Simulation of FCC Fractionator using ASPEN PLUS

A project report submitted in partial fulfillment of degree

MASTER OF TECHNOLOGY

In

Refining and Petrochemical Engineering

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By

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CERTIFICATE

This is to certify that **Mr. Mayur Ronghe,** a student of M.Tech (Refining & Petrochemical), final semester from **University of Petroleum & Energy Studies, Dehradun** has undergone Vocational Training at **Indian Oil Corporation Limited, R&D Centre, Faridabad** from **15.03.07** to **30.04.07**. During this training period, he worked on the project "**Simulation of FCC main fractionators using ASPEN PLUS**" in Hydroprocessing Division of R&D Centre.

He was found quite sincere and hard working during this period.

I wish him all the success in his future career.

(S.M.sanduja)
Dy. Manager (Training)

UNIVERSITY OF PETROLEUM & ENERGY STUDIES

CERTIFICATE

This is to certify that the project work entitled " **Simulation of FCC fractionator using ASPEN PLUS** " submitted by **Mayur Ronghe** in partial fulfillment of the requirements for the award of the degree of Master of Technology (Refining and Petrochemical Engineering), at College of Engineering, University of Petroleum and Energy Studies, Dehradun, is a record of the work carried out by him at Indian Oil Corporation Limited (Research and Development Centre), Faridabad under the guidance of Mr. C. Bennet (Chemical Engineering Division) and myself.

This work has not been submitted elsewhere for the degree.

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MAYUR RONGHE

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Chapter 1

Introduction

In the refinery operations catalytic cracking has a great importance because it breaks complex hydrocarbons into simpler molecules in order to increase the quality and quantity of lighter, more desirable products and decrease the amount of residuals. This process rearranges the molecular structure of hydrocarbon compounds to convert heavy hydrocarbon feedstock into lighter fractions such as kerosene, gasoline, LPG, heating oil, and petrochemical feedstock.

Catalytic cracking is similar to thermal cracking except that catalysts facilitate the conversion of the heavier molecules into lighter products. Use of a catalyst (a material that assists a chemical reaction but does not take part in it) in the cracking reaction increases the yield of improved-quality products under much less severe operating conditions than in thermal cracking. Typical temperatures are from 450°-950° C at much lower pressures of 0.7-1.5 atm. The catalysts used in refinery cracking units are typically solid materials (zeolite, aluminum hydrosilicate, treated bentonite clay, fuller's earth, bauxite, and silica-alumina) that come in the form of powders, beads, pellets or shaped materials called extrudites.

There are three basic functions in the catalytic cracking process:

Reaction - Feedstock reacts with catalyst and cracks into different hydrocarbons;

Regeneration - Catalyst is reactivated by burning off coke; and

Fractionation - Cracked hydrocarbon stream is separated into various products.

The catalytic cracking process is very flexible, and operating parameters can be adjusted to meet changing product demand. In addition to cracking, catalytic activities include dehydrogenation, hydrogenation, and isomerization.[2]

Chapter 2

Fluid Catalytic Cracking

Fluid catalytic cracking is a catalytic conversion process for converting heavy gas oils, namely, vacuum distillates into more valuable products such as LPG, gasoline, cycle oils, olefin rich light hydrocarbons that may be further processed to even more valuable products and fuel oils. The fluid catalytic cracking is a low pressure, intermediate to high temperature process. This process may be designed and operated to achieve either of the processing objectives:

a) Maximization of middle distillates;

b) Maximization of LPG and gasoline.

Reactions in this process are believed to proceed through the formation of carbonium ions. These carbonium ions undergo a number of reactions which include isomerization, carbon - carbon bond scission, hydrogen transfer and termination. Praffines crack to form lighter paraffin and olefins by carbon-carbon bond scission. Isoparaffines crack more rapidly than normal paraffines of the same carbon number. A high degree of isomerization in catalytic cracking results in low yield of methane, ethane, and ethylene. The most reactive class of hydrocarbon is Olefins. Under severe conditions the high boiling point olefins are converted to low carbon number olefins in the LPG and light gasoline boiling ranges. The hydrogen transfer reactions stabilizes gasoline boiling range olefins formed by primary cracking of gas oil, prior to their cracking further to C3-C4 by secondary reactions. The formation of aromatics takes place by hydrogen transfer reaction. The direct dehydrogenation of hydrocarbons produces hydrogen.

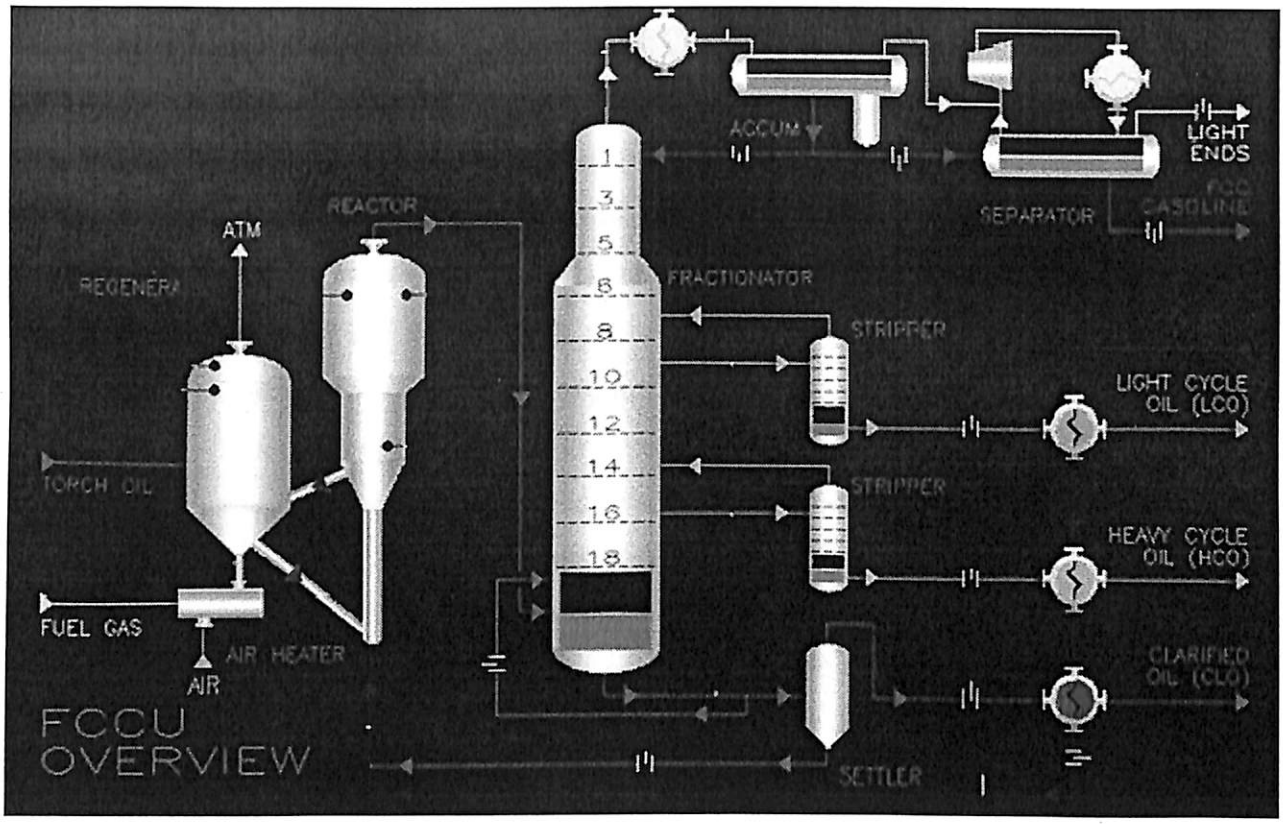
In this process oil is cracked in the presence of a finely divided catalyst, which is maintained in an aerated or fluidized state by the oil vapors. The fluid cracker consists of a catalyst section and a fractionating section that operate together as an integrated processing unit. The catalyst section contains the reactor and regenerator, which, with the standpipe and riser, form the catalyst circulation unit. The fluid catalyst is continuously circulated between the reactor and the regenerator using air, oil vapors, and steam as the conveying media.

A typical FCC process involves mixing a preheated hydrocarbon charge with hot, regenerated catalyst as it enters the riser leading to the reactor. The charge is combined with a recycle stream within the riser, vaporized, and raised to reactor temperature (480°-540° C) by the hot catalyst. As the mixture travels up the riser, the charge is cracked at 0.7-2.04 atm. In the more modern FCC units, all cracking takes place in the riser. The "reactor" no longer functions as a reactor; it merely serves as a holding vessel for the cyclones. This cracking continues until the oil vapors are separated from the catalyst in the reactor cyclones. The resultant product stream (cracked product) is then charged to a fractionating column where it is separated into fractions, and some of the heavy oil is recycled to the riser.[2]

FCC fractionator is associated with the overhead condenser, two side strippers and four pumparrounds. Light end products like LPG, Gasoline are separated from overhead assembly where as the heavy products like Heavy Naphtha, Light cycle Oil, Heavy Cycle oil will get separated from the respective side strippers. Pumparounds are used to maintain the stage temperature and recover the energy from the vapour stream flowing up the column.

Spent catalyst is regenerated to get rid of coke that collects on the catalyst during the process. Spent catalyst flows through the catalyst stripper to the regenerator, where most of the coke deposits burn off at the bottom where preheated air and spent catalyst are mixed. Fresh catalyst is added and worn-out catalyst removed to optimize the cracking process.

Fig.2.1 (FCCU Overview)



Chapter 3

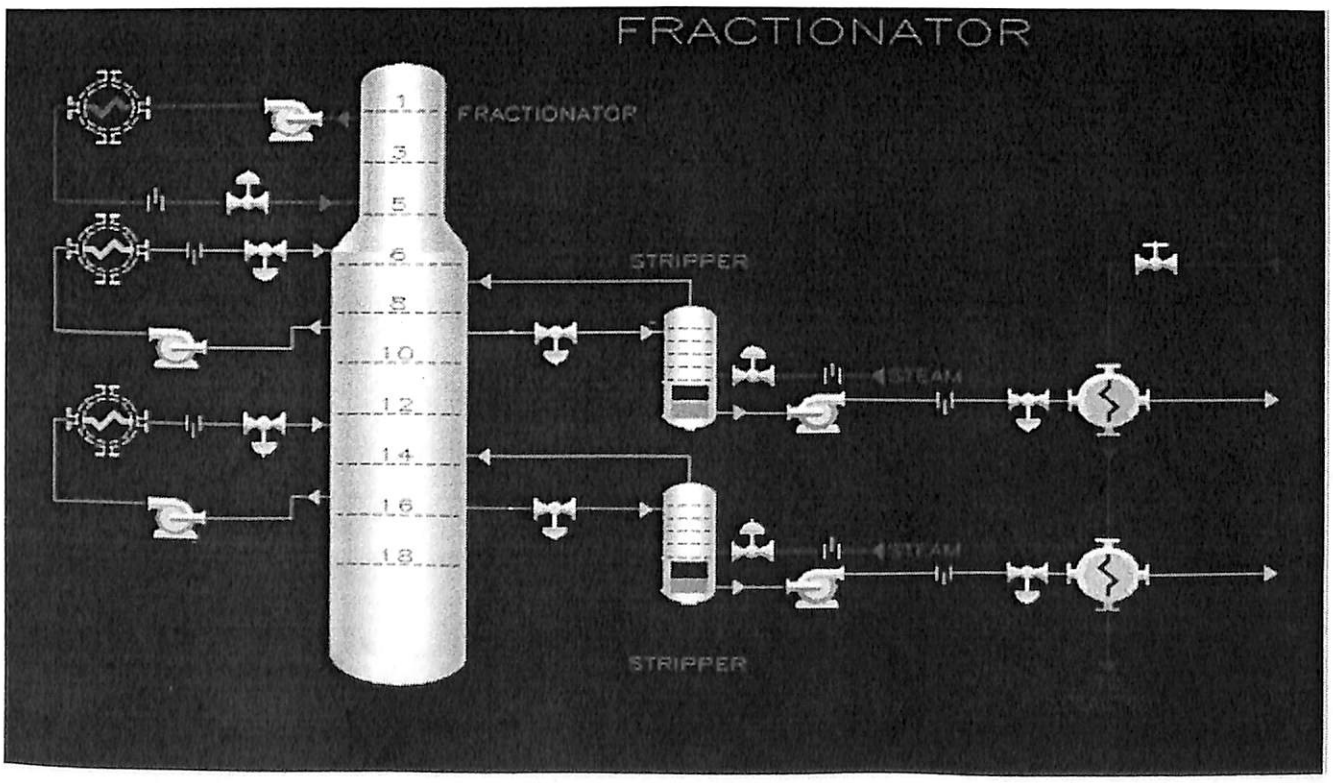
Literature Survey

The FCC main fractionator is a multicomponent distillation column equipped with four pumparounds (HN, LCO, HCO, and fractionator Bottoms), an Overhead Reflux System, and two Side Strippers for HN and LCO products.

The vapors from the Converter enter the quench or bottom section of the fractionator where they are cooled with the circulating bottoms pumparound which cascades down over the vapor entry point. This section of the tower also acts as a scrubber to prevent catalyst fines from passing up the tower into the more valuable "clean" products. Steam is injected to the base of the tower to keep the catalyst in suspension in the bottoms liquid.

The fractionator bottoms product and recycle streams are drawn from the bottoms pumparound downstream of the Slurry Settler. The recycle is returned to the riser from the bottom of the Slurry Settler for recovery of entrained catalyst and is mixed with the fresh feed, while the product is taken from the top of the Slurry Settler. Products HN, LCO are stripped out from their respective strippers. Gasoline, Sour Water and Wet gases are separated from the overhead. Part of the gasoline is pumped back to the tower as reflux.[4]

Fig 3.1 (FCC Fractionator)



In multi-stage, multi-component distillation column two types of problem arises, namely- Design and Simulation. (In design case column performance is given in terms of composition and we have to find out the critical number of equilibrium stages, feed plate, optimum reflux ratio etc. For solving design problems, very few methods are available in literature). In case of simulation also know as rating problem is applicable to existing column. In this case the number of theoretical stages, feed plate location, reflux ratio etc., are known and composition of the products are required to be found out. For solving simulation, numerous methods are available in literature.

Here we concentrate only on simulation problem using ASPEN PLUS simulation software. This simulation comes under rigorous calculation. Rigorous is used for solving the fundamental equation allocated with multicomponent stage-wise separation like material balance, energy balance, equilibrium relation for each stage. All the co-relation and non-linear algebraic equation for solving these equations are quite tedious and iterative and it needs software assistance.

In this thesis work, we are using Aspen Plus for the simulation of the column. All the specification for the process flowsheet has specified to simulate it and the simulated result has been analyzed. The column performance has been checked by varying the input data. Finally we have done the sensitivity analysis for the column by using the model analysis tool.

3.1 Standard Test methods for Distillation of Petroleum

1. ASTM D86

Standard Test Method for Distillation of Petroleum Products at Atmospheric Pressure.

This test method covers the atmospheric distillation of petroleum products using a laboratory batch distillation unit to determine quantitatively the boiling range characteristics of such products as natural gasoline, light and middle distillates, automotive spark-ignition engine fuels, aviation gasoline, aviation turbine fuels, regular and low sulfur diesel fuels, special petroleum spirits, naphtha, white spirits, kerosene, and Grades 1 and 2 burner fuels.

The test method is designed for the analysis of distillate fuels; it is not applicable to products containing appreciable quantities of residual material.

The method gives only the yield data. It cannot be used to separate the given sample into different cuts. This test method covers both manual and automated instruments.

2. ASTM D1160

Standard Test Method for Distillation of Petroleum Products at Reduced Pressure.

This test method covers the determination, at reduced pressures (vacuum distillation), of the range of boiling points for petroleum products that can be partially or completely vaporized at a maximum liquid temperature of 400°C. Both a manual method and an automatic method are specified. The pressure applied varies from 5 mm Hg to 40 mm Hg. The apparatus gives only the yield data; it cannot be used to separate the crude into different cuts.

Atmospheric Equivalent Temperature (AET): -The temperature at which the component would boil if the pressure is atmospheric pressure.

3. ASTM D2887

Standard Test Method for Boiling Range Distribution of Petroleum Fractions by Gas Chromatography.

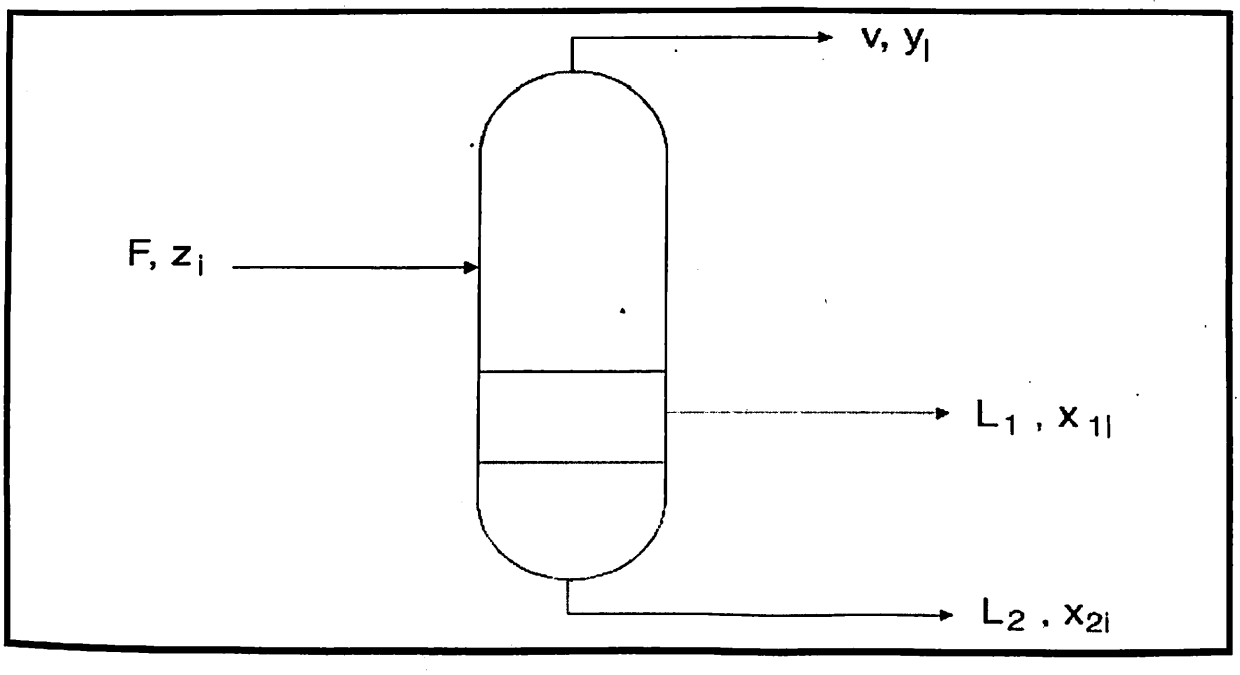
This test method covers the determination of the boiling range distribution of petroleum products. The test method is applicable to petroleum products and fractions having a final boiling point of 538°C (1000°F) or lower at atmospheric pressure as measured by this test method. This test method is limited to samples having a boiling range greater than 55°C (100°F), and having a vapor pressure sufficiently low to permit sampling at ambient temperature.

3.2 General Strategy of Mathematical Solution

Flash Calculations

Calculations for equilibrium flash operations such as flash drums, mixers, splitters, and valves. Flash calculations are also used to determine the thermodynamic state of each feed stream for any unit operation. For a flash calculation on any stream, there are a total of NC + 3 degrees of freedom, where NC is the number of components in the stream. If the stream composition and rate are fixed, then there are 2 degrees of freedom that may be fixed. These may, for example, be the temperature and pressure (an isothermal flash). The difference in the enthalpy of the feed and product streams constitutes the net duty of that unit operation.

Fig 3.2(Three phase equilibrium flash)



MESH Equations:

The Mass balance, Equilibrium, Summation, and Heat balance (or MESH) equations which may be written for a three-phase flash are given by:

Total Mass Balance:

$$F = V + L_1 + L_2 \qquad (1)$$

Component Mass Balance:

$$Fz_i = Vy_i + L_1 + L_2 \qquad (2)$$

Equilibrium:

$$y_i = K_{1i} x_{1i} \qquad (3)$$

$$y_i = K_{2i} x_{2i} \qquad (4)$$

$$x_{1i} = \frac{K_{2i}}{K_{1i}} x_{2i} \qquad (5)$$

Summations:

$$\sum_i y_i - \sum_i x_{1i} = 0 \qquad (6)$$

$$\sum_i y_i - \sum_i x_{2i} = 0 \qquad (7)$$

Heat Balance:

$$FH_f + Q = VH_v + L_1 H_{1i} + L_2 H_{2i} \qquad (8)$$

Two-phase Isothermal Flash Calculations

For a two-phase flash, the second liquid phase does not exist, i.e., L2 = 0, and L1 = L in equations (1) through (8) above. Substituting in equation (2) for L from equation (1), we obtain the following expression for the liquid mole fraction, xi:

$$x_i = \frac{z_i}{(K_i - 1)\frac{V}{F} + 1} \qquad (9)$$

The corresponding vapor mole fraction is then given by:

$$y_i = K_i x_i \qquad (10)$$

The mole fractions, xi and yi sum to 1.0, i.e.:

$$\sum_i x_i = \sum_i y_i = 1.0 \qquad (11)$$

However, the solution of equation (11) often gives rise to convergence difficulties for problems where the solution is reached iteratively. Rachford and Rice in 1952 suggested that the following form of equation (11) be used instead:

$$\sum_i y_i - \sum_i x_i = \sum_i \frac{(K_i - 1) z_i}{(K_i - 1)\frac{V}{F} + 1} \leq TOL \qquad (12)$$

Equation (12) is easily solved iteratively by a Newton-Raphson technique, with V/F as the iteration variable.

The following steps outline the solution algorithm:

1. The initial guesses for component K-values are obtained from ideal K- value methods. An initial value of V/F is assumed.
2. Equations (9) and (10) are then solved to obtain xi's and yi's.
3. After equation (12) is solved within the specified tolerance, the composition convergence criteria are checked, i.e., the changes in the vapor and liquid mole fraction for each component from iteration to iteration are calculated:

$$\frac{|(x_{i,ITER} - x_{i,ITER-1})|}{x_i} \leq TOL \qquad (14)$$

4. If the compositions are still changing from one iteration to the next, a damping factor is applied to the compositions in order to produce a stable convergence path.
5. Finally, the VLE convergence criterion is checked, i.e., the following condition must meet.

$$\left| \left(\sum y_i - \sum x_i \right)_{ITER} - \left(\sum y_i - \sum x_i \right)_{ITER-1} \right| \leq TOL \qquad (15)$$

If the VLE convergence criterion is not met, the vapor and liquid mole fractions are damped, and the component K-values are re-calculated. Rigorous K-values are calculated

using equation of state methods, generalized correlations, or liquid activity coefficient methods.

6. A check is made to see if the current iteration step, ITER, is greater than the maximum number of iteration steps ITERmax. If ITER > ITERmax, the flash has failed to reach a solution, and the calculations stop. If ITER < ITERmax, the calculations continue.

7. Steps 2 through 6 are repeated until the composition convergence criteria and the VLE criterion are met. The flash is then considered solved.

8. Finally, the heat balance equation (8) is solved for the flash duty, Q, once V and L are known.

3.3 Rigorous methods for Multicomponent distillation-type separation

Availability of large digital computers has made possible rigorous solutions of equilibrium-stage models for multicomponent, multistage distillation-type columns to an exactness limited only by the accuracy of the phase equilibrium and enthalpy data utilized. Time and cost requirements for obtaining such solutions are very low compared with the cost of manual solutions. Methods are available that can accurately solve almost any type of distillation-type problem quickly and efficiently. In general, these procedures make use of equation partitioning in conjunction with equation tearing and/or linearization by Newton-Raphson techniques.

(1) Thiele-Geddes stage-by-stage method for simple distillation

(2) Friday and Smith

(i) Bubble point (BP) method

(ii)Sum-Rates Method

(3) Boston and Sullivan inside-out method.

(4) Naphthali & Sandholm Simultaneous correction (SC) procedures.

In this simulation exercise Inside –Out method is used.

3.4 Thermodynamic Model.

The accuracy of any process simulation by computer software depends directly on the accuracy of the K-values used. The K-values are the essential ingredient for design and simulation of a separation system involving distillation columns, flash separators, etc.

At a given temperature T and pressure P, equilibrium is established between a liquid mixture and a vapor mixture on the condition that for each component *i*:

$$\mu_{iG}(T,P,y_{1,\ldots\ldots},y_N) = \mu_{iL}(T,P,x_1,\ldots\ldots,x_N) \qquad \ldots\ldots\ldots 16$$

where,

μ_i = chemical potential of component i

When the chemical potential of each component I, both phases is expressed in terms of fugacity using

$$\mu_{iG}(T,P,y_1,\ldots\ldots,y_N) = \mu_i^{\circ}(T) + RT\ln f_{iG}(T,P,y_1,\ldots\ldots,y_N) \qquad \ldots\ldots\ldots 17$$

$$\mu_{iL}(T,P,x_1,\ldots\ldots,x_N) = \mu_i^{\circ}(T) + RT\ln f_{iL}(T,P,x_1,\ldots\ldots,x_N) \qquad \ldots\ldots\ldots 18$$

with $\mu_i^{\circ}(T)$ the chemical potential of component I for the ideal gas at temperature T and a pressure of 1 bar, equation 16 reduces to :

$$f_{iG}(T,P,y_1,\ldots\ldots,y_N) = f_{iL}(T,P,x_1,\ldots\ldots,x_N) \qquad \ldots\ldots\ldots 19$$

where,

f_i = fugacity of component i

Using the definition of the fugacity coefficient relating the fugacities of each component in both liquid and vapor phase to its mole fraction x_i and y_i in both phases:

$$f_{iG}(T,P,y_1,\ldots\ldots,y_N) = \phi_{iG}(T,P,y_1,\ldots\ldots,y_N)y_iP \qquad \ldots\ldots\ldots 20$$

$$f_{iL}(T,P,x_1,\ldots\ldots,x_N) = \phi_{iL}(T,P,x_1,\ldots\ldots,x_N)x_iP \qquad \ldots\ldots\ldots 21$$

where,

ϕ_i = fugacity of component i

and combining equations 20 and 21 the ratio of the mole fractions of each component in vapor and liquid phase, the so called K-factor can be obtained using:

$$y/x = K_i = \phi_{iL}(T,P,x_1,.....,x_N)/\phi_{iG}(T,P,y_1,.....,y_N) \quad .....22$$

with values of fugacity coefficients ϕ_{iL} and ϕ_{iG} obtained from an equation of state.

In this simulation exercise I am using Grayson-Streed property package for the evaluation of K- value. This model is generally used for hydrocarbon mixture. The GS correlation can also be used for simulating topping units and heavy ends vacuum applications. The vapour phase fugacity coefficients are calculated with the Redlich Kwong equation of state. The pure liquid fugacity coefficients are calculated via the principle of corresponding states.

Chapter 4

ASPEN PLUS

ASPEN PLUS is a software package designed to allow a user to build a process model and then simulate the model .ASPEN PLUS can be used for a wide variety of chemical engineering tasks. Sample applications found in test programs include calculation of viscosity and thermal conductivity of various substances, determination of parameters for chemical systems, hydrogenation and distillation systems, solids handling, costing and economic evaluation, electrolyte systems, and advanced physical properties. For example, it can execute tasks as simple as describing thermodynamic properties of an ethanol and water mixture or as complex as predicting the steady-state behavior of a full-scale petrochemical plant without tedious calculations. This is where the idea of a process model is helpful. A process model can be defined as an engineering system's "blue print." The process model is a complete layout of the engineering system including the following:

Flowsheet

The process model flowsheet maps out the entire system. The flowsheet shows one or more inlet streams entering into the system's first unit operation (i.e., heat exchanger, compressor, reactor, distillation column, etc.) and continues through the process, illustrating all intermediate unit operations and the interconnecting streams. The flowsheet also indicates all product streams. Each stream and unit operation is labeled and identified.

Chemical Components

The process model specifies all chemical components of the system from the necessary reactants and products, to steam and cooling water.

Operating Conditions

All unit operations in the process model are kept under particular operating conditions (i.e., temperature, pressure, size). These are usually at the discretion of the engineer, for it is the operating conditions of the process that affect the outcome of the system.

ASPEN PLUS allows us to create your own process model, starting with the flowsheet, then specifying the chemical components and operating conditions. ASPEN PLUS will take all of your specifications and, with a click of the mouse button, simulate the model. The process simulation is the action that executes all necessary calculations needed to solve the outcome of the system, hence predicting its behavior. When the calculations are complete, ASPEN PLUS lists the results, stream

by stream and unit by unit, so you can observe what happened to the chemical species of your process model. [1]

Procedure for flowsheet simulation.

1. Process flowsheet development using model library.
2. Specify the component.
3. Specify the thermodynamic package.
4. Specify the block with required input.
5. Run the simulation.

4.1 Sensitivity analysis by using Aspen Plus

Sensitivity analysis is a tool for determining how a process reacts to varying key operating and design variables. You can use it to vary one or more flowsheet variables and study the effect of that variation on other flowsheet variables. It is a valuable tool for performing "what if" studies. The flowsheet variables that are varied must be inputs to the flowsheet. They can not be variables that are calculated during the simulation. You can use sensitivity analysis to verify if the solution to a design specification lies within the range of the manipulated variable. You can also use it to perform simple process optimization. [6]

Sensitivity blocks provide additional information to base-case results, but have no effect on the base-case simulation. The simulation runs independently of the sensitivity study.

Define a sensitivity block by:

1. Creating the sensitivity block.
2. Identifying the sampled flowsheet variables.
3. Identifying the input variables to manipulate to generate the table.
4. Defining what you want ASPEN PLUS to tabulate.

Chapter 5

Steady State Simulation using ASPEN PLUS

Flow sheet development is the first step of the simulation. Flowsheet can be developed by using model library. Model library is the collection of all process equipment, from where we can select the required equipment for the process flowsheet. Here I am using three three equipments/blocks to develop my process flow sheet.

a) Mixer

b) Heater

c) Fractionator

Since I don't have any reactor effluent composition data, here I am using the product assay and some product stream composition data to generate my feed. The input of the mixer is all the product streams of the fractionator. Output of the mixer is the fractionator feed which will get heated to the required temperature in the heater. Block connection can be done by using the material stream, where we can connect the blocks and name the streams. During the block specification we can give design specification to fix any parameter by varying the other one.

Fig.5.1 (Block Selection)

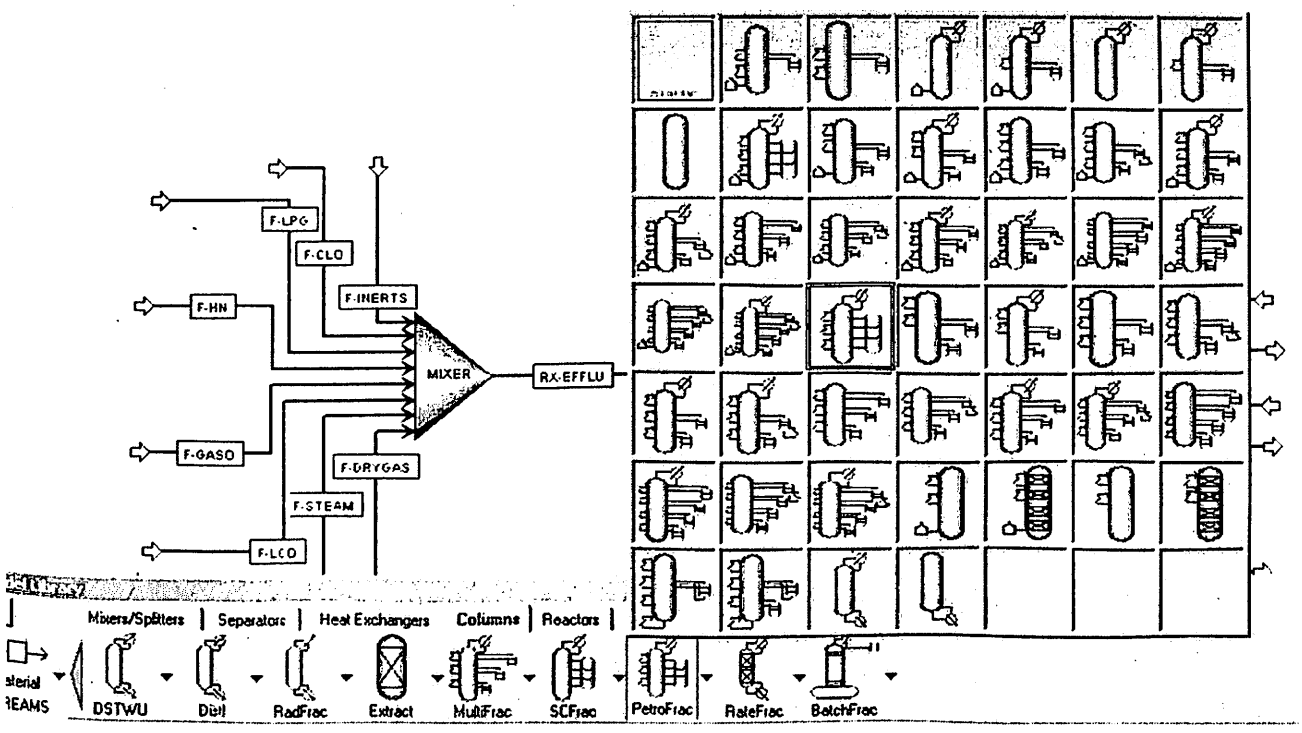
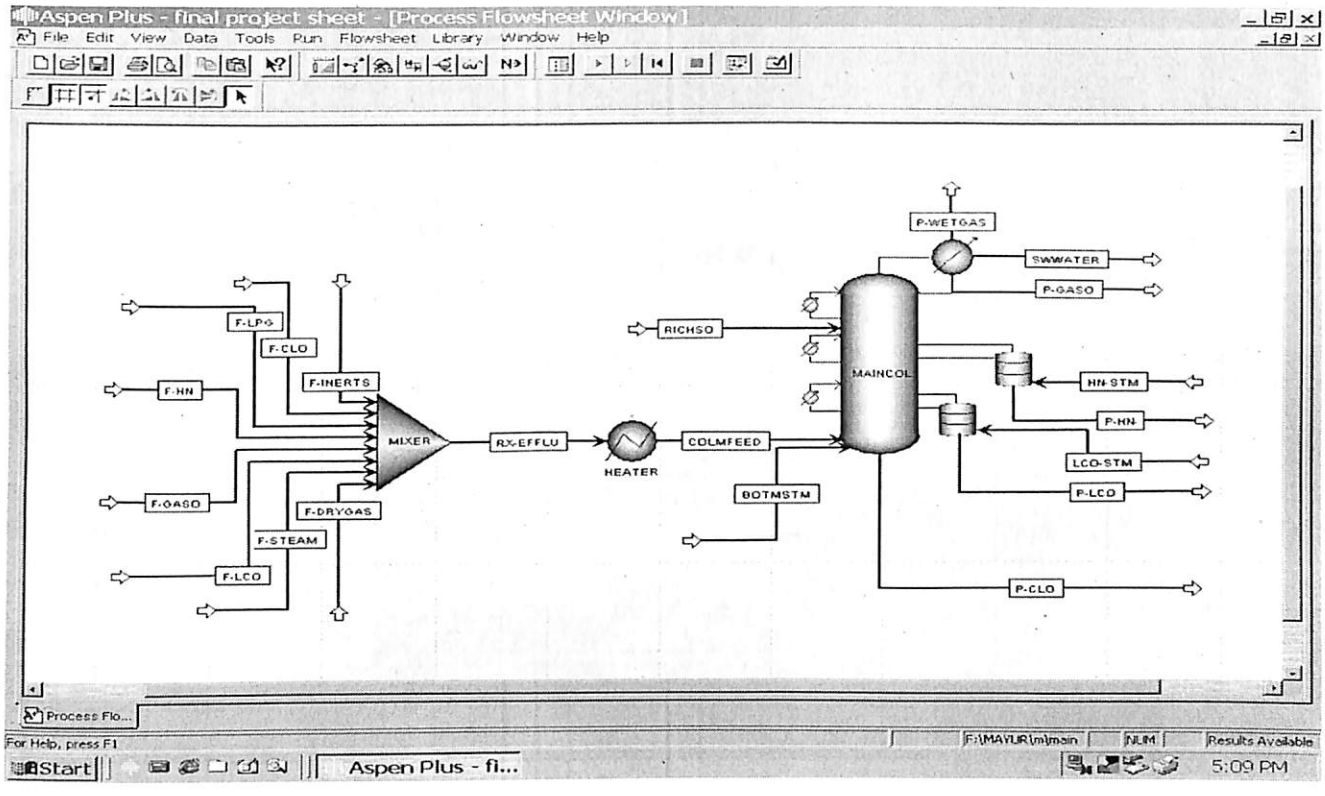


Fig.5.2 (Developed Process Flowsheet)



Once the flowsheet is developed, property, streams and block specification is required to run the simulation.

Fig.5.3 (Component Specification window)

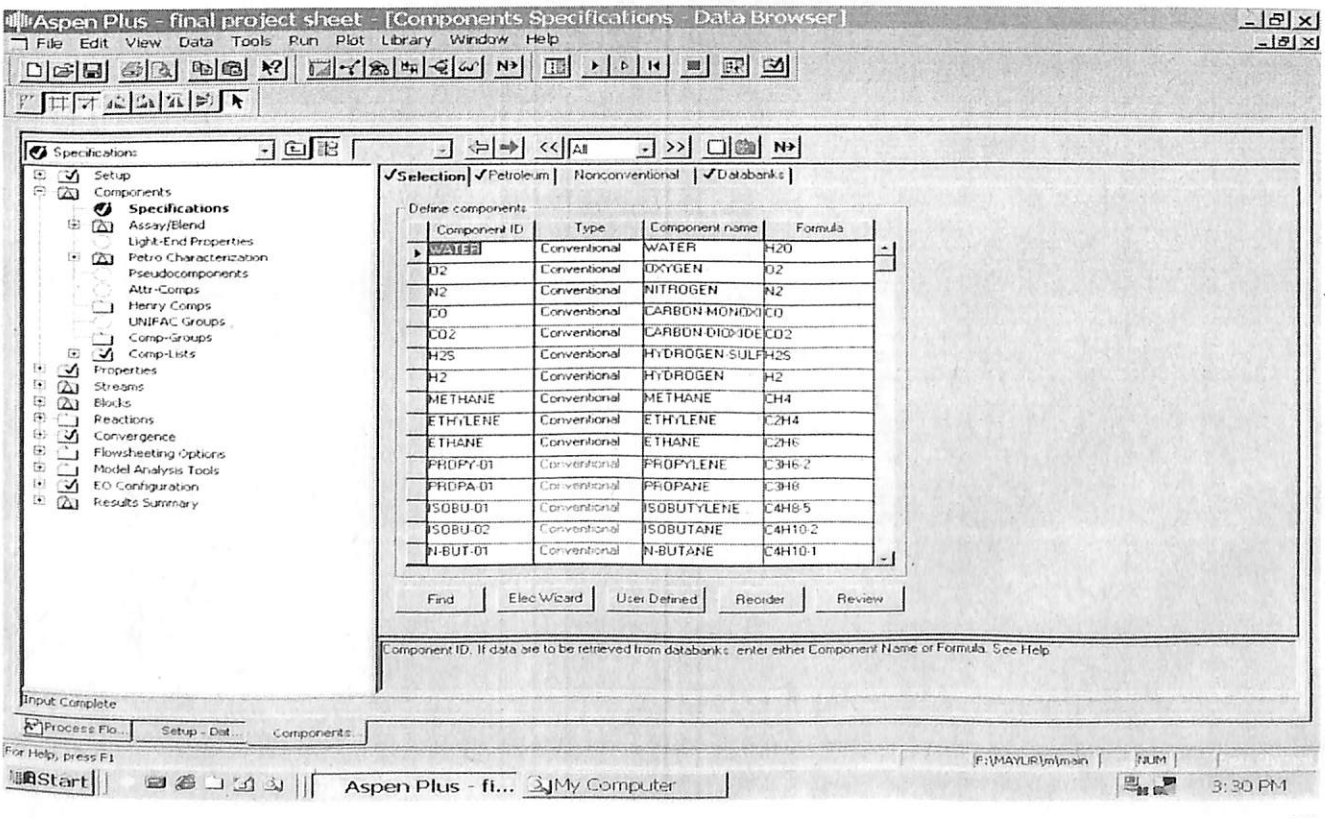


Fig 5.4(Assay specification window)

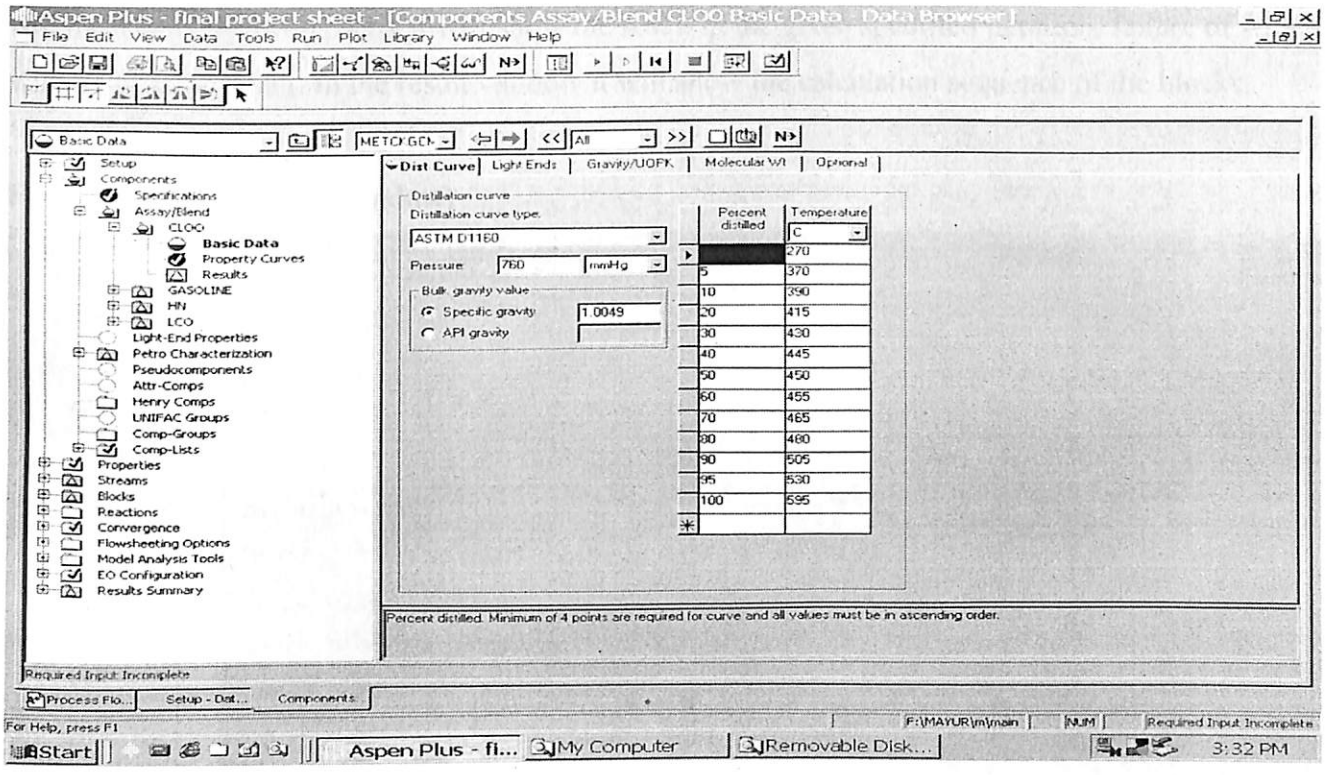
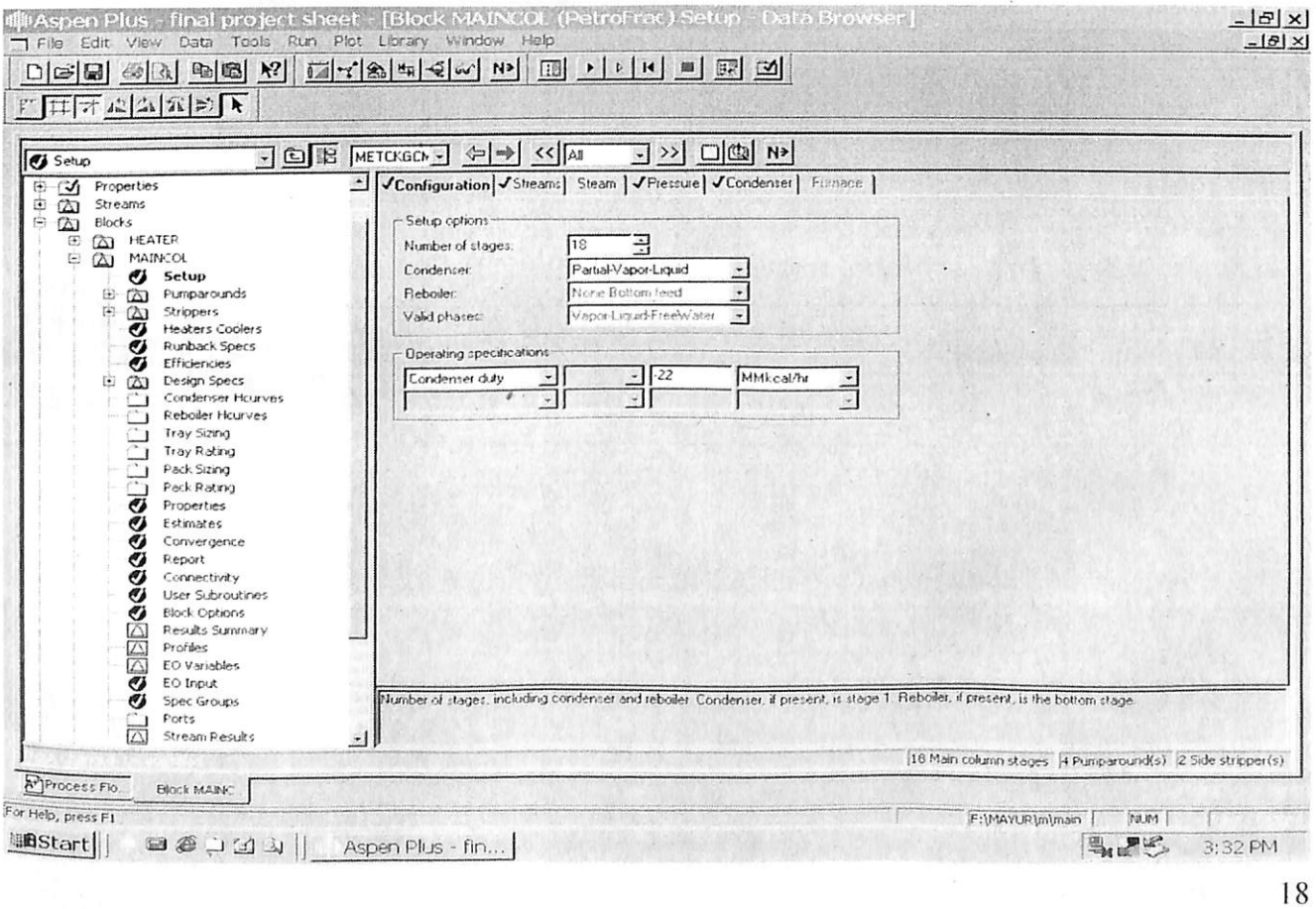
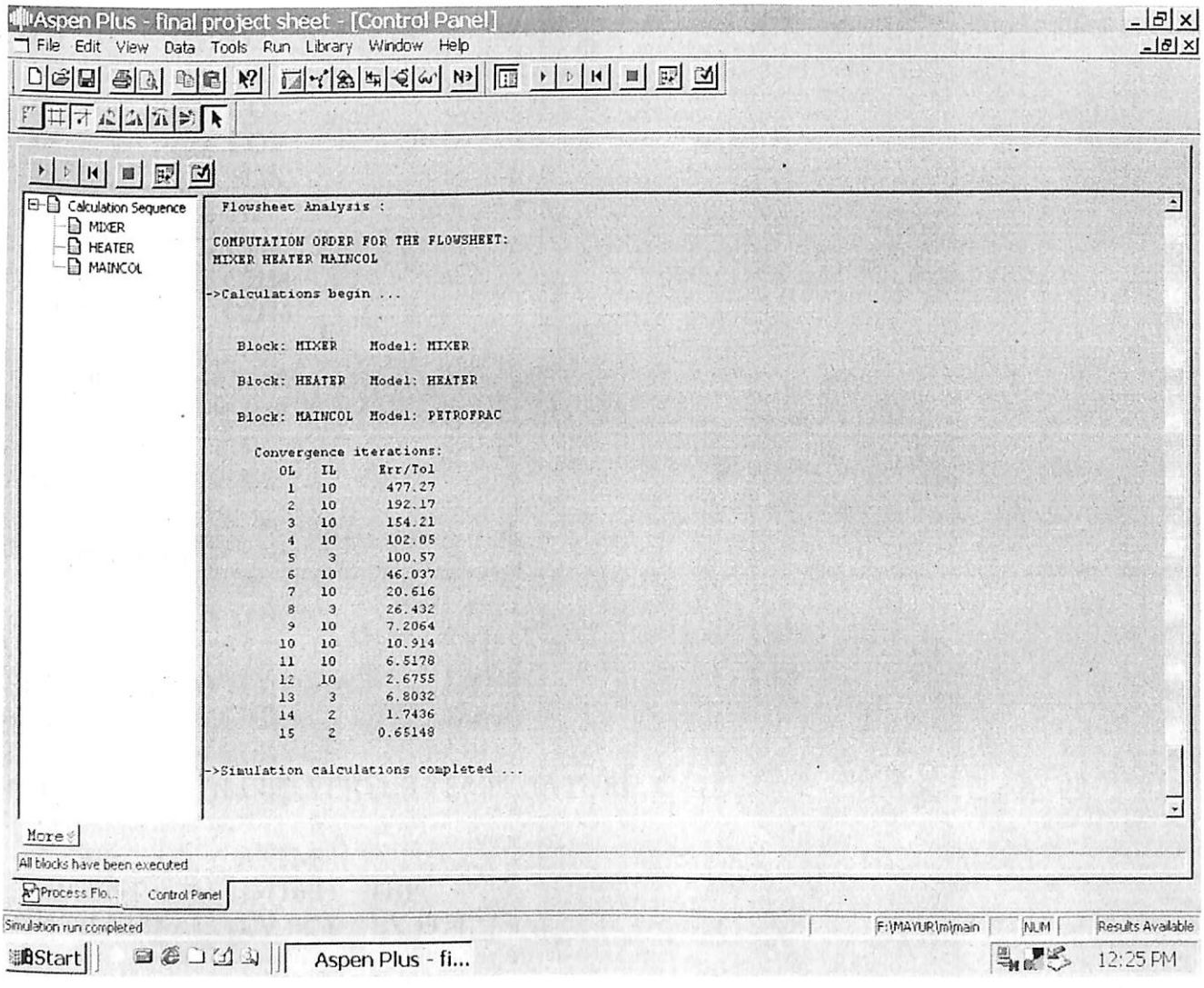


Fig 5.5(Block specification window)



Once the all input specification is given we can run the simulation. If all the given input specification will meet convergence criteria it will show the result in the given specified iteration, failure of which will not give the result. In the result window it will show the calculation sequence of the blocks.

Fig 5.6(Simulation result window)



5.1 Input data for the process flowsheet.

A) Components

ID	FORMULA
WATER	H2O
O2	O2
N2	N2
CO	CO
CO2	CO2
H2S	H2S
H2	H2
METHANE	CH4
ETHYLENE	C2H4
ETHANE	C2H6
PROPY-01	C3H6-2
PROPA-01	C3H8
ISOBU-01	C4H8-5
1-PEN-01	C5H10-2
N-PEN-01	C5H12-1

B) Feed Assay

a) Clarified Oil (CLO)

SPECIFIC GRAVITY 60F/60F 1.0049
MASS FLOW (KG/HR) 88800
DISTILLATION CURVES
PERCENT DISTILLED VERSUS TEMPERATURE, C

PERCENT DISTILLED	ASTM D1160 LV PCT	TBP LV PCT
0	270.0	260.2
5	370.0	341.7
10	390.0	380.6
30	430.0	425.8
50	450.0	450.0
70	465.0	465.0
90	505.0	505.0
95	530.0	530.0
100	595.0	595.0

b) Gasoline

SPECIFIC GRAVITY 60F/60F 0.716
MASS FLOW (KG/HR) 59600
DISTILLATION CURVES
PERCENT DISTILLED VERSUS TEMPERATURE, C

PERCENT DISTILLED	ASTM D86 LV PCT	TBP LV PCT
0	44.0	9.0
5	52.0	25.7
10	56.0	32.8
30	67.0	53.4
50	84.0	79.8
70	110.0	114.2
90	138.0	148.3
95	155.0	165.9
100	170.0	183.4

c) Light Cycle Oil (LCO)

SPECIFIC GRAVITY 60F/60F 0.9137
MASS FLOW (KG/HR) 58800
DISTILLATION CURVES
PERCENT DISTILLED VERSUS TEMPERATURE, C

PERCENT DISTILLED	ASTM D86 LV PCT	TBP LV PCT
0	179.0	139.9
5	198.0	175.6
10	212.0	191.2
30	252.0	245.0
50	289.0	293.1
70	335.0	346.6
90	383.0	399.2
95	397.1	414.6
100	411.3	430.0

d) Heavy Naphtha (HN)

SPECIFIC GRAVITY 60F/60F 0.8204
MASS FLOW (KG/HR) 19600
DISTILLATION CURVES
PERCENT DISTILLED VERSUS TEMPERATURE, C

PERCENT DISTILLED	ASTM D86 LV PCT	TBP LV PCT
0	89.0	41.7
5	128.0	91.5
10	140.0	115.4
30	164.0	153.4
50	182.0	181.1
70	196.0	201.7
90	225.0	236.7
95	247.0	259.2
100	265.0	281.8

C) Streams

a) Liquefied Petroleum Gas (LPG)

COMPONENT	MOLE FLOW (KMOL/HR)
PROPY-01	171
PROPA-01	84.74
ISOBU-01	190.63
ISOBU-02	101.57
N-BUT-01	28.49

b) Dry Gas

COMPONENT	MOLE FLOW (KMOL/HR)
H2S	23.1
H2	57.97
METHANE	107.71
ETHYLENE	43.85
ETHANE	55.98

c) Inert

COMPONENT	MOLE FLOW (KMOL/HR)
N2	43.14
CO	4.45
CO2	6.67

d) Steam

COMPONENT	MOLE FLOW (KMOL/HR)
WATER	486.66

e) Rich Stripping Oil (RICHSO)

COMPONENT	MASS FRAC
LCO	1
MASS FLOW (KG/HR)	30000

D) Block Specifications

a) Mixer

TEMPERATURE	C	469

b) Heater

SPECIFIED TEMPERATURE	C	489.000
SPECIFIED PRESSURE	KG/SQCM	3.80000

c) Fractionator

NUMBER OF STAGES		18
CONDENSER TEMPERATURE	C	40.0000
CONDENSER DUTY	MMKCAL/H	-22.0000

STAGE	PRESSURE (KG/SQCM)
1	3.03323
2	3.48323
18	3.83323

NO REBOILER

d) Strippers

1.HN-STRIP:

NUMBER OF STAGES		2
DRAW STAGE FROM MAIN COLUMN		4
VAPOR OVERHEAD RETURN STAGE TO MAIN COLUMN		3
BOTTOMS RATE	KG/HR	19,600.0
NO REBOILER		

2.LCO-STRIP:

NUMBER OF STAGES		2
DRAW STAGE FROM MAIN COLUMN		10
VAPOR OVERHEAD RETURN STAGE TO MAIN COLUMN		9
BOTTOMS RATE	KG/HR	85,400.0
NO REBOILER		

e) Pumparrounds

1.PUMPAROUND HN :

DRAW STAGE		4
RETURN STAGE		3
FLOW	KG/HR	386,000.
DELTA TEMPERATURE	C	- 47.0000

2. PUMPAROUND LCO :

DRAW STAGE		10
RETURN STAGE		9
FLOW	KG/HR	230,000.
DELTA TEMPERATURE	C	- 66.0000

3.PUMPAROUND CLO :

DRAW STAGE		17
RETURN STAGE		16
FLOW	KG/HR	200,000.
DELTA TEMPERATURE	C	- 104.000

4.PUMPAROUND HCO :

DRAW STAGE		14
RETURN STAGE		13
FLOW	KG/HR	145,000.
DELTA TEMPERATURE	C	-132.000

Chapter 6

Result and Discussion

With the given input specification ASPEN simulator has converged the data and results are available without error message, which indicates the given input data is appropriate. The resultant TBP profile of each product stream is analyzed with the given feed assay (Lab data). The product and feed TBP curves are matching with minor deviations, Column temperature and pressure profile is also studied for each stage. The exercise has been carried out for the maximum separation of gasoline and light ends. The gasoline flow rate from the fractionator is found to be 475.28 kmol/hr which is more among all the product flow rate.

Comparison of product assay with the input data.

1. CLO

PERCENT	TBP (LV PCT)	
DISTILLED	INPUT	OUTPUT
0	260.2	88.07
5	341.7	347.15
10	380.6	384.58
30	425.8	422.24
50	450.0	446.92
70	465.0	464.33
90	505.0	503.13
95	530.0	530.55
100	595.0	578.22

2. GASOLINE

PERCENT	TBP(LV PCT)	
DISTILLED	INPUT	OUTPUT
0	9.0	-81.7861
5	25.7	-15.5328
10	32.8	-7.2308
30	53.4	48.5449
50	79.8	79.5040
70	114.2	116.9848
90	148.3	161.0551
95	165.9	180.0987
100	183.4	208.1445

3. HEAVY NAPHTHA

PERCENT	TBP(LV PCT)	
DISTILLED	INPUT	OUTPUT
0	41.7	29.9896
5	91.5	91.1228
10	115.4	111.7036
30	153.4	146.3566
50	181.1	167.2064
70	201.7	185.8400
90	236.7	209.6278
95	259.2	222.6605
100	281.8	259.4348

4. LIGHT CYCLE OIL

PERCENT	TBP(LV PCT)	
DISTILLED	INPUT	OUTPUT
0	139.9	119.3090
5	175.6	187.3666
10	191.2	205.7382
30	245.0	252.767
50	293.1	294.2116
70	346.6	342.1728
90	399.2	395.3857
95	414.6	410.9585
100	430.0	449.2487

Fig.6.1 (TBP curve – Plot)

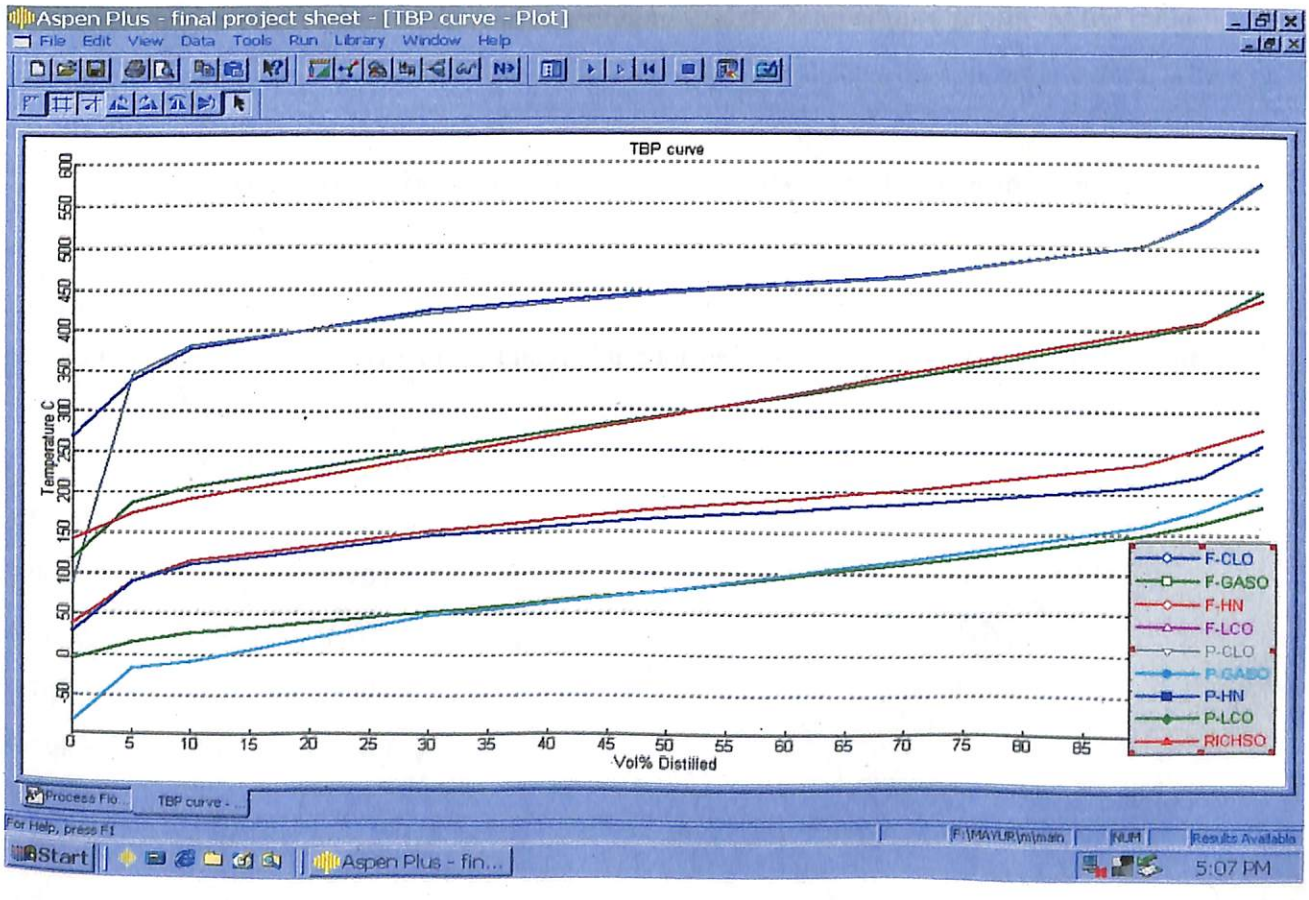
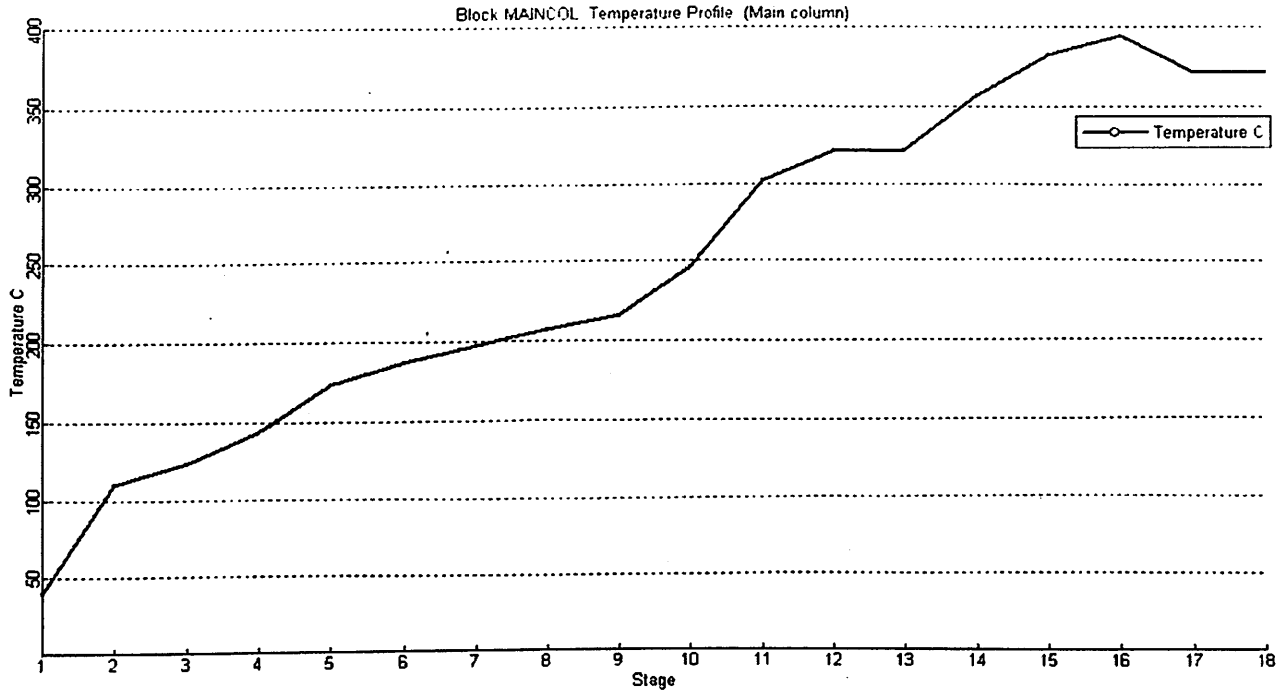


Fig.6.2 (Temperature Profile – Main column)



By analyzing the TBP curves of the various streams and the temperature profile of the main fractionator I can probably say that I have simulated the flowsheet with appropriate data, where as its not the exact or only criteria of analysis.

At the end of this work I have done Sensitivity analysis for the column. Column sensitivity in terms of reflux ratio has been studied for input pressure range. Result shows minute variation in reflux ratio for the given pressure range. Sensitivity analysis can be done for various parameters, but due to time constrain I have done for only one parameter. Results are as follows,

COL Press(Kg/CM^2)	RRatio
3.8000	2.186
3.9000	2.192
4.0000	2.198
4.1000	2.203
4.2000	2.209
4.3000	2.214
4.4000	2.220

4.5000	2.225
4.6000	2.230
4.7000	2.235
4.8000	2.240
3.332	2.138

A detail simulation report has enclosed in the Annexure.

Chapter 7

References

1.William M. Luyben, Wiley Publication, Distillation Design and Control using ASPEN Simulation.

2. Raze. FCC Handbook.

3 Gerald L.Kaes.Refinery Process Modeling – Modeling an FCC Unit and Gas Plant.

4. Watkins R.N. Petroleum Refinery Distillation. Page no.137-149

5. S.W.Golden, G.R.Martin, A.W.Sloley. "FCC main fractionator revamps", Hydrocarbon Processing, March 1993 page no.77-81

6. Aspen Plus user Guide, Version10, page no.20, 1-11

ANNEXURE

TOTAL FLOWSHEET BALANCE

	IN	OUT	RELATIVE DIFF
MOLE(KMOL/HR)	3042.72	3042.72	0.000000E+00
MASS(KG/HR)	304794.	304794.	-0.190974E-15
ENTHALPY(MMKCAL/H)	-65.1143	-124.957	0.478908

ASSAY DATA ANALYSIS

ASSAY ID: CLOO

SPECIFIC GRAVITY 60F/60F	1.0049
API GRAVITY	9.3100
DENSITY GM/CC	1.0024
MOLECULAR WEIGHT	MISSING

DISTILLATION CURVES

PERCENT DISTILLED VERSUS TEMPERATURE, C

PERCENT DISTILLED		ASTM D1160 LV PCT	TBP LV PCT
0		270.0	260.2
5		370.0	341.7
10		390.0	380.6
30		430.0	425.8
50		450.0	450.0
70		465.0	465.0
90		505.0	505.0
95		530.0	530.0
100		595.0	595.0
PRES	KG/SQCM 1.033	1.033	

ASSAY ID: GASOLINE

SPECIFIC GRAVITY 60F/60F	0.7160
API GRAVITY	66.1257
DENSITY GM/CC	0.7142
MOLECULAR WEIGHT	MISSING

DISTILLATION CURVES

PERCENT DISTILLED VERSUS
TEMPERATURE, C

PERCENT DISTILLED	ASTM D86 LV PCT	TBP LV PCT
0	44.0	9.0
5	52.0	25.7
10	56.0	32.8
30	67.0	53.4
50	84.0	79.8
70	110.0	114.2
90	138.0	148.3
95	155.0	165.9
100	170.0	183.4
PRES KG/SQCM	1.033	1.033

ASSAY ID: HEAVY NAPHTHA

SPECIFIC GRAVITY 60F/60F	0.8204
API GRAVITY	40.9768
DENSITY GM/CC	0.8183
MOLECULAR WEIGHT	MISSING

DISTILLATION CURVES

PERCENT DISTILLED VERSUS
TEMPERATURE, C

PERCENT DISTILLED	ASTM D86 LV PCT	TBP LV PCT
0	89.0	41.7
5	128.0	91.5
10	140.0	115.4
30	164.0	153.4
50	182.0	181.1
70	196.0	201.7
90	225.0	236.7
95	247.0	259.2
100	265.0	281.8
PRES KG/SQCM	1.033	1.033

ASSAY ID: LCO

SPECIFIC GRAVITY 60F/60F	0.9137
API GRAVITY	23.3648
DENSITY GM/CC	0.9114
MOLECULAR WEIGHT	MISSING

DISTILLATION CURVES

PERCENT DISTILLED VERSUS
TEMPERATURE, C

PERCENT DISTILLED	ASTM D86 LV PCT	TBP LV PCT
0	179.0	139.9
5	198.0	175.6
10	212.0	191.2
30	252.0	245.0
50	289.0	293.1
70	335.0	346.6
90	383.0	399.2
95	397.1	414.6
100	411.3	430.0
PRES KG/SQCM	1.033	1.033

PHYSICAL PROPERTIES SECTION

COMPONENTS

ID	TYPE	FORMULA	NAME OR ALIAS	REPORT NAME
WATER	C	H2O	H2O	WATER
O2	C	O2	O2	O2
N2	C	N2	N2	N2
CO	C	CO	CO	CO
CO2	C	CO2	CO2	CO2
H2S	C	H2S	H2S	H2S
H2	C	H2	H2	H2
METHANE	C	CH4	CH4	METHANE
ETHYLENE	C	C2H4	C2H4	ETHYLENE
ETHANE	C	C2H6	C2H6	ETHANE
PROPY-01	C	C3H6-2	C3H6-2	PROPY-01
PROPA-01	C	C3H8	C3H8	PROPA-01
ISOBU-01	C	C4H8-5	C4H8-5	ISOBU-01
ISOBU-02	C	C4H10-2	C4H10-2	ISOBU-02
N-BUT-01	C	C4H10-1	C4H10-1	N-BUT-01
1-PEN-01	C	C5H10-2	C5H10-2	1-PEN-01
2-MET-01	C	C5H12-2	C5H12-2	2-MET-01
N-PEN-01	C	C5H12-1	C5H12-1	N-PEN-01
PC36C	C	MISSING	MISSING	PC36C
PC58C	C	MISSING	MISSING	PC58C
PC72C	C	MISSING	MISSING	PC72C
PC86C	C	MISSING	MISSING	PC86C
PC100C	C	MISSING	MISSING	PC100C
PC115C	C	MISSING	MISSING	PC115C
PC128C	C	MISSING	MISSING	PC128C
PC142C	C	MISSING	MISSING	PC142C
PC156C	C	MISSING	MISSING	PC156C
PC170C	C	MISSING	MISSING	PC170C

PC184C	C	MISSING	MISSING	PC184C
PC197C	C	MISSING	MISSING	PC197C
PC211C	C	MISSING	MISSING	PC211C
PC225C	C	MISSING	MISSING	PC225C
PC239C	C	MISSING	MISSING	PC239C
PC253C	C	MISSING	MISSING	PC253C
PC267C	C	MISSING	MISSING	PC267C
PC280C	C	MISSING	MISSING	PC280C
PC295C	C	MISSING	MISSING	PC295C
PC309C	C	MISSING	MISSING	PC309C
PC323C	C	MISSING	MISSING	PC323C
PC336C	C	MISSING	MISSING	PC336C
PC350C	C	MISSING	MISSING	PC350C
PC364C	C	MISSING	MISSING	PC364C
PC379C	C	MISSING	MISSING	PC379C
PC392C	C	MISSING	MISSING	PC392C
PC406C	C	MISSING	MISSING	PC406C
PC420C	C	MISSING	MISSING	PC420C
PC444C	C	MISSING	MISSING	PC444C
PC466C	C	MISSING	MISSING	PC466C
PC494C	C	MISSING	MISSING	PC494C
PC521C	C	MISSING	MISSING	PC521C
PC551C	C	MISSING	MISSING	PC551C
PC579C	C	MISSING	MISSING	PC579C

U-O-S BLOCK SECTION

BLOCK: HEATER MODEL: HEATER

INLET STREAM: RX-EFFLU
OUTLET STREAM: COLMFEED
PROPERTY OPTION SET: GRAYSON SCATCHARD-HILDEBRAND / REDLICH-KWONG
FREE WATER OPTION SET: SYSOP12 ASME STEAM TABLE
SOLUBLE WATER OPTION: CORR SOLUBILITY DATA

*** MASS AND ENERGY BALANCE ***

	IN	OUT	RELATIVE DIFF.
TOTAL BALANCE			
MOLE(KMOL/HR)	2734.57	2734.57	0.000000E+00
MASS(KG/HR)	271794.	271794.	0.000000E+00
ENTHALPY(MMKCAL/H)	-46.0002	-42.1633	- 0.834099E-01

*** INPUT DATA ***

TWO PHASE TP FLASH
FREE WATER CONSIDERED

SPECIFIED TEMPERATURE	C	489.000
SPECIFIED PRESSURE	KG/SQCM	3.80000
MAXIMUM NO. ITERATIONS		30
CONVERGENCE TOLERANCE		0.000100000

*** RESULTS ***

OUTLET TEMPERATURE	C	489.00
OUTLET PRESSURE	KG/SQCM	3.8000
HEAT DUTY	MMKCAL/HR	3.8369
OUTLET VAPOR FRACTION		1.0000
OUTLET: 1ST LIQUID/TOTAL LIQUID		1.0000
PRESSURE-DROP CORRELATION PARAMETER		0.00000E+00

BLOCK: MAINCOL MODEL: PETROFRAC

	STREAM	COLUMN	STAGE	STREAM TYPE
INLETS:				
	RICHSO	MAIN COLUMN	9	MATERIAL
	COLMFEED	MAIN COLUMN	17	MATERIAL
	BOTMSTM	MAIN COLUMN	18	MATERIAL
	HN-STM	HN-STRIP	2	MATERIAL
	LCO-STM	LCO-STRI	2	MATERIAL
OUTLETS:				
	P-WETGAS	MAIN COLUMN	1	MATERIAL
	P-GASO	MAIN COLUMN	1	MATERIAL
	P-CLO	MAIN COLUMN	18	MATERIAL
	SWWATER	MAIN COLUMN	1	MATERIAL
	P-LCO	LCO-STRI	2	MATERIAL
	P-HN	HN-STRIP	2	MATERIAL

PROPERTY OPTION SET: GRAYSON SCATCHARD-HILDEBRAND / REDLICH-KWONG
FREE WATER OPTION SET: SYSOP12 ASME STEAM TABLE
SOLUBLE WATER OPTION: CORR SOLUBILITY DATA

*** MASS AND ENERGY BALANCE ***

	IN	OUT	RELATIVE DIFF.
TOTAL BALANCE			
MOLE(KMOL/HR)	3042.72	3042.72	-0.149454E-15
MASS(KG/HR)	304794.	304794.	0.000000E+00
ENTHALPY(MMKCAL/H)	-61.2774	-124.957	0.509613

****
********* INPUT DATA *********
****

FREE WATER CALCULATIONS PERFORMED

**** INPUT PARAMETERS ****

NUMBER OF STRIPPERS	2
NUMBER OF PUMPAROUNDS	4
DEGREE OF DAMPING	NONE

HYDRAULIC PARAMETER CALCULATIONS		NO
MAXIMUM NO. OF OUTSIDE LOOP ITERATIONS		25
MAXIMUM NO. OF INSIDE LOOP ITERATIONS		10
MAXIMUM NO. OF FLASH ITERATIONS		50
FLASH TOLERANCE		0.000100000
COLUMN CONVERGENCE TOLERANCE		0.000100000

BLOCK: MAINCOL MODEL: PETROFRAC (CONTINUED)

****
******* MAIN COLUMN : *******
****

**** COLUMN SPECIFICATIONS ****

NUMBER OF STAGES		18
CONDENSER TEMPERATURE	C	40.0000
CONDENSER DUTY	MMKCAL/H	-22.0000
NO REBOILER		

**** PUMPAROUND SPECIFICATIONS ****

PUMPAROUND HN :		
DRAW STAGE		4
RETURN STAGE		3
FLOW	KG/HR	386,000.
DELTA TEMPERATURE	C	-47.0000
PUMPAROUND LCO :		
DRAW STAGE		10
RETURN STAGE		9
FLOW	KG/HR	230,000.
DELTA TEMPERATURE	C	-66.0000
PUMPAROUND CLO :		
DRAW STAGE		17
RETURN STAGE		16
FLOW	KG/HR	200,000.
DELTA TEMPERATURE	C	-104.000
PUMPAROUND HCO :		
DRAW STAGE		14
RETURN STAGE		13
FLOW	KG/HR	145,000.
DELTA TEMPERATURE	C	-132.000

**** HEATERS ****

STAGE 17 DUTY	MMKCAL/H	-2.00000

**** PRESSURE SPECIFICATIONS ****

BLOCK: MAINCOL MODEL: PETROFRAC (CONTINUED)

STAGE	PRESSURE KG/SQCM
1	3.03323
2	3.48323
18	3.83323

**** SECTIONAL MURPHREE EFFICIENCY ****

STAGE1	STAGE2	EFFICIENCY
1	18	0.60000

****
******* HN-STRIP: *******
****

**** COLUMN SPECIFICATIONS ****

NUMBER OF STAGES		2
DRAW STAGE FROM MAIN COLUMN		4
VAPOR OVERHEAD RETURN STAGE TO MAIN COLUMN		3
BOTTOMS RATE	KG/HR	19,600.0
NO REBOILER		

**** SECTIONAL MURPHREE EFFICIENCY ****

STAGE1	STAGE2	EFFICIENCY
1	2	0.60000

****
******* LCO-STRI: *******
****

**** COLUMN SPECIFICATIONS ****

NUMBER OF STAGES		2
DRAW STAGE FROM MAIN COLUMN		10
VAPOR OVERHEAD RETURN STAGE TO MAIN COLUMN		9
BOTTOMS RATE	KG/HR	85,400.0
NO REBOILER		

**** SECTIONAL MURPHREE EFFICIENCY ****

STAGE1	STAGE2	EFFICIENCY
1	2	0.60000

BLOCK: MAINCOL MODEL: PETROFRAC (CONTINUED)

****
********* RESULTS *********
****

**** PUMPAROUND CONDITIONS (AT COOLER OUTLET) ****

NO.	NAME	STAGE DRAW	STAGE RETURN	TEMPERATURE C	PRESSURE KG/SQCM	VFRAC
1	HN	4	3	96.6353	3.5270	0.0
2	LCO	10	9	180.0235	3.6582	0.0
3	CLO	17	16	267.0000	3.8114	0.0
4	HCO	14	13	225.1680	3.7457	0.0

NO.	MOLE FLOW KMOL/HR	MASS FLOW KG/HR	STDVOL FLOW CUM/HR	DUTY MMKCAL/H
1	3081.0063	3.8600+05	485.5117	-10.1859
2	1126.6082	2.3000+05	255.3759	-8.8722
3	584.9568	2.0000+05	200.7546	-12.9777
4	473.9612	1.4500+05	148.7244	-11.6911

**** CONNECTING STREAMS BETWEEN MAIN COLUMN / HN-STRIP ****

NO.	TYPE	FROM/TO STAGE (MAIN COLUMN)	TEMPERATURE C	PRESSURE KG/SQCM	VFRAC
1	STRIPPER FEED	4	143.6353	3.5270	0.0
2	VAPOR OVERHEAD	3	139.9287	3.5051	1.0000

NO.	MOLE FLOW KMOL/HR	MASS FLOW KG/HR	STDVOL FLOW CUM/HR	DUTY MMKCAL/H
1	171.7479	2.1517+04	27.0644	
2	60.9682	2697.1391	3.4332	

BLOCK: MAINCOL MODEL: PETROFRAC (CONTINUED)

**** CONNECTING STREAMS BETWEEN MAIN COLUMN / LCO-STRI ****

NO.	TYPE	FROM/TO STAGE (MAIN COLUMN)	TEMPERATURE C	PRESSURE KG/SQCM	VFRAC
1	STRIPPER FEED	10	246.0235	3.6582	0.0
2	VAPOR OVERHEAD	9	242.1660	3.6364	1.0000

NO.	MOLE FLOW KMOL/HR	MASS FLOW KG/HR	STDVOL FLOW CUM/HR	DUTY MMKCAL/H
1	455.9217	9.3078+04	103.3468	
2	177.4121	9892.6011	11.6544	

**** MANIPULATED VARIABLES ****

CONDENSER DUTY OF MAIN COLUMN	MMKCAL/H	-15.3742

EXCH DUTY FOR STAGE 17 OF MAIN COLUMN MMKCAL/H -4.57896

**** DESIGN SPECIFICATIONS ****

NO	SPEC-TYPE	QUALIFIERS		UNIT	SPECIFIED VALUE	ABSOLUTE ERROR
1	TEMP	COLUMN:	MAIN COLUMN	C	110.00	0.38992E-04
		STAGE:	2			
2	TEMP	COLUMN:	MAIN COLUMN	C	371.00	-0.29169E-04
		STAGE:	17			

BLOCK: MAINCOL MODEL: PETROFRAC (CONTINUED)

****
******* MAIN COLUMN : *******
****

TOP STAGE TEMPERATURE	C	40.0000
BOTTOM STAGE TEMPERATURE	C	370.986
TOP STAGE LIQUID FLOW	KMOL/HR	842.684
BOTTOM STAGE LIQUID FLOW	KMOL/HR	266.326
BOTTOM STAGE VAPOR FLOW	KMOL/HR	0.45561
MOLAR REFLUX RATIO (ORGANIC PHASE)		2.1380
CONDENSER DUTY (W/O SUBCOOL)	MMKCAL/H	-15.3741
NO REBOILER		
HEAT DUTY FOR STAGE 17	MMKCAL/H	-4.57896
RATE OF FREE WATER DECANTED	KMOL/HR	500.941
FREE WATER REFLUX RATIO		0.0

**** PROFILES ****

STAGE	TEMPERATURE C	PRESSURE KG/SQCM	ENTHALPY KCAL/MOL LIQUID	ENTHALPY KCAL/MOL VAPOR	HEAT DUTY MMKCAL/H
1	40.000	3.0332	-40.421	-21.710	-15.3740
2	110.00	3.4832	-45.111	-30.820	
3	123.18	3.5051	-45.614	-31.265	-10.1858
4	143.64	3.5270	-44.588	-31.024	
5	173.53	3.5489	-43.252	-30.487	
6	187.65	3.5707	-42.647	-29.933	
8	207.46	3.6145	-44.134	-29.032	
9	215.85	3.6364	-50.819	-28.872	-8.8722
10	246.02	3.6582	-50.320	-27.096	
11	302.03	3.6801	-58.081	-25.261	
12	321.03	3.7020	-60.316	-24.746	
13	322.26	3.7239	-62.155	-25.012	-11.6911
14	357.17	3.7457	-57.314	-24.054	
15	382.46	3.7676	-54.782	-22.873	
16	394.79	3.7895	-54.351	-21.970	-12.9777
17	371.00	3.8114	-59.722	-30.802	-4.5789
18	370.99	3.8332	-59.756	-38.134	

**** MOLAR FLOW PROFILES ****

STAGE	FLOW RATE KMOL/HR		FEED RATE KMOL/HR			PRODUCT RATE KMOL/HR	
	LIQUID	VAPOR	LIQUID	VAPOR	MIXED	LIQUID	VAPOR
1	842.7	1245.				975.8991	1244.9548
2	326.4	2589.					
3	3907.	2547.	3081.0063	60.9682			
4	4077.	2986.				3252.7541	
5	775.8	3156.					
6	696.0	3107.					
8	514.9	2933.					
9	2029.	2847.	1268.2316	177.4120			
10	1856.	2915.				1582.5298	
11	167.2	2742.					
12	176.5	2636.					
13	822.1	2645.	473.9612				
14	841.0	2817.				473.9612	
15	317.4	2836.					
16	851.1	2786.	584.9567	2734.5679			
17	851.5	0.5668E-01				584.9567	
18	266.3	0.4556			0.2775	266.3256	

**** MASS FLOW PROFILES ****

STAGE	FLOW RATE KG/HR		FEED RATE KG/HR			PRODUCT RATE KG/HR	
	LIQUID	VAPOR	LIQUID	VAPOR	MIXED	LIQUID	VAPOR
1	0.7311E+05	0.5846E+05				.50232+05	.58462+05
2	0.3666E+05	0.1406E+06					
3	0.4771E+06	0.1454E+06	.38600+06	2697.1390			
4	0.5108E+06	0.1971E+06				.40751+06	
5	0.1055E+06	0.2308E+06					
6	0.1003E+06	0.2330E+06					
8	0.8525E+05	0.2195E+06					
9	0.3893E+06	0.2128E+06	.26000+06	9892.6010			
10	0.3788E+06	0.2469E+06				.32308+06	
11	0.4354E+05	0.2365E+06					
12	0.5013E+05	0.2242E+06					
13	0.2431E+06	0.2308E+06	.14500+06				
14	0.2573E+06	0.2788E+06				.14500+06	
15	0.1030E+06	0.2930E+06					
16	0.2911E+06	0.2837E+06	.20000+06	.27179+06			
17	0.2911E+06	3.975				.20000+06	
18	0.9110E+05	24.95			5.0000	.91099+05	

**** STANDARD LIQUID VOLUME FLOW PROFILES ****

STAGE	FLOW RATE CUM/HR		FEED RATE CUM/HR			PRODUCT RATE CUM/HR	
	LIQUID	VAPOR	LIQUID	VAPOR	MIXED	LIQUID	VAPOR
1	102.8	101.5				66.9755	101.4936
2	47.54	213.3					
3	603.7	216.0	485.5116	3.4331			
4	642.5	283.2				512.5760	
5	129.6	322.0					

6	121.3	321.7				
8	99.36	301.5				
9	438.0	291.5	288.4454	11.6544		
10	420.6	330.0				358.7227
11	46.04	312.6				
12	52.16	296.8				
13	250.8	302.9	148.7244			
14	263.9	352.8				148.7244
15	104.4	365.9				
16	292.2	355.1	200.7546	342.1549		
17	292.2	0.5105E-02				200.7546
18	91.44	0.3127E-01			.50096-02	91.4366

BLOCK: MAINCOL MODEL: PETROFRAC (CONTINUED)

****
******* HN-STRIP: *******
****

TOP STAGE TEMPERATURE	C	139.929
BOTTOM STAGE TEMPERATURE	C	136.015
TOP STAGE LIQUID FLOW	KMOL/HR	163.211
BOTTOM STAGE LIQUID FLOW	KMOL/HR	154.076
BOTTOM STAGE VAPOR FLOW	KMOL/HR	52.4309

NO REBOILER

**** PROFILES ****

STAGE	TEMPERATURE C	PRESSURE KG/SQCM	ENTHALPY KCAL/MOL LIQUID	ENTHALPY KCAL/MOL VAPOR	HEAT DUTY MMKCAL/H
1	139.93	3.5051	-45.833	-48.037	
2	136.02	3.5051	-46.605	-52.475	

**** MOLAR FLOW PROFILES ****

STAGE	FLOW RATE KMOL/HR LIQUID	FLOW RATE KMOL/HR VAPOR	FEED RATE KMOL/HR LIQUID	FEED RATE KMOL/HR VAPOR	FEED RATE KMOL/HR MIXED	PRODUCT RATE KMOL/HR LIQUID	PRODUCT RATE KMOL/HR VAPOR
1	163.2	60.97	171.7478				60.9682
2	154.1	52.43		43.2965		154.0762	

**** MASS FLOW PROFILES ****

STAGE	FLOW RATE KG/HR LIQUID	FLOW RATE KG/HR VAPOR	FEED RATE KG/HR LIQUID	FEED RATE KG/HR VAPOR	FEED RATE KG/HR MIXED	PRODUCT RATE KG/HR LIQUID	PRODUCT RATE KG/HR VAPOR
1	0.2060E+05	2697.	.21517+05				2697.1390
2	0.1960E+05	1777.		780.0000		.19600+05	

**** STANDARD LIQUID VOLUME FLOW PROFILES ****

STAGE	FLOW RATE CUM/HR	FEED RATE CUM/HR	PRODUCT RATE CUM/HR

	LIQUID	VAPOR	LIQUID	VAPOR	MIXED	LIQUID	VAPOR
1	25.76	3.433	27.0644				3.4331
2	24.41	2.126		0.7815		24.4127	

BLOCK: MAINCOL MODEL: PETROFRAC (CONTINUED)

****
******* LCO-STRI: *******
****

TOP STAGE TEMPERATURE	C	242.166
BOTTOM STAGE TEMPERATURE	C	236.981
TOP STAGE LIQUID FLOW	KMOL/HR	426.308
BOTTOM STAGE LIQUID FLOW	KMOL/HR	401.461
BOTTOM STAGE VAPOR FLOW	KMOL/HR	147.799

NO REBOILER

**** PROFILES ****

STAGE	TEMPERATURE C	PRESSURE KG/SQCM	ENTHALPY KCAL/MOL LIQUID	ENTHALPY KCAL/MOL VAPOR	HEAT DUTY MMKCAL/H
1	242.17	3.6364	-52.130	-46.971	
2	236.98	3.6364	-53.731	-51.523	

**** MOLAR FLOW PROFILES ****

STAGE	FLOW RATE KMOL/HR LIQUID	FLOW RATE KMOL/HR VAPOR	FEED RATE KMOL/HR LIQUID	FEED RATE KMOL/HR VAPOR	FEED RATE KMOL/HR MIXED	PRODUCT RATE KMOL/HR LIQUID	PRODUCT RATE KMOL/HR VAPOR
1	426.3	177.4	455.9216				177.4120
2	401.5	147.8		122.9511		401.4607	

**** MASS FLOW PROFILES ****

STAGE	FLOW RATE KG/HR LIQUID	FLOW RATE KG/HR VAPOR	FEED RATE KG/HR LIQUID	FEED RATE KG/HR VAPOR	FEED RATE KG/HR MIXED	PRODUCT RATE KG/HR LIQUID	PRODUCT RATE KG/HR VAPOR
1	0.8915E+05	9893.	.93078+05				9892.6010
2	0.8540E+05	5962.		2215.0000		.85400+05	

**** STANDARD LIQUID VOLUME FLOW PROFILES ****

STAGE	FLOW RATE CUM/HR LIQUID	FLOW RATE CUM/HR VAPOR	FEED RATE CUM/HR LIQUID	FEED RATE CUM/HR VAPOR	FEED RATE CUM/HR MIXED	PRODUCT RATE CUM/HR LIQUID	PRODUCT RATE CUM/HR VAPOR
1	98.41	11.65	103.3468				11.6544
2	93.91	6.722		2.2192		93.9117	

BLOCK: MIXER MODEL: MIXER

INLET STREAMS:	F-LPG	F-DRYGAS	F-INERTS	F-STEAM	F-GASO
	F-HN	F-LCO	F-CLO		

OUTLET STREAM: RX-EFFLU
PROPERTY OPTION SET: GRAYSON SCATCHARD-HILDEBRAND / REDLICH-KWONG
FREE WATER OPTION SET: SYSOP12 ASME STEAM TABLE
SOLUBLE WATER OPTION: CORR SOLUBILITY DATA

*** MASS AND ENERGY BALANCE ***

	IN	OUT	RELATIVE DIFF.
TOTAL BALANCE			
MOLE(KMOL/HR)	2734.57	2734.57	0.000000E+00
MASS(KG/HR)	271794.	271794.	0.000000E+00
ENTHALPY(MMKCAL/H)	-46.0002	-46.0002	0.308930E-15

*** INPUT DATA ***

TWO PHASE FLASH
FREE WATER CONSIDERED
MAXIMUM NO. ITERATIONS 30
CONVERGENCE TOLERANCE 0.000100000
OUTLET PRESSURE: MINIMUM OF INLET STREAM PRESSURES

BOTMSTM COLMFEED F-CLO F-DRYGAS F-GASO

STREAM ID	BOTMSTM	COLMFEED	F-CLO	F-DRYGAS	F-GASO
FROM :	----	HEATER	----	----	----
TO :	MAINCOL	MAINCOL	MIXER	MIXER	MIXER
SUBSTREAM: MIXED					
PHASE:	VAPOR	VAPOR	LIQUID	VAPOR	VAPOR
COMPONENTS: KMOL/HR					
WATER	0.2775	486.6600	0.0	0.0	0.0
O2	0.0	0.0	0.0	0.0	0.0
N2	0.0	43.1400	0.0	0.0	0.0
CO	0.0	4.4500	0.0	0.0	0.0
CO2	0.0	6.6700	0.0	0.0	0.0
H2S	0.0	22.9102	0.0	22.9102	0.0
H2	0.0	57.4936	0.0	57.4936	0.0
METHANE	0.0	106.8248	0.0	106.8248	0.0
ETHYLENE	0.0	43.4896	0.0	43.4896	0.0
ETHANE	0.0	55.5200	0.0	55.5200	0.0
PROPY-01	0.0	170.4854	0.0	0.0	0.0
PROPA-01	0.0	84.4850	0.0	0.0	0.0
ISOBU-01	0.0	190.0563	0.0	0.0	0.0
ISOBU-02	0.0	101.2643	0.0	0.0	0.0
N-BUT-01	0.0	28.4043	0.0	0.0	0.0
1-PEN-01	0.0	0.0	0.0	0.0	0.0
2-MET-01	0.0	0.0	0.0	0.0	0.0
N-PEN-01	0.0	0.0	0.0	0.0	0.0
PC36C	0.0	229.2091	0.0	0.0	227.3289
PC58C	0.0	82.4746	0.0	0.0	79.8276
PC72C	0.0	72.3803	0.0	0.0	69.4893
PC86C	0.0	58.1901	0.0	0.0	54.8897
PC100C	0.0	50.8024	0.0	0.0	46.0469
PC115C	0.0	65.1515	0.0	0.0	59.3108
PC128C	0.0	53.4760	0.0	0.0	45.3702
PC142C	0.0	47.3977	0.0	0.0	28.3582
PC156C	0.0	47.4430	0.0	0.0	20.2296
PC170C	0.0	39.7848	0.0	0.0	19.0582

PC184C	0.0	43.6537	0.0	0.0	9.1936
PC197C	0.0	33.5204	0.0	0.0	0.0
PC211C	0.0	28.3692	0.0	0.0	0.0
PC225C	0.0	26.8402	0.0	0.0	0.0
PC239C	0.0	22.3108	0.0	0.0	0.0
PC253C	0.0	22.0267	0.0	0.0	0.0
PC267C	0.0	23.1292	2.7075	0.0	0.0
PC280C	0.0	20.2128	2.8320	0.0	0.0
PC295C	0.0	17.2833	2.9783	0.0	0.0
PC309C	0.0	16.3152	3.1173	0.0	0.0
PC323C	0.0	16.5679	3.3119	0.0	0.0
PC336C	0.0	16.3213	3.6053	0.0	0.0
PC350C	0.0	14.5701	4.4017	0.0	0.0
PC364C	0.0	14.9531	5.9368	0.0	0.0
PC379C	0.0	19.5321	7.9916	0.0	0.0
PC392C	0.0	28.2368	13.4952	0.0	0.0
PC406C	0.0	25.9381	16.9140	0.0	0.0
PC420C	0.0	30.4949	21.8628	0.0	0.0
PC444C	0.0	74.0276	72.0115	0.0	0.0
PC466C	0.0	52.0616	52.0616	0.0	0.0
PC494C	0.0	22.6281	22.6281	0.0	0.0
PC521C	0.0	9.3921	9.3921	0.0	0.0
PC551C	0.0	4.5402	4.5402	0.0	0.0
PC579C	0.0	3.3062	3.3062	0.0	0.0
PC594C	0.0	0.1736	0.1736	0.0	0.0
COMPONENTS: KG/HR					
WATER	5.0000	8767.3162	0.0	0.0	0.0
O2	0.0	0.0	0.0	0.0	0.0
N2	0.0	1208.5015	0.0	0.0	0.0
CO	0.0	124.6463	0.0	0.0	0.0
CO2	0.0	293.5454	0.0	0.0	0.0
H2S	0.0	780.8215	0.0	780.8215	0.0
H2	0.0	115.9002	0.0	115.9002	0.0
METHANE	0.0	1713.7653	0.0	1713.7653	0.0
ETHYLENE	0.0	1220.0479	0.0	1220.0479	0.0
ETHANE	0.0	1669.4651	0.0	1669.4651	0.0
PROPY-01	0.0	7174.1353	0.0	0.0	0.0
PROPA-01	0.0	3725.4942	0.0	0.0	0.0
ISOBU-01	0.0	1.0664+04	0.0	0.0	0.0
ISOBU-02	0.0	5885.8281	0.0	0.0	0.0
N-BUT-01	0.0	1650.9525	0.0	0.0	0.0
1-PEN-01	0.0	0.0	0.0	0.0	0.0
2-MET-01	0.0	0.0	0.0	0.0	0.0
N-PEN-01	0.0	0.0	0.0	0.0	0.0
PC36C	0.0	1.6080+04	0.0	0.0	1.5948+04
PC58C	0.0	6577.4485	0.0	0.0	6366.3498
PC72C	0.0	6231.3081	0.0	0.0	5982.4156
PC86C	0.0	5385.5560	0.0	0.0	5080.1030
PC100C	0.0	5037.2614	0.0	0.0	4565.7325
PC115C	0.0	7128.1585	0.0	0.0	6489.1294
PC128C	0.0	6169.7710	0.0	0.0	5234.5662
PC142C	0.0	5746.4072	0.0	0.0	3438.0949
PC156C	0.0	6066.3415	0.0	0.0	2586.6734
PC170C	0.0	5410.6845	0.0	0.0	2591.8916
PC184C	0.0	6251.4774	0.0	0.0	1316.5783
PC197C	0.0	5047.2959	0.0	0.0	0.0

PC211C	0.0	4521.6111	0.0	0.0	0.0
PC225C	0.0	4522.1851	0.0	0.0	0.0
PC239C	0.0	3958.4152	0.0	0.0	0.0
PC253C	0.0	4129.4123	0.0	0.0	0.0
PC267C	0.0	4571.4548	535.1375	0.0	0.0
PC280C	0.0	4192.8995	587.4558	0.0	0.0
PC295C	0.0	3762.1355	648.3049	0.0	0.0
PC309C	0.0	3739.9337	714.5782	0.0	0.0
PC323C	0.0	3996.3759	798.8673	0.0	0.0
PC336C	0.0	4134.1163	913.2151	0.0	0.0
PC350C	0.0	3870.5474	1169.3166	0.0	0.0
PC364C	0.0	4165.1326	1653.6708	0.0	0.0
PC379C	0.0	5712.3416	2337.2150	0.0	0.0
PC392C	0.0	8609.8524	4114.8920	0.0	0.0
PC406C	0.0	8253.5137	5382.0550	0.0	0.0
PC420C	0.0	1.0125+04	7258.8286	0.0	0.0
PC444C	0.0	2.6316+04	2.5600+04	0.0	0.0
PC466C	0.0	1.9741+04	1.9741+04	0.0	0.0
PC494C	0.0	9277.1177	9277.1177	0.0	0.0
PC521C	0.0	4140.2859	4140.2859	0.0	0.0
PC551C	0.0	2157.8056	2157.8056	0.0	0.0
PC579C	0.0	1679.6020	1679.6020	0.0	0.0
PC594C	0.0	91.2791	91.2791	0.0	0.0
TOTAL FLOW:					
KMOL/HR	0.2775	2734.5680	253.2677	286.2382	659.1028
KG/HR	5.0000	2.7179+05	8.8800+04	5500.0000	5.9600+04
CUM/HR	2.0498	4.5860+04	137.4098	4869.8706	1.1063+04
STATE VARIABLES:					
TEMP C	180.0000	489.0000	489.0000	489.0000	489.0000
PRES KG/SQCM	5.0332	3.8000	3.8000	3.8000	3.8000
VFRAC	1.0000	1.0000	0.0	1.0000	1.0000
LFRAC	0.0	0.0	1.0000	0.0	0.0
SFRAC	0.0	0.0	0.0	0.0	0.0
ENTHALPY:					
KCAL/MOL	-56.6255	-15.4184	-32.8284	-3.2211	-12.3265
KCAL/KG	-3143.1933	-155.1276	-93.6303	-167.6373	-136.3155
MMKCAL/HR	-1.5716-02	-42.1633	-8.3145	-0.9220	-8.1245
ENTROPY:					
CAL/MOL-K	-10.5631	-77.9309	-334.5822	-4.7294	-81.8867
CAL/GM-K	-0.5863	-0.7841	-0.9543	-0.2461	-0.9056
DENSITY:					
MOL/CC	1.3540-04	5.9629-05	1.8432-03	5.8777-05	5.9579-05
GM/CC	2.4393-03	5.9266-03	0.6462	1.1294-03	5.3875-03
AVG MW	18.0153	99.3919	350.6172	19.2148	90.4260

MIXED SUBSTREAM PROPERTIES:

*** DRY TOTAL ***

TBPCRV C					
0.0	MISSING	MISSING	269.9052	MISSING	-3.6472
5.0000	MISSING	MISSING	341.1480	MISSING	17.7517
10.0000	MISSING	MISSING	379.5720	MISSING	28.5974
30.0000	MISSING	MISSING	425.6863	MISSING	53.9832
50.0000	MISSING	MISSING	448.8261	MISSING	80.0489
70.0000	MISSING	MISSING	465.8874	MISSING	113.1754
90.0000	MISSING	MISSING	504.1190	MISSING	149.2895
95.0000	MISSING	MISSING	531.8456	MISSING	165.2697

	100.0000	MISSING	MISSING	578.7180	MISSING	183.7908
D86CRV	C					
	0.0	MISSING	MISSING	301.9786	MISSING	35.3901
	5.0000	MISSING	MISSING	357.2253	MISSING	48.0634
	10.0000	MISSING	MISSING	381.7585	MISSING	53.2924
	30.0000	MISSING	MISSING	413.3319	MISSING	67.4975
	50.0000	MISSING	MISSING	427.8555	MISSING	84.2539
	70.0000	MISSING	MISSING	439.1536	MISSING	109.0032
	90.0000	MISSING	MISSING	471.8228	MISSING	139.4657
	95.0000	MISSING	MISSING	501.8169	MISSING	155.1754
	100.0000	MISSING	MISSING	531.8110	MISSING	170.8852
D1160CRV	C					
	0.0	MISSING	MISSING	142.8114	MISSING	-62.6447
	5.0000	MISSING	MISSING	204.5812	MISSING	-52.8892
	10.0000	MISSING	MISSING	234.2956	MISSING	-49.2055
	30.0000	MISSING	MISSING	269.7146	MISSING	-33.3548
	50.0000	MISSING	MISSING	286.4154	MISSING	-16.8899
	70.0000	MISSING	MISSING	301.4526	MISSING	8.7623
	90.0000	MISSING	MISSING	335.4968	MISSING	37.0674
	95.0000	MISSING	MISSING	360.4927	MISSING	49.7069
	100.0000	MISSING	MISSING	403.3463	MISSING	64.4453
VLSTDMX	BBL/DAY	MISSING	5.0324+04	1.3408+04	2779.8163	1.2391+04
APISTD		MISSING	47.9602	9.7394	300.8602	62.9825
SGSTD		MISSING	0.7885	1.0018	0.3272	0.7276
WAT		MISSING	11.1501	10.7581	18.4366	11.8598

F-HN F-INERTS F-LCO F-LPG F-STEAM

STREAM ID	F-HN	F-INERTS	F-LCO	F-LPG	F-STEAM
FROM :	----	----	----	----	----
TO :	MIXER	MIXER	MIXER	MIXER	MIXER
SUBSTREAM: MIXED					
PHASE:	VAPOR	VAPOR	VAPOR	VAPOR	VAPOR
COMPONENTS: KMOL/HR					
WATER	0.0	0.0	0.0	0.0	486.6600
O2	0.0	0.0	0.0	0.0	0.0
N2	0.0	43.1400	0.0	0.0	0.0
CO	0.0	4.4500	0.0	0.0	0.0
CO2	0.0	6.6700	0.0	0.0	0.0
H2S	0.0	0.0	0.0	0.0	0.0
H2	0.0	0.0	0.0	0.0	0.0
METHANE	0.0	0.0	0.0	0.0	0.0
ETHYLENE	0.0	0.0	0.0	0.0	0.0
ETHANE	0.0	0.0	0.0	0.0	0.0
PROPY-01	0.0	0.0	0.0	170.4854	0.0
PROPA-01	0.0	0.0	0.0	84.4850	0.0
ISOBU-01	0.0	0.0	0.0	190.0563	0.0
ISOBU-02	0.0	0.0	0.0	101.2643	0.0
N-BUT-01	0.0	0.0	0.0	28.4043	0.0
1-PEN-01	0.0	0.0	0.0	0.0	0.0
2-MET-01	0.0	0.0	0.0	0.0	0.0
N-PEN-01	0.0	0.0	0.0	0.0	0.0
PC36C	1.8802	0.0	0.0	0.0	0.0
PC58C	2.6470	0.0	0.0	0.0	0.0

PC72C	2.8910	0.0	0.0	0.0	0.0
PC86C	3.3004	0.0	0.0	0.0	0.0
PC100C	4.7555	0.0	0.0	0.0	0.0
PC115C	5.8407	0.0	0.0	0.0	0.0
PC128C	8.1058	0.0	0.0	0.0	0.0
PC142C	14.8091	0.0	4.2304	0.0	0.0
PC156C	19.7798	0.0	7.4336	0.0	0.0
PC170C	11.3810	0.0	9.3456	0.0	0.0
PC184C	17.6091	0.0	16.8511	0.0	0.0
PC197C	16.2145	0.0	17.3059	0.0	0.0
PC211C	11.1528	0.0	17.2165	0.0	0.0
PC225C	9.6517	0.0	17.1885	0.0	0.0
PC239C	4.2013	0.0	18.1096	0.0	0.0
PC253C	3.3789	0.0	18.6477	0.0	0.0
PC267C	3.3056	0.0	17.1161	0.0	0.0
PC280C	1.8576	0.0	15.5232	0.0	0.0
PC295C	0.0	0.0	14.3050	0.0	0.0
PC309C	0.0	0.0	13.1979	0.0	0.0
PC323C	0.0	0.0	13.2560	0.0	0.0
PC336C	0.0	0.0	12.7159	0.0	0.0
PC350C	0.0	0.0	10.1684	0.0	0.0
PC364C	0.0	0.0	9.0163	0.0	0.0
PC379C	0.0	0.0	11.5405	0.0	0.0
PC392C	0.0	0.0	14.7416	0.0	0.0
PC406C	0.0	0.0	9.0240	0.0	0.0
PC420C	0.0	0.0	8.6321	0.0	0.0
PC444C	0.0	0.0	2.0161	0.0	0.0
PC466C	0.0	0.0	0.0	0.0	0.0
PC494C	0.0	0.0	0.0	0.0	0.0
PC521C	0.0	0.0	0.0	0.0	0.0
PC551C	0.0	0.0	0.0	0.0	0.0
PC579C	0.0	0.0	0.0	0.0	0.0
PC594C	0.0	0.0	0.0	0.0	0.0

COMPONENTS: KG/HR					
WATER	0.0	0.0	0.0	0.0	8767.3162
O2	0.0	0.0	0.0	0.0	0.0
N2	0.0	1208.5015	0.0	0.0	0.0
CO	0.0	124.6463	0.0	0.0	0.0
CO2	0.0	293.5454	0.0	0.0	0.0
H2S	0.0	0.0	0.0	0.0	0.0
H2	0.0	0.0	0.0	0.0	0.0
METHANE	0.0	0.0	0.0	0.0	0.0
ETHYLENE	0.0	0.0	0.0	0.0	0.0
ETHANE	0.0	0.0	0.0	0.0	0.0
PROPY-01	0.0	0.0	0.0	7174.1353	0.0
PROPA-01	0.0	0.0	0.0	3725.4942	0.0
ISOBU-01	0.0	0.0	0.0	1.0664+04	0.0
ISOBU-02	0.0	0.0	0.0	5885.8281	0.0
N-BUT-01	0.0	0.0	0.0	1650.9525	0.0
1-PEN-01	0.0	0.0	0.0	0.0	0.0
2-MET-01	0.0	0.0	0.0	0.0	0.0
N-PEN-01	0.0	0.0	0.0	0.0	0.0
PC36C	131.9071	0.0	0.0	0.0	0.0
PC58C	211.0986	0.0	0.0	0.0	0.0
PC72C	248.8925	0.0	0.0	0.0	0.0
PC86C	305.4530	0.0	0.0	0.0	0.0

PC100C	471.5290	0.0	0.0	0.0	0.0
PC115C	639.0291	0.0	0.0	0.0	0.0
PC128C	935.2048	0.0	0.0	0.0	0.0
PC142C	1795.4296	0.0	512.8828	0.0	0.0
PC156C	2529.1610	0.0	950.5071	0.0	0.0
PC170C	1547.8017	0.0	1270.9912	0.0	0.0
PC184C	2521.7227	0.0	2413.1764	0.0	0.0
PC197C	2441.4813	0.0	2605.8146	0.0	0.0
PC211C	1777.5776	0.0	2744.0335	0.0	0.0
PC225C	1626.1705	0.0	2896.0146	0.0	0.0
PC239C	745.3935	0.0	3213.0217	0.0	0.0
PC253C	633.4590	0.0	3495.9533	0.0	0.0
PC267C	653.3548	0.0	3382.9625	0.0	0.0
PC280C	385.3341	0.0	3220.1096	0.0	0.0
PC295C	0.0	0.0	3113.8307	0.0	0.0
PC309C	0.0	0.0	3025.3555	0.0	0.0
PC323C	0.0	0.0	3197.5086	0.0	0.0
PC336C	0.0	0.0	3220.9011	0.0	0.0
PC350C	0.0	0.0	2701.2308	0.0	0.0
PC364C	0.0	0.0	2511.4618	0.0	0.0
PC379C	0.0	0.0	3375.1266	0.0	0.0
PC392C	0.0	0.0	4494.9604	0.0	0.0
PC406C	0.0	0.0	2871.4588	0.0	0.0
PC420C	0.0	0.0	2865.9989	0.0	0.0
PC444C	0.0	0.0	716.6997	0.0	0.0
PC466C	0.0	0.0	0.0	0.0	0.0
PC494C	0.0	0.0	0.0	0.0	0.0
PC521C	0.0	0.0	0.0	0.0	0.0
PC551C	0.0	0.0	0.0	0.0	0.0
PC579C	0.0	0.0	0.0	0.0	0.0
PC594C	0.0	0.0	0.0	0.0	0.0
TOTAL FLOW:					
KMOL/HR	142.7620	54.2600	277.5819	574.6954	486.6600
KG/HR	1.9600+04	1626.6932	5.8800+04	2.9100+04	8767.3162
CUM/HR	2355.4494	923.5211	4408.8441	9739.5968	8249.2091
STATE VARIABLES:					
TEMP C	489.0000	489.0000	489.0000	489.0000	489.0000
PRES KG/SQCM	3.8000	3.8000	3.8000	3.8000	3.8000
VFRAC	1.0000	1.0000	1.0000	1.0000	1.0000
LFRAC	0.0	0.0	0.0	0.0	0.0
SFRAC	0.0	0.0	0.0	0.0	0.0
ENTHALPY:					
KCAL/MOL	-7.2718	-10.1995	-9.1851	2.9547	-53.8274
KCAL/KG	-52.9662	-340.2160	-43.3607	58.3521	-2987.8764
MMKCAL/HR	-1.0382	-0.5534	-2.5496	1.6981	-26.1960
ENTROPY:					
CAL/MOL-K	-114.0310	7.5853	-181.1402	-33.0302	-5.2986
CAL/GM-K	-0.8306	0.2530	-0.8551	-0.6523	-0.2941
DENSITY:					
MOL/CC	6.0609-05	5.8753-05	6.2960-05	5.9006-05	5.8995-05
GM/CC	8.3211-03	1.7614-03	1.3337-02	2.9878-03	1.0628-03
AVG MW	137.2914	29.9796	211.8293	50.6355	18.0153

MIXED SUBSTREAM PROPERTIES:

*** DRY TOTAL ***
TBPCRV C

	0.0	38.7629	MISSING	142.4115	MISSING	MISSING
	5.0000	90.7176	MISSING	174.2761	MISSING	MISSING
	10.0000	116.0820	MISSING	191.3706	MISSING	MISSING
	30.0000	152.9230	MISSING	244.8337	MISSING	MISSING
	50.0000	179.1098	MISSING	293.1219	MISSING	MISSING
	70.0000	202.2489	MISSING	346.9700	MISSING	MISSING
	90.0000	237.5484	MISSING	400.3125	MISSING	MISSING
	95.0000	258.9456	MISSING	412.2859	MISSING	MISSING
	100.0000	279.5374	MISSING	439.9266	MISSING	MISSING
D86CRV	C					
	0.0	86.3816	MISSING	181.1361	MISSING	MISSING
	5.0000	123.5786	MISSING	203.0902	MISSING	MISSING
	10.0000	140.2580	MISSING	212.2382	MISSING	MISSING
	30.0000	163.2438	MISSING	251.7685	MISSING	MISSING
	50.0000	180.0948	MISSING	289.0084	MISSING	MISSING
	70.0000	196.1532	MISSING	335.3654	MISSING	MISSING
	90.0000	225.7742	MISSING	384.3162	MISSING	MISSING
	95.0000	244.5513	MISSING	402.1452	MISSING	MISSING
	100.0000	263.3284	MISSING	419.9742	MISSING	MISSING
D1160CRV	C					
	0.0	-24.9838	MISSING	55.7512	MISSING	MISSING
	5.0000	5.5157	MISSING	72.6369	MISSING	MISSING
	10.0000	18.8677	MISSING	79.2361	MISSING	MISSING
	30.0000	43.5354	MISSING	118.1247	MISSING	MISSING
	50.0000	60.7113	MISSING	153.4472	MISSING	MISSING
	70.0000	79.2296	MISSING	198.5818	MISSING	MISSING
	90.0000	107.7741	MISSING	244.1714	MISSING	MISSING
	95.0000	125.2519	MISSING	254.5274	MISSING	MISSING
	100.0000	142.1987	MISSING	278.6093	MISSING	MISSING
VLSTDMX	BBL/DAY	3630.9498	438.6835	9784.3774	7891.4967	MISSING
APISTD		41.7925	340.0000	24.1580	121.9507	MISSING
SGSTD		0.8165	0.3000	0.9090	0.5583	MISSING
WAT		11.4021	18.1912	10.9923	13.8516	MISSING

HN-STM LCO-STM P-CLO P-GASO P-HN

STREAM ID	HN-STM	LCO-STM	P-CLO	P-GASO	P-HN
FROM :	----	----	MAINCOL	MAINCOL	MAINCOL
TO :	MAINCOL	MAINCOL	----	----	----
SUBSTREAM: MIXED					
PHASE:	VAPOR	VAPOR	LIQUID	LIQUID	LIQUID
COMPONENTS: KMOL/HR					
WATER	43.2966	122.9512	0.1531	0.7902	4.6839
O2	0.0	0.0	0.0	0.0	0.0
N2	0.0	0.0	8.3182-02	8.1477-02	9.0544-06
CO	0.0	0.0	9.0394-03	1.3477-02	1.1199-06
CO2	0.0	0.0	5.4388-03	8.3514-02	1.2720-05
H2S	0.0	0.0	4.0091-02	1.2565	2.3016-03
H2	0.0	0.0	4.4705-02	6.8187-02	3.8016-06
METHANE	0.0	0.0	8.7549-02	0.8600	1.4509-04
ETHYLENE	0.0	0.0	9.5315-02	1.0530	7.7283-04
ETHANE	0.0	0.0	0.1179	1.8150	1.6439-03
PROPY-01	0.0	0.0	0.4022	14.0046	2.7172-02
PROPA-01	0.0	0.0	0.2029	7.3781	1.4170-02
ISOBU-01	0.0	0.0	0.6430	42.0763	0.2201

ISOBU-02	0.0	0.0	0.3138	18.1333	6.6567-02
N-BUT-01	0.0	0.0	0.1015	7.0528	4.1667-02
1-PEN-01	0.0	0.0	0.0	0.0	0.0
2-MET-01	0.0	0.0	0.0	0.0	0.0
N-PEN-01	0.0	0.0	0.0	0.0	0.0
PC36C	0.0	0.0	1.1240	101.4949	2.1594
PC58C	0.0	0.0	0.5038	43.7502	1.8803
PC72C	0.0	0.0	0.5067	40.8652	2.7834
PC86C	0.0	0.0	0.4655	33.7072	3.6893
PC100C	0.0	0.0	0.4638	29.0885	5.2001
PC115C	0.0	0.0	0.6762	35.4509	10.3864
PC128C	0.0	0.0	0.6261	26.5382	12.2396
PC142C	0.0	0.0	0.6323	21.0123	15.8368
PC156C	0.0	0.0	0.7153	17.8661	20.4379
PC170C	0.0	0.0	0.6807	12.0669	20.2271
PC184C	0.0	0.0	0.8463	9.9258	23.4185
PC197C	0.0	0.0	0.7314	4.9757	15.3146
PC211C	0.0	0.0	0.7126	2.1135	8.1879
PC225C	0.0	0.0	0.7799	0.8563	3.9483
PC239C	0.0	0.0	0.7617	0.3039	1.5999
PC253C	0.0	0.0	0.8934	0.1294	0.7511
PC267C	0.0	0.0	1.1207	6.3397-02	0.3935
PC280C	0.0	0.0	1.1758	3.0995-02	0.2011
PC295C	0.0	0.0	1.2480	1.5888-02	0.1065
PC309C	0.0	0.0	1.4749	9.7624-03	6.6868-02
PC323C	0.0	0.0	1.9213	7.0068-03	4.8679-02
PC336C	0.0	0.0	2.4971	5.1959-03	3.6424-02
PC350C	0.0	0.0	3.0765	3.5555-03	2.5070-02
PC364C	0.0	0.0	4.5767	2.7788-03	1.9666-02
PC379C	0.0	0.0	8.8925	2.6729-03	1.8962-02
PC392C	0.0	0.0	17.5192	2.6419-03	1.8784-02
PC406C	0.0	0.0	20.2624	1.3703-03	9.7516-03
PC420C	0.0	0.0	27.2864	8.7473-04	6.2334-03
PC444C	0.0	0.0	70.8060	6.1726-04	4.4007-03
PC466C	0.0	0.0	51.2423	1.3731-04	9.7672-04
PC494C	0.0	0.0	22.4624	2.7522-05	1.9619-04
PC521C	0.0	0.0	9.3494	7.0873-06	5.0474-05
PC551C	0.0	0.0	4.5248	4.2211-06	1.7813-05
PC579C	0.0	0.0	3.2965	2.3837-06	1.1026-05
PC594C	0.0	0.0	0.1731	1.5420-07	5.5533-07
COMPONENTS: KG/HR					
WATER	780.0000	2215.0000	2.7581	14.2352	84.3823
O2	0.0	0.0	0.0	0.0	0.0
N2	0.0	0.0	2.3302	2.2825	2.5365-04
CO	0.0	0.0	0.2532	0.3775	3.1368-05
CO2	0.0	0.0	0.2394	3.6754	5.5979-04
H2S	0.0	0.0	1.3664	42.8228	7.8443-02
H2	0.0	0.0	9.0119-02	0.1375	7.6635-06
METHANE	0.0	0.0	1.4045	13.7969	2.3276-03
ETHYLENE	0.0	0.0	2.6740	29.5408	2.1681-02
ETHANE	0.0	0.0	3.5455	54.5769	4.9431-02
PROPY-01	0.0	0.0	16.9234	589.3220	1.1434
PROPA-01	0.0	0.0	8.9491	325.3477	0.6249
ISOBU-01	0.0	0.0	36.0771	2360.7943	12.3468
ISOBU-02	0.0	0.0	18.2417	1053.9698	3.8691
N-BUT-01	0.0	0.0	5.9009	409.9307	2.4219

1-PEN-01	0.0	0.0	0.0	0.0	0.0
2-MET-01	0.0	0.0	0.0	0.0	0.0
N-PEN-01	0.0	0.0	0.0	0.0	0.0
PC36C	0.0	0.0	78.8540	7120.4667	151.4925
PC58C	0.0	0.0	40.1749	3489.1294	149.9558
PC72C	0.0	0.0	43.6203	3518.1356	239.6222
PC86C	0.0	0.0	43.0861	3119.6444	341.4530
PC100C	0.0	0.0	45.9862	2884.2402	515.6067
PC115C	0.0	0.0	73.9848	3878.6480	1136.3628
PC128C	0.0	0.0	72.2392	3061.8351	1412.1411
PC142C	0.0	0.0	76.6603	2547.4956	1920.0234
PC156C	0.0	0.0	91.4635	2284.4623	2613.3114
PC170C	0.0	0.0	92.5689	1641.0808	2750.8659
PC184C	0.0	0.0	121.1952	1421.4319	3353.6769
PC197C	0.0	0.0	110.1359	749.2166	2305.9748
PC211C	0.0	0.0	113.5797	336.8652	1305.0222
PC225C	0.0	0.0	131.4059	144.2711	665.2322
PC239C	0.0	0.0	135.1498	53.9225	283.8572
PC253C	0.0	0.0	167.4841	24.2550	140.8023
PC267C	0.0	0.0	221.4971	12.5304	77.7792
PC280C	0.0	0.0	243.9018	6.4295	41.7236
PC295C	0.0	0.0	271.6631	3.4584	23.1810
PC309C	0.0	0.0	338.0952	2.2379	15.3282
PC323C	0.0	0.0	463.4437	1.6901	11.7419
PC336C	0.0	0.0	632.4968	1.3161	9.2262
PC350C	0.0	0.0	817.2858	0.9445	6.6598
PC364C	0.0	0.0	1274.8336	0.7740	5.4780
PC379C	0.0	0.0	2600.6933	0.7817	5.5457
PC392C	0.0	0.0	5341.8940	0.8056	5.7275
PC406C	0.0	0.0	6447.5037	0.4360	3.1030
PC420C	0.0	0.0	9059.5482	0.2904	2.0696
PC444C	0.0	0.0	2.5171+04	0.2194	1.5644
PC466C	0.0	0.0	1.9430+04	5.2064-02	0.3703
PC494C	0.0	0.0	9209.2039	1.1284-02	8.0435-02
PC521C	0.0	0.0	4121.4480	3.1243-03	2.2250-02
PC551C	0.0	0.0	2150.5011	2.0062-03	8.4662-03
PC579C	0.0	0.0	1674.6686	1.2109-03	5.6015-03
PC594C	0.0	0.0	91.0224	8.1092-05	2.9203-04
TOTAL FLOW:					
KMOL/HR	43.2966	122.9512	266.3256	474.9583	154.0763
KG/HR	780.0000	2215.0000	9.1099+04	4.1208+04	1.9600+04
CUM/HR	319.7613	908.0401	121.6916	59.9087	28.1233
STATE VARIABLES:					
TEMP C	180.0000	180.0000	370.9857	40.0000	136.0154
PRES KG/SQCM	5.0332	5.0332	3.8332	3.0332	3.5051
VFRAC	1.0000	1.0000	0.0	0.0	0.0
LFRAC	0.0	0.0	1.0000	1.0000	1.0000
SFRAC	0.0	0.0	0.0	0.0	0.0
ENTHALPY:					
KCAL/MOL	-56.6255	-56.6255	-59.7556	-40.4210	-46.6053
KCAL/KG	-3143.1933	-3143.1933	-174.6935	-465.8890	-366.3667
MMKCAL/HR	-2.4517	-6.9623	-15.9147	-19.1986	-7.1809
ENTROPY:					
CAL/MOL-K	-10.5631	-10.5631	-357.3765	-136.2408	-173.4480
CAL/GM-K	-0.5863	-0.5863	-1.0448	-1.5703	-1.3635
DENSITY:					
MOL/CC	1.3540-04	1.3540-04	2.1885-03	7.9280-03	5.4786-03

GM/CC		2.4393-03	2.4393-03	0.7486	0.6878	0.6969
AVG MW		18.0153	18.0153	342.0595	86.7611	127.2095

MIXED SUBSTREAM PROPERTIES:

*** DRY TOTAL ***						
TBPCRV C						
0.0	%	MISSING	MISSING	88.0840	-81.8141	29.9873
5.0000	%	MISSING	MISSING	347.1154	-15.5585	91.1002
10.0000	%	MISSING	MISSING	384.5482	-7.2347	111.6792
30.0000	%	MISSING	MISSING	422.2101	48.5251	146.3084
50.0000	%	MISSING	MISSING	446.9025	79.4604	167.1507
70.0000	%	MISSING	MISSING	464.3182	116.9297	185.7933
90.0000	%	MISSING	MISSING	503.1179	160.9712	209.5707
95.0000	%	MISSING	MISSING	530.5316	180.0114	222.5958
100.0000	%	MISSING	MISSING	578.2184	208.0557	259.3426
D86CRV C						
0.0	%	MISSING	MISSING	157.4872	-30.9170	77.1918
5.0000	%	MISSING	MISSING	301.0481	4.1655	116.6584
10.0000	%	MISSING	MISSING	386.8507	20.7656	134.5699
30.0000	%	MISSING	MISSING	410.5373	62.9938	155.7199
50.0000	%	MISSING	MISSING	426.2341	83.6828	168.5536
70.0000	%	MISSING	MISSING	437.7997	112.5757	181.0546
90.0000	%	MISSING	MISSING	471.0653	151.4192	199.3378
95.0000	%	MISSING	MISSING	501.2250	172.1526	221.0611
100.0000	%	MISSING	MISSING	531.3847	192.8860	242.7844
D1160CRV C						
0.0	%	MISSING	MISSING	-16.9483	-115.9690	-34.3412
5.0000	%	MISSING	MISSING	136.2249	-86.9379	-0.1238
10.0000	%	MISSING	MISSING	238.6727	-74.8556	14.8181
30.0000	%	MISSING	MISSING	266.8290	-37.1502	37.8010
50.0000	%	MISSING	MISSING	284.7259	-17.3430	51.1994
70.0000	%	MISSING	MISSING	300.0656	11.6882	66.0446
90.0000	%	MISSING	MISSING	334.5992	46.3001	85.1210
95.0000	%	MISSING	MISSING	359.3022	61.4300	95.6392
100.0000	%	MISSING	MISSING	402.8855	83.9007	125.5775
VLSTDMX BBL/DAY		MISSING	MISSING	1.3802+04	8743.2271	3672.4690
APISTD		MISSING	MISSING	10.2386	67.2858	44.5331
SGSTD		MISSING	MISSING	0.9983	0.7118	0.8038
WAT		MISSING	MISSING	10.7967	12.0137	11.4812

GUJARAT FCCU GAS PLANT SIMULATION

STREAM SECTION

P-LCO P-WETGAS RICHSO RX-EFFLU SWWATER

STREAM ID	P-LCO	P-WETGAS	RICHSO	RX-EFFLU	SWWATER
FROM :	MAINCOL	MAINCOL	----	MIXER	MAINCOL
TO :	----	----	MAINCOL	HEATER	----
SUBSTREAM: MIXED					
PHASE:	LIQUID	VAPOR	LIQUID	VAPOR	LIQUID
COMPONENTS: KMOL/HR					
WATER	3.2574	143.3599	0.0	486.6600	500.9409
O2	0.0	0.0	0.0	0.0	0.0
N2	8.4955-05	42.9752	0.0	43.1400	0.0
CO	5.5637-06	4.4275	0.0	4.4500	0.0
CO2	1.1736-05	6.5810	0.0	6.6700	0.0
H2S	1.0521-03	21.6103	0.0	22.9102	0.0
H2	2.5074-05	57.3807	0.0	57.4936	0.0
METHANE	1.7896-04	105.8770	0.0	106.8248	0.0
ETHYLENE	8.9520-04	42.3396	0.0	43.4896	0.0
ETHANE	1.4505-03	53.5839	0.0	55.5200	0.0
PROPY-01	1.2989-02	156.0385	0.0	170.4854	0.0
PROPA-01	6.7280-03	76.8831	0.0	84.4850	0.0
ISOBU-01	7.0963-02	147.0461	0.0	190.0563	0.0
ISOBU-02	2.3937-02	82.7267	0.0	101.2643	0.0
N-BUT-01	1.2852-02	21.1955	0.0	28.4043	0.0
1-PEN-01	0.0	0.0	0.0	0.0	0.0
2-MET-01	0.0	0.0	0.0	0.0	0.0
N-PEN-01	0.0	0.0	0.0	0.0	0.0
PC36C	0.4206	124.0102	0.0	229.2091	0.0
PC58C	0.3086	36.0318	0.0	82.4746	0.0
PC72C	0.4183	27.8068	0.0	72.3803	0.0
PC86C	0.5217	19.8062	0.0	58.1901	0.0
PC100C	0.7121	15.3380	0.0	50.8024	0.0
PC115C	1.4017	17.2363	0.0	65.1515	0.0
PC128C	1.7565	12.3155	0.0	53.4760	0.0
PC142C	2.6471	9.4275	2.1584	47.3977	0.0
PC156C	4.3692	7.8472	3.7927	47.4430	0.0
PC170C	6.3555	5.2228	4.7682	39.7848	0.0
PC184C	13.8028	4.2578	8.5975	43.6537	0.0
PC197C	19.2053	2.1229	8.8295	33.5204	0.0
PC211C	25.2408	0.8983	8.7839	28.3692	0.0
PC225C	29.6622	0.3631	8.7696	26.8402	0.0
PC239C	28.7561	0.1287	9.2396	22.3108	0.0
PC253C	29.7123	5.4744-02	9.5142	22.0267	0.0
PC267C	30.2575	2.6812-02	8.7327	23.1292	0.0
PC280C	26.7118	1.3105-02	7.9200	20.2128	0.0
PC295C	23.2046	6.7162-03	7.2984	17.2833	0.0
PC309C	21.4931	4.1264-03	6.7336	16.3152	0.0
PC323C	21.3512	2.9615-03	6.7633	16.5679	0.0
PC336C	20.2681	2.1960-03	6.4877	16.3213	0.0
PC350C	16.6513	1.5027-03	5.1879	14.5701	0.0
PC364C	14.9529	1.1744-03	4.6002	14.9531	0.0
PC379C	16.5049	1.1297-03	5.8880	19.5321	0.0

PC392C	18.2163	1.1177-03	7.5212	28.2368	0.0
PC406C	10.2681	5.7972-04	4.6041	25.9381	0.0
PC420C	7.6051	3.7005-04	4.4041	30.4949	0.0
PC444C	4.2449	2.6113-04	1.0286	74.0276	0.0
PC466C	0.8181	5.8087-05	0.0	52.0616	0.0
PC494C	0.1654	1.1708-05	0.0	22.6281	0.0
PC521C	4.2673-02	3.0149-06	0.0	9.3921	0.0
PC551C	1.5346-02	1.4420-06	0.0	4.5402	0.0
PC579C	9.6969-03	7.6088-07	0.0	3.3062	0.0
PC594C	4.8751-04	2.9841-13	0.0	0.1736	0.0
COMPONENTS: KG/HR					
WATER	58.6822	2582.6684	0.0	8767.3162	9024.5900
O2	0.0	0.0	0.0	0.0	0.0
N2	2.3799-03	1203.8862	0.0	1208.5015	0.0
CO	1.5584-04	124.0154	0.0	124.6463	0.0
CO2	5.1651-04	289.6295	0.0	293.5454	0.0
H2S	3.5859-02	736.5180	0.0	780.8215	0.0
H2	5.0546-05	115.6726	0.0	115.9002	0.0
METHANE	2.8710-03	1698.5587	0.0	1713.7653	0.0
ETHYLENE	2.5114-02	1187.7864	0.0	1220.0479	0.0
ETHANE	4.3616-02	1611.2496	0.0	1669.4651	0.0
PROPY-01	0.5466	6566.1999	0.0	7174.1353	0.0
PROPA-01	0.2967	3390.2759	0.0	3725.4942	0.0
ISOBU-01	3.9815	8250.3902	0.0	1.0664+04	0.0
ISOBU-02	1.3913	4808.3562	0.0	5885.8281	0.0
N-BUT-01	0.7470	1231.9520	0.0	1650.9525	0.0
1-PEN-01	0.0	0.0	0.0	0.0	0.0
2-MET-01	0.0	0.0	0.0	0.0	0.0
N-PEN-01	0.0	0.0	0.0	0.0	0.0
PC36C	29.5089	8700.0503	0.0	1.6080+04	0.0
PC58C	24.6083	2873.5801	0.0	6577.4485	0.0
PC72C	36.0111	2393.9189	0.0	6231.3081	0.0
PC86C	48.2844	1833.0880	0.0	5385.5560	0.0
PC100C	70.6070	1520.8213	0.0	5037.2614	0.0
PC115C	153.3608	1885.8021	0.0	7128.1585	0.0
PC128C	202.6585	1420.8971	0.0	6169.7710	0.0
PC142C	320.9274	1142.9755	261.6749	5746.4072	0.0
PC156C	558.6699	1003.3869	484.9526	6066.3415	0.0
PC170C	864.3376	710.2963	648.4649	5410.6845	0.0
PC184C	1976.6396	609.7463	1231.2124	6251.4774	0.0
PC197C	2891.8165	319.6493	1329.4972	5047.2959	0.0
PC211C	4022.9798	143.1814	1400.0171	4521.6111	0.0
PC225C	4997.6523	61.1820	1477.5585	4522.1851	0.0
PC239C	5101.9464	22.8361	1639.2968	3958.4152	0.0
PC253C	5570.2574	10.2631	1783.6496	4129.4123	0.0
PC267C	5980.3501	5.2994	1726.0013	4571.4548	0.0
PC280C	5541.0392	2.7184	1642.9130	4192.8995	0.0
PC295C	5051.0602	1.4620	1588.6891	3762.1355	0.0
PC309C	4926.8752	0.9459	1543.5487	3739.9337	0.0
PC323C	5150.1677	0.7143	1631.3819	3996.3759	0.0
PC336C	5133.8379	0.5562	1643.3169	4134.1163	0.0
PC350C	4423.4371	0.3992	1378.1790	3870.5474	0.0
PC364C	4165.0779	0.3271	1281.3581	4165.1326	0.0
PC379C	4826.9938	0.3304	1722.0034	5712.3416	0.0
PC392C	5554.4316	0.3408	2293.3471	8609.8524	0.0
PC406C	3267.3165	0.1845	1465.0300	8253.5137	0.0

PC420C	2525.0407	0.1229	1462.2444	1.0125+04	0.0
PC444C	1509.0417	9.2830-02	365.6631	2.6316+04	0.0
PC466C	310.1992	2.2025-02	0.0	1.9741+04	0.0
PC494C	67.8173	4.8001-03	0.0	9277.1177	0.0
PC521C	18.8113	1.3291-03	0.0	4140.2859	0.0
PC551C	7.2933	6.8532-04	0.0	2157.8056	0.0
PC579C	4.9261	3.8653-04	0.0	1679.6020	0.0
PC594C	0.2564	1.5693-10	0.0	91.2791	0.0
TOTAL FLOW:					
KMOL/HR	401.4608	1244.9549	141.6234	2734.5680	500.9409
KG/HR	8.5400+04	5.8462+04	3.0000+04	2.7179+05	9024.5900
CUM/HR	115.6871	1.0423+04	35.6874	4.4595+04	9.0938
STATE VARIABLES:					
TEMP C	236.9809	40.0000	109.0000	468.9571	40.0000
PRES KG/SQCM	3.6364	3.0332	4.0332	3.8000	3.0332
VFRAC	0.0	1.0000	0.0	1.0000	0.0
LFRAC	1.0000	0.0	1.0000	0.0	1.0000
SFRAC	0.0	0.0	0.0	0.0	0.0
ENTHALPY:					
KCAL/MOL	-53.7311	-21.7103	-68.3802	-16.8215	-67.9975
KCAL/KG	-252.5870	-462.3211	-322.8081	-169.2442	-3774.4366
MMKCAL/HR	-21.5712	-27.0288	-9.6844	-46.0002	-34.0632
ENTROPY:					
CAL/MOL-K	-249.2787	-52.6739	-275.2847	-79.7943	-38.0852
CAL/GM-K	-1.1718	-1.1217	-1.2996	-0.8028	-2.1141
DENSITY:					
MOL/CC	3.4702-03	1.1944-04	3.9684-03	6.1320-05	5.5086-02
GM/CC	0.7382	5.6090-03	0.8406	6.0947-03	0.9924
AVG MW	212.7231	46.9594	211.8293	99.3919	18.0153

MIXED SUBSTREAM PROPERTIES:

*** DRY TOTAL ***					
TBPCRV C					
0.0 %	119.2892	MISSING	142.4115	MISSING	MISSING
5.0000 %	187.2533	MISSING	174.2761	MISSING	MISSING
10.0000 %	205.6258	MISSING	191.3706	MISSING	MISSING
30.0000 %	252.6705	MISSING	244.8337	MISSING	MISSING
50.0000 %	294.1040	MISSING	293.1219	MISSING	MISSING
70.0000 %	342.0683	MISSING	346.9700	MISSING	MISSING
90.0000 %	395.3349	MISSING	400.3125	MISSING	MISSING
95.0000 %	410.9257	MISSING	412.2859	MISSING	MISSING
100.0000 %	449.2331	MISSING	439.9266	MISSING	MISSING
D86CRV C					
0.0 %	166.1053	MISSING	181.1351	MISSING	MISSING
5.0000 %	208.4104	MISSING	203.0902	MISSING	MISSING
10.0000 %	227.2028	MISSING	212.2382	MISSING	MISSING
30.0000 %	259.7252	MISSING	251.7685	MISSING	MISSING
50.0000 %	289.9270	MISSING	289.0084	MISSING	MISSING
70.0000 %	329.7269	MISSING	335.3654	MISSING	MISSING
90.0000 %	378.5947	MISSING	384.3162	MISSING	MISSING
95.0000 %	401.7833	MISSING	402.1452	MISSING	MISSING
100.0000 %	424.9719	MISSING	419.9742	MISSING	MISSING
D1160CRV C					
0.0 %	32.0375	MISSING	55.7512	MISSING	MISSING
5.0000 %	73.0183	MISSING	72.6369	MISSING	MISSING
10.0000 %	90.7999	MISSING	79.2361	MISSING	MISSING

30.0000		124.5318	MISSING	118.1247	MISSING	MISSING
50.0000		154.2626	MISSING	153.4472	MISSING	MISSING
70.0000		194.4368	MISSING	198.5818	MISSING	MISSING
90.0000		239.8796	MISSING	244.1714	MISSING	MISSING
95.0000		253.3487	MISSING	254.5274	MISSING	MISSING
100.0000		286.7730	MISSING	278.6093	MISSING	MISSING
VLSTDMX	BBL/DAY	1.4168+04	1.4930+04	4992.0293	5.0324+04	MISSING
APISTD		23.7934	120.5348	24.1580	47.9602	MISSING
SGSTD		0.9112	0.5614	0.9090	0.7885	MISSING
WAT		10.9991	13.4526	10.9923	11.1501	MISSING

GUJARAT FCCU GAS PLANT SIMULATION

PROBLEM STATUS SECTION

BLOCK STATUS

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*                                                                           *
* Calculations were completed normally                                      *
*                                                                           *
* All Unit Operation blocks were completed normally                         *
*                                                                           *
* All streams were flashed normally                                         *
*                                                                           *
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