ A_t)$

ρ = fluid density of the brine at the tube entrance or exit

N_t = number of tubes

A_t = cross-sectional area of a single tube

Tube friction losses:

$$\Delta P_F = \frac{4\ f_t\ L\ (G_t/3600)^2}{2\rho g d_i 144} \qquad (3\text{-}12)$$

where: ΔP_F = pressure loss from friction inside the tube

f_t = the in-tube friction factor

L = tube length

The in-tube friction factor, corrected for non-isothermal conditions, is given by

$$f_t = \frac{0.048}{Re_t^{0.2}\phi_t} \qquad (3\text{-}13)$$

For the shell side (hydrocarbon) we resolved the pressure drop into four components: crossflow, baffle window, longflow, and the nozzle. Each component was calculated separately:

Nozzle:

$$\Delta P_N = \frac{(G_N/3600)^2\ k_N}{2\rho g 144} \qquad (3\text{-}14)$$

where ΔP_N = nozzle pressure loss

k_N = nozzle coefficient in number of velocity heads

$G_N = m_{Hc}/A_N$

A_N = cross-sectional area of the nozzle

ρ = hydrocarbon density in the nozzle

Crossflow:

$$\Delta P_x = \frac{4\, f_n N_R (N_B+1)\ (G_x/3600)^2}{2\rho g 144} \tag{3-15}$$

where: ΔP_x = cross flow pressure loss

f_n = cross flow friction factor

N_R = number of tube rows crossed

N_B = number of baffles

The cross flow friction factor was given as*

$$f_n = \frac{0.48\ B_n}{Re_{xh}^{\ 0.145}\ \phi_s} \tag{3-16}$$

where: $B_n = a\left(\frac{S_t}{d_h}\right)^{0.6}$

S_t = tube pitch transverse to the flow

d_h = hydraulic diameter

a = 1.000 for 90° tube layouts

= .500 for 60° tube layouts

= .707 for 45° tube layouts

= .867 for 30° tube layouts

*(Private communication, P. T. Doyle)

$$Re_{xh} = G_x d_h / u_b$$

Baffle window:

$$\Delta P_{wind} = \frac{(G_{wind}/3600)^2 \, k_{wind} \, N_B}{2\rho g 144} \tag{3-17}$$

where: ΔP_{wind} = baffle window pressure loss

k_{wind} = baffle window coefficient

$G_{wind} = m_{Hc}/A_{wind}$

A_{wind} = area of the baffle window

Long flow:

$$\Delta P_\ell = \frac{4 \, f_t \, L \, (G_\rho/3600)^2}{2\rho g d_h 144} \tag{3-18}$$

where:

ΔP_ℓ = pressure loss from long flow

$G_\ell = m_{Hc}/A_\ell$

A_ℓ = long flow area

L = tube length

Equations (3-10) through (3-18) comprise the basic pressure drop equations used for the data reduction of the primary heat exchangers.

The mass flows for the brine and the hydrocarbon were computed from the algorithms for the respective flow indicators using standard analyses.[5]

A set of fluid properties are needed in addition to the heat transfer and pressure drop equations. Because of the low total dissolved solids (≈4000) in the brine, the brine was treated as pure water. The water thermodynamic properties were computed from the Hemholtz free energy equation of Keenan and Keyes[6], and the transport properties from existing relationships.[7,8] The hydrocarbon thermodynamic and transport properties were computed from a computer code developed by the National Bureau of Standards and LBL. The computer code is based upon extended corresponding states.[9,10]

The computer codes supplied values for the pressure, enthalpy, thermal conductivity, and viscosity given the temperature and density. Iterative calculations were employed when given temperature and pressure, or pressure and enthalpy. All calculations were done at the specific input values (T & P, or P & H), with the exception of the heat capacity which was computed for a temperature interval as

$$C_p = \frac{H(T_2) - H(T_1)}{T_2 - T_1} \tag{3-19}$$

where:

$$T_2 > T_1$$

and H is the enthalpy.

Data-Reduction, Primary Heaters, Assumptions:

The tube inside diameter used for flow area and thermal resistance calculations was 0.606 inches, which corresponds to a 15 BWG tube wall rather than the nominal wall thickness of 0.062 inches for a 16 BWG tube. We used a 15 BWG tube wall thickness because it more closely represents the actual tube wall thickness because of the minimum wall specification used for 16 BWG tubes.

The specification of velocities on the shell side is dependent upon definition as there are many areas. The identification of various flow streams through the bundle of a shell and tube exchanger has been documented by various investigators and calculation of these flow streams can become quite complex. The result of such calculations is the definition of a fraction of the main fluid stream which passes through some average cross-sectional area of the tube bundle and is effective in the heat transfer process.

For a specific heat exchanger with a fixed geometry, the actual flow fractions for heat transfer and pressure drop may be incorporated into a constant derived from the data. This will hold true over a range of conditions where the flow fractions or percentage of fluid through the bundle remains relatively constant. For these reasons the definition of flow areas and bundle leakages are somewhat arbitrary for a specific data set. We sought, therefore, definitions that are consistant with those accepted within the industry.

For these tests we assumed that 70 percent of the total shell side flow passed through a minimum cross-sectional area. This cross-sectional area is located on a plane perpendicular to the flow at the mid point of the flow symmetry. For heat exchanger B-1 through B-5, the plane is at the center of the tube bundle and the area is the net area between the tubes. For exchanger B-6 the plane is located halfway between the bundle centerline and the shell and the area is the net area between tubes. By coincidence, because of the different baffle configurations and tube layout orientations the cross flow area for each exchanger is the same value, 20.3 sq. in.

For flow through the baffle window, we assumed that all the flow passed through the net area in the baffle window. The net window area is the total cross-sectional area of the baffle opening minus the total cross-sectional area of the tubes in the baffle window. The net window area for exchanger B-1 through B-5 is 11.8 sq. in.; for exchanger B-6, the outer window area (both sides of the central baffle) is 10.6 sq. in., the inner window area is 9.9 sq. in. An average value of 10.3 sq. in. was used for B-6.

The long flow mass velocity is parallel to the tubes and was defined as the total flow passing through the geometric mean area between the net baffle window area and the net cross-sectional free area in the tube bundle, which is 31.0 sq. in. for each exchanger.

The above geometry factors are therefore,

$$d_i = 0.606/12$$

$$d_o = 0.750/12$$

$$d_h = \frac{\text{4 times the net flow area}}{\text{wetted perimeter}}$$

$$= 0.543/12$$

$$A_t = (\pi d_i/2)^2/144$$

$$A_x = 20.3/144$$

$$A_{win} = \begin{cases} 11.8/144 \text{ for B-1 through B-5} \\ 10.3/144 \text{ for B-6} \end{cases}$$

$$A_\ell = \begin{cases} (31.0*11.8)^{1/2}/144 \text{ for B-1 through B-5} \\ (31.0*10.3)^{1/2}\ /144 \text{ for B-6} \end{cases}$$

Values for the three thermal resistances were also needed. For the wall resistance, k_{wall} = 26.6 (Btu/hr-ft^2 - °F) for carbon steel tubes, and with the above values for d_o, d_i and equation (6), r_{wall} = 2.5428 10^{-4}.

Because the shell side of the tubes was prepared to a clean metal surface, we took r_{shell} = 0.0. Because of the benign nature of the brine at the test conditions, and because no tube side (brine) fouling could be detected visually or from the data, r_{foul} was set to zero. We therefore employed,

$$r_{foul} = 0.0$$

$$r_{wall} = 2.5428\ 10^{-4} (hr\text{-}ft^2\text{-}°F/Btu)$$

$$r_{shell} = 0.0$$

The tube side pressure drop data stations were located between exchangers. The measured pressure drops needed to be averaged over two exchangers and corrected for the interconnecting piping. Because of the low measured pressured drops, the measured values were used directly and the tube side pressure drop calculation dispensed with. For the shell side, we took,

$$k_n = \begin{cases} 1.5 \text{ for an inlet nozzle} \\ 0.5 \text{ for an outlet nozzle} \end{cases}$$

$$k_{wind} = \begin{cases} 0.808 \text{ for B-1 through B-5} \\ 0.721 \text{ for B-6} \end{cases}$$

The values of k_{wind} were determined from a water-water calibration test[11] run on B-4 and B-6, and represents the only emprically adjusted geometry parameter used in the basic equations.

Data-Reduction, Primary Heaters, C_o, and h_o

Our intent is to quantify the deviation between the actual and predicted performance using the basic equations outlined above. Our approach was to introduce into the heat transfer and pressure drop equations a deviation parameter.

Since the tube side (brine) was not suspect, we used the tube side equations as given. For the shell side heat transfer we wrote,

$$h_o = C_o \cdot h_{o,corr} \tag{3-20}$$

where C_o is an adjustable parameter and $h_{o,corr}$ is given by some as yet unspecified function of h_x and h_ℓ.

For the shell side pressure drop we wrote,

$$\Delta P_s = \Delta P_{N,in} + C_s \sum_{i=1}^{3} \Delta P_i + \Delta P_{N,out} \tag{3-21}$$

where P_i is the pressure drop for one of the three shell side pressure drop components.

The parameters C_o and C_s equal unity if the basic equations give a perfect description of the exchanger performance, i.e., if they predicted the known surface area and the known pressure drop.

Finally, we introduced an area deviation defined as,

$$A_{dev} = 100\ (A_{cal} - A_{exp})/A_{exp} \tag{3-22}$$

where A_{cal} is the calculated area based upon equation (3-20), and A_{exp} is the known area. We define a pressure deviation as:

$$\Delta P_{dev} = \Delta P_{cal} - \Delta P_{exp} \tag{3-23}$$

where ΔP_{cal} is the calculated pressure drop based upon equation (3-21) and ΔP_{exp} is the experimentally measured pressure drop.

We first tackle the function h_o, which will yield a value for C_o. We assume that C_o is a fixed constant and the functional form for h_o is invariant from exchanger to exchanger. We start by rewriting equation (3-8) and (3-9) as:

$$\ln(Nu_\ell/Pr^{0.4}) = a_\ell + b_\ell\ Re_\ell \tag{3-24}$$

$$\ln(Nu_x/Pr^{1/3}) = a_x + b_x\ Re_x \tag{3-25}$$

If we had experimental values for h_o, we could then write,

$$Nu_\ell = h_o\ d_h/k_b \tag{3-26}$$

$$Nu_x = h_o\ d_o/k_b \tag{3-27}$$

and a linear regression of data on equations (3-24) and (3-25) would yield values for the parameters a_ℓ, b_ℓ and a_x, b_x from which the importance of h_x and h_ℓ to h_o could be deduced. Experimental values of h_o can only be determined when a stepwise calculation, such as described later on, is not necessary. This occurs only for the liquid region which is spanned for most test conditions by exchangers B-1 through B-3.

In the liquid region, the LMTD may be computed from the terminal temperatures (i.e., measured temperatures) of the exchangers, thus allowing U to be computed from

$$U = Q/(A\ LMTD) \tag{3-28}$$

where A is the exchanger area (292.2 ft^2) and Q is the brine duty, so picked over the hydrocarbon duty because the fluid properties of the brine (i.e., water) are known with greater accuracy than those of the hydrocarbon.

We computed h_{io} from equation (3-5), U from equation (3-28), and $h_o = h_{o,m}$ from equation (3-7). With a set of experimental h_o values, Nu_ℓ and Nu_x were computed and a linear regression applied to equations (3-24) and (3-25).

Since equations (3-8) and (3-9) in principle apply to pure fluids or mixtures, we limited the above analysis to the commercial isobutane data in order to provide a more stringent test of the mixture data. The bulk fluid properties were the average of those computed at the exchanger terminal conditions, the Sieder-Tate correction, ϕ, was computed as described later on, and the heat capacity was computed from equation (3-19) with the temperatures taken as the measured terminal temperatures.

Figure 3-1 is a T-Q plot for a typical data scan. The dotted line is the temperature profile from a stepwise calculation, and the straight line is the profile used for the above analysis. To expand the range of Reynolds numbers, data from a water-water calibration test on exchanger B-4 was included in the analysis. Table 3-3 reports the results.

We see from the tabulated results that equation (3-24) for long flow gave the best fit. In fact the value of $b_\ell = 0.81$ is remarkably close to the generally used value of 0.8. However, the value of $b_x = 0.79$ is not in good agreement with the generally accepted value of 0.6. Next we note that:

$$a_\ell = \ln(0.024C_\ell) \qquad (3\text{-}29)$$

$$a_x = \ln(0.33C_x) \qquad (3\text{-}30)$$

The values of C_ℓ and C_x are also listed in Table 3-3.

The value of $C_\ell = 0.936$ (see below) means that we need to multiply the standard longflow correlation by ≃-6% to predict the surface area of B-1 through B-3. On the other hand, $C_x = 0.138$, plus $b_x = 0.79$ strongly suggests that cross flow contributes little to the heat transfer.

TABLE 3-3

Long Flow and Cross Flow Analysis of

Liquid Region Data

Long flow:

$$a_{\ell} = -3.7958$$

$$b_{\ell} = 0.81$$

$$C_{\ell} = 0.936$$

Cross flow:

$$a_x = -3.0907$$

$$b_x = 0.79$$

$$C_x = 0.138$$

Long flow for $b_{\ell} = 0.8$:

$$C_{\ell} = 1.116 \pm 0.231$$

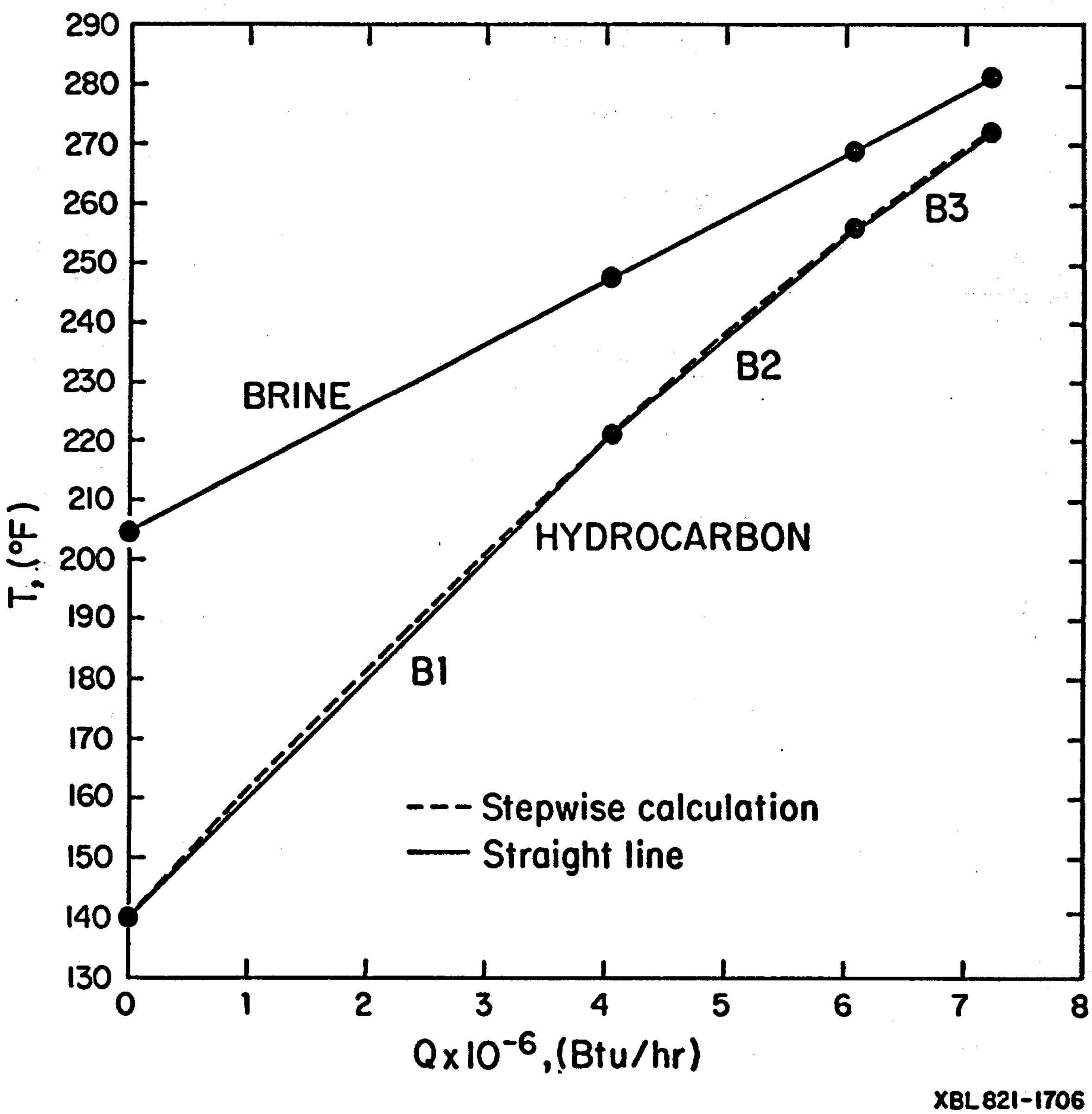


Fig. 3-1 Temperature vs Duty for B-1 through B-3 with Isobutane in the Heaters

With the above analysis, the test data was reanalyzed for long flow with b_ℓ fixed at 0.8. The results were C_ℓ = 1.116. Therefore, the remainder of the data-reduction was based upon,

$$h_o = C_o \cdot h_\ell \tag{3-31}$$

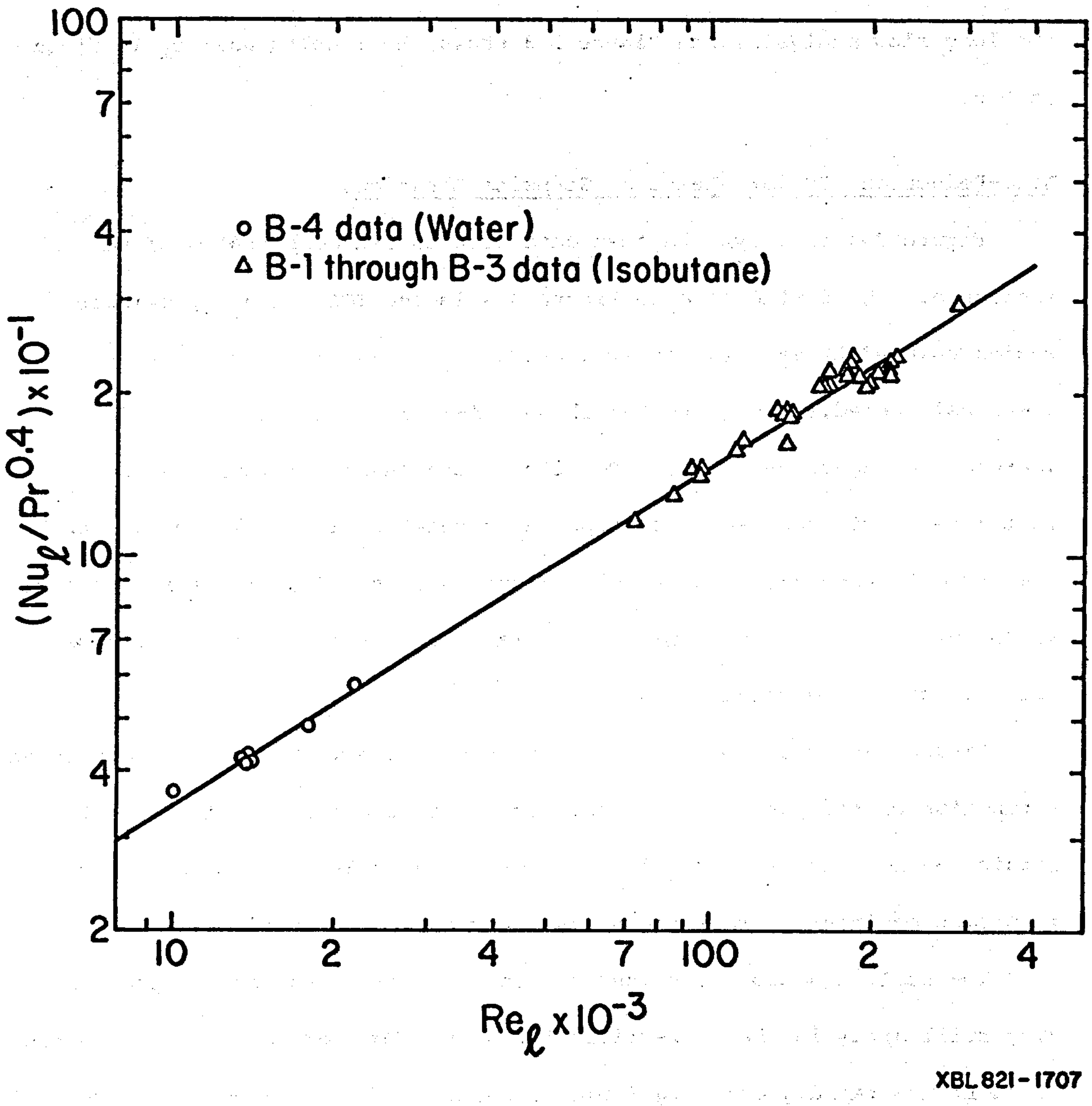
with C_o = 1.116. Figure 3-2 shows the final regression results for the long flow analysis, and Figure 3-3 shows the results when b_x is fixed at 0.6.

Data-Reduction, Primary Heaters, Stepwise Equations:

Figure 3-4 displays the test data area on P-H coordinates of pure isobutane. The dotted line in Figure 3-4 is the TCL. The approximate region spanned by each exchanger is also indicated as B-1 through B-6. As previously noted, exchangers B-1 through B-3 lie in the liquid region, whereas exchangers B-4 through B-6 lie in the "near-critical" region. In the near-critical region a stepwise calculation is necessary, as can be seen from Figures 3-5 through 3-7. Figure 3-5 is a T-Q plot for a nominal 80/20 test run. The nonlinear heat release (uptake) is typical of super-critical operating conditions.

Figure 3-6 is a plot of the hydrocarbon's thermophysical properties as a function of the shell side temperature. The rapid change in properties within B-6 results from crossing the TCL. Figure 3-7 is a plot of the important engineering parameters for the same test conditions.

The basic equations outlined earlier for heat transfer and pressure drop still apply in the near-critical region. To overcome the difficulties posed by the rapidly changing fluid properties, the exchanger is broken into segments (e.g., zones). The width of a zone is such that the basic



Long Flow Analysis for C_ℓ from Isobutane and Water-Water Test Data

$$Nu_\ell = C_\rho Re^{0.8} Pr^{0.4}$$

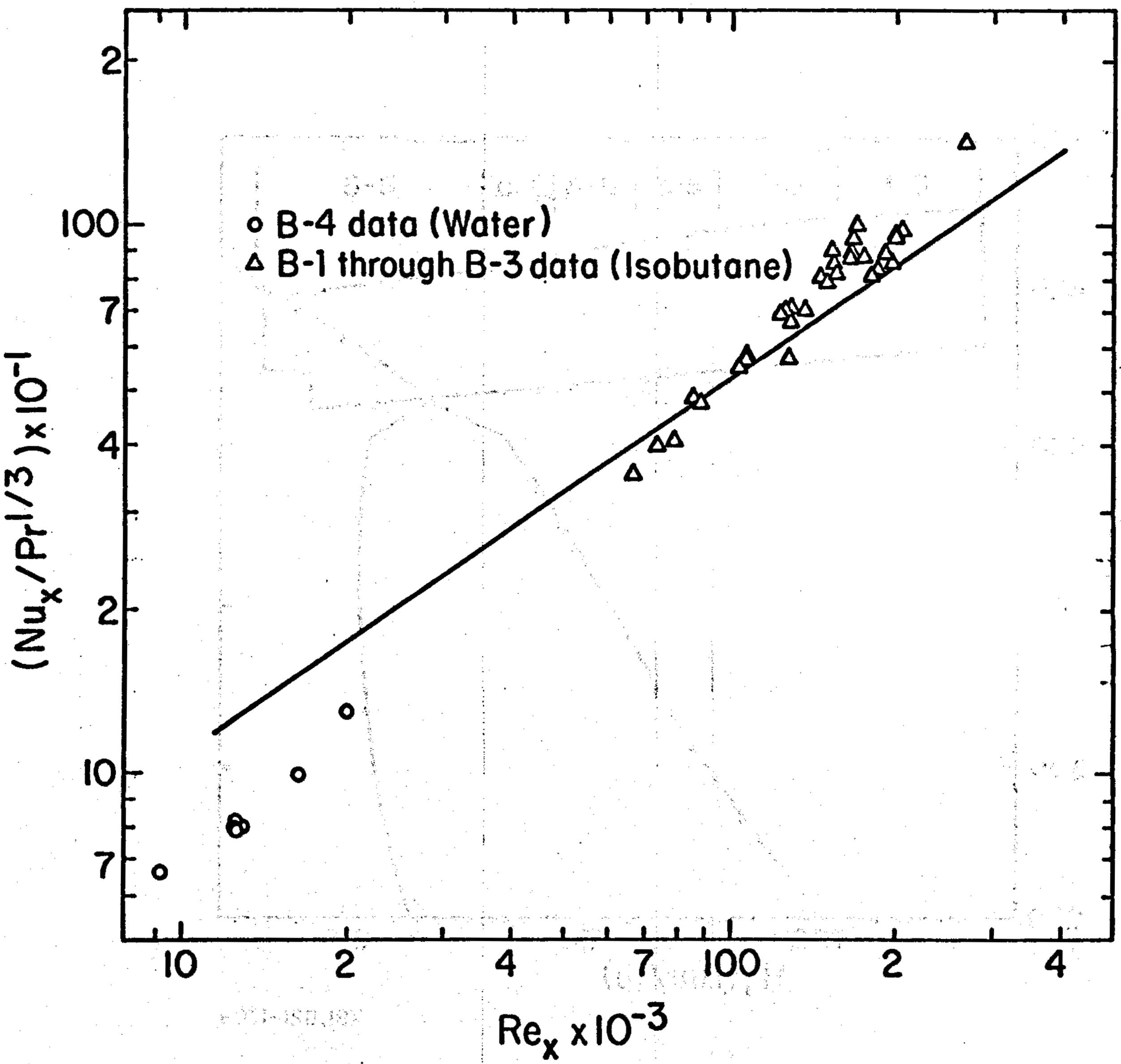


Fig. 3-3. Cross Flow Analysis for C_x from Isobutane and Water-Water Test Data

$$Nu_x = C_x\ Re^{0.6} Pr^{1/3}$$

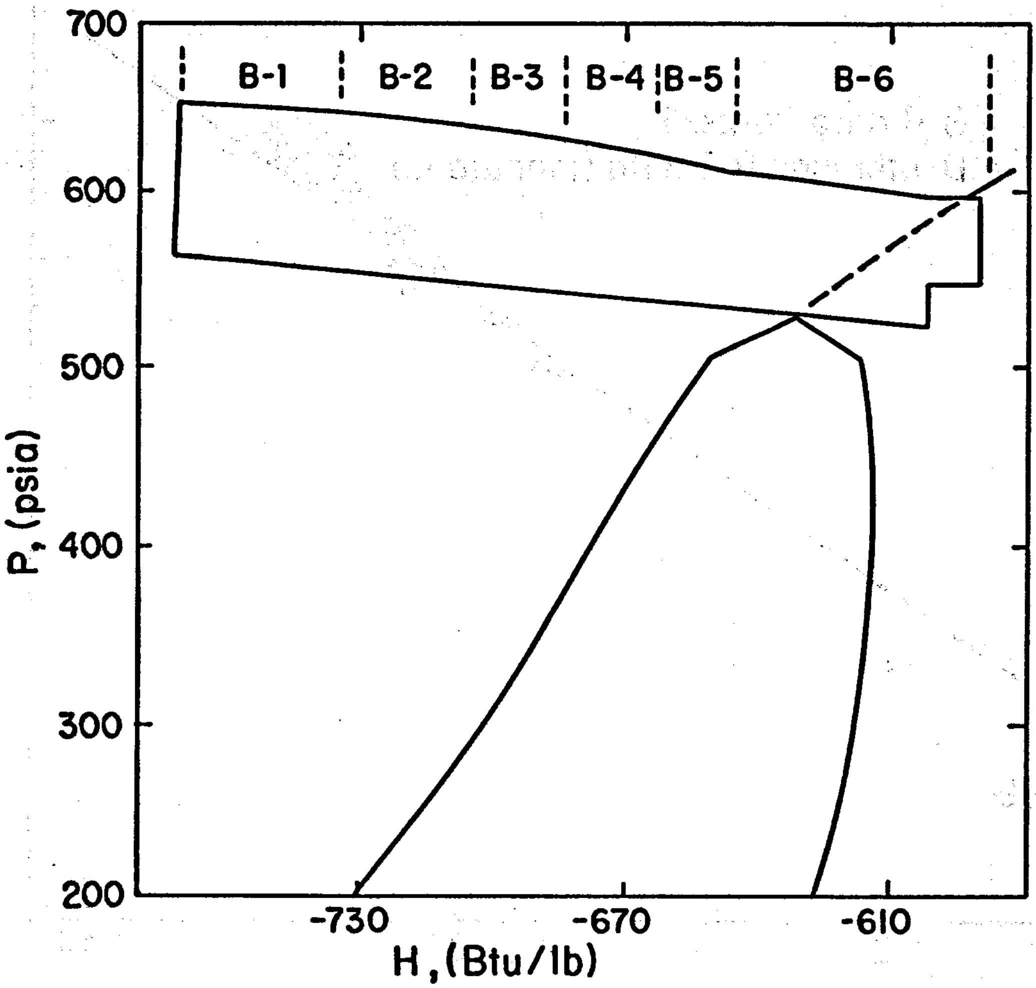


Fig. 3-4 Primary Heater Test Data Area

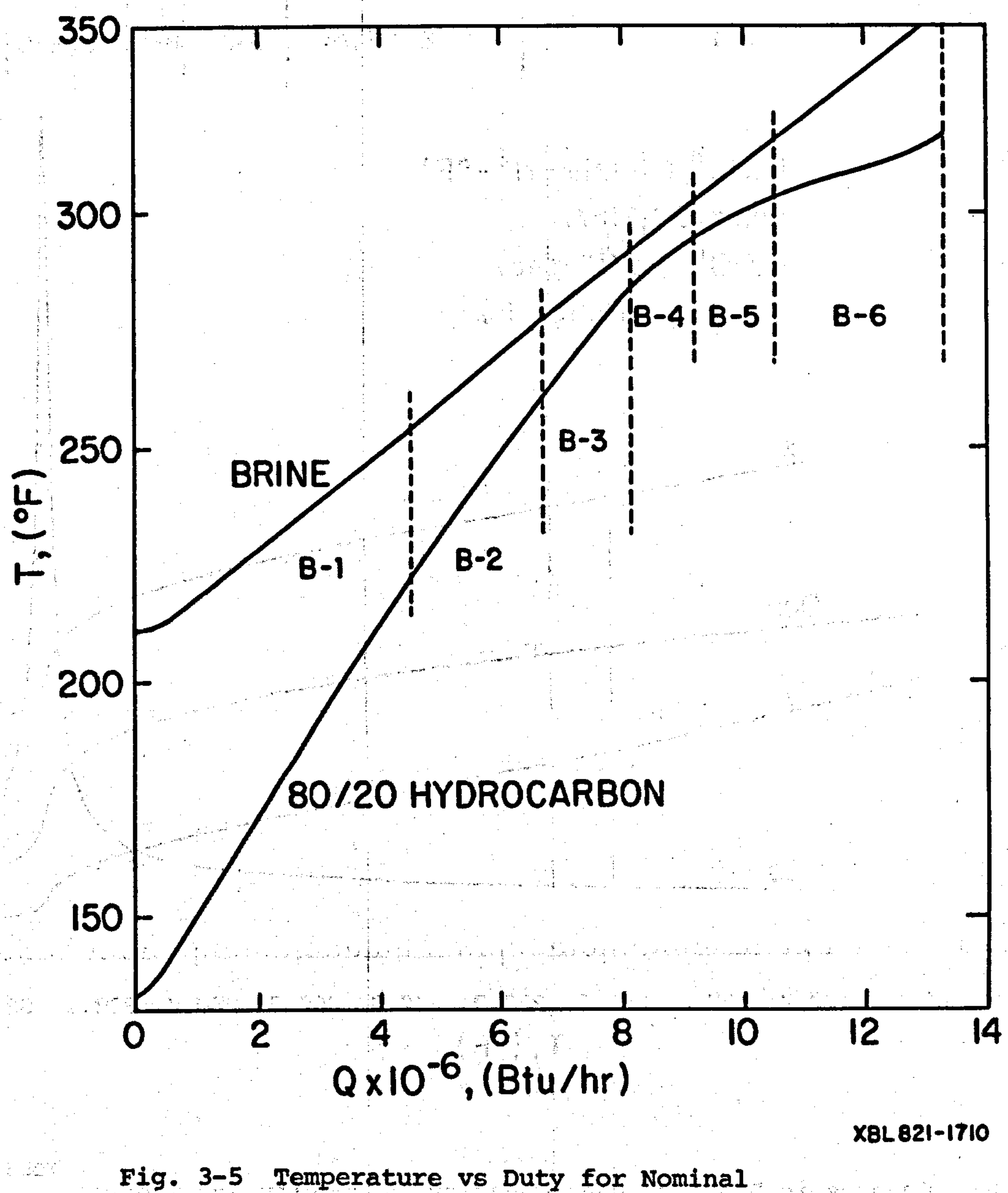


Fig. 3-5 Temperature vs Duty for Nominal 80/20 Test Run

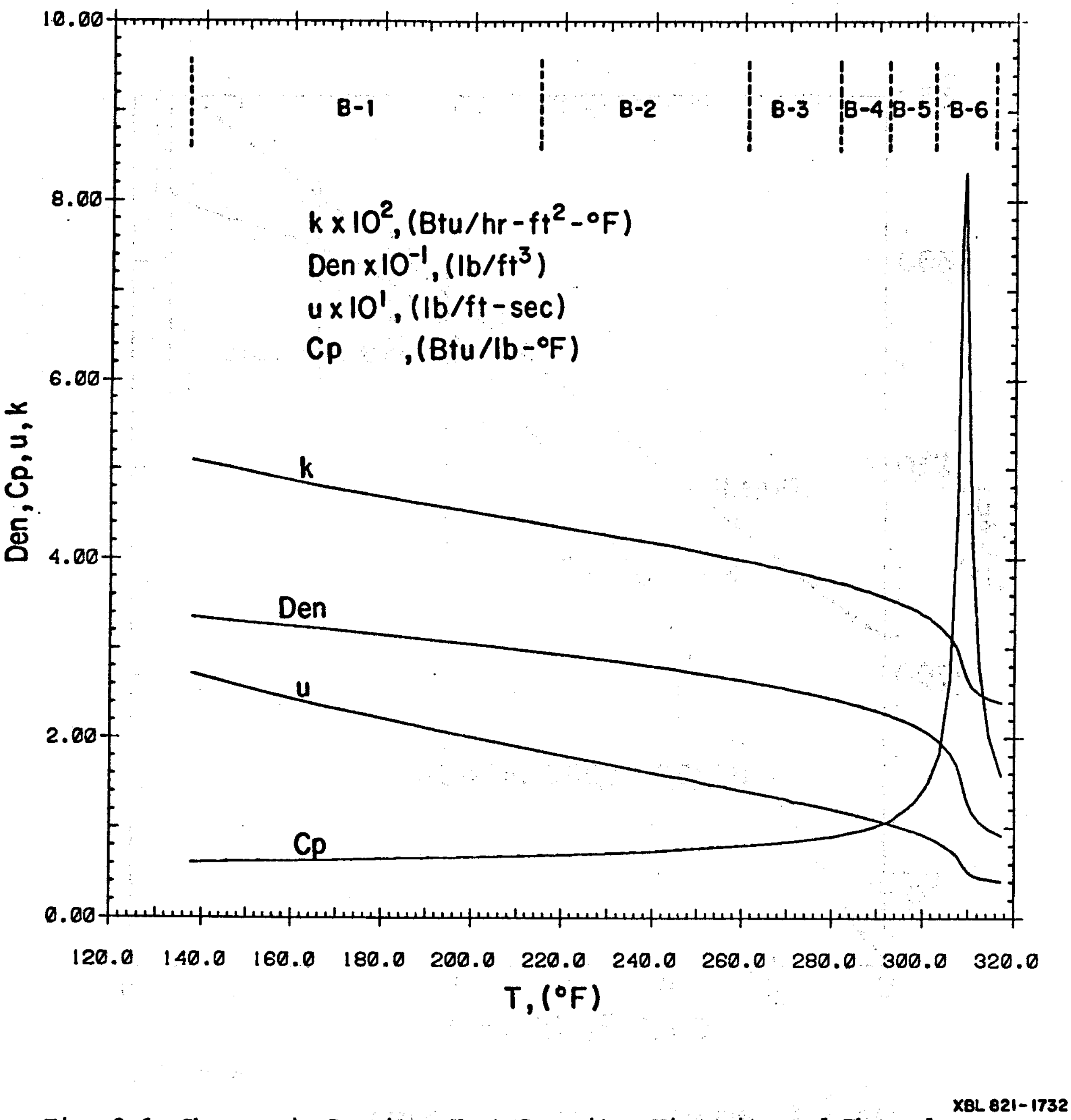


Fig. 3-6 Changes in Density, Heat Capacity, Viscosity and Thermal Conductivity for a Nominal 80/20 Test Fluid Passing through the Primary Heaters

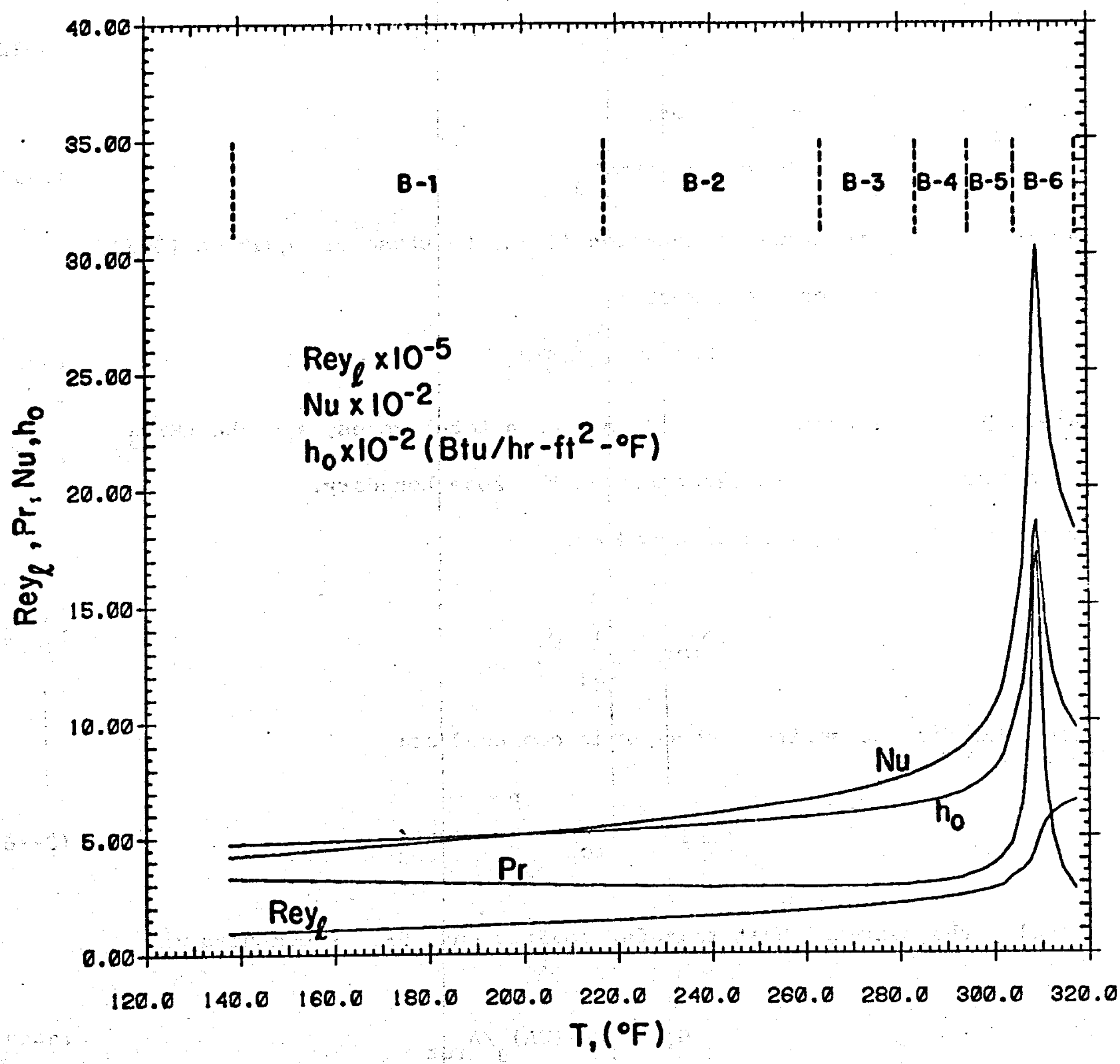


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Fig. 3-7 Changes in Nu, Pr, Rey_ℓ, and h_o for a Nominal 80/20 Test Fluid Passing through the Primary Heaters equations are valid within that zone. The zones are then summed and the performance factors extracted from the resulting sums. The stepwise calculation in reality is nothing more than a statistical averaging. For the entire exchanger we write,

$$Q_{tot} = U_f \cdot A_{tot} \cdot LMTD \quad (3\text{-}32)$$

We also write for the j^{th} zone,

$$Q_j = U_j \cdot A_j \cdot LMTD_j \quad (3\text{-}33)$$

We now relate the terms of equation (3-32) to those of equation (3-33).

For the j^{th} zone we compute:

$$(UA)_j = Q_j/LMTD_j \quad (3\text{-}34)$$

where Q_j is the duty of the j^{th} zone of n total zones, and the $LMTD_j$ is computed from the temperatures at the zone boundary.

The total duty, Q_{tot}, is computed as:

$$Q_{tot} = \sum_{j=1}^{n} Q_j \quad (3\text{-}35)$$

The LMTD for the entire exchanger is computed as:

$$LMTD = Q_{tot} / \sum_{j=1}^{n} (UA)_j \quad (3\text{-}36)$$

Finally the over-all heat transfer coefficient, U_f, is computed as:

$$U_f = \sum_{j=1}^{n} (UA)_j / A_{tot} \quad (3\text{-}37)$$

where A_{tot} is the total area computed as:

$$A_{tot} = \sum_{j=1}^{n} A_j \quad (3\text{-}38)$$

Each A_j is computed from:

$$A_j = Q_j/(U_j LMTD_j) \tag{3-39}$$

An individual U_j is computed from:

$$U_j = \frac{1}{\frac{1}{h_{io}} + r_{wall} + r_{foul} + \frac{1}{h_o}} \tag{3-40}$$

The overall weighted tube side and shell side film coefficients are computed as:

$$h_{io,wtd} = \frac{\sum (UA)_j}{Q_j/(LMTD_j h_{io})}$$

$$h_{o,wtd} = \frac{\sum (UA)_j}{Q_j/(LMTD_j h_o)}$$

The individual heat transfer coefficients for each zone used in equation (3-40) are computed as:

$$h_{io} = (0.022\ Rey_t^{0.8} Pr^{0.4} \frac{k_b}{d_o} \phi_t) \qquad \text{(eq. (3-5))} \tag{3-41}$$

$$h_o = C_o\ (0.024\ Rey_\ell^{0.8} Pr^{0.4} \frac{k_b}{d_h} \phi_s) \qquad \text{(eq. (3-31))} \tag{3-42}$$

$$= h_{o,ref}\ \phi_s \tag{3-43}$$

All the properties used in equation (3-41) are for the brine, and those for equation (3-42) for the hydrocarbon. The bulk thermophysical properties are computed as:

$$P_b = (P_j + P_{j-1})/2 \tag{3-44a}$$

$$T_b = (T_j + T_{j-1})/2 \tag{3-44b}$$

$$k_b = (k_j + k_{j-1})/2 \tag{3-44c}$$

$$u_b = (u_j + u_{j-1})/2 \tag{3-44d}$$

$$C_p = (H_j - H_{j-1})/(T_j - T_{j-1}) \tag{3-44e}$$

where for example, P_j is evaluated at the j^{th} boundary point, and P_{j-1} at the preceding boundary point, etc.*

Looking just at the shell side, we write,

$$Q_j = h_o A_j (T_w - T_b) \tag{3-45}$$

where T_w is the outside tube wall temperature. We use equation (3-45) to compute the Sieder-Tate correction, ϕ.

We write,

$$T_w = T_b + Q_i/(h_{o,ref} A_j) \tag{3-46}$$

$$u_w = u_w(T_w, P_b) \tag{3-47}$$

$$\phi = (u_b/u_w)^{0.14} \tag{3-48}$$

$$h_o = h_{o,ref}\phi \tag{3-49}$$

$$Q_{cal} = h_o \; A_i \; (T_w - T_b) \tag{3-50}$$

$$\left| (Q_{cal} - Q_j)/Q_j \right| < \delta \tag{3-51}$$

$$T_w = T_w - (Q_{cal} - Q_j)/(h_o \; A_j) \tag{3-52}$$

*To do the actual calculation, we evaluate all the thermophysical properties at the n+1 boundary points, then compute an average value for the zone. The j^{th} zone refers to the zone bounded by the j-1 and j boundary points.

First we compute an initial guess for T_w from equation (3-46). Then we evaluate u_w at T_w and P_b, equation (3-47); then we compute ϕ and h_o, and a calculated duty, Q_{cal}, equations (3-48) to (3-50). If equation (3-51) holds for a specified δ, we stop; if not we compute a new T_w from equation (3-52) and repeat the sequence of equations (3-48) through (3-52) until equation (3-51) is satisfied. The same procedure with the appropriate equations applies for ϕ on the tube side.

We treat the pressure drop equation similarily; we write for the entire exchanger,

$$\Delta P_{shell} = \Delta P_{N,in} + (\Delta P_x + \Delta P_{wind} + \Delta P_\ell) + \Delta P_{N,out} \qquad (3\text{-}53)$$

and for the ith zone,

$$\Delta P_j = \Delta P_{x,j} + \Delta P_{wind,j} + \Delta P_{\ell,j} \qquad (3\text{-}54)$$

The relationship between equation (3-53) and equation (3-54) is

$$\Delta P_x + \Delta P_{wind} + \Delta P_\ell = \sum_{j=1}^{n} \Delta P_j \qquad (3\text{-}55)$$

with

$$\Delta P_{x,j} = \Delta P_x \qquad \text{(equation (3-15))}$$

$$\Delta P_{wind,j} = \Delta P_{wind} \qquad \text{(equation (3-17))}$$

$$\Delta P_{\ell,j} = \Delta P_\ell \qquad \text{(equation (3-18))}$$

$$\Delta P_j = C_s\,(\Delta P_{x,j} + \Delta P_{wind,j} + \Delta P_{\ell,j})\,A_j/A_{tot} \qquad (3\text{-}56)$$

<u>Data-Reduction, Primary Heaters, Stepwise Calculational Procedure</u>

The basic and stepwise equations outlined above were incorporated into a computer code. The calculational procedure is for a fixed duty and is outlined below.

Input of experimental data and known geometry of exchanger (1)

--Compute Duties and Heat Balance--

$$Q_{Br} = m_{Br}\ (H_{in} - H_{out})_{Br} \quad (2)$$

$$Q_{Hc} = m_{Hc}\ (H_{out} - H_{in})_{HC} \quad (3)$$

$$\text{Error} = \frac{Q_{Hc} - Q_{Br}}{Q_{Br}} \times 100 \quad (4)$$

--Set Initial Values for P's and T's--

$$\Delta Q_{Br} = Q_{Br}/n \quad (5)$$

$$\Delta P_{Br} = (P_{in} - P_{out})_{Br}/n \quad (6)$$

$$\Delta H_{Br} = (H_{in} - H_{out})_{Br}/n \quad (7)$$

$$P_{Br,j} = P_{out,,Br} + (j-1)\Delta P_{Br} \qquad j=1,\ n+1 \quad (8)$$

$$H_{Br,j} = H_{out,Br} + (j-1)\Delta H_{Br} \qquad j=1,\ n+1 \quad (9)$$

$$T_{Br,j} = F_1(P_{Br,j},\ H_{Br,j}) \qquad j=1,\ n+1 \quad (10)$$

$$\rho_{Br,j} = F_2(T_{Br,j}, P_{Br,j}) \qquad j=1,\ n+1 \quad (11)$$

$$u_{Br,j} = F_3(T_{Br,j}\ \ P_{Br,j}) \qquad j=1,\ n+1 \quad (12)$$

$$k_{Br,j} = F_4(T_{Br,j},\ P_{Br,j}) \qquad j=1,\ n+1 \quad (13)$$

$$\Delta P_{Hc} = (P_{in} - P_{out})_{Hc}/n \quad (14)$$

$$\Delta H_{Hc} = (H_{out} - H_{in})_{Hc}/n \quad (15)$$

$$P_{Hc,j} = P_{in,Hc} - (j-1)\Delta P_{Hc} \qquad j=1,n+1 \quad (16)$$

$$H_{Hc,j} = H_{in,Hc} + (j-1)\Delta H_{Hc} \qquad j=1,\ n+1 \quad (17)$$

$$A_j = A_{Exch}/n \qquad j=1,\ n+1 \quad (18)$$

--Stepwise Calculation--

$$T_{Hc,j} = G_1(P_{Hc,j}, H_{Hc,j}) \qquad j=1, n+1 \qquad (19)$$

$$\rho_{Hc,j} = G_2(T_{Hc,j}, P_{Hc,j}) \qquad j=1, n+1 \qquad (20)$$

$$u_{Hc,j} = G_3(T_{Hc,j}, P_{Hc,j}) \qquad j=1, n+1 \qquad (21)$$

$$k_{Hc,j} = G_4(T_{Hc,j}, P_{Hc,j}) \qquad j=1, n+1 \qquad (22)$$

For j=1, n+1 for steps (23) to (36)

$$(T_b, \rho_b, u_b, k_b, C_p) \text{ from eq. (3-44a to 3-44f)} \qquad (23)$$

$$h_{io,j} = h_{io}(Rey_t, Pr, \phi, A_j), \quad \text{eq. (3-5)} \qquad (24)$$

$$(T_b, \rho_b, k_b, C_p)_{Hc} \text{ from eq. (3-44a to 3-44f)} \qquad (25)$$

$$h_{o,j} = h_o(Rey_\ell, Pr, \phi, A_j), \quad \text{eq. (3-42)} \qquad (26)$$

$$U_j = U(h_{io,j}, h_{o,j}, r_{wall}, r_{foul}), \quad \text{eq. (3-40)} \qquad (27)$$

$$T_a = T_{Br,j} - T_{Hc,j-1}$$

$$T_b = T_{Br} - T_{Hc,j-1}$$

$$LMTD_j = (T_a - T_b) / \ell n(T_a/T_b) \qquad (28)$$

$$A_j = \Delta Q_{Br}/(U_j \cdot LMTD_j) \qquad (29)$$

$$\Delta P_j = C_s(\Delta P_{x,j} + \Delta P_{wind,j} + \Delta P_{\ell,j}), \quad \text{eq. (3-56)} \qquad (30)$$

$$P_{Hc,j} = P_{Hc,j-1} - \Delta P_j$$

$$\sum A_j = \sum A_j + A_j \qquad (31)$$

$$\sum Q_j = \sum Q_j + \Delta Q_{Br} \qquad (32)$$

$$\sum (UA)_j = \sum (UA)_j + \Delta Q_{Br}/LMTD_j \qquad (33)$$

$$\sum h_{o,j} = \sum h_{o,j} + \frac{\Delta Q_{Br}}{LMTD_j \; h_{o,j}} \tag{34}$$

$$\sum h_{io,j} = \sum h_{io,j} + \frac{\Delta Q_{Br}}{LMTD_j \; h_{io,j}} \tag{35}$$

$$\sum \Delta P_j = \sum \Delta P_j + \Delta P_j \tag{36}$$

$$A_{cal} = \sum A_j \tag{37}$$

$$\Delta P_{cal} = P_{N,in} + \sum \Delta P_j + P_{N,out} \tag{38}$$

and if ΔP_{exp} (= ΔP_{Hc}) $\neq$ WP_{cal} then adjust C_s and repeat steps (19) through (38) until satisfactory agreement is achieved. Then compute

$$Q_{tot} = \sum \Delta Q_{Br}$$

$$A_{tot} = A_{cal}$$

$$LMTD = Q_{tot} / \sum (UA)_j$$

$$U = Q_{tot} / (A_{tot} \; LMTD)$$

$$h_{o,wtd} = \frac{\sum (UA)_i}{\sum h_{o,j}}$$

$$h_{io,wtd} = \frac{\sum (UA)_i}{\sum h_{io,j}}$$

At this point the calculation is fini.

<u>Data-Reduction, Primary Heaters, Test Results:</u>

Table 3-4 summarizes the test conditions. Each entry is the average of six to eight data scans. The actual analysis, however, was applied to each data scan. The number of data scans were: 96 for commercial isobutane,

Table 3-4

--- Heater Test Data Summary ---

Test #	T-Hc(exit, B-6) (°F)	P-Hc(exit, B-6) (psia)	m-Br (%)	m-Hc (%)	Bal* (%)
Commercial Isobutane					
1	314	603	98	87	2.3
2	329	601	98	71	2.0
3	333	602	96	50	5.4
5	311	600	107	98	0.3
6	308	571	104	102	1.0
7	326	572	106	84	.2
8	339	571	106	63	.3
9	340	572	101	41	1.5
10	312	573	107	102	.5
11	307	552	100	100	2.8
12	329	550	101	81	1.4
13	310	552	67	63	4.5
15	309	552	102	99	1.3
16	298	586	98	95	1.1
Nominal 90/10 Isobutane/Isopentane					
17	304	596	93	100	-5.2
18	323	600	98	82	1.1
19	339	602	84	57	1.6
20	306	571	104	99	-3.6
21	314	567	99	81	-5.3
22	314	566	74	58	-5.9
23	310	552	105	92	-3.8
24	326	557	103	74	0.1
25	328	554	79	56	-0.5
Nominal 80/20 Isobutane/Isopentane					
25a	313	598	101	106	-8.2
26	312	602	101	104	-7.3
27	310	603	98	102	-5.9
28	317	603	90	85	-3.7
29	335	598	90	62	1.4
30	307	574	101	110	-14.5
31	319	575	101	88	0.2
32	330	574	90	65	1.4
33	302	549	105	113	-18.6
34	316	550	105	91	1.2
35	339	550	106	68	1.0
36	315	603	105	100	-7.7

Notes: M-brine at 100% = 95408 (lb/hr)
M-hc at 100% = 85175 (lb/hr)

45 for nominal 90/10, and 68 for nominal 80/20, for a total of 210 data scans out of 218 total scans taken, with 8 scans rejected for inconsistencies in the data.

Heat Balances:

Heat balances were computed for individual exchangers as well as the entire train. The exchanger heat balances present a curious dichotomy as Table 3-5 illustrates. Test run 107, for a 90/10 test fluid, is one of the more blatant examples of a good overall heat balance but poor individual exchanger balances. The heat balances are excellent in the "liquid" region spanned by B-1 through B-3, but deteriorate rapidly as the fluid traverses the near-critical region. Exchanger B-6 straddles the TCL region with the maximum heat capacity occurring near the entrance to B-6.

Test run 141, a 80/20 test fluid, also listed in Table 3-5, illustrates the results when none of the exchangers encroach into the TCL region. For test run 141, B-6 lies just to the left of the TCL region. Most test conditions of Table 3-4 traverse the TCL region, and show heat imbalances similar, but usually half the magnitude, to those of test run 107.

Several factors interact to cause the disparity in the heat balances. Figure 3-8 illustrates on P-H coordinates the pressure drop through the exchanger train for test run 107. The absence of a horizontal inflection point, and the steep slope of the pressure curve indicates that errors in the pressure readings have a small effect on the heat balance. Figure 3-9 is a plot of T vs H for test run 107. The plot indicates the sensitive nature of the heat balance on temperature in the region spanned by B-5 and B-6 as evidenced by the horizontal inflection point. Consequently, uncertainties in the measured temperatures contribute strongly to the heat imbalances. For example, for test run 107, every 1°F change in the exit temperature of B-5 changes the heat balance by 10%. For many of the data scans, a change

Table 3-5

Exchanger Heat Balance

Test Run #107 (90/10)

Exchanger	Q_{Bal} (%)
B1	-1.9
B2	-3.8
B3	-5.3
B4	-19.0
B5	-49.9
B6	+50.8
B1-B6	+0.51

Test Run #141 (80/20)

Exchanger	Q_{Bal} (%)
B1	1.0
B2	-0.2
B3	-0.6
B4	-8.1
B5	-9.8
B6	-3.7
B1-B6	-4.0

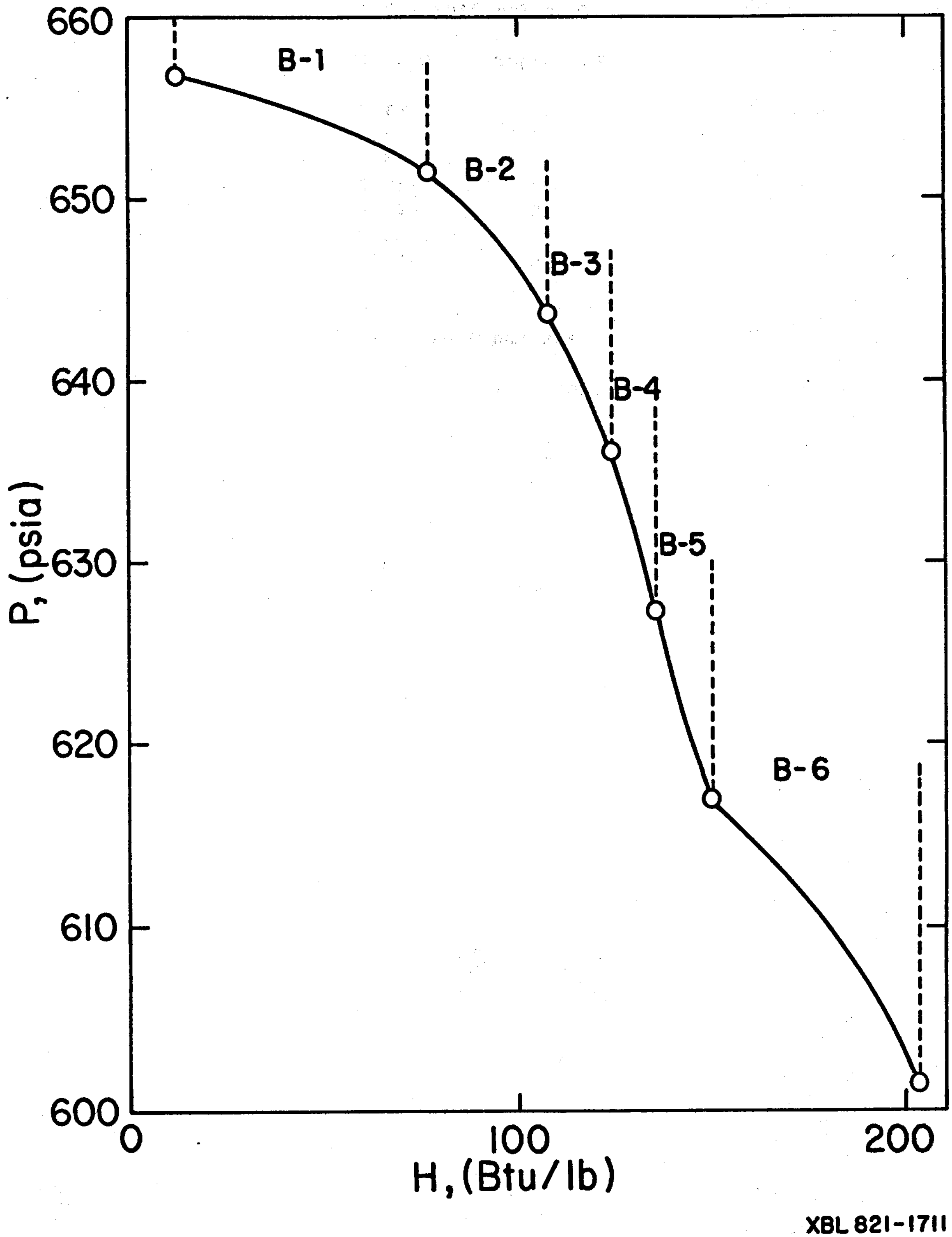

Fig. 3-8 Pressure vs Enthalpy for Nominal 90/10 Test Fluid Passing through Primary Heaters

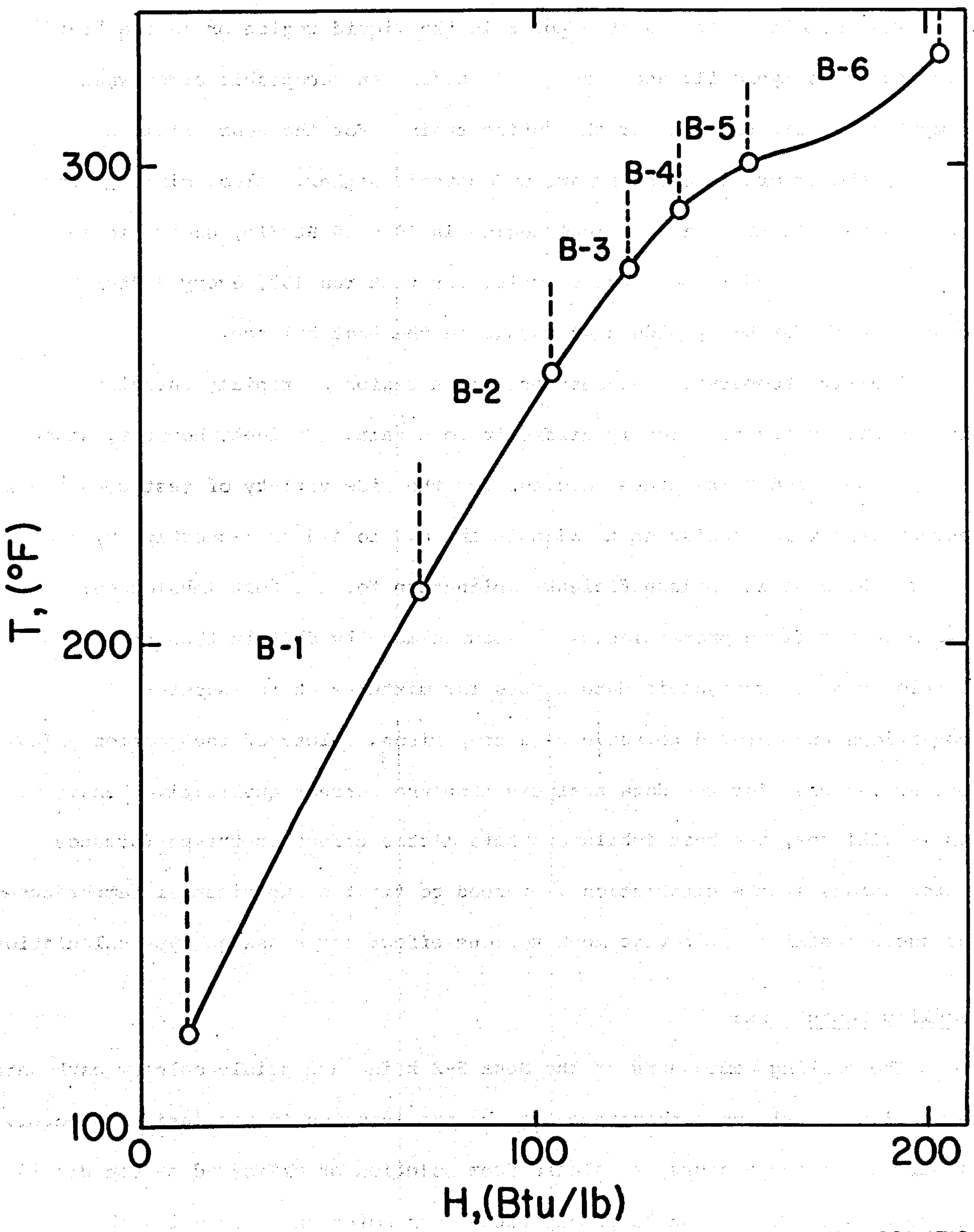

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Fig. 3-9 Temperature vs Enthalpy for Nominal 90/10 Test Fluid Passing through Primary Heaters in the hydrocarbon temperatures in the near critical region of 2-3°F yields satisfactory heat balances (< 3%) for B-4 through B-6.

The enthalpy computed at a point in the liquid region or in the "far" gas region is typically accurate to ±2 Btu/lb, an acceptable error when computing a heat balance for the entire train. For the near critical region, the errors in enthalpy are undoubtedly higher. Also, since ΔH for an exchanger in the near-critical region is 10 - 20 Btu/lb, uncertainties in H are magnified in ΔH. For example, for test run 107, every 1 Btu/lb change in ΔH for B-5 yields a 4% change in the heat balance.

Finally, temperature measurements in a region of rapidly changing heat capacity are notoriously difficult to obtain. We feel, however, since the pressure and temperature readings for the wide variety of test conditions encountered were consistent to ±1 psia and 0.1 to 1.0 °F respectively, that instrument bias is an insufficient explanation for the heat imbalances; which leaves fluid properties as the source more by default than proof, as little or no thermodynamic data exists for mixtures at the supercritical conditions encountered to serve as a comparison. Plots of the thermophysical properties used for the data analysis show the correct qualitative behavior. As we will see, the heat imbalances have little effect on the performance calculations if the calculation is forced to fit the experimental temperature-pressure profile, but have a more serious effect for a design type calculation.

Fouling Resistance:

The scaling components of the Mesa 6-2 brine are mainly calcium carbonate and silica. Calcium carbonate cannot be precipitated from solution by merely lowering the temperature; a release from solution of dissolved carbon dioxide is required. Silica can be precipitated from solution by lowering the brine temperature. Since the brine pressure was always sufficiently high to prevent

$CO_2(g)$ evolution, carbonate precipitation was not considered a problem. However, to assess the importance of scale formation, the overall measured heat transfer coefficient, U_m, as a function of time for exchanger B-1 was examined.

Exchanger B-1 was choosen because it is the coldest exchanger, and because its U_m can be computed directly using the four terminal exchanger temperatures without resorting to a zoned analysis, thereby avoiding the necessity of explicitly introducing a value for r_{foul}, while implictly including its effects in U_m. Also, because B-1 is in the cooled liquid region, the value of U_m will not be greatly affected by the composition range spanned by the test fluids, so the values of U_m for all three test fluids may be compared thereby allowing for a greater time spread.

The test sequence had been arranged to allow for evaluating changes in r_{foul} by having the last test run for each test fluid be a repeat of its first test run (see Table 3-4). Any change in U_m computed for the first and last test runs could be attributed to changes in r_{foul}.

Test runs 1, 16, 17, 25A, and 36 (see Table 3-4) were analyzed and U_m values for each data scan computed using equation (3-2) and (3-3). The resulting U_m values were regressed against real time. The tube side of the exchangers were cleaned prior to the start of testing and never thereafter. When the test loop was not operating, the exchangers were left packed with brine; consequently, the times used in the regression are accumulative rather than the sum of the actual running time since the chemistry of the brine does not stop because the brine stops flowing. Our interest is in the change in U_m however it arose.

Table 3-6 reports the results; the first equation is for all three test fluids, the second equation is for commerical isobutane. The time spanned for the analysis was 1172 hours for equation one and 805 hours for equation two.

Table 3-6

Results for r_{foul} from U_m for B-1

$$U_m = (321.6 \pm 0.3) + (0.0035 \pm 0.0004) * \text{time (hrs)} \quad (1)$$

$$U_m(iC_4) = (322.4 \pm 0.3) - (0.0027 \pm 0.0007) * \text{time (hrs)} \quad (2)$$

NOTE: The quantities in parenthesis are the values determined by regression analysis and their standard deviation.

The value of the slope is sufficiently small and outside the experimental accuracy in U_m to be considered experimentally zero. No significance can be attached to the sign of the slope for either equation. The results for commercial isobutane were included separately to see if they differ significantly from the combined data set. The results show no statistical differences. Based upon the above results, we set r_{foul} = 0.0 for all further analysis. Figure 3-10 is a plot of the results.

Performance Factors:

The heater test data was processed by two different methods, each employing the calculational procedure outline under stepwise calculations.

Heater performance involves two major factors, the pressure drop and the heater transfer. Since each affects the other, evaluating the selected pressure drop and heat transfer correlations separately is difficult. Method One attempts to evaluate the heat transfer correlations not by eliminating the pressure drop but rather by forcing conformity to experimental values, whereas Method Two allows the pressure drop and heat transfer effects to interact freely.

Method One:

In the first method the computed temperature-pressure profile for the entire heat exchanger train was forced to conform to the experimental profile. This was done by evaluating all six exchangers separately. For each exchanger the four terminal temperatures, pressures, and both flow rates, all as measured, were input to the analysis program. Each exchanger's entrance and exit state point was fixed at the measured values. The computed hydrocarbon pressure drop for each exchanger was made to conform to the experimental pressure drop through the adjustment

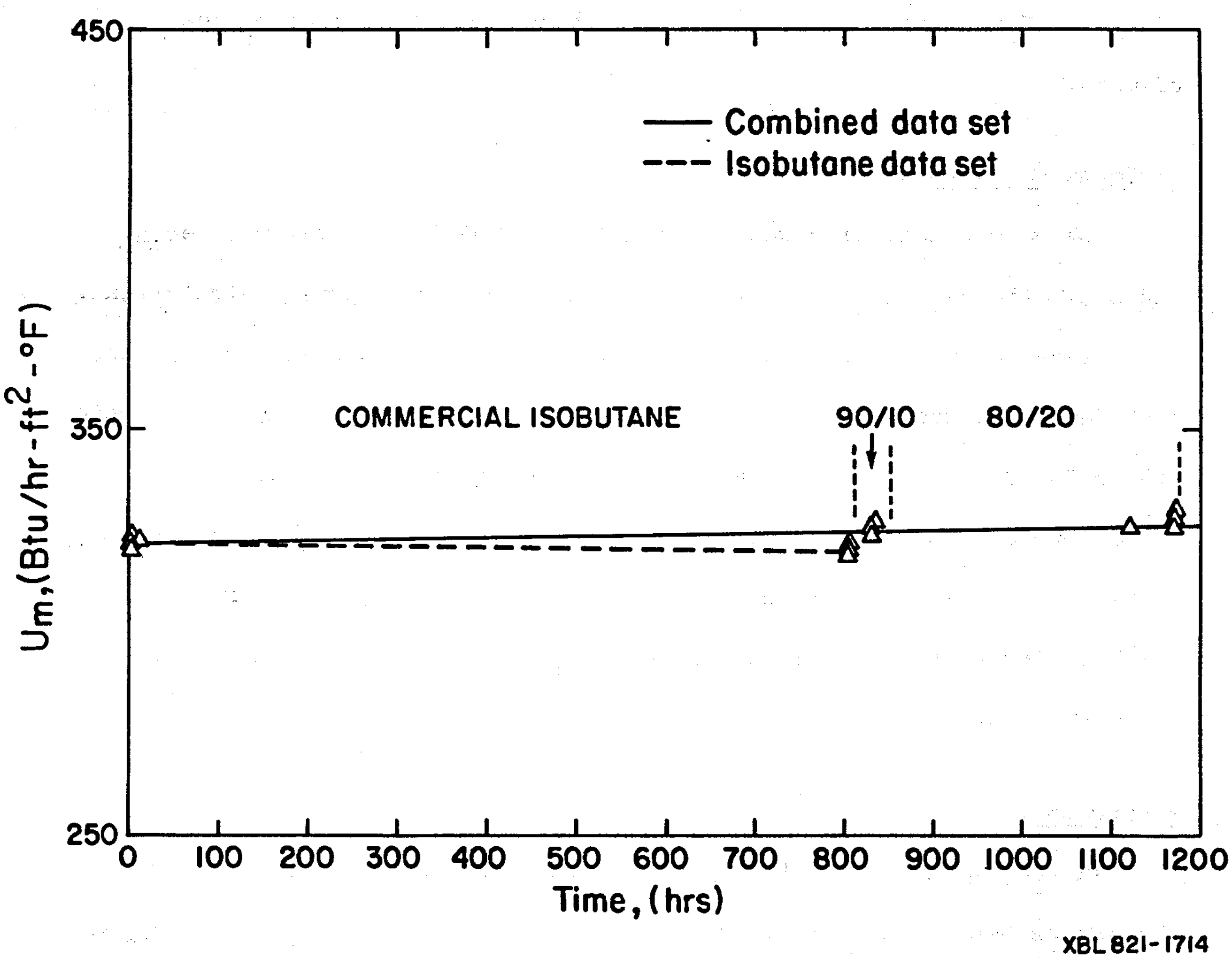

Fig. 3-10 Measured Overall Heat Transfer Coefficient for B-1
vs
Real Time

of the C_s parameter. Since the entrance and exit pressure and temperature were fixed, so were the enthalpies; therefore the ΔH for each hydrocarbon zone was based upon the overall hydrocarbon ΔH and not a 1st law heat balance applied to each zone, albeit the calculation used the brine side duty in evaluating the exchanger's performance.

The forced fit of the temperature-pressure profile minimizes the error in the overall area deviation. By not iterating on the pressure drop, any error in the calculated pressure drop would alter the temperature-pressure profile and compound the overall error in the prediction. The first method approximates the level of prediction a designer could expect if he were able to predict the pressure drop exactly. By conforming to the experimental temperature-pressure profile, we validate (or invalidate) the selected heat transfer correlations since we have suppressed that part of the calculation that projects a temperature-pressure profile.

The performance factors are the area, the overall measured heat transfer coefficient, the weighted LMTD, and the measured shell side film coefficient. A comparsion between the predicted area and the known area is given in Table 3-7. All entries are the average of the individual values from the data scans for the cited test fluid. Because exchanger B-6 differs from B-1 through B-5, the results for B-6 are reported separately.

The A_{dev} values are based upon the total exchanger area for B-1 through B-5 and B-6 respectively. The averaged individual exchanger areas are listed, plus their standard deviation, Std, and the percent deviation, % Dev, from the known exchanger area.

The values of A_{dev}, and the individual areas for B-1 through B-5 are in excellent agreement with experiment. The value of C_s varies little for the three test fluids and show a positive deviation of 1 to 9%.

Table 3-7

Exchanger Area form Method One Septwise Calculation

Commercial Isobutane

$A_{dev} = 0.66 \pm 1.51\%$ $C_s = 1.011 \pm 0.052$

Exchanger	$A_{cal}(ft^2)$	Std (ft^2)	% Dev
B-1	297.8	± 5.81	1.9
B-2	307.4	± 9.84	5.2
B-3	285.6	± 7.4	-2.3
B-4	283.9	± 9.5	-2.8
B-5	295.9	± 17.0	1.3

Nominal 90/10 Isobutane/Isopentane

$A_{dev} = 1.38 \pm 1.09\%$ $C_s = 1.088 \pm 0.055$

Exchanger	$A_{cal}(ft^2)$	Std (ft^2)	% Dev
B-1	290.3	± 4.3	-0.7
B-2	299.8	± 7.0	2.6
B-3	293.2	± 9.3	0.3
B-4	303.8	± 21.8	4.0
B-5	294.2	± 31.4	0.7

Nominal 80/20 Isobutane/Isopentane

$A_{dev} = 2.32 \pm 2.50\%$ $C_s = 1.032 \pm 0.042$

Exchanger	$A_{cal}(ft^2)$	Std (ft^2)	% Dev
B-1	282.1	± 1.5	-3.5
B-2	291.2	± 5.0	-0.3
B-3	282.7	± 13.2	-3.3
B-4	286.2	± 20.2	-2.0
B-5	284.8	± 25.0	-2.5

- - - - - - - - - - - - -

Exchanger B-6

Commercial Isobutane

$A_{dev} = \cdot 22.4 \pm 13.6\%$ $C_s = 1.016 \pm 0.182$

$A_{cal} = 226.7 \pm 39.7\ (ft^2)$

Nominal 90/10 Isobutane/Isopentane

$A_{dev} = -19.4 \pm 5.4\%$ $C_s = 1.196 \pm 0.156$

$A_{cal} = 244.2 \pm 15.9\ (ft^2)$

Nominal 80/20 Isobutane/Isopentane

$A_{dev} = -15.9 \pm 11.0\%$ $C_s = 1.184 \pm 0.093$

$A_{cal} = 245.5 \pm 32.1\ (ft^2)$

The results strongly suggest that the heat transfer and pressure drop algorithms chosen for modeling the exchangers are adequate for design purposes provided the temperature-pressure profile is known and adequate fluid properties are employed. This conclusion is further reinforced by the excellent fit to the mixture data for correlations scaled against the "pure" data.

The results for exchanger B-6 are also listed in Table 3-7. Exchanger B-6 in most test conditions straddles or lies to the right of the TCL region. We feel that the consistent area deviation of ≈ -20% for nearly all the data scans is a result of the heat transfer and pressure drop algorithm sensitivity to fluid property variation. Whether or not the fluid properties are accurately described in the B-6 region is moot as little if any experimental data, particularly for the mixtures, exists for the region. The results simply imply that given the fluid property base used, the computed shell side film coefficient is too large compared too the actual film coefficient. The implication is that the predicted enhancement in the film coefficient from the increase in the heat capacity in the TCL region does not fully exhibit itself in the form of increased exchanger performance, a fact consist with work by Tleimat[14].

Figure 3-11 is a scatter plot of A_{dev} for B-1 through B-5 for the individual commerical isobutane data scans. We see that the maximum excursion is less than ± 4%.

Tables 3-8 and 3-9 list the other measured performance for B-1 through B-5 and B-6 respectively. Each entry is an averaged value of the data scans for the test cited. Runs where only B-1 through B-4 were in operation were excluded.

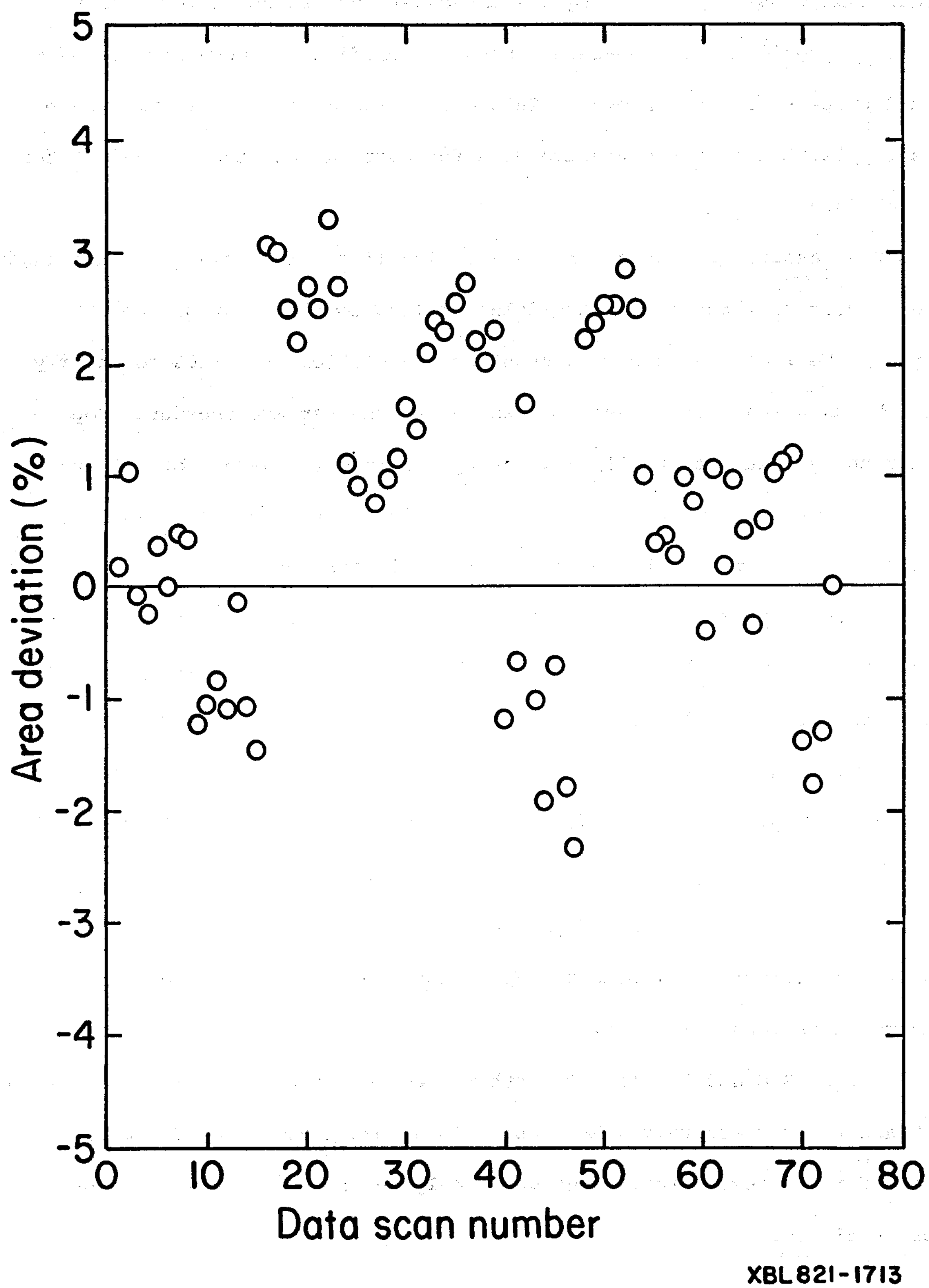

Fig. 3-11 Overall Area Deviation for Primary Heaters for Commerical Isobutane Data

Table 3-8

Performance for B-1 through B-5 from Method One Calculation

Run #	$T_{Br,in}$ (°F)	$T_{Br,out}$ (°F)	m_{Br} (lbs/hr)	$T_{Hc,in}$ (psia)	$P_{Hc,in}$ (psia)	$T_{Hc,out}$ (°F)	$P_{Hc,out}$ (psia)	m_{HC} (lbs/hr)	Duty (Btu/hr) $x10^{-6}$	LMTD (°F)	U_m	$h_{o,m}$	P-Pt (°F)
						--- Commercial Isobutane ---							
1	309.9	205.2	93200	140.6	666.8	292.0	620.4	74513	9.92	17.4	391	670	8.3
2	327.1	218.0	93365	131.5	653.9	309.7	616.3	60547	10.4	18.7	379	628	8.1
5	307.7	207.9	102357	152.1	675.8	290.4	619.9	83088	10.4	16.7	425	746	8.5
6	303.3	201.9	99136	152.2	651.8	285.3	593.0	86505	10.2	16.8	415	730	9.1
7	319.7	213.0	101133	142.8	639.4	295.8	593.2	71180	11.0	17.8	424	739	8.2
8	342.8	239.3	101006	138.1	635.7	339.2	585.9	53484	10.7	19.8	372	580	2.6
10	305.8	206.3	101684	157.0	656.3	286.4	596.0	86811	10.3	16.4	429	761	9.0
11	300.0	205.5	95408	161.1	633.1	281.5	575.3	88175	9.2	15.5	403	711	8.5
12	321.6	212.7	95938	146.5	616.8	293.9	571.9	69052	10.7	17.9	407	708	8.0
13	296.3	201.0	64052	146.3	584.4	279.1	561.7	53366	6.2	16.6	261	432	6.6
15	301.7	207.3	97556	162.1	632.8	281.8	575.7	84258	9.4	15.7	408	715	8.6
						--- 9/10 Isobutane/Isopentane ---							
18	316.7	202.4	93051	119.1	655.9	298.4	615.6	69858	10.8	19.6	379	607	8.5
19	334.9	220.0	80142	118.0	637.0	322.6	612.2	48672	9.4	19.5	330	529	8.1
20	305.6	191.9	98963	130.1	650.8	289.5	591.3	84485	11.4	20.0	391	660	10.7
21	345.5	202.7	44921	118.4	639.4	317.9	588.2	68725	13.9	24.1	393	663	11.3
22	340.6	204.3	70876	124.0	603.9	316.4	577.4	49535	9.9	21.0	322	537	8.8
23	306.0	193.4	100440	121.7	625.9	288.0	572.7	78711	11.5	19.9	394	662	9.1
24	343.6	218.0	98306	121.5	621.9	329.6	575.4	62899	12.6	22.4	386	630	10.5
25	341.3	219.4	75479	134.8	593.5	329.7	565.2	48090	9.4	19.8	326	530	8.9
						--- 80/20 Isobutane/Isopentane ---							
25A	315.1	192.6	96328	125.6	675.1	302.0	615.5	90258	12.0	21.6	380	633	11.4
26	344.7	197.7	96656	122.6	684.3	315.8	622.1	88362	14.5	24.7	402	686	13.7
28	316.6	201.5	85599	126.9	654.3	304.7	614.8	72582	10.0	20.1	341	551	9.4
29	330.9	229.6	86270	130.0	634.5	316.6	608.2	53067	8.9	17.5	351	562	7.0
30	310.2	192.9	96560	134.8	656.2	296.2	592.8	93821	11.5	20.7	380	635	11.2
31	316.4	210.3	96514	133.0	635.0	302.5	591.3	75087	10.4	19.3	369	597	8.7
32	324.6	222.6	85921	129.5	612.1	307.1	584.9	55691	8.9	17.6	348	560	6.8
33	307.6	196.4	100502	140.7	636.9	293.5	569.7	96419	11.4	19.8	393	660	10.6
34	314.3	208.4	100389	129.2	615.6	298.3	568.6	77524	10.8	19.4	382	620	8.0
35	337.8	230.1	100746	123.3	602.5	324.1	565.6	57842	11.1	20.7	368	575	8.2
36	317.8	206.1	100603	135.2	675.4	304.8	619.8	85595	11.4	20.4	383	634	10.1

Table 3-9

Performance for B-6 from Method One Calculation

Run #	$T_{Br,in}$ (°F)	$T_{Br,out}$ (°F)	m_{Br} (lbs/hr)	$T_{Hc,in}$ (psia)	$P_{Hc,in}$ (psia)	$T_{Hc,out}$ (°F)	$P_{HC,out}$ (psia)	m_{Hc} (lbs/hr)	Duty (Btu/hr) $x10^{-6}$	LMTD (°F)	U_m	$h_{o,m}$
					--- Commercial Isobutane ---							
1	339.4	309.9	93200	292.0	620.4	314.5	603.0	74513	2.85	24.2	403	674
2	338.9	327.1	93365	309.7	616.3	329.2	600.8	60547	1.15	13.4	295	416
5	339.5	307.7	102357	290.4	619.9	311.0	599.5	83088	3.37	25.0	462	820
6	342.8	303.3	99136	285.3	593.0	307.6	570.6	86505	4.06	29.1	478	888
7	342.6	319.7	101133	295.8	593.2	325.9	572.2	71180	2.41	22.1	373	576
10	344.9	305.8	101684	286.4	596.0	311.5	572.6	86811	4.13	29.9	474	860
11	344.3	300.0	95408	281.5	575.3	307.4	552.1	85175	4.36	31.1	480	917
12	344.6	321.6	95938	293.9	571.9	328.7	549.9	69052	2.29	22.6	346	523
13	338.0	296.3	64052	279.1	561.7	310.1	551.8	53366	2.76	27.0	350	631
15	344.4	301.7	97556	281.8	575.7	309.3	552.2	84258	4.32	31.6	468	861
					--- 90/10 Isobutane/Isopentane ---							
18	342.3	316.7	93051	298.4	615.6	322.7	599.7	69858	2.48	21.7	392	641
19	341.5	334.9	80142	322.6	612.2	338.8	602.5	48672	0.55	6.3	301	445
20	342.6	305.6	98963	289.5	591.3	306.5	570.6	84485	3.80	24.2	538	1119
23	342.8	306.0	100440	288.0	572.7	310.1	551.6	78711	3.83	26.6	493	933
					--- 80/20 Isobutane/Isopentane ---							
25A	344.0	315.1	96328	302.0	615.5	313.0	598.8	90258	2.90	18.8	528	1085
28	342.3	316.6	85599	304.7	614.8	316.6	603.0	72582	2.29	16.5	554	944
29	343.8	330.9	86270	356.6	608.2	334.7	598.5	53067	1.16	12.9	309	453
30	344.6	310.2	96560	296.2	592.8	307.0	574.4	93821	3.45	21.4	551	1193
31	344.9	316.4	96514	302.5	591.3	318.8	575.5	75087	2.86	19.4	505	989
32	342.8	324.6	85921	307.1	584.9	329.6	573.8	55691	1.64	18.9	296	426
33	344.5	307.6	100502	293.5	569.7	302.6	548.7	96419	3.85	21.9	602	1419
34	345.2	314.3	100389	298.3	568.6	316.6	550.4	77524	3.23	22.5	492	925
35	345.5	337.8	100746	324.1	565.6	338.9	550.3	57842	0.81	9.7	286	391
36	344.7	317.8	100603	304.8	619.8	315.6	602.9	85595	2.82	18.3	535	1054

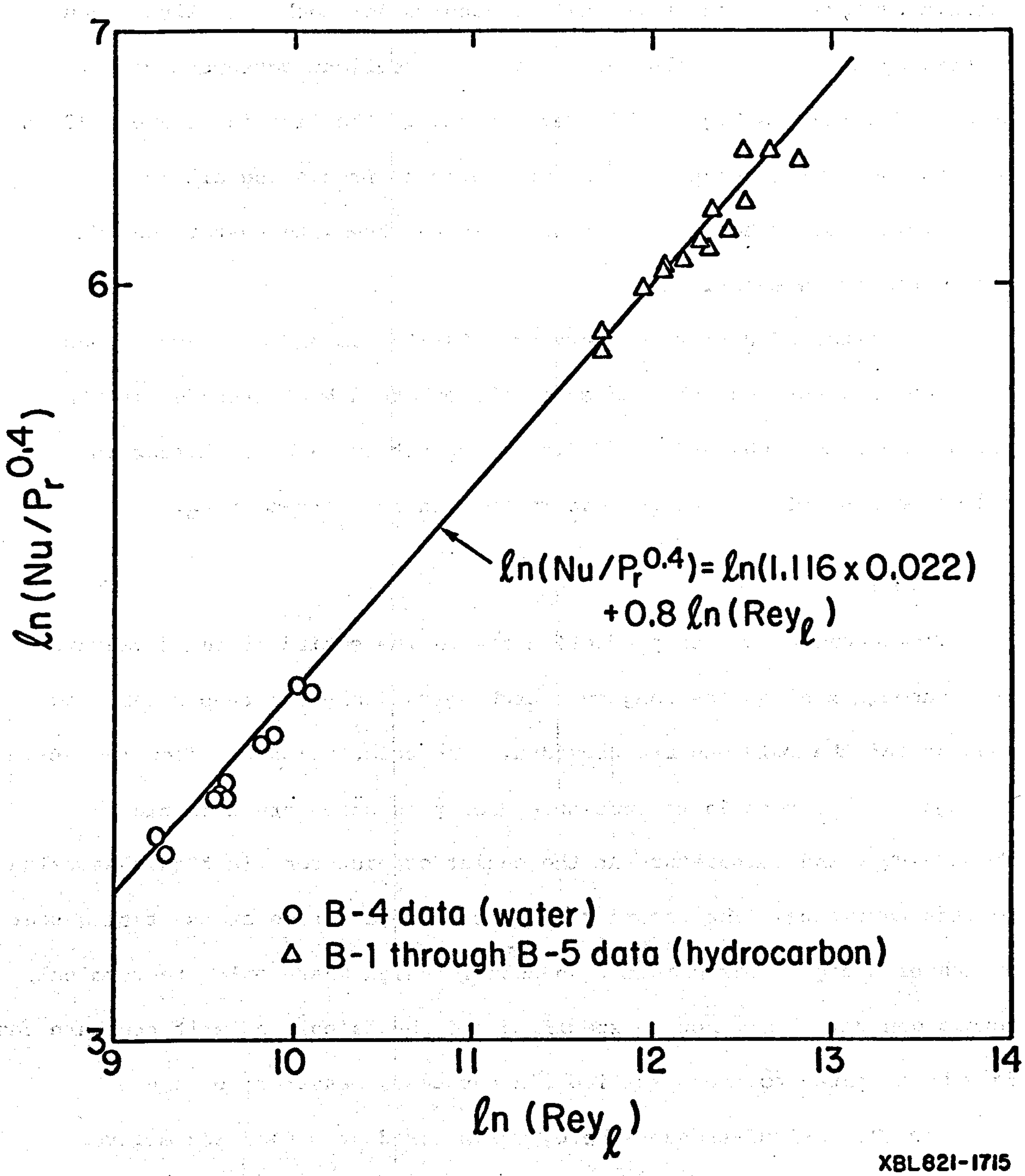

Fig. 3-12 Nusselt Plot for Primary heater Tests Based on Method One Calculation

In Table 3-8 the values of U_m vary from 429 to 261. The general trend of U_m is to lower values with increasing mole fraction of isopentane (for example, compare test runs 7, 21, and 31). However, the Nusselt numbers for the individual exchangers for each test fluid when plotted against the Reynolds number are in excellent agreement with predicted values as Figure 3-12 demonstrates. The line in Figure 3-12 is equation 3-24 with the plotted points selected from among all three test fluids for exchanger B-1 through B-5 and the water-water test data. The agreement is excellent.

The values of U_m for B-6 vary from 538 to 295 and are larger than those for B-1 through B-5 because of the enhanced heat transfer in TCL region. For B-6, the effect of fluid composition on U_m is harder to detect because of the greater uncertainty in the values of U_m.

Method Two:

The second method of prediction treats the entire train of heaters (B-1 through B-5) as one long heat exchanger. Only the temperature and pressure of the cold end are provided. The calculation proceeds from B-1 through B-5. Errors in the pressure drop prediction are accumulative as the pressure and temperature at the outlet of each zone is the inlet value for the next zone. The second method is representative of the task a heat exchanger designer performs for an actual design where only the terminal conditions may or may not be specified and the calculated exit pressure can only be compared to the specified (in our case, measured) pressure.

For this calculational scheme, C_s is fixed at 1.0115 and a first law heat balance is forced on each zone. The C_s value was obtained as the average of the individual values for the data scans for the commercial isobutane tests run with C_o fixed at 1.116.

Rather than run all the data scans and report out averaged values, one data scan representative of each test run was selected for analysis. The resulting performance parameters are compared in Table 3-10 to those obtained from the first calculational method. The A_{dev} values are for the total area of B-1 through B-5. The quantities subscripted with "m" are measured values from the first calculational method. The subscript 1 and 2 refer respectively to the first and second calculational methods, and the subscript "dev" are computed relative to the measured quantity.

We noted that with few exceptions U and U_m agree quite well, as do h_o and $h_{o,m}$, and P_{dev} is within acceptable limits. However, A_{dev} varies considerably. An interesting point is the consistently smaller computed pinch point versus the experimental value, P-Pt_1. This means the temperature-pressure profile as computed lies closer to the brine duty line than indicated by experiment. The result is a smaller LMTD for many zones and a concomitantly larger area.

The relationship is nicely demonstrated by the T-Q plot of Figure 3-13 for test run 21 (nominal 90/10 test fluid). The dotted line is the experimental hydrocarbon curve (method one calculation), the solid line the computed hydrocarbon curve (method two calculation). Both curves are qualitatively identical. Note however, the rapid increase in the computed temperature and the severe transition after the pinch point. There appears to be a critical pinch point of around 8 to 10°F, below which the calculated pinch point and the area deviate strongly from experiment.

Figures 3-14 and 3-15 illustrate the price paid in area and pressure drop to heat the hydrocarbon at supercritical conditions. Figure 3-14 is a temperature versus area profile for test run 25A. The hydrocarbon temperature rises 148°F (125 to 273°F) in the first half of the train, but only

Table 3-10

Performance for B-1 through B-5 for Selected Data Runs Using a Method Two Calculation

Test Run #	A_{dev} (%)	U	U_m	U_{dev} (%)	h_o	h_{om}	h_{dev} (%)	$LMTD_2$ (°F)	$LMTD_1$ (°F)	P_{dev} (psia)	$P\text{-}Pt_2$ (°F)	$P\text{-}Pt_1$ (°F)
Commercial Isobutane												
1	1.9	395	391	1.0	682	670	1.8	16.9	17.4	−0.7	7.9	8.3
2	5.5	388	379	2.4	651	628	3.7	17.3	18.7	−5.1	6.8	8.1
5	30.4	429	425	.9	753	746	0.9	12.8	16.7	0.6	5.5	8.5
6	18.6	422	415	1.7	751	730	2.9	14.1	16.8	0.2	7.0	9.1
7	23.3	423	424	−0.2	736	739	−0.4	14.4	17.8	−1.3	5.2	8.2
8	3.5	380	372	2.2	601	580	3.6	18.5	19.8	−6.8	2.2	2.6
10	19.4	431	429	0.5	768	761	0.9	13.6	16.4	−0.7	6.7	9.0
11	4.4	410	403	1.7	731	711	2.8	14.7	15.5	−0.3	8.6	8.5
12	12.2	414	407	1.7	727	708	2.7	15.6	17.9	−4.0	6.0	8.0
13	−5.6	300	261	14.9	509	432	17.8	15.0	16.6	−0.2	7.2	6.6
15	13.9	418	408	2.5	744	715	4.1	13.4	15.7	−2.0	6.9	8.6
Nominal 90/10 Isobutane/Isopentane												
18	34.6	394	379	4.0	671	607	10.5	14.0	19.6	0.4	4.7	8.5
19	52.8	344	330	4.2	563	529	6.4	12.3	19.5	6.4	3.4	8.1
20	113.4	421	391	7.7	741	660	12.3	8.7	20.0	−6.2	2.6	10.7
21	99.0	411	393	4.6	711	663	7.2	11.6	24.1	−8.8	2.7	11.3
22	601.7	48	322	−85.1	591	537	10.1	20.0	21.0	−15.0	−.7	8.8
23	161.8	424	394	7.6	742	662	12.1	7.1	19.9	−71.0	1.4	9.1
24	24.4	404	386	4.7	678	630	7.6	17.2	22.9	−4.7	5.9	10.5
25	38.2	336	326	3.1	554	530	4.5	13.8	19.8	−2.5	4.1	8.9
Nominal 80/20 Isobutane/Isopentane												
25A	−2.3	399	380	5.0	686	633	8.4	21.0	21.6	−0.7	10.1	11.4
26	−0.1	423	402	5.2	747	686	8.9	23.6	24.7	−3.0	12.4	13.7
28	9.0	364	391	6.7	611	551	10.9	17.3	20.1	2.0	6.8	9.4
29	57.7	366	351	4.3	601	562	6.9	10.6	17.5	14.8	2.5	7.0
30	3.8	405	380	6.6	703	535	10.7	18.8	20.7	1.0	9.4	11.2
31	22.9	397	369	7.6	668	597	11.9	14.6	19.3	2.6	5.1	8.7
32	41.8	369	348	6.0	613	560	9.5	11.7	17.6	2.5	3.0	6.8
33	4.6	415	393	5.6	723	660	9.5	17.9	19.8	−0.2	9.0	10.6
34	17.9	407	382	6.5	688	620	11.0	15.4	19.4	1.1	5.4	8.0
35	31.4	406	368	10.3	672	575	16.9	14.2	11.1	−6.6	3.7	8.2
36	11.3	410	383	7.1	696	634	9.8	17.2	20.4	0.6	7.0	10.1

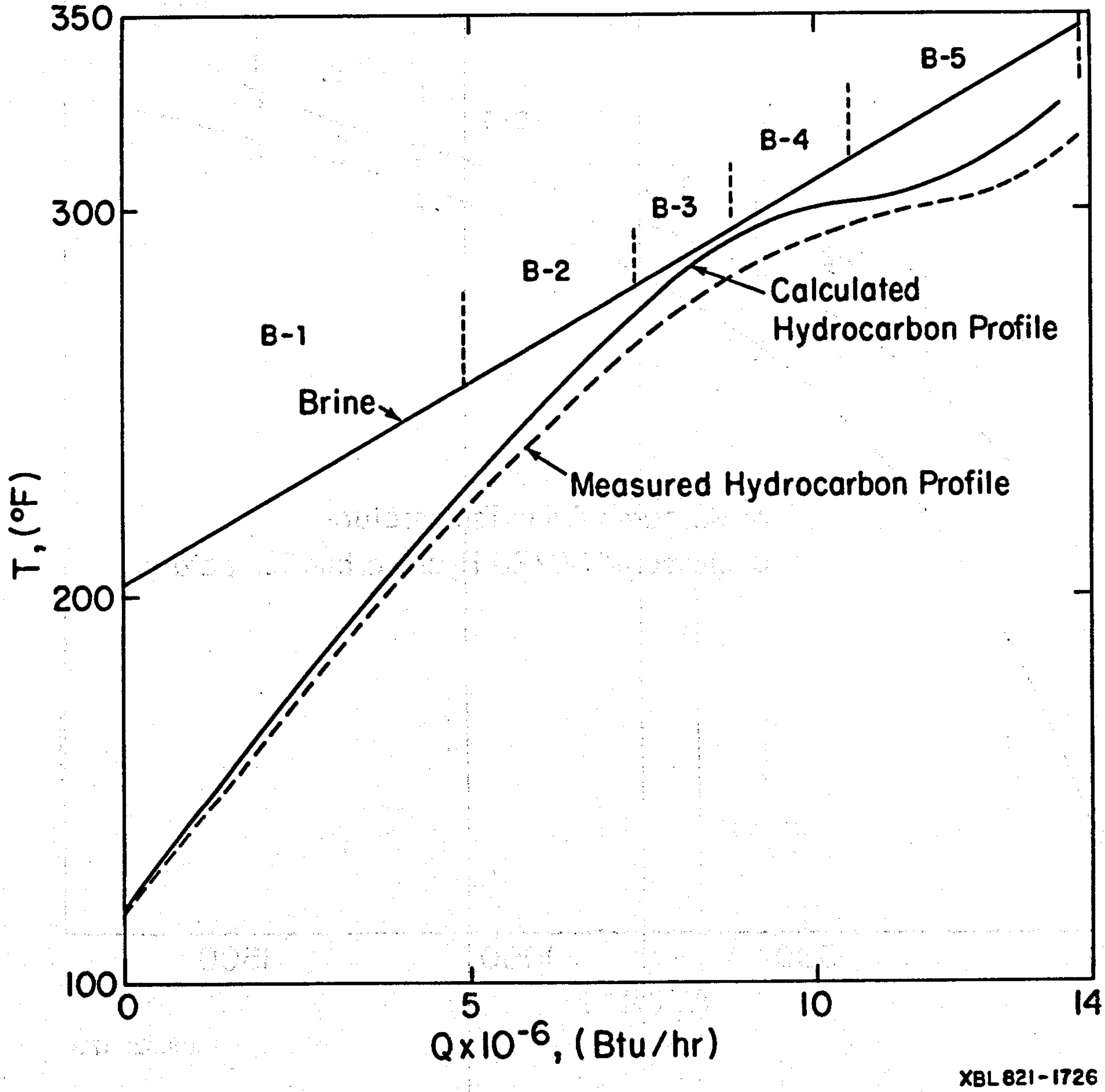

Fig. 3-13 Temperature vs Duty for Nominal 90/10 Test Fluid in Primary Heaters

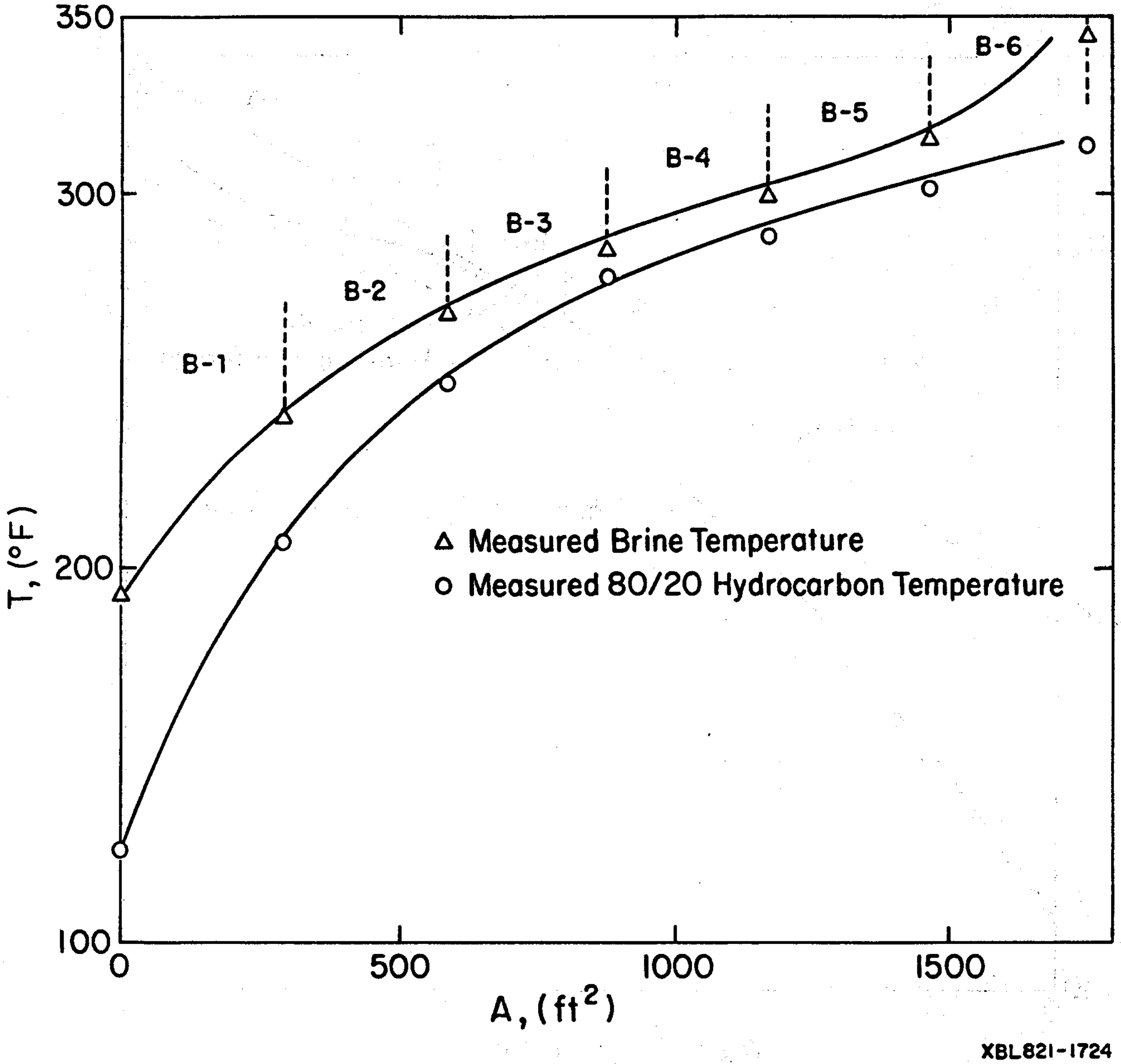

Fig. 3-14 Temperature vs Area for Nominal 80/20 Test Fluid in Primary Heaters

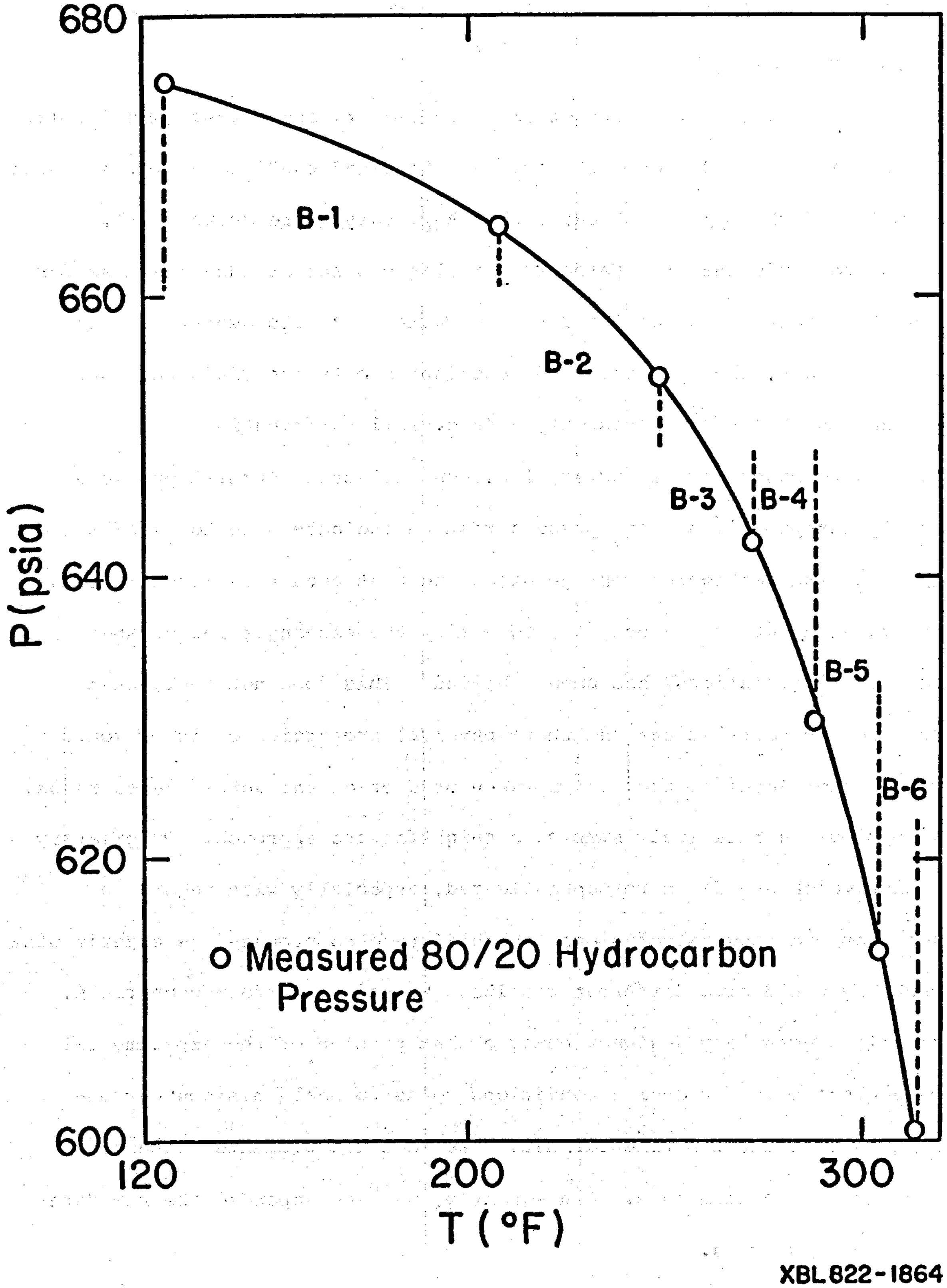

Fig. 3-15 Pressure vs Temperature for Nominal 80/20 Test Fluid in Primary Heaters

40°F (273 to 313°F) in the last half. Figure 3-15 is a pressure versus temperature profile for test run 25A. The hydrocarbon pressure drops 33 psia (675 to 642 psia) in the first half of the train, and 43 psia (642 to 599 psia) in the last half.

From Table 3-10, if we restrict our attention to those test runs (1, 18, and 26) that are located around the original "design" conditions, we see, with the exception of the 90/10 test data, that A_{dev} values are quite small. Overall, we conclude that the selected correlations appear adequate. As for the consistent area deviation for B-6 (see Table 3-8), its overall effect must be weighted by the fact that B-6 contributes only one sixth the total area so that the 20% error makes only a 4% overall contribution.

We find no major discrepancies, i.e., our selected correlations were not totally inappropriate. The present results indicate good to excellent agreement for the particular configuration and test condition investigated.

The main intent of the program, to verify the exchanger performance with existing correlations, has been achieved. This does not imply that different design correlations and thermophysical properties could or would achieve the same level of accuracy between prediction and actual performance. We have employed a relatively simple, straightforward approach. Proprietary codes exist which are far more sophisticated, especially with regard to pressure drop and flow calculations, which if used to process the experimental data probably would give different results. We cannot perform such tasks, but strongly suggest any designer analyze that portion of the experimental data base closest to his design conditions so as to scale his own correlations against actual experimental data. We feel the ultimate value of this program is the data base. Consequently, we have appended the raw data scans for the test runs.

TEST RESULTS, CONDENSER

Hydrocarbon Composition:

The method of preparing the hydrocarbon test fluids and their chemical analysis were as described under Hydrocarbon Sampling and Analysis, and Hydrocarbon Composition for the primary heaters. Table 3-11 lists the test fluid compositions.

Numerical instabilities were encountered in performing the dew point and bubble point calculations needed for the condenser data analysis because of the low mole fractions of propane, n-butane, and n-pentane. Consequently, for the condenser data analysis, the isobutane composition was set equal to the sum of the propane, n-butane, and isobutane mole fractions as listed in Table 3-11, and the isopentane composition was set equal to unity minus the isobutane composition.

Data Analysis, Condenser:

Whereas the intent of the primary heater data analysis was to validate the heater performance, for the condenser the intent is to report "measured" quantities such as overall heat transfer coefficients, shell side film coefficients, Reynolds numbers, etc. These measured quantities could then be used as a benchmark for larger or more complicated condenser designs. We have adopted this approach because modeling of condensers, though a well traveled road, ends in as many different locales as the modeling vehicles employed. We have attempted to maintain a simple approach whose results would have the widest applicability. Consequently, we have choosen "conventional" models and dispensed with any stepwise calculations across the tube bundle. The following presentation of basic equations reflects this approach. A certain familiarity of the reader with the equation is assumed. Nomenclature used is listed in Table 3-12.

Table 3-11

Hydrocarbon Composition for the Condenser Tests

Commercial Isobutane

Component	Mole %
Propane	0.33
n-Butane	3.28
i-Butane	96.39

Nominal 90/10 Isobutane/Isopentane

Component	Mole %
Propane	0.33 ± 0.01
n-Butane	2.97 ± 0.02
i-Butane	87.22 ± 0.06
n-Pentane	0.45 ± 0.05
i-Pentane	9.06 ± 0.01

Nominal 80/20 Isobutane/Isopentane

Component	Mole %
Propane	0.26 ± 0.00
n-Butane	2.55 ± 0.00
i-Butane	74.90 ± 0.06
n-Pentane	1.05 ± 0.00
i-Pentane	21.24 ± 0.06

Data Reduction-Condenser, The Basic Equations:

A modified form of the basic heat transfer equation was used for the condenser:

$$Q_{cond} = U_{cond} A_{cond} MTD \tag{3-57}$$

where Q_{cond}, U_{cond}, and A_{cond} have their usual meaning and MTD is the mean temperature difference computed as,

$$MTD = F \cdot LMTD \tag{3-58}$$

where LMTD is the log-mean-temperature difference defined for the condenser as

$$T_a = T_{vap} - T_{cw,out}$$

$$T_b = T_{liq} - T_{cw,in}$$

$$LMTD = (T_a - T_b)/\ell_n(T_a/T_b) \tag{3-59}$$

and F is a correction factor for non-isothermal conditions* defined as

$$F = -a/N_{tp} * \ell n(1+ \ell n(1-b/r)) \tag{3-60}$$

where:

N_{tp} = 1 (number of tube passes)

$r = (T_{vapor} - T_{liq})/(T_{cw,out} - T_{cw,in})$

$p = (T_{cw,out} - T_{cw,in})/(T_{vapor} - T_{cw,in})$

$b = r*p$

$a = \ell n(1-p)/(1-b))/(r-1)$

T_{vap} = hydrocarbon dew point temperature at condenser pressure, P_{cond}

T_{liq} = hydrocarbon bubble point temperature at P_{cond}

$T_{cw,in}$ = cooling water inlet temperature

$T_{cw,out}$ = cooling water outlet temperature

*(Private communication, P. T. Doyle)

Table 3-12

NOMENCLATURE

A - Surface area, f^2

C_p - Heat capacity, Btu/lb_m-°F

d - Diameter, ft

g - Acceleration of gravity, ft/sec

G - Mass velocity, lb_m/hr-ft

h - Heat transfer coefficient, Btu/hr-ft^2-°F

k - Thermal conductivity, Btu/hr-ft^2-°F

L - Tube length, ft

m - Fluid mass flow, lb_m/hr

N_u - Nusselt number, dimensionless

p - pressure, lb_f/in^2

Pr - Prandtl number, dimensionless

Q - Heat load, Btu/hr

r - thermal resistance (individual), hr-ft^2/Btu

Re - Reynolds number, dimensionless

T - Fluid Temperature, °F

LMTD - Log mean temperature difference, °F

MTD - Mean temperature difference, °F

U - Overall heat transfer coefficient, Btu/hr-ft^2-°F

u - Viscosity, lbs/ft-sec

ρ - Fluid density, lb_m/ft^3

Z - Bulk mole fraction of hydrocarbon component, dimensionless

SUBSCRIPTS

b - Bulk property

i,o - Inside and outside areas, respectively

io - Inside valve referred to outside surface area

cw - Cooling water

Hc - Hydrocarbon

m - measured quantity

in - inlet

out - outlet

shell - shell side

wall - tube interior wall

The overall heat transfer coefficient may be treated as a series of connected thermal resistances, i.e.,

$$\frac{1}{U_{cond}} = \frac{1}{h_{io}} + r_{foul} + r_{wall} + r_{shell} + \frac{1}{h_o} \tag{3-61}$$

where:

h_{io} is the tube side film coefficient referred to the outside tube area,

r_{foul} is the tube side fouling resistance,

r_{shell} is the shell side fouling resistance,

h_o is the shell side film coefficient referred to the outside tube area

Because we are interested in measured quantities, we rearrange equations (3-57) and (3-61) to yield,

$$U_m = Q_{cond}/(A_{cond}MTD) \tag{3-62}$$

$$h_{o,m} = \frac{1}{\frac{1}{U_m} - r_{wall} - r_{foul} - r_{shell} - \frac{1}{h_{io}}} \tag{3-63}$$

The last three terms in equation (3-63) were computed from correlations which are functions of the thermophysical fluid properties and geometry factors. As with the primary heaters, the tube side film coefficient was computed from the Dittus-Boelter equation, given as,

$$Nu_t = 0.022\ Re_t^{0.8} P_r^{0.4} \tag{3-64}$$

where:

$$Nu_t = h_{io} d_o / k_b$$

$$Re_t = G_t d_i / u_b$$

$$P_r = C_p u_b / k_b$$

$G_t = m_{cw}N_p/(N_tA_t)$

d_o = outside tube diameter

d_i = inside tube diameter

k_b = thermal conductivity of the bulk fluid

u_b = viscosity of the bulk fluid

C_p = heat capacity of the bulk fluid

m_{cw} = mass flow rate of the cooling water

N_p = number of cooling water tube passes

N_t = number of tubes

A_t = cross-sectional area of a single tube

The tube wall thermal resistance was computed as

$$r_{wall} = d_o \ell n(d_o/d_i)/(2\ \rho\ k_{wall}) \qquad (3\text{-}65)$$

The relationship for r_{foul} is discussed later.

The other condensing parameters of interest are the Reynolds number, the Nusselt number and the clean overall heat transfer coefficient.

The condensate Reynolds number, Rey_c, is given as

$$Rey_c = \frac{4\Gamma}{u_{liq}} \qquad (3\text{-}66)$$

where:

Γ = tube loading

$= m_{Hc}/N_{cs}L$

m_{Hc} = mass flow of the hydrocarbon

N_{cs} = number of condensing streams

L = tube length

u_{liq} = the hydrocarbon bulk viscosity at the bubble point

The Nusselt number for no vapor shear effects is given as,

$$Nu_c = h_{o,m} d_c / k_{liq} \tag{3-67}$$

where:

$$d_c = \left(\frac{u^2_{liq}}{g\,\rho_{liq}(\rho_{liq} - \rho_{vap})} \right)^{1/3}$$

k_{liq} = liquid hydrocarbon thermal conductivity at the bubble point

g = acceleration of gravity

ρ_{liq} = bubble point hydrocarbon density

ρ_{vap} = dew point hydrocarbon density

The clean overall heat transfer coefficient, U_{clean}, is given by,

$$U_{clean} = \frac{1}{\frac{1}{U_m} - r_{foul}} \tag{3-68}$$

The above equations assume wet tube wall conditions. The wet tube wall model was adopted because in all test runs the cooling water exit temperature was well below the hydrocarbon dew point temperature for the set condenser pressure. The condensing mechanism is therefore liquid on the tube wall in contact with vapor. Consequently, the dew point temperature is used in the model rather than the temperature of the incoming superheated vapor.

Data Reduction, Condenser, Assumptions:

The condenser basic equations we used have no empricially adjustable parameters; only the correct thermophysical properties are needed. The cooling water properties presented no problems and were taken to be those for pure water. The hydrocarbon properties require the dew point and bubble point temperatures.

The temperatures for equation 3-66 through 3-67 were specified as

$$T_{vap,cal} = F_1(P_{cond}, Z_{iC_4}) \quad \text{(dew point)} \tag{3-69}$$

$$T_{liq,cal} = F_2(P_{cond}, Z_{iC_4}) \quad \text{(bubble point)} \tag{3-70}$$

$$T_{liq,exp} = T_{Hc,out} \tag{3-71}$$

$$T_{vap,exp} = T_{liq,exp} + (T_{vap,cal} - T_{liq,cal}) \tag{3-72}$$

where:

$T_{vap,cal}$ is the calculated dew point from fluid property algorithms

$T_{liq,cal}$ is the calculated bubble point from fluid property algorithms

$T_{liq,exp}$ is the experimental bubble point

$T_{HC,out}$ is the measured temperature of the hydrocarbon exiting the condenser

$T_{vap,exp}$ is the experimental dew point temperature

Z_{iC_4} is the bulk mole fraction of isobutane

The fluid property algorithms were written to allow calculation of the bubble point and dew point temperatures given the condenser pressure and hydrocarbon composition using the standard method of equating component fugacities across the phase boundary. When the computed bubble points were compared with experimental data[12] and the measured condenser hydrocarbon exit temperatures, the hydrocarbon algorithms were found to yield bubble points five to ten degrees higher than the experimental data or the measured exit temperatures. However, the computed isobaric temperature differences across the dome were in much better agreement with experiment. Since the experimental data was limited, the algorithms could not be reliably readjusted. The simplest approach was to take the bubble point temperature as the measured hydrocarbon exit temperature, $T_{HC,out}$.

The condenser tests were run such that the condenser's two downcomers, where the exit temperatures were measured, were never flooded with liquid so that $T_{HC,out}$ includes a minium of subcooling.

The dew point temperature could not, however, be directly measured. The hydrocarbon domes are retrograde, which would require a two-phase expansion from the throttle valve to produce a condenser inlet state on or very near the dew point. Since no provisions existed to indicate where in the two-phase region the expansion should start, and since such a procedure would of necessity rely directly upon calculated temperatures and physical properties, the simple approach of requiring the hydrocarbon exiting the primary heaters to be fully in the gas phase was adopted, albeit the exit conditions were often subcritical. The above procedure eliminated any possibility of liquid carry over to the condenser and insured that the incoming gas was fully superheated. The exit conditions from the heat exchanger train were set by noting the hydrocarbon temperature distribution and operating at five to ten degrees above the computed dew point for the heat exchanger train exit pressure. Consequently, the measured $T_{HC,in}$ is a superheated gas temperature. To establish a dew point temperature, the calculated temperature difference across the dome at P_{cond} was added to $T_{liq,exp}$. Equations 3-69 through 3-72 summarize the temperature assumptions.

The temperatures used in the condenser analysis are therefore,

$$T_{vap} = T_{vap,exp}$$

$$T_{liq} = T_{liq,exp} = T_{Hc,out}$$

$$T_{cw,in} = T_{cw,in} \text{ (measured)}$$

$$T_{cw,out} = T_{cw,out} \text{ (measured)}$$

The geometry factors are:

$$d_o = 0.75/12$$

$$d_i = 0.560/12$$

$$A_t = (\pi d_i/2)^2/144$$

$$N_p = 2$$

$$N_t = 336$$

$$N_{cs} = 36 \text{ for full tube bundle}$$
$$18 \text{ for half tube bundle}$$

$$L = 19.6$$

$$g = 32.17406$$

Values for the three thermal resistances are also needed. For the wall resistance, k_{wall} = 26.2 (Btu/hr-ft^2-°F) for carbon steel tubes. With the above values of the tube diameters, equation 3-65 was used to compute r_{wall}. Because the shell side was throughly cleaned and maintained in such a state throughout the tests, r_{shell} was taken as zero. The values of r_{foul} depend on the run time, and are discussed below. We therefore have

$$r_{wall} = 3.484\ 10^{-4} \text{ (deg-°F-hr-ft}^2\text{/Btu)}$$

$$r_{shell} = 0.0$$

The bulk properties used in computing the tube side film coefficient were computed as

$$k_b = (k_{cw,in} + k_{cw,out})/2 \tag{3-73}$$

$$u_b = (u_{cw,in} + u_{cw,out})/2 \tag{3-74}$$

$$C_p = \frac{(H_{cw,out} - H_{cw,in})}{(T_{cw,out} - T_{cw,in})} \tag{3-75}$$

i.e., as the average of the entrance and exit values for the transport properties, and as a constant heat capacity based on the entrance and exit enthalpies, H, and temperatures, T.

Data Reduction, Condenser, Test Results:

Table 3-12 summarizes the condenser test conditions. Each entry is the average of five to eight data scans. The actual analysis was applied to each data scan. The number of data scans were: 48 for commercial isobutane, 39 for nominal 90/10, and 46 for nominal 80/20, for a total of 133 scans out of 140 total scans taken, with 7 scans rejected for data inconsistencies. The reported heat balances are relative to the cooling water duty and the duty is based on the cooling water.

Fouling Resistance:

Because of the test conditions employed, the tube side fouling could not be taken as zero. Changes in r_{foul} could, however, be determined by using a differential resistance method of analysis.

For any data scan at time t_o,

$$\frac{1}{h_{o,m}(t_o)} = \frac{1}{U_m(t_o)} - r_{wall} - r_{foul}(t_o) - \frac{1}{h_{io}(t_o)} \tag{3-76}$$

Table 3-12

Condenser Test Summary

Test #	$T_{cw,in}$ (°F)	$T_{cw,out}$ (°F)	m_{cw} (lbs/hr)	$T_{Hc,in}$ (°F)	$T_{Hc,out}$ (°F)	P_{cond} (psia)	m_{Hc} (lbs/hr)	Duty x 10^{-6} (Btu/hr)	Q_{bal} (%)
Commercial Isobutane									
1	111.0	131.3	496945	212.0	173.8	205.1	81502	10.50	1.2
2	110.7	126.7	479748	171.4	157.7	172.3	62858	7.59	2.1
3	79.9	98.8	376760	238.5	124.9	115.9	39096	7.08	1.2
4	86.7	112.5	374758	170.9	151.7	159.3	76893	9.65	1.6
5	84.2	106.8	373982	214.6	140.4	139.8	53564	8.43	1.3
6	105.4	125.8	442385	206.1	163.9	184.6	66793	8.95	1.2
7	116.0	135.9	432733	203.7	174.0	205.7	69858	8.55	2.4
8*	98.2	113.1	507173	197.9	172.7	203.0	62136	7.48	2.4
Nominal 90/10									
9	118.9	140.8	399152	211.4	180.5	205.5	70218	8.71	0.9
10	102.2	125.2	350826	200.3	168.2	182.8	72713	9.43	0.3
11	94.5	115.5	423201	206.9	154.6	162.0	61968	8.85	1.0
12	78.9	96.9	370304	221.0	125.7	108.4	38442	6.63	1.1
13	82.1	117.4	193197	205.4	142.9	135.8	44237	6.76	1.1
14	118.8	139.1	399854	211.9	176.8	201.8	63615	8.08	1.0
15*	99.0	115.6	484015	206.7	177.5	201.7	63615	7.98	1.3
Nominal 80/20									
16	113.5	138.6	393314	213.6	182.8	205.3	76699	9.99	4.6
17	97.6	123.0	403376	213.2	172.6	174.5	71887	10.20	5.1
18	83.7	121.9	262970	210.3	167.4	160.6	69382	9.99	4.2
19	78.4	114.9	243898	191.4	155.8	140.9	61428	8.88	4.9
20	76.0	90.4	434426	226.5	113.3	90.3	33158	6.21	2.8
21	81.9	102.8	433223	244.6	131.3	131.0	47448	9.03	4.4
22	109.1	135.5	387783	242.6	189.7	204.6	76464	10.41	3.7
23*	94.4	114.9	486591	243.1	196.0	219.6	79766	9.92	5.4

*Half bundle test

If the initial test conditions are repeated at some later time, t_1, and we assume that,

$$h_{o,m}(t_1) - h_{o,m}(t_o) = 0 \tag{3-77}$$

then we have

$$\Delta r_{foul} = \frac{1}{U_m(t_1)} - \frac{1}{U_m(t_o)} - \left(\frac{1}{h_{io}(t_1)} - \frac{1}{h_{io}(t_o)}\right) \tag{3-78}$$

Further assuming that the change in r_{foul} between time t_o and t_1 is linear, we have

$$\Delta t = t_1 - t_o \tag{3-79}$$

$$\frac{dr_{foul}}{dt} = \frac{\Delta r_{foul}}{\Delta t} \tag{3-80}$$

The fouling resistance at any time on the interval t_o to t_1 is then given as

$$r_{foul}(t) = r^o_{foul} + \frac{\Delta r_{foul}}{\Delta t} (t - t_o) \quad t_o < t < t_1 \tag{3-81}$$

where r^o_{foul} is the initial fouling resistance at time t_o which in lieu of other data must be specified.

The condenser tests were structured so that for each test fluid, the last test run was a repeat of the initial test run, thus allowing $r_{foul}/\Delta t$ to be determined for each of the three fluids tested. The condenser tubes were hydrolanced just prior to the start of testing. A value of 0.0005 for r^o_{foul} was chosen to represent the just-cleaned tubes. Since the tubes were not cleaned again during the course of testing, the value of r^o_{foul} for the 90/10 test was taken as the last value of r_{foul} for the commercial isobutane tests, and t_o for the 90/10 test was set equal to the time of the last commercial isobutane test. The same procedure was followed for the 80/20 tests only with the last values of the 90/10 test used as the initial values for the 80/20 test, etc.

Using the average of the individual data scans for test runs 1, 7, and 9, 14, and 16, 22 (see Table 3-12), and the above method of calculation, the three fouling resistance equations listed in Table 3-13 were derived. The three equations of Table 3-13 were then used in computing $h_{o,m}$ and U_{clean} according to equation (3-68) through (3-75) for the individual data scans. Figure 3-16 is a plot of r_{foul} versus real time.

Performance Factors:

Each data scan was analyzed using the basic equations and the appropriate fouling resistance. Table 3-14 lists the performance factors for one selected data scan from each test run. Figure 3-17 is a plot of U_m and U_{clean} for the full bundle test runs of Table 3-14 against the test run number. Figure 3-18 is a plot of $h_{o,m}$ for the same test runs against the test run number.

From Figure 3-17 we see that U_m and U_{clean} decrease with increasing isopentane composition. These results are in qualitative argument with experimental data on single tube condensation[13]. The implication is that more surface area would be needed for a mixture than for pure isobutane running at the same condenser pressure as the mixture. However, we note from Table 3-13 that the performance of commercial isobutane and nominal 80/20 mixture can be comparable for similar conditions, and in some case the mixtures perform better. The other factor is the mixtures higher temperature gradient for condensation for the same condenser pressure which apparently offsets the lower value of the film coefficient.

Table 3-13

Condenser Tube Side Fouling Resistance

Commercial Isobutane Tests

$$r_{foul} = 0.0005 + 12.98\ 10^{-6}\ t(hrs),\ 0 < t < 55.75$$

Nominal 90/10 Isobutane/Isopentane Tests

$$r_{foul} = 1.224\ 10^{-3} + 8.575\ 10^{-6}\ t(hrs),\ 55.75 < t < 104.5$$

Nominal 80/20 Isobutane/Isopentane Tests

$$r_{foul} = 1.642\ 10^{-3} + 10.01\ 10^{-6}\ t(hrs),\ 104.5 < t < 198.25$$

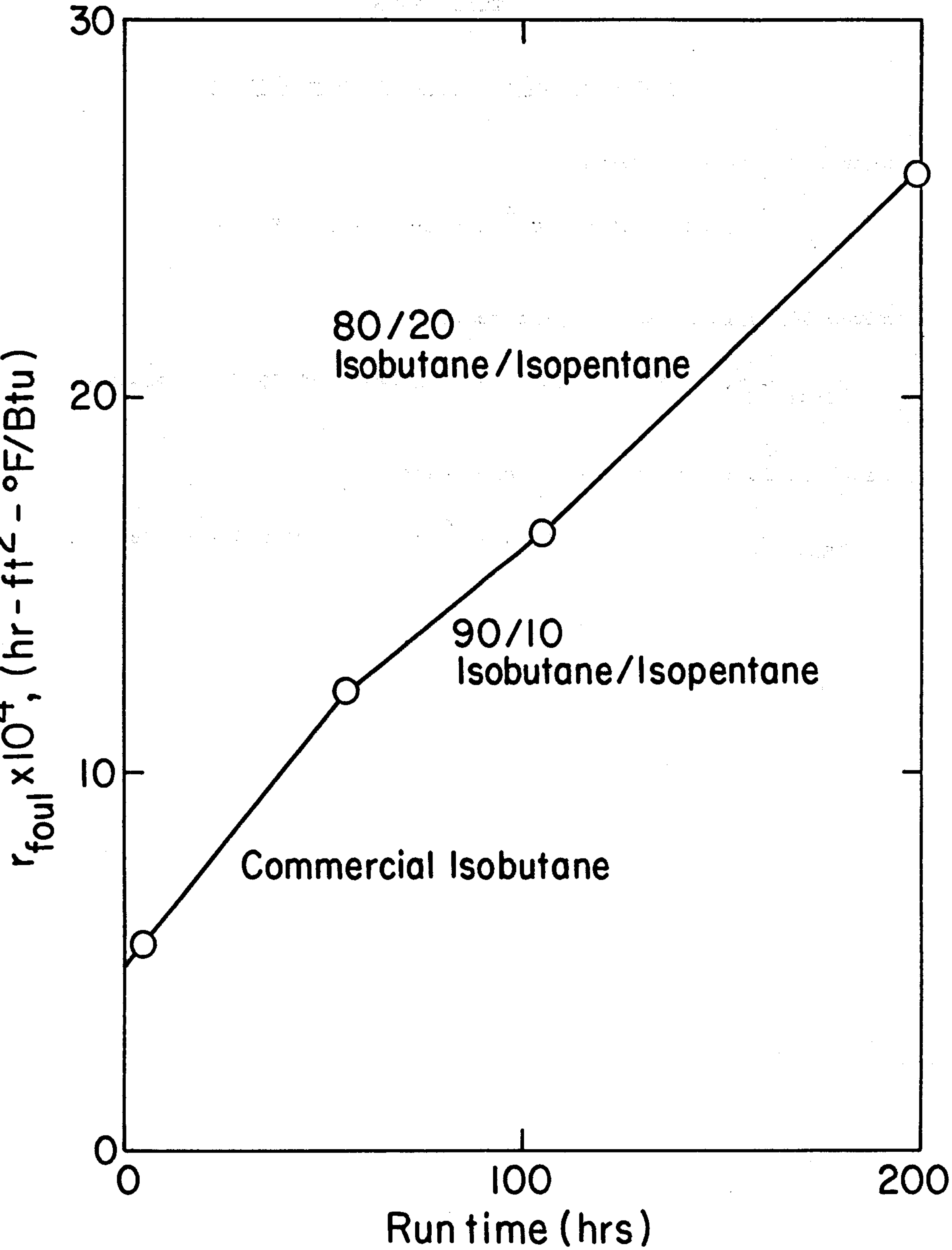

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Fig. 3-16 r_{foul} vs Condenser Run Time

Table 3-14

Condenser Performance for Selected Data Scans

Test #	Time (hrs)	$r_{foul} \times 10^3$	U_m	U_{clean}	$h_{o,m}$	h_{io}	Nu	Rey_c	P_r	Q_{bal} (%)
Commercial Isobutane										
1	8.5	0.610	156	173	210	1461	.224	2480	3.6	0.08
2	10.25	0.633	151	166	202	1410	.215	1764	3.6	0.77
3	26.75	0.847	159	183	243	1005	.260	909	5.2	0.07
4	31.50	0.909	147	170	218	1055	.232	2080	4.6	1.04
5	34.75	0.951	149	173	225	1034	.240	1365	4.8	0.53
6	51.50	1.169	145	175	217	1301	.232	1936	3.8	0.67
7	53.50	1.195	141	169	208	1338	.222	2112	3.4	0.61
8*	54.75	1.211	178	227	299	1394	.319	3711	4.3	0.07
Nominal 90/10										
9	76.50	1.402	128	155	189	1274	.202	2151	3.3	0.55
10	78.50	1.419	128	157	193	1221	.206	2052	3.3	0.11
11	81.25	1.442	131	162	200	1198	.214	1625	4.3	0.17
12	98.50	1.590	126	158	201	988	.216	876	5.3	0.89
13	100.00	1.603	117	144	208	559	.222	1112	4.7	0.32
14	102.00	1.620	127	159	194	1274	.208	1881	3.3	0.28
15*	104.50	1.642	169	234	314	1346	.336	3786	4.2	0.15
Nominal 80/20										
16	149.25	2.090	114	151	182	1241	.195	2280	3.4	4.2
17	151.25	2.110	116	154	189	1181	.202	1962	4.1	4.1
18	153.25	2.130	111	145	189	809	.202	1842	4.5	3.2
19	169.75	2.295	106	140	185	728	.198	1536	4.9	4.1
20	174.50	2.343	135	198	264	1095	.286	660	5.6	1.7
21	176.50	2.363	152	237	334	1144	.360	1044	5.0	3.6
22	196.4	2.562	111	156	191	1188	.204	2244	3.7	1.3
23*	198.00	2.578	159	269	382	1335	.409	4913	4.3	5.0

*Half bundle test

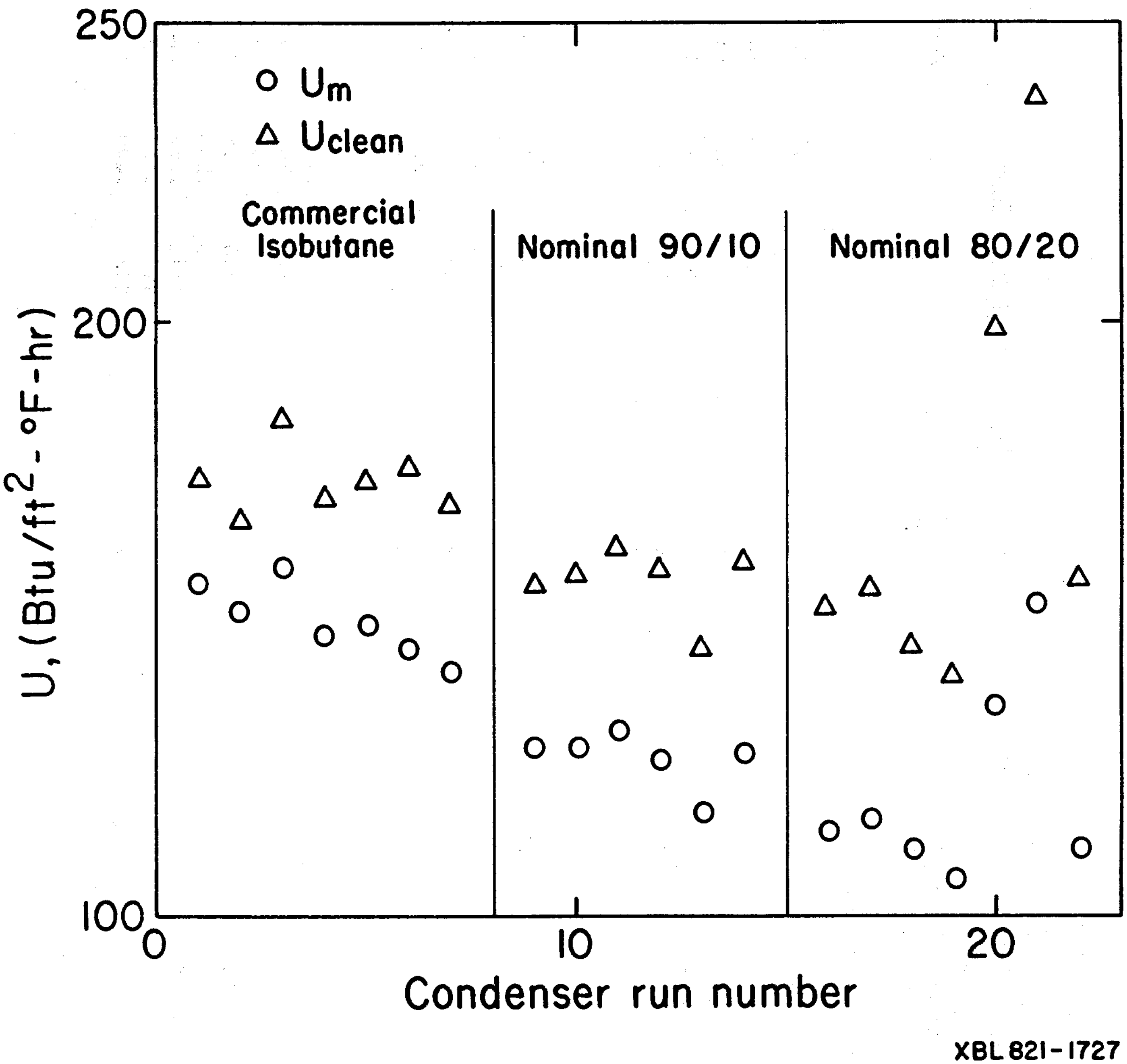

Fig. 3-17 Condenser Overall Heat Transfer Coefficient vs Condenser Run Number

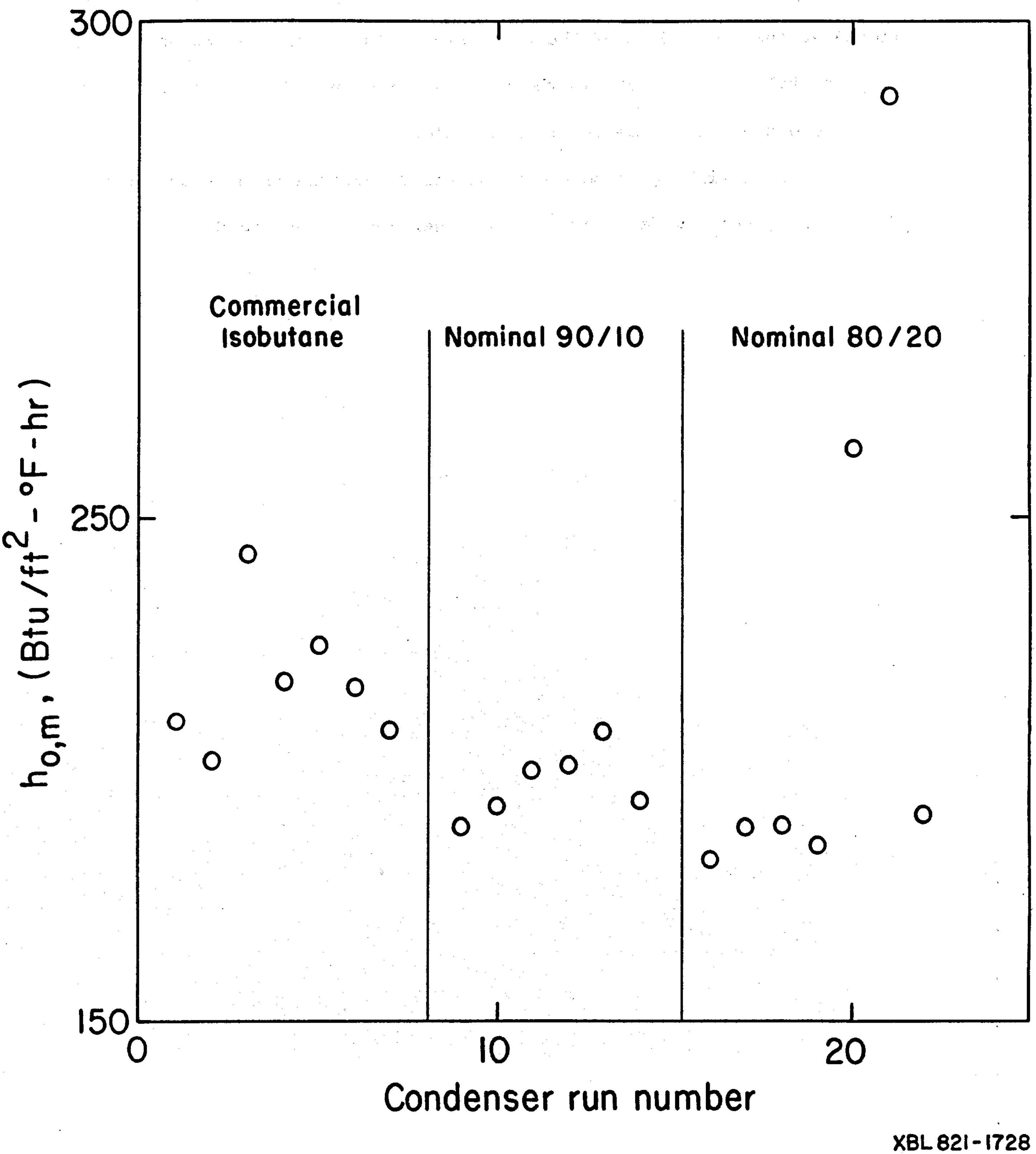

Fig. 3-18 Condensate Film Coefficient vs Condenser Run Number

Figure 3-19 is a plot of Nu versus Rey_c for the results of Table 3-13. The left hand section is for laminar conditions; it is then followed by a transition region and a turbulent region where the film coefficient increases sharply. Most of the test data falls in the transition region with the half bundle tests in the turbulant region and at conditions more likely choosen for a commercial application.

For those wishing to do a more detailed analysis than presented in this report, the raw data for the condenser runs is appended.

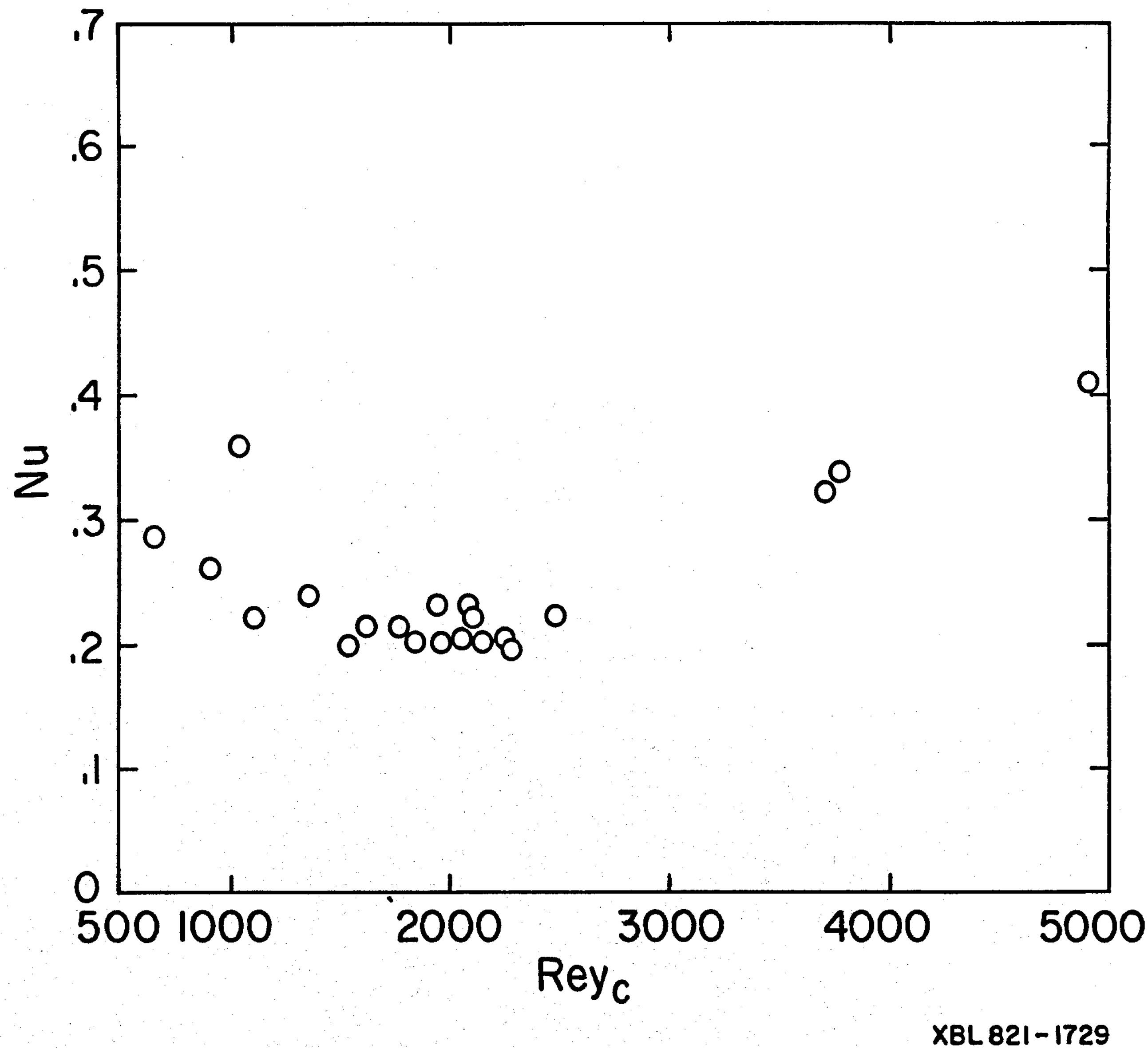

Fig. 3-19 Condensate Nusselt Number vs Condensate Reynolds Number

SECTION 4 - SUMMARY AND CONCLUSIONS

A Rankine cycle using a hydrocarbon working fluid shows promise for converting the thermal energy of moderate-temperature hydrothermal geothermal resources into electric power. In order to obtain performance data on the binary process a test loop employing state-of-the-art shell-and-tube heat exchangers was constructed and installed at the U.S. Department of Energy's East Mesa Test Facility. The test loop has provided performance data on heating isobutane and mixtures of isobutane/isopentane at supercritical conditions in the vicinity of their critical pressure and temperature and for condensing the same fluids. The results and analyses of those tests are reported herein.

The test loop consisted of three fluid loops: brine, hydrocarbon, and cooling water. The three loops were interconnected through the primary brine/hydrocarbon heat exchanger train and the condenser/subcooler train. An expansion valve was used in lieu of a turbine, and the heat load was rejected to the atmosphere through a wet cooling tower. The test loop was instrumented to record temperatures, pressures, and flow rates for the brine, hydrocarbon, and cooling water entering and exiting each exchanger.

Problems encountered during the operation of the test loop and their solution were:

1. The shell side of the exchangers was successfully cleaned using a HCl/ammonium bifluoride-ammonium citrate solution which gave excellent results.
2. Hydrolancing of the exchanger tubes proved quick, simple, and gave excellent results.
3. Suspended matter swept up by the circulating hydrocarbon was effectively removed by filtering.

4. Instrument performance was excellent with no failures in flow meters, thermometers, pressure gauges, or controllers.
5. Leaks in the heat exchangers occurred during the testing. All leaks were from weld failures at the tube/tube-sheet interface. All leaks were repaired in the field by heli-arc welding.
6. Analysis of the hydrocarbon taken from the test loop during testing showed no detectable levels of water.
7. The test loop was stable for all test conditions encountered, both for subcritical and supercritical operations, and for traversing between either mode.

The test data for the primary heaters and condenser covers an area of commercial interest. The test data was analyzed using models common to the heat transfer industry. Analysis of the primary heater data yielded area predictions, overall heat transfer coefficients, shell side film coefficients, mean temperature differences, exchanger pinch points, and shell side pressure drop predictions. We found that:

1. Heat transfer and pressure drop correlations applicable in the liquid region (non-critical region) that yield state-of-the-art accuracy can be used as a basis for a stepwise performance calculation of a supercritical binary heat exchanger train.
2. Thermodynamic and transport property algorithms are an integral part of the performance correlation. The use of other property data will produce results different from those found in this investigation.
3. When the heat transfer and pressure drop correlations employed were empirically adjusted, though the standard forms were not

modified, to give a high degree of accuracy for liquids well removed from the critical region, the correlations could then be used, unadjusted, for performance calculations of the experimental data from the liquid region through the transposed critical region.

4. When the hydrocarbon temperature-pressure profile along the exchanger train is known (in our case measured), the area calculated from the correlations agreed generally within 2% of the overall train area with predicted individual exchanger areas varying from -0.3 to 5.2% from the known values.

5. When the hydrocarbon temperature-pressure profile along the exchanger train was calculated (as in the case of designing an exchanger train) significantly greater error in the calculated area resulted. The errors appear due to uncertainties in the P-H-T correlations, primarily in the near-critical region where the temperature pinch point occurred. Experimental temperature pinch points ranged from 2.5 to 13.7°F with most values between 8 to 9°F. The P-H-T correlation generally predicted pinch points smaller than the experimental values resulting in over-prediction of the required area. The overall train area calculated for commercial isobutane and nominal 80/20 isobutane/isopentane averaged 11% higher than the actual area. The calculated area for nominal 90/10 isobutane/isopentane were much worse, averaging 70% higher.

6. For the 80/20 mixtures, when the operating pinch point was 10°F or greater, the calculated area was less than 12% larger than the known area. In general, for pinch points less than 10°F, the

calculated areas deviated from 10 to 600%. Based upon the calculational methods of this report, an increase in the operating temperature pinch appears necessary to reduce errors in the area to acceptable levels, particularly for the 90/10 mixture.

7. Additional experimental work on the thermodynamic properties in the near-critical region appears necessary to improve the accuracy of performance predictions for 90/10 mixtures, and for temperature pinch points of 10°F or less.

8. For the hot exchanger, the correlations consistently underpredicted the area by approximately 20%. The results are consistent with other investigators[14] that concluded the increased heat transfer effect near the Transposed Critical Line is less than predicted by standard equations. Errors in the predicted area represented about 4% of the overall train area and appear not to introduce unacceptable error for design of industrial heat exchanger trains spanning the temperature interval explored in this investigation. However, investigation of heat transfer in the near critical region is of interest and should be pursued and more fully understood.

9. Fouling of the brine or hydrocarbon was not measureable throughout the duration of the tests.

10. The overall heat transfer coefficients (Btu/hr-ft^2-°F) varied from 390 to 425 for commercial isobutane, 395 to 326 for the nominal 90/10 mixture, and from 351 to 402 for the nominal 80/20 mixture.

Analysis of the condenser data yielded overall heat transfer coefficients, shell side film coefficients, mean temperature differences, and tube side fouling resistance as a function of time. We found that:

1. The relationship between time and fouling of the cooling water side as determined by measurements outlined in this investigation was necessary for obtaining the hydrocarbon condensing coefficients.
2. Assuming a wet tube wall for calculation of the mean temperature difference, and including the desuperheating duty in the total condensing heat load were applicable for the test conditions encountered.
3. The overall condensation coefficients for isobutane, 90/10 and 80/20 mixtures show a slight decrease with increasing isopentane content in agreement with earlier work.[13] The condensing coefficients (Btu/hr-ft^2-°F) for the full bundle tests were 190 to 240 for overall condensate Reynolds numbers of 600 to 2000. The half bundle tests increased the Reynolds number to 3700 to 4900 yielding condensing coefficients of 300 to 380.
4. The data further confirms the departure from Nusselt type condensation as higher tube loadings are achieved. For all the data taken, the condensing coefficient was essentially constant until Reynolds numbers of about 3700 were reached were the coefficient increased by 50%. No data was taken in the range of Reynolds number from 2200 to 3700, therefore the actual departure point was not determined.

Acknowledgements

We thank R. Fulton and K. Mirk for their reviewing, editing, and timely comments and improvements to the manuscript; Ms. Ruthie Redic for manuscript preparation and editing; Ms. Marilee Bailey for the graphic arts; the staff and management of the Earth Sciences Division for their support; the East Mesa Geothermal Test Facility for hosting the field work; and C. McFarland and R. LaSala from the U.S. Department of Energy for their support and encouragement.

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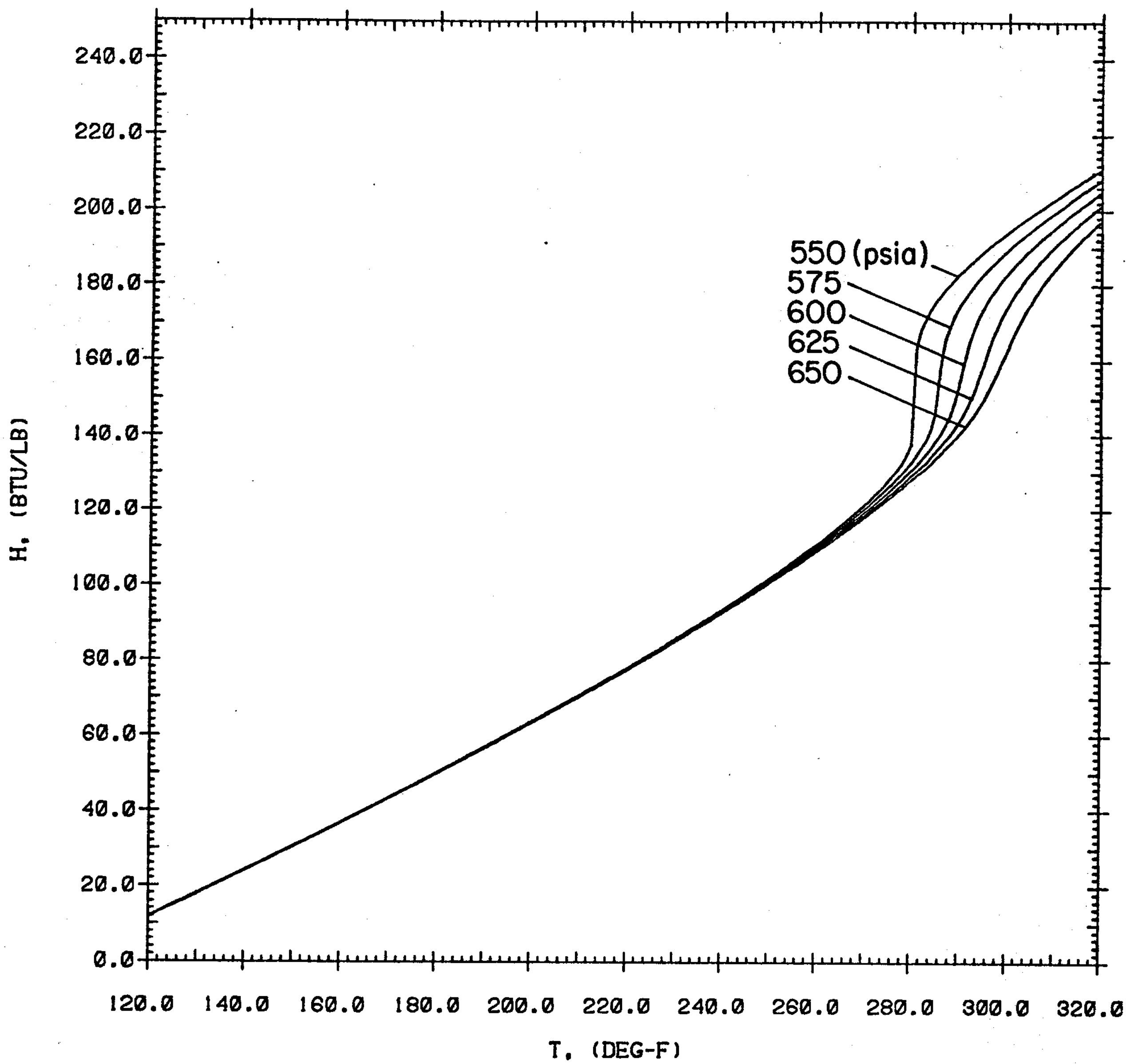
Appendix A

Fluid Property Plots

for Data Area

Spanned by Primary Heaters



ENTHALPY VS T, 100/0 I-BUTANE/I-PENTANE

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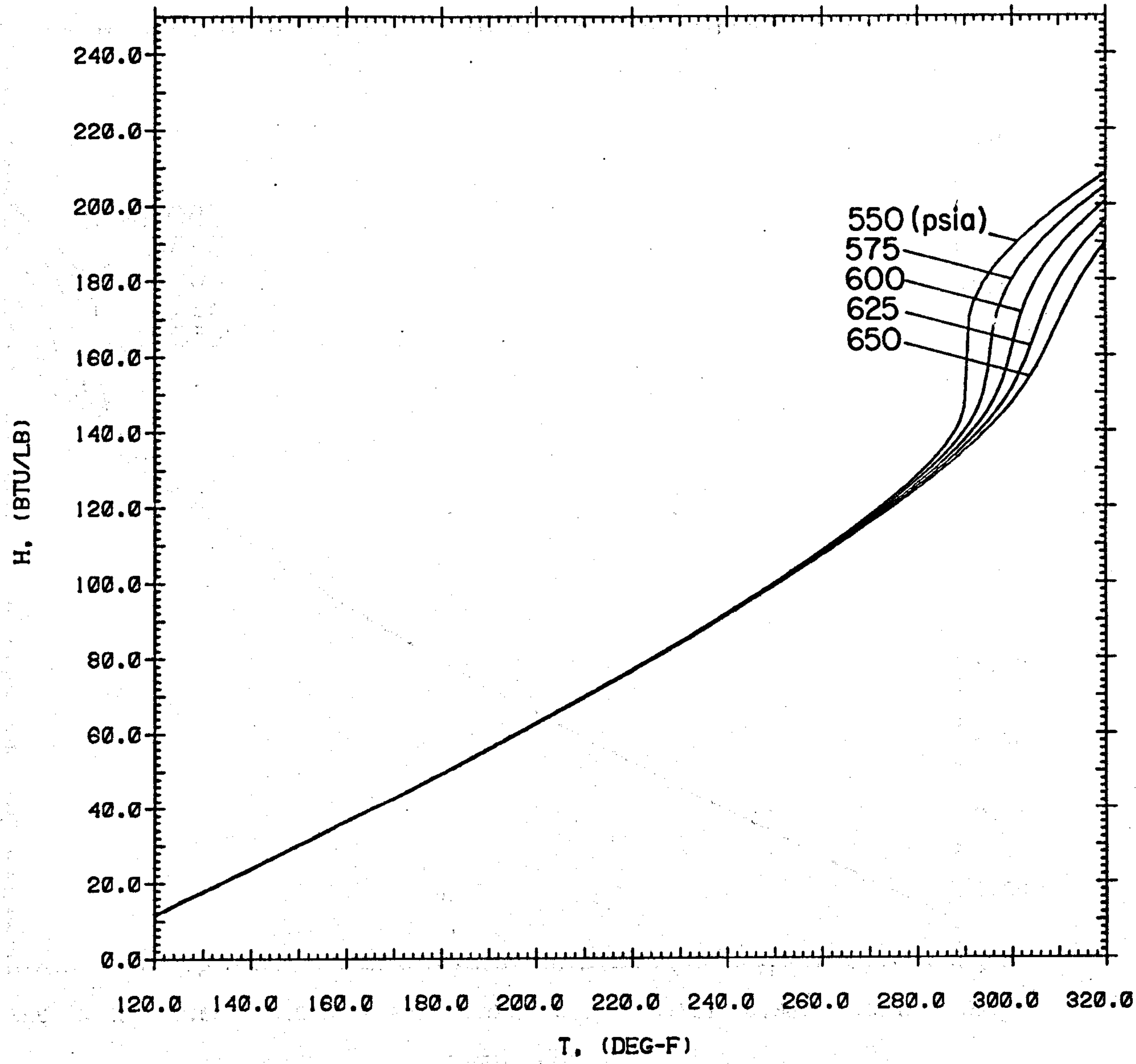

ENTHALPY VS T, 90/10 I-BUTANE/I-PENTANE

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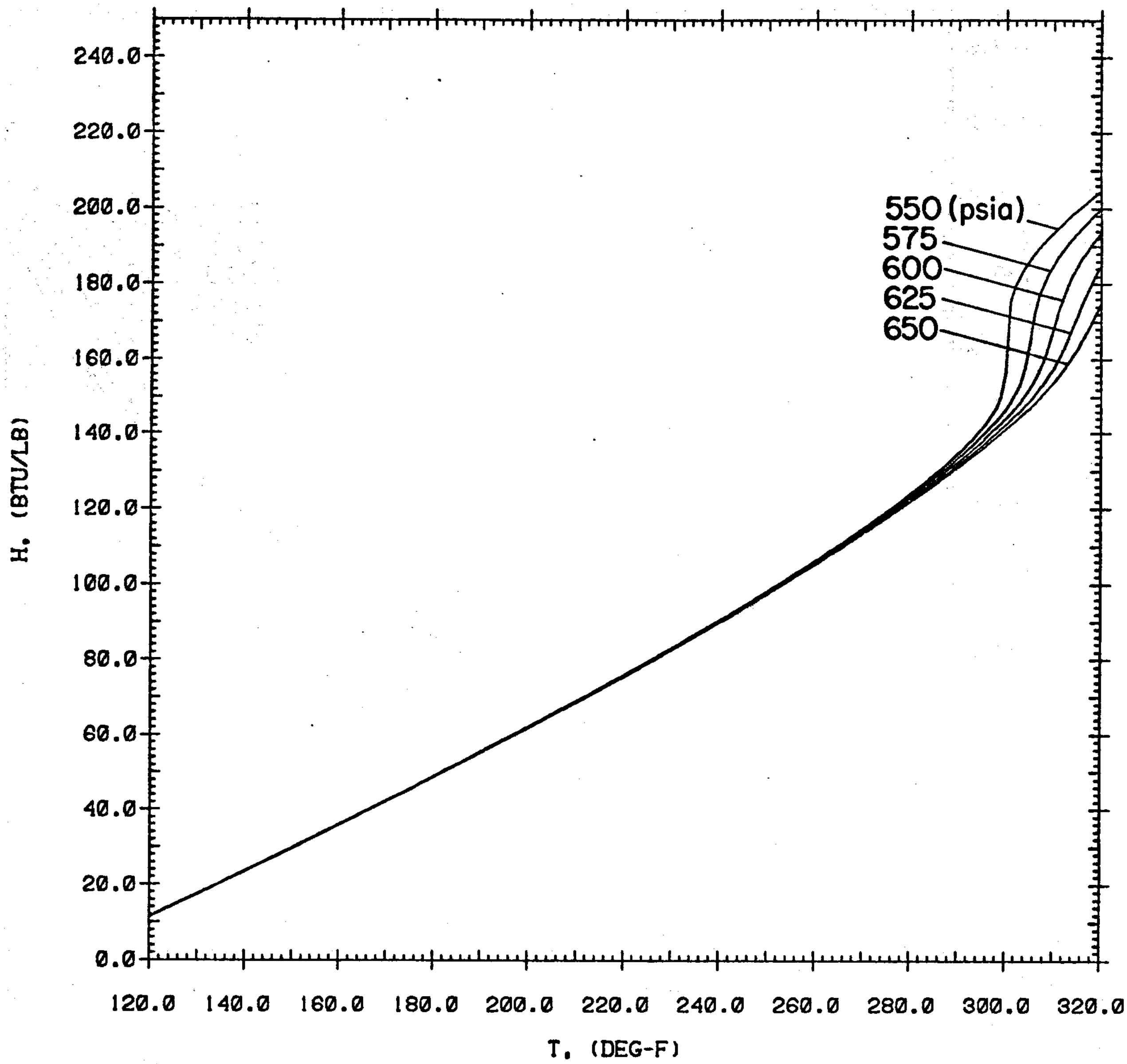

ENTHALPY VS T, 80/20 I-BUTANE/I-PENTANE

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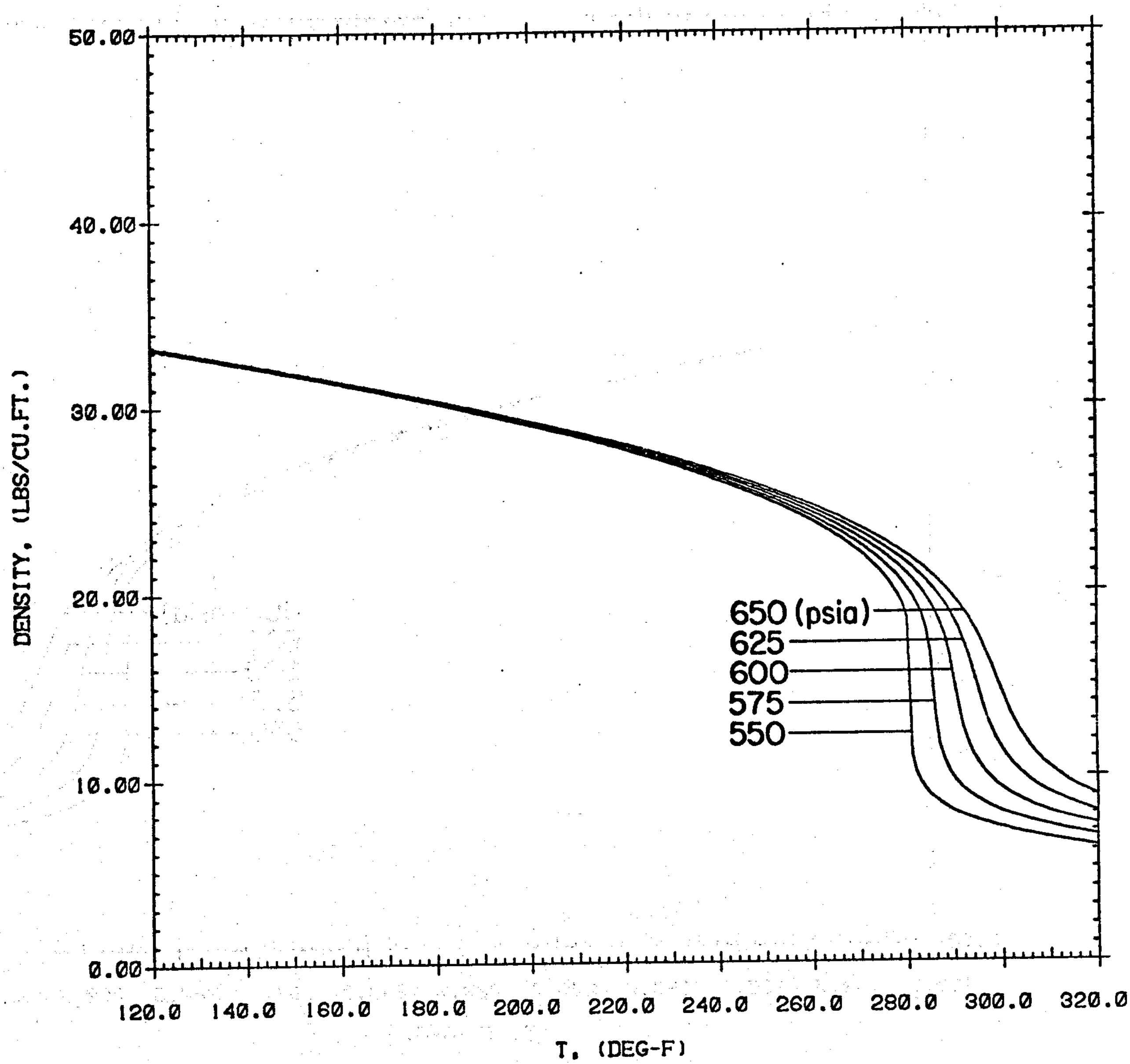

DENSITY VS T, 100/0 I-BUTANE/I-PENTANE

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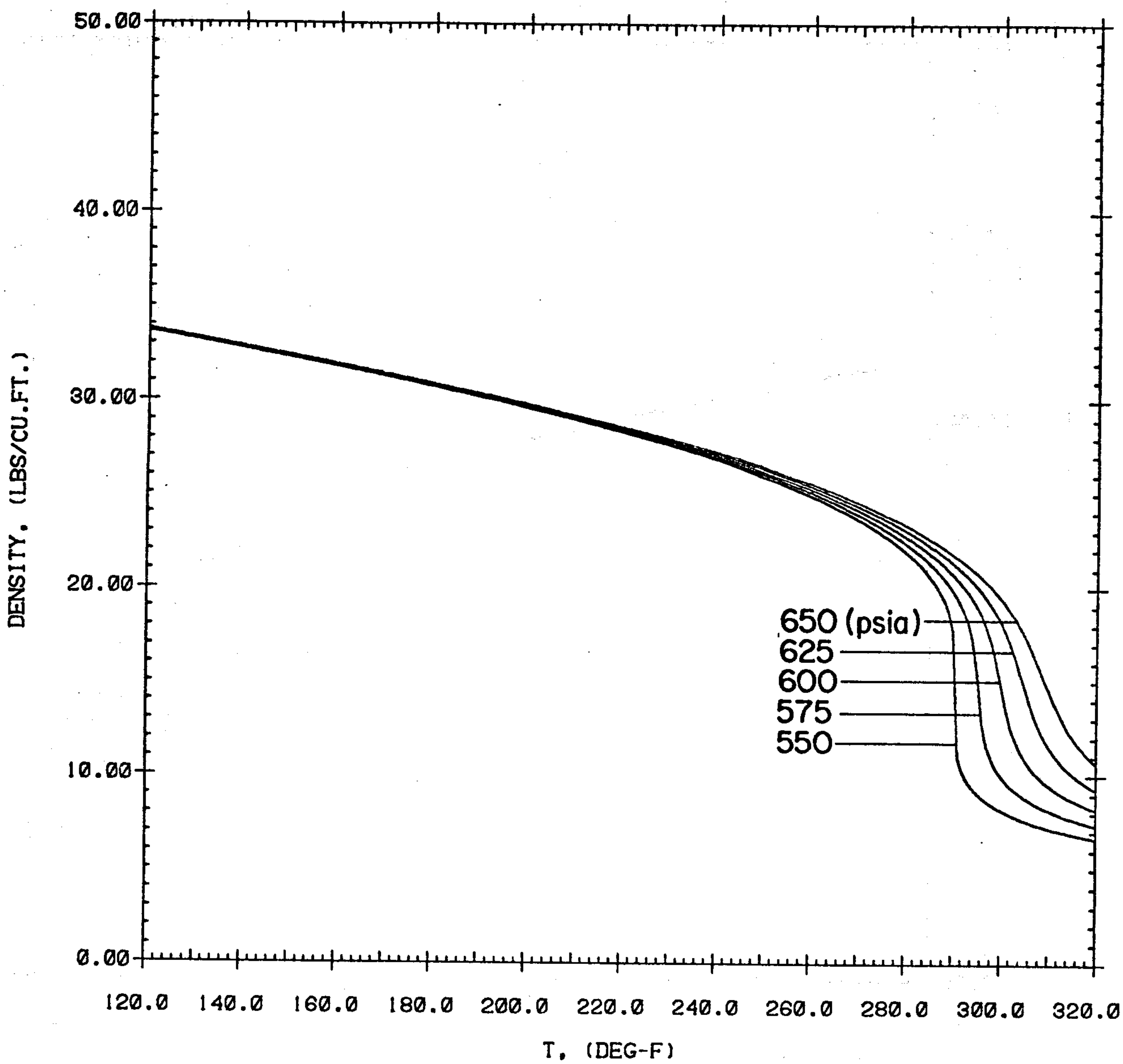

DENSITY VS T, 90/10 I-BUTANE/I-PENTANE

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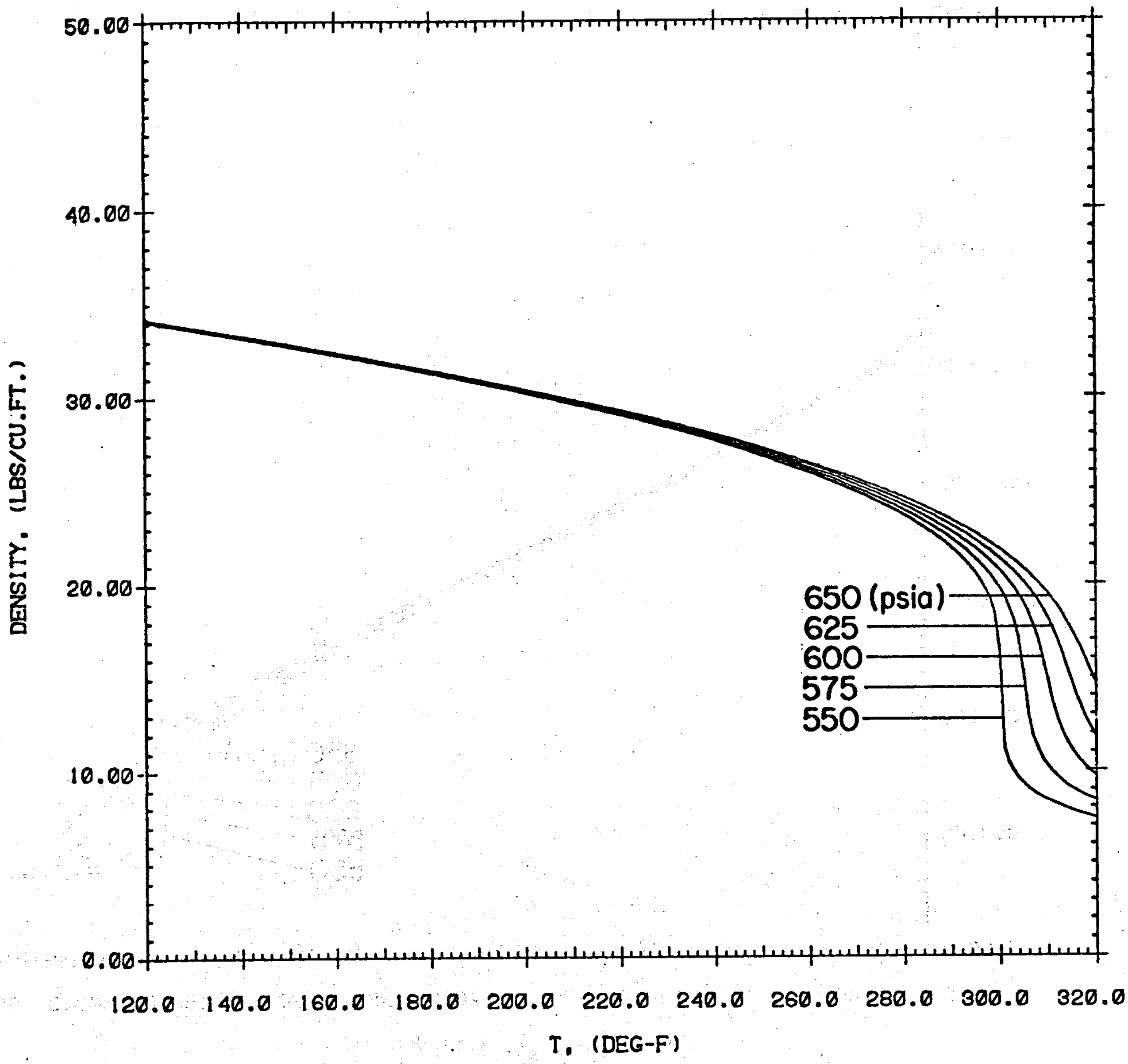

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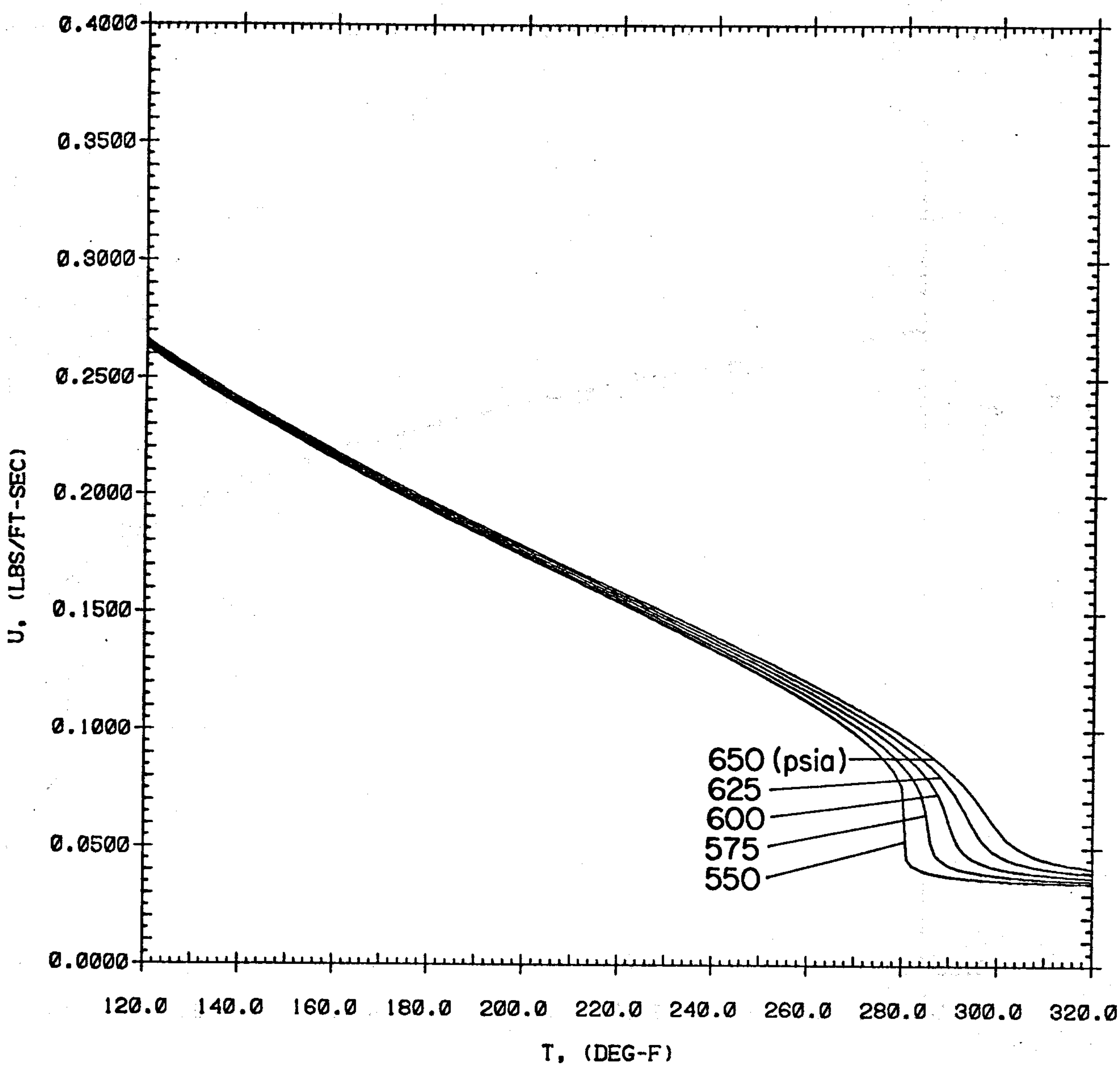


VISCOSITY VS T, 100/0 I-BUTANE/I-PENTANE

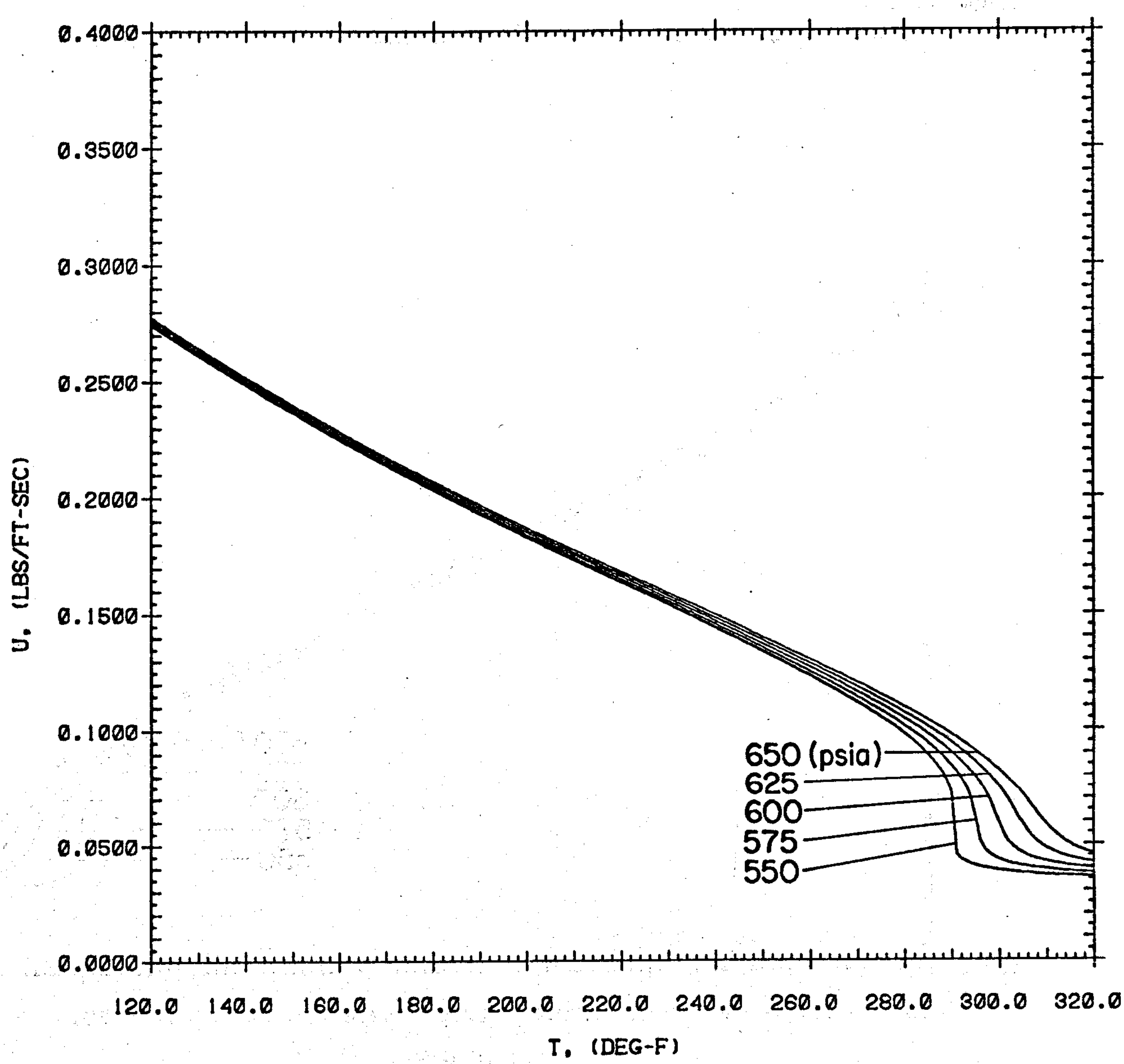
XBL 821-1698

ABSTRACT

Analysis of field performance data from a binary cycle test loop using geothermal brine and a hydrocarbon working fluid is reported. Results include test loop operational problems, and shell-and-tube heat exchanger performance factors such as overall heat transfer coefficients, film coefficients, pinch points, and pressure drops.

Performance factors are for six primary heaters having brine in the tubes and hydrocarbon in the shells in counterflow, and for a condenser having cooling water in the tubes and hydrocarbon in the shell. Working fluids reported are isobutane, 90/10 isobutane/isopentane, and 80/20 isobutane/isopentane. Performance factors are for heating each working fluid at supercritical conditions in the vicinity of their critical pressure and temperature and condensing the same fluid.

TABLE OF CONTENTS



VISCOSITY VS T, 90/10 I-BUTANE/I-PENTANE

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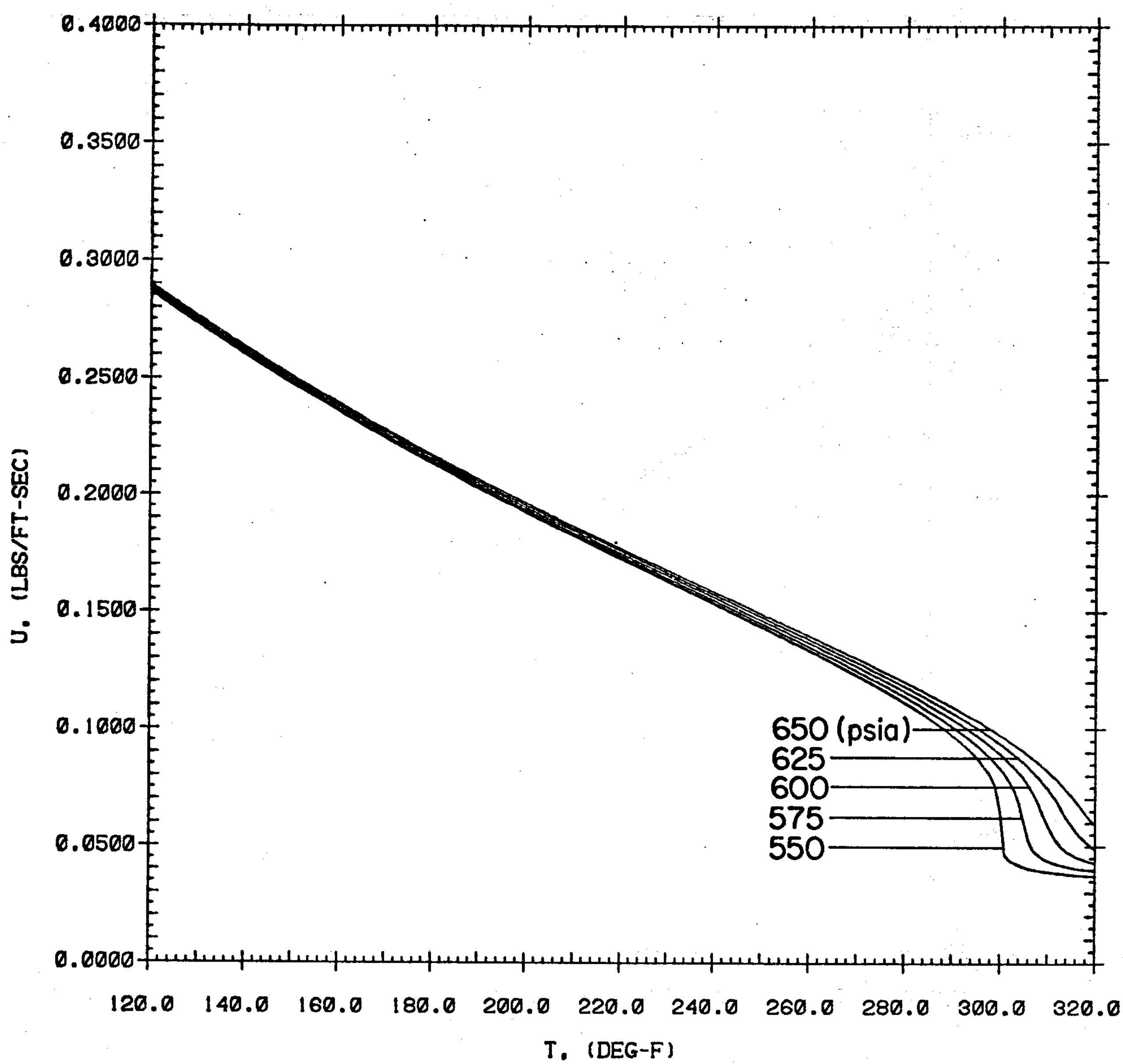

VISCOSITY VS T, 80/20 I-BUTANE/I-PENTANE

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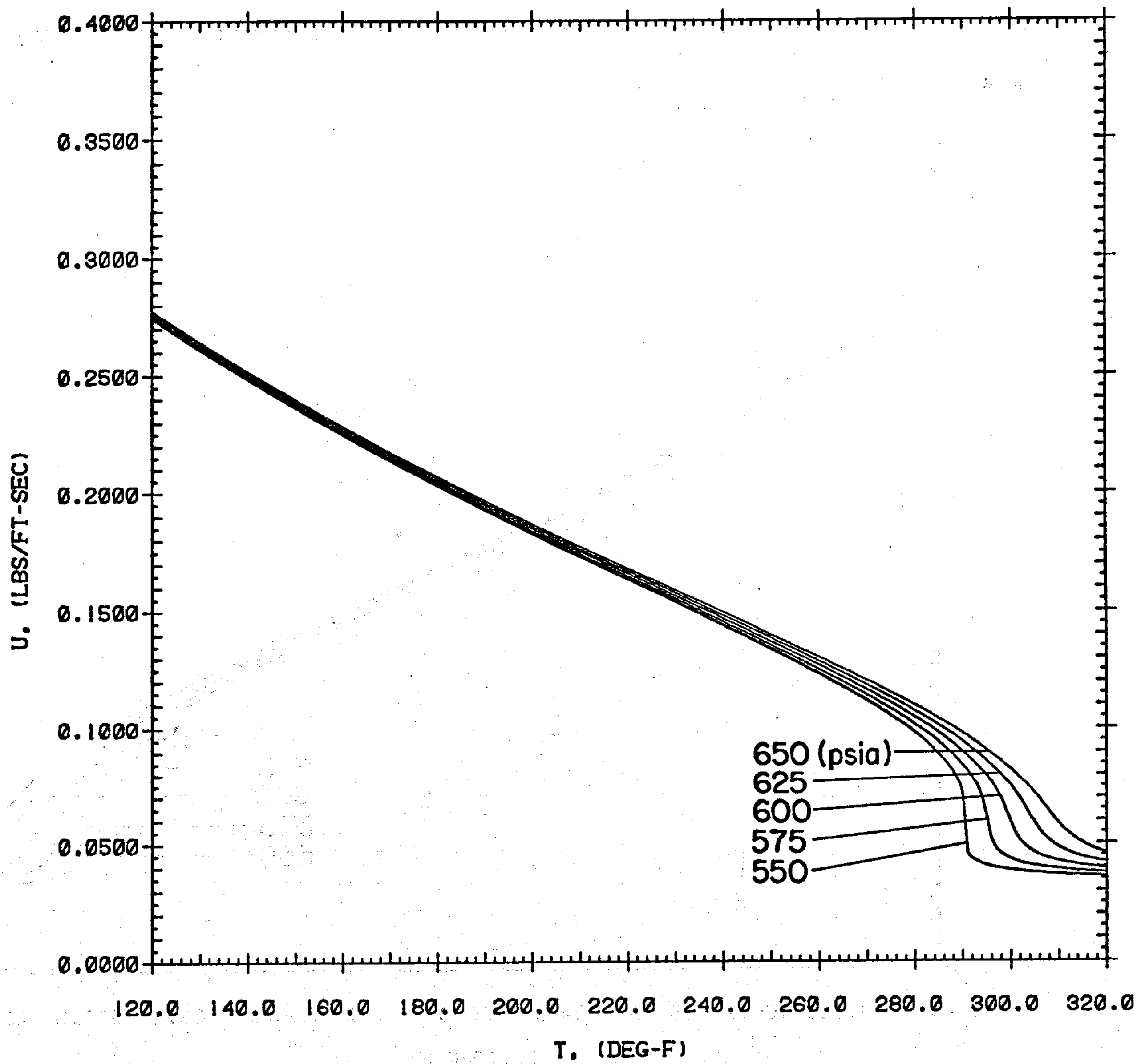

VISCOSITY VS T, 90/10 I-BUTANE/I-PENTANE

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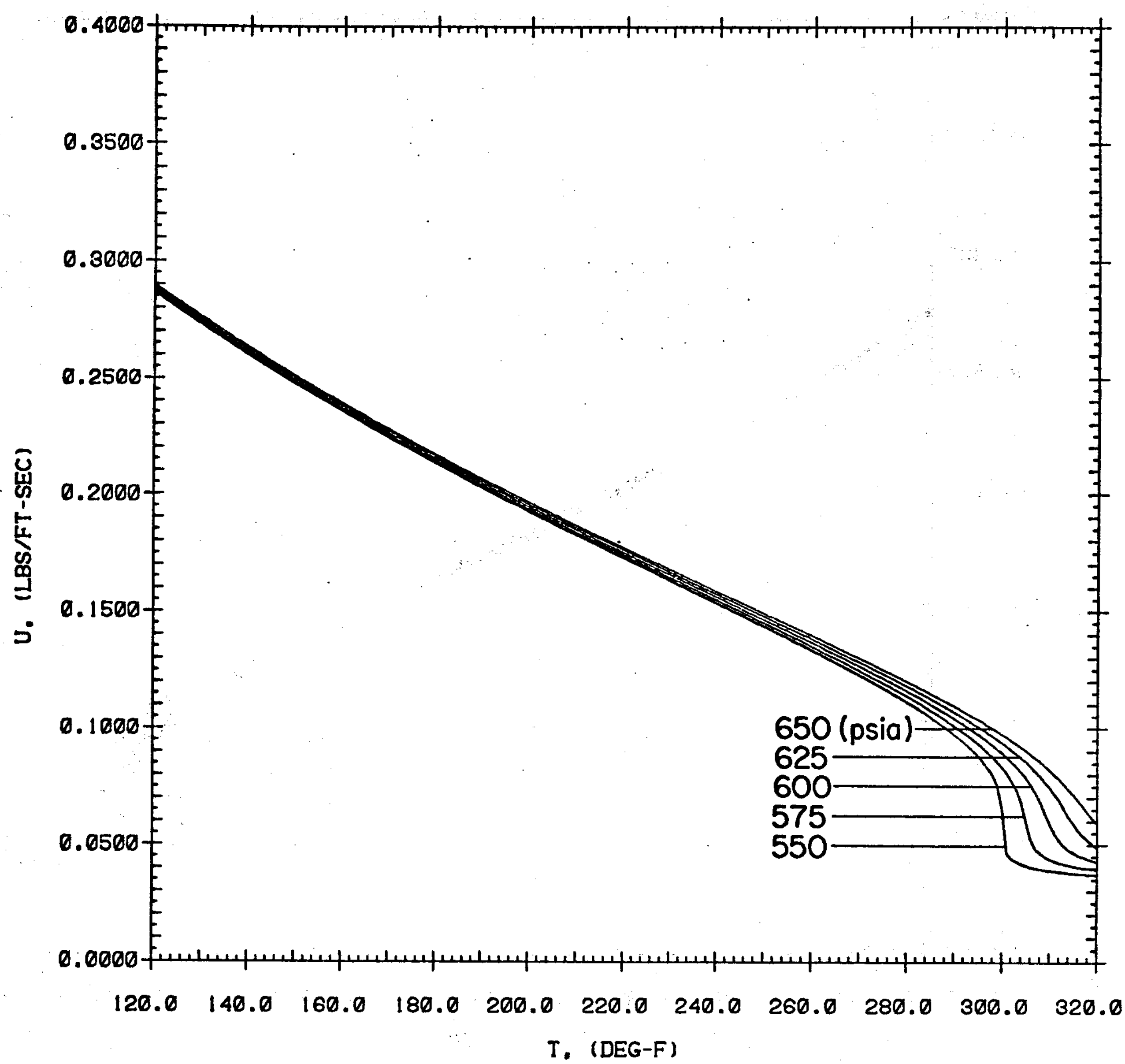

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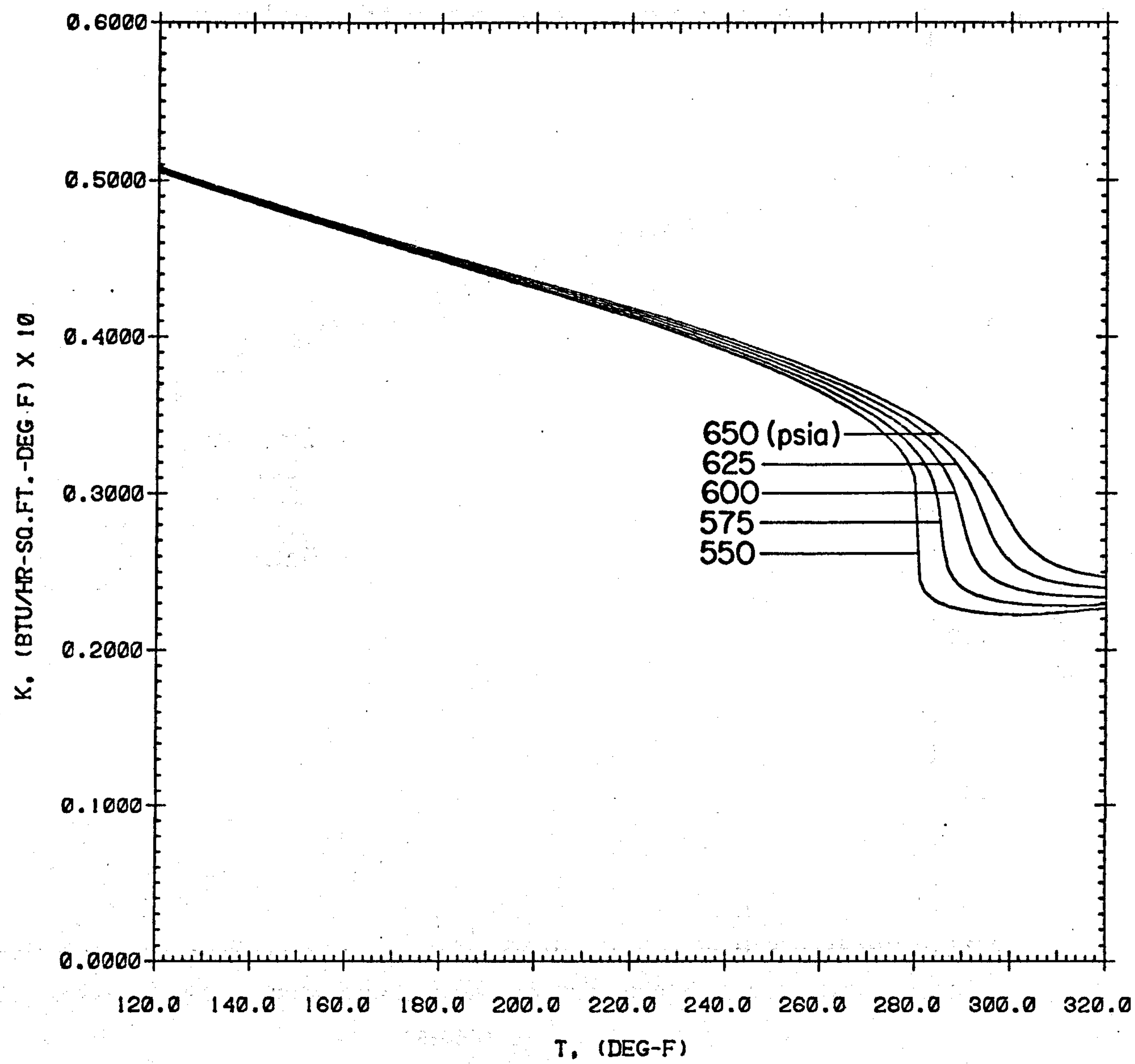

THERM.COND. VS T, 100/0 I-BUTANE/I-PENTANE

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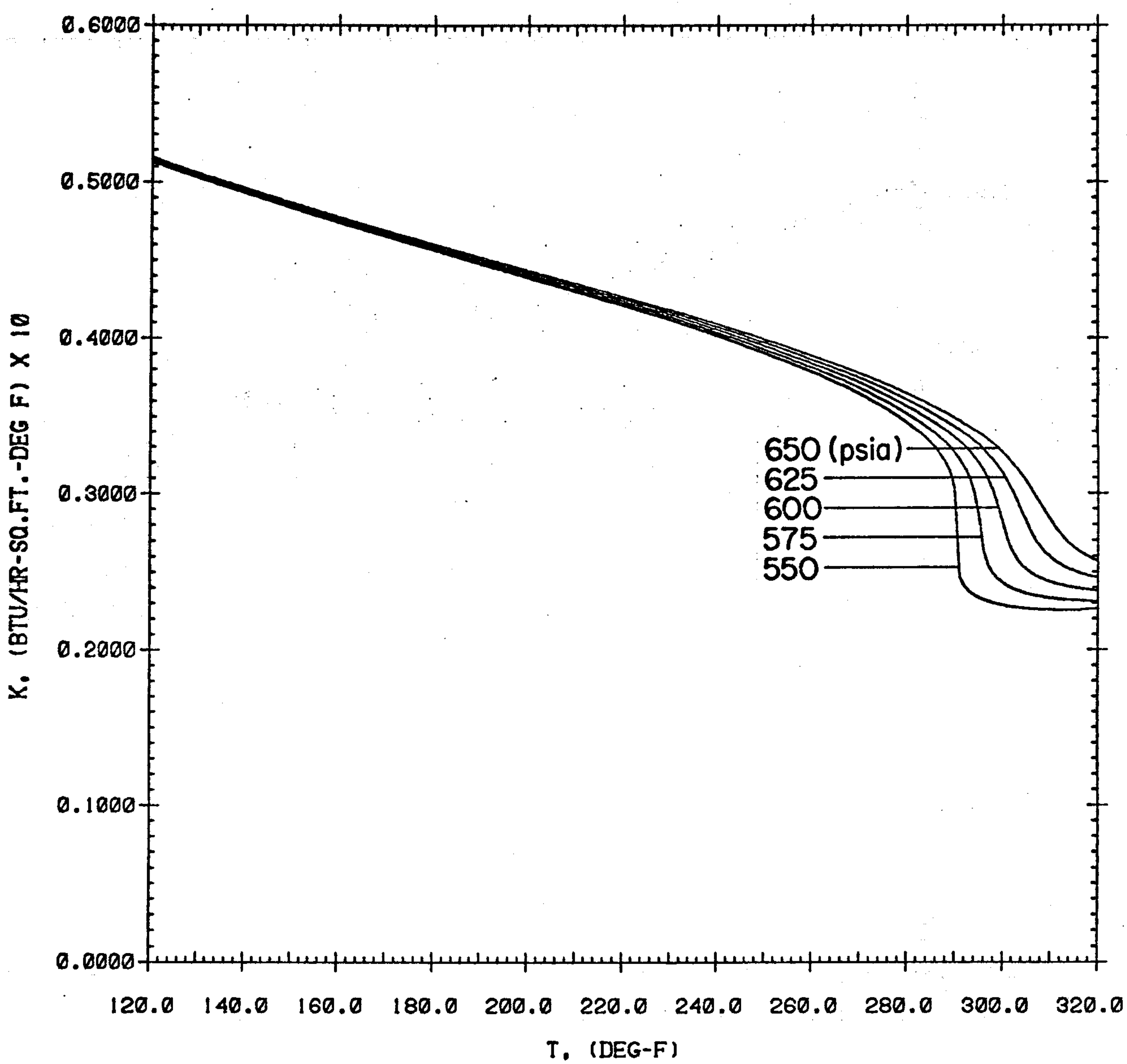
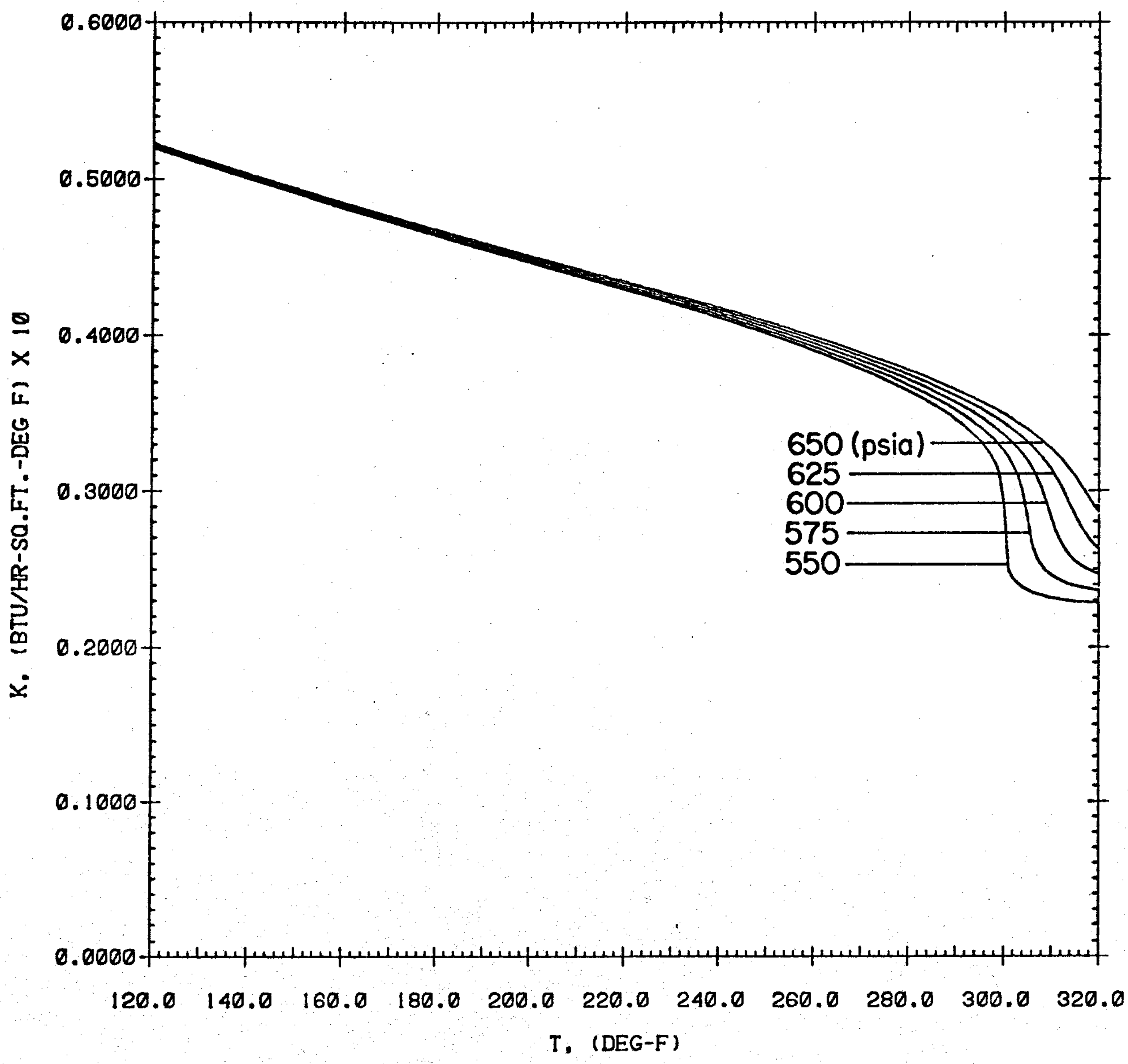


THERM.COND. VS T, 90/10 I-BUTANE/I-PENTANE

XBL821-1694



THERM.COND. VS T, 80/20 I-BUTANE/I-PENTANE

XBL 821-1693

Appendix B

Heater Test Raw Data

Nomenclature

C3 - composition of propane
N-C4 - composition of n-butane
I-C4 - composition of isobutane
N-C5 - composition of n-pentane
I-C5 - composition of isopentane

PI101 Brine pressure

BR Brine
HC Hydrocarbon

PI204 Hydrocarbon pressure

TW101 Brine temperature B1-out
TW102 Brine temperature at B1/B2
TW103 Brine temperature at B2/B3
TW104 Brine temperature at B3/B4
TW105 Brine temperature at B5/B6
TW106 Brine temperature at B6-in

TW201 through TW207 same location as TW101 through TW207 only for the hydrocarbon

ISOBUTANE HEATER TEST DATA

```
HEATER TEST DATA RUN HTR-1    DATE 14-OCT-80  TIME 07-00

C3 (MOLE C/C)= .60  N-C4=2.56  I-C4=96.84  N-C5=0.    I-C5= 0.

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 314.2 (PSIA)    BR FLOW RATE (LBS/HR)= 93203.8
PI108 (B4/B3)= 304.9           HC FLOW RATE (LBS/HR)= 74324.4
PI108 (B1-OUT)=297.1

PI204 (B1-IN)= 667.8 (PSIA)    TW101=205.0    TW201=139.7 (DEG-F)
PI204 (B1/B2)= 660.6           TW102=248.4    TW202=221.7
PI204 (B2/B3)= 651.6           TW103=269.4    TW203=256.0
PI204 (B3/B4)= 643.0           TW104=282.0    TW204=272.7
PI204 (B4/B5)= 633.0           TW105=292.1    TW205=283.6
PI204 (B5/B6)= 621.4           TW106=310.5    TW206=292.3
PI204 (B6-OUT)=604.1           TW107=339.5    TW207=314.8
```

```
HEATER TEST DATA RUN HTR-1    DATE 14-OCT-80  TIME 07-15

C3 (MOLE C/C)= .60  N-C4=2.56  I-C4=96.84  N-C5=0.    I-C5= 0.

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 314.0 (PSIA)    BR FLOW RATE (LBS/HR)= 93210.4
PI108 (B4/B3)= 304.9           HC FLOW RATE (LBS/HR)= 74349.4
PI108 (B1-OUT)=297.2

PI204 (B1-IN)= 667.3 (PSIA)    TW101=204.6    TW201=139.4 (DEG-F)
PI204 (B1/B2)= 661.1           TW102=248.0    TW202=221.3
PI204 (B2/B3)= 652.0           TW103=269.1    TW203=255.8
PI204 (B3/B4)= 643.2           TW104=281.8    TW204=272.6
PI204 (B4/B5)= 632.6           TW105=292.0    TW205=283.5
PI204 (B5/B6)= 620.9           TW106=310.4    TW206=292.2
PI204 (B6-OUT)=603.1           TW107=339.4    TW207=314.6
```

```
HEATER TEST DATA RUN HTR-1    DATE 14-OCT-80  TIME 07-30

C3 (MOLE C/C)= .60  N-C4=2.56  I-C4=96.84  N-C5=0.    I-C5= 0.

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 314.0 (PSIA)    BR FLOW RATE (LBS/HR)= 93207.1
PI108 (B4/B3)= 304.7           HC FLOW RATE (LBS/HR)= 74835.7
PI108 (B1-OUT)=297.1

PI204 (B1-IN)= 666.8 (PSIA)    TW101=204.8    TW201=139.7 (DEG-F)
PI204 (B1/B2)= 660.7           TW102=247.8    TW202=221.1
PI204 (B2/B3)= 651.3           TW103=269.2    TW203=255.8
PI204 (B3/B4)= 642.9           TW104=281.5    TW204=272.2
PI204 (B4/B5)= 632.6           TW105=291.9    TW205=283.4
PI204 (B5/B6)= 620.9           TW106=309.8    TW206=292.0
PI204 (B6-OUT)=603.6           TW107=339.2    TW207=314.0
```

```
HEATER TEST DATA RUN HTR-1     DATE 14-OCT-80   TIME 07-45

C3 (MOLE C/C)= .60  N-C4=2.56  I-C4=96.84  N-C5=0.    I-C5= 0.

NUM OF EXCHANGERS=6

PI108  (B6-IN)= 314.3 (PSIA)     BR FLOW RATE (LBS/HR)= 93203.8
PI108  (B4/B3)= 305.0            HC FLOW RATE (LBS/HR)= 74765.9
PI108  (B1-OUT)=297.1

PI204  (B1-IN)= 666.9 (PSIA)     TW101=205.0     TW201=140.4 (DEG-F)
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PI204  (B2/B3)= 651.3            TW103=269.1     TW203=255.8
PI204  (B3/B4)= 642.6            TW104=281.6     TW204=272.2
PI204  (B4/B5)= 632.3            TW105=291.8     TW205=283.3
PI204  (B5/B6)= 620.6            TW106=309.4     TW206=292.0
PI204  (B6-OUT)=603.2            TW107=339.8     TW207=315.0

-----------------------------------------------------------------

HEATER TEST DATA RUN HTR-1     DATE 14-OCT-80   TIME 08-00

C3 (MOLE C/C)= .60  N-C4=2.56  I-C4=96.84  N-C5=0.    I-C5= 0.

NUM OF EXCHANGERS=6

PI108  (B6-IN)= 313.9 (PSIA)     BR FLOW RATE (LBS/HR)= 93200.4
PI108  (B4/B3)= 304.6            HC FLOW RATE (LBS/HR)= 74472.9
PI108  (B1-OUT)=297.0

PI204  (B1-IN)= 666.5 (PSIA)     TW101=205.2     TW201=140.7 (DEG-F)
PI204  (B1/B2)= 660.1            TW102=248.0     TW202=221.5
PI204  (B2/B3)= 650.8            TW103=269.1     TW203=255.8
PI204  (B3/B4)= 641.9            TW104=281.7     TW204=272.4
PI204  (B4/B5)= 631.6            TW105=291.8     TW205=283.3
PI204  (B5/B6)= 620.1            TW106=309.8     TW206=292.0
PI204  (B6-OUT)=602.6            TW107=339.4     TW207=314.7

-----------------------------------------------------------------

HEATER TEST DATA RUN HTR-1     DATE 14-OCT-80   TIME 08-15

C3 (MOLE C/C)= .60  N-C4=2.56  I-C4=96.84  N-C5=0.    I-C5= 0.

NUM OF EXCHANGERS=6

PI108  (B6-IN)= 313.9 (PSIA)     BR FLOW RATE (LBS/HR)= 93193.8
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PI108  (B1-OUT)=296.7

PI204  (B1-IN)= 666.7 (PSIA)     TW101=205.6     TW201=141.2 (DEG-F)
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PI204  (B2/B3)= 651.1            TW103=269.3     TW203=256.0
PI204  (B3/B4)= 642.2            TW104=281.8     TW204=272.6
PI204  (B4/B5)= 631.9            TW105=291.9     TW205=283.5
PI204  (B5/B6)= 620.1            TW106=310.1     TW206=292.1
PI204  (B6-OUT)=602.5            TW107=339.6     TW207=315.2

-----------------------------------------------------------------
```

```
HEATER TEST DATA RUN HTR-1    DATE 14-OCT-80  TIME 08-30

C3 (MOLE O/O)= .60  N-C4=2.56  I-C4=96.84  N-C5=0.    I-C5= 0.

NUM OF EXCHANGERS=6

PI108  (B6-IN)= 313.5 (PSIA)    BR FLOW RATE (LBS/HR)= 93192.1
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PI108  (B1-OUT)=296.5

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PI204  (B2/B3)= 650.6           TW103=269.3    TW203=256.0
PI204  (B3/B4)= 642.0           TW104=281.7    TW204=272.5
PI204  (B4/B5)= 631.7           TW105=291.7    TW205=283.4
PI204  (B5/B6)= 620.0           TW106=310.0    TW206=292.0
PI204  (B6-OUT)=602.5           TW107=339.4    TW207=313.8

--------------------------------------------------------------

HEATER TEST DATA RUN HTR-1    DATE 14-OCT-80  TIME 08-45

C3 (MOLE O/O)= .60  N-C4=2.56  I-C4=96.84  N-C5=0.    I-C5= 0.

NUM OF EXCHANGERS=6

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PI108  (B1-OUT)=296.4

PI204  (B1-IN)= 665.7 (PSIA)    TW101=206.1    TW201=142.3 (DEG-F)
PI204  (B1/B2)= 659.4           TW102=248.5    TW202=222.3
PI204  (B2/B3)= 650.1           TW103=269.3    TW203=256.0
PI204  (B3/B4)= 641.5           TW104=281.6    TW204=272.5
PI204  (B4/B5)= 631.3           TW105=291.5    TW205=283.3
PI204  (B5/B6)= 619.6           TW106=309.6    TW206=291.8
PI204  (B6-OUT)=602.3           TW107=338.7    TW207=313.7

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HEATER TEST DATA RUN HTR-2    DATE 14-OCT-80  TIME 10-00

C3 (MOLE O/O)= .60  N-C4=2.56  I-C4=96.84  N-C5=0.    I-C5= 0.

NUM OF EXCHANGERS=6

PI108  (B6-IN)= 312.5 (PSIA)    BR FLOW RATE (LBS/HR)= 93369.0
PI108  (B4/B3)= 303.3           HC FLOW RATE (LBS/HR)= 60526.8
PI108  (B1-OUT)=295.7

PI204  (B1-IN)= 655.0 (PSIA)    TW101=217.8    TW201=130.4 (DEG-F)
PI204  (B1/B2)= 656.6           TW102=263.8    TW202=236.7
PI204  (B2/B3)= 644.3           TW103=282.4    TW203=270.8
PI204  (B3/B4)= 638.2           TW104=293.2    TW204=285.0
PI204  (B4/B5)= 629.6           TW105=305.9    TW205=293.5
PI204  (B5/B6)= 616.8           TW106=327.4    TW206=310.4
PI204  (B6-OUT)=601.1           TW107=339.4    TW207=331.0

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HEATER TEST DATA RUN HTR-2    DATE 14-OCT-80  TIME 10-30

C3 (MOLE C/C)= .60  N-C4=2.56  I-C4=96.84  N-C5=0.    I-C5= 0.

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 312.4 (PSIA)    ER FLOW RATE (LBS/HR)= 93364.5
PI108 (B4/B3)= 303.1           HC FLOW RATE (LBS/HR)= 60474.1
PI108 (B1-OUT)=295.5

PI204 (B1-IN)= 654.0 (PSIA)    TW101=218.1    TW201=131.0 (DEG-F)
PI204 (B1/B2)= 650.0           TW102=263.7    TW202=236.7
PI204 (B2/B3)= 643.6           TW103=282.6    TW203=270.9
PI204 (B3/B4)= 637.5           TW104=293.3    TW204=285.0
PI204 (B4/B5)= 629.2           TW105=306.0    TW205=293.5
PI204 (B5/B6)= 616.3           TW106=328.0    TW206=310.9
PI204 (B6-OUT)=601.0           TW107=339.4    TW207=328.8

--------------------------------------------------------------------

HEATER TEST DATA RUN HTR-2    DATE 14-OCT-80  TIME 10-45

C3 (MOLE C/C)= .60  N-C4=2.56  I-C4=96.84  N-C5=0.    I-C5= 0.

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 312.2 (PSIA)    ER FLOW RATE (LBS/HR)= 93366.3
PI108 (B4/B3)= 303.0           HC FLOW RATE (LBS/HR)= 60474.6
PI108 (B1-OUT)=295.5

PI204 (B1-IN)= 654.2 (PSIA)    TW101=218.0    TW201=131.0 (DEG-F)
PI204 (B1/B2)= 650.0           TW102=263.9    TW202=236.9
PI204 (B2/B3)= 643.5           TW103=282.5    TW203=270.9
PI204 (B3/B4)= 637.2           TW104=293.4    TW204=285.2
PI204 (B4/B5)= 628.9           TW105=306.0    TW205=293.5
PI204 (B5/B6)= 616.5           TW106=328.0    TW206=311.0
PI204 (B6-OUT)=600.8           TW107=339.4    TW207=329.1

--------------------------------------------------------------------

HEATER TEST DATA RUN HTR-2    DATE 14-OCT-80  TIME 11-00

C3 (MOLE C/C)= .60  N-C4=2.56  I-C4=96.84  N-C5=0.    I-C5= 0.

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 312.4 (PSIA)    ER FLOW RATE (LBS/HR)= 93365.4
PI108 (B4/B3)= 303.0           HC FLOW RATE (LBS/HR)= 60694.7
PI108 (B1-OUT)=295.5

PI204 (B1-IN)= 654.0 (PSIA)    TW101=218.0    TW201=131.5 (DEG-F)
PI204 (B1/B2)= 650.1           TW102=263.7    TW202=236.7
PI204 (B2/B3)= 643.7           TW103=282.3    TW203=270.7
PI204 (B3/B4)= 637.5           TW104=293.1    TW204=284.9
PI204 (B4/B5)= 629.1           TW105=305.6    TW205=293.4
PI204 (B5/B6)= 616.6           TW106=327.4    TW206=310.2
PI204 (B6-OUT)=601.4           TW107=338.8    TW207=330.1

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HEATER TEST DATA RUN HTR-2     DATE 14-OCT-80  TIME 11-15

C3 (MOLE C/C)= .60  N-C4=2.56  I-C4=96.84  N-C5=0.    I-C5= 0.

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 312.2 (PSIA)     ER FLOW RATE (LBS/HR)= 93365.4
PI108 (B4/B3)= 303.0            HC FLOW RATE (LBS/HR)= 60396.5
PI108 (B1-OUT)=295.4

PI204 (B1-IN)= 653.2 (PSIA)     TW101=218.0    TW201=131.9 (DEG-F)
PI204 (B1/B2)= 649.1            TW102=263.5    TW202=236.6
PI204 (B2/B3)= 642.6            TW103=282.1    TW203=270.5
PI204 (B3/B4)= 636.3            TW104=292.7    TW204=284.7
PI204 (B4/B5)= 628.1            TW105=304.0    TW205=293.0
PI204 (B5/B6)= 615.7            TW106=326.7    TW206=309.1
PI204 (B6-OUT)=600.4            TW107=338.8    TW207=328.4
```

```
HEATER TEST DATA RUN HTR-2     DATE 14-OCT-80  TIME 11-30

C3 (MOLE C/C)= .60  N-C4=2.56  I-C4=96.84  N-C5=0.    I-C5= 0.

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 312.5 (PSIA)     ER FLOW RATE (LBS/HR)= 93361.9
PI108 (B4/B3)= 303.8            HC FLOW RATE (LBS/HR)= 60397.5
PI108 (B1-OUT)=295.7

PI204 (B1-IN)= 653.7 (PSIA)     TW101=218.2    TW201=131.9 (DEG-F)
PI204 (B1/B2)= 649.3            TW102=263.7    TW202=236.9
PI204 (B2/B3)= 642.6            TW103=282.0    TW203=270.5
PI204 (B3/B4)= 636.5            TW104=292.7    TW204=284.7
PI204 (B4/B5)= 628.4            TW105=304.4    TW205=292.9
PI204 (B5/B6)= 616.0            TW106=326.3    TW206=308.5
PI204 (B6-OUT)=600.3            TW107=338.8    TW207=328.6
```

```
HEATER TEST DATA RUN HTR-2     DATE 14-OCT-80  TIME 11-45

C3 (MOLE C/C)= .60  N-C4=2.56  I-C4=96.84  N-C5=0.    I-C5= 0.

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 312.6 (PSIA)     ER FLOW RATE (LBS/HR)= 93361.9
PI108 (B4/B3)= 303.2            HC FLOW RATE (LBS/HR)= 60862.3
PI108 (B1-OUT)=295.8

PI204 (B1-IN)= 653.3 (PSIA)     TW101=218.2    TW201=132.6 (DEG-F)
PI204 (B1/B2)= 649.1            TW102=263.4    TW202=236.6
PI204 (B2/B3)= 642.6            TW103=281.9    TW203=270.3
PI204 (B3/B4)= 636.5            TW104=292.3    TW204=284.4
PI204 (B4/B5)= 628.1            TW105=304.0    TW205=292.6
PI204 (B5/B6)= 616.1            TW106=325.9    TW206=307.9
PI204 (B6-OUT)=600.8            TW107=338.1    TW207=328.7
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```
HEATER TEST DATA RUN HTR-3    DATE 15-OCT-80   TIME 11-15

C3 (MOLE C/C)= .60  N-C4=2.56  I-C4=96.84  N-C5=0.    I-C5= 0.

NUM OF EXCHANGERS=4

PI108 (B6-IN)= 307.7 (PSIA)    BR FLOW RATE (LBS/HR)= 93508.6
PI108 (B4/B3)= 303.6           HC FLOW RATE (LBS/HR)= 38955.7
PI108 (B1-OUT)=296.0

PI204 (B1-IN)= 640.1 (PSIA)    TW101=259.5    TW201=127.4 (DEG-F)
PI204 (B1/B2)= 638.2           TW102=305.2    TW202=280.8
PI204 (B2/B3)= 633.1           TW103=331.6    TW203=315.6
PI204 (B3/B4)= 625.4           TW104=339.0    TW204=333.3
PI204 (B4/B5)= 617.5           TW105=336.9    TW205=337.9
PI204 (B5/B6)= 609.0           TW106=322.7    TW206=334.4
PI204 (B6-OUT)=601.8           TW107=311.3    TW207=333.2

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HEATER TEST DATA RUN HTR-3    DATE 15-OCT-80   TIME 11-30

C3 (MOLE C/C)= .60  N-C4=2.56  I-C4=96.84  N-C5=0.    I-C5= 0.

NUM OF EXCHANGERS=4

PI108 (B6-IN)= 307.6 (PSIA)    BR FLOW RATE (LBS/HR)= 93677.2
PI108 (B4/B3)= 303.7           HC FLOW RATE (LBS/HR)= 38611.5
PI108 (B1-OUT)=296.0

PI204 (B1-IN)= 639.4 (PSIA)    TW101=250.4    TW201=126.4 (DEG-F)
PI204 (B1/B2)= 637.5           TW102=306.6    TW202=281.6
PI204 (B2/B3)= 632.4           TW103=332.4    TW203=316.9
PI204 (B3/B4)= 625.1           TW104=338.9    TW204=333.8
PI204 (B4/B5)= 617.0           TW105=336.8    TW205=337.8
PI204 (B5/B6)= 608.8           TW106=322.6    TW206=334.0
PI204 (B6-OUT)=601.7           TW107=310.9    TW207=333.0

--------------------------------------------------------------

HEATER TEST DATA RUN HTR-3    DATE 15-OCT-80   TIME 12-33

C3 (MOLE C/C)= .60  N-C4=2.56  I-C4=96.84  N-C5=0.    I-C5= 0.

NUM OF EXCHANGERS=4

PI108 (B6-IN)= 312.4 (PSIA)    BR FLOW RATE (LBS/HR)= 92588.8
PI108 (B4/B3)= 303.1           HC FLOW RATE (LBS/HR)= 44502.7
PI108 (B1-OUT)=295.5

PI204 (B1-IN)= 648.4 (PSIA)    TW101=249.0    TW201=138.1 (DEG-F)
PI204 (B1/B2)= 645.6           TW102=293.6    TW202=269.4
PI204 (B2/B3)= 641.4           TW103=316.7    TW203=298.4
PI204 (B3/B4)= 633.6           TW104=332.5    TW204=322.5
PI204 (B4/B5)= 623.2           TW105=335.0    TW205=334.4
PI204 (B5/B6)= 612.7           TW106=338.8    TW206=335.4
PI204 (B6-OUT)=603.2           TW107=339.0    TW207=336.6

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HEATER TEST DATA RUN HTR-3    DATE 15-OCT-80  TIME 12-45

C3 (MOLE O/O)= .60  N-C4=2.56  I-C4=96.84  N-C5=0.    I-C5= 0.

NUM OF EXCHANGERS=4

PI108  (B6-IN)= 312.5 (PSIA)    BR FLOW RATE (LBS/HR)= 92777.4
PI108  (B4/B3)= 303.2           HC FLOW RATE (LBS/HR)= 44983.4
PI108  (B1-OUT)=295.7

PI204  (B1-IN)= 647.8 (PSIA)    TW101=249.1    TW201=138.7 (DEG-F)
PI204  (B1/B2)= 645.1           TW102=293.3    TW202=268.9
PI204  (B2/B3)= 640.6           TW103=316.4    TW203=298.4
PI204  (B3/B4)= 633.4           TW104=332.6    TW204=322.6
PI204  (B4/B5)= 622.4           TW105=335.1    TW205=334.7
PI204  (B5/B6)= 612.6           TW106=338.9    TW206=335.8
PI204  (B6-OUT)=602.6           TW107=339.2    TW207=337.1
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HEATER TEST DATA RUN HTR-3    DATE 15-OCT-80  TIME 13-00

C3 (MOLE O/O)= .60  N-C4=2.56  I-C4=96.84  N-C5=0.    I-C5= 0.

NUM OF EXCHANGERS=4

PI108  (B6-IN)= 312.1 (PSIA)    BR FLOW RATE (LBS/HR)= 92592.8
PI108  (B4/B3)= 302.8           HC FLOW RATE (LBS/HR)= 44963.7
PI108  (B1-OUT)=295.1

PI204  (B1-IN)= 647.7 (PSIA)    TW101=248.8    TW201=139.0 (DEG-F)
PI204  (B1/B2)= 645.2           TW102=293.6    TW202=269.1
PI204  (B2/B3)= 640.5           TW103=316.2    TW203=298.2
PI204  (B3/B4)= 632.8           TW104=332.8    TW204=323.1
PI204  (B4/B5)= 622.2           TW105=334.6    TW205=333.6
PI204  (B5/B6)= 611.2           TW106=338.4    TW206=335.4
PI204  (B6-OUT)=601.8           TW107=338.7    TW207=336.8
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```
HEATER TEST DATA RUN HTR-3    DATE 15-OCT-80  TIME 13-15

C3 (MOLE O/O)= .60  N-C4=2.56  I-C4=96.84  N-C5=0.    I-C5= 0.

NUM OF EXCHANGERS=4

PI108  (B6-IN)= 312.3 (PSIA)    BR FLOW RATE (LBS/HR)= 92779.4
PI108  (B4/B3)= 302.8           HC FLOW RATE (LBS/HR)= 44944.1
PI108  (B1-OUT)=295.4

PI204  (B1-IN)= 647.6 (PSIA)    TW101=249.0    TW201=139.3 (DEG-F)
PI204  (B1/B2)= 645.1           TW102=293.4    TW202=269.1
PI204  (B2/B3)= 640.3           TW103=316.2    TW203=298.2
PI204  (B3/B4)= 633.4           TW104=332.5    TW204=322.8
PI204  (B4/B5)= 622.4           TW105=335.0    TW205=334.2
PI204  (B5/B6)= 611.8           TW106=338.8    TW206=335.6
PI204  (B6-OUT)=602.3           TW107=338.9    TW207=336.5
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```
HEATER TEST DATA RUN HTR-5    DATE 15-OCT-80  TIME 16-00

C3 (MOLE C/C)= .60  N-C4=2.56  I-C4=96.84  N-C5=0.    I-C5= 0.

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 279.9 (PSIA)    BR FLOW RATE (LBS/HR)=102517.2
PI108 (B4/B3)= 269.0           HC FLOW RATE (LBS/HR)= 83608.1
PI108 (B1-OUT)=260.9

PI204 (B1-IN)= 676.0 (PSIA)    TW101=207.5    TW201=152.0 (DEG-F)
PI204 (B1/B2)= 668.2           TW102=246.2    TW202=221.7
PI204 (B2/B3)= 656.6           TW103=267.1    TW203=253.6
PI204 (B3/B4)= 646.0           TW104=279.9    TW204=270.4
PI204 (B4/B5)= 633.4           TW105=290.2    TW205=281.5
PI204 (B5/B6)= 619.6           TW106=307.9    TW206=290.3
PI204 (B6-OUT)=599.0           TW107=339.9    TW207=310.9
--------------------------------------------------------------------
HEATER TEST DATA RUN HTR-5    DATE 15-OCT-80  TIME 16-15

C3 (MOLE C/C)= .60  N-C4=2.56  I-C4=96.84  N-C5=0.    I-C5= 0.

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 280.1 (PSIA)    BR FLOW RATE (LBS/HR)=102340.0
PI108 (B4/B3)= 269.0           HC FLOW RATE (LBS/HR)= 83225.6
PI108 (B1-OUT)=260.6

PI204 (B1-IN)= 676.1 (PSIA)    TW101=207.6    TW201=152.0 (DEG-F)
PI204 (B1/B2)= 668.2           TW102=246.2    TW202=221.7
PI204 (B2/B3)= 656.7           TW103=267.3    TW203=253.8
PI204 (B3/B4)= 646.4           TW104=279.9    TW204=270.3
PI204 (B4/B5)= 633.6           TW105=290.2    TW205=281.6
PI204 (B5/B6)= 619.9           TW106=307.8    TW206=290.4
PI204 (B6-OUT)=599.5           TW107=339.6    TW207=310.9
--------------------------------------------------------------------
HEATER TEST DATA RUN HTR-5    DATE 15-OCT-80  TIME 16-30

C3 (MOLE C/C)= .60  N-C4=2.56  I-C4=96.84  N-C5=0.    I-C5= 0.

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 280.0 (PSIA)    BR FLOW RATE (LBS/HR)=102162.6
PI108 (B4/B3)= 269.1           HC FLOW RATE (LBS/HR)= 83448.5
PI108 (B1-OUT)=261.2

PI204 (B1-IN)= 675.9 (PSIA)    TW101=207.7    TW201=152.2 (DEG-F)
PI204 (B1/B2)= 667.9           TW102=246.4    TW202=221.9
PI204 (B2/B3)= 656.4           TW103=267.3    TW203=253.8
PI204 (B3/B4)= 645.8           TW104=279.9    TW204=270.4
PI204 (B4/B5)= 633.2           TW105=290.2    TW205=281.5
PI204 (B5/B6)= 619.5           TW106=307.8    TW206=290.4
PI204 (B6-OUT)=599.0           TW107=339.6    TW207=311.0
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HEATER TEST DATA RUN HTR-5    DATE 15-OCT-80  TIME 16-45

C3 (MOLE O/O)= .60  N-C4=2.56  I-C4=96.84  N-C5=0.    I-C5= 0.

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 280.1 (PSIA)    BR FLOW RATE (LBS/HR)=102159.9
PI108 (B4/B3)= 269.2           HC FLOW RATE (LBS/HR)= 83182.5
PI108 (B1-OUT)=261.4

PI204 (B1-IN)= 676.4 (PSIA)    TW101=207.9    TW201=152.3 (DEG-F)
PI204 (B1/B2)= 668.2           TW102=246.6    TW202=222.0
PI204 (B2/B3)= 656.8           TW103=267.4    TW203=253.8
PI204 (B3/B4)= 646.4           TW104=280.0    TW204=270.5
PI204 (B4/B5)= 633.7           TW105=290.4    TW205=281.6
PI204 (B5/B6)= 620.1           TW106=308.0    TW206=290.4
PI204 (B6-OUT)=599.4           TW107=339.8    TW207=311.0

----------------------------------------------------------------

HEATER TEST DATA RUN HTR-5    DATE 15-OCT-80  TIME 17-00

C3 (MOLE O/O)= .60  N-C4=2.56  I-C4=96.84  N-C5=0.    I-C5= 0.

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 280.1 (PSIA)    BR FLOW RATE (LBS/HR)=102332.7
PI108 (B4/B3)= 269.2           HC FLOW RATE (LBS/HR)= 82917.3
PI108 (B1-OUT)=261.4

PI204 (B1-IN)= 675.4 (PSIA)    TW101=208.0    TW201=152.4 (DEG-F)
PI204 (B1/B2)= 667.8           TW102=246.6    TW202=222.1
PI204 (B2/B3)= 656.5           TW103=267.5    TW203=254.0
PI204 (B3/B4)= 646.1           TW104=279.9    TW204=270.5
PI204 (B4/B5)= 633.6           TW105=290.2    TW205=281.6
PI204 (B5/B6)= 620.1           TW106=307.5    TW206=290.3
PI204 (B6-OUT)=599.7           TW107=339.3    TW207=310.8

----------------------------------------------------------------

HEATER TEST DATA RUN HTR-5    DATE 15-OCT-80  TIME 17-15

C3 (MOLE O/O)= .60  N-C4=2.56  I-C4=96.84  N-C5=0.    I-C5= 0.

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 279.9 (PSIA)    BR FLOW RATE (LBS/HR)=102330.8
PI108 (B4/B3)= 269.1           HC FLOW RATE (LBS/HR)= 82938.1
PI108 (B1-OUT)=261.2

PI204 (B1-IN)= 675.9 (PSIA)    TW101=208.1    TW201=152.2 (DEG-F)
PI204 (B1/B2)= 667.8           TW102=246.8    TW202=222.3
PI204 (B2/B3)= 656.7           TW103=267.5    TW203=254.0
PI204 (B3/B4)= 646.1           TW104=280.1    TW204=270.6
PI204 (B4/B5)= 633.5           TW105=290.3    TW205=281.7
PI204 (B5/B6)= 619.8           TW106=307.7    TW206=290.5
PI204 (B6-OUT)=599.3           TW107=339.4    TW207=311.0

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HEATER TEST DATA RUN HTR-5     DATE 15-OCT-80  TIME 17-30

C3 (MOLE C/C)= .60  N-C4=2.56  I-C4=96.84  N-C5=0.    I-C5= 0.

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 280.4 (PSIA)    BR FLOW RATE (LBS/HR)=102507.1
PI108 (B4/B3)= 269.7           HC FLOW RATE (LBS/HR)= 82692.8
PI108 (B1-OUT)=261.5

PI204 (B1-IN)= 675.2 (PSIA)    TW101=208.1    TW201=152.1 (DEG-F)
PI204 (B1/B2)= 667.3           TW102=246.9    TW202=222.4
PI204 (B2/B3)= 656.1           TW103=267.6    TW203=254.1
PI204 (B3/B4)= 645.6           TW104=280.1    TW204=270.8
PI204 (B4/B5)= 633.2           TW105=290.2    TW205=281.7
PI204 (B5/B6)= 619.7           TW106=307.5    TW206=290.5
PI204 (B6-OUT)=599.5           TW107=339.1    TW207=310.9
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```
HEATER TEST DATA RUN HTR-5     DATE 15-OCT-80  TIME 17-45

C3 (MOLE C/C)= .60  N-C4=2.56  I-C4=96.84  N-C5=0.    I-C5= 0.

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 280.6 (PSIA)    BR FLOW RATE (LBS/HR)=102504.3
PI108 (B4/B3)= 269.3           HC FLOW RATE (LBS/HR)= 82695.0
PI108 (B1-OUT)=261.4

PI204 (B1-IN)= 675.8 (PSIA)    TW101=208.2    TW201=152.1 (DEG-F)
PI204 (B1/B2)= 668.0           TW102=247.0    TW202=222.5
PI204 (B2/B3)= 657.0           TW103=267.7    TW203=254.2
PI204 (B3/B4)= 646.4           TW104=280.2    TW204=270.8
PI204 (B4/B5)= 633.8           TW105=290.4    TW205=281.8
PI204 (B5/B6)= 620.1           TW106=307.6    TW206=290.5
PI204 (B6-OUT)=599.8           TW107=339.1    TW207=311.1
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```
HEATER TEST DATA RUN HTR-6     DATE 16-OCT-80  TIME 07-30

C3 (MOLE C/C)= .60  N-C4=2.56  I-C4=96.84  N-C5=0.    I-C5= 0.

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 252.4 (PSIA)    BR FLOW RATE (LBS/HR)= 99412.3
PI108 (B4/B3)= 242.5           HC FLOW RATE (LBS/HR)= 86497.1
PI108 (B1-OUT)=234.4

PI204 (B1-IN)= 652.6 (PSIA)    TW101=201.7    TW201=151.6 (DEG-F)
PI204 (B1/B2)= 643.7           TW102=239.4    TW202=214.3
PI204 (B2/B3)= 631.8           TW103=260.5    TW203=246.6
PI204 (B3/B4)= 620.7           TW104=274.3    TW204=264.0
PI204 (B4/B5)= 608.1           TW105=285.3    TW205=276.0
PI204 (B5/B6)= 593.8           TW106=304.0    TW206=285.7
PI204 (B6-OUT)=571.2           TW107=343.6    TW207=308.7
```

HEATER TEST DATA RUN HTR-6 DATE 16-OCT-80 TIME 07-45

C3 (MOLE C/C)= .60 N-C4=2.56 I-C4=96.84 N-C5=0. I-C5= 0.

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 252.3 (PSIA) BR FLOW RATE (LBS/HR)= 99231.1
PI108 (B4/B3)= 242.1 HC FLOW RATE (LBS/HR)= 86741.5
PI108 (B1-OUT)=234.3

PI204 (B1-IN)= 653.2 (PSIA)	TW101=201.7	TW201=151.7 (DEG-F)
PI204 (B1/B2)= 644.2	TW102=239.2	TW202=214.4
PI204 (B2/B3)= 632.5	TW103=260.4	TW203=246.4
PI204 (B3/B4)= 621.2	TW104=274.1	TW204=263.9
PI204 (B4/B5)= 608.5	TW105=285.2	TW205=275.9
PI204 (B5/B6)= 594.1	TW106=303.8	TW206=285.5
PI204 (B6-OUT)=571.5	TW107=343.4	TW207=308.6

HEATER TEST DATA RUN HTR-6 DATE 16-OCT-80 TIME 08-00

C3 (MOLE C/C)= .60 N-C4=2.56 I-C4=96.84 N-C5=0. I-C5= 0.

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 251.9 (PSIA) BR FLOW RATE (LBS/HR)= 99228.4
PI108 (B4/B3)= 241.9 HC FLOW RATE (LBS/HR)= 86701.0
PI108 (B1-OUT)=234.0

PI204 (B1-IN)= 653.0 (PSIA)	TW101=201.9	TW201=152.0 (DEG-F)
PI204 (B1/B2)= 644.2	TW102=239.2	TW202=214.5
PI204 (B2/B3)= 632.3	TW103=260.4	TW203=246.5
PI204 (B3/B4)= 621.0	TW104=274.0	TW204=263.9
PI204 (B4/B5)= 608.1	TW105=285.2	TW205=275.9
PI204 (B5/B6)= 593.8	TW106=303.8	TW206=285.5
PI204 (B6-OUT)=571.3	TW107=343.5	TW207=308.5

HEATER TEST DATA RUN HTR-6 DATE 16-OCT-80 TIME 08-15

C3 (MOLE C/C)= .60 N-C4=2.56 I-C4=96.84 N-C5=0. I-C5= 0.

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 251.6 (PSIA) BR FLOW RATE (LBS/HR)= 98866.0
PI108 (B4/B3)= 241.5 HC FLOW RATE (LBS/HR)= 86670.1
PI108 (B1-OUT)=233.6

PI204 (B1-IN)= 651.9 (PSIA)	TW101=201.8	TW201=152.2 (DEG-F)
PI204 (B1/B2)= 643.2	TW102=239.1	TW202=214.5
PI204 (B2/B3)= 631.2	TW103=260.2	TW203=246.2
PI204 (B3/B4)= 619.6	TW104=273.9	TW204=263.7
PI204 (B4/B5)= 607.2	TW105=284.9	TW205=275.6
PI204 (B5/B6)= 593.3	TW106=303.4	TW206=285.3
PI204 (B6-OUT)=570.3	TW107=343.2	TW207=307.9

HEATER TEST DATA RUN HTR-6 DATE 16-OCT-80 TIME 08-30

C3 (MOLE C/C)= .60 N-C4=2.56 I-C4=96.84 N-C5=0. I-C5= 0.

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 251.5 (PSIA)	BR FLOW RATE (LBS/HR)= 98865.9
PI108 (B4/B3)= 241.9	HC FLOW RATE (LBS/HR)= 86660.6
PI108 (B1-OUT)=233.7	

PI204 (B1-IN)= 651.2 (PSIA)	TW101=201.8	TW201=152.3 (DEG-F)
PI204 (B1/B2)= 642.4	TW102=239.0	TW202=214.4
PI204 (B2/B3)= 630.6	TW103=260.1	TW203=246.2
PI204 (B3/B4)= 619.5	TW104=273.7	TW204=263.6
PI204 (B4/B5)= 606.8	TW105=284.8	TW205=275.6
PI204 (B5/B6)= 592.3	TW106=303.8	TW206=285.2
PI204 (B6-OUT)=569.9	TW107=342.7	TW207=307.5

HEATER TEST DATA RUN HTR-6 DATE 16-OCT-80 TIME 08-45

C3 (MOLE C/C)= .60 N-C4=2.56 I-C4=96.84 N-C5=0. I-C5= 0.

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 252.1 (PSIA)	BR FLOW RATE (LBS/HR)= 99044.3
PI108 (B4/B3)= 241.7	HC FLOW RATE (LBS/HR)= 86130.7
PI108 (B1-OUT)=233.7	

PI204 (B1-IN)= 651.1 (PSIA)	TW101=202.0	TW201=152.4 (DEG-F)
PI204 (B1/B2)= 642.2	TW102=239.0	TW202=214.5
PI204 (B2/B3)= 630.4	TW103=260.2	TW203=246.4
PI204 (B3/B4)= 619.2	TW104=273.7	TW204=263.6
PI204 (B4/B5)= 606.7	TW105=284.7	TW205=275.5
PI204 (B5/B6)= 592.5	TW106=302.4	TW206=285.1
PI204 (B6-OUT)=570.4	TW107=342.2	TW207=307.4

HEATER TEST DATA RUN HTR-6 DATE 16-OCT-80 TIME 09-00

C3 (MOLE C/C)= .60 N-C4=2.56 I-C4=96.84 N-C5=0. I-C5= 0.

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 251.1 (PSIA)	BR FLOW RATE (LBS/HR)= 99220.5
PI108 (B4/B3)= 241.0	HC FLOW RATE (LBS/HR)= 86333.4
PI108 (B1-OUT)=233.3	

PI204 (B1-IN)= 651.3 (PSIA)	TW101=202.3	TW201=152.8 (DEG-F)
PI204 (B1/B2)= 642.7	TW102=239.4	TW202=214.9
PI204 (B2/B3)= 630.9	TW103=260.4	TW203=246.6
PI204 (B3/B4)= 619.6	TW104=273.8	TW204=263.8
PI204 (B4/B5)= 607.1	TW105=284.8	TW205=275.7
PI204 (B5/B6)= 592.9	TW106=303.2	TW206=285.2
PI204 (B6-OUT)=570.4	TW107=342.1	TW207=306.4

```
HEATER TEST DATA RUN HTR-6     DATE 16-OCT-80  TIME 09-15

C3 (MOLE O/O)= .60  N-C4=2.56  I-C4=96.84  N-C5=0.     I-C5= 0.

NUM OF EXCHANGERS=6

PI108  (B6-IN)= 251.5 (PSIA)     BR FLOW RATE (LBS/HR)= 99218.7
PI108  (B4/B3)= 241.4            HC FLOW RATE (LBS/HR)= 86303.3
PI108  (B1-OUT)=233.4

PI204  (B1-IN)= 650.4 (PSIA)     TW101=202.4    TW201=153.0 (DEG-F)
PI204  (B1/B2)= 642.3            TW102=239.3    TW202=214.9
PI204  (B2/B3)= 630.1            TW103=260.3    TW203=246.5
PI204  (B3/B4)= 619.0            TW104=273.7    TW204=263.6
PI204  (B4/B5)= 606.6            TW105=284.6    TW205=275.5
PI204  (B5/B6)= 592.1            TW106=302.8    TW206=285.0
PI204  (B6-OUT)=569.9            TW107=341.8    TW207=305.7

--------------------------------------------------------------------

HEATER TEST DATA RUN HTR-7     DATE 16-OCT-80  TIME 10-30

C3 (MOLE O/O)= .60  N-C4=2.56  I-C4=96.84  N-C5=0.     I-C5= 0.

NUM OF EXCHANGERS=6

PI108  (B6-IN)= 257.4 (PSIA)     BR FLOW RATE (LBS/HR)=100830.5
PI108  (B4/B3)= 247.0            HC FLOW RATE (LBS/HR)= 70899.0
PI108  (B1-OUT)=238.9

PI204  (B1-IN)= 638.7 (PSIA)     TW101=212.6    TW201=141.8 (DEG-F)
PI204  (B1/B2)= 633.2            TW102=254.4    TW202=228.8
PI204  (B2/B3)= 624.9            TW103=273.7    TW203=261.5
PI204  (B3/B4)= 616.7            TW104=284.9    TW204=276.3
PI204  (B4/B5)= 607.0            TW105=295.0    TW205=285.4
PI204  (B5/B6)= 593.3            TW106=318.8    TW206=295.4
PI204  (B6-OUT)=572.7            TW107=341.8    TW207=324.6

--------------------------------------------------------------------

HEATER TEST DATA RUN HTR-7     DATE 16-OCT-80  TIME 10-45

C3 (MOLE O/O)= .60  N-C4=2.56  I-C4=96.84  N-C5=0.     I-C5= 0.

NUM OF EXCHANGERS=6

PI108  (B6-IN)= 257.1 (PSIA)     BR FLOW RATE (LBS/HR)=100828.5
PI108  (B4/B3)= 246.7            HC FLOW RATE (LBS/HR)= 71101.6
PI108  (B1-OUT)=238.5

PI204  (B1-IN)= 639.1 (PSIA)     TW101=212.7    TW201=142.4 (DEG-F)
PI204  (B1/B2)= 633.4            TW102=254.5    TW202=229.1
PI204  (B2/B3)= 625.1            TW103=273.7    TW203=261.6
PI204  (B3/B4)= 616.7            TW104=284.5    TW204=276.4
PI204  (B4/B5)= 607.1            TW105=295.1    TW205=285.4
PI204  (B5/B6)= 593.3            TW106=319.1    TW206=295.5
PI204  (B6-OUT)=572.6            TW107=342.0    TW207=325.9

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HEATER TEST DATA RUN HTR-7     DATE 16-OCT-80   TIME 11-00

C3 (MOLE C/C)= .60  N-C4=2.56  I-C4=96.84  N-C5=0.    I-C5= 0.

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 257.2 (PSIA)     ER FLOW RATE (LBS/HR)=101003.4
PI108 (B4/B3)= 246.7            HC FLOW RATE (LBS/HR)= 71074.7
PI108 (B1-OUT)=238.9

PI204 (B1-IN)= 638.6 (PSIA)     TW101=212.9    TW201=142.6 (DEG-F)
PI204 (B1/B2)= 633.1            TW102=254.4    TW202=229.0
PI204 (B2/B3)= 624.7            TW103=273.6    TW203=261.5
PI204 (B3/B4)= 616.6            TW104=284.5    TW204=276.3
PI204 (B4/B5)= 606.8            TW105=295.0    TW205=285.3
PI204 (B5/B6)= 592.9            TW106=319.2    TW206=295.5
PI204 (B6-OUT)=572.0            TW107=342.1    TW207=325.3
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HEATER TEST DATA RUN HTR-7     DATE 16-OCT-80   TIME 11-15

C3 (MOLE C/C)= .60  N-C4=2.56  I-C4=96.84  N-C5=0.    I-C5= 0.

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 257.1 (PSIA)     ER FLOW RATE (LBS/HR)=101001.5
PI108 (B4/B3)= 246.4            HC FLOW RATE (LBS/HR)= 71065.4
PI108 (B1-OUT)=238.6

PI204 (B1-IN)= 639.2 (PSIA)     TW101=213.0    TW201=142.7 (DEG-F)
PI204 (B1/B2)= 633.4            TW102=254.2    TW202=228.9
PI204 (B2/B3)= 625.1            TW103=273.6    TW203=261.5
PI204 (B3/B4)= 616.9            TW104=284.4    TW204=276.2
PI204 (B4/B5)= 607.2            TW105=295.2    TW205=285.4
PI204 (B5/B6)= 593.2            TW106=319.4    TW206=295.4
PI204 (B6-OUT)=572.3            TW107=342.6    TW207=325.8
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HEATER TEST DATA RUN HTR-7     DATE 16-OCT-80   TIME 11-30

C3 (MOLE C/C)= .60  N-C4=2.56  I-C4=96.84  N-C5=0.    I-C5= 0.

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 256.8 (PSIA)     ER FLOW RATE (LBS/HR)=101179.6
PI108 (B4/B3)= 246.5            HC FLOW RATE (LBS/HR)= 71039.9
PI108 (B1-OUT)=238.4

PI204 (B1-IN)= 639.4 (PSIA)     TW101=212.9    TW201=143.0 (DEG-F)
PI204 (B1/B2)= 633.4            TW102=254.5    TW202=229.1
PI204 (B2/B3)= 624.9            TW103=273.6    TW203=261.5
PI204 (B3/B4)= 616.6            TW104=284.5    TW204=276.4
PI204 (B4/B5)= 606.6            TW105=295.2    TW205=285.4
PI204 (B5/B6)= 592.8            TW106=319.7    TW206=295.7
PI204 (B6-OUT)=571.8            TW107=342.6    TW207=326.6
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HEATER TEST DATA RUN HTR-7    DATE 16-OCT-80  TIME 11-45

C3 (MOLE O/O)= .60  N-C4=2.56  I-C4=96.84  N-C5=0.    I-C5= 0.

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 256.6 (PSIA)    BR FLOW RATE (LBS/HR)=101178.6
PI108 (B4/B3)= 246.4           HC FLOW RATE (LBS/HR)= 71035.0
PI108 (B1-OUT)=238.1

PI204 (B1-IN)= 639.5 (PSIA)    TW101=213.0    TW201=143.0 (DEG-F)
PI204 (B1/B2)= 633.7           TW102=254.6    TW202=229.1
PI204 (B2/B3)= 625.3           TW103=273.8    TW203=261.6
PI204 (B3/B4)= 617.0           TW104=284.7    TW204=276.5
PI204 (B4/B5)= 607.2           TW105=295.5    TW205=285.5
PI204 (B5/B6)= 593.4           TW106=320.2    TW206=296.0
PI204 (B6-OUT)=572.0           TW107=342.9    TW207=326.8
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HEATER TEST DATA RUN HTR-7    DATE 16-OCT-80  TIME 12-00

C3 (MOLE O/O)= .60  N-C4=2.56  I-C4=96.84  N-C5=0.    I-C5= 0.

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 256.7 (PSIA)    BR FLOW RATE (LBS/HR)=101170.2
PI108 (B4/B3)= 246.1           HC FLOW RATE (LBS/HR)= 71505.2
PI108 (B1-OUT)=238.0

PI204 (B1-IN)= 639.8 (PSIA)    TW101=213.4    TW201=143.5 (DEG-F)
PI204 (B1/B2)= 634.0           TW102=254.3    TW202=229.1
PI204 (B2/B3)= 625.5           TW103=274.0    TW203=261.8
PI204 (B3/B4)= 617.2           TW104=284.7    TW204=276.4
PI204 (B4/B5)= 607.2           TW105=295.6    TW205=285.6
PI204 (B5/B6)= 593.2           TW106=320.4    TW206=296.0
PI204 (B6-OUT)=572.0           TW107=343.4    TW207=327.4
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HEATER TEST DATA RUN HTR-7    DATE 16-OCT-80  TIME 12-15

C3 (MOLE O/O)= .60  N-C4=2.56  I-C4=96.84  N-C5=0.    I-C5= 0.

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 253.9 (PSIA)    BR FLOW RATE (LBS/HR)=101869.6
PI108 (B4/B3)= 241.2           HC FLOW RATE (LBS/HR)= 71719.4
PI108 (B1-OUT)=233.1

PI204 (B1-IN)= 641.0 (PSIA)    TW101=213.7    TW201=143.9 (DEG-F)
PI204 (B1/B2)= 635.0           TW102=254.8    TW202=229.5
PI204 (B2/B3)= 626.5           TW103=274.2    TW203=262.0
PI204 (B3/B4)= 618.1           TW104=285.0    TW204=276.7
PI204 (B4/B5)= 608.2           TW105=296.1    TW205=285.9
PI204 (B5/B6)= 593.6           TW106=321.0    TW206=296.8
PI204 (B6-OUT)=572.2           TW107=343.5    TW207=327.2
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HEATER TEST DATA RUN HTR-8     DATE 16-OCT-80  TIME 13-00

C3 (MOLE C/C)= .60  N-C4=2.56  I-C4=96.84  N-C5=0.    I-C5= 0.

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 256.7 (PSIA)    BR FLOW RATE (LBS/HR)=101003.5
PI108 (B4/B3)= 246.2           HC FLOW RATE (LBS/HR)= 53303.1
PI108 (B1-OUT)=238.0

PI204 (B1-IN)= 635.0 (PSIA)    TW101=239.4    TW201=138.4 (DEG-F)
PI204 (B1/B2)= 631.6           TW102=284.6    TW202=258.5
PI204 (B2/B3)= 625.8           TW103=306.0    TW203=290.0
PI204 (B3/B4)= 617.0           TW104=328.6    TW204=311.6
PI204 (B4/B5)= 602.0           TW105=338.7    TW205=333.2
PI204 (B5/B6)= 585.6           TW106=341.8    TW206=339.1
PI204 (B6-OUT)=569.9           TW107=344.0    TW207=341.0
----------------------------------------------------------------------

HEATER TEST DATA RUN HTR-8     DATE 16-OCT-80  TIME 13-15

C3 (MOLE C/C)= .60  N-C4=2.56  I-C4=96.84  N-C5=0.    I-C5= 0.

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 256.8 (PSIA)    BR FLOW RATE (LBS/HR)=101008.8
PI108 (B4/B3)= 246.0           HC FLOW RATE (LBS/HR)= 53594.4
PI108 (B1-OUT)=237.9

PI204 (B1-IN)= 635.2 (PSIA)    TW101=239.2    TW201=138.0 (DEG-F)
PI204 (B1/B2)= 631.6           TW102=284.7    TW202=258.6
PI204 (B2/B3)= 625.9           TW103=306.0    TW203=290.1
PI204 (B3/B4)= 616.8           TW104=328.8    TW204=312.1
PI204 (B4/B5)= 601.9           TW105=338.6    TW205=333.6
PI204 (B5/B6)= 585.4           TW106=342.2    TW206=338.8
PI204 (B6-OUT)=569.8           TW107=344.0    TW207=341.0
----------------------------------------------------------------------

HEATER TEST DATA RUN HTR-8     DATE 16-OCT-80  TIME 13-30

C3 (MOLE C/C)= .60  N-C4=2.56  I-C4=96.84  N-C5=0.    I-C5= 0.

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 256.8 (PSIA)    BR FLOW RATE (LBS/HR)=101003.5
PI108 (B4/B3)= 246.0           HC FLOW RATE (LBS/HR)= 53608.0
PI108 (B1-OUT)=238.0

PI204 (B1-IN)= 636.1 (PSIA)    TW101=239.4    TW201=137.8 (DEG-F)
PI204 (B1/B2)= 632.6           TW102=284.9    TW202=258.8
PI204 (B2/B3)= 626.6           TW103=306.4    TW203=290.4
PI204 (B3/B4)= 617.7           TW104=328.9    TW204=312.4
PI204 (B4/B5)= 602.9           TW105=339.0    TW205=334.0
PI204 (B5/B6)= 586.4           TW106=341.6    TW206=339.3
PI204 (B6-OUT)=571.7           TW107=344.0    TW207=341.8
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HEATER TEST DATA RUN HTR-8     DATE 16-OCT-80  TIME 13-45

C3 (MOLE C/C)= .60  N-C4=2.56  I-C4=96.84  N-C5=0.    I-C5= 0.

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 256.8 (PSIA)    BR FLOW RATE (LBS/HR)=101007.7
PI108 (B4/B3)= 246.1           HC FLOW RATE (LBS/HR)= 53346.9
PI108 (B1-OUT)=238.0

PI204 (B1-IN)= 635.7 (PSIA)    TW101=239.2    TW201=137.8 (DEG-F)
PI204 (B1/B2)= 632.3           TW102=285.0    TW202=258.8
PI204 (B2/B3)= 626.4           TW103=306.4    TW203=290.3
PI204 (B3/B4)= 617.4           TW104=329.3    TW204=312.8
PI204 (B4/B5)= 602.6           TW105=339.2    TW205=334.0
PI204 (B5/B6)= 586.0           TW106=342.8    TW206=339.2
PI204 (B6-OUT)=571.2           TW107=344.4    TW207=342.3

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HEATER TEST DATA RUN HTR-8     DATE 16-OCT-80  TIME 14-00

C3 (MOLE C/C)= .60  N-C4=2.56  I-C4=96.84  N-C5=0.    I-C5= 0.

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 256.7 (PSIA)    BR FLOW RATE (LBS/HR)=101003.5
PI108 (B4/B3)= 246.2           HC FLOW RATE (LBS/HR)= 53324.3
PI108 (B1-OUT)=238.0

PI204 (B1-IN)= 635.9 (PSIA)    TW101=239.4    TW201=138.1 (DEG-F)
PI204 (B1/B2)= 632.6           TW102=284.5    TW202=258.4
PI204 (B2/B3)= 626.7           TW103=306.2    TW203=290.2
PI204 (B3/B4)= 617.7           TW104=328.5    TW204=311.6
PI204 (B4/B5)= 602.9           TW105=339.3    TW205=333.8
PI204 (B5/B6)= 586.3           TW106=343.3    TW206=339.0
PI204 (B6-OUT)=571.6           TW107=344.2    TW207=341.6

-----------------------------------------------------------------

HEATER TEST DATA RUN HTR-8     DATE 16-OCT-80  TIME 14-15

C3 (MOLE C/C)= .60  N-C4=2.56  I-C4=96.84  N-C5=0.    I-C5= 0.

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 256.7 (PSIA)    BR FLOW RATE (LBS/HR)=101003.5
PI108 (B4/B3)= 246.2           HC FLOW RATE (LBS/HR)= 53331.1
PI108 (B1-OUT)=238.1

PI204 (B1-IN)= 635.5 (PSIA)    TW101=239.4    TW201=138.0 (DEG-F)
PI204 (B1/B2)= 632.2           TW102=284.7    TW202=258.6
PI204 (B2/B3)= 626.3           TW103=306.3    TW203=290.3
PI204 (B3/B4)= 617.4           TW104=328.8    TW204=312.0
PI204 (B4/B5)= 602.7           TW105=339.2    TW205=334.0
PI204 (B5/B6)= 586.2           TW106=343.5    TW206=339.1
PI204 (B6-OUT)=571.6           TW107=344.2    TW207=341.6

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HEATER TEST DATA RUN HTR-8     DATE 16-OCT-80  TIME 14-30

C3 (MOLE C/C)= .60  N-C4=2.56  I-C4=96.84  N-C5=0.    I-C5= 0.

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 256.7 (PSIA)     ER FLOW RATE (LBS/HR)=101004.6
PI108 (B4/B3)= 246.5            HC FLOW RATE (LBS/HR)= 53331.7
PI108 (B1-OUT)=238.0

PI204 (B1-IN)= 635.6 (PSIA)     TW101=239.4    TW201=138.0 (DEG-F)
PI204 (B1/B2)= 631.9            TW102=285.0    TW202=258.8
PI204 (B2/B3)= 626.0            TW103=306.5    TW203=290.4
PI204 (B3/B4)= 617.0            TW104=329.3    TW204=312.6
PI204 (B4/B5)= 602.2            TW105=339.5    TW205=334.2
PI204 (B5/B6)= 585.6            TW106=343.4    TW206=339.4
PI204 (B6-OUT)=571.5            TW107=344.4    TW207=341.5

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HEATER TEST DATA RUN HTR-8     DATE 16-OCT-80  TIME 14-45

C3 (MOLE C/C)= .60  N-C4=2.56  I-C4=96.84  N-C5=0.    I-C5= 0.

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 256.6 (PSIA)     ER FLOW RATE (LBS/HR)=101016.2
PI108 (B4/B3)= 246.2            HC FLOW RATE (LBS/HR)= 54034.8
PI108 (B1-OUT)=238.1

PI204 (B1-IN)= 636.1 (PSIA)     TW101=238.8    TW201=139.0 (DEG-F)
PI204 (B1/B2)= 631.6            TW102=284.6    TW202=258.4
PI204 (B2/B3)= 625.6            TW103=305.2    TW203=289.6
PI204 (B3/B4)= 617.0            TW104=328.9    TW204=311.9
PI204 (B4/B5)= 602.0            TW105=339.4    TW205=333.6
PI204 (B5/B6)= 585.4            TW106=343.6    TW206=339.4
PI204 (B6-OUT)=570.2            TW107=344.5    TW207=342.0

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HEATER TEST DATA RUN HTR-9     DATE 16-OCT-80  TIME 15-30

C3 (MOLE C/C)= .60  N-C4=2.56  I-C4=96.84  N-C5=0.    I-C5= 0.

NUM OF EXCHANGERS=4

PI108 (B6-IN)= 253.7 (PSIA)     ER FLOW RATE (LBS/HR)=101514.4
PI108 (B4/B3)= 246.6            HC FLOW RATE (LBS/HR)= 34619.2
PI108 (B1-OUT)=240.3

PI204 (B1-IN)= 606.4 (PSIA)     TW101=277.8    TW201=136.8 (DEG-F)
PI204 (B1/B2)= 604.5            TW102=325.1    TW202=291.8
PI204 (B2/B3)= 598.1            TW103=343.6    TW203=334.6
PI204 (B3/B4)= 591.6            TW104=345.5    TW204=342.9
PI204 (B4/B5)= 585.2            TW105=345.0    TW205=345.2
PI204 (B5/B6)= 578.3            TW106=332.6    TW206=341.2
PI204 (B6-OUT)=572.5            TW107=326.8    TW207=341.0

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HEATER TEST DATA RUN HTR-9     DATE 16-OCT-80   TIME 15-45

C3 (MOLE C/C)= .60   N-C4=2.56   I-C4=96.84   N-C5=0.     I-C5= 0.

NUM OF EXCHANGERS=4

PI108 (B6-IN)= 253.2 (PSIA)     BR FLOW RATE (LBS/HR)=101692.0
PI108 (B4/B3)= 248.2            HC FLOW RATE (LBS/HR)= 34890.3
PI108 (B1-OUT)=240.0

PI204 (B1-IN)= 608.7 (PSIA)     TW101=277.5     TW201=136.7 (DEG-F)
PI204 (B1/B2)= 606.5            TW102=324.7     TW202=291.6
PI204 (B2/B3)= 598.1            TW103=343.7     TW203=336.6
PI204 (B3/B4)= 591.2            TW104=345.5     TW204=342.9
PI204 (B4/B5)= 583.6            TW105=345.0     TW205=345.4
PI204 (B5/B6)= 576.6            TW106=332.3     TW206=341.1
PI204 (B6-OUT)=572.2            TW107=325.6     TW207=340.8

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HEATER TEST DATA RUN HTR-9     DATE 16-OCT-80   TIME 16-15

C3 (MOLE C/C)= .60   N-C4=2.56   I-C4=96.84   N-C5=0.     I-C5= 0.

NUM OF EXCHANGERS=4

PI108 (B6-IN)= 253.3 (PSIA)     BR FLOW RATE (LBS/HR)=101729.0
PI108 (B4/B3)= 248.5            HC FLOW RATE (LBS/HR)= 33821.5
PI108 (B1-OUT)=240.1

PI204 (B1-IN)= 606.6 (PSIA)     TW101=276.0     TW201=137.2 (DEG-F)
PI204 (B1/B2)= 605.8            TW102=324.8     TW202=291.8
PI204 (B2/B3)= 599.6            TW103=343.0     TW203=336.2
PI204 (B3/B4)= 593.3            TW104=345.2     TW204=342.5
PI204 (B4/B5)= 585.8            TW105=344.6     TW205=345.0
PI204 (B5/B6)= 578.3            TW106=332.0     TW206=340.8
PI204 (B6-OUT)=572.0            TW107=325.0     TW207=339.6

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HEATER TEST DATA RUN HTR-9     DATE 16-OCT-80   TIME 16-30

C3 (MOLE C/C)= .60   N-C4=2.56   I-C4=96.84   N-C5=0.     I-C5= 0.

NUM OF EXCHANGERS=4

PI108 (B6-IN)= 253.3 (PSIA)     BR FLOW RATE (LBS/HR)=101562.3
PI108 (B4/B3)= 248.5            HC FLOW RATE (LBS/HR)= 35366.1
PI108 (B1-OUT)=240.1

PI204 (B1-IN)= 607.7 (PSIA)     TW101=275.8     TW201=137.5 (DEG-F)
PI204 (B1/B2)= 606.7            TW102=324.4     TW202=291.3
PI204 (B2/B3)= 597.0            TW103=343.0     TW203=336.0
PI204 (B3/B4)= 594.5            TW104=345.3     TW204=342.0
PI204 (B4/B5)= 587.3            TW105=345.0     TW205=345.6
PI204 (B5/B6)= 579.9            TW106=332.3     TW206=341.6
PI204 (B6-OUT)=572.0            TW107=325.4     TW207=340.6

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HEATER TEST DATA RUN HTR-10 DATE 16-OCT-80 TIME 17-30

C3 (MOLE C/C)= .60 N-C4=2.56 I-C4=96.84 N-C5=0. I-C5= 0.

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 252.5 (PSIA)	BR FLOW RATE (LBS/HR)=101837.0
PI108 (B4/B3)= 242.0	HC FLOW RATE (LBS/HR)= 86893.2
PI108 (B1-OUT)=233.6	

PI204 (B1-IN)= 655.9 (PSIA)	TW101=206.0	TW201=156.4 (DEG-F)
PI204 (B1/B2)= 647.2	TW102=241.8	TW202=218.6
PI204 (B2/B3)= 635.2	TW103=262.9	TW203=249.3
PI204 (B3/B4)= 623.8	TW104=275.8	TW204=266.0
PI204 (B4/B5)= 610.6	TW105=286.7	TW205=277.5
PI204 (B5/B6)= 595.6	TW106=305.7	TW206=286.4
PI204 (B6-OUT)=572.0	TW107=345.0	TW207=311.4

HEATER TEST DATA RUN HTR-10 DATE 16-OCT-80 TIME 17-45

C3 (MOLE C/C)= .60 N-C4=2.56 I-C4=96.84 N-C5=0. I-C5= 0.

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 253.7 (PSIA)	BR FLOW RATE (LBS/HR)=101658.6
PI108 (B4/B3)= 242.3	HC FLOW RATE (LBS/HR)= 86845.4
PI108 (B1-OUT)=233.6	

PI204 (B1-IN)= 655.8 (PSIA)	TW101=206.1	TW201=156.7 (DEG-F)
PI204 (B1/B2)= 646.9	TW102=241.9	TW202=218.8
PI204 (B2/B3)= 634.7	TW103=262.9	TW203=249.3
PI204 (B3/B4)= 623.3	TW104=275.8	TW204=266.1
PI204 (B4/B5)= 610.4	TW105=286.5	TW205=277.4
PI204 (B5/B6)= 595.4	TW106=305.6	TW206=286.4
PI204 (B6-OUT)=572.1	TW107=344.6	TW207=311.0

HEATER TEST DATA RUN HTR-10 DATE 16-OCT-80 TIME 18-00

C3 (MOLE C/C)= .60 N-C4=2.56 I-C4=96.84 N-C5=0. I-C5= 0.

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 254.4 (PSIA)	BR FLOW RATE (LBS/HR)=101653.3
PI108 (B4/B3)= 242.5	HC FLOW RATE (LBS/HR)= 86800.4
PI108 (B1-OUT)=234.6	

PI204 (B1-IN)= 656.4 (PSIA)	TW101=206.4	TW201=157.1 (DEG-F)
PI204 (B1/B2)= 647.5	TW102=242.1	TW202=219.1
PI204 (B2/B3)= 635.6	TW103=263.0	TW203=249.5
PI204 (B3/B4)= 624.1	TW104=276.0	TW204=266.3
PI204 (B4/B5)= 611.1	TW105=286.8	TW205=277.6
PI204 (B5/B6)= 596.3	TW106=305.8	TW206=286.5
PI204 (B6-OUT)=572.7	TW107=345.0	TW207=311.4

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HEATER TEST DATA RUN HTR-10   DATE 16-OCT-80  TIME 18-15

C3 (MOLE C/C)= .60  N-C4=2.56  I-C4=96.84  N-C5=0.    I-C5= 0.

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 252.6 (PSIA)    BR FLOW RATE (LBS/HR)=101651.3
PI108 (B4/B3)= 242.3           HC FLOW RATE (LBS/HR)= 86773.7
PI108 (B1-OUT)=234.0

PI204 (B1-IN)= 656.5 (PSIA)    TW101=206.5     TW201=157.3 (DEG-F)
PI204 (B1/B2)= 647.8           TW102=242.0     TW202=219.1
PI204 (B2/B3)= 635.6           TW103=263.0     TW203=249.5
PI204 (B3/B4)= 624.1           TW104=275.9     TW204=266.3
PI204 (B4/B5)= 611.0           TW105=286.8     TW205=277.6
PI204 (B5/B6)= 596.1           TW106=305.8     TW206=286.6
PI204 (B6-OUT)=573.0           TW107=345.0     TW207=311.6
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HEATER TEST DATA RUN HTR-10   DATE 16-OCT-80  TIME 18-30

C3 (MOLE C/C)= .60  N-C4=2.56  I-C4=96.84  N-C5=0.    I-C5= 0.

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 252.6 (PSIA)    BR FLOW RATE (LBS/HR)=101649.6
PI108 (B4/B3)= 242.0           HC FLOW RATE (LBS/HR)= 86755.0
PI108 (B1-OUT)=234.5

PI204 (B1-IN)= 656.9 (PSIA)    TW101=206.6     TW201=157.4 (DEG-F)
PI204 (B1/B2)= 646.4           TW102=242.2     TW202=219.2
PI204 (B2/B3)= 636.1           TW103=263.2     TW203=249.7
PI204 (B3/B4)= 624.7           TW104=276.1     TW204=266.4
PI204 (B4/B5)= 611.5           TW105=287.0     TW205=277.8
PI204 (B5/B6)= 596.4           TW106=306.2     TW206=286.7
PI204 (B6-OUT)=572.9           TW107=345.1     TW207=312.0
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HEATER TEST DATA RUN HTR-11   DATE 20-OCT-80  TIME 07-00

C3 (MOLE C/C)= .60  N-C4=2.56  I-C4=96.84  N-C5=0.    I-C5= 0.

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 298.3 (PSIA)    BR FLOW RATE (LBS/HR)= 95143.9
PI108 (B4/B3)= 286.5           HC FLOW RATE (LBS/HR)= 86645.6
PI108 (B1-OUT)=281.0

PI204 (B1-IN)= 638.6 (PSIA)    TW101=203.0     TW201=161.4 (DEG-F)
PI204 (B1/B2)= 629.8           TW102=236.0     TW202=214.1
PI204 (B2/B3)= 617.1           TW103=256.2     TW203=242.8
PI204 (B3/B4)= 605.6           TW104=268.9     TW204=259.6
PI204 (B4/B5)= 592.7           TW105=280.4     TW205=271.3
PI204 (B5/B6)= 577.9           TW106=298.4     TW206=281.1
PI204 (B6-OUT)=554.5           TW107=343.3     TW207=302.4
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HEATER TEST DATA RUN HTR-11   DATE 20-OCT-80  TIME 08-30

C3 (MOLE C/C)= .60  N-C4=2.56  I-C4=96.84  N-C5=0.    I-C5= 0.

NUM OF EXCHANGERS=6

PI108  (B6-IN)= 297.1 (PSIA)     BR FLOW RATE (LBS/HR)= 95315.8
PI108  (B4/B3)= 287.3            HC FLOW RATE (LBS/HR)= 84605.2
PI108  (B1-OUT)=279.8

PI204  (B1-IN)= 632.9 (PSIA)     TW101=204.0    TW201=157.6 (DEG-F)
PI204  (B1/B2)= 624.5            TW102=238.6    TW202=215.5
PI204  (B2/B3)= 613.2            TW103=256.8    TW203=245.6
PI204  (B3/B4)= 602.6            TW104=271.0    TW204=262.0
PI204  (B4/B5)= 590.4            TW105=282.0    TW205=273.2
PI204  (B5/B6)= 576.0            TW106=300.4    TW206=261.7
PI204  (B6-OUT)=553.2            TW107=344.2    TW207=307.9

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HEATER TEST DATA RUN HTR-11   DATE 20-OCT-80  TIME 08-45

C3 (MOLE C/C)= .60  N-C4=2.56  I-C4=96.84  N-C5=0.    I-C5= 0.

NUM OF EXCHANGERS=6

PI108  (B6-IN)= 297.0 (PSIA)     BR FLOW RATE (LBS/HR)= 95290.4
PI108  (B4/B3)= 286.9            HC FLOW RATE (LBS/HR)= 85155.1
PI108  (B1-OUT)=280.0

PI204  (B1-IN)= 633.4 (PSIA)     TW101=205.5    TW201=161.0 (DEG-F)
PI204  (B1/B2)= 624.7            TW102=239.2    TW202=216.8
PI204  (B2/B3)= 613.3            TW103=258.9    TW203=246.0
PI204  (B3/B4)= 602.7            TW104=271.0    TW204=262.2
PI204  (B4/B5)= 590.2            TW105=281.9    TW205=273.1
PI204  (B5/B6)= 575.8            TW106=300.3    TW206=281.6
PI204  (B6-OUT)=552.7            TW107=344.2    TW207=307.6

--------------------------------------------------------------------

HEATER TEST DATA RUN HTR-11   DATE 20-OCT-80  TIME 09-00

C3 (MOLE C/C)= .60  N-C4=2.56  I-C4=96.84  N-C5=0.    I-C5= 0.

NUM OF EXCHANGERS=6

PI108  (B6-IN)= 296.3 (PSIA)     BR FLOW RATE (LBS/HR)= 95278.4
PI108  (B4/B3)= 286.5            HC FLOW RATE (LBS/HR)= 85213.2
PI108  (B1-OUT)=279.2

PI204  (B1-IN)= 633.3 (PSIA)     TW101=206.2    TW201=162.4 (DEG-F)
PI204  (B1/B2)= 624.6            TW102=239.3    TW202=217.3
PI204  (B2/B3)= 613.0            TW103=258.9    TW203=246.0
PI204  (B3/B4)= 602.3            TW104=270.9    TW204=262.0
PI204  (B4/B5)= 589.9            TW105=281.8    TW205=273.0
PI204  (B5/B6)= 575.4            TW106=300.1    TW206=281.5
PI204  (B6-OUT)=552.4            TW107=344.2    TW207=307.4

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HEATER TEST DATA RUN HTR-11   DATE 20-OCT-80   TIME 09-15

C3 (MOLE C/C)= .60  N-C4=2.56  I-C4=96.84  N-C5=0.    I-C5= 0.

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 296.2 (PSIA)    BR FLOW RATE (LBS/HR)= 95470.1
PI108 (B4/B3)= 286.3           HC FLOW RATE (LBS/HR)= 84653.8
PI108 (B1-OUT)=279.1

PI204 (B1-IN)= 632.1 (PSIA)    TW101=206.0    TW201=161.0 (DEG-F)
PI204 (B1/B2)= 623.5           TW102=239.6    TW202=217.6
PI204 (B2/B3)= 612.0           TW103=259.2    TW203=246.4
PI204 (B3/B4)= 601.3           TW104=271.1    TW204=262.4
PI204 (B4/B5)= 588.8           TW105=282.0    TW205=273.3
PI204 (B5/B6)= 574.4           TW106=300.6    TW206=281.9
PI204 (B6-OUT)=551.2           TW107=344.5    TW207=308.4

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HEATER TEST DATA RUN HTR-11   DATE 20-OCT-80   TIME 09-30

C3 (MOLE C/C)= .60  N-C4=2.56  I-C4=96.84  N-C5=0.    I-C5= 0.

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 295.8 (PSIA)    BR FLOW RATE (LBS/HR)= 95466.6
PI108 (B4/B3)= 286.0           HC FLOW RATE (LBS/HR)= 84547.7
PI108 (B1-OUT)=278.6

PI204 (B1-IN)= 631.2 (PSIA)    TW101=206.2    TW201=161.7 (DEG-F)
PI204 (B1/B2)= 623.0           TW102=239.5    TW202=217.6
PI204 (B2/B3)= 611.7           TW103=259.2    TW203=246.4
PI204 (B3/B4)= 601.1           TW104=270.9    TW204=262.1
PI204 (B4/B5)= 588.8           TW105=281.9    TW205=273.2
PI204 (B5/B6)= 574.6           TW106=300.3    TW206=281.4
PI204 (B6-OUT)=551.6           TW107=344.7    TW207=308.2

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HEATER TEST DATA RUN HTR-11   DATE 20-OCT-80   TIME 09-45

C3 (MOLE C/C)= .60  N-C4=2.56  I-C4=96.84  N-C5=0.    I-C5= 0.

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 295.6 (PSIA)    BR FLOW RATE (LBS/HR)= 95649.5
PI108 (B4/B3)= 285.7           HC FLOW RATE (LBS/HR)= 84301.7
PI108 (B1-OUT)=278.6

PI204 (B1-IN)= 632.3 (PSIA)    TW101=206.5    TW201=161.7 (DEG-F)
PI204 (B1/B2)= 623.7           TW102=240.2    TW202=218.1
PI204 (B2/B3)= 612.1           TW103=259.4    TW203=245.7
PI204 (B3/B4)= 601.3           TW104=271.6    TW204=262.9
PI204 (B4/B5)= 588.8           TW105=282.2    TW205=273.5
PI204 (B5/B6)= 574.2           TW106=301.1    TW206=281.7
PI204 (B6-OUT)=550.8           TW107=344.7    TW207=309.0

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HEATER TEST DATA RUN HTR-11   DATE 20-OCT-80  TIME 10-00

C3 (MOLE C/C)= .60  N-C4=2.56  I-C4=96.84  N-C5=0.    I-C5= 0.

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 295.1 (PSIA)    BR FLOW RATE (LBS/HR)= 95647.6
PI108 (B4/B3)= 285.3           HC FLOW RATE (LBS/HR)= 84274.3
PI108 (B1-OUT)=277.5

PI204 (B1-IN)= 630.7 (PSIA)    TW101=206.6    TW201=161.9 (DEG-F)
PI204 (B1/B2)= 622.4           TW102=239.9    TW202=218.0
PI204 (B2/B3)= 610.9           TW103=259.4    TW203=246.7
PI204 (B3/B4)= 600.4           TW104=271.2    TW204=262.4
PI204 (B4/B5)= 588.0           TW105=282.0    TW205=273.4
PI204 (B5/B6)= 573.9           TW106=300.7    TW206=281.5
PI204 (B6-OUT)=550.6           TW107=344.9    TW207=308.8
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HEATER TEST DATA RUN HTR-12   DATE 20-OCT-80  TIME 11-15

C3 (MOLE C/C)= .60  N-C4=2.56  I-C4=96.84  N-C5=0.    I-C5= 0.

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 294.5 (PSIA)    BR FLOW RATE (LBS/HR)= 95919.3
PI108 (B4/B3)= 284.6           HC FLOW RATE (LBS/HR)= 69356.0
PI108 (B1-OUT)=277.0

PI204 (B1-IN)= 617.2 (PSIA)    TW101=212.5    TW201=146.1 (DEG-F)
PI204 (B1/B2)= 611.7           TW102=252.1    TW202=227.7
PI204 (B2/B3)= 603.5           TW103=270.7    TW203=258.9
PI204 (B3/B4)= 595.4           TW104=281.2    TW204=273.2
PI204 (B4/B5)= 586.2           TW105=292.8    TW205=281.9
PI204 (B5/B6)= 571.6           TW106=322.0    TW206=294.2
PI204 (B6-OUT)=549.3           TW107=345.5    TW207=330.2
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HEATER TEST DATA RUN HTR-12   DATE 20-OCT-80  TIME 11-30

C3 (MOLE C/C)= .60  N-C4=2.56  I-C4=96.84  N-C5=0.    I-C5= 0.

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 294.7 (PSIA)    BR FLOW RATE (LBS/HR)= 95914.0
PI108 (B4/B3)= 284.9           HC FLOW RATE (LBS/HR)= 66891.5
PI108 (B1-OUT)=277.0

PI204 (B1-IN)= 618.2 (PSIA)    TW101=212.8    TW201=145.8 (DEG-F)
PI204 (B1/B2)= 612.6           TW102=252.3    TW202=228.1
PI204 (B2/B3)= 604.4           TW103=271.2    TW203=259.4
PI204 (B3/B4)= 596.6           TW104=281.6    TW204=273.6
PI204 (B4/B5)= 587.7           TW105=293.1    TW205=282.2
PI204 (B5/B6)= 572.8           TW106=322.8    TW206=295.3
PI204 (B6-OUT)=550.7           TW107=345.2    TW207=330.4
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HEATER TEST DATA RUN HTR-12   DATE 20-OCT-80  TIME 11-45

C3 (MOLE C/C)= .60  N-C4=2.56  I-C4=96.84  N-C5=0.    I-C5= 0.

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 295.1 (PSIA)    BR FLOW RATE (LBS/HR)= 95915.9
PI108 (B4/B3)= 285.1           HC FLOW RATE (LBS/HR)= 69089.7
PI108 (B1-OUT)=277.4

PI204 (B1-IN)= 617.5 (PSIA)    TW101=212.7    TW201=146.2 (DEG-F)
PI204 (B1/B2)= 612.0           TW102=252.4    TW202=228.0
PI204 (B2/B3)= 603.9           TW103=271.0    TW203=259.2
PI204 (B3/B4)= 596.1           TW104=281.5    TW204=273.4
PI204 (B4/B5)= 587.0           TW105=292.8    TW205=282.1
PI204 (B5/B6)= 572.3           TW106=322.6    TW206=294.8
PI204 (B6-OUT)=550.2           TW107=345.5    TW207=330.2

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HEATER TEST DATA RUN HTR-12   DATE 20-OCT-80  TIME 12-00

C3 (MOLE C/C)= .60  N-C4=2.56  I-C4=96.84  N-C5=0.    I-C5= 0.

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 294.9 (PSIA)    BR FLOW RATE (LBS/HR)= 95921.2
PI108 (B4/B3)= 285.2           HC FLOW RATE (LBS/HR)= 69333.0
PI108 (B1-OUT)=277.5

PI204 (B1-IN)= 616.5 (PSIA)    TW101=212.4    TW201=146.3 (DEG-F)
PI204 (B1/B2)= 611.2           TW102=252.8    TW202=227.9
PI204 (B2/B3)= 603.1           TW103=270.6    TW203=258.9
PI204 (B3/B4)= 595.1           TW104=281.2    TW204=273.2
PI204 (B4/B5)= 586.0           TW105=292.2    TW205=281.7
PI204 (B5/B6)= 571.5           TW106=321.6    TW206=294.0
PI204 (B6-OUT)=549.5           TW107=344.5    TW207=328.6

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HEATER TEST DATA RUN HTR-12   DATE 20-OCT-80  TIME 12-15

C3 (MOLE C/C)= .60  N-C4=2.56  I-C4=96.84  N-C5=0.    I-C5= 0.

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 294.9 (PSIA)    BR FLOW RATE (LBS/HR)= 95914.1
PI108 (B4/B3)= 285.1           HC FLOW RATE (LBS/HR)= 69045.4
PI108 (B1-OUT)=277.5

PI204 (B1-IN)= 616.6 (PSIA)    TW101=212.8    TW201=146.6 (DEG-F)
PI204 (B1/B2)= 611.5           TW102=252.1    TW202=227.9
PI204 (B2/B3)= 603.5           TW103=270.7    TW203=259.0
PI204 (B3/B4)= 595.6           TW104=281.0    TW204=273.0
PI204 (B4/B5)= 586.6           TW105=292.1    TW205=281.7
PI204 (B5/B6)= 572.3           TW106=321.2    TW206=293.5
PI204 (B6-OUT)=549.8           TW107=344.2    TW207=327.6

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HEATER TEST DATA RUN HTR-12   DATE 20-OCT-80   TIME 12-34

C3 (MOLE O/O)= .60   N-C4=2.56   I-C4=96.84   N-C5=0.    I-C5= 0.

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 294.9 (PSIA)     BR FLOW RATE (LBS/HR)= 96100.8
PI108 (B4/B3)= 285.1            HC FLOW RATE (LBS/HR)= 69003.2
PI108 (B1-OUT)=277.4

PI204 (B1-IN)= 616.4 (PSIA)     TW101=212.8     TW201=147.0 (DEG-F)
PI204 (B1/B2)= 611.1            TW102=252.3     TW202=228.1
PI204 (B2/B3)= 602.9            TW103=270.6     TW203=258.9
PI204 (B3/B4)= 594.9            TW104=281.1     TW204=273.1
PI204 (B4/B5)= 585.6            TW105=291.9     TW205=281.6
PI204 (B5/B6)= 571.6            TW106=321.2     TW206=293.5
PI204 (B6-OUT)=549.7            TW107=343.8     TW207=327.6

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HEATER TEST DATA RUN HTR-12   DATE 20-OCT-80   TIME 12-45

C3 (MOLE O/O)= .60   N-C4=2.56   I-C4=96.84   N-C5=0.    I-C5= 0.

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 294.5 (PSIA)     BR FLOW RATE (LBS/HR)= 95911.4
PI108 (B4/B3)= 284.8            HC FLOW RATE (LBS/HR)= 68735.4
PI108 (B1-OUT)=277.3

PI204 (B1-IN)= 616.1 (PSIA)     TW101=213.0     TW201=147.1 (DEG-F)
PI204 (B1/B2)= 610.8            TW102=252.3     TW202=228.1
PI204 (B2/B3)= 602.9            TW103=270.6     TW203=259.0
PI204 (B3/B4)= 594.8            TW104=281.0     TW204=273.1
PI204 (B4/B5)= 586.9            TW105=291.9     TW205=281.7
PI204 (B5/B6)= 571.5            TW106=321.0     TW206=293.4
PI204 (B6-OUT)=549.9            TW107=343.8     TW207=326.6

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HEATER TEST DATA RUN HTR-12   DATE 20-OCT-80   TIME 13-00

C3 (MOLE O/O)= .60   N-C4=2.56   I-C4=96.84   N-C5=0.    I-C5= 0.

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 294.2 (PSIA)     BR FLOW RATE (LBS/HR)= 95911.3
PI108 (B4/B3)= 284.4            HC FLOW RATE (LBS/HR)= 68975.4
PI108 (B1-OUT)=276.7

PI204 (B1-IN)= 615.6 (PSIA)     TW101=213.0     TW201=147.3 (DEG-F)
PI204 (B1/B2)= 610.6            TW102=252.2     TW202=228.1
PI204 (B2/B3)= 602.9            TW103=270.5     TW203=258.9
PI204 (B3/B4)= 594.9            TW104=280.9     TW204=273.0
PI204 (B4/B5)= 585.6            TW105=291.7     TW205=281.6
PI204 (B5/B6)= 571.6            TW106=320.6     TW206=293.0
PI204 (B6-OUT)=549.9            TW107=344.1     TW207=328.2

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HEATER TEST DATA RUN HTR-13   DATE 20-OCT-80   TIME 14-45

C3 (MOLE C/C)= .60  N-C4=2.56  I-C4=96.84  N-C5=0.    I-C5= 0.

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 403.1 (PSIA)    BR FLOW RATE (LBS/HR)= 63984.0
PI108 (B4/B3)= 398.5           HC FLOW RATE (LBS/HR)= 53091.0
PI108 (B1-OUT)=394.7

PI204 (B1-IN)= 584.3 (PSIA)    TW101=200.8    TW201=146.2 (DEG-F)
PI204 (B1/B2)= 581.2           TW102=239.5    TW202=217.5
PI204 (B2/B3)= 576.3           TW103=258.8    TW203=247.7
PI204 (B3/B4)= 572.1           TW104=270.0    TW204=262.3
PI204 (B4/B5)= 567.1           TW105=278.7    TW205=272.2
PI204 (B5/B6)= 561.5           TW106=296.3    TW206=279.1
PI204 (B6-OUT)=551.6           TW107=338.2    TW207=309.8

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HEATER TEST DATA RUN HTR-13   DATE 20-OCT-80   TIME 15-00

C3 (MOLE C/C)= .60  N-C4=2.56  I-C4=96.84  N-C5=0.    I-C5= 0.

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 404.7 (PSIA)    BR FLOW RATE (LBS/HR)= 63982.5
PI108 (B4/B3)= 400.3           HC FLOW RATE (LBS/HR)= 53317.5
PI108 (B1-OUT)=396.5

PI204 (B1-IN)= 583.6 (PSIA)    TW101=200.9    TW201=146.5 (DEG-F)
PI204 (B1/B2)= 580.6           TW102=239.5    TW202=217.5
PI204 (B2/B3)= 575.6           TW103=258.8    TW203=247.6
PI204 (B3/B4)= 571.7           TW104=269.8    TW204=262.2
PI204 (B4/B5)= 566.9           TW105=278.6    TW205=272.0
PI204 (B5/B6)= 561.1           TW106=296.1    TW206=279.0
PI204 (B6-OUT)=551.6           TW107=338.5    TW207=310.2

-----------------------------------------------------------------

HEATER TEST DATA RUN HTR-13   DATE 20-OCT-80   TIME 15-15

C3 (MOLE C/C)= .60  N-C4=2.56  I-C4=96.84  N-C5=0.    I-C5= 0.

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 404.9 (PSIA)    BR FLOW RATE (LBS/HR)= 63983.1
PI108 (B4/B3)= 400.5           HC FLOW RATE (LBS/HR)= 53360.1
PI108 (B1-OUT)=396.7

PI204 (B1-IN)= 584.5 (PSIA)    TW101=200.9    TW201=146.0 (DEG-F)
PI204 (B1/B2)= 581.5           TW102=239.6    TW202=217.6
PI204 (B2/B3)= 576.9           TW103=259.0    TW203=247.9
PI204 (B3/B4)= 572.4           TW104=269.9    TW204=262.4
PI204 (B4/B5)= 567.5           TW105=278.8    TW205=272.2
PI204 (B5/B6)= 561.8           TW106=296.3    TW206=279.1
PI204 (B6-OUT)=551.9           TW107=337.9    TW207=309.6

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HEATER TEST DATA RUN HTR-13   DATE 20-OCT-80   TIME 15-30

C3 (MOLE C/C)= .60  N-C4=2.56  I-C4=96.84  N-C5=0.    I-C5= 0.

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 405.2 (PSIA)    BR FLOW RATE (LBS/HR)= 63981.6
PI108 (B4/B3)= 401.2           HC FLOW RATE (LBS/HR)= 53319.7
PI108 (B1-OUT)=397.5

PI204 (B1-IN)= 584.5 (PSIA)    TW101=201.0     TW201=146.5 (DEG-F)
PI204 (B1/B2)= 581.5           TW102=239.8     TW202=217.8
PI204 (B2/B3)= 576.6           TW103=259.0     TW203=248.0
PI204 (B3/B4)= 572.4           TW104=270.1     TW204=262.5
PI204 (B4/B5)= 567.1           TW105=278.9     TW205=272.3
PI204 (B5/B6)= 561.6           TW106=296.3     TW206=279.2
PI204 (B6-OUT)=551.7           TW107=337.9     TW207=310.0

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HEATER TEST DATA RUN HTR-13   DATE 20-OCT-80   TIME 15-45

C3 (MOLE C/C)= .60  N-C4=2.56  I-C4=96.84  N-C5=0.    I-C5= 0.

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 405.7 (PSIA)    BR FLOW RATE (LBS/HR)= 63981.6
PI108 (B4/B3)= 401.5           HC FLOW RATE (LBS/HR)= 53343.2
PI108 (B1-OUT)=397.7

PI204 (B1-IN)= 584.2 (PSIA)    TW101=201.0     TW201=146.2 (DEG-F)
PI204 (B1/B2)= 581.5           TW102=239.6     TW202=217.7
PI204 (B2/B3)= 576.6           TW103=259.1     TW203=248.0
PI204 (B3/B4)= 572.4           TW104=269.8     TW204=262.2
PI204 (B4/B5)= 567.4           TW105=278.9     TW205=272.3
PI204 (B5/B6)= 561.9           TW106=296.2     TW206=279.2
PI204 (B6-OUT)=552.1           TW107=337.6     TW207=309.6

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HEATER TEST DATA RUN HTR-13   DATE 20-OCT-80   TIME 16-00

C3 (MOLE C/C)= .60  N-C4=2.56  I-C4=96.84  N-C5=0.    I-C5= 0.

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 406.0 (PSIA)    BR FLOW RATE (LBS/HR)= 63981.1
PI108 (B4/B3)= 401.6           HC FLOW RATE (LBS/HR)= 53560.5
PI108 (B1-OUT)=397.8

PI204 (B1-IN)= 584.6 (PSIA)    TW101=201.1     TW201=146.7 (DEG-F)
PI204 (B1/B2)= 581.5           TW102=239.8     TW202=218.0
PI204 (B2/B3)= 576.6           TW103=259.0     TW203=248.0
PI204 (B3/B4)= 572.3           TW104=270.0     TW204=262.5
PI204 (B4/B5)= 567.1           TW105=279.0     TW205=272.4
PI204 (B5/B6)= 561.6           TW106=296.0     TW206=279.4
PI204 (B6-OUT)=551.6           TW107=338.1     TW207=310.4

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HEATER TEST DATA RUN HTR-13 DATE 20-OCT-80 TIME 16-15

C3 (MOLE C/C)= .60 N-C4=2.56 I-C4=96.84 N-C5=0. I-C5= 0.

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 406.0 (PSIA) BR FLOW RATE (LBS/HR)= 64259.0
PI108 (B4/B3)= 401.6 HC FLOW RATE (LBS/HR)= 53577.0
PI108 (B1-OUT)=398.0

PI204 (B1-IN)= 584.9 (PSIA)	TW101=201.3	TW201=146.5 (DEG-F)
PI204 (B1/B2)= 581.9	TW102=240.0	TW202=218.0
PI204 (B2/B3)= 577.1	TW103=259.3	TW203=248.2
PI204 (B3/B4)= 572.7	TW104=270.3	TW204=262.7
PI204 (B4/B5)= 567.6	TW105=279.1	TW205=272.5
PI204 (B5/B6)= 562.0	TW106=296.9	TW206=278.9
PI204 (B6-OUT)=552.1	TW107=338.1	TW207=310.8

HEATER TEST DATA RUN HTR-13 DATE 20-OCT-80 TIME 16-30

C3 (MOLE C/C)= .60 N-C4=2.56 I-C4=96.84 N-C5=0. I-C5= 0.

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 406.3 (PSIA) BR FLOW RATE (LBS/HR)= 64260.1
PI108 (B4/B3)= 401.9 HC FLOW RATE (LBS/HR)= 53355.8
PI108 (B1-OUT)=398.3

PI204 (B1-IN)= 584.4 (PSIA)	TW101=201.2	TW201=146.1 (DEG-F)
PI204 (B1/B2)= 581.3	TW102=239.9	TW202=217.9
PI204 (B2/B3)= 576.6	TW103=259.2	TW203=248.2
PI204 (B3/B4)= 572.4	TW104=270.1	TW204=262.5
PI204 (B4/B5)= 567.2	TW105=279.0	TW205=272.5
PI204 (B5/B6)= 561.8	TW106=296.8	TW206=279.3
PI204 (B6-OUT)=551.7	TW107=338.0	TW207=310.8

HEATER TEST DATA RUN HTR-15 DATE 20-OCT-80 TIME 17-45

C3 (MOLE C/C)= .60 N-C4=2.56 I-C4=96.84 N-C5=0. I-C5= 0.

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 294.9 (PSIA) BR FLOW RATE (LBS/HR)= 97681.1
PI108 (B4/B3)= 285.0 HC FLOW RATE (LBS/HR)= 84303.8
PI108 (B1-OUT)=277.2

PI204 (B1-IN)= 632.8 (PSIA)	TW101=207.2	TW201=161.7 (DEG-F)
PI204 (B1/B2)= 624.4	TW102=241.3	TW202=219.4
PI204 (B2/B3)= 613.1	TW103=260.3	TW203=247.6
PI204 (B3/B4)= 602.4	TW104=272.2	TW204=263.0
PI204 (B4/B5)= 590.2	TW105=282.8	TW205=274.1
PI204 (B5/B6)= 575.9	TW106=302.0	TW206=281.9
PI204 (B6-OUT)=552.4	TW107=344.4	TW207=309.5

HEATER TEST DATA RUN HTR-15   DATE 20-OCT-80   TIME 18-00

C3 (MOLE C/C)= .60 N-C4=2.56 I-C4=96.84 N-C5=0.   I-C5= 0.

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 295.0 (PSIA)   ER FLOW RATE (LBS/HR)= 97677.6
PI108 (B4/B3)= 285.4   HC FLOW RATE (LBS/HR)= 84234.5
PI108 (B1-OUT)=277.3

PI204 (B1-IN)= 632.5 (PSIA)   TW101=207.4   TW201=162.2 (DEG-F)
PI204 (B1/B2)= 624.3   TW102=240.9   TW202=219.2
PI204 (B2/B3)= 612.8   TW103=260.1   TW203=247.4
PI204 (B3/B4)= 602.0   TW104=272.0   TW204=262.8
PI204 (B4/B5)= 598.7   TW105=282.6   TW205=273.9
PI204 (B5/B6)= 575.4   TW106=301.6   TW206=281.8
PI204 (B6-OUT)=551.9   TW107=344.5   TW207=309.2

HEATER TEST DATA RUN HTR-15   DATE 20-OCT-80   TIME 16-15

C3 (MOLE C/C)= .60 N-C4=2.56 I-C4=96.84 N-C5=0.   I-C5= 0.

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 295.1 (PSIA)   ER FLOW RATE (LBS/HR)= 97310.1
PI108 (B4/B3)= 285.5   HC FLOW RATE (LBS/HR)= 84236.7
PI108 (B1-OUT)=277.5

PI204 (B1-IN)= 633.0 (PSIA)   TW101=207.4   TW201=162.2 (DEG-F)
PI204 (B1/B2)= 624.5   TW102=240.9   TW202=219.3
PI204 (B2/B3)= 613.0   TW103=260.1   TW203=247.4
PI204 (B3/B4)= 602.3   TW104=272.0   TW204=262.8
PI204 (B4/B5)= 590.0   TW105=282.6   TW205=273.9
PI204 (B5/B6)= 575.7   TW106=301.6   TW206=281.9
PI204 (B6-OUT)=552.3   TW107=344.4   TW207=309.1

HEATER TEST DATA RUN HTR-16   DATE 17-NOV-80   TIME 08-15

C3 (MOLE C/C)= .60 N-C4=2.56 I-C4=96.84 N-C5=0.   I-C5= 0.

NUM OF EXCHANGERS=4

PI108 (B6-IN)= 300.1 (PSIA)   ER FLOW RATE (LBS/HR)= 93173.7
PI108 (B4/B3)= 296.5   HC FLOW RATE (LBS/HR)= 81396.4
PI108 (B1-OUT)=288.6

PI204 (B1-IN)= 686.7 (PSIA)   TW101=194.8   TW201=115.9 (DEG-F)
PI204 (B1/B2)= 679.5   TW102=248.4   TW202=213.0
PI204 (B2/B3)= 668.3   TW103=279.9   TW203=259.4
PI204 (B3/B4)= 657.6   TW104=304.5   TW204=284.7
PI204 (B4/B5)= 639.2   TW105=344.8   TW205=307.8
PI204 (B5/B6)= 612.2   TW106=294.9   TW206=303.5
PI204 (B6-OUT)=588.3   TW107=309.3   TW207=298.8

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HEATER TEST DATA RUN HTR-16   DATE 17-NOV-80   TIME 08-30

C3 (MOLE C/C)= .60  N-C4=2.56  I-C4=96.84  N-C5=0.    I-C5= 0.

NUM OF EXCHANGERS=4

PI108 (B6-IN)= 300.0 (PSIA)    BR FLOW RATE (LBS/HR)= 93167.4
PI108 (B4/B3)= 295.6           HC FLOW RATE (LBS/HR)= 81062.5
PI108 (B1-OUT)=288.3

PI204 (B1-IN)= 686.0 (PSIA)    TW101=195.2    TW201=116.5 (DEG-F)
PI204 (B1/B2)= 678.3           TW102=248.7    TW202=213.7
PI204 (B2/B3)= 667.5           TW103=280.0    TW203=259.6
PI204 (B3/B4)= 656.5           TW104=304.7    TW204=284.9
PI204 (B4/B5)= 637.9           TW105=344.6    TW205=308.0
PI204 (B5/B6)= 610.9           TW106=295.4    TW206=303.9
PI204 (B6-OUT)=587.0           TW107=303.9    TW207=299.0
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HEATER TEST DATA RUN HTR-16   DATE 17-NOV-80   TIME 08-45

C3 (MOLE C/C)= .60  N-C4=2.56  I-C4=96.84  N-C5=0.    I-C5= 0.

NUM OF EXCHANGERS=4

PI108 (B6-IN)= 300.1 (PSIA)    BR FLOW RATE (LBS/HR)= 93172.1
PI108 (B4/B3)= 296.0           HC FLOW RATE (LBS/HR)= 81521.5
PI108 (B1-OUT)=288.4

PI204 (B1-IN)= 684.6 (PSIA)    TW101=194.9    TW201=117.2 (DEG-F)
PI204 (B1/B2)= 677.2           TW102=248.4    TW202=213.3
PI204 (B2/B3)= 666.2           TW103=279.4    TW203=259.0
PI204 (B3/B4)= 655.2           TW104=304.1    TW204=284.3
PI204 (B4/B5)= 636.5           TW105=344.3    TW205=307.0
PI204 (B5/B6)= 609.3           TW106=295.0    TW206=303.0
PI204 (B6-OUT)=585.3           TW107=294.0    TW207=298.0
-----------------------------------------------------------------------

HEATER TEST DATA RUN HTR-16   DATE 17-NOV-80   TIME 09-00

C3 (MOLE C/C)= .60  N-C4=2.56  I-C4=96.84  N-C5=0.    I-C5= 0.

NUM OF EXCHANGERS=4

PI108 (B6-IN)= 300.1 (PSIA)    BR FLOW RATE (LBS/HR)= 93360.8
PI108 (B4/B3)= 296.0           HC FLOW RATE (LBS/HR)= 81212.6
PI108 (B1-OUT)=286.5

PI204 (B1-IN)= 685.5 (PSIA)    TW101=195.2    TW201=117.6 (DEG-F)
PI204 (B1/B2)= 677.0           TW102=248.4    TW202=213.4
PI204 (B2/B3)= 666.1           TW103=279.4    TW203=259.0
PI204 (B3/B4)= 655.2           TW104=304.0    TW204=284.2
PI204 (B4/B5)= 636.6           TW105=344.0    TW205=307.0
PI204 (B5/B6)= 609.4           TW106=294.3    TW206=303.4
PI204 (B6-OUT)=585.5           TW107=291.5    TW207=298.0
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HEATER TEST DATA RUN HTR-16   DATE 17-NOV-80   TIME 09-15

C3 (MOLE C/C)= .60   N-C4=2.56   I-C4=96.84   N-C5=0.   I-C5= 0.

NUM OF EXCHANGERS=4

PI108 (B6-IN)= 300.2 (PSIA)   BR FLOW RATE (LBS/HR)= 93549.0
PI108 (B4/B3)= 296.0   HC FLOW RATE (LBS/HR)= 81165.9
PI108 (B1-OUT)=286.5

PI204 (B1-IN)= 684.0 (PSIA)   TW101=195.5   TW201=118.0 (DEG-F)
PI204 (B1/B2)= 676.5   TW102=248.3   TW202=213.5
PI204 (B2/B3)= 665.5   TW103=279.5   TW203=259.1
PI204 (B3/B4)= 654.7   TW104=304.0   TW204=284.0
PI204 (B4/B5)= 636.4   TW105=344.0   TW205=307.0
PI204 (B5/B6)= 609.2   TW106=293.7   TW206=303.3
PI204 (B6-OUT)=585.4   TW107=288.3   TW207=297.8

HEATER TEST DATA RUN HTR-16   DATE 17-NOV-80   TIME 09-30

C3 (MOLE C/C)= .60   N-C4=2.56   I-C4=96.84   N-C5=0.   I-C5= 0.

NUM OF EXCHANGERS=4

PI108 (B6-IN)= 300.0 (PSIA)   BR FLOW RATE (LBS/HR)= 93549.0
PI108 (B4/B3)= 295.6   HC FLOW RATE (LBS/HR)= 81411.9
PI108 (B1-OUT)=288.2

PI204 (B1-IN)= 683.6 (PSIA)   TW101=195.5   TW201=118.2 (DEG-F)
PI204 (B1/B2)= 676.3   TW102=248.5   TW202=213.8
PI204 (B2/B3)= 665.6   TW103=279.4   TW203=259.1
PI204 (B3/B4)= 654.5   TW104=303.9   TW204=284.2
PI204 (B4/B5)= 636.0   TW105=344.0   TW205=306.9
PI204 (B5/B6)= 609.8   TW106=293.6   TW206=302.8
PI204 (B6-OUT)=585.1   TW107=287.1   TW207=297.7

NOMINAL 90/10 HEATER DATA

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HEATER TEST DATA RUN HTR-17   DATE 19-NOV-80  TIME 10-00

C3 (MOLE C/C)= .54  N-C4=2.30  I-C4=86.97  N-C5= .48  I-C5= 9.71

NUM OF EXCHANGERS=4

PI108 (B6-IN)= 296.5 (PSIA)    BR FLOW RATE (LBS/HR)= 94807.1
PI108 (B4/B3)= 292.7           HC FLOW RATE (LBS/HR)= 81334.6
PI108 (B1-OUT)=284.6

PI204 (B1-IN)= 685.8 (PSIA)    TW101=200.5    TW201=119.8 (DEG-F)
PI204 (B1/B2)= 678.4           TW102=256.0    TW202=219.3
PI204 (B2/B3)= 667.9           TW103=287.5    TW203=266.8
PI204 (B3/B4)= 656.9           TW104=310.9    TW204=292.3
PI204 (B4/B5)= 640.0           TW105=346.0    TW205=312.1
PI204 (B5/B6)= 616.6           TW106=299.8    TW206=307.8
PI204 (B6-OUT)=596.1           TW107=322.9    TW207=304.0
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HEATER TEST DATA RUN HTR-17   DATE 19-NOV-80  TIME 10-15

C3 (MOLE C/C)= .54  N-C4=2.30  I-C4=86.97  N-C5= .48  I-C5= 9.71

NUM OF EXCHANGERS=4

PI108 (B6-IN)= 296.2 (PSIA)    BR FLOW RATE (LBS/HR)= 94986.5
PI108 (B4/B3)= 292.5           HC FLOW RATE (LBS/HR)= 81042.1
PI108 (B1-OUT)=284.5

PI204 (B1-IN)= 685.5 (PSIA)    TW101=201.0    TW201=120.0 (DEG-F)
PI204 (B1/B2)= 678.1           TW102=256.6    TW202=222.0
PI204 (B2/B3)= 667.6           TW103=287.8    TW203=267.2
PI204 (B3/B4)= 657.1           TW104=311.1    TW204=292.7
PI204 (B4/B5)= 640.5           TW105=346.8    TW205=312.2
PI204 (B5/B6)= 617.1           TW106=300.1    TW206=308.0
PI204 (B6-OUT)=597.0           TW107=316.5    TW207=304.5
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HEATER TEST DATA RUN HTR-17   DATE 19-NOV-80  TIME 10-30

C3 (MOLE C/C)= .54  N-C4=2.30  I-C4=86.97  N-C5= .48  I-C5= 9.71

NUM OF EXCHANGERS=4

PI108 (B6-IN)= 296.0 (PSIA)    BR FLOW RATE (LBS/HR)= 94890.4
PI108 (B4/B3)= 292.1           HC FLOW RATE (LBS/HR)= 80749.4
PI108 (B1-OUT)=284.5

PI204 (B1-IN)= 685.1 (PSIA)    TW101=201.2    TW201=120.2 (DEG-F)
PI204 (B1/B2)= 677.6           TW102=256.7    TW202=220.2
PI204 (B2/B3)= 667.1           TW103=287.8    TW203=267.3
PI204 (B3/B4)= 656.5           TW104=311.1    TW204=292.7
PI204 (B4/B5)= 640.0           TW105=345.8    TW205=312.2
PI204 (B5/B6)= 616.7           TW106=300.7    TW206=308.0
PI204 (B6-OUT)=596.5           TW107=310.4    TW207=304.5
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HEATER TEST DATA RUN HTR-17   DATE 19-NOV-80   TIME 10-45

C3 (MOLE C/C)= .54  N-C4=2.30  I-C4=86.97  N-C5= .48  I-C5= 9.71

NUM OF EXCHANGERS=4

PI108  (B6-IN)= 296.0 (PSIA)    ER FLOW RATE (LBS/HR)= 94985.1
PI108  (B4/B3)= 292.0           HC FLOW RATE (LBS/HR)= 80758.4
PI108  (B1-OUT)=284.2

PI204  (B1-IN)= 684.6 (PSIA)    TW101=201.2    TW201=120.1 (DEG-F)
PI204  (B1/B2)= 677.4           TW102=256.8    TW202=220.2
PI204  (B2/B3)= 666.7           TW103=287.9    TW203=267.3
PI204  (B3/B4)= 656.1           TW104=311.0    TW204=292.8
PI204  (B4/B5)= 639.5           TW105=346.0    TW205=312.4
PI204  (B5/B6)= 616.2           TW106=301.0    TW206=308.0
PI204  (B6-OUT)=596.1           TW107=305.7    TW207=304.5

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HEATER TEST DATA RUN HTR-17   DATE 19-NOV-80   TIME 11-00

C3 (MOLE C/C)= .54  N-C4=2.30  I-C4=86.97  N-C5= .48  I-C5= 9.71

NUM OF EXCHANGERS=4

PI108  (B6-IN)= 296.0 (PSIA)    ER FLOW RATE (LBS/HR)= 94790.5
PI108  (B4/B3)= 291.6           HC FLOW RATE (LBS/HR)= 80478.1
PI108  (B1-OUT)=284.1

PI204  (B1-IN)= 685.0 (PSIA)    TW101=201.5    TW201=120.2 (DEG-F)
PI204  (B1/B2)= 677.5           TW102=257.1    TW202=220.5
PI204  (B2/B3)= 667.0           TW103=288.0    TW203=267.6
PI204  (B3/B4)= 656.4           TW104=311.3    TW204=293.0
PI204  (B4/B5)= 639.8           TW105=346.0    TW205=312.6
PI204  (B5/B6)= 616.8           TW106=301.0    TW206=308.4
PI204  (B6-OUT)=596.5           TW107=301.0    TW207=304.9

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HEATER TEST DATA RUN HTR-17   DATE 19-NOV-80   TIME 11-15

C3 (MOLE C/C)= .54  N-C4=2.30  I-C4=86.97  N-C5= .48  I-C5= 9.71

NUM OF EXCHANGERS=4

PI108  (B6-IN)= 295.6 (PSIA)    ER FLOW RATE (LBS/HR)= 94792.1
PI108  (B4/B3)= 291.7           HC FLOW RATE (LBS/HR)= 80757.6
PI108  (B1-OUT)=284.0

PI204  (B1-IN)= 684.3 (PSIA)    TW101=201.4    TW201=120.1 (DEG-F)
PI204  (B1/B2)= 676.6           TW102=256.7    TW202=220.3
PI204  (B2/B3)= 666.3           TW103=287.9    TW203=267.4
PI204  (B3/B4)= 655.7           TW104=311.1    TW204=292.7
PI204  (B4/B5)= 639.4           TW105=346.8    TW205=312.4
PI204  (B5/B6)= 616.3           TW106=301.0    TW206=308.0
PI204  (B6-OUT)=596.4           TW107=297.5    TW207=304.5

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HEATER TEST DATA RUN HTR-17   DATE 19-NOV-80  TIME 11-30

C3 (MOLE C/C)= .54  N-C4=2.30  I-C4=86.97  N-C5= .48  I-C5= 9.71

NUM OF EXCHANGERS=4

PI108 (B6-IN)= 295.4 (PSIA)    BR FLOW RATE (LBS/HR)= 94792.1
PI108 (B4/B3)= 291.5           HC FLOW RATE (LBS/HR)= 80496.4
PI108 (B1-OUT)=283.0

PI204 (B1-IN)= 684.1 (PSIA)    TW101=201.4    TW201=120.0 (DEG-F)
PI204 (B1/B2)= 677.0           TW102=257.0    TW202=220.4
PI204 (B2/B3)= 666.5           TW103=288.0    TW203=267.5
PI204 (B3/B4)= 656.0           TW104=311.2    TW204=292.8
PI204 (B4/B5)= 639.5           TW105=346.1    TW205=312.5
PI204 (B5/B6)= 616.2           TW106=301.1    TW206=308.2
PI204 (B6-OUT)=596.0           TW107=296.5    TW207=304.7
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HEATER TEST DATA RUN HTR-17   DATE 19-NOV-80  TIME 11-45

C3 (MOLE C/C)= .54  N-C4=2.30  I-C4=86.97  N-C5= .48  I-C5= 9.71

NUM OF EXCHANGERS=4

PI108 (B6-IN)= 295.9 (PSIA)    BR FLOW RATE (LBS/HR)= 94695.5
PI108 (B4/B3)= 292.0           HC FLOW RATE (LBS/HR)= 79974.4
PI108 (B1-OUT)=284.0

PI204 (B1-IN)= 684.0 (PSIA)    TW101=201.5    TW201=119.8 (DEG-F)
PI204 (B1/B2)= 677.6           TW102=257.1    TW202=220.6
PI204 (B2/B3)= 666.4           TW103=298.1    TW203=267.6
PI204 (B3/B4)= 656.0           TW104=311.2    TW204=292.9
PI204 (B4/B5)= 639.7           TW105=345.7    TW205=312.4
PI204 (B5/B6)= 616.5           TW106=300.7    TW206=308.2
PI204 (B6-OUT)=596.5           TW107=295.5    TW207=304.7
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HEATER TEST DATA RUN HTR-18   DATE 19-NOV-80  TIME 13-00

C3 (MOLE C/C)= .54  N-C4=2.30  I-C4=86.97  N-C5= .48  I-C5= 9.71

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 309.5 (PSIA)    BR FLOW RATE (LBS/HR)= 93051.3
PI108 (B4/B3)= 290.6           HC FLOW RATE (LBS/HR)= 70177.1
PI108 (B1-OUT)=283.2

PI204 (B1-IN)= 655.2 (PSIA)    TW101=202.4    TW201=119.5 (DEG-F)
PI204 (B1/B2)= 649.4           TW102=252.0    TW202=219.5
PI204 (B2/B3)= 641.5           TW103=275.2    TW203=260.5
PI204 (B3/B4)= 634.0           TW104=287.8    TW204=278.7
PI204 (B4/B5)= 625.0           TW105=298.4    TW205=289.7
PI204 (B5/B6)= 614.2           TW106=317.0    TW206=298.4
PI204 (B6-OUT)=598.6           TW107=342.6    TW207=323.1
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HEATER TEST DATA RUN HTR-18   DATE 19-NOV-80   TIME 13-15

C3 (MOLE C/C)= .54  N-C4=2.30  I-C4=86.97  N-C5= .48  I-C5= 9.71

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 309.5 (PSIA)    BR FLOW RATE (LBS/HR)= 93056.2
PI108 (B4/B3)= 290.5           HC FLOW RATE (LBS/HR)= 69931.9
PI108 (B1-OUT)=283.3

PI204 (B1-IN)= 654.7 (PSIA)    TW101=202.1    TW201=119.2 (DEG-F)
PI204 (B1/B2)= 649.0           TW102=251.9    TW202=220.2
PI204 (B2/B3)= 641.2           TW103=275.1    TW203=260.3
PI204 (B3/B4)= 633.5           TW104=287.6    TW204=278.7
PI204 (B4/B5)= 625.0           TW105=298.2    TW205=289.5
PI204 (B5/B6)= 614.2           TW106=316.5    TW206=298.2
PI204 (B6-OUT)=598.5           TW107=342.3    TW207=322.5
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HEATER TEST DATA RUN HTR-18   DATE 19-NOV-80   TIME 13-45

C3 (MOLE C/C)= .54  N-C4=2.30  I-C4=86.97  N-C5= .48  I-C5= 9.71

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 309.4 (PSIA)    BR FLOW RATE (LBS/HR)= 93048.0
PI108 (B4/B3)= 290.5           HC FLOW RATE (LBS/HR)= 69385.8
PI108 (B1-OUT)=283.0

PI204 (B1-IN)= 656.9 (PSIA)    TW101=202.6    TW201=119.3 (DEG-F)
PI204 (B1/B2)= 651.5           TW102=252.0    TW202=220.5
PI204 (B2/B3)= 643.8           TW103=275.4    TW203=260.6
PI204 (B3/B4)= 636.2           TW104=287.9    TW204=278.8
PI204 (B4/B5)= 627.4           TW105=298.4    TW205=289.7
PI204 (B5/B6)= 617.0           TW106=316.5    TW206=298.4
PI204 (B6-OUT)=602.0           TW107=342.1    TW207=322.6
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HEATER TEST DATA RUN HTR-18   DATE 19-NOV-80   TIME 14-00

C3 (MOLE C/C)= .54  N-C4=2.30  I-C4=86.97  N-C5= .48  I-C5= 9.71

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 309.5 (PSIA)    BR FLOW RATE (LBS/HR)= 93049.6
PI108 (B4/B3)= 290.6           HC FLOW RATE (LBS/HR)= 69936.4
PI108 (B1-OUT)=283.2

PI204 (B1-IN)= 656.7 (PSIA)    TW101=202.5    TW201=119.2 (DEG-F)
PI204 (B1/B2)= 651.2           TW102=252.0    TW202=220.6
PI204 (B2/B3)= 643.7           TW103=275.5    TW203=260.8
PI204 (B3/B4)= 636.2           TW104=288.0    TW204=278.9
PI204 (B4/B5)= 627.3           TW105=298.5    TW205=289.9
PI204 (B5/B6)= 617.0           TW106=316.7    TW206=298.6
PI204 (B6-OUT)=602.0           TW107=342.1    TW207=322.9
```

HEATER TEST DATA RUN HTR-19   DATE 19-NOV-80   TIME 15-15

C3 (MOLE C/C)= .54   N-C4=2.30   I-C4=86.97   N-C5= .48   I-C5= 9.71

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 304.0 (PSIA)   BR FLOW RATE (LBS/HR)= 80148.6
PI108 (B4/B3)= 298.0   HC FLOW RATE (LBS/HR)= 49075.8
PI108 (B1-OUT)=292.3

PI204 (B1-IN)= 636.3 (PSIA)	TW101=219.6	TW201=118.5 (DEG-F)
PI204 (B1/B2)= 633.9	TW102=268.0	TW202=240.0
PI204 (B2/B3)= 629.7	TW103=288.3	TW203=277.0
PI204 (B3/B4)= 625.7	TW104=298.3	TW204=290.3
PI204 (B4/B5)= 620.7	TW105=313.4	TW205=299.7
PI204 (B5/B6)= 612.3	TW106=333.0	TW206=319.8
PI204 (B6-OUT)=602.6	TW107=341.2	TW207=337.7

HEATER TEST DATA RUN HTR-19   DATE 19-NOV-80   TIME 15-30

C3 (MOLE C/C)= .54   N-C4=2.30   I-C4=86.97   N-C5= .48   I-C5= 9.71

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 304.0 (PSIA)   BR FLOW RATE (LBS/HR)= 80147.1
PI108 (B4/B3)= 297.7   HC FLOW RATE (LBS/HR)= 48818.3
PI108 (B1-OUT)=292.0

PI204 (B1-IN)= 637.0 (PSIA)	TW101=219.7	TW201=118.3 (DEG-F)
PI204 (B1/B2)= 634.5	TW102=269.8	TW202=240.9
PI204 (B2/B3)= 630.0	TW103=288.8	TW203=277.5
PI204 (B3/B4)= 626.0	TW104=299.5	TW204=291.4
PI204 (B4/B5)= 620.4	TW105=315.0	TW205=300.4
PI204 (B5/B6)= 611.5	TW106=334.4	TW206=322.0
PI204 (B6-OUT)=601.9	TW107=341.5	TW207=338.6

HEATER TEST DATA RUN HTR-19   DATE 19-NOV-80   TIME 15-45

C3 (MOLE C/C)= .54   N-C4=2.30   I-C4=86.97   N-C5= .48   I-C5= 9.71

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 304.5 (PSIA)   BR FLOW RATE (LBS/HR)= 80141.1
PI108 (B4/B3)= 297.6   HC FLOW RATE (LBS/HR)= 48566.0
PI108 (B1-OUT)=292.4

PI204 (B1-IN)= 637.2 (PSIA)	TW101=220.1	TW201=118.0 (DEG-F)
PI204 (B1/B2)= 634.4	TW102=269.8	TW202=241.2
PI204 (B2/B3)= 630.3	TW103=289.2	TW203=278.0
PI204 (B3/B4)= 626.5	TW104=299.9	TW204=291.8
PI204 (B4/B5)= 621.3	TW105=315.9	TW205=301.0
PI204 (B5/B6)= 612.4	TW106=335.0	TW206=322.9
PI204 (B6-OUT)=602.5	TW107=341.4	TW207=339.0

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HEATER TEST DATA RUN HTR-19   DATE 19-NOV-80  TIME 16-00

C3 (MOLE C/C)= .54  N-C4=2.30  I-C4=86.97  N-C5= .48  I-C5= 9.71

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 304.4 (PSIA)    BR FLOW RATE (LBS/HR)= 80134.9
PI108 (B4/B3)= 298.0           HC FLOW RATE (LBS/HR)= 48591.1
PI108 (B1-OUT)=292.3

PI204 (B1-IN)= 637.4 (PSIA)    TW101=220.5    TW201=117.6 (DEG-F)
PI204 (B1/B2)= 634.3           TW102=270.6    TW202=242.0
PI204 (B2/B3)= 630.1           TW103=289.6    TW203=278.6
PI204 (B3/B4)= 626.2           TW104=300.8    TW204=292.6
PI204 (B4/B5)= 620.5           TW105=317.2    TW205=301.8
PI204 (B5/B6)= 611.9           TW106=336.0    TW206=324.4
PI204 (B6-OUT)=601.9           TW107=341.7    TW207=339.3

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HEATER TEST DATA RUN HTR-19   DATE 19-NOV-80  TIME 16-15

C3 (MOLE C/C)= .54  N-C4=2.30  I-C4=86.97  N-C5= .48  I-C5= 9.71

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 308.0 (PSIA)    BR FLOW RATE (LBS/HR)= 80138.1
PI108 (B4/B3)= 301.0           HC FLOW RATE (LBS/HR)= 48307.0
PI108 (B1-OUT)=293.0

PI204 (B1-IN)= 637.2 (PSIA)    TW101=220.3    TW201=117.8 (DEG-F)
PI204 (B1/B2)= 635.1           TW102=270.4    TW202=241.4
PI204 (B2/B3)= 631.9           TW103=289.4    TW203=277.9
PI204 (B3/B4)= 627.5           TW104=300.6    TW204=292.5
PI204 (B4/B5)= 622.5           TW105=316.5    TW205=302.0
PI204 (B5/B6)= 613.4           TW106=335.9    TW206=324.1
PI204 (B6-OUT)=604.0           TW107=341.7    TW207=339.5

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HEATER TEST DATA RUN HTR-20   DATE 20-NOV-80  TIME 07-30

C3 (MOLE C/C)= .54  N-C4=2.30  I-C4=86.97  N-C5= .48  I-C5= 9.71

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 274.2 (PSIA)    BR FLOW RATE (LBS/HR)= 98869.2
PI108 (B4/B3)= 264.2           HC FLOW RATE (LBS/HR)= 84398.6
PI108 (B1-OUT)=255.7

PI204 (B1-IN)= 650.5 (PSIA)    TW101=191.0    TW201=128.0 (DEG-F)
PI204 (B1/B2)= 642.1           TW102=235.2    TW202=204.0
PI204 (B2/B3)= 630.0           TW103=260.2    TW203=242.9
PI204 (B3/B4)= 618.9           TW104=275.9    TW204=264.2
PI204 (B4/B5)= 606.3           TW105=288.5    TW205=278.3
PI204 (B5/B6)= 592.0           TW106=305.6    TW206=289.4
PI204 (B6-OUT)=571.6           TW107=341.8    TW207=306.4

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HEATER TEST DATA RUN HTR-20   DATE 20-NOV-80   TIME 07-45

C3 (MOLE C/C)= .54 N-C4=2.30 I-C4=86.97 N-C5= .48 I-C5= 9.71

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 274.0 (PSIA)	BR FLOW RATE (LBS/HR)= 98860.9
PI108 (B4/B3)= 263.8	HC FLOW RATE (LBS/HR)= 84768.7
PI108 (B1-OUT)=255.3	

PI204 (B1-IN)= 651.5 (PSIA)	TW101=191.5	TW201=129.5 (DEG-F)
PI204 (B1/B2)= 642.4	TW102=235.4	TW202=204.5
PI204 (B2/B3)= 630.1	TW103=260.2	TW203=243.1
PI204 (B3/B4)= 618.4	TW104=276.0	TW204=264.1
PI204 (B4/B5)= 605.5	TW105=288.7	TW205=278.4
PI204 (B5/B6)= 591.0	TW106=305.7	TW206=289.6
PI204 (B6-OUT)=570.1	TW107=342.1	TW207=306.7

HEATER TEST DATA RUN HTR-20   DATE 20-NOV-80   TIME 08-00

C3 (MOLE C/C)= .54 N-C4=2.30 I-C4=86.97 N-C5= .48 I-C5= 9.71

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 273.5 (PSIA)	BR FLOW RATE (LBS/HR)= 98852.7
PI108 (B4/B3)= 263.5	HC FLOW RATE (LBS/HR)= 84366.3
PI108 (B1-OUT)=254.8	

PI204 (B1-IN)= 651.5 (PSIA)	TW101=192.0	TW201=130.7 (DEG-F)
PI204 (B1/B2)= 642.8	TW102=235.6	TW202=205.0
PI204 (B2/B3)= 630.5	TW103=260.1	TW203=243.0
PI204 (B3/B4)= 619.0	TW104=276.0	TW204=264.1
PI204 (B4/B5)= 606.1	TW105=289.5	TW205=278.4
PI204 (B5/B6)= 591.5	TW106=305.7	TW206=289.5
PI204 (B6-OUT)=570.8	TW107=343.2	TW207=306.5

HEATER TEST DATA RUN HTR-20   DATE 20-NOV-80   TIME 08-15

C3 (MOLE C/C)= .54 N-C4=2.30 I-C4=86.97 N-C5= .48 I-C5= 9.71

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 273.5 (PSIA)	BR FLOW RATE (LBS/HR)= 99028.5
PI108 (B4/B3)= 263.2	HC FLOW RATE (LBS/HR)= 84607.4
PI108 (B1-OUT)=254.5	

PI204 (B1-IN)= 650.4 (PSIA)	TW101=192.4	TW201=130.9 (DEG-F)
PI204 (B1/B2)= 642.2	TW102=236.0	TW202=205.4
PI204 (B2/B3)= 629.8	TW103=260.4	TW203=243.4
PI204 (B3/B4)= 618.6	TW104=276.2	TW204=264.4
PI204 (B4/B5)= 606.0	TW105=289.6	TW205=278.5
PI204 (B5/B6)= 591.6	TW106=305.8	TW206=289.5
PI204 (B6-OUT)=570.5	TW107=343.1	TW207=306.6

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HEATER TEST DATA RUN HTR-20   DATE 20-NOV-80   TIME 08-30

C3 (MOLE C/C)= .54  N-C4=2.30  I-C4=86.97  N-C5= .48  I-C5= 9.71

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 273.0 (PSIA)     BR FLOW RATE (LBS/HR)= 99203.9
PI108 (B4/B3)= 262.8            HC FLOW RATE (LBS/HR)= 84282.8
PI108 (B1-OUT)=254.1

PI204 (B1-IN)= 650.0 (PSIA)     TW101=192.8    TW201=131.4 (DEG-F)
PI204 (B1/B2)= 641.2            TW102=236.1    TW202=205.6
PI204 (B2/B3)= 629.0            TW103=260.5    TW203=243.5
PI204 (B3/B4)= 617.7            TW104=276.1    TW204=264.3
PI204 (B4/B5)= 604.9            TW105=288.6    TW205=276.3
PI204 (B5/B6)= 590.4            TW106=305.4    TW206=289.6
PI204 (B6-OUT)=569.8            TW107=343.0    TW207=306.3

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HEATER TEST DATA RUN HTR-21   DATE 20-NOV-80   TIME 09-15

C3 (MOLE C/C)= .54  N-C4=2.30  I-C4=86.97  N-C5= .48  I-C5= 9.71

NUM OF EXCHANGERS=5

PI108 (B6-IN)= 295.0 (PSIA)     BR FLOW RATE (LBS/HR)= 94961.2
PI108 (B4/B3)= 287.6            HC FLOW RATE (LBS/HR)= 68623.6
PI108 (B1-OUT)=280.0

PI204 (B1-IN)= 640.1 (PSIA)     TW101=202.6    TW201=118.3 (DEG-F)
PI204 (B1/B2)= 634.1            TW102=253.5    TW202=220.5
PI204 (B2/B3)= 625.6            TW103=278.6    TW203=262.2
PI204 (B3/B4)= 617.4            TW104=293.4    TW204=282.0
PI204 (B4/B5)= 607.0            TW105=311.2    TW205=293.8
PI204 (B5/B6)= 588.6            TW106=345.5    TW206=318.0
PI204 (B6-OUT)=567.5            TW107=331.8    TW207=314.3

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HEATER TEST DATA RUN HTR-21   DATE 20-NOV-80   TIME 09-30

C3 (MOLE C/C)= .54  N-C4=2.30  I-C4=86.97  N-C5= .48  I-C5= 9.71

NUM OF EXCHANGERS=5

PI108 (B6-IN)= 294.8 (PSIA)     BR FLOW RATE (LBS/HR)= 94956.1
PI108 (B4/B3)= 287.5            HC FLOW RATE (LBS/HR)= 68894.6
PI108 (B1-OUT)=279.7

PI204 (B1-IN)= 640.0 (PSIA)     TW101=202.9    TW201=118.3 (DEG-F)
PI204 (B1/B2)= 634.3            TW102=253.5    TW202=220.7
PI204 (B2/B3)= 625.5            TW103=278.6    TW203=262.6
PI204 (B3/B4)= 617.4            TW104=293.5    TW204=282.1
PI204 (B4/B5)= 606.8            TW105=311.4    TW205=294.0
PI204 (B5/B6)= 588.6            TW106=345.7    TW206=318.1
PI204 (B6-OUT)=567.5            TW107=323.2    TW207=314.4

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HEATER TEST DATA RUN HTR-21   DATE 20-NOV-80  TIME 09-45

C3 (MOLE O/O)= .54  N-C4=2.30  I-C4=86.97  N-C5= .48  I-C5= 9.71

NUM OF EXCHANGERS=5

PI108 (B6-IN)= 294.6 (PSIA)    BR FLOW RATE (LBS/HR)= 94959.4
PI108 (B4/B3)= 287.1           HC FLOW RATE (LBS/HR)= 68893.3
PI108 (B1-OUT)=279.4

PI204 (B1-IN)= 639.4 (PSIA)    TW101=202.7    TW201=118.3 (DEG-F)
PI204 (B1/B2)= 633.5           TW102=253.6    TW202=220.7
PI204 (B2/B3)= 625.0           TW103=278.4    TW203=262.4
PI204 (B3/B4)= 616.6           TW104=293.3    TW204=282.0
PI204 (B4/B5)= 606.1           TW105=311.2    TW205=293.8
PI204 (B5/B6)= 588.2           TW106=345.6    TW206=317.9
PI204 (B6-OUT)=566.9           TW107=314.1    TW207=314.3

-------------------------------------------------------------------

HEATER TEST DATA RUN HTR-21   DATE 20-NOV-80  TIME 10-00

C3 (MOLE O/O)= .54  N-C4=2.30  I-C4=86.97  N-C5= .48  I-C5= 9.71

NUM OF EXCHANGERS=5

PI108 (B6-IN)= 294.6 (PSIA)    BR FLOW RATE (LBS/HR)= 94962.8
PI108 (B4/B3)= 287.4           HC FLOW RATE (LBS/HR)= 68611.1
PI108 (B1-OUT)=279.6

PI204 (B1-IN)= 638.4 (PSIA)    TW101=202.5    TW201=118.4 (DEG-F)
PI204 (B1/B2)= 633.3           TW102=253.5    TW202=220.4
PI204 (B2/B3)= 624.2           TW103=278.2    TW203=262.1
PI204 (B3/B4)= 615.8           TW104=293.0    TW204=281.8
PI204 (B4/B5)= 605.2           TW105=311.0    TW205=293.6
PI204 (B5/B6)= 587.2           TW106=345.4    TW206=317.7
PI204 (B6-OUT)=566.0           TW107=306.2    TW207=314.1

-------------------------------------------------------------------

HEATER TEST DATA RUN HTR-21   DATE 20-NOV-80  TIME 10-15

C3 (MOLE O/O)= .54  N-C4=2.30  I-C4=86.97  N-C5= .48  I-C5= 9.71

NUM OF EXCHANGERS=5

PI108 (B6-IN)= 294.5 (PSIA)    BR FLOW RATE (LBS/HR)= 94764.8
PI108 (B4/B3)= 287.1           HC FLOW RATE (LBS/HR)= 68604.3
PI108 (B1-OUT)=279.5

PI204 (B1-IN)= 639.3 (PSIA)    TW101=203.0    TW201=118.5 (DEG-F)
PI204 (B1/B2)= 633.5           TW102=253.6    TW202=220.7
PI204 (B2/B3)= 625.0           TW103=278.5    TW203=262.5
PI204 (B3/B4)= 616.7           TW104=293.2    TW204=282.0
PI204 (B4/B5)= 606.0           TW105=311.2    TW205=293.8
PI204 (B5/B6)= 588.2           TW106=345.3    TW206=317.9
PI204 (B6-OUT)=567.0           TW107=301.3    TW207=314.3

-------------------------------------------------------------------
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```
HEATER TEST CATA RUN HTR-22   CATE 20-NOV-80  TIME 11-00

C3 (MOLE C/C)= .54  N-C4=2.30  I-C4=86.97  N-C5= .48  I-C5= 9.71

NUM OF EXCHANGERS=5

PI108 (B6-IN)= 383.2 (PSIA)    BR FLOW RATE (LBS/HR)= 70878.1
PI108 (B4/B3)= 379.4           HC FLOW RATE (LBS/HR)= 50328.1
PI108 (B1-OUT)=375.0

PI204 (B1-IN)= 604.0 (PSIA)    TW101=204.1    TW201=123.4 (DEG-F)
PI204 (B1/B2)= 601.0           TW102=254.1    TW202=224.3
PI204 (B2/B3)= 596.6           TW103=276.4    TW203=263.4
PI204 (B3/B4)= 592.4           TW104=289.3    TW204=280.5
PI204 (B4/B5)= 587.0           TW105=306.5    TW205=290.8
PI204 (B5/B6)= 577.2           TW106=341.2    TW206=317.4
PI204 (B6-OUT)=566.0           TW107=302.9    TW207=315.5
```

```
HEATER TEST DATA RUN HTR-22   DATE 20-NOV-80  TIME 11-15

C3 (MOLE C/C)= .54  N-C4=2.30  I-C4=86.97  N-C5= .48  I-C5= 9.71

NUM OF EXCHANGERS=5

PI108 (B6-IN)= 383.5 (PSIA)    BR FLOW RATE (LBS/HR)= 70879.3
PI108 (B4/B3)= 379.6           HC FLOW RATE (LBS/HR)= 49225.7
PI108 (B1-OUT)=375.1

PI204 (B1-IN)= 604.0 (PSIA)    TW101=204.0    TW201=123.8 (DEG-F)
PI204 (B1/B2)= 600.6           TW102=253.1    TW202=224.3
PI204 (B2/B3)= 596.3           TW103=276.0    TW203=262.9
PI204 (B3/B4)= 592.0           TW104=288.7    TW204=279.8
PI204 (B4/B5)= 586.8           TW105=305.9    TW205=290.5
PI204 (B5/B6)= 577.2           TW106=341.1    TW206=316.2
PI204 (B6-OUT)=566.1           TW107=300.3    TW207=314.1
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```
HEATER TEST CATA RUN HTR-22   CATE 20-NOV-80  TIME 11-30

C3 (MOLE C/C)= .54  N-C4=2.30  I-C4=86.97  N-C5= .48  I-C5= 9.71

NUM OF EXCHANGERS=5

PI108 (B6-IN)= 383.5 (PSIA)    BR FLOW RATE (LBS/HR)= 70878.1
PI108 (B4/B3)= 379.5           HC FLOW RATE (LBS/HR)= 49481.6
PI108 (B1-OUT)=375.1

PI204 (B1-IN)= 604.0 (PSIA)    TW101=204.1    TW201=124.0 (DEG-F)
PI204 (B1/B2)= 600.6           TW102=253.5    TW202=224.9
PI204 (B2/B3)= 596.4           TW103=275.8    TW203=262.9
PI204 (B3/B4)= 592.1           TW104=288.7    TW204=280.0
PI204 (B4/B5)= 586.6           TW105=305.8    TW205=290.5
PI204 (B5/B6)= 577.0           TW106=340.6    TW206=316.1
PI204 (B6-OUT)=565.8           TW107=299.1    TW207=314.0
```

```
HEATER TEST DATA RUN HTR-22   DATE 20-NOV-80  TIME 11-45

C3 (MOLE C/C)= .54  N-C4=2.30  I-C4=86.97  N-C5= .48  I-C5= 9.71

NUM OF EXCHANGERS=5

PI108 (B6-IN)= 383.7 (PSIA)    BR FLOW RATE (LBS/HR)= 70878.1
PI108 (B4/B3)= 380.0           HC FLOW RATE (LBS/HR)= 49714.6
PI108 (B1-OUT)=375.0

PI204 (B1-IN)= 602.1 (PSIA)    TW101=204.1    TW201=124.5 (DEG-F)
PI204 (B1/B2)= 598.5           TW102=253.1    TW202=224.5
PI204 (B2/B3)= 593.6           TW103=275.6    TW203=262.9
PI204 (B3/B4)= 591.2           TW104=288.6    TW204=279.7
PI204 (B4/B5)= 586.9           TW105=305.3    TW205=290.3
PI204 (B5/B6)= 577.7           TW106=340.0    TW206=315.4
PI204 (B6-OUT)=567.5           TW107=297.8    TW207=313.3

----------------------------------------------------------------------

HEATER TEST DATA RUN HTR-22   DATE 20-NOV-80  TIME 12-00

C3 (MOLE C/C)= .54  N-C4=2.30  I-C4=86.97  N-C5= .48  I-C5= 9.71

NUM OF EXCHANGERS=5

PI108 (B6-IN)= 384.6 (PSIA)    BR FLOW RATE (LBS/HR)= 70865.9
PI108 (B4/B3)= 380.2           HC FLOW RATE (LBS/HR)= 48927.0
PI108 (B1-OUT)=376.2

PI204 (B1-IN)= 605.5 (PSIA)    TW101=205.1    TW201=124.3 (DEG-F)
PI204 (B1/B2)= 602.9           TW102=254.4    TW202=226.2
PI204 (B2/B3)= 597.8           TW103=276.8    TW203=264.0
PI204 (B3/B4)= 593.6           TW104=289.4    TW204=280.7
PI204 (B4/B5)= 588.0           TW105=306.4    TW205=291.0
PI204 (B5/B6)= 578.1           TW106=339.9    TW206=316.8
PI204 (B6-OUT)=566.8           TW107=297.3    TW207=314.7

----------------------------------------------------------------------

HEATER TEST DATA RUN HTR-23   DATE 20-NOV-80  TIME 12-30

C3 (MOLE C/C)= .54  N-C4=2.30  I-C4=86.97  N-C5= .48  I-C5= 9.71

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 269.9 (PSIA)    BR FLOW RATE (LBS/HR)=100817.6
PI108 (B4/B3)= 259.1           HC FLOW RATE (LBS/HR)= 78912.4
PI108 (B1-OUT)=250.4

PI204 (B1-IN)= 626.3 (PSIA)    TW101=193.4    TW201=120.8 (DEG-F)
PI204 (B1/B2)= 618.5           TW102=239.2    TW202=207.0
PI204 (B2/B3)= 608.0           TW103=263.4    TW203=247.5
PI204 (B3/B4)= 598.0           TW104=277.5    TW204=266.3
PI204 (B4/B5)= 586.6           TW105=288.4    TW205=279.3
PI204 (B5/B6)= 573.5           TW106=306.0    TW206=287.8
PI204 (B6-OUT)=552.3           TW107=342.9    TW207=310.5

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HEATER TEST DATA RUN HTR-23   DATE 20-NOV-80  TIME 12-45

C3 (MOLE C/C)= .54  N-C4=2.30  I-C4=86.97  N-C5= .48  I-C5= 9.71

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 269.5 (PSIA)    BR FLOW RATE (LBS/HR)=100458.9
PI108 (B4/B3)= 259.2           HC FLOW RATE (LBS/HR)= 79058.7
PI108 (B1-OUT)=250.5

PI204 (B1-IN)= 626.0 (PSIA)    TW101=193.4    TW201=122.0 (DEG-F)
PI204 (B1/B2)= 617.9           TW102=239.3    TW202=207.4
PI204 (B2/B3)= 607.5           TW103=262.9    TW203=247.2
PI204 (B3/B4)= 597.2           TW104=277.3    TW204=266.6
PI204 (B4/B5)= 585.7           TW105=288.5    TW205=279.2
PI204 (B5/B6)= 572.2           TW106=306.2    TW206=288.0
PI204 (B6-OUT)=550.9           TW107=343.5    TW207=310.8
--------------------------------------------------------------------------------
HEATER TEST DATA RUN HTR-23   DATE 20-NOV-80  TIME 13-00

C3 (MOLE C/C)= .54  N-C4=2.30  I-C4=86.97  N-C5= .48  I-C5= 9.71

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 269.4 (PSIA)    BR FLOW RATE (LBS/HR)=100453.9
PI108 (B4/B3)= 259.0           HC FLOW RATE (LBS/HR)= 78768.6
PI108 (B1-OUT)=250.5

PI204 (B1-IN)= 626.1 (PSIA)    TW101=193.7    TW201=122.2 (DEG-F)
PI204 (B1/B2)= 618.4           TW102=239.5    TW202=207.7
PI204 (B2/B3)= 608.0           TW103=263.2    TW203=247.4
PI204 (B3/B4)= 597.9           TW104=277.4    TW204=266.8
PI204 (B4/B5)= 586.5           TW105=288.5    TW205=279.3
PI204 (B5/B6)= 573.2           TW106=306.1    TW206=288.0
PI204 (B6-OUT)=552.1           TW107=343.0    TW207=310.2
--------------------------------------------------------------------------------
HEATER TEST DATA RUN HTR-23   DATE 20-NOV-80  TIME 13-15

C3 (MOLE C/C)= .54  N-C4=2.30  I-C4=86.97  N-C5= .48  I-C5= 9.71

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 269.9 (PSIA)    BR FLOW RATE (LBS/HR)=100279.1
PI108 (B4/B3)= 259.4           HC FLOW RATE (LBS/HR)= 78247.9
PI108 (B1-OUT)=250.6

PI204 (B1-IN)= 625.5 (PSIA)    TW101=193.4    TW201=122.0 (DEG-F)
PI204 (B1/B2)= 617.9           TW102=239.4    TW202=207.5
PI204 (B2/B3)= 607.3           TW103=263.0    TW203=247.2
PI204 (B3/B4)= 597.0           TW104=277.3    TW204=266.8
PI204 (B4/B5)= 585.5           TW105=288.3    TW205=279.2
PI204 (B5/B6)= 572.2           TW106=306.0    TW206=288.0
PI204 (B6-OUT)=551.0           TW107=342.5    TW207=310.0
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HEATER TEST DATA RUN HTR-23   DATE 20-NOV-80  TIME 13-30

C3 (MOLE C/C)= .54  N-C4=2.30  I-C4=86.97  N-C5= .48  I-C5= 9.71

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 269.7 (PSIA)    BR FLOW RATE (LBS/HR)=100190.8
PI108 (B4/B3)= 259.4           HC FLOW RATE (LBS/HR)= 78568.5
PI108 (B1-OUT)=250.9

PI204 (B1-IN)= 625.4 (PSIA)    TW101=193.3    TW201=121.5 (DEG-F)
PI204 (B1/B2)= 617.5           TW102=239.2    TW202=207.3
PI204 (B2/B3)= 606.9           TW103=263.0    TW203=247.2
PI204 (B3/B4)= 597.0           TW104=277.2    TW204=266.5
PI204 (B4/B5)= 585.6           TW105=288.3    TW205=279.2
PI204 (B5/B6)= 572.5           TW106=305.9    TW206=288.0
PI204 (B6-OUT)=551.5           TW107=342.0    TW207=309.1
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HEATER TEST DATA RUN HTR-24   DATE 20-NOV-80  TIME 14-45

C3 (MOLE C/C)= .54  N-C4=2.30  I-C4=86.97  N-C5= .48  I-C5= 9.71

NUM OF EXCHANGERS=5

PI108 (B6-IN)= 278.9 (PSIA)    BR FLOW RATE (LBS/HR)= 98224.3
PI108 (B4/B3)= 270.7           HC FLOW RATE (LBS/HR)= 63188.1
PI108 (B1-OUT)=262.4

PI204 (B1-IN)= 622.0 (PSIA)    TW101=217.5    TW201=121.3 (DEG-F)
PI204 (B1/B2)= 617.3           TW102=266.1    TW202=235.5
PI204 (B2/B3)= 610.4           TW103=286.5    TW203=273.5
PI204 (B3/B4)= 604.0           TW104=299.3    TW204=288.9
PI204 (B4/B5)= 593.0           TW105=321.0    TW205=298.7
PI204 (B5/B6)= 575.0           TW106=343.5    TW206=329.4
PI204 (B6-OUT)=556.1           TW107=316.4    TW207=325.7
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```
HEATER TEST DATA RUN HTR-24   DATE 20-NOV-80  TIME 15-00

C3 (MOLE C/C)= .54  N-C4=2.30  I-C4=86.97  N-C5= .48  I-C5= 9.71

NUM OF EXCHANGERS=5

PI108 (B6-IN)= 278.6 (PSIA)    BR FLOW RATE (LBS/HR)= 98214.9
PI108 (B4/B3)= 270.5           HC FLOW RATE (LBS/HR)= 63147.1
PI108 (B1-OUT)=262.2

PI204 (B1-IN)= 622.0 (PSIA)    TW101=218.0    TW201=121.8 (DEG-F)
PI204 (B1/B2)= 617.4           TW102=266.3    TW202=235.8
PI204 (B2/B3)= 610.3           TW103=286.8    TW203=273.7
PI204 (B3/B4)= 603.8           TW104=299.4    TW204=289.0
PI204 (B4/B5)= 593.4           TW105=321.4    TW205=298.8
PI204 (B5/B6)= 575.2           TW106=343.6    TW206=329.5
PI204 (B6-OUT)=556.5           TW107=313.4    TW207=326.3
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HEATER TEST DATA RUN HTR-24   DATE 20-NOV-80  TIME 15-15

C3 (MOLE C/C)= .54  N-C4=2.30  I-C4=86.97  N-C5= .48  I-C5= 9.71

NUM OF EXCHANGERS=5

PI108 (B6-IN)= 278.8 (PSIA)   BR FLOW RATE (LBS/HR)= 98389.4
PI108 (B4/B3)= 270.9          HC FLOW RATE (LBS/HR)= 62631.8
PI108 (B1-OUT)=262.3

PI204 (B1-IN)= 622.0 (PSIA)   TW101=218.4     TW201=121.5 (DEG-F)
PI204 (B1/B2)= 617.5          TW102=266.4     TW202=236.0
PI204 (B2/B3)= 610.5          TW103=287.0     TW203=274.0
PI204 (B3/B4)= 604.0          TW104=299.5     TW204=289.0
PI204 (B4/B5)= 594.1          TW105=321.4     TW205=299.2
PI204 (B5/B6)= 576.0          TW106=343.5     TW206=329.5
PI204 (B6-OUT)=557.8          TW107=309.3     TW207=325.5

------------------------------------------------------------------

HEATER TEST DATA RUN HTR-24   DATE 20-NOV-80  TIME 15-30

C3 (MOLE C/C)= .54  N-C4=2.30  I-C4=86.97  N-C5= .48  I-C5= 9.71

NUM OF EXCHANGERS=5

PI108 (B6-IN)= 279.0 (PSIA)   BR FLOW RATE (LBS/HR)= 98396.9
PI108 (B4/B3)= 270.4          HC FLOW RATE (LBS/HR)= 62630.6
PI108 (B1-OUT)=262.5

PI204 (B1-IN)= 621.4 (PSIA)   TW101=218.0     TW201=121.5 (DEG-F)
PI204 (B1/B2)= 616.6          TW102=266.6     TW202=236.1
PI204 (B2/B3)= 610.0          TW103=286.9     TW203=273.9
PI204 (B3/B4)= 603.5          TW104=299.7     TW204=289.2
PI204 (B4/B5)= 593.3          TW105=321.4     TW205=299.2
PI204 (B5/B6)= 575.4          TW106=343.6     TW206=329.8
PI204 (B6-OUT)=556.9          TW107=308.3     TW207=326.1

------------------------------------------------------------------

HEATER TEST DATA RUN HTR-25   DATE 21-NOV-80  TIME 07-30

C3 (MOLE C/C)= .54  N-C4=2.30  I-C4=86.97  N-C5= .48  I-C5= 9.71

NUM OF EXCHANGERS=5

PI108 (B6-IN)= 365.5 (PSIA)   BR FLOW RATE (LBS/HR)= 75113.8
PI108 (B4/B3)= 361.0          HC FLOW RATE (LBS/HR)= 48783.1
PI108 (B1-OUT)=355.4

PI204 (B1-IN)= 593.5 (PSIA)   TW101=218.0     TW201=134.3 (DEG-F)
PI204 (B1/B2)= 591.0          TW102=265.2     TW202=237.8
PI204 (B2/B3)= 586.9          TW103=282.2     TW203=271.2
PI204 (B3/B4)= 582.8          TW104=295.5     TW204=286.3
PI204 (B4/B5)= 577.0          TW105=317.3     TW205=294.4
PI204 (B5/B6)= 565.9          TW106=341.2     TW206=329.4
PI204 (B6-OUT)=554.8          TW107=333.4     TW207=328.0

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HEATER TEST DATA RUN HTR-25   DATE 21-NOV-80   TIME 07-45

C3 (MOLE C/C)= .54  N-C4=2.30  I-C4=86.97  N-C5= .48  I-C5= 9.71

NUM OF EXCHANGERS=5

PI108 (B6-IN)= 364.2 (PSIA)     BR FLOW RATE (LBS/HR)= 75470.0
PI108 (B4/B3)= 359.8            HC FLOW RATE (LBS/HR)= 48503.2
PI108 (B1-OUT)=354.6

PI204 (B1-IN)= 592.7 (PSIA)     TW101=218.0    TW201=134.5 (DEG-F)
PI204 (B1/B2)= 589.5            TW102=264.0    TW202=238.0
PI204 (B2/B3)= 584.7            TW103=282.5    TW203=271.6
PI204 (B3/B4)= 580.3            TW104=294.1    TW204=285.3
PI204 (B4/B5)= 574.1            TW105=316.2    TW205=294.5
PI204 (B5/B6)= 562.8            TW106=341.3    TW206=328.3
PI204 (B6-OUT)=552.2            TW107=325.1    TW207=326.4

---------------------------------------------------------------------

HEATER TEST DATA RUN HTR-25   DATE 21-NOV-80   TIME 08-30

C3 (MOLE C/C)= .54  N-C4=2.30  I-C4=86.97  N-C5= .48  I-C5= 9.71

NUM OF EXCHANGERS=5

PI108 (B6-IN)= 364.5 (PSIA)     BR FLOW RATE (LBS/HR)= 75554.3
PI108 (B4/B3)= 360.0            HC FLOW RATE (LBS/HR)= 47692.1
PI108 (B1-OUT)=355.0

PI204 (B1-IN)= 594.8 (PSIA)     TW101=220.4    TW201=134.8 (DEG-F)
PI204 (B1/B2)= 592.3            TW102=265.6    TW202=239.7
PI204 (B2/B3)= 588.5            TW103=284.0    TW203=273.2
PI204 (B3/B4)= 585.0            TW104=295.6    TW204=286.5
PI204 (B4/B5)= 578.0            TW105=320.1    TW205=297.5
PI204 (B5/B6)= 566.5            TW106=341.4    TW206=330.1
PI204 (B6-OUT)=554.5            TW107=315.0    TW207=328.4

---------------------------------------------------------------------

HEATER TEST DATA RUN HTR-25   DATE 21-NOV-80   TIME 08-45

C3 (MOLE C/C)= .54  N-C4=2.30  I-C4=86.97  N-C5= .48  I-C5= 9.71

NUM OF EXCHANGERS=5

PI108 (B6-IN)= 364.0 (PSIA)     BR FLOW RATE (LBS/HR)= 75777.4
PI108 (B4/B3)= 359.4            HC FLOW RATE (LBS/HR)= 47381.6
PI108 (B1-OUT)=354.2

PI204 (B1-IN)= 593.1 (PSIA)     TW101=221.3    TW201=135.5 (DEG-F)
PI204 (B1/B2)= 590.5            TW102=266.0    TW202=240.3
PI204 (B2/B3)= 586.6            TW103=284.6    TW203=273.8
PI204 (B3/B4)= 582.8            TW104=296.0    TW204=286.8
PI204 (B4/B5)= 576.4            TW105=321.0    TW205=298.4
PI204 (B5/B6)= 565.7            TW106=341.6    TW206=330.8
PI204 (B6-OUT)=555.0            TW107=313.0    TW207=329.0

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NOMINAL 80/20 CONDENSER TEST DATA

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HEATER TEST DATA RUN HTR-25A  DATE 1-DEC-80   TIME 12-45

C3 (MOLE C/C)= .47  N-C4=2.00  I-C4=75.77  N-C5=1.02  I-C5=20.74

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 282.2 (PSIA)    BR FLOW RATE (LBS/HR)= 96261.2
PI108 (B4/B3)= 272.0           HC FLOW RATE (LBS/HR)= 90288.5
PI108 (B1-OUT)=263.3

PI204 (B1-IN)= 675.0 (PSIA)    TW101=192.1    TW201=124.8 (DEG-F)
PI204 (B1/B2)= 666.1           TW102=240.0    TW202=206.0
PI204 (B2/B3)= 654.5           TW103=268.4    TW203=249.2
PI204 (B3/B4)= 643.0           TW104=286.1    TW204=273.1
PI204 (B4/B5)= 630.9           TW105=300.4    TW205=288.8
PI204 (B5/B6)= 616.1           TW106=315.1    TW206=302.0
PI204 (B6-OUT)=599.0           TW107=343.9    TW207=312.8

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HEATER TEST DATA RUN HTR-25A  DATE 1-DEC-80   TIME 13-00

C3 (MOLE C/C)= .47  N-C4=2.00  I-C4=75.77  N-C5=1.02  I-C5=20.74

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 281.9 (PSIA)    BR FLOW RATE (LBS/HR)= 96253.2
PI108 (B4/B3)= 272.0           HC FLOW RATE (LBS/HR)= 90266.3
PI108 (B1-OUT)=263.5

PI204 (B1-IN)= 675.1 (PSIA)    TW101=192.6    TW201=125.0 (DEG-F)
PI204 (B1/B2)= 666.0           TW102=240.4    TW202=206.6
PI204 (B2/B3)= 654.0           TW103=268.6    TW203=249.4
PI204 (B3/B4)= 642.4           TW104=286.2    TW204=273.2
PI204 (B4/B5)= 629.6           TW105=300.3    TW205=288.9
PI204 (B5/B6)= 615.9           TW106=315.0    TW206=302.0
PI204 (B6-OUT)=598.7           TW107=344.0    TW207=313.0

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HEATER TEST DATA RUN HTR-25A  DATE 1-DEC-80   TIME 13-15

C3 (MOLE C/C)= .47  N-C4=2.00  I-C4=75.77  N-C5=1.02  I-C5=20.74

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 281.4 (PSIA)    BR FLOW RATE (LBS/HR)= 96445.4
PI108 (B4/B3)= 271.7           HC FLOW RATE (LBS/HR)= 90164.6
PI108 (B1-OUT)=263.1

PI204 (B1-IN)= 675.0 (PSIA)    TW101=192.3    TW201=125.9 (DEG-F)
PI204 (B1/B2)= 666.1           TW102=241.1    TW202=206.8
PI204 (B2/B3)= 654.0           TW103=268.8    TW203=249.8
PI204 (B3/B4)= 642.6           TW104=286.3    TW204=273.4
PI204 (B4/B5)= 629.5           TW105=300.2    TW205=288.9
PI204 (B5/B6)= 615.9           TW106=315.0    TW206=302.0
PI204 (B6-OUT)=598.8           TW107=343.9    TW207=313.0

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HEATER TEST DATA RUN HTR-25A  DATE 1-DEC-80   TIME 13-30

C3 (MOLE C/C)= .47  N-C4=2.00  I-C4=75.77  N-C5=1.02  I-C5=20.74

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 280.8 (PSIA)    BR FLOW RATE (LBS/HR)= 96432.5
PI108 (B4/B3)= 271.2           HC FLOW RATE (LBS/HR)= 90164.9
PI108 (B1-OUT)=263.0

PI204 (B1-IN)= 675.1 (PSIA)    TW101=193.1    TW201=125.9 (DEG-F)
PI204 (B1/B2)= 666.0           TW102=240.8    TW202=207.0
PI204 (B2/B3)= 654.0           TW103=268.9    TW203=250.0
PI204 (B3/B4)= 642.0           TW104=286.4    TW204=273.5
PI204 (B4/B5)= 629.0           TW105=300.4    TW205=289.1
PI204 (B5/B6)= 615.4           TW106=315.2    TW206=302.1
PI204 (B6-OUT)=598.7           TW107=344.4    TW207=313.4
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```
HEATER TEST DATA RUN HTR-25A  DATE 1-DEC-80   TIME 13-45

C3 (MOLE C/C)= .47  N-C4=2.00  I-C4=75.77  N-C5=1.02  I-C5=20.74

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 280.4 (PSIA)    BR FLOW RATE (LBS/HR)= 96246.7
PI108 (B4/B3)= 271.3           HC FLOW RATE (LBS/HR)= 90404.1
PI108 (B1-OUT)=263.0

PI204 (B1-IN)= 675.1 (PSIA)    TW101=193.0    TW201=126.2 (DEG-F)
PI204 (B1/B2)= 666.1           TW102=240.6    TW202=206.9
PI204 (B2/B3)= 654.0           TW103=268.7    TW203=249.8
PI204 (B3/B4)= 642.6           TW104=286.3    TW204=273.3
PI204 (B4/B5)= 629.3           TW105=300.2    TW205=288.9
PI204 (B5/B6)= 615.1           TW106=315.0    TW206=302.0
PI204 (B6-OUT)=598.6           TW107=343.8    TW207=313.0
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```
HEATER TEST DATA RUN HTR-26   DATE 1-DEC-80   TIME 14-00

C3 (MOLE C/C)= .47  N-C4=2.00  I-C4=75.77  N-C5=1.02  I-C5=20.74

NUM OF EXCHANGERS=5

PI108 (B6-IN)= 278.9 (PSIA)    BR FLOW RATE (LBS/HR)= 96359.1
PI108 (B4/B3)= 271.5           HC FLOW RATE (LBS/HR)= 88627.2
PI108 (B1-OUT)=263.0

PI204 (B1-IN)= 683.5 (PSIA)    TW101=197.6    TW201=122.7 (DEG-F)
PI204 (B1/B2)= 675.0           TW102=249.6    TW202=213.2
PI204 (B2/B3)= 663.6           TW103=280.2    TW203=259.7
PI204 (B3/B4)= 652.3           TW104=299.3    TW204=284.9
PI204 (B4/B5)= 638.6           TW105=316.6    TW205=301.4
PI204 (B5/B6)= 621.9           TW106=344.6    TW206=315.7
PI204 (B6-OUT)=601.8           TW107=337.2    TW207=312.6
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HEATER TEST DATA RUN HTR-26   DATE 1-DEC-80   TIME 14-15

C3 (MOLE C/C)= .47  N-C4=2.00  I-C4=75.77  N-C5=1.02  I-C5=20.74

NUM OF EXCHANGERS=5

PI108 (B6-IN)= 278.9 (PSIA)    ER FLOW RATE (LBS/HR)= 96734.0
PI108 (B4/B3)= 271.0           HC FLOW RATE (LBS/HR)= 88375.4
PI108 (B1-OUT)=262.8

PI204 (B1-IN)= 683.8 (PSIA)    TW101=197.5    TW201=122.5 (DEG-F)
PI204 (B1/B2)= 675.2           TW102=249.8    TW202=213.4
PI204 (B2/B3)= 663.2           TW103=280.2    TW203=259.8
PI204 (B3/B4)= 652.0           TW104=299.4    TW204=285.0
PI204 (B4/B5)= 638.8           TW105=316.4    TW205=302.4
PI204 (B5/B6)= 621.0           TW106=344.8    TW206=316.2
PI204 (B6-OUT)=601.6           TW107=327.8    TW207=312.2
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```
HEATER TEST DATA RUN HTR-26   DATE 1-DEC-80   TIME 14-30

C3 (MOLE C/C)= .47  N-C4=2.00  I-C4=75.77  N-C5=1.02  I-C5=20.74

NUM OF EXCHANGERS=5

PI108 (B6-IN)= 279.0 (PSIA)    ER FLOW RATE (LBS/HR)= 96734.0
PI108 (B4/B3)= 271.3           HC FLOW RATE (LBS/HR)= 88365.9
PI108 (B1-OUT)=262.7

PI204 (B1-IN)= 684.3 (PSIA)    TW101=197.5    TW201=122.6 (DEG-F)
PI204 (B1/B2)= 675.8           TW102=249.6    TW202=213.2
PI204 (B2/B3)= 663.6           TW103=280.1    TW203=259.5
PI204 (B3/B4)= 652.5           TW104=299.2    TW204=284.8
PI204 (B4/B5)= 638.5           TW105=316.0    TW205=302.2
PI204 (B5/B6)= 621.7           TW106=344.2    TW206=315.2
PI204 (B6-OUT)=601.5           TW107=316.8    TW207=312.0
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```
HEATER TEST DATA RUN HTR-26   DATE 1-DEC-80   TIME 14-45

C3 (MOLE C/C)= .47  N-C4=2.00  I-C4=75.77  N-C5=1.02  I-C5=20.74

NUM OF EXCHANGERS=5

PI108 (B6-IN)= 278.8 (PSIA)    ER FLOW RATE (LBS/HR)= 96729.0
PI108 (B4/B3)= 271.1           HC FLOW RATE (LBS/HR)= 88358.2
PI108 (B1-OUT)=262.8

PI204 (B1-IN)= 685.5 (PSIA)    TW101=197.8    TW201=122.7 (DEG-F)
PI204 (B1/B2)= 677.0           TW102=249.8    TW202=213.4
PI204 (B2/B3)= 665.4           TW103=280.5    TW203=260.0
PI204 (B3/B4)= 654.4           TW104=299.4    TW204=285.0
PI204 (B4/B5)= 641.2           TW105=316.6    TW205=302.4
PI204 (B5/B6)= 623.1           TW106=344.9    TW206=315.7
PI204 (B6-OUT)=603.0           TW107=307.4    TW207=312.6
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HEATER TEST DATA RUN HTR-26   DATE 1-DEC-80   TIME 15-00

C3 (MOLE C/C)= .47  N-C4=2.00  I-C4=75.77  N-C5=1.02  I-C5=20.74

NUM OF EXCHANGERS=5

PI108 (B6-IN)= 279.9 (PSIA)    BR FLOW RATE (LBS/HR)= 96725.7
PI108 (B4/B3)= 271.3           HC FLOW RATE (LBS/HR)= 89081.1
PI108 (B1-OUT)=262.7

PI204 (B1-IN)= 684.5 (PSIA)    TW101=198.0    TW201=122.7 (DEG-F)
PI204 (B1/B2)= 675.9           TW102=250.0    TW202=213.5
PI204 (B2/B3)= 664.5           TW103=280.6    TW203=260.1
PI204 (B3/B4)= 653.3           TW104=299.5    TW204=285.1
PI204 (B4/B5)= 639.8           TW105=316.6    TW205=302.4
PI204 (B5/B6)= 623.0           TW106=345.1    TW206=316.0
PI204 (B6-OUT)=602.8           TW107=302.2    TW207=312.8

-----------------------------------------------------------------------

HEATER TEST DATA RUN HTR-27   DATE 1-DEC-80   TIME 15-15

C3 (MOLE C/C)= .47  N-C4=2.00  I-C4=75.77  N-C5=1.02  I-C5=20.74

NUM OF EXCHANGERS=4

PI108 (B6-IN)= 275.4 (PSIA)    BR FLOW RATE (LBS/HR)= 97184.6
PI108 (B4/B3)= 271.9           HC FLOW RATE (LBS/HR)= 86673.3
PI108 (B1-OUT)=262.9

PI204 (B1-IN)= 690.2 (PSIA)    TW101=203.8    TW201=120.6 (DEG-F)
PI204 (B1/B2)= 682.0           TW102=260.4    TW202=221.8
PI204 (B2/B3)= 670.0           TW103=293.8    TW203=271.4
PI204 (B3/B4)= 659.0           TW104=314.8    TW204=298.0
PI204 (B4/B5)= 642.9           TW105=344.2    TW205=317.3
PI204 (B5/B6)= 621.4           TW106=339.2    TW206=313.8
PI204 (B6-OUT)=603.0           TW107=300.0    TW207=310.8

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HEATER TEST DATA RUN HTR-27   DATE 1-DEC-80   TIME 15-30

C3 (MOLE C/C)= .47  N-C4=2.00  I-C4=75.77  N-C5=1.02  I-C5=20.74

NUM OF EXCHANGERS=4

PI108 (B6-IN)= 275.0 (PSIA)    BR FLOW RATE (LBS/HR)= 97186.4
PI108 (B4/B3)= 271.9           HC FLOW RATE (LBS/HR)= 86989.2
PI108 (B1-OUT)=262.9

PI204 (B1-IN)= 689.5 (PSIA)    TW101=203.7    TW201=120.2 (DEG-F)
PI204 (B1/B2)= 681.0           TW102=260.6    TW202=221.3
PI204 (B2/B3)= 668.8           TW103=293.8    TW203=271.4
PI204 (B3/B4)= 657.5           TW104=316.5    TW204=298.2
PI204 (B4/B5)= 642.0           TW105=344.6    TW205=316.4
PI204 (B5/B6)= 620.8           TW106=333.0    TW206=313.8
PI204 (B6-OUT)=602.2           TW107=300.0    TW207=310.7

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HEATER TEST DATA RUN HTR-27   DATE 1-DEC-80   TIME 15-45

C3 (MOLE C/C)= .47 N-C4=2.00 I-C4=75.77 N-C5=1.02 I-C5=20.74

NUM OF EXCHANGERS=4

PI108 (B6-IN)= 275.2 (PSIA)   BR FLOW RATE (LBS/HR)= 97188.1
PI108 (B4/B3)= 271.3   HC FLOW RATE (LBS/HR)= 86990.0
PI108 (B1-OUT)=263.1

PI204 (B1-IN)= 689.8 (PSIA)   TW101=203.6   TW201=120.2 (DEG-F)
PI204 (B1/B2)= 681.1   TW102=261.0   TW202=221.6
PI204 (B2/B3)= 669.5   TW103=293.7   TW203=271.3
PI204 (B3/B4)= 657.5   TW104=316.8   TW204=298.9
PI204 (B4/B5)= 641.6   TW105=344.7   TW205=317.4
PI204 (B5/B6)= 621.2   TW106=327.6   TW206=314.0
PI204 (B6-OUT)=602.6   TW107=300.6   TW207=311.0

HEATER TEST DATA RUN HTR-27   DATE 1-DEC-80   TIME 16-00

C3 (MOLE C/C)= .47 N-C4=2.00 I-C4=75.77 N-C5=1.02 I-C5=20.74

NUM OF EXCHANGERS=4

PI108 (B6-IN)= 275.4 (PSIA)   BR FLOW RATE (LBS/HR)= 97184.7
PI108 (B4/B3)= 271.5   HC FLOW RATE (LBS/HR)= 86981.2
PI108 (B1-OUT)=263.0

PI204 (B1-IN)= 690.5 (PSIA)   TW101=203.8   TW201=120.3 (DEG-F)
PI204 (B1/B2)= 682.3   TW102=260.9   TW202=221.5
PI204 (B2/B3)= 670.5   TW103=293.8   TW203=271.3
PI204 (B3/B4)= 659.0   TW104=316.8   TW204=298.8
PI204 (B4/B5)= 643.1   TW105=345.2   TW205=317.6
PI204 (B5/B6)= 622.0   TW106=322.6   TW206=314.0
PI204 (B6-OUT)=603.5   TW107=300.8   TW207=310.8

HEATER TEST DATA RUN HTR-27   DATE 1-DEC-80   TIME 16-15

C3 (MOLE C/C)= .47 N-C4=2.00 I-C4=75.77 N-C5=1.02 I-C5=20.74

NUM OF EXCHANGERS=4

PI108 (B6-IN)= 275.0 (PSIA)   BR FLOW RATE (LBS/HR)= 97184.6
PI108 (B4/B3)= 271.5   HC FLOW RATE (LBS/HR)= 85600.8
PI108 (B1-OUT)=262.9

PI204 (B1-IN)= 291.1 (PSIA)   TW101=203.8   TW201=120.4 (DEG-F)
PI204 (B1/B2)= 683.0   TW102=261.0   TW202=221.7
PI204 (B2/B3)= 671.1   TW103=294.0   TW203=271.6
PI204 (B3/B4)= 659.5   TW104=317.0   TW204=299.0
PI204 (B4/B5)= 643.5   TW105=345.2   TW205=317.8
PI204 (B5/B6)= 622.5   TW106=317.4   TW206=314.2
PI204 (B6-OUT)=604.5   TW107=301.4   TW207=311.2

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HEATER TEST DATA RUN HTR-28   DATE 2-DEC-80   TIME 07-00

C3 (MOLE C/C)= .47  N-C4=2.00  I-C4=75.77  N-C5=1.02  I-C5=20.74

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 274.0 (PSIA)     BR FLOW RATE (LBS/HR)= 85546.7
PI108 (B4/B3)= 266.5            HC FLOW RATE (LBS/HR)= 71900.8
PI108 (B1-OUT)=259.6

PI204 (B1-IN)= 653.9 (PSIA)     TW101=201.5    TW201=124.9 (DEG-F)
PI204 (B1/B2)= 648.2            TW102=251.5    TW202=218.7
PI204 (B2/B3)= 640.6            TW103=277.9    TW203=261.0
PI204 (B3/B4)= 633.3            TW104=292.1    TW204=281.7
PI204 (B4/B5)= 624.8            TW105=303.8    TW205=294.5
PI204 (B5/B6)= 615.5            TW106=316.4    TW206=305.0
PI204 (B6-OUT)=603.9            TW107=342.0    TW207=316.2
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HEATER TEST DATA RUN HTR-28   DATE 2-DEC-80   TIME 07-15

C3 (MOLE C/C)= .47  N-C4=2.00  I-C4=75.77  N-C5=1.02  I-C5=20.74

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 273.6 (PSIA)     BR FLOW RATE (LBS/HR)= 85611.3
PI108 (B4/B3)= 266.3            HC FLOW RATE (LBS/HR)= 71305.9
PI108 (B1-OUT)=260.0

PI204 (B1-IN)= 652.4 (PSIA)     TW101=201.4    TW201=125.4 (DEG-F)
PI204 (B1/B2)= 647.0            TW102=251.8    TW202=219.1
PI204 (B2/B3)= 639.5            TW103=277.5    TW203=260.8
PI204 (B3/B4)= 632.5            TW104=292.4    TW204=281.9
PI204 (B4/B5)= 624.4            TW105=303.8    TW205=294.5
PI204 (B5/B6)= 615.1            TW106=317.0    TW206=304.8
PI204 (B6-OUT)=603.6            TW107=341.8    TW207=316.5
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HEATER TEST DATA RUN HTR-28   DATE 2-DEC-80   TIME 07-30

C3 (MOLE C/C)= .47  N-C4=2.00  I-C4=75.77  N-C5=1.02  I-C5=20.74

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 273.9 (PSIA)     BR FLOW RATE (LBS/HR)= 85612.7
PI108 (B4/B3)= 266.2            HC FLOW RATE (LBS/HR)= 72951.8
PI108 (B1-OUT)=259.6

PI204 (B1-IN)= 655.3 (PSIA)     TW101=201.3    TW201=125.4 (DEG-F)
PI204 (B1/B2)= 649.1            TW102=251.0    TW202=218.4
PI204 (B2/B3)= 641.2            TW103=276.8    TW203=260.0
PI204 (B3/B4)= 633.5            TW104=291.7    TW204=281.1
PI204 (B4/B5)= 624.5            TW105=303.4    TW205=294.0
PI204 (B5/B6)= 615.0            TW106=316.4    TW206=304.6
PI204 (B6-OUT)=603.0            TW107=342.0    TW207=316.4
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HEATER TEST DATA RUN HTR-28   DATE 2-DEC-80   TIME 07-45

C3 (MOLE C/C)= .47  N-C4=2.00  I-C4=75.77  N-C5=1.02  I-C5=20.74

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 273.5 (PSIA)    BR FLOW RATE (LBS/HR)= 85611.2
PI108 (B4/B3)= 266.0           HC FLOW RATE (LBS/HR)= 72994.1
PI108 (B1-OUT)=259.5

PI204 (B1-IN)= 655.0 (PSIA)    TW101=201.4    TW201=127.9 (DEG-F)
PI204 (B1/B2)= 648.8           TW102=250.8    TW202=218.4
PI204 (B2/B3)= 640.4           TW103=276.6    TW203=259.9
PI204 (B3/B4)= 633.0           TW104=291.5    TW204=280.9
PI204 (B4/B5)= 624.1           TW105=303.2    TW205=293.8
PI204 (B5/B6)= 614.5           TW106=316.4    TW206=304.6
PI204 (B6-OUT)=602.5           TW107=342.4    TW207=316.6

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HEATER TEST DATA RUN HTR-28   DATE 2-DEC-80   TIME 08-00

C3 (MOLE C/C)= .47  N-C4=2.00  I-C4=75.77  N-C5=1.02  I-C5=20.74

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 273.4 (PSIA)    BR FLOW RATE (LBS/HR)= 85608.2
PI108 (B4/B3)= 265.6           HC FLOW RATE (LBS/HR)= 73192.3
PI108 (B1-OUT)=259.2

PI204 (B1-IN)= 655.0 (PSIA)    TW101=201.6    TW201=128.7 (DEG-F)
PI204 (B1/B2)= 649.0           TW102=250.7    TW202=218.5
PI204 (B2/B3)= 640.6           TW103=276.5    TW203=259.8
PI204 (B3/B4)= 633.0           TW104=291.4    TW204=280.8
PI204 (B4/B5)= 624.0           TW105=303.3    TW205=293.7
PI204 (B5/B6)= 614.2           TW106=316.5    TW206=304.6
PI204 (B6-OUT)=602.3           TW107=343.0    TW207=316.8

-------------------------------------------------------------------

HEATER TEST DATA RUN HTR-28   DATE 2-DEC-80   TIME 08-15

C3 (MOLE C/C)= .47  N-C4=2.00  I-C4=75.77  N-C5=1.02  I-C5=20.74

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 273.4 (PSIA)    BR FLOW RATE (LBS/HR)= 85602.2
PI108 (B4/B3)= 265.7           HC FLOW RATE (LBS/HR)= 73145.8
PI108 (B1-OUT)=259.1

PI204 (B1-IN)= 655.0 (PSIA)    TW101=202.0    TW201=129.2 (DEG-F)
PI204 (B1/B2)= 649.1           TW102=251.0    TW202=218.9
PI204 (B2/B3)= 640.7           TW103=276.8    TW203=260.1
PI204 (B3/B4)= 633.3           TW104=291.6    TW204=280.9
PI204 (B4/B5)= 624.4           TW105=303.3    TW205=293.9
PI204 (B5/B6)= 614.7           TW106=316.6    TW206=304.8
PI204 (B6-OUT)=602.7           TW107=342.6    TW207=316.6

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HEATER TEST DATA RUN HTR-29 DATE 2-DEC-80 TIME 09-00

C3 (MOLE C/C)= .47 N-C4=2.00 I-C4=75.77 N-C5=1.02 I-C5=20.74

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 272.6 (PSIA) BR FLOW RATE (LBS/HR)= 85994.0
PI108 (B4/B3)= 265.0 HC FLOW RATE (LBS/HR)= 52956.4
PI108 (B1-OUT)=258.2

PI204 (B1-IN)= 635.5 (PSIA) TW101=229.6 TW201=129.7 (DEG-F)
PI204 (B1/B2)= 632.5 TW102=278.0 TW202=248.9
PI204 (B2/B3)= 627.6 TW103=296.5 TW203=285.3
PI204 (B3/B4)= 623.1 TW104=305.2 TW204=299.0
PI204 (B4/B5)= 617.3 TW105=315.2 TW205=306.8
PI204 (B5/B6)= 610.0 TW106=330.4 TW206=316.3
PI204 (B6-OUT)=600.5 TW107=343.4 TW207=333.6

HEATER TEST DATA RUN HTR-29 DATE 2-DEC-80 TIME 09-15

C3 (MOLE C/C)= .47 N-C4=2.00 I-C4=75.77 N-C5=1.02 I-C5=20.74

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 272.6 (PSIA) BR FLOW RATE (LBS/HR)= 86000.9
PI108 (B4/B3)= 265.0 HC FLOW RATE (LBS/HR)= 53513.4
PI108 (B1-OUT)=258.3

PI204 (B1-IN)= 635.6 (PSIA) TW101=229.2 TW201=129.5 (DEG-F)
PI204 (B1/B2)= 630.9 TW102=277.9 TW202=248.8
PI204 (B2/B3)= 625.5 TW103=296.3 TW203=285.2
PI204 (B3/B4)= 620.5 TW104=306.2 TW204=298.9
PI204 (B4/B5)= 614.6 TW105=315.2 TW205=306.8
PI204 (B5/B6)= 607.0 TW106=330.8 TW206=316.2
PI204 (B6-OUT)=597.3 TW107=343.5 TW207=334.2

HEATER TEST DATA RUN HTR-29 DATE 2-DEC-80 TIME 09-30

C3 (MOLE C/C)= .47 N-C4=2.00 I-C4=75.77 N-C5=1.02 I-C5=20.74

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 272.6 (PSIA) BR FLOW RATE (LBS/HR)= 86410.4
PI108 (B4/B3)= 265.0 HC FLOW RATE (LBS/HR)= 53208.5
PI108 (B1-OUT)=258.1

PI204 (B1-IN)= 634.1 (PSIA) TW101=229.4 TW201=130.0 (DEG-F)
PI204 (B1/B2)= 630.9 TW102=277.9 TW202=248.8
PI204 (B2/B3)= 626.0 TW103=296.3 TW203=285.1
PI204 (B3/B4)= 621.5 TW104=305.9 TW204=298.9
PI204 (B4/B5)= 615.9 TW105=315.2 TW205=306.7
PI204 (B5/B6)= 608.0 TW106=330.7 TW206=316.4
PI204 (B6-OUT)=596.5 TW107=343.6 TW207=334.7

HEATER TEST DATA RUN HTR-29   DATE 2-DEC-80   TIME 09-45

C3 (MOLE C/C)= .47 N-C4=2.00 I-C4=75.77 N-C5=1.02 I-C5=20.74

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 272.4 (PSIA)   BR FLOW RATE (LBS/HR)= 86408.7
PI108 (B4/B3)= 264.6   HC FLOW RATE (LBS/HR)= 53200.8
PI108 (B1-OUT)=258.0

PI204 (B1-IN)= 635.5 (PSIA)   TW101=229.5   TW201=130.1 (DEG-F)
PI204 (B1/B2)= 633.0   TW102=278.0   TW202=248.8
PI204 (B2/B3)= 627.5   TW103=296.3   TW203=285.1
PI204 (B3/B4)= 622.9   TW104=306.0   TW204=298.9
PI204 (B4/B5)= 616.0   TW105=315.2   TW205=306.8
PI204 (B5/B6)= 608.0   TW106=330.9   TW206=316.7
PI204 (B6-OUT)=597.7   TW107=343.8   TW207=335.2

HEATER TEST DATA RUN HTR-29   DATE 2-DEC-80   TIME 10-00

C3 (MOLE C/C)= .47 N-C4=2.00 I-C4=75.77 N-C5=1.02 I-C5=20.74

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 272.0 (PSIA)   BR FLOW RATE (LBS/HR)= 86400.0
PI108 (B4/B3)= 264.5   HC FLOW RATE (LBS/HR)= 52357.9
PI108 (B1-OUT)=257.8

PI204 (B1-IN)= 632.5 (PSIA)   TW101=230.0   TW201=130.3 (DEG-F)
PI204 (B1/B2)= 628.5   TW102=278.1   TW202=249.0
PI204 (B2/B3)= 624.4   TW103=296.5   TW203=285.2
PI204 (B3/B4)= 621.0   TW104=306.0   TW204=298.7
PI204 (B4/B5)= 616.1   TW105=315.2   TW205=306.9
PI204 (B5/B6)= 609.7   TW106=331.2   TW206=316.8
PI204 (B6-OUT)=600.2   TW107=344.0   TW207=335.1

HEATER TEST DATA RUN HTR-29   DATE 2-DEC-80   TIME 10-15

C3 (MOLE C/C)= .47 N-C4=2.00 I-C4=75.77 N-C5=1.02 I-C5=20.74

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 271.5 (PSIA)   BR FLOW RATE (LBS/HR)= 86406.8
PI108 (B4/B3)= 263.5   HC FLOW RATE (LBS/HR)= 53157.2
PI108 (B1-OUT)=257.0

PI204 (B1-IN)= 634.0 (PSIA)   TW101=229.6   TW201=130.7 (DEG-F)
PI204 (B1/B2)= 629.6   TW102=278.1   TW202=249.3
PI204 (B2/B3)= 624.5   TW103=296.3   TW203=285.2
PI204 (B3/B4)= 619.5   TW104=306.2   TW204=299.0
PI204 (B4/B5)= 614.0   TW105=315.4   TW205=307.0
PI204 (B5/B6)= 606.2   TW106=331.5   TW206=317.2
PI204 (B6-OUT)=597.0   TW107=344.4   TW207=335.2

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HEATER TEST DATA RUN HTR-30   DATE 2-DEC-80   TIME 11-15

C3 (MOLE C/C)= .47  N-C4=2.00  I-C4=75.77  N-C5=1.02  I-C5=20.74

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 277.6 (PSIA)    BR FLOW RATE (LBS/HR)= 96251.1
PI108 (B4/B3)= 268.3           HC FLOW RATE (LBS/HR)= 93722.4
PI108 (B1-OUT)=259.9

PI204 (B1-IN)= 657.0 (PSIA)    TW101=192.7    TW201=134.5 (DEG-F)
PI204 (B1/B2)= 647.2           TW102=236.1    TW202=204.8
PI204 (B2/B3)= 634.2           TW103=263.0    TW203=244.0
PI204 (B3/B4)= 622.5           TW104=280.5    TW204=267.0
PI204 (B4/B5)= 609.8           TW105=294.3    TW205=282.9
PI204 (B5/B6)= 593.6           TW106=310.4    TW206=296.2
PI204 (B6-OUT)=575.1           TW107=344.4    TW207=307.2
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HEATER TEST DATA RUN HTR-30   DATE 2-DEC-80   TIME 11-30

C3 (MOLE C/C)= .47  N-C4=2.00  I-C4=75.77  N-C5=1.02  I-C5=20.74

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 277.5 (PSIA)    BR FLOW RATE (LBS/HR)= 96438.5
PI108 (B4/B3)= 268.2           HC FLOW RATE (LBS/HR)= 93978.4
PI108 (B1-OUT)=260.0

PI204 (B1-IN)= 656.4 (PSIA)    TW101=192.7    TW201=134.6 (DEG-F)
PI204 (B1/B2)= 646.6           TW102=236.1    TW202=204.8
PI204 (B2/B3)= 633.6           TW103=263.0    TW203=244.0
PI204 (B3/B4)= 621.5           TW104=280.6    TW204=267.2
PI204 (B4/B5)= 607.5           TW105=294.3    TW205=283.1
PI204 (B5/B6)= 592.6           TW106=310.2    TW206=296.2
PI204 (B6-OUT)=574.3           TW107=344.6    TW207=307.1
---------------------------------------------------------------------------

HEATER TEST DATA RUN HTR-30   DATE 2-DEC-80   TIME 11-45

C3 (MOLE C/C)= .47  N-C4=2.00  I-C4=75.77  N-C5=1.02  I-C5=20.74

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 277.3 (PSIA)    BR FLOW RATE (LBS/HR)= 96436.8
PI108 (B4/B3)= 268.1           HC FLOW RATE (LBS/HR)= 93942.2
PI108 (B1-OUT)=259.8

PI204 (B1-IN)= 656.5 (PSIA)    TW101=192.8    TW201=134.9 (DEG-F)
PI204 (B1/B2)= 647.0           TW102=236.0    TW202=204.7
PI204 (B2/B3)= 633.7           TW103=263.0    TW203=244.1
PI204 (B3/B4)= 621.5           TW104=280.5    TW204=267.0
PI204 (B4/B5)= 607.7           TW105=294.3    TW205=283.1
PI204 (B5/B6)= 593.0           TW106=310.2    TW206=296.1
PI204 (B6-OUT)=574.6           TW107=344.6    TW207=307.0
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HEATER TEST DATA RUN HTR-30   DATE 2-DEC-80   TIME 12-00

C3 (MOLE C/C)= .47  N-C4=2.00  I-C4=75.77  N-C5=1.02  I-C5=20.74

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 277.5 (PSIA)    BR FLOW RATE (LBS/HR)= 96807.3
PI108 (B4/B3)= 268.2           HC FLOW RATE (LBS/HR)= 93695.0
PI108 (B1-OUT)=260.0

PI204 (B1-IN)= 656.0 (PSIA)    TW101=193.0    TW201=134.7 (DEG-F)
PI204 (B1/B2)= 646.3           TW102=236.3    TW202=204.9
PI204 (B2/B3)= 633.6           TW103=263.2    TW203=244.3
PI204 (B3/B4)= 621.7           TW104=280.6    TW204=267.2
PI204 (B4/B5)= 608.0           TW105=294.4    TW205=283.3
PI204 (B5/B6)= 593.0           TW106=310.2    TW206=296.3
PI204 (B6-OUT)=574.5           TW107=344.6    TW207=307.2
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HEATER TEST DATA RUN HTR-30   DATE 2-DEC-80   TIME 12-15

C3 (MOLE C/C)= .47  N-C4=2.00  I-C4=75.77  N-C5=1.02  I-C5=20.74

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 277.5 (PSIA)    BR FLOW RATE (LBS/HR)= 96807.2
PI108 (B4/B3)= 267.8           HC FLOW RATE (LBS/HR)= 93940.6
PI108 (B1-OUT)=259.8

PI204 (B1-IN)= 656.0 (PSIA)    TW101=193.0    TW201=134.9 (DEG-F)
PI204 (B1/B2)= 646.1           TW102=236.4    TW202=205.0
PI204 (B2/B3)= 633.0           TW103=263.2    TW203=244.2
PI204 (B3/B4)= 621.0           TW104=280.7    TW204=267.4
PI204 (B4/B5)= 606.9           TW105=294.3    TW205=283.1
PI204 (B5/B6)= 592.4           TW106=310.2    TW206=296.1
PI204 (B6-OUT)=574.0           TW107=344.8    TW207=307.0
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HEATER TEST DATA RUN HTR-30   DATE 2-DEC-80   TIME 12-30

C3 (MOLE C/C)= .47  N-C4=2.00  I-C4=75.77  N-C5=1.02  I-C5=20.74

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 277.4 (PSIA)    BR FLOW RATE (LBS/HR)= 96617.3
PI108 (B4/B3)= 267.9           HC FLOW RATE (LBS/HR)= 93644.8
PI108 (B1-OUT)=259.6

PI204 (B1-IN)= 655.5 (PSIA)    TW101=193.2    TW201=135.1 (DEG-F)
PI204 (B1/B2)= 646.0           TW102=236.3    TW202=205.0
PI204 (B2/B3)= 632.8           TW103=263.1    TW203=244.3
PI204 (B3/B4)= 621.0           TW104=280.6    TW204=267.2
PI204 (B4/B5)= 606.7           TW105=294.3    TW205=283.1
PI204 (B5/B6)= 592.0           TW106=310.2    TW206=296.1
PI204 (B6-OUT)=573.6           TW107=344.8    TW207=307.0
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HEATER TEST DATA RUN HTR-31   DATE 2-DEC-80   TIME 13-15

C3 (MOLE O/O)= .47  N-C4=2.00  I-C4=75.77  N-C5=1.02  I-C5=20.74

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 277.1 (PSIA)    BR FLOW RATE (LBS/HR)= 96521.5
PI108 (B4/B3)= 267.8           HC FLOW RATE (LBS/HR)= 75494.8
PI108 (B1-OUT)=259.5

PI204 (B1-IN)= 634.9 (PSIA)    TW101=209.9    TW201=132.5 (DEG-F)
PI204 (B1/B2)= 629.0           TW102=256.7    TW202=225.4
PI204 (B2/B3)= 620.0           TW103=279.7    TW203=264.0
PI204 (B3/B4)= 611.6           TW104=292.3    TW204=282.9
PI204 (B4/B5)= 601.7           TW105=302.6    TW205=293.8
PI204 (B5/B6)= 590.9           TW106=316.3    TW206=302.4
PI204 (B6-OUT)=574.7           TW107=344.9    TW207=318.8
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HEATER TEST DATA RUN HTR-31   DATE 2-DEC-80   TIME 13-30

C3 (MOLE O/O)= .47  N-C4=2.00  I-C4=75.77  N-C5=1.02  I-C5=20.74

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 277.2 (PSIA)    BR FLOW RATE (LBS/HR)= 96516.3
PI108 (B4/B3)= 267.9           HC FLOW RATE (LBS/HR)= 74964.3
PI108 (B1-OUT)=259.6

PI204 (B1-IN)= 635.3 (PSIA)    TW101=210.2    TW201=132.4 (DEG-F)
PI204 (B1/B2)= 629.4           TW102=257.1    TW202=225.8
PI204 (B2/B3)= 620.6           TW103=280.1    TW203=265.0
PI204 (B3/B4)= 612.3           TW104=292.6    TW204=283.2
PI204 (B4/B5)= 602.8           TW105=302.9    TW205=294.1
PI204 (B5/B6)= 591.8           TW106=316.6    TW206=302.7
PI204 (B6-OUT)=575.7           TW107=345.0    TW207=319.1
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HEATER TEST DATA RUN HTR-31   DATE 2-DEC-80   TIME 13-45

C3 (MOLE O/O)= .47  N-C4=2.00  I-C4=75.77  N-C5=1.02  I-C5=20.74

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 277.1 (PSIA)    BR FLOW RATE (LBS/HR)= 96516.3
PI108 (B4/B3)= 267.8           HC FLOW RATE (LBS/HR)= 74954.4
PI108 (B1-OUT)=259.6

PI204 (B1-IN)= 635.2 (PSIA)    TW101=210.2    TW201=132.5 (DEG-F)
PI204 (B1/B2)= 629.3           TW102=256.2    TW202=225.9
PI204 (B2/B3)= 620.7           TW103=280.1    TW203=265.0
PI204 (B3/B4)= 612.0           TW104=292.7    TW204=283.3
PI204 (B4/B5)= 602.3           TW105=302.8    TW205=294.1
PI204 (B5/B6)= 591.5           TW106=316.6    TW206=302.6
PI204 (B6-OUT)=575.7           TW107=345.0    TW207=319.0
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HEATER TEST DATA RUN HTR-31   DATE 2-DEC-80   TIME 14-00

C3 (MOLE O/O)= .47  N-C4=2.00  I-C4=75.77  N-C5=1.02  I-C5=20.74

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 277.0 (PSIA)    BR FLOW RATE (LBS/HR)= 96518.0
PI108 (B4/B3)= 267.9           HC FLOW RATE (LBS/HR)= 74933.8
PI108 (B1-OUT)=259.5

PI204 (B1-IN)= 634.7 (PSIA)    TW101=210.1    TW201=132.7 (DEG-F)
PI204 (B1/B2)= 628.7           TW102=256.6    TW202=225.7
PI204 (B2/B3)= 620.2           TW103=280.0    TW203=264.9
PI204 (B3/B4)= 611.6           TW104=292.4    TW204=283.0
PI204 (B4/B5)= 602.2           TW105=302.6    TW205=294.0
PI204 (B5/B6)= 591.4           TW106=316.2    TW206=302.4
PI204 (B6-OUT)=575.9           TW107=345.0    TW207=318.8

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HEATER TEST DATA RUN HTR-31   DATE 2-DEC-80   TIME 14-15

C3 (MOLE O/O)= .47  N-C4=2.00  I-C4=75.77  N-C5=1.02  I-C5=20.74

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 277.0 (PSIA)    BR FLOW RATE (LBS/HR)= 96509.2
PI108 (B4/B3)= 267.8           HC FLOW RATE (LBS/HR)= 75097.8
PI108 (B1-OUT)=259.6

PI204 (B1-IN)= 634.9 (PSIA)    TW101=210.6    TW201=133.8 (DEG-F)
PI204 (B1/B2)= 629.0           TW102=257.1    TW202=226.0
PI204 (B2/B3)= 620.3           TW103=279.9    TW203=264.9
PI204 (B3/B4)= 611.7           TW104=292.5    TW204=283.1
PI204 (B4/B5)= 602.2           TW105=302.6    TW205=293.9
PI204 (B5/B6)= 591.0           TW106=316.4    TW206=302.4
PI204 (B6-OUT)=575.3           TW107=345.0    TW207=319.0

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HEATER TEST DATA RUN HTR-31   DATE 2-DEC-80   TIME 14-30

C3 (MOLE O/O)= .47  N-C4=2.00  I-C4=75.77  N-C5=1.02  I-C5=20.74

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 277.4 (PSIA)    BR FLOW RATE (LBS/HR)= 96505.7
PI108 (B4/B3)= 268.1           HC FLOW RATE (LBS/HR)= 75078.0
PI108 (B1-OUT)=259.8

PI204 (B1-IN)= 634.8 (PSIA)    TW101=210.8    TW201=134.0 (DEG-F)
PI204 (B1/B2)= 629.0           TW102=257.5    TW202=226.4
PI204 (B2/B3)= 620.3           TW103=280.2    TW203=265.2
PI204 (B3/B4)= 611.6           TW104=292.7    TW204=283.4
PI204 (B4/B5)= 602.3           TW105=302.6    TW205=294.1
PI204 (B5/B6)= 591.2           TW106=316.9    TW206=302.6
PI204 (B6-OUT)=575.5           TW107=344.4    TW207=318.2

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HEATER TEST DATA RUN HTR-32 DATE 3-DEC-80 TIME 07-00

C3 (MOLE C/C)= .47 N-C4=2.00 I-C4=75.77 N-C5=1.02 I-C5=20.74

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 274.1 (PSIA)	BR FLOW RATE (LBS/HR)= 85698.4
PI108 (B4/B3)= 266.7	HC FLOW RATE (LBS/HR)= 55222.3
PI108 (B1-OUT)=260.0	

PI204 (B1-IN)= 613.0 (PSIA)	TW101=222.5	TW201=127.8 (DEG-F)
PI204 (B1/B2)= 609.7	TW102=270.4	TW202=241.3
PI204 (B2/B3)= 604.4	TW103=288.4	TW203=277.9
PI204 (B3/B4)= 599.7	TW104=298.7	TW204=292.1
PI204 (B4/B5)= 593.7	TW105=307.8	TW205=299.8
PI204 (B5/B6)= 585.9	TW106=324.3	TW206=307.4
PI204 (B6-OUT)=575.0	TW107=342.2	TW207=328.4

HEATER TEST DATA RUN HTR-32 DATE 3-DEC-80 TIME 07-15

C3 (MOLE C/C)= .47 N-C4=2.00 I-C4=75.77 N-C5=1.02 I-C5=20.74

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 274.0 (PSIA)	BR FLOW RATE (LBS/HR)= 85701.8
PI108 (B4/B3)= 267.0	HC FLOW RATE (LBS/HR)= 55440.6
PI108 (B1-OUT)=260.0	

PI204 (B1-IN)= 612.7 (PSIA)	TW101=222.3	TW201=128.6 (DEG-F)
PI204 (B1/B2)= 609.5	TW102=270.2	TW202=241.0
PI204 (B2/B3)= 604.0	TW103=289.0	TW203=277.6
PI204 (B3/B4)= 599.0	TW104=298.7	TW204=291.8
PI204 (B4/B5)= 593.4	TW105=307.5	TW205=299.5
PI204 (B5/B6)= 585.5	TW106=324.1	TW206=306.9
PI204 (B6-OUT)=574.4	TW107=342.3	TW207=329.0

HEATER TEST DATA RUN HTR-32 DATE 3-DEC-80 TIME 07-30

C3 (MOLE C/C)= .47 N-C4=2.00 I-C4=75.77 N-C5=1.02 I-C5=20.74

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 273.9 (PSIA)	BR FLOW RATE (LBS/HR)= 85809.1
PI108 (B4/B3)= 266.5	HC FLOW RATE (LBS/HR)= 55886.0
PI108 (B1-OUT)=259.8	

PI204 (B1-IN)= 612.0 (PSIA)	TW101=222.1	TW201=129.9 (DEG-F)
PI204 (B1/B2)= 608.4	TW102=269.6	TW202=240.5
PI204 (B2/B3)= 603.0	TW103=288.5	TW203=277.0
PI204 (B3/B4)= 598.1	TW104=298.1	TW204=291.3
PI204 (B4/B5)= 592.1	TW105=307.0	TW205=299.0
PI204 (B5/B6)= 584.5	TW106=324.4	TW206=306.5
PI204 (B6-OUT)=573.2	TW107=342.8	TW207=329.2

HEATER TEST DATA RUN HTR-32   DATE 3-DEC-80   TIME 07-45

C3 (MOLE C/C)= .47 N-C4=2.00 I-C4=75.77 N-C5=1.02 I-C5=20.74

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 273.6 (PSIA)   BR FLOW RATE (LBS/HR)= 86109.0
PI108 (B4/B3)= 266.1   HC FLOW RATE (LBS/HR)= 55877.7
PI108 (B1-OUT)=259.5

PI204 (B1-IN)= 611.4 (PSIA)	TW101=222.8	TW201=130.0 (DEG-F)
PI204 (B1/B2)= 608.3	TW102=269.8	TW202=241.0
PI204 (B2/B3)= 603.1	TW103=288.9	TW203=277.4
PI204 (B3/B4)= 598.5	TW104=298.3	TW204=291.5
PI204 (B4/B5)= 592.6	TW105=307.4	TW205=299.3
PI204 (B5/B6)= 584.9	TW106=324.9	TW206=307.0
PI204 (B6-OUT)=573.9	TW107=343.5	TW207=330.4

HEATER TEST DATA RUN HTR-32   DATE 3-DEC-80   TIME 08-00

C3 (MOLE C/C)= .47 N-C4=2.00 I-C4=75.77 N-C5=1.02 I-C5=20.74

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 273.6 (PSIA)   BR FLOW RATE (LBS/HR)= 86107.3
PI108 (B4/B3)= 266.0   HC FLOW RATE (LBS/HR)= 55878.3
PI108 (B1-OUT)=259.4

PI204 (B1-IN)= 611.7 (PSIA)	TW101=222.9	TW201=130.0 (DEG-F)
PI204 (B1/B2)= 608.0	TW102=270.1	TW202=241.2
PI204 (B2/B3)= 603.6	TW103=289.0	TW203=277.6
PI204 (B3/B4)= 597.8	TW104=298.4	TW204=291.6
PI204 (B4/B5)= 592.0	TW105=307.8	TW205=299.4
PI204 (B5/B6)= 564.0	TW106=325.0	TW206=307.2
PI204 (B6-OUT)=572.9	TW107=342.9	TW207=329.8

HEATER TEST DATA RUN HTR-32   DATE 3-DEC-80   TIME 08-15

C3 (MOLE C/C)= .47 N-C4=2.00 I-C4=75.77 N-C5=1.02 I-C5=20.74

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 273.6 (PSIA)   BR FLOW RATE (LBS/HR)= 86102.3
PI108 (B4/B3)= 265.8   HC FLOW RATE (LBS/HR)= 55842.9
PI108 (B1-OUT)=259.3

PI204 (B1-IN)= 612.0 (PSIA)	TW101=223.2	TW201=130.5 (DEG-F)
PI204 (B1/B2)= 608.7	TW102=270.4	TW202=241.6
PI204 (B2/B3)= 603.3	TW103=289.2	TW203=277.8
PI204 (B3/B4)= 598.3	TW104=298.6	TW204=291.8
PI204 (B4/B5)= 592.5	TW105=307.8	TW205=299.5
PI204 (B5/B6)= 584.7	TW106=325.1	TW206=307.4
PI204 (B6-OUT)=573.3	TW107=343.2	TW207=330.7

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HEATER TEST DATA RUN HTR-33   DATE 3-DEC-80   TIME 09-00

C3 (MOLE C/C)= .47  N-C4=2.00  I-C4=75.77  N-C5=1.02  I-C5=20.74

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 242.5 (PSIA)     BR FLOW RATE (LBS/HR)=100593.1
PI108 (B4/B3)= 231.6            HC FLOW RATE (LBS/HR)= 96737.6
PI108 (B1-OUT)=223.0

PI204 (B1-IN)= 637.5 (PSIA)     TW101=195.8    TW201=140.0 (DEG-F)
PI204 (B1/B2)= 627.3            TW102=237.0    TW202=207.0
PI204 (B2/B3)= 613.5            TW103=262.4    TW203=244.2
PI204 (B3/B4)= 600.8            TW104=279.1    TW204=266.6
PI204 (B4/B5)= 586.0            TW105=292.0    TW205=281.4
PI204 (B5/B6)= 570.3            TW106=307.6    TW206=293.5
PI204 (B6-OUT)=549.5            TW107=344.2    TW207=302.1

---------------------------------------------------------------------

HEATER TEST DATA RUN HTR-33   DATE 3-DEC-80   TIME 09-15

C3 (MOLE C/C)= .47  N-C4=2.00  I-C4=75.77  N-C5=1.02  I-C5=20.74

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 242.5 (PSIA)     BR FLOW RATE (LBS/HR)=100586.2
PI108 (B4/B3)= 231.7            HC FLOW RATE (LBS/HR)= 96412.7
PI108 (B1-OUT)=223.0

PI204 (B1-IN)= 637.7 (PSIA)     TW101=196.2    TW201=140.5 (DEG-F)
PI204 (B1/B2)= 627.2            TW102=237.4    TW202=207.4
PI204 (B2/B3)= 613.5            TW103=262.6    TW203=244.4
PI204 (B3/B4)= 600.7            TW104=279.3    TW204=266.7
PI204 (B4/B5)= 585.7            TW105=292.2    TW205=281.4
PI204 (B5/B6)= 570.1            TW106=307.6    TW206=293.5
PI204 (B6-OUT)=549.2            TW107=344.3    TW207=302.4

---------------------------------------------------------------------

HEATER TEST DATA RUN HTR-33   DATE 3-DEC-80   TIME 09-30

C3 (MOLE C/C)= .47  N-C4=2.00  I-C4=75.77  N-C5=1.02  I-C5=20.74

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 242.4 (PSIA)     BR FLOW RATE (LBS/HR)=100761.8
PI108 (B4/B3)= 231.5            HC FLOW RATE (LBS/HR)= 96366.1
PI108 (B1-OUT)=222.7

PI204 (B1-IN)= 637.2 (PSIA)     TW101=196.4    TW201=140.8 (DEG-F)
PI204 (B1/B2)= 627.1            TW102=237.6    TW202=207.7
PI204 (B2/B3)= 613.3            TW103=262.7    TW203=244.6
PI204 (B3/B4)= 600.5            TW104=279.4    TW204=266.8
PI204 (B4/B5)= 585.6            TW105=292.2    TW205=281.5
PI204 (B5/B6)= 570.2            TW106=307.6    TW206=293.5
PI204 (B6-OUT)=549.0            TW107=344.6    TW207=302.7

---------------------------------------------------------------------
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```
HEATER TEST DATA RUN HTR-33   DATE 3-DEC-80   TIME 09-45

C3 (MOLE C/C)= .47  N-C4=2.00  I-C4=75.77  N-C5=1.02  I-C5=20.74

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 242.0 (PSIA)    BR FLOW RATE (LBS/HR)=100311.8
PI108 (B4/B3)= 231.3           HC FLOW RATE (LBS/HR)= 96376.5
PI108 (B1-OUT)=222.5

PI204 (B1-IN)= 636.5 (PSIA)    TW101=196.5     TW201=140.7 (DEG-F)
PI204 (B1/B2)= 626.0           TW102=237.8     TW202=207.9
PI204 (B2/B3)= 612.5           TW103=262.8     TW203=244.8
PI204 (B3/B4)= 600.6           TW104=279.5     TW204=267.0
PI204 (B4/B5)= 584.6           TW105=292.2     TW205=281.5
PI204 (B5/B6)= 569.3           TW106=307.6     TW206=293.5
PI204 (B6-OUT)=548.1           TW107=344.4     TW207=302.7
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```
HEATER TEST DATA RUN HTR-33   DATE 3-DEC-80   TIME 10-00

C3 (MOLE C/C)= .47  N-C4=2.00  I-C4=75.77  N-C5=1.02  I-C5=20.74

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 241.7 (PSIA)    BR FLOW RATE (LBS/HR)=100363.9
PI108 (B4/B3)= 231.0           HC FLOW RATE (LBS/HR)= 96337.3
PI108 (B1-OUT)=222.1

PI204 (B1-IN)= 636.3 (PSIA)    TW101=196.6     TW201=141.0 (DEG-F)
PI204 (B1/B2)= 626.0           TW102=237.8     TW202=208.0
PI204 (B2/B3)= 612.4           TW103=262.8     TW203=244.8
PI204 (B3/B4)= 599.8           TW104=279.4     TW204=267.0
PI204 (B4/B5)= 584.7           TW105=292.2     TW205=281.5
PI204 (B5/B6)= 569.0           TW106=307.6     TW206=293.5
PI204 (B6-OUT)=548.5           TW107=344.7     TW207=302.8
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```
HEATER TEST DATA RUN HTR-33   DATE 3-DEC-80   TIME 10-15

C3 (MOLE C/C)= .47  N-C4=2.00  I-C4=75.77  N-C5=1.02  I-C5=20.74

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 241.5 (PSIA)    BR FLOW RATE (LBS/HR)=100396.4
PI108 (B4/B3)= 231.0           HC FLOW RATE (LBS/HR)= 96286.3
PI108 (B1-OUT)=222.1

PI204 (B1-IN)= 636.4 (PSIA)    TW101=196.8     TW201=141.4 (DEG-F)
PI204 (B1/B2)= 625.8           TW102=237.8     TW202=208.0
PI204 (B2/B3)= 612.1           TW103=262.8     TW203=244.8
PI204 (B3/B4)= 599.4           TW104=279.3     TW204=266.9
PI204 (B4/B5)= 584.4           TW105=292.1     TW205=281.5
PI204 (B5/B6)= 569.0           TW106=307.5     TW206=293.5
PI204 (B6-OUT)=547.9           TW107=344.7     TW207=302.8
```

HEATER TEST DATA RUN HTR-34   DATE 3-DEC-80   TIME 10-45

C3 (MOLE C/C)= .47 N-C4=2.00 I-C4=75.77 N-C5=1.02 I-C5=20.74

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 241.5 (PSIA)   BR FLOW RATE (LBS/HR)=100373.9
PI108 (B4/B3)= 231.0   HC FLOW RATE (LBS/HR)= 77619.6
PI108 (B1-OUT)=222.0

PI204 (B1-IN)= 616.0 (PSIA)   TW101=208.2   TW201=129.7 (DEG-F)
PI204 (B1/B2)= 609.5   TW102=254.5   TW202=223.1
PI204 (B2/B3)= 599.8   TW103=277.4   TW203=262.6
PI204 (B3/B4)= 591.0   TW104=289.8   TW204=279.7
PI204 (B4/B5)= 580.5   TW105=298.9   TW205=290.9
PI204 (B5/B6)= 568.8   TW106=314.0   TW206=298.3
PI204 (B6-OUT)=550.6   TW107=345.0   TW207=316.6

HEATER TEST DATA RUN HTR-34   DATE 3-DEC-80   TIME 11-00

C3 (MOLE C/C)= .47 N-C4=2.00 I-C4=75.77 N-C5=1.02 I-C5=20.74

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 241.5 (PSIA)   BR FLOW RATE (LBS/HR)=100339.9
PI108 (B4/B3)= 230.8   HC FLOW RATE (LBS/HR)= 77639.5
PI108 (B1-OUT)=222.0

PI204 (B1-IN)= 616.0 (PSIA)   TW101=208.1   TW201=129.5 (DEG-F)
PI204 (B1/B2)= 609.6   TW102=254.5   TW202=223.2
PI204 (B2/B3)= 600.0   TW103=277.6   TW203=262.4
PI204 (B3/B4)= 591.1   TW104=289.8   TW204=280.5
PI204 (B4/B5)= 580.6   TW105=299.0   TW205=291.1
PI204 (B5/B6)= 569.0   TW106=314.2   TW206=298.3
PI204 (B6-OUT)=550.7   TW107=345.0   TW207=316.1

HEATER TEST DATA RUN HTR-34   DATE 3-DEC-80   TIME 11-15

C3 (MOLE C/C)= .47 N-C4=2.00 I-C4=75.77 N-C5=1.02 I-C5=20.74

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 241.1 (PSIA)   BR FLOW RATE (LBS/HR)=100373.9
PI108 (B4/B3)= 230.5   HC FLOW RATE (LBS/HR)= 77598.6
PI108 (B1-OUT)=221.8

PI204 (B1-IN)= 615.6 (PSIA)   TW101=208.2   TW201=129.9 (DEG-F)
PI204 (B1/B2)= 609.2   TW102=254.6   TW202=223.2
PI204 (B2/B3)= 599.3   TW103=277.4   TW203=262.2
PI204 (B3/B4)= 590.6   TW104=289.8   TW204=280.5
PI204 (B4/B5)= 580.3   TW105=298.9   TW205=290.9
PI204 (B5/B6)= 568.6   TW106=314.2   TW206=298.2
PI204 (B6-OUT)=550.4   TW107=345.2   TW207=316.2

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HEATER TEST DATA RUN HTR-34   DATE 3-DEC-80   TIME 11-30

C3 (MOLE C/C)= .47  N-C4=2.00  I-C4=75.77  N-C5=1.02  I-C5=20.74

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 241.1 (PSIA)    BR FLOW RATE (LBS/HR)=100545.2
PI108 (B4/B3)= 230.5           HC FLOW RATE (LBS/HR)= 77366.7
PI108 (B1-OUT)=221.6

PI204 (B1-IN)= 615.5 (PSIA)    TW101=208.6    TW201=129.5 (DEG-F)
PI204 (B1/B2)= 609.0           TW102=255.0    TW202=223.7
PI204 (B2/B3)= 599.5           TW103=277.8    TW203=262.6
PI204 (B3/B4)= 590.7           TW104=290.1    TW204=280.8
PI204 (B4/B5)= 580.4           TW105=299.2    TW205=291.2
PI204 (B5/B6)= 566.6           TW106=314.6    TW206=298.4
PI204 (B6-OUT)=550.5           TW107=345.3    TW207=316.8

------------------------------------------------------------------

HEATER TEST DATA RUN HTR-34   DATE 3-DEC-80   TIME 11-45

C3 (MOLE C/C)= .47  N-C4=2.00  I-C4=75.77  N-C5=1.02  I-C5=20.74

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 241.0 (PSIA)    BR FLOW RATE (LBS/HR)=100334.4
PI108 (B4/B3)= 230.5           HC FLOW RATE (LBS/HR)= 77329.9
PI108 (B1-OUT)=221.5

PI204 (B1-IN)= 614.7 (PSIA)    TW101=208.4    TW201=129.9 (DEG-F)
PI204 (B1/B2)= 608.3           TW102=254.7    TW202=223.4
PI204 (B2/B3)= 598.7           TW103=277.5    TW203=262.4
PI204 (B3/B4)= 590.0           TW104=289.8    TW204=280.6
PI204 (B4/B5)= 579.5           TW105=299.0    TW205=291.0
PI204 (B5/B6)= 567.8           TW106=314.4    TW206=298.2
PI204 (B6-OUT)=549.6           TW107=345.2    TW207=316.6

------------------------------------------------------------------

HEATER TEST DATA RUN HTR-34   DATE 3-DEC-80   TIME 12-00

C3 (MOLE C/C)= .47  N-C4=2.00  I-C4=75.77  N-C5=1.02  I-C5=20.74

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 241.2 (PSIA)    BR FLOW RATE (LBS/HR)=100364.7
PI108 (B4/B3)= 230.5           HC FLOW RATE (LBS/HR)= 77588.6
PI108 (B1-OUT)=221.6

PI204 (B1-IN)= 615.6 (PSIA)    TW101=208.7    TW201=130.0 (DEG-F)
PI204 (B1/B2)= 609.4           TW102=254.9    TW202=223.6
PI204 (B2/B3)= 600.0           TW103=277.7    TW203=262.6
PI204 (B3/B4)= 591.0           TW104=290.0    TW204=280.8
PI204 (B4/B5)= 580.5           TW105=299.2    TW205=291.2
PI204 (B5/B6)= 566.7           TW106=314.4    TW206=298.4
PI204 (B6-OUT)=550.5           TW107=345.6    TW207=317.0

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HEATER TEST DATA RUN HTR-35   DATE 3-DEC-80   TIME 12-30

C3 (MOLE C/C)= .47  N-C4=2.00  I-C4=75.77  N-C5=1.02  I-C5=20.74

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 241.3 (PSIA)    BR FLOW RATE (LBS/HR)=100840.9
PI108 (B4/B3)= 230.5           HC FLOW RATE (LBS/HR)= 57965.9
PI108 (B1-OUT)=221.5

PI204 (B1-IN)= 602.3 (PSIA)    TW101=230.1    TW201=123.5 (DEG-F)
PI204 (B1/B2)= 598.6           TW102=277.2    TW202=247.4
PI204 (B2/B3)= 592.5           TW103=294.7    TW203=283.5
PI204 (B3/B4)= 586.8           TW104=304.6    TW204=296.4
PI204 (B4/B5)= 579.1           TW105=318.6    TW205=303.2
PI204 (B5/B6)= 565.4           TW106=337.7    TW206=323.6
PI204 (B6-OUT)=550.0           TW107=345.2    TW207=338.7
----------------------------------------------------------------------
HEATER TEST DATA RUN HTR-35   DATE 3-DEC-80   TIME 12-45

C3 (MOLE C/C)= .47  N-C4=2.00  I-C4=75.77  N-C5=1.02  I-C5=20.74

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 240.6 (PSIA)    BR FLOW RATE (LBS/HR)=100842.8
PI108 (B4/B3)= 230.2           HC FLOW RATE (LBS/HR)= 57967.1
PI108 (B1-OUT)=221.0

PI204 (B1-IN)= 603.0 (PSIA)    TW101=230.0    TW201=123.5 (DEG-F)
PI204 (B1/B2)= 599.1           TW102=277.4    TW202=247.6
PI204 (B2/B3)= 593.0           TW103=294.7    TW203=283.6
PI204 (B3/B4)= 587.3           TW104=304.8    TW204=296.6
PI204 (B4/B5)= 579.4           TW105=318.8    TW205=303.4
PI204 (B5/B6)= 565.5           TW106=337.7    TW206=324.0
PI204 (B6-OUT)=550.3           TW107=345.7    TW207=338.8
----------------------------------------------------------------------
HEATER TEST DATA RUN HTR-35   DATE 3-DEC-80   TIME 13-00

C3 (MOLE C/C)= .47  N-C4=2.00  I-C4=75.77  N-C5=1.02  I-C5=20.74

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 240.6 (PSIA)    BR FLOW RATE (LBS/HR)=100660.1
PI108 (B4/B3)= 230.1           HC FLOW RATE (LBS/HR)= 57714.6
PI108 (B1-OUT)=221.0

PI204 (B1-IN)= 602.5 (PSIA)    TW101=230.3    TW201=123.2 (DEG-F)
PI204 (B1/B2)= 598.7           TW102=277.5    TW202=247.7
PI204 (B2/B3)= 592.6           TW103=295.0    TW203=283.9
PI204 (B3/B4)= 587.2           TW104=304.8    TW204=296.6
PI204 (B4/B5)= 579.3           TW105=318.5    TW205=303.7
PI204 (B5/B6)= 565.4           TW106=337.7    TW206=324.4
PI204 (B6-OUT)=550.2           TW107=345.4    TW207=339.2
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HEATER TEST DATA RUN HTR-35   DATE 3-DEC-80   TIME 13-15

C3 (MOLE C/C)= .47  N-C4=2.00  I-C4=75.77  N-C5=1.02  I-C5=20.74

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 240.6 (PSIA)    BR FLOW RATE (LBS/HR)=100660.1
PI108 (B4/B3)= 230.0           HC FLOW RATE (LBS/HR)= 57736.7
PI108 (B1-OUT)=221.0

PI204 (B1-IN)= 602.7 (PSIA)    TW101=230.3    TW201=122.9 (DEG-F)
PI204 (B1/B2)= 599.4           TW102=277.7    TW202=248.0
PI204 (B2/B3)= 593.3           TW103=295.2    TW203=284.1
PI204 (B3/B4)= 587.7           TW104=305.1    TW204=296.8
PI204 (B4/B5)= 579.8           TW105=320.0    TW205=304.0
PI204 (B5/B6)= 565.6           TW106=338.1    TW206=324.8
PI204 (B6-OUT)=550.9           TW107=345.6    TW207=339.4
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HEATER TEST DATA RUN HTR-35   DATE 3-DEC-80   TIME 13-30

C3 (MOLE C/C)= .47  N-C4=2.00  I-C4=75.77  N-C5=1.02  I-C5=20.74

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 240.9 (PSIA)    BR FLOW RATE (LBS/HR)=100803.5
PI108 (B4/B3)= 230.0           HC FLOW RATE (LBS/HR)= 57448.5
PI108 (B1-OUT)=221.0

PI204 (B1-IN)= 602.6 (PSIA)    TW101=230.2    TW201=123.1 (DEG-F)
PI204 (B1/B2)= 598.7           TW102=277.5    TW202=247.7
PI204 (B2/B3)= 592.6           TW103=295.0    TW203=283.9
PI204 (B3/B4)= 587.0           TW104=304.9    TW204=296.6
PI204 (B4/B5)= 579.3           TW105=319.4    TW205=303.7
PI204 (B5/B6)= 565.6           TW106=338.0    TW206=324.4
PI204 (B6-OUT)=550.9           TW107=345.4    TW207=338.8
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HEATER TEST DATA RUN HTR-35   DATE 3-DEC-80   TIME 13-45

C3 (MOLE C/C)= .47  N-C4=2.00  I-C4=75.77  N-C5=1.02  I-C5=20.74

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 240.7 (PSIA)    BR FLOW RATE (LBS/HR)=100668.2
PI108 (B4/B3)= 230.2           HC FLOW RATE (LBS/HR)= 58216.7
PI108 (B1-OUT)=221.1

PI204 (B1-IN)= 602.0 (PSIA)    TW101=229.9    TW201=123.8 (DEG-F)
PI204 (B1/B2)= 598.1           TW102=277.1    TW202=247.3
PI204 (B2/B3)= 592.1           TW103=294.5    TW203=283.4
PI204 (B3/B4)= 586.6           TW104=304.4    TW204=296.3
PI204 (B4/B5)= 578.7           TW105=318.4    TW205=303.1
PI204 (B5/B6)= 565.5           TW106=337.4    TW206=323.2
PI204 (B6-OUT)=550.0           TW107=345.4    TW207=338.3
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HEATER TEST DATA RUN HTR-36   DATE 3-DEC-80   TIME 14-30

C3 (MOLE C/C)= .47  N-C4=2.00  I-C4=75.77  N-C5=1.02  I-C5=20.74

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 240.7 (PSIA)    BR FLOW RATE (LBS/HR)=100671.0
PI108 (B4/B3)= 230.3           HC FLOW RATE (LBS/HR)= 86168.1
PI108 (B1-OUT)=221.5

PI204 (B1-IN)= 675.1 (PSIA)    TW101=205.6    TW201=134.9 (DEG-F)
PI204 (B1/B2)= 667.1           TW102=251.9    TW202=219.6
PI204 (B2/B3)= 655.9           TW103=277.3    TW203=259.8
PI204 (B3/B4)= 645.0           TW104=292.0    TW204=280.8
PI204 (B4/B5)= 632.8           TW105=304.0    TW205=293.9
PI204 (B5/B6)= 619.5           TW106=317.6    TW206=304.7
PI204 (B6-OUT)=602.5           TW107=345.4    TW207=315.3
--------------------------------------------------------------------

HEATER TEST DATA RUN HTR-36   DATE 3-DEC-80   TIME 14-45

C3 (MOLE C/C)= .47  N-C4=2.00  I-C4=75.77  N-C5=1.02  I-C5=20.74

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 241.0 (PSIA)    BR FLOW RATE (LBS/HR)=100599.6
PI108 (B4/B3)= 230.4           HC FLOW RATE (LBS/HR)= 86124.5
PI108 (B1-OUT)=221.5

PI204 (B1-IN)= 675.4 (PSIA)    TW101=205.6    TW201=135.3 (DEG-F)
PI204 (B1/B2)= 667.0           TW102=252.0    TW202=219.8
PI204 (B2/B3)= 655.5           TW103=277.2    TW203=259.6
PI204 (B3/B4)= 644.5           TW104=292.1    TW204=280.9
PI204 (B4/B5)= 632.3           TW105=304.0    TW205=293.8
PI204 (B5/B6)= 618.7           TW106=317.8    TW206=304.6
PI204 (B6-OUT)=601.5           TW107=345.1    TW207=316.2
--------------------------------------------------------------------

HEATER TEST DATA RUN HTR-36   DATE 3-DEC-80   TIME 15-00

C3 (MOLE C/C)= .47  N-C4=2.00  I-C4=75.77  N-C5=1.02  I-C5=20.74

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 241.0 (PSIA)    BR FLOW RATE (LBS/HR)=100596.0
PI108 (B4/B3)= 230.0           HC FLOW RATE (LBS/HR)= 85853.9
PI108 (B1-OUT)=221.4

PI204 (B1-IN)= 675.2 (PSIA)    TW101=205.8    TW201=135.3 (DEG-F)
PI204 (B1/B2)= 667.0           TW102=252.0    TW202=219.7
PI204 (B2/B3)= 655.5           TW103=277.4    TW203=259.8
PI204 (B3/B4)= 644.6           TW104=292.1    TW204=280.9
PI204 (B4/B5)= 632.6           TW105=304.0    TW205=293.9
PI204 (B5/B6)= 619.4           TW106=317.7    TW206=304.7
PI204 (B6-OUT)=602.5           TW107=344.8    TW207=315.4
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HEATER TEST DATA RUN HTR-36   DATE 3-DEC-80   TIME 15-15

C3 (MOLE C/C)= .47  N-C4=2.00  I-C4=75.77  N-C5=1.02  I-C5=20.74

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 241.0 (PSIA)    BR FLOW RATE (LBS/HR)=100585.2
PI108 (B4/B3)= 230.6           HC FLOW RATE (LBS/HR)= 84815.2
PI108 (B1-OUT)=221.6

PI204 (B1-IN)= 674.3 (PSIA)    TW101=206.4    TW201=134.9 (DEG-F)
PI204 (B1/B2)= 666.1           TW102=252.4    TW202=220.2
PI204 (B2/B3)= 655.0           TW103=277.8    TW203=260.2
PI204 (B3/B4)= 644.6           TW104=292.2    TW204=281.1
PI204 (B4/B5)= 633.1           TW105=304.1    TW205=294.0
PI204 (B5/B6)= 620.0           TW106=317.6    TW206=304.8
PI204 (B6-OUT)=603.5           TW107=344.2    TW207=315.2
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HEATER TEST DATA RUN HTR-36   DATE 3-DEC-80   TIME 15-30

C3 (MOLE C/C)= .47  N-C4=2.00  I-C4=75.77  N-C5=1.02  I-C5=20.74

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 241.0 (PSIA)    BR FLOW RATE (LBS/HR)=100585.2
PI108 (B4/B3)= 230.5           HC FLOW RATE (LBS/HR)= 85315.7
PI108 (B1-OUT)=221.5

PI204 (B1-IN)= 675.8 (PSIA)    TW101=206.4    TW201=135.3 (DEG-F)
PI204 (B1/B2)= 667.6           TW102=253.0    TW202=220.7
PI204 (B2/B3)= 656.5           TW103=278.0    TW203=260.6
PI204 (B3/B4)= 645.5           TW104=292.7    TW204=281.6
PI204 (B4/B5)= 633.7           TW105=304.4    TW205=294.4
PI204 (B5/B6)= 620.4           TW106=318.0    TW206=305.2
PI204 (B6-OUT)=603.5           TW107=344.2    TW207=315.6
```

```
HEATER TEST DATA RUN HTR-36   DATE 3-DEC-80   TIME 15-45

C3 (MOLE C/C)= .47  N-C4=2.00  I-C4=75.77  N-C5=1.02  I-C5=20.74

NUM OF EXCHANGERS=6

PI108 (B6-IN)= 241.0 (PSIA)    BR FLOW RATE (LBS/HR)=100581.6
PI108 (B4/B3)= 230.5           HC FLOW RATE (LBS/HR)= 85295.7
PI108 (B1-OUT)=221.6

PI204 (B1-IN)= 676.5 (PSIA)    TW101=206.6    TW201=135.5 (DEG-F)
PI204 (B1/B2)= 668.7           TW102=253.0    TW202=220.8
PI204 (B2/B3)= 657.1           TW103=278.0    TW203=260.6
PI204 (B3/B4)= 646.4           TW104=292.8    TW204=281.7
PI204 (B4/B5)= 634.3           TW105=304.4    TW205=294.5
PI204 (B5/B6)= 621.0           TW106=318.0    TW206=305.0
PI204 (B6-OUT)=604.0           TW107=344.4    TW207=316.0
```

Appendix C

Condenser Test Raw Data

Nomenclature

C3	-	composition of propane
N-C4	-	composition of n-butane
I-C4	-	composition of isobutane
N-C5	-	composition of n-pentane
I-C5	-	composition of isopentane
CW		Cooling water
HC		Hydrocarbon
P-COND		Condenser hydrocarbon pressure
TW209		Hydrocarbon temperature entering condenser
TW210		Hydrocarbon temperature exiting condenser
PI305		Cooling water pressure entering condenser
PI306		Cooling water pressure exiting condenser
TW305		Cooling water temperature entering condenser
TW306		Cooling water temperature exiting the condenser

Isobutane Condenser Test Data

CONDENSER DATA RUN COND-50 DATE 21-MAR-81 TIME 09-30

C3 (MOLE O/O)= .33 N-C4=3.28 I-C4=96.39 N-C4= 0. I-C5= 0.

CW FLOW RATE (LBS/HR)=457003.0 HC FLOW RATE (LBS/HR)= 66629.8

P-COND (PSIA)=247.1
TW209 (DEG-F)=243.2 TW210=193.2

PI305 (PSIG)= 66.0 PI306= 10.0
TW305 (DEG-F)=146.6 TW306=163.8

CONDENSER DATA RUN COND-50 DATE 21-MAR-81 TIME 10-30

C3 (MOLE O/O)= .33 N-C4=3.28 I-C4=96.39 N-C4= 0. I-C5= 0.

CW FLOW RATE (LBS/HR)=438488.4 HC FLOW RATE (LBS/HR)= 86161.2

P-COND (PSIA)=242.5
TW209 (DEG-F)=214.0 TW210=192.3

PI305 (PSIG)= 70.0 PI306= 10.0
TW305 (DEG-F)=163.0 TW306=173.0

CONDENSER DATA RUN COND-50 DATE 21-MAR-81 TIME 12-30

C3 (MOLE O/O)= .33 N-C4=3.28 I-C4=96.39 N-C4= 0. I-C5= 0.

CW FLOW RATE (LBS/HR)=496718.7 HC FLOW RATE (LBS/HR)= 81091.5

P-COND (PSIA)=204.3
TW209 (DEG-F)=213.4 TW210=173.4

PI305 (PSIG)= 38.0 PI306= 10.0
TW305 (DEG-F)=110.0 TW306=131.0

CONDENSER DATA RUN COND-50 DATE 21-MAR-81 TIME 13-00

C3 (MOLE O/O)= .33 N-C4=3.28 I-C4=96.39 N-C4= 0. I-C5= 0.

CW FLOW RATE (LBS/HR)=498160.5 HC FLOW RATE (LBS/HR)= 81778.2

P-COND (PSIA)=206.3
TW209 (DEG-F)=213.0 TW210=174.0

PI305 (PSIG)= 37.5 PI306= 11.0
TW305 (DEG-F)=110.4 TW306=131.5

```
CONDENSER DATA RUN COND-50  DATE 21-MAR-81  TIME 13-15

C3 (MOLE O/O)= .33  N-C4=3.28  I-C4=96.39  N-C4= 0.    I-C5= 0.

CW FLOW RATE (LBS/HR)=496717.9     HC FLOW RATE (LBS/HR)= 81816.9

P-COND (PSIA)=205.7
TW209 (DEG-F)=212.2      TW210=173.9

PI305  (PSIG)= 37.5      PI306= 11.0
TW305 (DEG-F)=110.0      TW306=131.2

----------------------------------------------------------------------

CONDENSER DATA RUN COND-50  DATE 21-MAR-81  TIME 13-30

C3 (MOLE O/O)= .33  N-C4=3.28  I-C4=96.39  N-C4= 0.    I-C5= 0.

CW FLOW RATE (LBS/HR)=497203.4     HC FLOW RATE (LBS/HR)= 81513.6

P-COND (PSIA)=205.4
TW209 (DEG-F)=212.0      TW210=174.0

PI305  (PSIG)= 38.0      PI306= 11.0
TW305 (DEG-F)=110.1      TW306=131.4

----------------------------------------------------------------------

CONDENSER DATA RUN COND-50  DATE 21-MAR-81  TIME 13-45

C3 (MOLE O/O)= .33  N-C4=3.28  I-C4=96.39  N-C4= 0.    I-C5= 0.

CW FLOW RATE (LBS/HR)=496717.1     HC FLOW RATE (LBS/HR)= 81251.1

P-COND (PSIA)=205.0
TW209 (DEG-F)=211.8      TW210=173.9

PI305  (PSIG)= 37.0      PI306= 11.0
TW305 (DEG-F)=110.0      TW306=131.2

----------------------------------------------------------------------

CONDENSER DATA RUN COND-50  DATE 21-MAR-81  TIME 14-00

C3 (MOLE O/O)= .33  N-C4=3.28  I-C4=96.39  N-C4= 0.    I-C5= 0.

CW FLOW RATE (LBS/HR)=496718.7     HC FLOW RATE (LBS/HR)= 81522.8

P-COND (PSIA)=204.3
TW209 (DEG-F)=211.0      TW210=173.7

PI305  (PSIG)= 38.0      PI306= 10.5
TW305 (DEG-F)=110.0      TW306=131.4

----------------------------------------------------------------------
```

CONDENSER DATA RUN COND-50 DATE 21-MAR-81 TIME 14-15

C3 (MOLE C/C)= .33 N-C4=3.28 I-C4=96.39 N-C4= 0. I-C5= 0.

CW FLOW RATE (LBS/HR)=496222.4 HC FLOW RATE (LBS/HR)= 81543.7

P-COND (PSIA)=204.7
TW209 (DEG-F)=210.4 TW210=173.6

PI305 (PSIG)= 38.0 PI306= 10.5
TW305 (DEG-F)=110.0 TW306=131.5

CONDENSER DATA RUN COND-51 DATE 21-MAR-81 TIME 15-00

C3 (MOLE C/C)= .33 N-C4=3.28 I-C4=96.39 N-C4= 0. I-C5= 0.

CW FLOW RATE (LBS/HR)=487042.5 HC FLOW RATE (LBS/HR)= 63041.4

P-COND (PSIA)=169.6
TW209 (DEG-F)=173.0 TW210=156.0

PI305 (PSIG)= 55.5 PI306= 10.5
TW305 (DEG-F)=108.0 TW306=124.1

CONDENSER DATA RUN COND-51 DATE 21-MAR-81 TIME 15-15

C3 (MOLE C/C)= .33 N-C4=3.28 I-C4=96.39 N-C4= 0. I-C5= 0.

CW FLOW RATE (LBS/HR)=484729.2 HC FLOW RATE (LBS/HR)= 63120.0

P-COND (PSIA)=171.6
TW209 (DEG-F)=172.0 TW210=157.1

PI305 (PSIG)= 57.0 PI306= 11.0
TW305 (DEG-F)=111.0 TW306=126.7

CONDENSER DATA RUN COND-51 DATE 21-MAR-81 TIME 15-30

C3 (MOLE C/C)= .33 N-C4=3.28 I-C4=96.39 N-C4= 0. I-C5= 0.

CW FLOW RATE (LBS/HR)=475742.1 HC FLOW RATE (LBS/HR)= 62360.2

P-COND (PSIA)=172.4
TW209 (DEG-F)=171.0 TW210=157.7

PI305 (PSIG)= 59.0 PI306= 11.0
TW305 (DEG-F)=111.5 TW306=127.2

CONDENSER DATA RUN COND-51 DATE 21-MAR-81 TIME 15-45

C3 (MOLE C/C)= .33 N-C4=3.28 I-C4=96.39 N-C4= C. I-C5= 0.

CW FLOW RATE (LBS/HR)=479769.6 HC FLOW RATE (LBS/HR)= 62890.9

P-COND (PSIA)=171.5
TW209 (DEG-F)=171.0 TW210=158.5

PI305 (PSIG)= 61.0 PI306= 10.5
TW305 (DEG-F)=111.0 TW306=127.0

CONDENSER DATA RUN COND-51 DATE 21-MAR-81 TIME 16-00

C3 (MOLE C/C)= .33 N-C4=3.28 I-C4=96.39 N-C4= 0. I-C5= 0.

CW FLOW RATE (LBS/HR)=476295.2 HC FLOW RATE (LBS/HR)= 62329.9

P-COND (PSIA)=174.3
TW209 (DEG-F)=171.0 TW210=158.5

PI305 (PSIG)= 60.0 PI306= 10.5
TW305 (DEG-F)=111.0 TW306=127.5

CONDENSER DATA RUN COND-51 DATE 21-MAR-81 TIME 16-15

C3 (MOLE C/C)= .33 N-C4=3.28 I-C4=96.39 N-C4= C. I-C5= 0.

CW FLOW RATE (LBS/HR)=477739.0 HC FLOW RATE (LBS/HR)= 63404.5

P-COND (PSIA)=173.4
TW209 (DEG-F)=171.0 TW210=158.2

PI305 (PSIG)= 60.0 PI306= 10.5
TW305 (DEG-F)=111.4 TW306=127.5

CONDENSER DATA RUN COND-51 DATE 21-MAR-81 TIME 16-30

C3 (MOLE C/C)= .33 N-C4=3.28 I-C4=96.39 N-C4= C. I-C5= 0.

CW FLOW RATE (LBS/HR)=476770.6 HC FLOW RATE (LBS/HR)= 62860.8

P-COND (PSIA)=173.2
TW209 (DEG-F)=171.1 TW210=158.3

PI305 (PSIG)= 61.0 PI306= 11.0
TW305 (DEG-F)=111.2 TW306=127.0

```
CONDENSER DATA RUN COND-52  DATE 22-MAR-81  TIME 07-30

C3 (MOLE C/C)= .33  N-C4=3.28  I-C4=96.39  N-C4= 0.    I-C5= 0.

CW FLOW RATE (LBS/HR)=375822.4     HC FLOW RATE (LBS/HR)= 39008.0

P-COND (PSIA)=115.7
TW209 (DEG-F)=239.7      TW210=124.7

PI305  (PSIG)= 28.0      PI306=  9.5
TW305 (DEG-F)= 79.8      TW306= 98.6

-----------------------------------------------------------------

CONDENSER DATA RUN COND-52  DATE 22-MAR-81  TIME 07-45

C3 (MOLE C/C)= .33  N-C4=3.28  I-C4=96.39  N-C4= 0.    I-C5= 0.

CW FLOW RATE (LBS/HR)=376831.9     HC FLOW RATE (LBS/HR)= 39007.8

P-COND (PSIA)=115.1
TW209 (DEG-F)=240.0      TW210=124.6

PI305  (PSIG)= 28.0      PI306= 10.0
TW305 (DEG-F)= 79.6      TW306= 98.5

-----------------------------------------------------------------

CONDENSER DATA RUN COND-52  DATE 22-MAR-81  TIME 08-00

C3 (MOLE C/C)= .33  N-C4=3.28  I-C4=96.39  N-C4= 0.    I-C5= 0.

CW FLOW RATE (LBS/HR)=376837.6     HC FLOW RATE (LBS/HR)= 38997.4

P-COND (PSIA)=115.7
TW209 (DEG-F)=240.0      TW210=124.8

PI305  (PSIG)= 28.0      PI306= 10.0
TW305 (DEG-F)= 79.5      TW306= 98.5

-----------------------------------------------------------------

CONDENSER DATA RUN COND-52  DATE 22-MAR-81  TIME 08-15

C3 (MOLE C/C)= .33  N-C4=3.28  I-C4=96.39  N-C4= 0.    I-C5= 0.

CW FLOW RATE (LBS/HR)=376332.8     HC FLOW RATE (LBS/HR)= 38716.3

P-COND (PSIA)=115.3
TW209 (DEG-F)=238.8      TW210=124.6

PI305  (PSIG)= 28.0      PI306= 10.0
TW305 (DEG-F)= 79.6      TW306= 98.6

-----------------------------------------------------------------
```

CONDENSER DATA RUN COND-52 DATE 22-MAR-81 TIME 08-30

C3 (MOLE C/C)= .33 N-C4=3.28 I-C4=96.39 N-C4= 0. I-C5= 0.

CW FLOW RATE (LBS/HR)=376310.1 HC FLOW RATE (LBS/HR)= 39505.1

P-COND (PSIA)=116.4
TW209 (DEG-F)=238.1 TW210=125.1

PI305 (PSIG)= 28.0 PI306= 10.0
TW305 (DEG-F)= 80.0 TW306= 99.0

CONDENSER DATA RUN COND-52 DATE 22-MAR-81 TIME 08-45

C3 (MOLE C/C)= .33 N-C4=3.28 I-C4=96.39 N-C4= 0. I-C5= 0.

CW FLOW RATE (LBS/HR)=378283.5 HC FLOW RATE (LBS/HR)= 39491.6

P-COND (PSIA)=116.6
TW209 (DEG-F)=236.6 TW210=125.4

PI305 (PSIG)= 28.0 PI306= 10.0
TW305 (DEG-F)= 80.4 TW306= 99.2

CONDENSER DATA RUN COND-52 DATE 22-MAR-81 TIME 09-00

C3 (MOLE C/C)= .33 N-C4=3.28 I-C4=96.39 N-C4= 0. I-C5= 0.

CW FLOW RATE (LBS/HR)=376780.6 HC FLOW RATE (LBS/HR)= 36945.5

P-COND (PSIA)=116.6
TW209 (DEG-F)=236.4 TW210=125.5

PI305 (PSIG)= 28.0 PI306= 10.0
TW305 (DEG-F)= 80.5 TW306= 99.2

CONDENSER DATA RUN COND-52 DATE 22-MAR-81 TIME 12-30

C3 (MOLE C/C)= .33 N-C4=3.28 I-C4=96.39 N-C4= 0. I-C5= 0.

CW FLOW RATE (LBS/HR)=374919.5 HC FLOW RATE (LBS/HR)= 76752.2

P-COND (PSIA)=160.0
TW209 (DEG-F)=172.6 TW210=151.8

PI305 (PSIG)= 28.0 PI306= 15.0
TW305 (DEG-F)= 86.5 TW306=112.5

CONDENSER DATA RUN COND-52 DATE 22-MAR-81 TIME 12-45

C3 (MOLE O/O)= .33 N-C4=3.28 I-C4=96.39 N-C4= 0. I-C5= 0.

CW FLOW RATE (LBS/HR)=374913.1 HC FLOW RATE (LBS/HR)= 76650.8

P-COND (PSIA)=160.2
TW209 (DEG-F)=172.0 TW210=151.7

PI305 (PSIG)= 28.0 PI306= 15.0
TW305 (DEG-F)= 86.6 TW306=112.5

CONDENSER DATA RUN COND-52 DATE 22-MAR-81 TIME 13-09

C3 (MOLE O/O)= .33 N-C4=3.28 I-C4=96.39 N-C4= 0. I-C5= 0.

CW FLOW RATE (LBS/HR)=374913.1 HC FLOW RATE (LBS/HR)= 76914.8

P-COND (PSIA)=160.3
TW209 (DEG-F)=171.2 TW210=151.7

PI305 (PSIG)= 28.0 PI306= 15.0
TW305 (DEG-F)= 86.6 TW306=112.6

CONDENSER DATA RUN COND-52 DATE 22-MAR-81 TIME 13-19

C3 (MOLE O/O)= .33 N-C4=3.28 I-C4=96.39 N-C4= 0. I-C5= 0.

CW FLOW RATE (LBS/HR)=374900.3 HC FLOW RATE (LBS/HR)= 77167.3

P-COND (PSIA)=159.6
TW209 (DEG-F)=170.4 TW210=151.7

PI305 (PSIG)= 28.0 PI306= 15.0
TW305 (DEG-F)= 86.8 TW306=112.6

CONDENSER DATA RUN COND-52 DATE 22-MAR-81 TIME 13-30

C3 (MOLE O/O)= .33 N-C4=3.28 I-C4=96.39 N-C4= 0. I-C5= 0.

CW FLOW RATE (LBS/HR)=375390.8 HC FLOW RATE (LBS/HR)= 76902.7

P-COND (PSIA)=155.4
TW209 (DEG-F)=170.0 TW210=151.7

PI305 (PSIG)= 28.0 PI306= 15.0
TW305 (DEG-F)= 86.9 TW306=112.6

CONDENSER DATA RUN COND-52 DATE 22-MAR-81 TIME 13-45

C3 (MOLE O/O)= .33 N-C4=3.28 I-C4=96.39 N-C4= 0. I-C5= 0.

CW FLOW RATE (LBS/HR)=373396.3 HC FLOW RATE (LBS/HR)= 76972.7

P-COND (PSIA)=160.1
TW209 (DEG-F)=169.0 TW210=151.6

PI305 (PSIG)= 28.0 PI306= 15.0
TW305 (DEG-F)= 86.9 TW306=112.5

CONDENSER DATA RUN COND-53 DATE 22-MAR-81 TIME 15-30

C3 (MOLE O/O)= .33 N-C4=3.28 I-C4=96.39 N-C4= 0. I-C5= 0.

CW FLOW RATE (LBS/HR)=374084.5 HC FLOW RATE (LBS/HR)= 53644.6

P-COND (PSIA)=139.4
TW209 (DEG-F)=215.0 TW210=140.1

PI305 (PSIG)= 28.0 PI306= 15.0
TW305 (DEG-F)= 83.9 TW306=106.5

CONDENSER DATA RUN COND-53 DATE 22-MAR-81 TIME 15-45

C3 (MOLE O/O)= .33 N-C4=3.28 I-C4=96.39 N-C4= 0. I-C5= 0.

CW FLOW RATE (LBS/HR)=374060.0 HC FLOW RATE (LBS/HR)= 53542.0

P-COND (PSIA)=139.7
TW209 (DEG-F)=214.8 TW210=140.5

PI305 (PSIG)= 28.0 PI306= 15.0
TW305 (DEG-F)= 84.3 TW306=106.9

CONDENSER DATA RUN COND-53 DATE 22-MAR-81 TIME 16-00

C3 (MOLE O/O)= .33 N-C4=3.28 I-C4=96.39 N-C4= 0. I-C5= 0.

CW FLOW RATE (LBS/HR)=373555.1 HC FLOW RATE (LBS/HR)= 53535.2

P-COND (PSIA)=140.1
TW209 (DEG-F)=214.6 TW210=140.5

PI305 (PSIG)= 28.0 PI306= 15.0
TW305 (DEG-F)= 84.4 TW306=107.0

```
CONDENSER DATA RUN COND-53  DATE 22-MAR-81  TIME 16-15

C3 (MOLE C/C)= .33  N-C4=3.28  I-C4=96.39  N-C4= 0.    I-C5= 0.

CW FLOW RATE (LBS/HR)=374564.9     HC FLOW RATE (LBS/HR)= 53549.7

P-COND (PSIA)=139.7
TW209 (DEG-F)=214.0      TW210=140.5

PI305  (PSIG)= 28.0      PI306= 15.0
TW305 (DEG-F)= 84.2      TW306=106.9
```

```
CONDENSER DATA RUN COND-53  DATE 22-MAR-81  TIME 16-30

C3 (MOLE C/C)= .33  N-C4=3.28  I-C4=96.39  N-C4= 0.    I-C5= 0.

CW FLOW RATE (LBS/HR)=373561.3     HC FLOW RATE (LBS/HR)= 53549.7

P-COND (PSIA)=140.1
TW209 (DEG-F)=214.5      TW210=140.5

PI305  (PSIG)= 28.0      PI306= 15.0
TW305 (DEG-F)= 84.3      TW306=106.9
```

```
CONDENSER DATA RUN COND-54  DATE 23-MAR-81  TIME 07-30

C3 (MOLE C/C)= .33  N-C4=3.28  I-C4=96.39  N-C4= 0.    I-C5= 0.

CW FLOW RATE (LBS/HR)=442113.7     HC FLOW RATE (LBS/HR)= 66180.8

P-COND (PSIA)=184.3
TW209 (DEG-F)=207.5      TW210=163.9

PI305  (PSIG)= 58.5      PI306= 39.5
TW305 (DEG-F)=105.5      TW306=125.9
```

```
CONDENSER DATA RUN COND-54  DATE 23-MAR-81  TIME 08-00

C3 (MOLE C/C)= .33  N-C4=3.28  I-C4=96.39  N-C4= 0.    I-C5= 0.

CW FLOW RATE (LBS/HR)=441091.0     HC FLOW RATE (LBS/HR)= 66654.2

P-COND (PSIA)=185.0
TW209 (DEG-F)=206.0      TW210=163.6

PI305  (PSIG)= 58.5      PI306= 39.5
TW305 (DEG-F)=105.8      TW306=126.0
```

CONDENSER DATA RUN COND-54 DATE 23-MAR-81 TIME 08-15

C3 (MOLE C/C)= .33 N-C4=3.28 I-C4=96.39 N-C4= 0. I-C5= 0.

CW FLOW RATE (LBS/HR)=442590.2 HC FLOW RATE (LBS/HR)= 66617.2

P-COND (PSIA)=184.6
TW209 (DEG-F)=205.2 TW210=163.9

PI305 (PSIG)= 58.0 PI306= 39.0
TW305 (DEG-F)=105.7 TW306=126.0

CONDENSER DATA RUN COND-54 DATE 23-MAR-81 TIME 08-30

C3 (MOLE C/C)= .33 N-C4=3.28 I-C4=96.39 N-C4= 0. I-C5= 0.

CW FLOW RATE (LBS/HR)=443134.3 HC FLOW RATE (LBS/HR)= 67127.1

P-COND (PSIA)=184.3
TW209 (DEG-F)=206.5 TW210=163.9

PI305 (PSIG)= 57.0 PI306= 38.0
TW305 (DEG-F)=105.2 TW306=125.5

CONDENSER DATA RUN COND-54 DATE 23-MAR-81 TIME 08-45

C3 (MOLE C/C)= .33 N-C4=3.28 I-C4=96.39 N-C4= 0. I-C5= 0.

CW FLOW RATE (LBS/HR)=442608.4 HC FLOW RATE (LBS/HR)= 67098.1

P-COND (PSIA)=184.7
TW209 (DEG-F)=205.5 TW210=164.2

PI305 (PSIG)= 57.0 PI306= 38.0
TW305 (DEG-F)=105.5 TW306=125.8

CONDENSER DATA RUN COND-54 DATE 23-MAR-81 TIME 09-00

C3 (MOLE C/C)= .33 N-C4=3.28 I-C4=96.39 N-C4= 0. I-C5= 0.

CW FLOW RATE (LBS/HR)=442656.3 HC FLOW RATE (LBS/HR)= 67079.7

P-COND (PSIA)=184.3
TW209 (DEG-F)=206.0 TW210=164.0

PI305 (PSIG)= 56.5 PI306= 37.5
TW305 (DEG-F)=105.0 TW306=125.5

CONDENSER DATA RUN COND-54 DATE 23-MAR-81 TIME 10-15

C3 (MOLE O/O)= .33 N-C4=3.28 I-C4=96.39 N-C4= 0. I-C5= 0.

CW FLOW RATE (LBS/HR)=433557.6 HC FLOW RATE (LBS/HR)= 70131.6

P-COND (PSIA)=206.0
TW209 (DEG-F)=203.0 TW210=174.1

PI305 (PSIG)= 63.5 PI306= 45.0
TW305 (DEG-F)=116.5 TW306=136.2

CONDENSER DATA RUN COND-55 DATE 23-MAR-81 TIME 10-30

C3 (MOLE O/O)= .33 N-C4=3.28 I-C4=96.39 N-C4= 0. I-C5= 0.

CW FLOW RATE (LBS/HR)=432566.6 HC FLOW RATE (LBS/HR)= 70122.1

P-COND (PSIA)=206.2
TW209 (DEG-F)=203.1 TW210=174.2

PI305 (PSIG)= 63.5 PI306= 45.1
TW305 (DEG-F)=116.5 TW306=136.5

CONDENSER DATA RUN COND-55 DATE 23-MAR-81 TIME 10-45

C3 (MOLE O/O)= .33 N-C4=3.28 I-C4=96.39 N-C4= 0. I-C5= 0.

CW FLOW RATE (LBS/HR)=432618.8 HC FLOW RATE (LBS/HR)= 69604.0

P-COND (PSIA)=205.5
TW209 (DEG-F)=203.8 TW210=174.0

PI305 (PSIG)= 63.0 PI306= 45.0
TW305 (DEG-F)=116.0 TW306=136.0

CONDENSER DATA RUN COND-55 DATE 23-MAR-81 TIME 11-00

C3 (MOLE O/O)= .33 N-C4=3.28 I-C4=96.39 N-C4= 0. I-C5= 0.

CW FLOW RATE (LBS/HR)=432650.4 HC FLOW RATE (LBS/HR)= 69330.2

P-COND (PSIA)=205.3
TW209 (DEG-F)=204.0 TW210=173.9

PI305 (PSIG)= 63.0 PI306= 45.0
TW305 (DEG-F)=115.7 TW306=135.8

CONDENSER DATA RUN COND-55 DATE 23-MAR-81 TIME 11-15

C3 (MOLE C/C)= .33 N-C4=3.28 I-C4=96.39 N-C4= 0. I-C5= 0.

CW FLOW RATE (LBS/HR)=432171.9 HC FLOW RATE (LBS/HR)= 70100.9

P-COND (PSIA)=205.3
TW209 (DEG-F)=204.6 TW210=174.0

PI305 (PSIG)= 63.0 PI306= 45.0
TW305 (DEG-F)=115.5 TW306=135.0

CONDENSER DATA RUN COND-56 DATE 23-MAR-81 TIME 12-15

C3 (MOLE C/C)= .33 N-C4=3.28 I-C4=96.39 N-C4= 0. I-C5= 0.

CW FLOW RATE (LBS/HR)=513059.4 HC FLOW RATE (LBS/HR)= 61558.2

P-COND (PSIA)=201.4
TW209 (DEG-F)=201.4 TW210=172.0

PI305 (PSIG)= 39.0 PI306= 22.5
TW305 (DEG-F)= 96.8 TW306=112.0

CONDENSER DATA RUN COND-56 DATE 23-MAR-81 TIME 12-30

C3 (MOLE C/C)= .33 N-C4=3.28 I-C4=96.39 N-C4= 0. I-C5= 0.

CW FLOW RATE (LBS/HR)=508008.2 HC FLOW RATE (LBS/HR)= 61858.4

P-COND (PSIA)=202.6
TW209 (DEG-F)=198.8 TW210=172.3

PI305 (PSIG)= 43.0 PI306= 26.0
TW305 (DEG-F)= 97.6 TW306=112.6

CONDENSER DATA RUN COND-56 DATE 23-MAR-81 TIME 12-45

C3 (MOLE C/C)= .33 N-C4=3.28 I-C4=96.39 N-C4= 0. I-C5= 0.

CW FLOW RATE (LBS/HR)=506437.0 HC FLOW RATE (LBS/HR)= 62404.9

P-COND (PSIA)=203.1
TW209 (DEG-F)=197.4 TW210=172.8

PI305 (PSIG)= 45.0 PI306= 28.0
TW305 (DEG-F)= 98.4 TW306=113.1

CONCENSER CATA RUN CCND-56   CATE 23-MAR-81   TIME 13-00

C3 (MOLE C/C)= .33   N-C4=3.28   I-C4=96.39   N-C4= 0.   I-C5= 0.

CW FLOW RATE (LBS/HR)=504387.9   HC FLOW RATE (LBS/HR)= 62423.9

P-CCND (PSIA)=203.8
TW209 (DEG-F)=196.5   TW210=173.2

PI305 (PSIG)= 46.5   PI306= 30.0
TW305 (DEG-F)= 99.0   TW306=113.5

CONCENSER CATA RUN COND-56   CATE 23-MAR-81   TIME 13-15

C3 (MCLE C/C)= .33   N-C4=3.28   I-C4=96.39   N-C4= 0.   I-C5= 0.

CW FLOW RATE (LBS/HR)=503660.4   HC FLOW RATE (LBS/HR)= 62433.9

P-CCND (PSIA)=204.2
TW209 (DEG-F)=195.5   TW210=173.3

PI305 (PSIG)= 47.0   PI306= 30.5
TW305 (DEG-F)= 99.3   TW306=114.1

NOMINAL 90/10 CONDENSER TEST DATA

CONDENSER DATA RUN COND-57 DATE 24-MAR-81 TIME 09-00

C3 (MOLE O/O)= .30 N-C4=2.97 I-C4=87.22 N-C4= .45 I-C5= 9.06

CW FLOW RATE (LBS/HR)=400084.4 HC FLOW RATE (LBS/HR)= 69871.0

P-COND (PSIA)=205.2
TW209 (DEG-F)=212.3 TW210=180.3

PI305 (PSIG)= 66.0 PI306= 46.0
TW305 (DEG-F)=119.3 TW306=141.1

CONDENSER DATA RUN COND-57 DATE 24-MAR-81 TIME 09-15

C3 (MOLE O/O)= .30 N-C4=2.97 I-C4=87.22 N-C4= .45 I-C5= 9.06

CW FLOW RATE (LBS/HR)=398599.6 HC FLOW RATE (LBS/HR)= 69585.2

P-COND (PSIA)=205.4
TW209 (DEG-F)=212.7 TW210=180.6

PI305 (PSIG)= 66.5 PI306= 46.0
TW305 (DEG-F)=119.3 TW306=141.1

CONDENSER DATA RUN COND-57 DATE 24-MAR-81 TIME 09-30

C3 (MOLE O/O)= .30 N-C4=2.97 I-C4=87.22 N-C4= .45 I-C5= 9.06

CW FLOW RATE (LBS/HR)=399114.2 HC FLOW RATE (LBS/HR)= 70072.7

P-COND (PSIA)=205.9
TW209 (DEG-F)=211.5 TW210=180.6

PI305 (PSIG)= 66.0 PI306= 46.0
TW305 (DEG-F)=119.1 TW306=141.0

CONDENSER DATA RUN COND-57 DATE 24-MAR-81 TIME 09-45

C3 (MOLE O/O)= .30 N-C4=2.97 I-C4=87.22 N-C4= .45 I-C5= 9.06

CW FLOW RATE (LBS/HR)=399153.5 HC FLOW RATE (LBS/HR)= 70577.9

P-COND (PSIA)=205.7
TW209 (DEG-F)=210.0 TW210=180.6

PI305 (PSIG)= 65.9 PI306= 45.5
TW305 (DEG-F)=118.7 TW306=140.6

CONDENSER DATA RUN COND-57 DATE 24-MAR-81 TIME 10-00

C3 (MOLE C/C)= .30 N-C4=2.97 I-C4=87.22 N-C4= .45 I-C5= 9.06

CW FLOW RATE (LBS/HR)=399172.8 HC FLOW RATE (LBS/HR)= 71367.1

P-COND (PSIA)=205.6
TW209 (DEG-F)=209.0 TW210=180.6

PI305 (PSIG)= 65.0 PI306= 45.5
TW305 (DEG-F)=118.5 TW306=140.6

CONDENSER DATA RUN COND-57 DATE 24-MAR-81 TIME 10-15

C3 (MOLE C/C)= .30 N-C4=2.97 I-C4=87.22 N-C4= .45 I-C5= 9.06

CW FLOW RATE (LBS/HR)=398677.6 HC FLOW RATE (LBS/HR)= 69832.1

P-COND (PSIA)=205.3
TW209 (DEG-F)=213.0 TW210=180.3

PI305 (PSIG)= 65.0 PI306= 45.5
TW305 (DEG-F)=118.5 TW306=140.5

CONDENSER DATA RUN COND-58 DATE 24-MAR-81 TIME 11-15

C3 (MOLE C/C)= .30 N-C4=2.97 I-C4=87.22 N-C4= .45 I-C5= 9.06

CW FLOW RATE (LBS/HR)=412059.7 HC FLOW RATE (LBS/HR)= 72864.9

P-COND (PSIA)=180.2
TW209 (DEG-F)=199.5 TW210=168.1

PI305 (PSIG)= 54.0 PI306= 33.5
TW305 (DEG-F)=102.7 TW306=125.5

CONDENSER DATA RUN COND-58 DATE 24-MAR-81 TIME 11-30

C3 (MOLE C/C)= .30 N-C4=2.97 I-C4=87.22 N-C4= .45 I-C5= 9.06

CW FLOW RATE (LBS/HR)=412072.6 HC FLOW RATE (LBS/HR)= 72588.2

P-COND (PSIA)=180.3
TW209 (DEG-F)=200.3 TW210=168.4

PI305 (PSIG)= 53.9 PI306= 33.0
TW305 (DEG-F)=102.9 TW306=125.5

CONDENSER DATA RUN COND-58 DATE 24-MAR-81 TIME 11-45

C3 (MOLE C/C)= .30 N-C4=2.97 I-C4=87.22 N-C4= .45 I-C5= 9.06

CW FLOW RATE (LBS/HR)=412115.7 HC FLOW RATE (LBS/HR)= 72599.4

P-COND (PSIA)=183.4
TW209 (DEG-F)=200.5 TW210=168.1

PI305 (PSIG)= 53.0 PI306= 32.5
TW305 (DEG-F)=102.0 TW306=125.1

CONDENSER DATA RUN COND-58 DATE 24-MAR-81 TIME 12-00

C3 (MOLE C/C)= .30 N-C4=2.97 I-C4=87.22 N-C4= .45 I-C5= 9.06

CW FLOW RATE (LBS/HR)=413101.2 HC FLOW RATE (LBS/HR)= 72837.8

P-COND (PSIA)=184.4
TW209 (DEG-F)=200.5 TW210=168.2

PI305 (PSIG)= 53.0 PI306= 32.5
TW305 (DEG-F)=102.1 TW306=125.1

CONDENSER DATA RUN COND-58 DATE 24-MAR-81 TIME 12-15

C3 (MOLE C/C)= .30 N-C4=2.97 I-C4=87.22 N-C4= .45 I-C5= 9.06

CW FLOW RATE (LBS/HR)=414103.6 HC FLOW RATE (LBS/HR)= 72571.0

P-COND (PSIA)=184.0
TW209 (DEG-F)=200.6 TW210=168.2

PI305 (PSIG)= 52.9 PI306= 32.0
TW305 (DEG-F)=102.0 TW306=124.9

CONDENSER DATA RUN COND-58 DATE 24-MAR-81 TIME 12-30

C3 (MOLE C/C)= .30 N-C4=2.97 I-C4=87.22 N-C4= .45 I-C5= 9.06

CW FLOW RATE (LBS/HR)=414094.2 HC FLOW RATE (LBS/HR)= 72813.1

P-COND (PSIA)=184.4
TW209 (DEG-F)=200.6 TW210=168.1

PI305 (PSIG)= 52.0 PI306= 32.0
TW305 (DEG-F)=102.1 TW306=125.0

CONDENSER DATA RUN COND-59 DATE 24-MAR-81 TIME 13-30

C3 (MOLE C/C)= .30 N-C4=2.97 I-C4=87.22 N-C4= .45 I-C5= 9.06

CW FLOW RATE (LBS/HR)=422749.4 HC FLOW RATE (LBS/HR)= 61718.0

P-COND (PSIA)=161.6
TW209 (DEG-F)=208.5 TW210=154.2

PI305 (PSIG)= 42.5 PI306= 22.0
TW305 (DEG-F)= 93.7 TW306=115.0

CONDENSER DATA RUN COND-59 DATE 24-MAR-81 TIME 13-45

C3 (MOLE C/C)= .30 N-C4=2.97 I-C4=87.22 N-C4= .45 I-C5= 9.06

CW FLOW RATE (LBS/HR)=421730.1 HC FLOW RATE (LBS/HR)= 61970.0

P-COND (PSIA)=161.7
TW209 (DEG-F)=207.6 TW210=154.2

PI305 (PSIG)= 43.0 PI306= 22.0
TW305 (DEG-F)= 94.0 TW306=115.1

CONDENSER DATA RUN COND-59 DATE 24-MAR-81 TIME 14-00

C3 (MOLE C/C)= .30 N-C4=2.97 I-C4=87.22 N-C4= .45 I-C5= 9.06

CW FLOW RATE (LBS/HR)=423183.2 HC FLOW RATE (LBS/HR)= 61928.7

P-COND (PSIA)=162.4
TW209 (DEG-F)=207.0 TW210=154.6

PI305 (PSIG)= 43.0 PI306= 22.0
TW305 (DEG-F)= 94.5 TW306=115.5

CONDENSER DATA RUN COND-59 DATE 24-MAR-81 TIME 14-15

C3 (MOLE C/C)= .30 N-C4=2.97 I-C4=87.22 N-C4= .45 I-C5= 9.06

CW FLOW RATE (LBS/HR)=423614.2 HC FLOW RATE (LBS/HR)= 62164.0

P-COND (PSIA)=162.6
TW209 (DEG-F)=206.3 TW210=155.0

PI305 (PSIG)= 42.0 PI306= 21.5
TW305 (DEG-F)= 95.3 TW306=116.0

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CONDENSER DATA RUN COND-59  DATE 24-MAR-81  TIME 14-30

C3 (MOLE O/O)= .30  N-C4=2.97  I-C4=87.22  N-C4=  .45  I-C5= 9.06

CW FLOW RATE (LBS/HR)=423638.9     HC FLOW RATE (LBS/HR)= 62138.8

P-COND (PSIA)=162.6
TW209 (DEG-F)=206.2     TW210=154.9

PI305  (PSIG)= 42.0     PI306= 21.0
TW305 (DEG-F)= 95.0     TW306=116.0

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CONDENSER DATA RUN COND-59  DATE 24-MAR-81  TIME 14-45

C3 (MOLE O/O)= .30  N-C4=2.97  I-C4=87.22  N-C4=  .45  I-C5= 9.06

CW FLOW RATE (LBS/HR)=424177.6     HC FLOW RATE (LBS/HR)= 61885.7

P-COND (PSIA)=161.9
TW209 (DEG-F)=205.6     TW210=154.8

PI305  (PSIG)= 42.0     PI306= 21.0
TW305 (DEG-F)= 94.5     TW306=115.5

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CONDENSER DATA RUN COND-60  DATE 25-MAR-81  TIME 07-00

C3 (MOLE O/O)= .30  N-C4=2.97  I-C4=87.22  N-C4=  .45  I-C5= 9.06

CW FLOW RATE (LBS/HR)=370407.9     HC FLOW RATE (LBS/HR)= 38135.0

P-COND (PSIA)=103.5
TW209 (DEG-F)=221.8     TW210=125.3

PI305  (PSIG)= 31.5     PI306= 15.0
TW305 (DEG-F)= 78.5     TW306= 96.5

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CONDENSER DATA RUN COND-60  DATE 25-MAR-81  TIME 07-15

C3 (MOLE O/O)= .30  N-C4=2.97  I-C4=87.22  N-C4=  .45  I-C5= 9.06

CW FLOW RATE (LBS/HR)=370407.9     HC FLOW RATE (LBS/HR)= 38407.3

P-COND (PSIA)=106.6
TW209 (DEG-F)=221.1     TW210=125.2

PI305  (PSIG)= 31.5     PI306= 15.0
TW305 (DEG-F)= 78.5     TW306= 96.4

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CONDENSER DATA RUN COND-60 DATE 25-MAR-81 TIME 07-45

C3 (MOLE O/O)= .30 N-C4=2.97 I-C4=87.22 N-C4= .45 I-C5= 9.06

CW FLOW RATE (LBS/HR)=370407.9 HC FLOW RATE (LBS/HR)= 38405.9

P-COND (PSIA)=109.4
TW209 (DEG-F)=220.9 TW210=125.4

PI305 (PSIG)= 31.9 PI306= 15.0
TW305 (DEG-F)= 78.5 TW306= 96.5

CONDENSER DATA RUN COND-60 DATE 25-MAR-81 TIME 08-00

C3 (MOLE O/O)= .30 N-C4=2.93 I-C4=87.22 N-C4= .45 I-C5= 9.06

CW FLOW RATE (LBS/HR)=370359.2 HC FLOW RATE (LBS/HR)= 38635.4

P-COND (PSIA)=111.0
TW209 (DEG-F)=220.0 TW210=126.2

PI305 (PSIG)= 32.0 PI306= 15.0
TW305 (DEG-F)= 79.4 TW306= 97.4

CONDENSER DATA RUN COND-60 DATE 25-MAR-81 TIME 08-15

C3 (MOLE O/O)= .30 N-C4=2.93 I-C4=87.22 N-C4= .45 I-C5= 9.06

CW FLOW RATE (LBS/HR)=369654.5 HC FLOW RATE (LBS/HR)= 38625.5

P-COND (PSIA)=111.5
TW209 (DEG-F)=221.1 TW210=126.7

PI305 (PSIG)= 32.0 PI306= 15.0
TW305 (DEG-F)= 79.5 TW306= 97.5

CONDENSER DATA RUN COND-61 DATE 25-MAR-81 TIME 09-30

C3 (MOLE O/O)= .30 N-C4=2.93 I-C4=87.22 N-C4= .45 I-C5= 9.06

CW FLOW RATE (LBS/HR)=170190.1 HC FLOW RATE (LBS/HR)= 44693.5

P-COND (PSIA)=138.9
TW209 (DEG-F)=201.4 TW210=144.3

PI305 (PSIG)= 71.0 PI306= 66.5
TW305 (DEG-F)= 80.8 TW306=120.2

CONDENSER DATA RUN COND-61 DATE 25-MAR-81 TIME 09-45

C3 (MOLE O/O)= .30 N-C4=2.93 I-C4=87.22 N-C4= .45 I-C5= 9.06

CW FLOW RATE (LBS/HR)=184129.1   HC FLOW RATE (LBS/HR)= 44102.0

P-COND (PSIA)=137.1
TW209 (DEG-F)=205.0   TW210=143.5

PI305 (PSIG)= 69.0   PI306= 63.0
TW305 (DEG-F)= 82.0   TW306=118.0

CONDENSER DATA RUN COND-61 DATE 25-MAR-81 TIME 10-00

C3 (MOLE O/O)= .30 N-C4=2.93 I-C4=87.22 N-C4= .45 I-C5= 9.06

CW FLOW RATE (LBS/HR)=199098.6   HC FLOW RATE (LBS/HR)= 45431.3

P-COND (PSIA)=134.0
TW209 (DEG-F)=205.4   TW210=143.1

PI305 (PSIG)= 68.5   PI306= 60.0
TW305 (DEG-F)= 82.0   TW306=117.4

CONDENSER DATA RUN COND-61 DATE 25-MAR-81 TIME 10-15

C3 (MOLE O/O)= .30 N-C4=2.93 I-C4=87.22 N-C4= .45 I-C5= 9.06

CW FLOW RATE (LBS/HR)=197102.7   HC FLOW RATE (LBS/HR)= 43560.3

P-COND (PSIA)=135.3
TW209 (DEG-F)=206.8   TW210=142.8

PI305 (PSIG)= 68.5   PI306= 60.0
TW305 (DEG-F)= 82.0   TW306=116.6

CONDENSER DATA RUN COND-61 DATE 25-MAR-81 TIME 10-45

C3 (MOLE O/O)= .30 N-C4=2.93 I-C4=87.22 N-C4= .45 I-C5= 9.06

CW FLOW RATE (LBS/HR)=202058.9   HC FLOW RATE (LBS/HR)= 43821.0

P-COND (PSIA)=135.1
TW209 (DEG-F)=207.0   TW210=142.1

PI305 (PSIG)= 66.0   PI306= 59.0
TW305 (DEG-F)= 83.0   TW306=116.0

CONDENSER DATA RUN COND-61 DATE 25-MAR-81 TIME 11-00

C3 (MOLE C/C)= .30 N-C4=2.93 I-C4=87.22 N-C4= .45 I-C5= 9.06

CW FLOW RATE (LBS/HR)=206552.1 HC FLOW RATE (LBS/HR)= 43814.7

P-COND (PSIA)=134.3
TW209 (DEG-F)=206.6 TW210=141.9

PI305 (PSIG)= 65.5 PI306= 59.0
TW305 (DEG-F)= 82.9 TW306=116.0

CONDENSER DATA RUN COND-62 DATE 25-MAR-81 TIME 11-30

C3 (MOLE C/C)= .30 N-C4=2.93 I-C4=87.22 N-C4= .45 I-C5= 9.06

CW FLOW RATE (LBS/HR)=399165.3 HC FLOW RATE (LBS/HR)= 62640.2

P-COND (PSIA)=201.7
TW209 (DEG-F)=214.4 TW210=176.5

PI305 (PSIG)= 67.0 PI306= 47.5
TW305 (DEG-F)=118.6 TW306=139.0

CONDENSER DATA RUN COND-62 DATE 25-MAR-81 TIME 11-45

C3 (MOLE C/C)= .30 N-C4=2.93 I-C4=87.22 N-C4= .45 I-C5= 9.06

CW FLOW RATE (LBS/HR)=399620.6 HC FLOW RATE (LBS/HR)= 63814.4

P-COND (PSIA)=201.5
TW209 (DEG-F)=211.4 TW210=176.8

PI305 (PSIG)= 67.0 PI306= 47.1
TW305 (DEG-F)=119.0 TW306=139.5

CONDENSER DATA RUN COND-62 DATE 25-MAR-81 TIME 12-00

C3 (MOLE C/C)= .30 N-C4=2.93 I-C4=87.22 N-C4= .45 I-C5= 9.06

CW FLOW RATE (LBS/HR)=400610.3 HC FLOW RATE (LBS/HR)= 64036.8

P-COND (PSIA)=202.2
TW209 (DEG-F)=211.4 TW210=177.0

PI305 (PSIG)= 66.9 PI306= 47.1
TW305 (DEG-F)=119.0 TW306=139.3

CONDENSER DATA RUN CCND-62 DATE 25-MAR-81 TIME 12-15

C3 (MOLE C/C)= .30 N-C4=2.93 I-C4=87.22 N-C4= .45 I-C5= 9.06

CW FLOW RATE (LBS/HR)=399669.9 HC FLOW RATE (LBS/HR)= 63549.7

P-CCND (PSIA)=201.6
TW209 (DEG-F)=211.4 TW210=176.6

PI305 (PSIG)= 66.5 PI306= 47.0
TW305 (DEG-F)=118.5 TW306=138.8

CONDENSER DATA RUN CCND-62 DATE 25-MAR-81 TIME 12-30

C3 (MOLE C/C)= .30 N-C4=2.93 I-C4=87.22 N-C4= .45 I-C5= 9.06

CW FLOW RATE (LBS/HR)=400115.2 HC FLOW RATE (LBS/HR)= 64036.4

P-CCND (PSIA)=202.0
TW209 (DEG-F)=210.8 TW210=177.3

PI305 (PSIG)= 66.5 PI306= 47.0
TW305 (DEG-F)=119.0 TW306=139.0

CONDENSER DATA RUN CCND-63 DATE 25-MAR-81 TIME 13-15

C3 (MOLE C/C)= .30 N-C4=2.93 I-C4=87.22 N-C4= .45 I-C5= 9.06

CW FLOW RATE (LBS/HR)=483493.9 HC FLOW RATE (LBS/HR)= 64831.6

P-CCND (PSIA)=202.1
TW209 (DEG-F)=207.8 TW210=177.6

PI305 (PSIG)= 45.0 PI306= 27.0
TW305 (DEG-F)= 99.0 TW306=116.0

CONDENSER DATA RUN CCND-63 DATE 25-MAR-81 TIME 13-30

C3 (MOLE C/C)= .30 N-C4=2.93 I-C4=87.22 N-C4= .45 I-C5= 9.06

CW FLOW RATE (LBS/HR)=483961.6 HC FLOW RATE (LBS/HR)= 64519.1

P-CCND (PSIA)=202.4
TW209 (DEG-F)=207.2 TW210=177.8

PI305 (PSIG)= 45.0 PI306= 27.5
TW305 (DEG-F)= 99.3 TW306=116.0

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CONDENSER DATA RUN COND-63   DATE 25-MAR-81   TIME 13-45

C3 (MOLE C/C)= .30  N-C4=2.93  I-C4=87.22  N-C4=   .45  I-C5= 9.06

CW FLOW RATE (LBS/HR)=483493.9      HC FLOW RATE (LBS/HR)= 64340.6

P-COND (PSIA)=201.4
TW209 (DEG-F)=206.4      TW210=177.8

PI305  (PSIG)= 45.0      PI306= 27.5
TW305 (DEG-F)= 99.0      TW306=115.5

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CONDENSER DATA RUN COND-63   DATE 25-MAR-81   TIME 14-00

C3 (MOLE C/C)= .30  N-C4=2.93  I-C4=87.22  N-C4=   .45  I-C5= 9.06

CW FLOW RATE (LBS/HR)=484480.3      HC FLOW RATE (LBS/HR)= 64793.5

P-COND (PSIA)=201.5
TW209 (DEG-F)=205.8      TW210=177.0

PI305  (PSIG)= 46.0      PI306= 27.5
TW305 (DEG-F)= 99.1      TW306=115.2

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CONDENSER DATA RUN COND-63   DATE 25-MAR-81   TIME 14-15

C3 (MOLE C/C)= .30  N-C4=2.93  I-C4=87.22  N-C4=   .45  I-C5= 9.06

CW FLOW RATE (LBS/HR)=484538.0      HC FLOW RATE (LBS/HR)= 64037.5

P-COND (PSIA)=201.0
TW209 (DEG-F)=206.4      TW210=177.2

PI305  (PSIG)= 45.0      PI306= 27.5
TW305 (DEG-F)= 98.5      TW306=115.1

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NOMINAL 80/20 HEATER DATA

CONDENSER DATA RUN COND-64 DATE 27-MAR-81 TIME 10-00

C3 (MOLE C/C)= .26 N-C4=2.55 I-C4=74.90 N-C4= 1.05 I-C5=21.24

CW FLOW RATE (LBS/HR)=399186.0   HC FLOW RATE (LBS/HR)= 70334.6

P-COND (PSIA)=204.3
TW209 (DEG-F)=229.6   TW210=163.2

PI305 (PSIG)= 51.0   PI306= 29.0
TW305 (DEG-F)=102.0   TW306=129.4

CONDENSER DATA RUN COND-64 DATE 27-MAR-81 TIME 10-30

C3 (MOLE C/C)= .26 N-C4=2.55 I-C4=74.90 N-C4= 1.05 I-C5=21.24

CW FLOW RATE (LBS/HR)=392261.7   HC FLOW RATE (LBS/HR)= 74443.6

P-COND (PSIA)=203.9
TW209 (DEG-F)=217.0   TW210=184.9

PI305 (PSIG)= 59.0   PI306= 38.0
TW305 (DEG-F)=113.0   TW306=138.0

CONDENSER DATA RUN COND-64 DATE 27-MAR-81 TIME 10-45

C3 (MOLE C/C)= .26 N-C4=2.55 I-C4=74.90 N-C4= 1.05 I-C5=21.24

CW FLOW RATE (LBS/HR)=391645.4   HC FLOW RATE (LBS/HR)= 74957.9

P-COND (PSIA)=205.8
TW209 (DEG-F)=217.0   TW210=186.8

PI305 (PSIG)= 60.0   PI306= 39.0
TW305 (DEG-F)=114.3   TW306=139.2

CONDENSER DATA RUN COND-64 DATE 27-MAR-81 TIME 11-00

C3 (MOLE C/C)= .26 N-C4=2.55 I-C4=74.90 N-C4= 1.05 I-C5=21.24

CW FLOW RATE (LBS/HR)=392655.8   HC FLOW RATE (LBS/HR)= 77677.6

P-COND (PSIA)=206.4
TW209 (DEG-F)=213.1   TW210=187.8

PI305 (PSIG)= 60.0   PI306= 39.0
TW305 (DEG-F)=114.1   TW306=139.2

CONDENSER DATA RUN COND-64 DATE 27-MAR-81 TIME 11-25

C3 (MOLE C/C)= .26 N-C4=2.55 I-C4=74.90 N-C4= 1.05 I-C5=21.24

CW FLOW RATE (LBS/HR)=392261.7 HC FLOW RATE (LBS/HR)= 80298.7

P-COND (PSIA)=205.3
TW209 (DEG-F)=202.5 TW210=187.1

PI305 (PSIG)= 59.0 PI306= 38.0
TW305 (DEG-F)=113.0 TW306=138.1

CONDENSER DATA RUN COND-64 DATE 27-MAR-81 TIME 12-00

C3 (MOLE C/C)= .26 N-C4=2.55 I-C4=74.90 N-C4= 1.05 I-C5=21.24

CW FLOW RATE (LBS/HR)=391765.8 HC FLOW RATE (LBS/HR)= 82485.7

P-COND (PSIA)=205.9
TW209 (DEG-F)=202.4 TW210=187.3

PI305 (PSIG)= 59.0 PI306= 38.0
TW305 (DEG-F)=113.0 TW306=138.5

CONDENSER DATA RUN COND-65 DATE 27-MAR-81 TIME 12-45

C3 (MOLE C/C)= .26 N-C4=2.55 I-C4=74.90 N-C4= 1.05 I-C5=21.24

CW FLOW RATE (LBS/HR)=402954.4 HC FLOW RATE (LBS/HR)= 72992.0

P-COND (PSIA)=179.7
TW209 (DEG-F)=212.6 TW210=173.3

PI305 (PSIG)= 46.5 PI306= 24.5
TW305 (DEG-F)= 98.9 TW306=124.0

CONDENSER DATA RUN COND-65 DATE 27-MAR-81 TIME 13-00

C3 (MOLE C/C)= .26 N-C4=2.55 I-C4=74.90 N-C4= 1.05 I-C5=21.24

CW FLOW RATE (LBS/HR)=404485.8 HC FLOW RATE (LBS/HR)= 72393.6

P-COND (PSIA)=179.0
TW209 (DEG-F)=212.8 TW210=172.4

PI305 (PSIG)= 45.0 PI306= 23.2
TW305 (DEG-F)= 98.0 TW306=123.5

CONDENSER DATA RUN COND-65 DATE 27-MAR-81 TIME 13-15

C3 (MOLE C/C)= .26 N-C4=2.55 I-C4=74.90 N-C4= 1.05 I-C5=21.24

CW FLOW RATE (LBS/HR)=404004.6 HC FLOW RATE (LBS/HR)= 72385.0

P-COND (PSIA)=178.2
TW209 (DEG-F)=214.0 TW210=172.6

PI305 (PSIG)= 45.0 PI306= 22.5
TW305 (DEG-F)= 97.8 TW306=123.1

CONDENSER DATA RUN COND-65 DATE 27-MAR-81 TIME 13-45

C3 (MOLE C/C)= .26 N-C4=2.55 I-C4=74.90 N-C4= 1.05 I-C5=21.24

CW FLOW RATE (LBS/HR)=402592.3 HC FLOW RATE (LBS/HR)= 69132.7

P-COND (PSIA)=169.8
TW209 (DEG-F)=214.0 TW210=172.3

PI305 (PSIG)= 45.0 PI306= 22.5
TW305 (DEG-F)= 96.8 TW306=122.2

CONDENSER DATA RUN COND-65 DATE 27-MAR-81 TIME 14-00

C3 (MOLE C/C)= .26 N-C4=2.55 I-C4=74.90 N-C4= 1.05 I-C5=21.24

CW FLOW RATE (LBS/HR)=403572.8 HC FLOW RATE (LBS/HR)= 72210.9

P-COND (PSIA)=170.2
TW209 (DEG-F)=213.4 TW210=172.2

PI305 (PSIG)= 46.0 PI306= 24.0
TW305 (DEG-F)= 97.0 TW306=122.5

CONDENSER DATA RUN COND-65 DATE 27-MAR-81 TIME 14-15

C3 (MOLE C/C)= .26 N-C4=2.55 I-C4=74.90 N-C4= 1.05 I-C5=21.24

CW FLOW RATE (LBS/HR)=402537.4 HC FLOW RATE (LBS/HR)= 72206.4

P-COND (PSIA)=170.4
TW209 (DEG-F)=212.4 TW210=173.0

PI305 (PSIG)= 46.0 PI306= 24.0
TW305 (DEG-F)= 97.5 TW306=122.8

CONDENSER DATA RUN COND-66 DATE 27-MAR-81 TIME 15-00

C3 (MOLE C/C)= .26 N-C4=2.55 I-C4=74.90 N-C4= 1.05 I-C5=21.24

CW FLOW RATE (LBS/HR)=266366.2 HC FLOW RATE (LBS/HR)= 69150.3

P-COND (PSIA)=160.4
TW209 (DEG-F)=210.4 TW210=167.2

PI305 (PSIG)= 55.0 PI306= 45.0
TW305 (DEG-F)= 84.0 TW306=121.5

CONDENSER DATA RUN COND-66 DATE 27-MAR-81 TIME 15-15

C3 (MOLE C/C)= .26 N-C4=2.55 I-C4=74.90 N-C4= 1.05 I-C5=21.24

CW FLOW RATE (LBS/HR)=265867.8 HC FLOW RATE (LBS/HR)= 69695.2

P-COND (PSIA)=160.5
TW209 (DEG-F)=211.2 TW210=167.4

PI305 (PSIG)= 55.5 PI306= 45.0
TW305 (DEG-F)= 84.0 TW306=121.6

CONDENSER DATA RUN COND-66 DATE 27-MAR-81 TIME 15-30

C3 (MOLE C/C)= .26 N-C4=2.55 I-C4=74.90 N-C4= 1.05 I-C5=21.24

CW FLOW RATE (LBS/HR)=266362.3 HC FLOW RATE (LBS/HR)= 69431.4

P-COND (PSIA)=160.1
TW209 (DEG-F)=210.8 TW210=167.3

PI305 (PSIG)= 55.5 PI306= 45.0
TW305 (DEG-F)= 84.1 TW306=121.5

CONDENSER DATA RUN COND-66 DATE 27-MAR-81 TIME 15-45

C3 (MOLE C/C)= .26 N-C4=2.55 I-C4=74.90 N-C4= 1.05 I-C5=21.24

CW FLOW RATE (LBS/HR)=263881.5 HC FLOW RATE (LBS/HR)= 69422.1

P-COND (PSIA)=160.5
TW209 (DEG-F)=210.0 TW210=167.4

PI305 (PSIG)= 56.0 PI306= 45.5
TW305 (DEG-F)= 83.8 TW306=121.9

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CONDENSER DATA RUN COND-66  DATE 27-MAR-81  TIME 16-00

C3 (MOLE C/C)= .26  N-C4=2.55  I-C4=74.90  N-C4= 1.05  I-C5=21.24

CW FLOW RATE (LBS/HR)=261899.0      HC FLOW RATE (LBS/HR)= 69150.8

P-COND (PSIA)=160.8
TW209 (DEG-F)=210.2       TW210=167.5

PI305  (PSIG)= 56.0       PI306= 46.0
TW305 (DEG-F)= 83.5       TW306=122.0

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CONDENSER DATA RUN COND-66  DATE 27-MAR-81  TIME 16-15

C3 (MOLE C/C)= .26  N-C4=2.55  I-C4=74.90  N-C4= 1.05  I-C5=21.24

CW FLOW RATE (LBS/HR)=257907.7      HC FLOW RATE (LBS/HR)= 69405.0

P-COND (PSIA)=161.0
TW209 (DEG-F)=210.2       TW210=167.7

PI305  (PSIG)= 55.5       PI306= 47.0
TW305 (DEG-F)= 83.5       TW306=122.4

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CONDENSER DATA RUN COND-66  DATE 27-MAR-81  TIME 16-30

C3 (MOLE C/C)= .26  N-C4=2.55  I-C4=74.90  N-C4= 1.05  I-C5=21.24

CW FLOW RATE (LBS/HR)=258420.3      HC FLOW RATE (LBS/HR)= 69422.3

P-COND (PSIA)=160.8
TW209 (DEG-F)=209.0       TW210=167.3

PI305  (PSIG)= 57.0       PI306= 47.0
TW305 (DEG-F)= 83.2       TW306=122.1

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CONDENSER DATA RUN COND-67  DATE 28-MAR-81  TIME 07-00

C3 (MOLE C/C)= .26  N-C4=2.55  I-C4=74.90  N-C4= 1.05  I-C5=21.24

CW FLOW RATE (LBS/HR)=242138.9      HC FLOW RATE (LBS/HR)= 60854.9

P-COND (PSIA)=140.5
TW209 (DEG-F)=192.0       TW210=155.6

PI305  (PSIG)= 61.0       PI306= 51.0
TW305 (DEG-F)= 78.4       TW306=115.0

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CONDENSER DATA RUN COND-67 DATE 28-MAR-81 TIME 07-15

C3 (MOLE C/C)= .26 N-C4=2.55 I-C4=74.90 N-C4= 1.05 I-C5=21.24

CW FLOW RATE (LBS/HR)=241643.2 HC FLOW RATE (LBS/HR)= 61086.6

P-COND (PSIA)=140.9
TW209 (DEG-F)=191.6 TW210=155.9

PI305 (PSIG)= 61.0 PI306= 51.0
TW305 (DEG-F)= 78.3 TW306=114.9

CONDENSER DATA RUN COND-67 DATE 28-MAR-81 TIME 07-30

C3 (MOLE C/C)= .26 N-C4=2.55 I-C4=74.90 N-C4= 1.05 I-C5=21.24

CW FLOW RATE (LBS/HR)=241650.3 HC FLOW RATE (LBS/HR)= 61358.5

P-COND (PSIA)=140.9
TW209 (DEG-F)=191.5 TW210=155.9

PI305 (PSIG)= 61.0 PI306= 51.0
TW305 (DEG-F)= 78.1 TW306=114.9

CONDENSER DATA RUN COND-67 DATE 28-MAR-81 TIME 07-45

C3 (MOLE C/C)= .26 N-C4=2.55 I-C4=74.90 N-C4= 1.05 I-C5=21.24

CW FLOW RATE (LBS/HR)=242135.4 HC FLOW RATE (LBS/HR)= 61605.7

P-COND (PSIA)=141.2
TW209 (DEG-F)=191.0 TW210=156.0

PI305 (PSIG)= 61.0 PI306= 51.0
TW305 (DEG-F)= 78.5 TW306=115.0

CONDENSER DATA RUN COND-67 DATE 28-MAR-81 TIME 08-00

C3 (MOLE C/C)= .26 N-C4=2.55 I-C4=74.90 N-C4= 1.05 I-C5=21.24

CW FLOW RATE (LBS/HR)=245630.1 HC FLOW RATE (LBS/HR)= 61852.4

P-COND (PSIA)=141.3
TW209 (DEG-F)=191.0 TW210=155.9

PI305 (PSIG)= 61.0 PI306= 50.5
TW305 (DEG-F)= 78.5 TW306=115.1

CONDENSER DATA RUN COND-67 DATE 28-MAR-81 TIME 08-15

C3 (MOLE C/C)= .26 N-C4=2.55 I-C4=74.90 N-C4= 1.05 I-C5=21.24

CW FLOW RATE (LBS/HR)=250123.4 HC FLOW RATE (LBS/HR)= 61564.9

P-COND (PSIA)=140.7
TW209 (DEG-F)=191.0 TW210=155.8

PI305 (PSIG)= 61.0 PI306= 50.0
TW305 (DEG-F)= 78.5 TW306=114.6

CONDENSER DATA RUN COND-68 DATE 28-MAR-81 TIME 09-45

C3 (MOLE C/C)= .26 N-C4=2.55 I-C4=74.90 N-C4= 1.05 I-C5=21.24

CW FLOW RATE (LBS/HR)=434537.6 HC FLOW RATE (LBS/HR)= 33844.5

P-COND (PSIA)= 86.8
TW209 (DEG-F)=190.0 TW210=113.0

PI305 (PSIG)= 44.0 PI306= 17.5
TW305 (DEG-F)= 75.0 TW306= 88.7

CONDENSER DATA RUN COND-68 DATE 28-MAR-81 TIME 10-45

C3 (MOLE C/C)= .26 N-C4=2.55 I-C4=74.90 N-C4= 1.05 I-C5=21.24

CW FLOW RATE (LBS/HR)=434508.0 HC FLOW RATE (LBS/HR)= 33559.9

P-COND (PSIA)= 88.1
TW209 (DEG-F)=206.2 TW210=115.1

PI305 (PSIG)= 44.0 PI306= 17.5
TW305 (DEG-F)= 75.5 TW306= 89.5

CONDENSER DATA RUN COND-68 DATE 28-MAR-81 TIME 11-15

C3 (MOLE C/C)= .26 N-C4=2.55 I-C4=74.90 N-C4= 1.05 I-C5=21.24

CW FLOW RATE (LBS/HR)=434490.0 HC FLOW RATE (LBS/HR)= 33017.0

P-COND (PSIA)= 91.1
TW209 (DEG-F)=226.1 TW210=112.0

PI305 (PSIG)= 44.0 PI306= 17.0
TW305 (DEG-F)= 75.9 TW306= 90.5

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CONDENSER DATA RUN COND-68  DATE 28-MAR-81  TIME 11-45

C3 (MOLE C/C)= .26  N-C4=2.55  I-C4=74.90  N-C4= 1.05  I-C5=21.24

CW FLOW RATE (LBS/HR)=434459.1     HC FLOW RATE (LBS/HR)= 32996.4

P-COND (PSIA)= 91.5
TW209 (DEG-F)=226.5      TW210=113.3

PI305  (PSIG)= 43.5      PI306= 17.0
TW305 (DEG-F)= 76.3      TW306= 91.0

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CONDENSER DATA RUN COND-68  DATE 28-MAR-81  TIME 12-00

C3 (MOLE C/C)= .26  N-C4=2.55  I-C4=74.90  N-C4= 1.05  I-C5=21.24

CW FLOW RATE (LBS/HR)=434447.6     HC FLOW RATE (LBS/HR)= 32718.7

P-COND (PSIA)= 91.6
TW209 (DEG-F)=226.7      TW210=113.4

PI305  (PSIG)= 44.0      PI306= 17.0
TW305 (DEG-F)= 76.5      TW306= 91.0

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CONDENSER DATA RUN COND-68  DATE 28-MAR-81  TIME 12-15

C3 (MOLE C/C)= .26  N-C4=2.55  I-C4=74.90  N-C4= 1.05  I-C5=21.24

CW FLOW RATE (LBS/HR)=433954.3     HC FLOW RATE (LBS/HR)= 32987.9

P-COND (PSIA)= 91.4
TW209 (DEG-F)=226.3      TW210=113.2

PI305  (PSIG)= 44.0      PI306= 17.5
TW305 (DEG-F)= 76.4      TW306= 91.0

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CONDENSER DATA RUN COND-68  DATE 28-MAR-81  TIME 12-30

C3 (MOLE C/C)= .26  N-C4=2.55  I-C4=74.90  N-C4= 1.05  I-C5=21.24

CW FLOW RATE (LBS/HR)=434447.6     HC FLOW RATE (LBS/HR)= 32988.2

P-COND (PSIA)= 91.9
TW209 (DEG-F)=226.9      TW210=113.0

PI305  (PSIG)= 44.0      PI306= 17.5
TW305 (DEG-F)= 76.9      TW306= 91.0

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CONDENSER DATA RUN COND-69 DATE 28-MAR-81 TIME 14-00

C3 (MOLE O/O)= .26 N-C4=2.55 I-C4=74.90 N-C4= 1.05 I-C5=21.24

CW FLOW RATE (LBS/HR)=433626.7 HC FLOW RATE (LBS/HR)= 47359.3

P-COND (PSIA)=130.8
TW209 (DEG-F)=245.1 TW210=131.9

PI305 (PSIG)= 44.0 PI306= 17.0
TW305 (DEG-F)= 81.9 TW306=102.5

CONDENSER DATA RUN COND-69 DATE 28-MAR-81 TIME 14-15

C3 (MOLE O/O)= .26 N-C4=2.55 I-C4=74.90 N-C4= 1.05 I-C5=21.24

CW FLOW RATE (LBS/HR)=432129.7 HC FLOW RATE (LBS/HR)= 47346.8

P-COND (PSIA)=130.6
TW209 (DEG-F)=244.8 TW210=131.6

PI305 (PSIG)= 44.0 PI306= 17.0
TW305 (DEG-F)= 81.9 TW306=102.5

CONDENSER DATA RUN COND-69 DATE 28-MAR-81 TIME 14-30

C3 (MOLE O/O)= .26 N-C4=2.55 I-C4=74.90 N-C4= 1.05 I-C5=21.24

CW FLOW RATE (LBS/HR)=433592.8 HC FLOW RATE (LBS/HR)= 47489.9

P-COND (PSIA)=131.2
TW209 (DEG-F)=244.4 TW210=131.9

PI305 (PSIG)= 44.0 PI306= 17.0
TW305 (DEG-F)= 82.0 TW306=102.7

CONDENSER DATA RUN COND-69 DATE 28-MAR-81 TIME 14-40

C3 (MOLE O/O)= .26 N-C4=2.55 I-C4=74.90 N-C4= 1.05 I-C5=21.24

CW FLOW RATE (LBS/HR)=433585.9 HC FLOW RATE (LBS/HR)= 47596.1

P-COND (PSIA)=131.3
TW209 (DEG-F)=244.8 TW210=132.0

PI305 (PSIG)= 44.0 PI306= 17.0
TW305 (DEG-F)= 82.1 TW306=103.0

CONDENSER DATA RUN COND-69 DATE 28-MAR-81 TIME 14-45

C3 (MOLE C/C)= .26	N-C4=2.55	I-C4=74.90	N-C4= 1.05	I-C5=21.24
CW FLOW RATE (LBS/HR)=433080.1		HC FLOW RATE (LBS/HR)= 54435.5		
P-COND (PSIA)=130.9				
TW209 (DEG-F)=213.0	TW210=138.4			
PI305 (PSIG)= 44.0	PI306= 17.5			
TW305 (DEG-F)= 82.2	TW306=103.4			

CONDENSER DATA RUN COND-70 DATE 29-MAR-81 TIME 08-30

C3 (MOLE C/C)= .26	N-C4=2.55	I-C4=74.90	N-C4= 1.05	I-C5=21.24
CW FLOW RATE (LBS/HR)=381315.2		HC FLOW RATE (LBS/HR)= 89392.9		
P-COND (PSIA)=207.6				
TW209 (DEG-F)=221.6	TW210=190.8			
PI305 (PSIG)= 67.0	PI306= 45.0			
TW305 (DEG-F)=107.9	TW306=127.5			

CONDENSER DATA RUN COND-70 DATE 29-MAR-81 TIME 08-45

C3 (MOLE C/C)= .26	N-C4=2.55	I-C4=74.90	N-C4= 1.05	I-C5=21.24
CW FLOW RATE (LBS/HR)=381794.9		HC FLOW RATE (LBS/HR)= 94322.9		
P-COND (PSIA)=206.7				
TW209 (DEG-F)=210.4	TW210=190.2			
PI305 (PSIG)= 60.0	PI306= 38.0			
TW305 (DEG-F)=108.0	TW306=127.0			

CONDENSER DATA RUN COND-70 DATE 29-MAR-81 TIME 09-15

C3 (MOLE C/C)= .26	N-C4=2.55	I-C4=74.90	N-C4= 1.05	I-C5=21.24
CW FLOW RATE (LBS/HR)=389751.0		HC FLOW RATE (LBS/HR)= 89900.5		
P-COND (PSIA)=207.5				
TW209 (DEG-F)=239.0	TW210=191.1			
PI305 (PSIG)= 51.0	PI306= 29.0			
TW305 (DEG-F)=101.9	TW306=143.2			

CONDENSER DATA RUN COND-70 DATE 29-MAR-81 TIME 09-30

C3 (MOLE O/O)= .26 N-C4=2.55 I-C4=74.90 N-C4= 1.05 I-C5=21.24

CW FLOW RATE (LBS/HR)=390794.6 HC FLOW RATE (LBS/HR)= 89579.1

P-COND (PSIA)=206.4
TW209 (DEG-F)=239.0 TW210=190.9

PI305 (PSIG)= 51.0 PI306= 28.0
TW305 (DEG-F)=101.3 TW306=143.5

CONDENSER DATA RUN COND-70 DATE 29-MAR-81 TIME 09-45

C3 (MOLE O/O)= .26 N-C4=2.55 I-C4=74.90 N-C4= 1.05 I-C5=21.24

CW FLOW RATE (LBS/HR)=390289.2 HC FLOW RATE (LBS/HR)= 84370.1

P-COND (PSIA)=205.2
TW209 (DEG-F)=249.5 TW210=190.4

PI305 (PSIG)= 51.0 PI306= 28.5
TW305 (DEG-F)=101.4 TW306=143.5

CONDENSER DATA RUN COND-70 DATE 29-MAR-81 TIME 10-10

C3 (MOLE O/O)= .26 N-C4=2.55 I-C4=74.90 N-C4= 1.05 I-C5=21.24

CW FLOW RATE (LBS/HR)=390076.5 HC FLOW RATE (LBS/HR)= 75442.4

P-COND (PSIA)=205.7
TW209 (DEG-F)=264.6 TW210=190.1

PI305 (PSIG)= 54.0 PI306= 32.0
TW305 (DEG-F)=104.0 TW306=132.5

CONDENSER DATA RUN COND-70 DATE 29-MAR-81 TIME 10-20

C3 (MOLE O/O)= .26 N-C4=2.55 I-C4=74.90 N-C4= 1.05 I-C5=21.24

CW FLOW RATE (LBS/HR)=387696.8 HC FLOW RATE (LBS/HR)= 77380.2

P-COND (PSIA)=203.9
TW209 (DEG-F)=240.6 TW210=189.3

PI305 (PSIG)= 59.0 PI306= 37.0
TW305 (DEG-F)=108.6 TW306=135.0

CONDENSER DATA RUN COND-70 DATE 29-MAR-81 TIME 10-30

C3 (MOLE O/O)= .26 N-C4=2.55 I-C4=74.90 N-C4= 1.05 I-C5=21.24

CW FLOW RATE (LBS/HR)=386870.8 HC FLOW RATE (LBS/HR)= 78252.6

P-COND (PSIA)=204.7
TW209 (DEG-F)=244.5 TW210=189.6

PI305 (PSIG)= 59.0 PI306= 37.0
TW305 (DEG-F)=109.0 TW306=135.5

CONDENSER DATA RUN COND-70 DATE 29-MAR-81 TIME 10-40

C3 (MOLE O/O)= .26 N-C4=2.55 I-C4=74.90 N-C4= 1.05 I-C5=21.24

CW FLOW RATE (LBS/HR)=387115.1 HC FLOW RATE (LBS/HR)= 74745.7

P-COND (PSIA)=204.3
TW209 (DEG-F)=271.0 TW210=189.7

PI305 (PSIG)= 60.0 PI306= 38.0
TW305 (DEG-F)=109.6 TW306=136.0

CONDENSER DATA RUN COND-70 DATE 29-MAR-81 TIME 10-50

C3 (MOLE O/O)= .26 N-C4=2.55 I-C4=74.90 N-C4= 1.05 I-C5=21.24

CW FLOW RATE (LBS/HR)=386618.8 HC FLOW RATE (LBS/HR)= 74784.1

P-COND (PSIA)=204.4
TW209 (DEG-F)=252.4 TW210=189.7

PI305 (PSIG)= 60.0 PI306= 38.0
TW305 (DEG-F)=109.6 TW306=136.0

CONDENSER DATA RUN COND-71 DATE 29-MAR-81 TIME 11-15

C3 (MOLE O/O)= .26 N-C4=2.55 I-C4=74.90 N-C4= 1.05 I-C5=21.24

CW FLOW RATE (LBS/HR)=485927.2 HC FLOW RATE (LBS/HR)= 79479.1

P-COND (PSIA)=218.8
TW209 (DEG-F)=205.0 TW210=195.6

PI305 (PSIG)= 33.2 PI306= 13.5
TW305 (DEG-F)= 94.2 TW306=114.1

CONDENSER DATA RUN COND-71 DATE 29-MAR-81 TIME 11-30

C3 (MOLE C/C)= .26 N-C4=2.55 I-C4=74.90 N-C4= 1.05 I-C5=21.24

CW FLOW RATE (LBS/HR)=487401.9   HC FLOW RATE (LBS/HR)= 79436.4

P-COND (PSIA)=218.8
TW209 (DEG-F)=243.3   TW210=195.7

PI305 (PSIG)= 33.0   PI306= 13.5
TW305 (DEG-F)= 94.4   TW306=114.8

CONDENSER DATA RUN COND-71 DATE 29-MAR-81 TIME 11-45

C3 (MOLE C/C)= .26 N-C4=2.55 I-C4=74.90 N-C4= 1.05 I-C5=21.24

CW FLOW RATE (LBS/HR)=486406.1   HC FLOW RATE (LBS/HR)= 79936.0

P-COND (PSIA)=219.8
TW209 (DEG-F)=243.0   TW210=196.2

PI305 (PSIG)= 33.0   PI306= 13.7
TW305 (DEG-F)= 94.4   TW306=115.0

CONDENSER DATA RUN COND-71 DATE 29-MAR-81 TIME 12-00

C3 (MOLE C/C)= .26 N-C4=2.55 I-C4=74.90 N-C4= 1.05 I-C5=21.24

CW FLOW RATE (LBS/HR)=485898.9   HC FLOW RATE (LBS/HR)= 79926.8

P-COND (PSIA)=220.2
TW209 (DEG-F)=243.0   TW210=196.2

PI305 (PSIG)= 33.0   PI306= 13.5
TW305 (DEG-F)= 94.9   TW306=115.0
