A

Thesis titled

"CONVERSION OF PLASTICS TO DIESEL"

Submitted in partial fulfillment of the requirements for the award of Degree of
Master of Technology
In
Refining & Petrochemical Engineering

Submitted By
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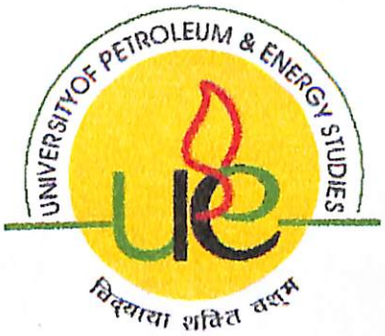

College of Engineering
University of Petroleum & Energy Studies
Dehradun
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April, 2009

CERTIFICATE

This is to certify that the work contained in this thesis titled "**CONVERSION OF PLASTICS TO DIESEL**" has been carried out by **Rakesh Vankayala** under my supervision.

Date 12/8/2009

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CERTIFICATE

This is to certify that the work contained in this thesis titled "**MODELING AND SIMULATION OF PLASTICS TO DIESEL**" has been carried out by **Mr. Rakesh Vankayala** under our supervision and has not been submitted elsewhere for a degree.

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Nomenclature

Acronyms and abbreviations:

MSW	– Municipal Solid Waste
GPCB	– Gujarat Pollution Control Board
MMTA	– Million Metric Tons Per Annum.
MMT	– Million Metric Tons.
USD	– United States Dollar.
kTA	– Kilo Tons Per Annum.
MoU	– Memorandum of Understanding.
k	- Rate constant
TPD	- Tonnes per Day
PET	- Polyethylene Terepthalates.
LDPE	- Low Density Polyethylene.
PVC	-Polyvinyl Chloride
HDPE	-High Density Polyethylene
PP	-Polypropylene
PS	- polystyrene
CPCB	- central Pollution Control Board

Synopsis

Objective:

To convert plastics to diesel.

Abstract:

The current project contains about the various types of plastics that will be generally present in municipal solid waste (MSW) along with its properties. The best adoptable technology for converting these plastics to diesel. Modeling of the process and then finding out the optimum operable parameters. Checking these values with ASPEN HYSYS.

Description:

The collected plastics are first shredded, to increase the surface area. This facilitates for easy and fast melting in a limited area. Then they were heated to its melting point. These melted plastics are now decomposed or cracked to molecule of diesel range (preferred product in this project). This can be done by using catalyst or heat (pyrolysis) by maintaining required temperatures. The cracked molecule may be gases (lighters) or liquids. So these are separated using distillation. The liquid and gas molecules (streams) are now sent for solid separation by centrifugation and filtration in order to remove any fine solids of plastics or any other solids formed during reactions. These are now quality checked and are blended with additives to attain required product properties.

Chapter 1

Introduction

The population is increasing day by day, the demand for the things which are being used in our daily life ranging from tooth brush to airplanes are also increasing proportionally along with the generation of different type of wastes. With the advent of plastics which replaced most of the metallurgical parts and components being used in our daily life. The usage and dependency of humans on these plastics are being increasing exponentially. So in this **age of plastics** the demand for the plastics is increasing tremendously. At the same time the concentration of these plastics in MSW (municipal solid wastes) is also increasing.

As per the Indian MSW rules 2000 "Municipal Solid Waste" includes commercial and residential wastes generated in a municipal notified areas in either semi solid or solid form excluding industrial hazardous waste but including bio – medical wastes. It is estimated that about 42 million tons of MSW is generated annually from Indian urban areas and is creating a lot of problem to handle these solid wastes.

These plastics with their extraordinary stability are boon to industry and curse to environment. These are playing a vital role in industries due to light weight, flexibility, stability and their strength. And the same properties are now creating problems to handle the plastic waste. At a moment these plastics replaced most of the metal components in all the industries and brought tremendous change mostly in automobile industry. Now the current problem is with the handling of this plastic waste. There are many technologies for the plastic management but are not very handy. The current upcoming technology is conversion of these plastics to diesel range products, production of lube oils or value added products from the plastic waste. But due to the varying properties of a wide range of plastics, operating parameters play a key role in obtaining these desired products. As these plastics are hydrocarbons. So, an effort on conversion of these hydrocarbons into fuel range hydrocarbons is being done.

We can hardly find an item, equipment or a minute without the use of plastics.

1.1 Supply and demand scenario of plastics in India

These plastics are being produced from Naphtha. More than 60% of the produced naphtha was being used for the production of different polymers. So, certainly these polymers are also hydrocarbons as they are derived from them. As per the survey conducted by **Plastindia Foundation**, globally the use of plastics on volume basis it is more than combined use of steel and aluminum. In the year 2000 India ranked10th in terms of consumption and it is estimated that it will rank 3rd by the year 2010 with an increased consumption of about 8.5 MMTPA. At the same time it is creating employment for 9 million people. And the demand is still increasing which is making lager investments in both downstream and upstream sector of this industry. These plastics are being used in almost all areas ranging from food production (agriculture) to food processing and packaging industries. Now it became difficult to think for a while without the use of these polymers / plastics.

PP (Polypropylene) is the one among the mostly used plastic. In the year 2000 its consumption was 23 kTA and is estimated that by the year 2010 it will reach 135 kTA.

1.2 Principle

The basic conceptual or theoretical principle being used here is these polymeric materials are formed from large number of molecules which are linked together to form large chain molecules derived from hydrocarbons. So, why can't these give the fuels or products on cracking which are being produced on refining / processing crude oil which is also a hydrocarbon.

Now on selective cracking of these long chain molecules in a controlled way such that the products formed will be in the range of diesel. The Cracking temperatures of different compounds vary depending upon the carbon number. By maintaining proper conditions we can control the extent cracking limited to the molecules in the range of diesel molecules. Catalysts are also being used for increasing selectivity and to operate the process at low temperatures and pressures of the process.

Chapter 2

Literature Review

Due to increasing MSW various proposals were being made for effective management of this waste disposal. Later on New Technologies emerged out for handling MSW, process like incineration, producing bio- degradable polymers, recycling of plastics etc., But on recycling, the plastics looses their properties and so it's not an advisable way to handle this problem. One among all the processes and is still in the stage of research and development is plastics to diesel conversion.

Few US patents (ref: journals/papers 3) claims a method for conversion of plastic waste into oil by reaction using water in a super critical or near super critical state as a reaction medium, method of simultaneous treatment of waste plastic and spent vegetable oils by heating and reshaping into solid fuels. There are even processes for production of value added Chemicals, Lubricants. Few of them are Catalytic processes and few are Pyrolysis based.

The work on the evolution of new catalysts for this process is still going on and one of the Indian company who are working on this issue is Indian Oil Corporation (ref: journals/papers 4). Till now the latest catalysts are of zeolite based due to their cracking properties and many other compositions are available. The conversion of all the plastics into Diesel is not yet commercialized. But work is still going on to handle mixed plastic wastes. Now the most challenge lies in the separation of these plastics either before processing or during the process. Still new and new technologies are being emerging.

Plastics on Pyrolysis will produce Olefins and Paraffin's. Besides these, there will be the formation of some other toxic compounds like polychlorinated dibenzodioxines, dibenzofurans, polychloro biphenyls and highly corrosive hydrochloric acid (ref: journals / papers 4). The formation of these compounds is limited to the type of feed being used or being handled.

There are few commercial plants that were set up in many parts of Europe but in East Asia and in India these are not familiar as still research is going on. The commercial plants established in European countries can handle capacities up to 20 tons per day (ref: websites 11). At the same time there are few restrictions in the type of plastics fed. But the processes are not universal, as in few units like PET (Poly

Ethylene Terepthalates), and thermoset plastics cannot be handled in few units. To avail this technology, the current problem is to sort the plastics as per requirements.

The properties of few plastics are discussed in appendix 2.

2.1 Basic chemistry

Carbon is an interesting molecule. As it's the only compound in the Periodic table that will form only covalent bonds due to it electro negativity. The difference in electro negativity with other molecules will always be less than 1.9 and meets the basic criteria for a covalent bond formation.

It can form long chain molecules by the property of catenation. When this carbon chain breaks by bond dissociation there is every possibility of formation of an ionic / charged atom at one end, which is unstable. To become stable its effect will be on the adjacent carbon atoms and the other too will be charged but slightly less in strength and this continues throughout the chain. So the centre carbon atom will have less force than all other atoms.

During dissociation or decomposition of molecules by cracking, the molecule first breaks at centre and forms two fragments. These fragments can be again dissociated by giving bond dissociation energy. This energy differs as the length of carbon chain varies. But the energy required to remove one carbon atom only from any numbered carbon chain will be same. With this principle the concept of selectivity came.

The current polymers may be cyclic or straight line in nature but are not aromatics. These are long chained cyclic compounds with varying carbon numbers in hundreds and thousands and even lot more. So, in order to break the molecule the energy given will first split the molecule into two by breaking the bonds at centre. Still upon further supplement of heat, it can finally lead to the formation of coke along with few lighters. Coke formation is due to atomic shift between ions or molecules for stability. And during this, as the basic constituent molecules of the polymers being olefins upon cracking the molecules formed can be again olefins only. These olefins are the precursors for coke formation due to unsaturation. So, in order to avoid coke formation the reaction should proceed in the presence of hydrogen. It will now acts like a hydro cracker for better quality of product and getting maximum valuables.

2.2 Decomposition

The principle of decomposition is that this will be done by addition of heat, for this case we don't consider catalyst.

If a solid material has taken the heat supplied will be first used to increase its internal energy and will be slowly liquefied. Now even still energy is supplied it will be used for latent heat of vaporization by building up its internal energy. Further on supplying heat / energy, the formed vapors increase the internal energy. But the final state of this will be internal energy only. By using this internal energy, the molecules get excited and finally there will be increase in the atom size due to excitation of electrons. Now the bond length increases hence the bond strength will be weakened at this situation. If still energy is given at this point, the bond will be broken.

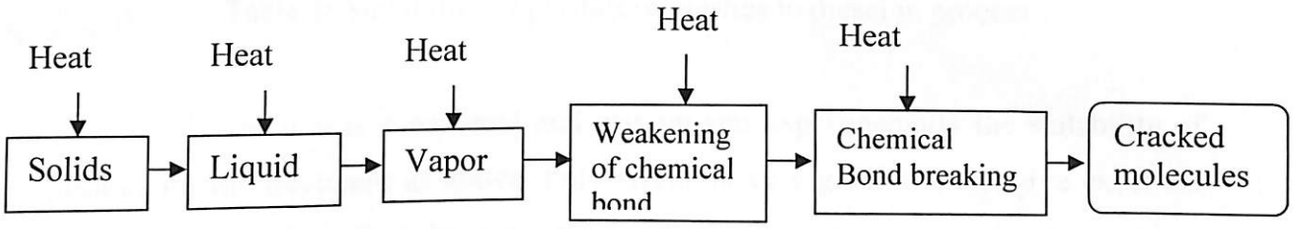

Fig 1: Decomposition Process.

2.3 Raw material availability:

As per Central Pollution Control Board, India, it is estimated that 10 thousand tons per day of plastic waste is generated in India, which is 9% of 1.20 lacs TPD of MSW in India. Of this, 80% are thermo plastics and the rest 20% are thermoset plastics. Thermo plastics include PET, LDPE, PVC, HDPE, PP, PS. Where as thermosets include alkyd, epoxy, ester, melamine formaldehyde, phenolic formaldehyde, silicon, urea formaldehyde, poly urethanes, metalized and multi layered plastics etc.,

2.4 Raw materials specifications

Polymer	System suitability
Polyethylene (PE)	**Very good**
Polypropylene (PP)	**Very good**
Polystyrene (PS)	**Very good** (gives excellent properties to produce fuel)
ABS Resin (ABS)	Good, Requires off gas counter measures.
Polyvinylchloride (PVC)	Not suitable, should be avoided.
Polyurethenes (PUR)	Fair, Oil recovery is small.
Fiber Reinforced Plastics (FRP)	Fair, Pre – treatment is required to remove fibres.
Polyethylene Terepthalate (PET)	Not suitable

Table 1: Suitability of plastics in plastics to diesel in process

Till now it was considered and was proven experimentally the suitability of plastics for the treatment as above. Polystyrene is very good and can give excellent properties to produce fuel, because it's a polymer having an aromatic ring and not being a thermoset polymer. So it also gives an aromatic ring compound on decomposition, as its very difficult to break the aromatic ring by general processes. Whatever the way it is done it is to be economically viable.

2.5 Economic viability

There are technologies available that will produce 500 litres of Diesel per hour at a total production cost of 25 cents per litre. But even then this is raw material specific. In general terms one tonne of plastic will give 900 litres of fuel (ref: websites 11,16,17).

Prof Alka Umesh Zadgaonkar, department of applied chemistry of G.H. Raison College Of Engineering had established a unit to produce 5000 litres of fuel per day from 5 MTD of plastic waste. The present selling price of this Diesel is USD 0.4 per litre. Even, it too depends on the waste plastics being processed (ref: websites 14, 18).

2.6 Process

First the plastics are collected and are shredded into pieces in order to increase the surface area. And reduce the volume of these solids, if any are having hollow bodies. Now these plastics are melted in a furnace or in any tank from which the liquid phase is now sent to a catalytic converter where the required conditions for converting this molten material into fuel are maintained. The reaction will be cracking. These cracking reactions may take place by using heat (pyrolysis / thermal cracking) or by using a catalyst (catalytic cracking). Now these cracked molecules are sent to Distillation column, where the molecules are separated out depending on their differential boiling points. Now the obtained molecules are quality checked. If these molecules meet the requirement then it is sent for further processing, else recycled or treated to extract the exact required molecules, or it will be blended.

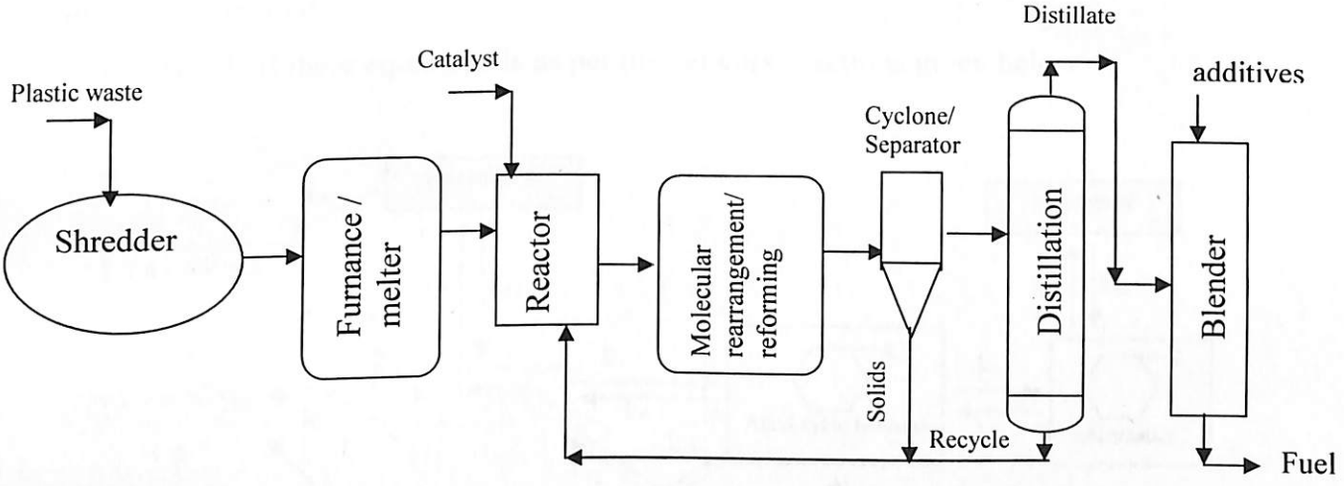

Fig 2: General flow sheet for plastics to Diesel process

2.7 Catalyst:

The latest catalyst was developed by Indian Oil Corporation is having few constituents as its catalyst recipe of (ref: journals / papers 4).

1. faujasite – Having good cracking properties for gasoline range molecules.
2. Pseudoboehmite alumina – Cracking for large molecules with metal tolerant nature and sulfur reduction properties.
3. Polyammonium silicate – It acts as a support due to silica concentration. This support it also acts as a cracking media.
4. Kaolin clay – This is a good Binder.

Chapter 3:

Theoretical Development

Considering the reactants to be polyethylene, polypropylene and polystyrene mathematical modeling is to be done.

In this modeling is done for overall conversion. The possible reactions that are assumed and considered to be are.

1. Cracking
2. Dehydrogenation
3. Isomerization.
4. Hydrogenation.
5. Dehydro Cyclization.

The possibilities of the above reactions to be involved depend on the plastic materials that are being used.

The Network of these equations is as per the network reactions given below

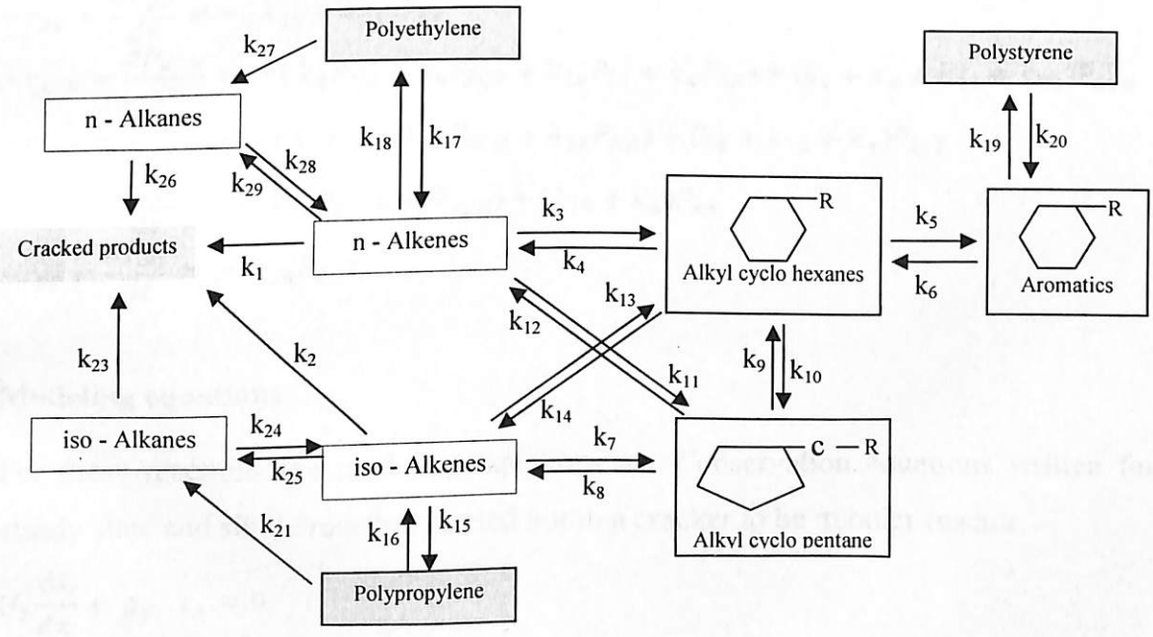

Fig 3: Network of reactions involved

This network of reactions explain the interlink between different reactions. In the network, identification of the precursors of a particular compound can be identified. On product component analysis if any of the undesired molecules are

present, by getting its precursors we can select the operating conditions or catalyst in such a way that those reactions can be reduced or eliminated.

If any reaction thus reduced or eliminated will not have its rate constant (k) value. For such reaction, the particular terms which represent the reaction in the modeled equations will tend to zero and can be eliminated.

3.1 Model Development

Rate of Reaction:

$$r_C = \frac{dP_c}{dt} = -(k_1 P_{NA} + k_2 P_{IA} + k_{23} P_I + k_{26} P_A)$$

$$-r_A = \frac{dP_A}{dt} = -(k_{27} P_{PE} + k_{28} P_{NA}) + (k_{26} + k_{29}) P_A$$

$$-r_I = \frac{dP_I}{dt} = -(k_{25} P_{IA} + k_{21} P_{PP}) + (k_{23} + k_{24}) P_I$$

$$-r_{PE} = \frac{dP_{PE}}{dt} = -(k_{27} + k_{17}) P_{PE}$$

$$-r_{NA} = \frac{dP_{NA}}{dt} = -(k_{17} P_{PE} + k_{27} P_A + k_{12} P_{ACP} + k_4 P_{ACH}) + (k_{18} + k_{28} + k_{11} + k_3) P_A$$

$$-r_{IA} = \frac{dP_{IA}}{dt} = -(k_{14} P_{ACH} + k_8 P_{ACP} + k_{16} P_{PP} + k_{24} P_I) + (k_{13} + k_7 + k_{15} + k_{25}) P_{IA}$$

$$-r_{PP} = \frac{dP_{PP}}{dt} = -(k_{16} + k_{21}) P_{PP}$$

$$-r_{ACH} = \frac{dP_{ACH}}{dt} = -(k_3 P_{NA} + k_9 P_{ACP} + k_{13} P_{IA} + k_6 P_{AR}) + (k_4 + k_5 + k_{14} + k_{10}) P_{ACH}$$

$$-r_{ACP} = \frac{dP_{ACP}}{dt} = -(k_7 P_{IA} + k_{10} P_{ACH} + k_{11} P_{NA}) + (k_8 + k_{12} + k_9) P_{ACP}$$

$$-r_{AR} = \frac{dP_{AR}}{dt} = -(k_{20} P_{PS} + k_5 P_{ACH}) + (k_{19} + k_6) P_{AR}$$

$$-r_{PS} = \frac{dP_{PS}}{dt} = -k_{20} P_{PS}$$

Modeling equations:

For these reactions the modeling equations are Conservation equations written for steady state and single reaction carried out in a cracker to be tubular reactor.

$$U_S \frac{dC}{dz} + \rho_s \cdot r_A = 0$$

For two dimensional flow from navier strokes equations

$$U_S \cdot \rho_B \cdot C_p \frac{\partial T}{\partial z} - \rho_s(-\Delta H) r_A + 4\frac{U}{d_t}(T - T_r) = 0$$

Where,

U_s = superficial velocity

C = concentration

ρ_s = catalyst density
r_A = rate of reaction
ρ_B = bulk density
C_p = heat capacity
T = temperature

ΔH = heat of reaction

U = overall heat transfer coefficient
T_r = temperature of surroundings.

d_t = tube diameter

z = axial direction

When the resistance to mass and heat transfer inside the particle is important, the rate of reaction is not uniform throughout the particle. So we need to have the solid phase modeling as.

$$\frac{D_e}{\xi}\frac{d}{d\xi}\left(\xi^2\frac{dC_s}{d\xi}\right) - \rho_s r_A(C_s, T_s) = 0$$

$$\frac{D_e}{\xi}\frac{d}{d\xi}\left(\xi^2\frac{dT_s}{d\xi}\right) - \rho_s (-\Delta H)\, r_A(C_s, T_s) = 0$$

$$D_e(r_i) = \frac{\varepsilon_s}{\Gamma}\left(\frac{1}{D_{MA}} + \frac{1}{D_{kA(r_i)}}\right)^{-1}$$

Where,

ξ = catalyst particle radial distance.

D_e= effective diffusivity.

ε_s = porosity of the catalyst particle.

Γ = tortousity

D_{MA} = molecular diffusivity

D_{kA} = Knudsen diffusivity

The continuity for every reaction in general be:

$$\frac{\varepsilon_s}{\Gamma}\left(\frac{1}{D_{MA}}+\frac{1}{D_{kA(\eta)}}\right)^{-1}\left[\frac{\partial^2 C}{\partial r^2}+\frac{1}{r}\frac{\partial C}{\partial r}\right]-U_s\frac{\partial C}{\partial z}-\rho_s r_A=0$$

For dehydrogenation reaction it turns to be:

$$\varepsilon_s\left(\frac{1}{D_{MA}}+\frac{1}{D_{kA(\eta)}}\right)^{-1}\left[\frac{\partial^2 p_H}{\partial r^2}+\frac{1}{r}\frac{\partial p_H}{\partial r}\right]-U_s\frac{\partial p_H}{\partial z}-\rho_s(r_{ACH}+r_{ACP})=0$$

For dehydrocyclization reaction it turns to be:

$$\varepsilon_s\left(\frac{1}{D_{MA}}+\frac{1}{D_{kA(\eta)}}\right)^{-1}\left[\frac{\partial^2 p_C}{\partial r^2}+\frac{1}{r}\frac{\partial p_C}{\partial r}\right]-U_s\frac{\partial p_C}{\partial z}-\rho_s(-r_{IP}-r_{ACH}+r_{NP})=0$$

For hydrocracking reaction it turns to be:

$$\varepsilon_s\left(\frac{1}{D_{MA}}+\frac{1}{D_{kA(\eta)}}\right)^{-1}\left[\frac{\partial^2 p_{HC}}{\partial r^2}+\frac{1}{r}\frac{\partial p_{HC}}{\partial r}\right]-U_s\frac{\partial p_{HC}}{\partial z}-\rho_s(-r_C)=0$$

For isomerization reaction it turns to be:

$$\varepsilon_s\left(\frac{1}{D_{MA}}+\frac{1}{D_{kA(\eta)}}\right)^{-1}\left[\frac{\partial^2 p_I}{\partial r^2}+\frac{1}{r}\frac{\partial p_I}{\partial r}\right]-U_s\frac{\partial p_I}{\partial z}-\rho_s(-r_{NP}-r_{IP})=0$$

Overall continuity equation for all reactions will be

$$\varepsilon_s\left(\frac{1}{D_{MA}}+\frac{1}{D_{kA(\eta)}}\right)^{-1}\left[\frac{\partial^2 p_C}{\partial r^2}+\frac{1}{r}\frac{\partial p}{\partial r}\right]-U_s\frac{\partial p}{\partial z}-\rho_s(-r_C-r_{IP}+r_{ACP}-r_{AR})=0$$

Considering the cracker to be an isothermal system the heat balance will be:

$$dT/dt=(-1)/(C_p(n+1))\left[K_1 p_{NP}\,[\Delta H]_{r(NP-C)}+K_1 p_{IP}\,[\Delta H]_{r(IP-C)}+K_2 p_{ACH}\,[\Delta H]_{r(ACH-NP)}+1\right.$$

The energy equation for dehydrogenation is:

$$k_{err}\left[\frac{\partial^2 T}{\partial r^2}+\frac{1}{r}\frac{\partial T}{\partial r}\right]-U_S\rho_B C_p\frac{\partial T}{\partial z}+\rho_S(-\Delta H)(r_{ACH}+r_{ACP})=0$$

The energy equation for dehydrocyclization is:

$$k_{err}\left[\frac{\partial^2 T}{\partial r^2}+\frac{1}{r}\frac{\partial T}{\partial r}\right]-U_S\rho_B C_p\frac{\partial T}{\partial z}+\rho_S(-\Delta H)(-r_{IP}-r_{ACH}+r_{NP})=0$$

The energy equation for hydrocracking is:

$$k_{err}\left[\frac{\partial^2 T}{\partial r^2}+\frac{1}{r}\frac{\partial T}{\partial r}\right]-U_S\rho_B C_p\frac{\partial T}{\partial z}+\rho_S(-\Delta H)(r_C)=0$$

The energy equation for isomerization is:

$$k_{err}\left[\frac{\partial^2 T}{\partial r^2}+\frac{1}{r}\frac{\partial T}{\partial r}\right]-U_S\rho_B C_p\frac{\partial T}{\partial z}+\rho_S(-\Delta H)(-r_{XP}-r_{IP})=0$$

The overall energy equation for all the reactions was is:

$$k_{err}\left[\frac{\partial^2 T}{\partial r^2}+\frac{1}{r}\frac{\partial T}{\partial r}\right]-U_S\rho_B C_p\frac{\partial T}{\partial z}+\rho_S(-\Delta H)(-r_{IP}+r_{ACP}+r_C)=0$$

C : cracked products

NA: n – alkenes

A: n – Alkanes

IA: Iso Alkenes

I : Iso Alkanes

ACP: alkyl cyclo pentane

AR : Aromatics

ACH: Alkyl Cyclo Hexanes

PE: Polyethylene

PP: Poly propylene

PS: polystyrene

Chapter 4

Experimental / computational

4.1 Simulation:

For the process of converting plastics to diesel, simulation is to be done in order to estimate the product. But during this, some assumptions are to be considered for software compatibility. The software used is ASPEN – HYSYS.

4.2 Flow sheet development

After shredding the plastics are sent to melter where they are melted. Inorder to avoid the solids entering the subsequent units, which are formed due to improper melting the feed is fed to the cracker in vapor phase. This condition is maintained so that plastics (solid state) doesnot settle over catalyst. As we are considering pyrolysis where the reaction will to be in vapor phase there is a combined benefit by raising the polymer temperature to it vapor phase temperature. Now these are sent to the cracker where the molecules are cracked and reforming reactions are assumed to take place during simulation, and then it will be distilled for pure products. During distillation a part of solid fraction in the bottoms is considered along with heaviers. As few un melted plastic solids may appear as impurities. Before this distillation process the vapors coming from the cracker are cooled and the heat is used for melting of plastics in melter. Here during simulation heat source will be taken as an utility so, this gives the information about how much amount of heat is required for the plastics to melt.

4.3 Assumptions and Explanations:

ASPEN HYSYS cannot handle polymeric substances. These substances were not included in HYSYS library. But a provision is made to create hypothetical components both in solid state as well as in liquid state. So for the polymeric substances in the form of solids as well as in the form of liquids (molten polymers) hypothetical components were created. For creating such a component few details regarding molecular properties like

molecular weight, densities, boiling points, melting points as per the requirements depending upon the type of hypothetical component created are required. Information or details about all the properties are not needed, but few basing on few properties others will be estimated.

The problem is that even though solid densities of polymers were known but in liquid state they were not known. This was confirmed as the measured values are at 25^0C. But the boiling temperatures were known for these polymers. So a temperature less than 20^0C to its decomposition temperature is considered as a boiling point of these polymers.

In the actual flow sheet one of the step mentioned was molecular rearrangement. But the products formed after cracking are not known even the stoichiometry of these reactions is also not known to avoid this complexity during simulation. A common reaction in which polymeric liquid is cracked and rearranged is considered in the same reactor. If the reactions and catalyst properties with respect to rates are known then those can be used directly.

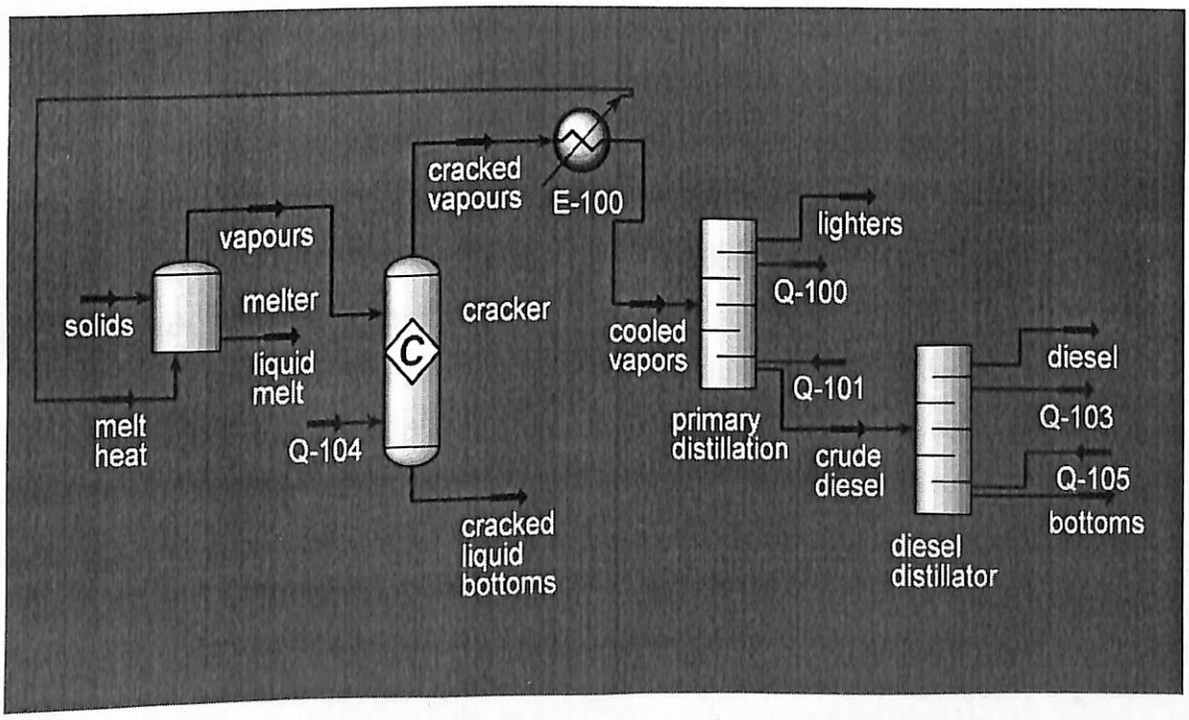

Fig 4: flow sheet made in simulation

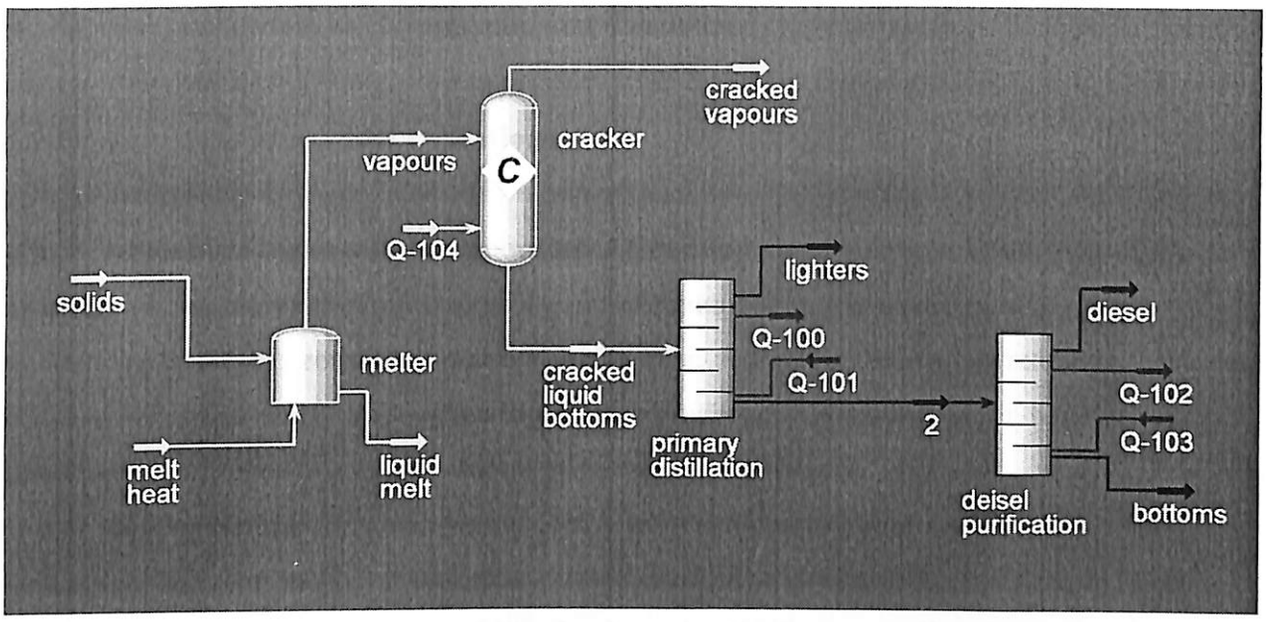

Fig 5: flow sheet for sizing

Simulated values and reports are included in Appendix 3

4.4 Validation with commercial units

These results are to be compared with the pilot plant data. As hypothetical components (which may not be exactly same as the polymers) are taken during simulation, few properties of the real plastics were taken to estimate the other parameters and properties. For better understanding it is better to see the coding structure. This entire simulation has taken place in steady state mode. So this gives us an idea about the initial parameters that can be considered and now the Process is to be tuned accordingly. At the same time, the catalyst being used in actual process will give an idea about the reactions going on and accordingly new catalysts are to be designed and prepared, for better selectivity and for better conversion of the process. If the feed composition is changing we need to even play with many parameters. A single plastic may have many uses with varied properties.

Chapter 5

Results and discussions

5.1 Observations and model validations:

Due to the hypothetical components it followed an exothermic reaction instead of endothermic cracking reaction. One of the possibilities is due to consideration of cracking as well as reforming reactions in the same reactor. Although Reforming reactions are Endothermic due to Hydrogenation reactions, exothermic reaction would have taken place.

During simulation when the cracked vapors are directly sent into the distillation column, a peculiar behavior that was observed i.e., the reversal of the Temperature profile. The vapors are entering at 500^0 C, where the distillate as well as bottoms are at $50\ ^0$ C and 120^0C respectively. Reboiler could not exist and the load on condenser has increased tremendously. So Reverse temperature profile was developed, where the distillate was collected at the bottoms and the bottoms at top. Asking for a Reflux ratio less than zero. This is an absurd. Due to these even the simulator is not accepting the heavy key in distillate as n – pentane where as light key in bottoms as Cetane instead accepting in reverse was. As per the existing situation it is correct. But it is not acceptable. This is an entirely a different scenario. This is because the top product composition will be in vapor phase which are now bottoms, where as the cooled lighters are sent back to column. But the heaviers turn to liquid state first and then bottoms on cooling. More over the feed is completely in vapor phase and moves up easily.

Inorder to overcome this situation, there are two methods. To following the first method these are to be cooled such that the vapors entering will be in mixed phase. Or a separator can be used. But the distillation column was used here by specifying the key components in the distillate and the bottoms first and then simulated. Then the profile seems to be as per required criteria. In the second method, the vapors are to be cooled before entering the distillation column. So a cooler has to be used to reduce condenser loads, and no need to specify the temperatures. It had simulated the desired temperatures

accordingly as a part of heat integration. This heat was being used to melt the Polymeric feed in the melter. So it balances the temperatures and loads accordngly.

5.2 Results:

The results obtained after simulation are compared with the standards of Indian Oil Corporation limited. As per the CPCB norms, the produced fuels need to meet their standards. Upon comparing the obtained results during simulation, we can get the specified cut of these processed molecules Inorder to meet the densities and boiling points of the fraction. And it is need to calculate the cetane index etc., accordingly as per the cut. But the simulator provides these properties on overall basis. If they satisfy the specifications. it can be sent for further treatment. At the same time, these properties as depend upon the type of plastic feed taken. The current obtained Diesel is of purely paraffins and a little amount of olefins (negligible). But actual diesel will have few aromatics, naphthenes etc., these can be obtained if Polystyrene is also included in the feed. Which was proved experimentally (for details refer table 1).

The obtained simulated results are attached / given in the appendix 3.

Chapter6

Recommendations and Conclusion

6.1 Recommendations:

With my observations and knowledge. We can mix these plastic feed with the heaviers / residue that is being processed in a refinery. For this a compatibility check is to be done. As per literature survey, it was found that the latest developed indigenous catalyst for India is a zeolite based catalyst. This catalysts composition is suitable for the cracking reactions that will take place in refineries. Similar to refinery operations, in this process also after cracking, Reforming process is involved for achieving better quality and quantity of desired range molecules. But here the problem is the mode of reformer to be used. We may get Aromatics and Fuel compounds as per the raw materials used in the process. So, an integration of both Aromatic as well as Fuel mode reformer is to be done or plastics are to be selected accordingly.

During simulation, it was even observed that on hydro cracking of this plastic we get more yield of Diesel and at the same time Cetane number of produced Diesel was also increased. So, it implies that a better quality product can be produced with a better yield.

6.2 Conclusion:

In this age of plastics one of the best ways to handle this plastic waste is to get valuable products out of it. Which not only solve the problem of waste plastic handling, solves the problem of energy crisis to some extent. At the same time if this process is integrated with Refinery operations for all plastic wastes, gives a solution of cradle to grave which is needed now a days.

This helps to provide a cleaner and greener environment for us and our future generations. And it maintain ecological balance. Now we can say that the plastics are boon to Industry and Environment.

Recently Maharashtra government has signed an MoU with the unit set up by Prof.Alka Umesh Zadgonkar, Department of Applied Chemistry, G.H Raison college of Engineering for the production of fuel from plastic waste at places near Mumbai.

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12. http://books.google.co.in/books?id=RBkrKvKR_xQC&pg=PA458&lpg=PA458&dq=reaction+conditions+and+kinetics+of+plastics+to+Diesel&source=bl&ots=PHlu5mGdT7&sig=WKgb0myDjMw1m5b3PTPIjIJnIUk&hl=en&ei=qgffSeScCJeIkQWejrTSCw&sa=X&oi=book_result&ct=result&resnum=3#PPA141,M1
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21. http://www.iocl.com/Products/HighSpeedDiesel.aspx

Journals / papers:

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2. Overview Waste plastics to Diesel fuel, innovative environmental technology by envo smart technologies.
3. A process and apparatues for manufacture of liquid fuel from waste plastic and refinery waste. International publication number WO 02/061015A1, Intenational application number PCT /IN 01/00061by, zadgaonkar, umesh, arun, zadgaonkar, alka, umesh.
4. A catalyst composition for catalytic cracking of waste plastic. International publication number WO 2005/094990A1. International application number PCT/IN2004/000366. Applicant: Indian Oil Corporation Limited.

Organizations:

1. CIPET – Ahmadabad
2. GEPIL – Surat.

8. Appendix 1

ASTM or UL test	Property	Poly Propylene			Poly Vinyl Chloride		Poly Ethylene			Poly Styrene		Teflon		
		Homopolymer	Co-Polymer	Flame Retardant	PVC	CPVC	LDPE	HDPE	UHMW	GP-PS	HI-PS	PTFE (UNFILLED)	PTFE (25% GLASS FILLED)	PTFE (25% CARBON FILLED)
PHYSICAL PROPERTIES														
D792	Density (lb/in³) (g/cm³)	0.033 0.905	0.033 0.897	0.035 0.988	0.051 1.41	0.055 1.52	0.033 0.92	0.035 0.95	0.034 0.93	0.043 1.05	0.043 1.04	0.078 2.16	0.081 2.25	0.075 2.08
D570	Water Absorption, 24 hrs (%)	<0.01	0.01	0.02	0	0.04	<0.01	0	0	0.06	0.01	< 0.01	0.02	0.05
THERMAL PROPERTIES														
D696	Coefficient of Linear Thermal Expansion (x 10-5 in./in./°F)	6.2	6.6	-	6.1	3.7	3	6	11	4.0	4.2	7.5	6.4	6.0
D648	Heat Deflection Temp (°F / °C) at 66 psi at 264 psi	210 / 99 125 / 52	173 / 78 110 / 43	106 / 41 57 / 14	176 / 80	217 / 103	120 / 48 105 / 36	170 / 76 150 / 40	203 / 95 180 / 82	200 / 95	195 / 92	132 / 55	150 / 65	150 / 65
D3418	Melting Temperature (°F / °C)	**327 / 164**	**327 / 164**	**327 / 164**	**n.a.**	**n.a.**	**230 / 110**	**260 / 125**	**280 / 138**	**224 / 107**	**214 / 102**	**635 / 335**	**635 / 335**	**635 / 335**
-	Max Operating Temp (°F / °C)	180 / 82	170 / 77	180 / 82	140 / 60	200 / 93	160 / 71	180 / 82	180 / 82	150 / 65	140 / 60	500 / 260	500 / 260	500 / 260
C177	Thermal Conductivity (BTU-in/ft²-hr-°F) (x 10-4 cal/cm-sec-°C)	0.76-0.81 2.6-2.8	- -	- -	0.90 3.1	0.95 3.3	- -	- -	2.92 10.06	- -	- -	1.70 5.86	3.1 10.6	4.5 15.5
UL94	Flammability Rating	HB	n.r.	V-O	V-O	V-O	n.r.	n.r.	H-B	H-B	H-B	V-O	V-O	V-O

9. Appendix 2

Indian Oil corporation high speed diesel standards

Sl no.	Characteristics	Requirements		Method of test
		BS II	BS II	
1.	Acidity, inorganic	Nil	Nil	P :2
2.	Acidity, total mg of KOH /g, max	To report	To report	P:2
3.	Ash, percentage by mass, max	0.01	0.01	P:4 / ISO 6245
4.	Carbon residue (ramsbottom) on 10 percent residue percent by mass, max	0.30	0.30	P:8 / ISO 10370
5.	Cetane number, min	48	51	P:9 / ISO 5165
6.	Cetane index, min	46	46	D 4737 / ISO 4264
7.	Pour points, max a. Winter b. summer	 3^0 C 15^0 C	 3^0 C 15^0 C	P:10 / D 5949 or D 5950 or D 5985
8.	Copper strip corrosion for 3 hrs at 100^0 C	Not worse than no. 1	Not worse than no.1	P:15 / ISO 2160
9.	Distillation, percent (V/V) recovered			P:18 / ISO 3405
	a. At 350^0C	85	-	
	b. At 360^0C	-	95	
	c. At 370^0C	95	-	
10.	Flash point			
	a. Abel ^{0}C, min	35	35	P:20
	b. Pensky martens closed cup ^{0}C, min	66	66	P:21
11. .	Kinematic viscosity, cSt, at 40^0C	2.0 to 5.0	2.0 to 5.0	P:25 / ISO 3104
12.	sediments, percent by mass, max	0.05	-	P:30
13.	Total contamination, mg / kg	24	24	EN 12662
14.	density at 15^{0C}	820 – 860	820 – 845	P:16 or P:32 / D 4052 ? ISO 3675 or ISO 12185
15.	Total sulphur, mg / kg max	500	350	IP 336 or 4294 ISO 14596 or ISO 8754 / P:83 / D2785 / D 5433 / D 2622 / D 3120
16.	Water content, percent (v/v) Water content, mg/kg, max	 0.05 -	 - 200	P:40 / ISO 3733 / ISO 6296 / ISO 12937
17.	Cold filter plugging point (CFPP), max a. Winter b. Summer	 6^0C 18^0C	 6^0C 18^0C	P:110 / D 6371
18.	Total sediments mg per 100 ml, max	1.5	-	Annex A /ISO 11205 / D 2274
19.	Oxidation stability, g/m^3, max	-	25	ISO 12205 or D 2274
20.	Polycyclic aromatic hydrocarbon (PAH) percent by mass, max	-	11	IP 391 or EN 1296
21.	Lubricity corrected wear scar diameter (WSD 1.4) at 60^0C, microns, max	460	460	ISO 12156 – 1
22.	Oxygen content percent by mass, max	0.6	0.6	Annex B

10. Appendix 3

Simulation key words:

Solids	Polymeric Feed
Melt heat	Heat given to melt the polymeric material
Melter	Equipment used for melting the polymers
Vapours	Gases coming from the melter
Liquid melt	The Liquid polymeric mixture The Liquid polymeric mixture
Cracker	Reactor to crack the polymers and convert them into required products
Cracked vapours	Gases coming out of cracker
Q -104	Heat input to cracker
Cracked liquid bottoms	The Liquid material from cracker
E -100	Heat exchanger used to cool cracked vapors
Primary Distillation	Distillation column used for separating cooled vapors (cracked) coming from cracker through heat exchanger
Lighters	The Gases coming out, after primary distillation
Crude Diesel	–the bottoms of Primary Distillation.
Diesel Distillator	The Bottoms from Primary Distillation column are separated here
Diesel	The Gases coming out after Crude Diesel Distillation in Diesel distillatory
Bottoms	The waste liquid / un reacted liquid from the process.

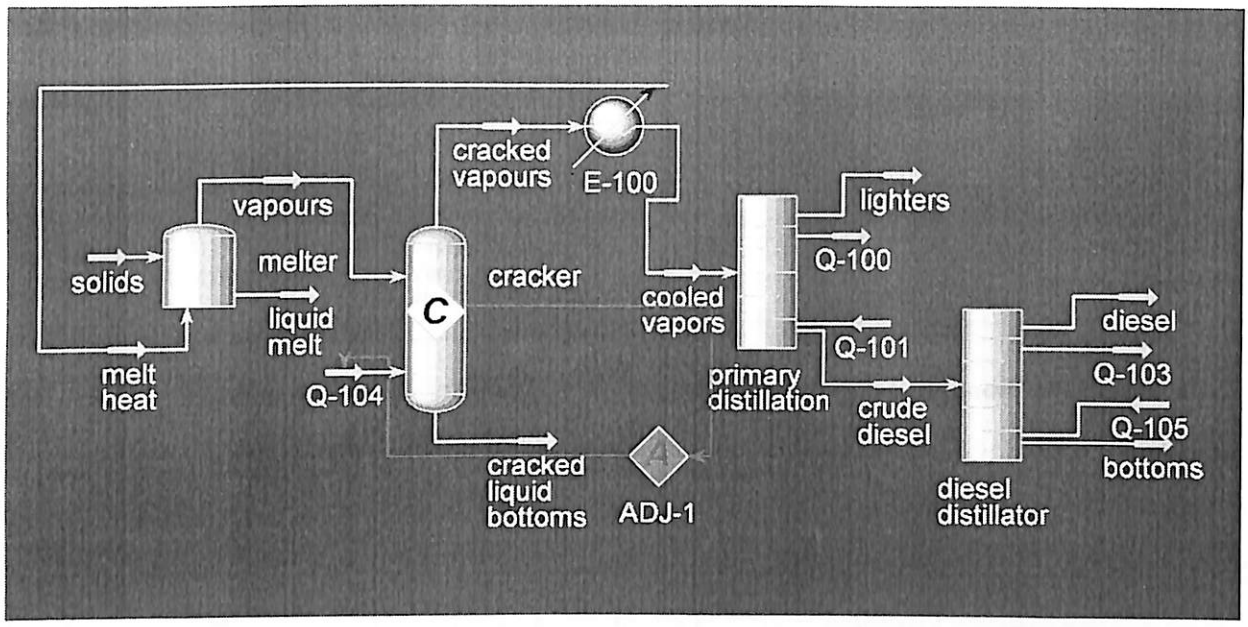

Fig 6: flow sheet for optimization.

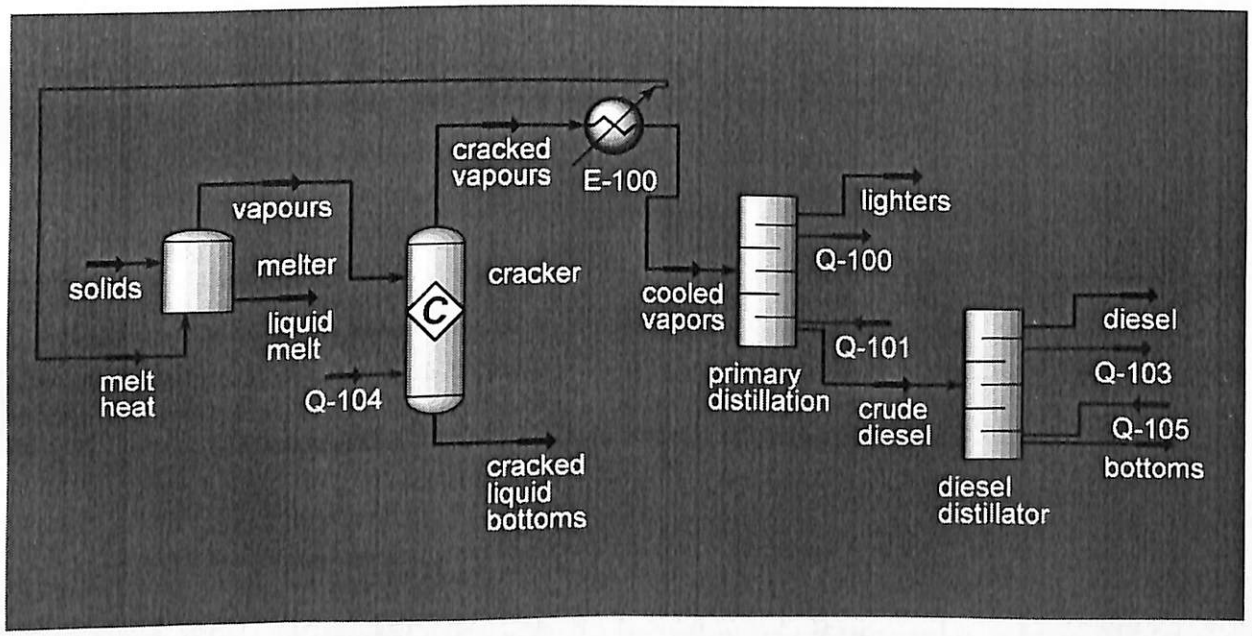

Fig 7: flow sheet for the entire process with the code names.

Cooled vapors:

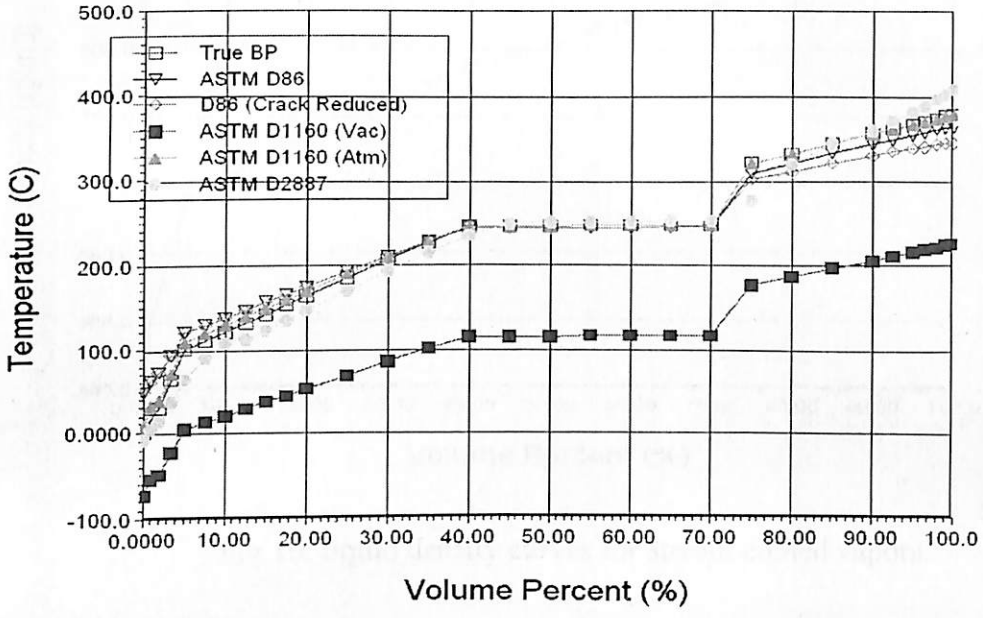

Fig 8: temperature curves for stream cooled vapors.

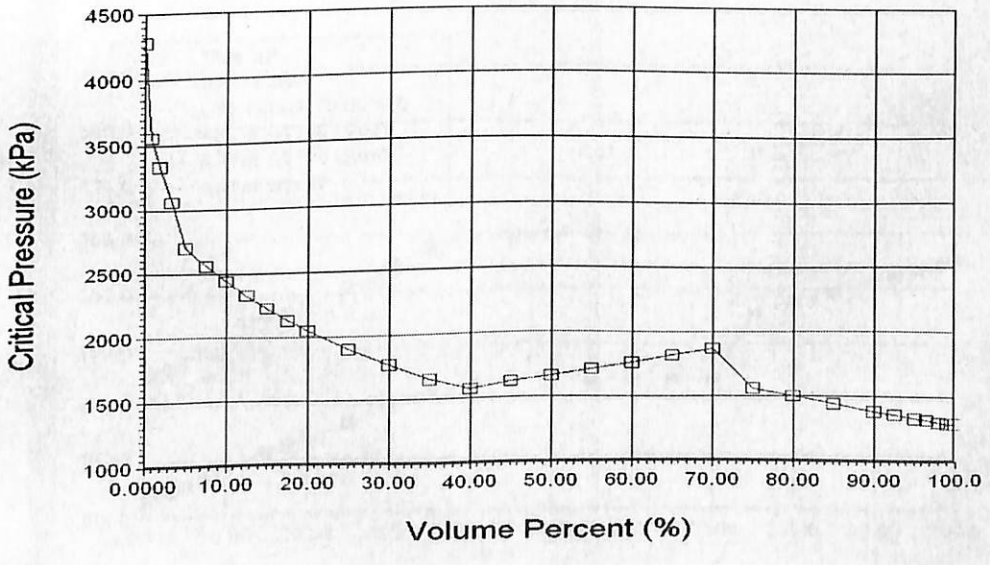

Fig 9: critical pressure curves for the stream cooled vapors

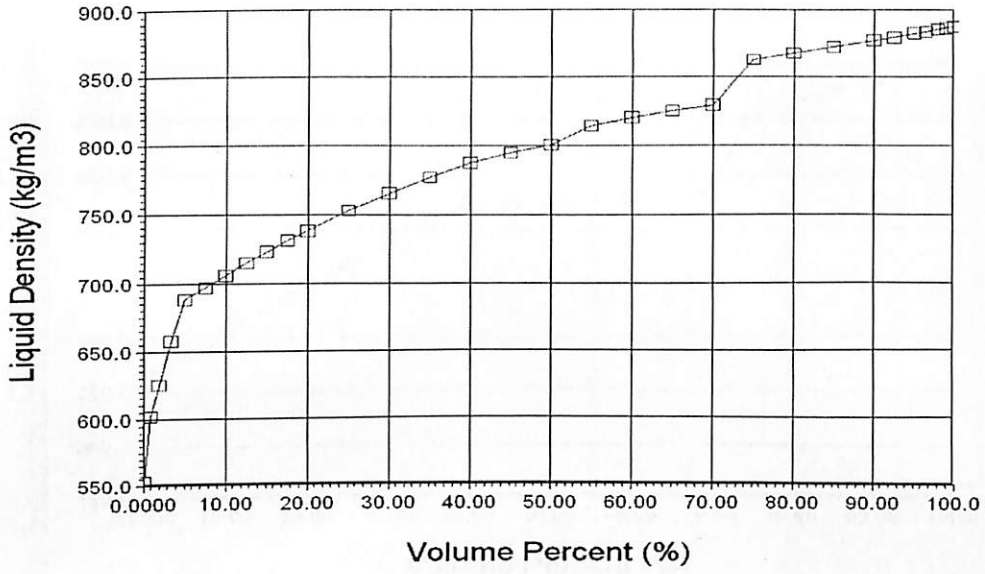

Fig 10: liquid density curves for stream cooled vapors.

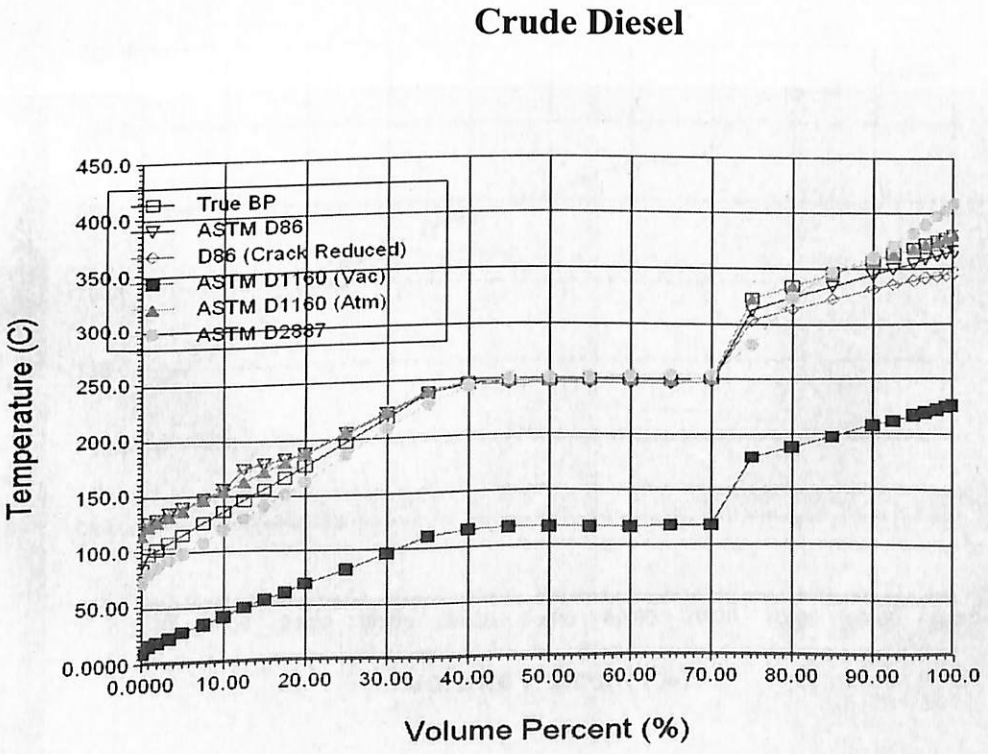

Fig 11: temperature curves for stream crude Diesel

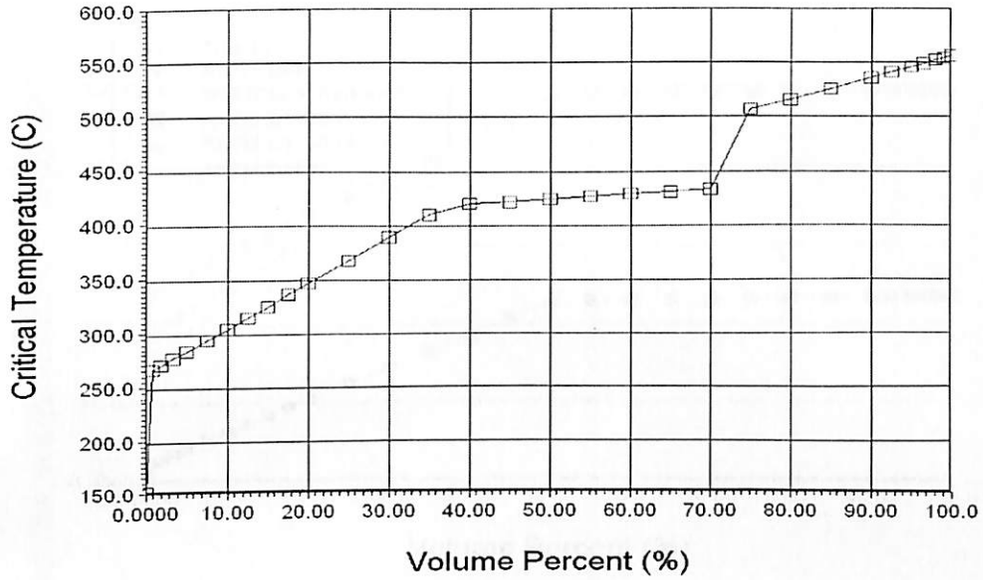

Fig 12:critical temperature curves for stream crude Diesel

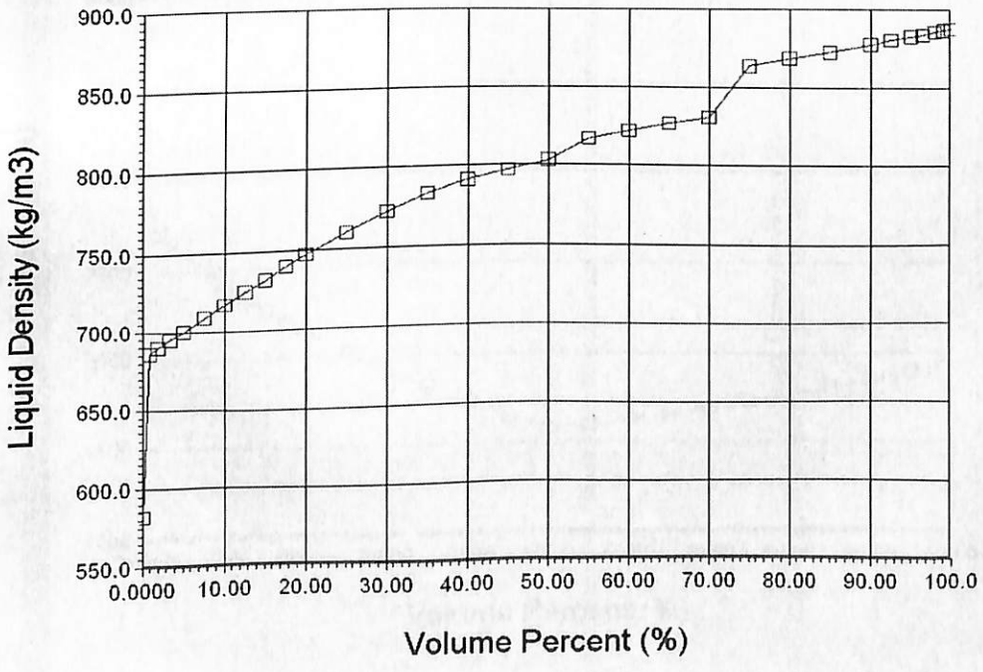

Fig 13: liquid density curve for stream crude Diesel.

Diesel

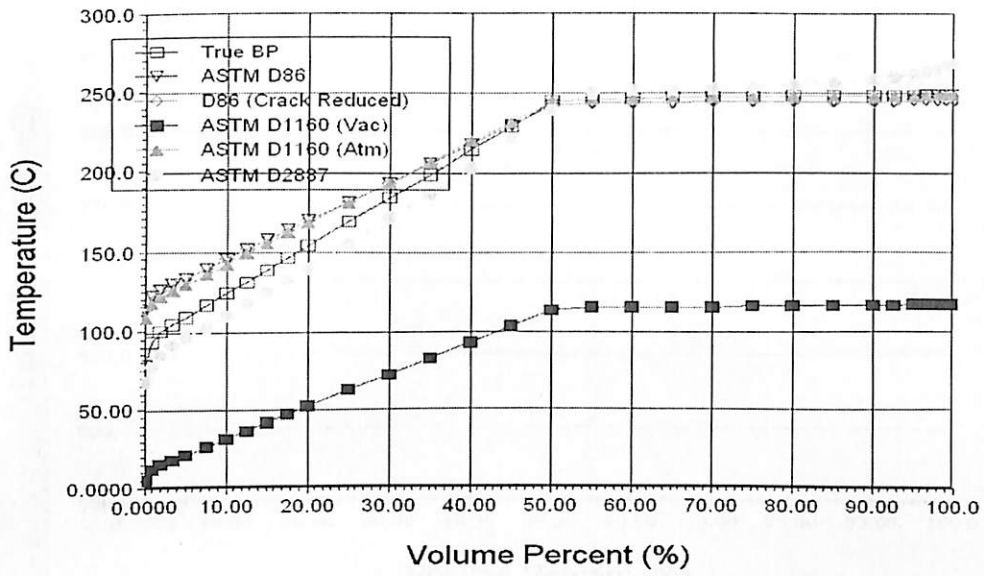

Fig 14: temperature curves for stream Diesel.

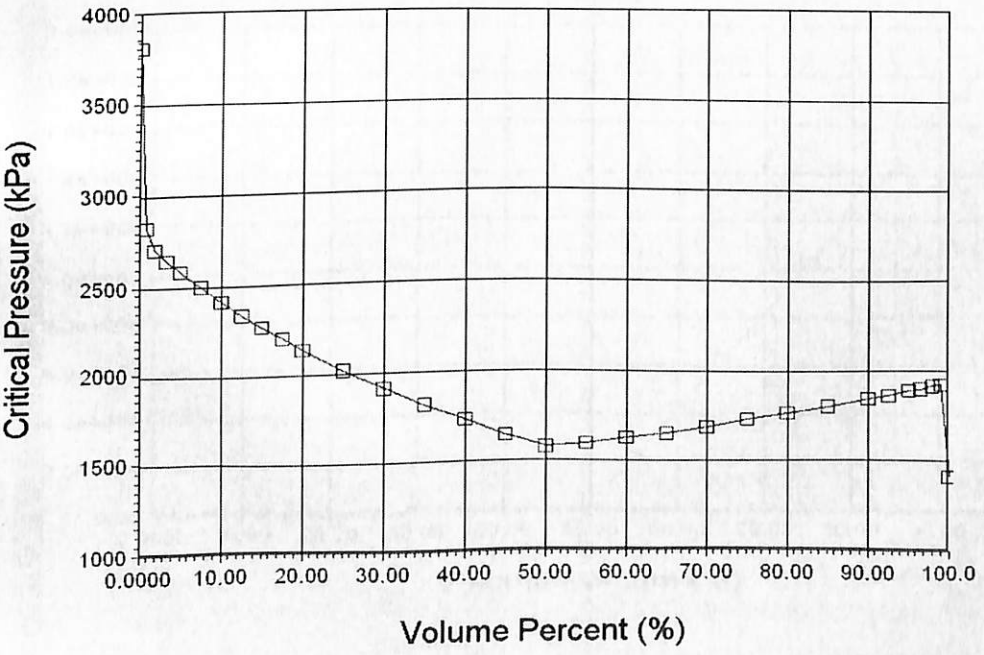

Fig 15: critical pressure curves for stream Diesel

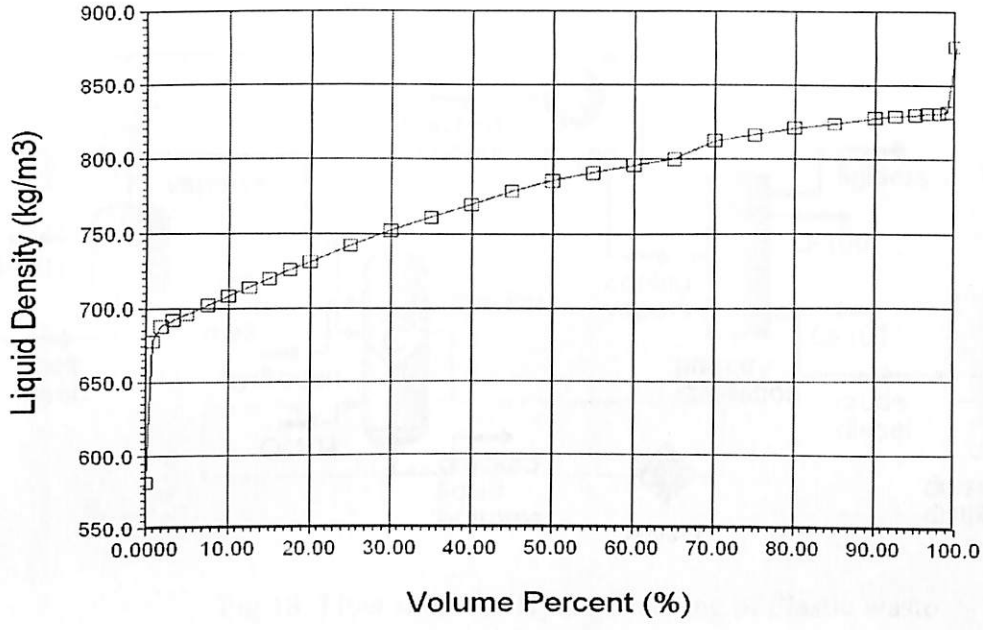

Fig 16: liquid density curves for Diesel stream

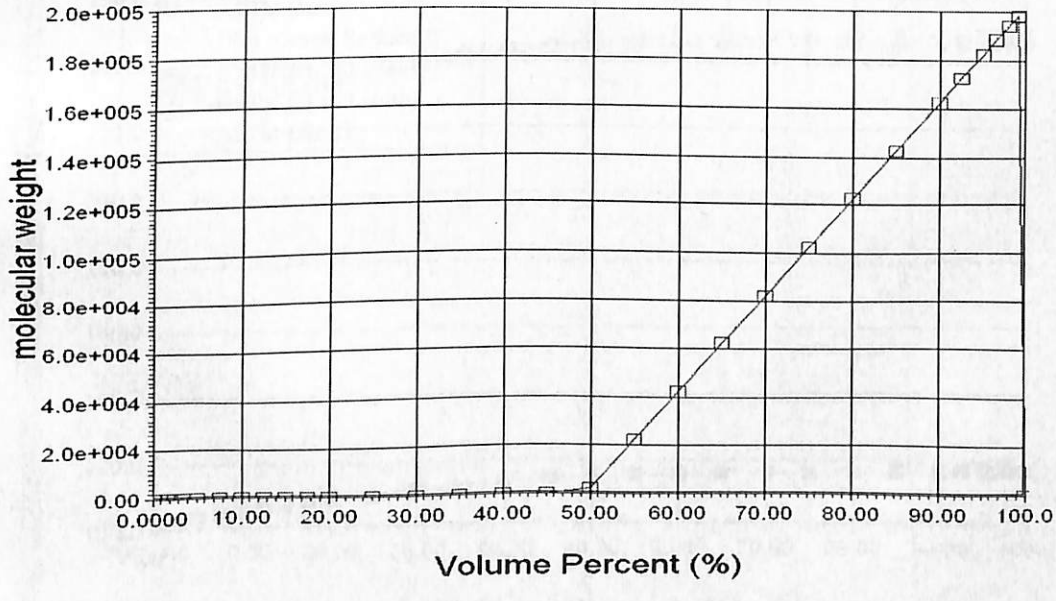

Fig 17: molecular weight distribution for Diesel stream.

Graphs obtained on hydro crcaking

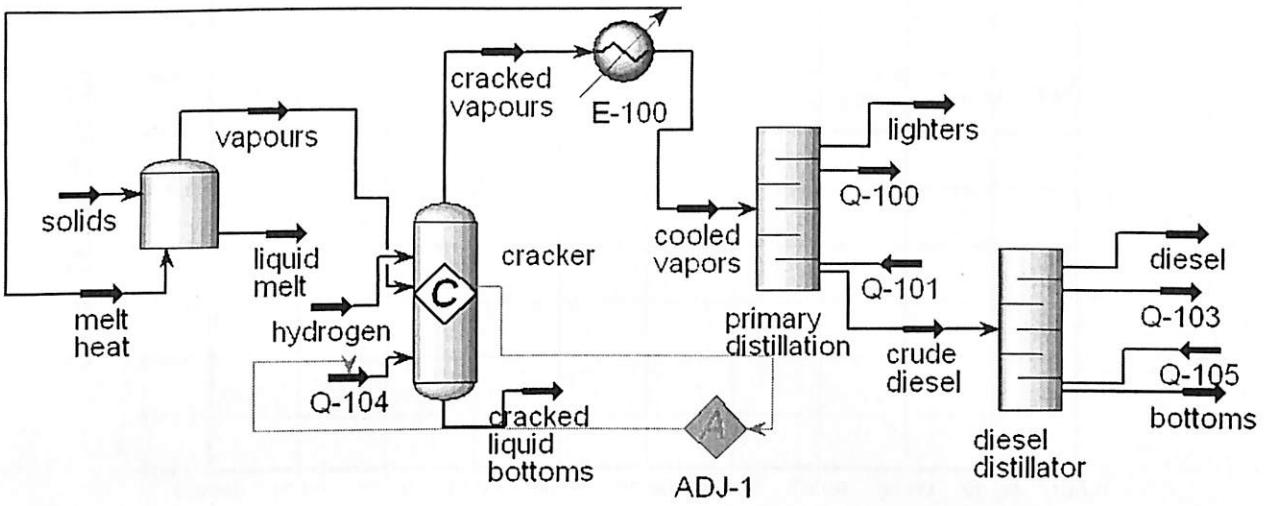

Fig 18: Flow sheet for Hydro Cracking of Plastic waste

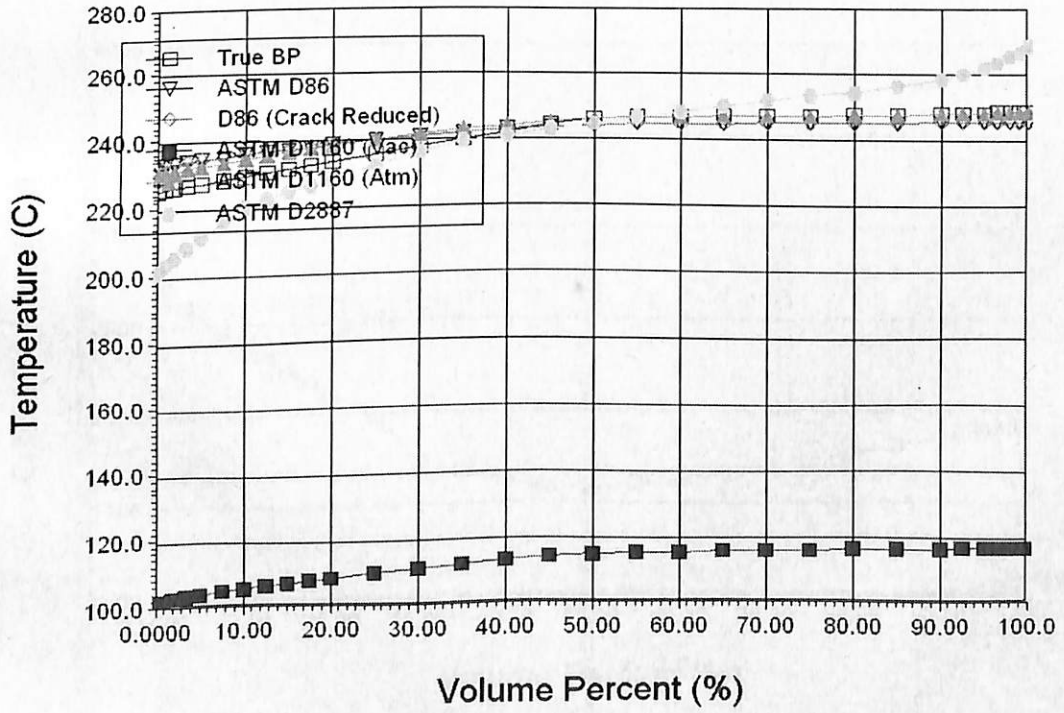

Fig 19: Boiling point curves – Diesel

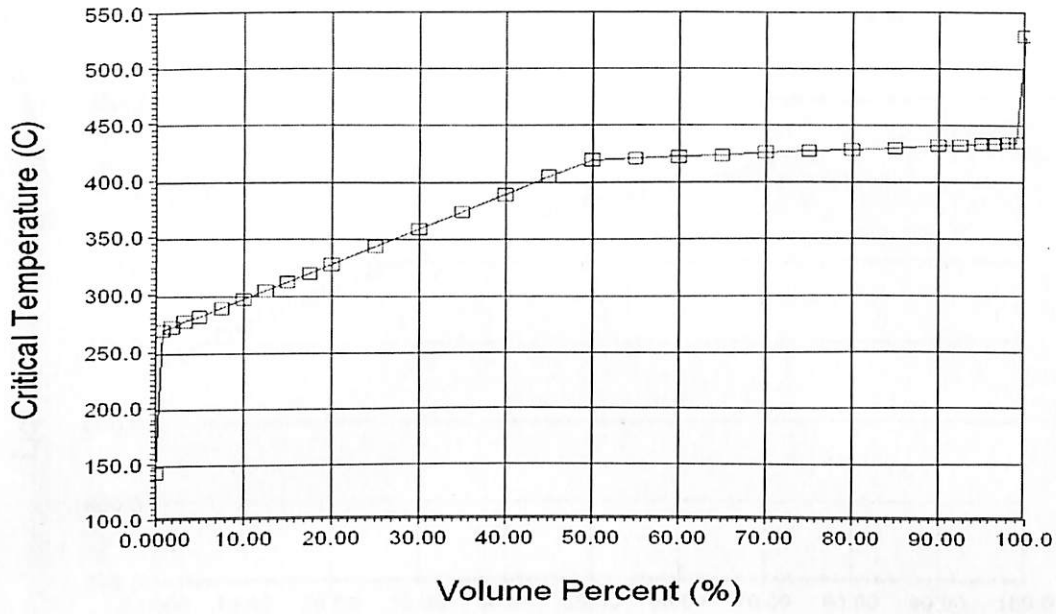

Fig 20: Critical Temeperature curve – Diesel.

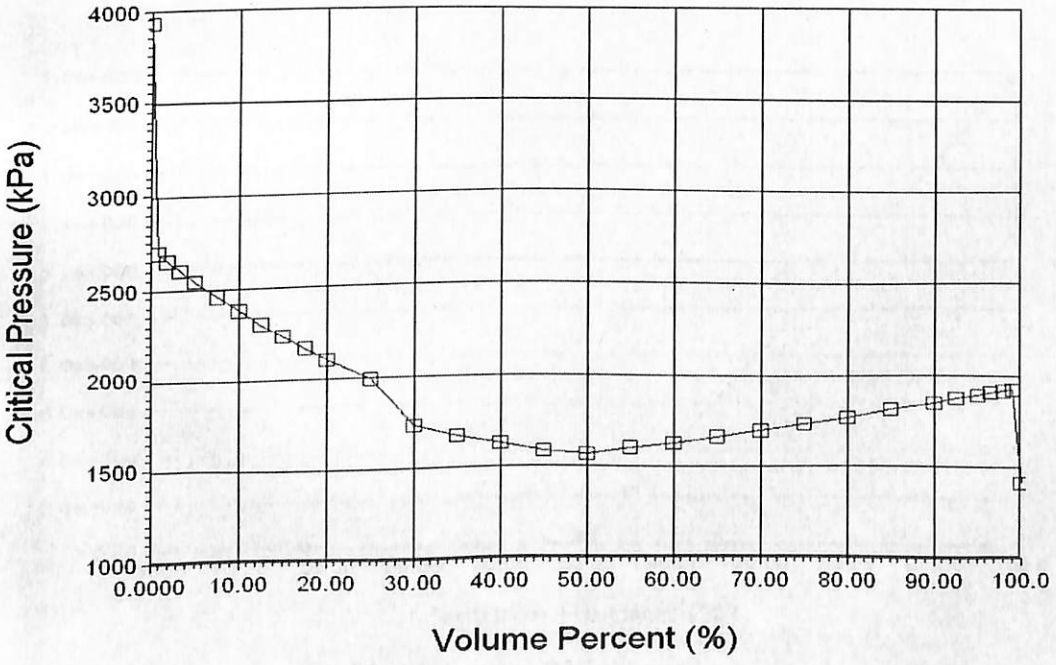

Fig 21: Critical Pressure curve – diesel.

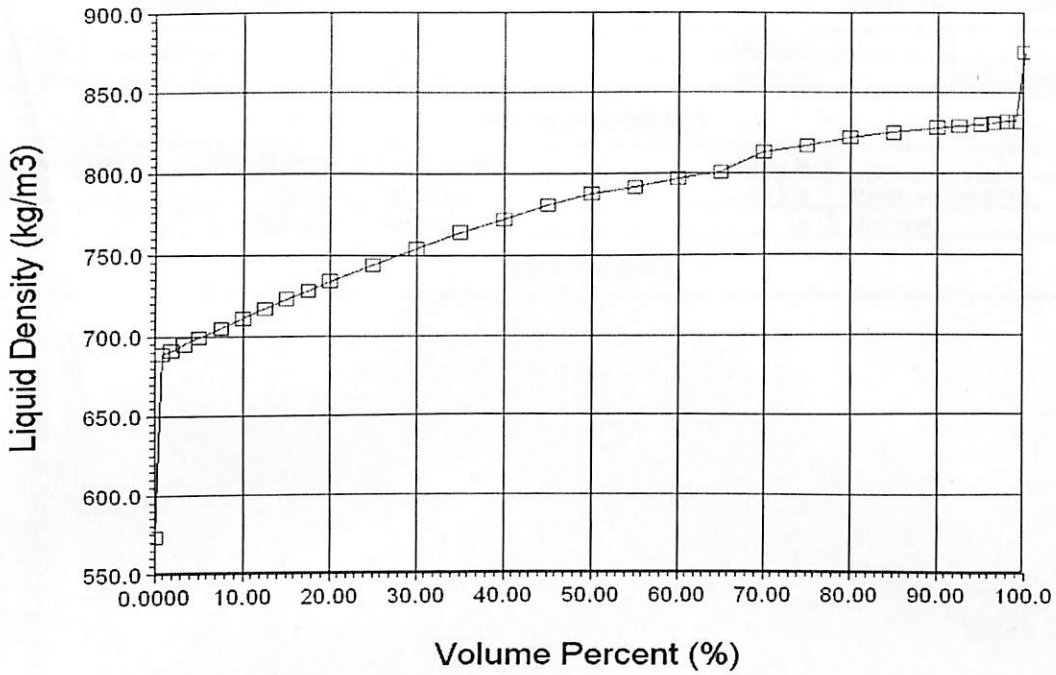

Fig 22: Liquid Density Curve – Diesel.

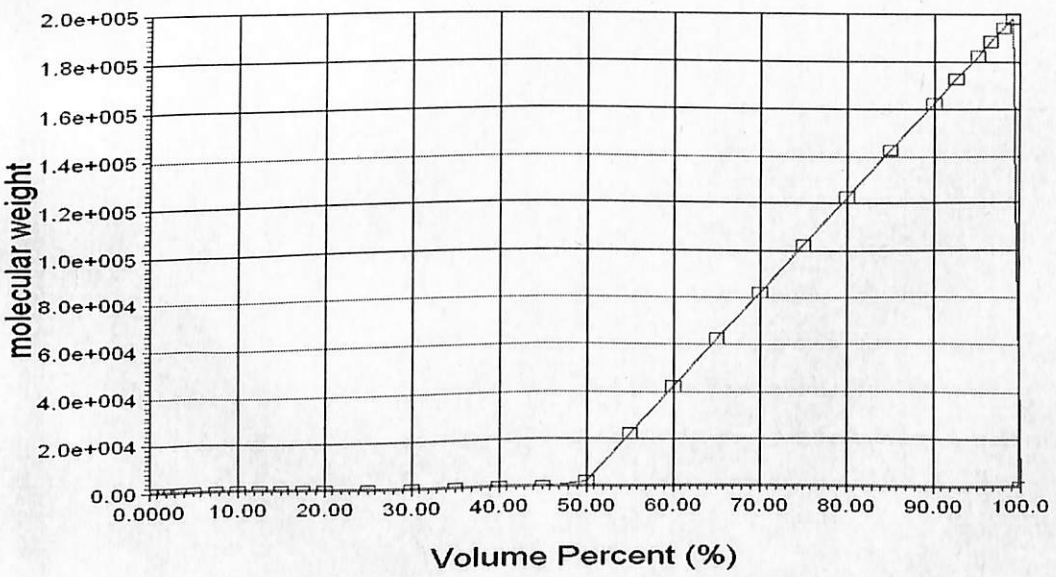

Fig 23: Molecular Weight curve – Diesel.

University Of Petroleum And Energy
UPES,
Bidholi,
Dehradun,
Uttarakhand

Case Name: D:\RAKI\SIMULATION\FINAL\PLASTICS TO DIESEL SIZING ADJU

Unit Set: SI

Date/Time: Mon Apr 20 18:43:47 2009

Adjust: ADJ-1

Adjusted Variable		Measured Variable	
OBJECT	VARIABLE	OBJECT	VARIABLE
Q-104	Heat Flow	cracker	ec % Conversion (Spec % Conversion

Solving Parameters

Source for Target Value:	User Supplied	Target Value:	99.00 % *		
Solving Method:	Secant	Tolerance:	0.00 % *	Maximum Iterations:	10 *
Step Size:	1.000 kJ/h *	Maximum:	—	Minimum:	—

User Variables

* Specified by user.

Licensed to: TEAM LND

University Of Petroleum And Energy S
UPES,
Bidholi,
Dehradun,
Uttarakhand

Case Name: D:\RAKI\SIMULATION\FINAL\PLASTICS TO DIESEL SIZING ADJUS

Unit Set: SI

Date/Time: Mon Apr 20 18:44:31 2009

Stream: cooled vapors

Boiling Point Curves: cooled vapors

BOILING POINT CURVES

Basis	Stream
Liquid Volume	cooled vapors

RESULTS

BP Curves Results

Cut Point (%)	TBP (C)	ASTM D86 (C)	D86 Crack Reduced (C)	ASTM D1160(Vac) (C)	ASTM D1160(Atm) (C)	ASTM D2887 (C)
0.00	-0.24	50.25	50.25	-71.05	8.94	-6.14
1.00	17.72	63.57	63.57	-52.52	33.51	5.55
2.00	30.98	73.17	73.17	-48.14	39.29	14.98
3.50	64.61	94.98	94.98	-22.49	72.89	38.80
5.00	100.84	121.18	121.18	5.70	109.37	65.20
7.50	111.46	130.20	130.20	13.68	119.62	91.98
10.00	122.09	139.22	139.22	21.66	129.83	107.54
12.50	132.72	148.24	148.24	29.64	140.00	113.27
15.00	143.35	157.26	157.26	37.63	150.14	124.33
17.50	153.98	166.28	166.28	45.61	160.24	135.60
20.00	164.61	175.31	175.31	53.59	170.31	147.06
25.00	185.88	193.35	193.35	69.56	190.34	170.50
30.00	207.12	211.39	211.39	85.52	210.22	194.20
35.00	228.38	229.43	229.43	101.49	229.97	216.82
40.00	246.43	244.75	244.75	115.05	246.64	237.52
45.00	246.96	245.10	245.10	115.46	247.14	251.07
50.00	247.49	245.46	245.46	115.86	247.63	251.72
55.00	248.02	245.82	245.82	116.27	248.13	252.38
60.00	248.55	246.17	246.17	116.68	248.63	253.04
65.00	249.07	246.53	246.53	117.08	249.13	253.72
70.00	249.60	246.89	246.89	117.49	249.63	254.40
75.00	321.78	310.81	302.93	177.21	321.78	278.73
80.00	333.32	322.64	313.03	186.91	333.31	320.12
85.00	344.85	334.09	322.51	196.64	344.85	344.22
90.00	356.39	345.15	331.37	206.42	356.39	359.68
92.50	362.16	350.53	335.56	211.32	362.16	369.74
95.00	367.93	355.82	339.61	216.23	367.93	381.83
96.50	371.39	358.95	341.97	219.19	371.39	389.71
98.00	374.85	362.04	344.28	222.14	374.85	398.06
99.00	377.16	364.08	345.78	224.12	377.16	403.86
100.00	379.46	366.11	347.27	226.09	379.46	409.85

CRITICAL PROPERTIES

Cut Point (%)	Critical Temperature (C)	Critical Pressure (kPa)	Acentricity Factor	Molecular Weight	Liquid Density (kg/m3)
0.00	127.06	4285.04	0.1939	47.046	553.38
1.00	168.64	3563.27	0.2114	64.737	602.19
2.00	189.97	3349.22	0.2319	72.151	626.83
3.50	230.01	3069.93	0.2948	84.505	658.71
5.00	269.48	2704.07	0.3530	102.260	688.91
7.50	280.39	2568.56	0.3673	111.330	697.97
10.00	291.30	2445.97	0.3815	120.401	706.74
12.50	302.21	2334.56	0.3958	129.471	715.22
15.00	313.12	2232.85	0.4100	138.542	723.41
17.50	324.03	2139.64	0.4243	147.613	731.31
20.00	334.94	2053.89	0.4385	156.683	738.92
25.00	356.76	1901.49	0.4671	174.824	753.27
30.00	378.58	1770.15	0.4956	192.966	766.47
35.00	400.40	1655.77	0.5241	211.107	778.50
40.00	419.21	1576.52	0.5484	4694.714	788.78
45.00	421.56	1620.10	0.5500	33824.215	795.28
50.00	423.90	1666.15	0.5516	62553.715	801.74
55.00	426.25	1714.89	0.5533	91483.215	815.07
60.00	428.60	1766.57	0.5549	120412.716	821.32
65.00	430.94	1821.47	0.5565	149342.216	826.40

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* Specified by user.

Stream: cooled vapors (continued

Boiling Point Curves: cooled vapors (conti

Cut Point (%)	Critical Temperature (C)	Critical Pressure (kPa)	Acentricity Factor	Molecular Weight	Liquid Density (kg/m3)
70.00	433.29	1879.88	0.5581	197374.537	830.33
75.00	504.58	1569.92	0.6597	188162.341	863.66
80.00	514.96	1504.82	0.6766	111364.732	868.54
85.00	525.34	1444.91	0.6935	34567.124	873.42
90.00	535.71	1389.59	0.7104	-42230.485	878.31
92.50	540.90	1363.49	0.7188	-80629.289	880.75
95.00	546.09	1338.34	0.7273	-119028.093	883.19
96.50	549.20	1323.70	0.7323	-142067.375	884.65
98.00	552.31	1309.37	0.7374	-165106.658	886.12
99.00	554.39	1299.99	0.7408	-180466.180	887.09
100.00	556.46	1290.75	0.7442	-195825.701	888.07

COLD PROPERTIES

True VP at 37.8 C	(kPa)	20.1281	Cetane Index		33.6558
Reid VP at 37.8 C	(kPa)	18.2101	Research Octane Number		—
ASTM D93 Flash Point	(C)	27.2878	Viscosity at 37.8 C	(cP)	2.79337
ASTM D97 Pour Point	(C)	-8.9890	Viscosity at 97.8 C	(cP)	0.99504
Refractive Index		1.4919			

P:N:A

Paraffins [mol%]	31.8955	Naphthas [mol%]	28.4865	Aromatics [mol%]	39.6180

Stream: crude diesel

Boiling Point Curves: crude diesel

BOILING POINT CURVES

Basis	Stream
Liquid Volume	crude diesel

RESULTS

BP Curves Results

Cut Point (%)	TBP (C)	ASTM D86 (C)	D86 Crack Reduced (C)	ASTM D1160(Vac) (C)	ASTM D1160(Atm) (C)	ASTM D2887 (C)
0.00	84.15	119.53	119.53	9.67	114.47	73.23
1.00	98.51	126.37	126.37	16.11	122.73	80.41
2.00	102.61	129.65	129.65	18.85	126.24	86.30
3.50	108.77	134.58	134.58	22.98	131.51	93.24
5.00	114.92	139.51	139.51	27.10	136.76	98.65
7.50	125.18	147.73	147.73	33.97	145.50	107.87
10.00	135.44	155.94	155.94	40.84	154.21	118.33
12.50	145.70	173.61	173.61	47.71	162.90	129.17
15.00	155.96	178.73	178.73	54.58	171.55	140.24
17.50	166.21	183.08	183.08	61.45	180.19	151.47
20.00	176.47	188.80	188.80	68.32	188.79	162.77
25.00	196.99	205.23	205.23	82.06	205.93	185.97
30.00	217.50	221.65	221.65	95.80	222.95	209.02
35.00	238.02	238.08	238.08	109.54	239.88	228.61
40.00	246.65	244.96	244.96	116.34	247.00	243.14
45.00	247.16	245.29	245.29	116.72	247.45	250.39
50.00	247.67	245.63	245.63	116.09	247.91	251.16
55.00	248.18	245.97	245.97	116.46	248.37	251.96
60.00	248.69	246.31	246.31	116.84	248.83	252.78
65.00	249.20	246.65	246.65	117.21	249.29	253.61
70.00	249.71	246.99	246.99	117.59	249.74	254.45
75.00	323.79	312.83	304.68	178.90	323.79	282.49
80.00	334.93	324.17	314.32	188.26	334.93	325.04
85.00	346.06	335.15	323.38	197.66	346.06	347.68
90.00	357.19	345.77	331.86	207.10	357.19	360.94
92.50	362.76	350.95	335.88	211.83	362.76	370.29
95.00	368.33	356.03	339.77	216.58	368.33	381.89
96.50	371.67	359.04	342.04	219.43	371.67	389.58
98.00	375.01	362.02	344.26	222.28	375.01	397.82

Stream:crude diesel (continued)

Boiling Point Curves: crude diesel (continu

BP Curves Results

Cut Point (%)	TBP (C)	ASTM D86 (C)	D86 Crack Reduced (C)	ASTM D1160(Vac) (C)	ASTM D1160(Atm) (C)	ASTM D2887 (C)
99.00	377.24	363.98	345.71	224.19	377.24	403.59
100.00	379.46	365.93	347.14	226.09	379.46	409.58

CRITICAL PROPERTIES

Cut Point (%)	Critical Temperature (C)	Critical Pressure (kPa)	Acentricity Factor	Molecular Weight	Liquid Density (kg/m3)
0.00	151.46	3805.56	0.2007	57.888	582.55
1.00	267.09	2735.65	0.3499	100.275	686.89
2.00	271.30	2680.42	0.3554	103.777	690.44
3.50	277.62	2601.63	0.3637	109.030	695.70
5.00	283.94	2527.33	0.3719	114.282	700.85
7.50	294.47	2412.51	0.3857	123.037	709.23
10.00	305.00	2307.67	0.3994	131.792	717.34
12.50	315.53	2211.56	0.4132	140.546	725.18
15.00	326.06	2123.14	0.4269	149.301	732.74
17.50	336.59	2041.52	0.4407	158.055	740.04
20.00	347.12	1965.94	0.4545	166.810	747.07
25.00	368.18	1830.41	0.4820	184.319	760.32
30.00	389.24	1712.36	0.5095	201.828	772.49
35.00	410.30	1608.62	0.5370	219.337	783.58
40.00	420.19	1594.48	0.5491	16811.120	791.49
45.00	422.46	1637.47	0.5507	44730.919	797.75
50.00	424.72	1682.84	0.5522	72650.719	804.00
55.00	426.99	1730.80	0.5538	100570.519	817.16
60.00	429.25	1781.56	0.5553	128490.319	822.85
65.00	431.51	1835.40	0.5569	156410.119	827.47
70.00	433.78	1892.59	0.5584	198575.328	831.01
75.00	506.39	1558.16	0.6627	174760.350	864.51
80.00	516.41	1496.16	0.6790	148811.205	869.22
85.00	526.42	1438.91	0.6953	26525.929	873.93
90.00	536.44	1385.88	0.7116	-47591.281	878.65
92.50	541.44	1360.81	0.7197	-84649.886	881.00
95.00	546.45	1336.62	0.7279	-121708.491	883.36
96.50	549.45	1322.52	0.7327	-143943.654	884.77
98.00	552.46	1308.71	0.7376	-166178.817	886.19
99.00	554.46	1299.67	0.7409	-181002.259	887.13
100.00	556.46	1290.75	0.7442	-195825.701	888.07

COLD PROPERTIES

True VP at 37.8 C	(kPa)	0.7760	Cetane Index		31.9003
Reid VP at 37.8 C	(kPa)	---	Research Octane Number		---
ASTM D93 Flash Point	(C)	39.8034	Viscosity at 37.8 C	(cP)	3.25457
ASTM D97 Pour Point	(C)	-4.1016	Viscosity at 97.8 C	(cP)	1.10497
Refractive Index		1.4952			

P:N:A

Paraffins [mol%]	41.9131	Naphthas [mol%]	36.5824	Aromatics [mol%]	21.5045

Stream: diesel

Boiling Point Curves: diesel

BOILING POINT CURVES

Basis	Stream
Liquid Volume	diesel

RESULTS

BP Curves Results

Cut Point (%)	TBP (C)	ASTM D86 (C)	D86 Crack Reduced (C)	ASTM D1160(Vac) (C)	ASTM D1160(Atm) (C)	ASTM D2887 (C)
0.00	78.89	114.53	114.53	5.67	109.33	67.91

Stream: diesel (continued)

Boiling Point Curves: diesel (continued)

BP Curves Results

Cut Point (%)	TBP (C)	ASTM D86 (C)	D86 Crack Reduced (C)	ASTM D1160(Vac) (C)	ASTM D1160(Atm) (C)	ASTM D2887 (C)
1.00	93.54	122.69	122.69	12.26	117.79	78.63
2.00	100.41	127.00	127.00	15.80	122.34	86.38
3.50	104.90	130.60	130.60	18.85	126.24	91.94
5.00	109.40	134.19	134.19	21.91	130.14	97.26
7.50	116.90	140.19	140.19	26.99	136.63	103.27
10.00	124.39	146.19	146.19	32.08	143.10	110.56
12.50	131.89	152.19	152.19	37.16	149.55	117.96
15.00	139.39	158.18	158.18	42.25	156.00	125.43
17.50	146.88	164.18	164.18	47.33	162.42	132.97
20.00	154.38	170.18	170.18	52.42	168.84	140.56
25.00	169.37	182.17	182.17	62.59	181.62	155.87
30.00	184.37	194.17	194.17	72.76	194.34	171.43
35.00	199.36	206.16	206.16	82.94	207.01	187.40
40.00	214.35	218.16	218.16	93.11	219.62	203.92
45.00	229.35	230.15	230.15	103.28	232.18	221.24
50.00	244.34	242.15	242.15	113.45	244.68	239.44
55.00	246.56	243.90	243.90	114.99	246.56	249.85
60.00	246.81	244.06	244.06	115.19	246.81	251.32
65.00	247.06	244.23	244.23	115.39	247.06	251.97
70.00	247.30	244.39	244.39	115.59	247.30	252.20
75.00	247.55	244.56	244.56	115.79	247.55	253.11
80.00	247.80	244.72	244.72	116.00	247.80	254.69
85.00	248.04	244.89	244.89	116.20	248.04	256.47
90.00	248.29	245.05	245.05	116.40	248.29	258.09
92.50	248.41	245.14	245.14	116.50	248.41	259.82
95.00	248.54	245.22	245.22	116.60	248.54	262.08
96.50	248.61	245.27	245.27	116.66	248.61	263.66
98.00	248.69	245.32	245.32	116.72	248.69	265.48
99.00	248.73	245.35	245.35	116.76	248.73	266.84
100.00	248.78	245.38	245.38	116.80	248.78	268.35

CRITICAL PROPERTIES

Cut Point (%)	Critical Temperature (C)	Critical Pressure (kPa)	Acentricity Factor	Molecular Weight	Liquid Density (kg/m3)
0.00	151.46	3805.56	0.2007	57.888	582.55
1.00	256.17	2829.26	0.3333	95.491	678.70
2.00	269.04	2709.88	0.3524	101.891	688.53
3.50	273.65	2650.57	0.3585	105.730	692.41
5.00	278.27	2593.80	0.3645	109.569	696.23
7.50	285.97	2504.40	0.3746	115.967	702.48
10.00	293.66	2420.96	0.3848	122.364	708.60
12.50	301.36	2342.90	0.3947	128.762	714.56
15.00	309.05	2269.72	0.4047	135.160	720.39
17.50	316.75	2200.97	0.4148	141.558	726.06
20.00	324.44	2136.27	0.4248	147.956	731.60
25.00	339.83	2017.63	0.4449	160.751	742.24
30.00	355.22	1911.48	0.4650	173.547	752.30
35.00	370.61	1815.94	0.4852	186.342	761.78
40.00	386.00	1729.50	0.5053	199.138	770.69
45.00	401.39	1650.91	0.5254	211.934	779.02
50.00	416.79	1579.16	0.5455	224.729	786.78
55.00	420.28	1596.11	0.5492	17892.425	791.73
60.00	421.94	1627.36	0.5503	38296.038	796.30
65.00	423.59	1659.86	0.5514	58699.650	800.87
70.00	425.25	1693.69	0.5526	79103.262	812.04
75.00	426.90	1728.92	0.5537	99506.874	816.92
80.00	428.55	1765.65	0.5548	119910.486	821.22
85.00	430.21	1803.97	0.5560	140314.099	824.94
90.00	431.86	1844.00	0.5571	160717.711	828.09
92.50	432.69	1864.69	0.5577	195586.833	829.45
95.00	433.52	1885.84	0.5583	188092.119	830.66

Stream: diesel (continued)

Boiling Point Curves: diesel (continued)

Cut Point (%)	Critical Temperature (C)	Critical Pressure (kPa)	Acentricity Factor	Molecular Weight	Liquid Density (kg/m3)
96.50	434.01	1898.77	0.5586	199098.779	831.32
98.00	434.51	1911.87	0.5589	199733.054	831.92
99.00	434.84	1920.71	0.5592	199949.025	832.30
100.00	530.99	1414.21	0.7027	-7316.191	876.09

COLD PROPERTIES

True VP at 37.8 C	(kPa)	0.9991	Cetane Index		31.6444
Reid VP at 37.8 C	(kPa)	—	Research Octane Number		—
ASTM D93 Flash Point	(C)	32.5629	Viscosity at 37.8 C	(cP)	2.10584
ASTM D97 Pour Point	(C)	-10.9210	Viscosity at 97.8 C	(cP)	0.60667
Refractive Index		1.4948			

P:N:A

Paraffins [mol%]	26.4465	Naphthas [mol%]	30.3218	Aromatics [mol%]	43.2318

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Dehradun,
Uttarakhand

Case Name: D:\RAKI\SIMULATION\FINAL\PLASTICS TO DIESEL SIZING ADJUS

Unit Set: SI

Date/Time: Mon Apr 20 18:44:33 2009

Cooler: E-100

CONNECTIONS

Inlet Stream

STREAM NAME	FROM UNIT OPERATION
cracked vapours	Conversion Reactor cracker

Outlet Stream

STREAM NAME	TO UNIT OPERATION
cooled vapors	Shortcut Column primary distillation

Energy Stream

STREAM NAME	TO UNIT OPERATION
melt heat	Tank melter

PARAMETERS

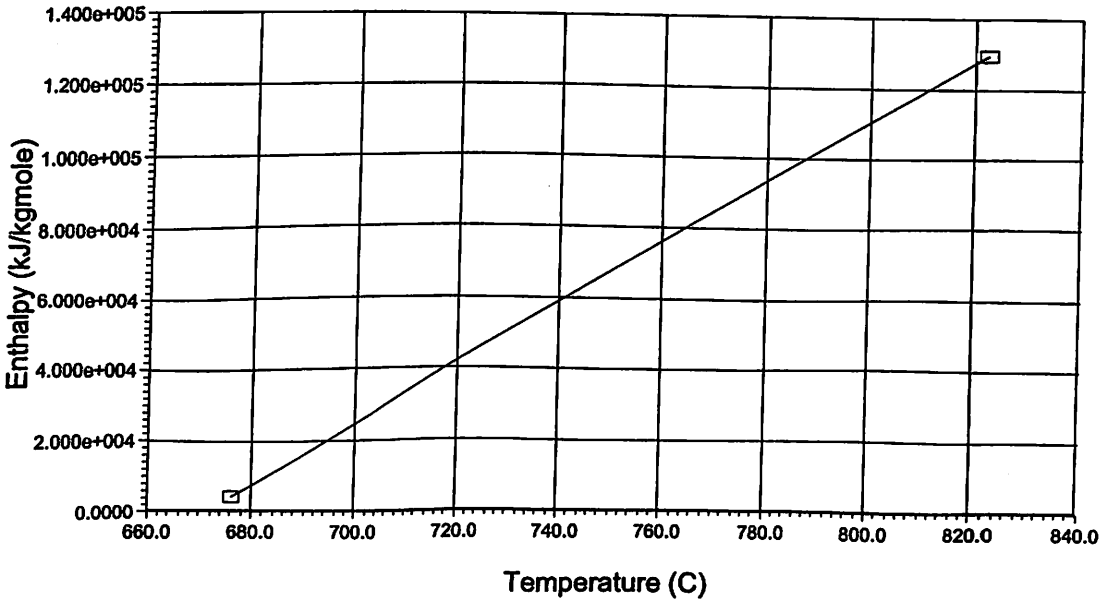
Pressure Drop:	0.0000 kPa	Duty:	5.528e+006 kJ/h	Volume:	0.1000 m3
Function:	Not Selected	Zones:	1		

User Variables

PERFORMANCE PROFILES

Zone	Pressure (kPa)	Temperature (C)	Vapour Fraction	Enthalpy (kJ/kgmole)
Inlet	202.65	822.26	1.0000	129843.25
0	202.65	676.32	1.0000	4707.90

PERFORMANCE PLOT



PERFORMANCE TABLE

Temperature (C)	Pressure (kPa)	Heat Flow (kJ/h)	Enthalpy (kJ/kgmole)	Vapour Fraction
822.26	202.65	0.00	129843.25	1.0000
676.32	202.65	-5527646.01	4707.90	1.0000

DYNAMICS

Model Details: Product Temp Spec

Zone	1 *	Delta P	(kPa)	0.0000

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* Specified by user.

Cooler: E-100 (continued)

Volume (m3)	0.1000 *	Overall K kg/hr/sqrt(kPa-kg/m3))	—
Duty (kJ/h)	5.528e+006	Product Temperature (C)	676.3 *

Holdup Details

Phase	Accumulation (kgmole/h)	Moles (kgmole)	Volume (m3)
Vapour	0.0000	0.0000	0.0000
Liquid	0.0000	0.0000	0.0000
Aqueous	0.0000	0.0000	0.0000
Total	**0.0000**	**0.0000**	**0.0000**

Individual Zone Holdups: Zone 0

Delta P Specs and Duties

Zone	dP Value (kPa)	dP Option	Duty (kJ/h)
0 *	0.0000 *	not specified	-5.528e+006 *

Zone Conductance Specifications

Zone	k (kg/hr/sqrt(kPa-kg/m3))	Specification
0 *	—	Disabled

NOTES

Vessel Sizing: melter

Vertical Seperator Properties: melter

L/D Ratio	5.000 *	Demister to Top (m)	0.3048 *
Liq. Res. Time (seconds)	1.035e+005 *	Tot. Length - Height (m)	1.676 *

Construction Information

Chem Eng Fab Index	252.5	Allowable Stress (kPa)	9.446e+004
Material Type	Carbon Steel	Shell Thickness (mm)	6.350
Mass Density (kg/m3)	7861	Corrosion Thickness (mm)	3.175
FMC	1.000	Joint Efficiency	1.000

Costing Coefficients

Shell Thick		Shell Mass		Base Cost		Accessories	
A1:	0.4000 *	A4:	0.8116 *	A5:	8.600 *	A8:	1017 *
A2:	2.000 *			A6:	-0.2165 *	A9:	0.7396 *
A3:	0.2000 *			A7:	4.580e-002 *	A10:	0.7068 *

Costing Results

Base Cost ($US)	5205	Associated Cost ($US)	608.5	Total Cost (FOB $US)	5814

Sizing Results

Diameter (m)	0.3048	Liquid Residence Time (seconds)	1.035e+005
Total Length (m)	1.676	Liquid Surge Height (m)	0.4572
L/D Ratio	5.000	LLSD (m)	0.4572
Max. Allowable Vapour Velocity (m/s)	—	Liquid Res. Time at LLSD (seconds)	1.035e+005
Demister Thickness (mm)	0.0000		

Vapour Space

Sump To Inlet Nozzle (m)	0.3048	Demister To Head (m)	0.3048
Inlet Nozzle to Demister (m)	0.5334	Ellipsoidal Head (m)	7.620e-002
Demister Thickness (mm)	0.0000	Total Vapour Height (m)	1.219

* Specified by user.

Licensed to: TEAM LND

Conversion Reactor: cracker

CONNECTIONS

Inlet Stream Connections

Stream Name	From Unit Operation
vapours	Tank melter

Outlet Stream Connections

Stream Name	To Unit Operation
cracked vapours	Cooler: E-100
cracked liquid bottoms	

Energy Stream Connections

Stream Name	From Unit Operation
Q-104	

PARAMETERS

Physical Parameters		Optional Heat Transfer: Heating	
Delta P	**Vessel Volume**	**Duty**	**Energy Stream**
-33.61 kPa	126.8 m3	73.10 kJ/h *	Q-104

User Variables

RATING

Sizing

Cylinder		Vertical		Reactor has a Boot: No	
Volume	126.8 m3	Diameter	3.810 m *	Height	11.13 *

DYNAMICS

Vessel Parameters: Initialize from User

Vessel Volume	(m3)	126.8	Level Calculator		Vertical cylinder
Vessel Diameter	(m)	3.810 *	Fraction Calculator		Use levels and nozzles
Vessel Height	(m)	11.13 *	Feed Delta P	(kPa)	-33.61
Liquid Level Percent	(%)	50.00	Vessel Pressure	(kPa)	202.6

Holdup : Initial Liquid Mole Fractions

2244688-C10:	—	n-Butane:	—	liquid bott*:	—	s polypropy*:	—
s polyethyl*:	—	i-Pentane:	—	n-Hexane:	—	liq polypro*:	—
liq polyeth*:	—	n-Pentane:	—	n-Heptane:	—		

Initial Flash Pressure: — Initial Flash Temperature: —

Holdup: Vessel Levels

Phase	Level (m)	Percent (%)	Volume (m3)
Vapour	—	—	0.0000
Liquid	—	—	0.0000
Aqueous	—	—	0.0000

Holdup: Details

Phase	Accumulation (kgmole/h)	Moles (kgmole)	Volume (m3)
Vapour	0.0000	0.0000 *	0.0000
Liquid	0.0000	0.0000 *	0.0000
Aqueous	0.0000	0.0000 *	0.0000
Total	**0.0000**	**0.0000**	**0.0000**

Duty Valve Source : Direct_Q

Available UA	(kJ/C-h)	3.600e+005	Heat Capacity	(kJ/kgmole-C)	75.00
Utility HoldUp	(kgmole)	100.0	Inlet Temp.	(C)	15.00
Mole Flow	(kgmole/h)	—	Outlet Temp.	(C)	15.00

* Specified by user.

Licensed to: TEAM LND

Conversion Reactor: cracker (continued)

Min. Mole Flow	(kgmole/h)	—	Temp. Approach	(C)	10.00
Max. Mole Flow	(kgmole/h)	—	Heat Flow	(kJ/h)	73.10 *

Liquid Heater Height as % of Vessel Volume

Top of Heater: 5.00 % *	Bottom of Heater: 0.00 % *

Heat Flow into the PFR: Heating

NOTES

Tank: melter

CONNECTIONS

Inlet Stream

Stream Name	From Unit Operation
solids	

Outlet Stream

Stream Name	To Unit Operation
vapours	Conversion Reactor: cracker
liquid melt	

Energy Stream

Stream Name	From Unit Operation
melt heat	Cooler: E-100

PARAMETERS

Vessel Volume:	20.00 m3 *	Level SP:	50.00 % *	Liquid Volume:	10.00 m3
Vessel Pressure:	169.0 kPa	Pressure Drop:	-67.72 kPa	Duty:	5.528e+006 kJ/h
Heat Transfer Mode:	Heating				

User Variables

RATING

Sizing

Cylinder		Vertical		Separator has a Boot:	No
Volume	20.00 m3 *	Diameter	2.570 m	Height	3.855

DYNAMICS

Vessel Parameters: Initialize from Product

Vessel Volume	(m3)	20.00 *	Level Calculator		Vertical cylinder
Vessel Diameter	(m)	2.570	Fraction Calculator		Use levels and nozzles
Vessel Height	(m)	3.855	Feed Delta P	(kPa)	-67.72
Liquid Level Percent	(%)	50.00 *	Vessel Pressure	(kPa)	169.0 *

Holdup: Vessel Levels

Phase	Level (m)	Percent (%)	Volume (m3)
Vapour	—	—	0.0000
Liquid	—	—	0.0000
Aqueous	—	—	0.0000

Holdup: Details

Phase	Accumulation (kgmole/h)	Moles (kgmole)	Volume (m3)
Vapour	0.0000	0.0000 *	0.0000
Liquid	0.0000	0.0000 *	0.0000
Aqueous	0.0000	0.0000 *	0.0000

Licensed to: TEAM LND
* Specified by user.

Tank: melter (continued)

Total	0.0000	0.0000	0.0000

Heat Flow into the PFR: Heating

Material Stream: solids

Fluid Package: Basis-1
Property Package: Peng Robinson

CONDITIONS

	Overall	Solid Phase			
Vapour / Phase Fraction	0.0000 *	1.0000			
Temperature: (C)	30.00 *	30.00			
Pressure: (kPa)	101.3 *	101.3			
Molar Flow (kgmole/h)	5.000e-002	5.000e-002			
Mass Flow (kg/h)	1.000e+004 *	1.000e+004			
Std Ideal Liq Vol Flow (m3/h)	10.96	10.96			
Molar Enthalpy (kJ/kgmole)	4.182e+006	4.182e+006			
Molar Entropy (kJ/kgmole-C)	4.779e+006	4.779e+006			
Heat Flow (kJ/h)	2.091e+005	2.091e+005			
Liq Vol Flow @Std Cond (m3/h)	10.96 *	10.96			

PROPERTIES

	Overall	Solid Phase			
Molecular Weight	2.000e+005	2.000e+005			
Molar Density (kgmole/m3)	4.562e-003	4.562e-003			
Mass Density (kg/m3)	912.4	912.4			
Act. Volume Flow (m3/h)	10.96	10.96			
Mass Enthalpy (kJ/kg)	20.91	20.91			
Mass Entropy (kJ/kg-C)	23.89	23.89			
Heat Capacity (kJ/kgmole-C)	8.363e+005	8.363e+005			
Mass Heat Capacity (kJ/kg-C)	4.182	4.182			
Lower Heating Value (kJ/kgmole)	—	—			
Mass Lower Heating Value (kJ/kg)	—	—			
Phase Fraction [Vol. Basis]	—	1.000			
Phase Fraction [Mass Basis]	0.0000	1.000			
Partial Pressure of CO2 (kPa)	0.0000	—			
Cost Based on Flow (Cost/s)	0.0000	0.0000			
Act. Gas Flow (ACT_m3/h)	—	—			
Avg. Liq. Density (kgmole/m3)	4.562e-003	4.562e-003			
Specific Heat (kJ/kgmole-C)	8.363e+005	8.363e+005			
Std. Gas Flow (STD_m3/h)	1.182	1.182			
Std. Ideal Liq. Mass Density (kg/m3)	912.4	912.4			
Act. Liq. Flow (m3/s)	—	—			
Z Factor	8.812	8.812			
Watson K	—	—			
User Property	—	—			
Cp/(Cp - R)	1.000	1.000			
Cp/Cv	1.000	1.000			
Heat of Vap. (kJ/kgmole)	—	—			
Kinematic Viscosity (cSt)	—	—			
Liq. Mass Density (Std. Cond) (kg/m3)	912.4	912.4			
Liq. Vol. Flow (Std. Cond) (m3/h)	10.96	10.96			
Liquid Fraction	1.000	0.0000			
Molar Volume (m3/kgmole)	219.2	219.2			
Mass Heat of Vap. (kJ/kg)	—	—			
Phase Fraction [Molar Basis]	0.0000	1.0000			
Surface Tension (dyne/cm)	—	—			
Thermal Conductivity (W/m-K)	—	—			
Viscosity (cP)	—	—			

K VALUE

COMPONENTS	MIXED	LIGHT	HEAVY
2244688-C10	—	—	—
s polyethyl*	0.0000	—	0.0000
liq polyeth*	—	—	—
n-Butane	—	—	—
i-Pentane	—	—	—
n-Pentane	—	—	—
liquid bott*	—	—	—
n-Hexane	—	—	—
n-Heptane	—	—	—
s polypropy*	0.0000	—	0.0000

* Specified by user.
Licensed to: TEAM LND

Material Stream: solids (continued)

Fluid Package: Basis-1
Property Package: Peng Robinson

K VALUE

COMPONENTS	MIXED	LIGHT	HEAVY
liq polypro*	—	—	—

Material Stream: liquid melt

Fluid Package: Basis-1
Property Package: Peng Robinson

CONDITIONS

	Overall	Vapour Phase	Solid Phase	Liquid Phase
Vapour / Phase Fraction	0.0000	0.0000	1.0000	0.0000
Temperature: (C)	320.0	320.0	320.0	320.0
Pressure: (kPa)	169.0	169.0	169.0	169.0
Molar Flow (kgmole/h)	5.000e-006	0.0000	5.000e-006	0.0000
Mass Flow (kg/h)	1.000	0.0000	1.000	0.0000
Std Ideal Liq Vol Flow (m3/h)	1.096e-003	0.0000	1.096e-003	0.0000
Molar Enthalpy (kJ/kgmole)	2.467e+008	1.147e+008	2.467e+008	1.149e+008
Molar Entropy (kJ/kgmole-C)	5.340e+006	7.986e+005	5.340e+006	8.036e+005
Heat Flow (kJ/h)	1234	0.0000	1234	0.0000
Liq Vol Flow @Std Cond (m3/h)	1.096e-003 *	0.0000	1.096e-003	0.0000

PROPERTIES

	Overall	Vapour Phase	Solid Phase	Liquid Phase
Molecular Weight	2.000e+005	2.000e+005	2.000e+005	2.000e+005
Molar Density (kgmole/m3)	4.562e-003	3.748e-002	4.562e-003	2.467
Mass Density (kg/m3)	912.4	7497	912.4	4.935e+005
Act. Volume Flow (m3/h)	1.096e-003	0.0000	1.096e-003	0.0000
Mass Enthalpy (kJ/kg)	1234	573.6	1234	574.7
Mass Entropy (kJ/kg-C)	26.70	3.993	26.70	4.018
Heat Capacity (kJ/kgmole-C)	8.363e+005	5.295e+005	8.363e+005	5.305e+005
Mass Heat Capacity (kJ/kg-C)	4.182	2.648	4.182	2.652
Lower Heating Value (kJ/kgmole)	—	—	—	—
Mass Lower Heating Value (kJ/kg)	—	—	—	—
Phase Fraction [Vol. Basis]	—	—	1.000	—
Phase Fraction [Mass Basis]	2.122e-314	0.0000	1.000	0.0000
Partial Pressure of CO2 (kPa)	0.0000	—	—	—
Cost Based on Flow (Cost/s)	0.0000	0.0000	0.0000	0.0000
Act. Gas Flow (ACT_m3/h)	—	—	—	—
Avg. Liq. Density (kgmole/m3)	4.562e-003	4.237e-003	4.562e-003	4.278e-003
Specific Heat (kJ/kgmole-C)	8.363e+005	5.295e+005	8.363e+005	5.305e+005
Std. Gas Flow (STD_m3/h)	1.182e-004	0.0000	1.182e-004	0.0000
Std. Ideal Liq. Mass Density (kg/m3)	912.4	847.4	912.4	855.5
Act. Liq. Flow (m3/s)	—	—	—	—
Z Factor	—	0.9145	7.513	1.389e-002
Watson K	—	—	—	—
User Property	—	—	—	—
Cp/(Cp - R)	1.000	1.000	1.000	1.000
Cp/Cv	1.000	1.000	1.000	1.000
Heat of Vap. (kJ/kgmole)	—	—	—	—
Kinematic Viscosity (cSt)	—	3.183e-002	—	2.687e-002
Liq. Mass Density (Std. Cond) (kg/m3)	912.4	852.3	912.4	860.1
Liq. Vol. Flow (Std. Cond) (m3/h)	1.096e-003	0.0000	1.096e-003	0.0000
Liquid Fraction	1.000	0.0000	0.0000	1.000
Molar Volume (m3/kgmole)	219.2	26.68	219.2	0.4053
Mass Heat of Vap. (kJ/kg)	—	—	—	—
Phase Fraction [Molar Basis]	0.0000	0.0000	1.0000	0.0000
Surface Tension (dyne/cm)	—	—	—	8.225
Thermal Conductivity (W/m-K)	—	0.8152	—	5.530e-002
Viscosity (cP)	—	0.2386	—	13.26

K VALUE

COMPONENTS	MIXED	LIGHT	HEAVY
2244688-C10	—	—	—
s polyethyl*	0.0000	—	0.0000
liq polyeth*	—	0.6553	—

* Specified by user.

Material Stream: liquid melt (continued)

Fluid Package: Basis-1
Property Package: Peng Robinson

K VALUE

COMPONENTS	MIXED	LIGHT	HEAVY
n-Butane	—	—	—
i-Pentane	—	—	—
n-Pentane	—	—	—
liquid bott*	—	—	—
n-Hexane	—	—	—
n-Heptane	—	—	—
s polypropy*	0.0000	—	0.0000
liq polypro*	—	2.109	—

Material Stream: vapours

Fluid Package: Basis-1
Property Package: Peng Robinson

CONDITIONS

	Overall	Vapour Phase	Liquid Phase		
Vapour / Phase Fraction	1.0000 *	1.0000	0.0000		
Temperature: (C)	320.0 *	320.0	320.0		
Pressure: (kPa)	169.0	169.0	169.0		
Molar Flow (kgmole/h)	4.999e-002	4.999e-002	0.0000		
Mass Flow (kg/h)	9999	9999	0.0000		
Std Ideal Liq Vol Flow (m3/h)	11.80	11.80	0.0000		
Molar Enthalpy (kJ/kgmole)	1.147e+008	1.147e+008	1.149e+008		
Molar Entropy (kJ/kgmole-C)	7.986e+005	7.986e+005	8.036e+005		
Heat Flow (kJ/h)	5.735e+006	5.735e+006	0.0000		
Liq Vol Flow @Std Cond (m3/h)	11.73 *	11.73	0.0000		

PROPERTIES

	Overall	Vapour Phase	Liquid Phase		
Molecular Weight	2.000e+005	2.000e+005	2.000e+005		
Molar Density (kgmole/m3)	3.749e-002	3.749e-002	2.852e-003		
Mass Density (kg/m3)	7497	7497	570.4		
Act. Volume Flow (m3/h)	1.334	1.334	0.0000		
Mass Enthalpy (kJ/kg)	573.6	573.6	574.7		
Mass Entropy (kJ/kg-C)	3.993	3.993	4.018		
Heat Capacity (kJ/kgmole-C)	5.295e+005	5.295e+005	5.305e+005		
Mass Heat Capacity (kJ/kg-C)	2.648	2.648	2.652		
Lower Heating Value (kJ/kgmole)	—	—	—		
Mass Lower Heating Value (kJ/kg)	—	—	—		
Phase Fraction [Vol. Basis]	—	1.000	—		
Phase Fraction [Mass Basis]	2.122e-314	1.000	0.0000		
Partial Pressure of CO2 (kPa)	0.0000	—	—		
Cost Based on Flow (Cost/s)	0.0000	0.0000	0.0000		
Act. Gas Flow (ACT_m3/h)	—	1.334	—		
Avg. Liq. Density (kgmole/m3)	4.237e-003	4.237e-003	4.278e-003		
Specific Heat (kJ/kgmole-C)	5.295e+005	5.295e+005	5.305e+005		
Std. Gas Flow (STD_m3/h)	1.182	1.182	0.0000		
Std. Ideal Liq. Mass Density (kg/m3)	847.4	847.4	855.5		
Act. Liq. Flow (m3/s)	—	—	—		
Z Factor	—	0.9144	12.02		
Watson K	—	—	—		
User Property	—	—	—		
Cp/(Cp - R)	1.000	1.000	1.000		
Cp/Cv	1.000	1.000	1.000		
Heat of Vap. (kJ/kgmole)	1.060e+007	1.060e+007	1.060e+007		
Kinematic Viscosity (cSt)	3.182e-002	3.182e-002	0.2561		
Liq. Mass Density (Std. Cond) (kg/m3)	852.3	852.3	860.1		
Liq. Vol. Flow (Std. Cond) (m3/h)	11.73	11.73	0.0000		
Liquid Fraction	0.0000	0.0000	1.000		
Molar Volume (m3/kgmole)	26.68	26.68	350.6		
Mass Heat of Vap. (kJ/kg)	53.02	53.02	53.02		
Phase Fraction [Molar Basis]	1.0000	1.0000	0.0000		
Surface Tension (dyne/cm)	—	—	8.225		
Thermal Conductivity (W/m-K)	0.8152	0.8152	5.530e-002		

* Specified by user.

Licensed to: TEAM LND

Material Stream: vapours (continued)

Fluid Package: Basis-1
Property Package: Peng Robinson

PROPERTIES

		Overall	Vapour Phase	Liquid Phase		
Viscosity	(cP)	0.2386	0.2386	0.1461		

K VALUE

COMPONENTS	MIXED	LIGHT	HEAVY
2244688-C10	—	—	—
s polyethyl*	—	—	—
liq polyeth*	0.6553	0.6553	—
n-Butane	—	—	—
I-Pentane	—	—	—
n-Pentane	—	—	—
liquid bott*	—	—	—
n-Hexane	—	—	—
n-Heptane	—	—	—
s polypropy*	—	—	—
liq polypro*	2.109	2.109	—

Material Stream: cracked liquid bottoms

Fluid Package: Basis-1
Property Package: Peng Robinson

CONDITIONS

		Overall	Vapour Phase	Liquid Phase		
Vapour / Phase Fraction		0.0000	0.0000	1.0000		
Temperature:	(C)	822.3	822.3	822.3		
Pressure:	(kPa)	202.6 *	202.6	202.6		
Molar Flow	(kgmole/h)	0.0000	0.0000	0.0000		
Mass Flow	(kg/h)	0.0000	0.0000	0.0000		
Std Ideal Liq Vol Flow	(m3/h)	0.0000	0.0000	0.0000		
Molar Enthalpy	(kJ/kgmole)	1.298e+005	1.298e+005	1.298e+005		
Molar Entropy	(kJ/kgmole-C)	1060	1061	1060		
Heat Flow	(kJ/h)	0.0000	0.0000	0.0000		
Liq Vol Flow @Std Cond	(m3/h)	0.0000 *	0.0000	0.0000		

PROPERTIES

		Overall	Vapour Phase	Liquid Phase		
Molecular Weight		226.3	226.4	226.3		
Molar Density	(kgmole/m3)	2.237e-002	2.237e-002	2.237e-002		
Mass Density	(kg/m3)	5.063	5.064	5.063		
Act. Volume Flow	(m3/h)	0.0000	0.0000	0.0000		
Mass Enthalpy	(kJ/kg)	573.6	573.6	573.6		
Mass Entropy	(kJ/kg-C)	4.686	4.686	4.686		
Heat Capacity	(kJ/kgmole-C)	880.4	880.5	880.4		
Mass Heat Capacity	(kJ/kg-C)	3.890	3.890	3.890		
Lower Heating Value	(kJ/kgmole)	—	—	—		
Mass Lower Heating Value	(kJ/kg)	—	—	—		
Phase Fraction [Vol. Basis]		—	—	1.000		
Phase Fraction [Mass Basis]		2.122e-314	0.0000	1.000		
Partial Pressure of CO2	(kPa)	0.0000	—	—		
Cost Based on Flow	(Cost/s)	0.0000	0.0000	0.0000		
Act. Gas Flow	(ACT_m3/h)	—	—	—		
Avg. Liq. Density	(kgmole/m3)	—	—	—		
Specific Heat	(kJ/kgmole-C)	880.4	880.5	880.4		
Std. Gas Flow	(STD_m3/h)	0.0000	0.0000	0.0000		
Std. Ideal Liq. Mass Density	(kg/m3)	803.2	803.2	803.2		
Act. Liq. Flow	(m3/s)	0.0000	—	0.0000		
Z Factor		—	0.9947	0.9947		
Watson K		—	—	—		
User Property		—	—	—		
Cp/(Cp - R)		1.010	1.010	1.010		
Cp/Cv		1.010	1.010	1.010		
Heat of Vap.	(kJ/kgmole)	1.448e+005	1.448e+005	1.448e+005		
Kinematic Viscosity	(cSt)	0.5459	3.838	0.5459		
Liq. Mass Density (Std. Cond)	(kg/m3)	878.9	879.0	878.9		

* Specified by user.

Material Stream: cracked liquid bottoms (

Fluid Package: Basis-1
Property Package: Peng Robinson

PROPERTIES

	Overall	Vapour Phase	Liquid Phase		
Liq. Vol. Flow (Std. Cond) (m3/h)	0.0000	0.0000	0.0000		
Liquid Fraction	1.000	0.0000	1.000		
Molar Volume (m3/kgmole)	44.70	44.70	44.70		
Mass Heat of Vap. (kJ/kg)	640.0	640.0	640.0		
Phase Fraction [Molar Basis]	0.0000	0.0000	1.0000		
Surface Tension (dyne/cm)	0.0000	—	0.0000		
Thermal Conductivity (W/m-K)	1.804e-003	7.508e-002	1.804e-003		
Viscosity (cP)	2.764e-003	1.943e-002	2.764e-003		

K VALUE

COMPONENTS	MIXED	LIGHT	HEAVY
2244688-C10	1.000	1.000	—
s polyethyl*	—	—	—
liq polyeth*	1.001	1.001	—
n-Butane	0.9982	0.9982	—
i-Pentane	0.9984	0.9984	—
n-Pentane	0.9983	0.9983	—
liquid bott*	1.001	1.001	—
n-Hexane	0.9985	0.9985	—
n-Heptane	0.9987	0.9987	—
s polypropy*	—	—	—
liq polypro*	0.9998	0.9998	—

Material Stream: cracked vapours

Fluid Package: Basis-1
Property Package: Peng Robinson

CONDITIONS

	Overall	Vapour Phase	Liquid Phase		
Vapour / Phase Fraction	1.0000	1.0000	0.0000		
Temperature: (C)	822.3	822.3	822.3		
Pressure: (kPa)	202.6	202.6	202.6		
Molar Flow (kgmole/h)	44.17	44.17	0.0000		
Mass Flow (kg/h)	9999	9999	0.0000		
Std Ideal Liq Vol Flow (m3/h)	12.45	12.45	0.0000		
Molar Enthalpy (kJ/kgmole)	1.298e+005	1.298e+005	1.298e+005		
Molar Entropy (kJ/kgmole-C)	1061	1061	1060		
Heat Flow (kJ/h)	5.736e+006	5.736e+006	0.0000		
Liq Vol Flow @Std Cond (m3/h)	11.38 *	11.38	0.0000		

PROPERTIES

	Overall	Vapour Phase	Liquid Phase		
Molecular Weight	226.4	226.4	226.3		
Molar Density (kgmole/m3)	2.237e-002	2.237e-002	2.237e-002		
Mass Density (kg/m3)	5.064	5.064	5.063		
Act. Volume Flow (m3/h)	1975	1975	0.0000		
Mass Enthalpy (kJ/kg)	573.6	573.6	573.6		
Mass Entropy (kJ/kg-C)	4.686	4.686	4.686		
Heat Capacity (kJ/kgmole-C)	880.5	880.5	880.4		
Mass Heat Capacity (kJ/kg-C)	3.890	3.890	3.890		
Lower Heating Value (kJ/kgmole)	—	—	—		
Mass Lower Heating Value (kJ/kg)	—	—	—		
Phase Fraction [Vol. Basis]	—	1.000	—		
Phase Fraction [Mass Basis]	2.122e-314	1.000	0.0000		
Partial Pressure of CO2 (kPa)	0.0000	—	—		
Cost Based on Flow (Cost/s)	0.0000	0.0000	0.0000		
Act. Gas Flow (ACT_m3/h)	—	1975	—		
Avg. Liq. Density (kgmole/m3)	3.548	3.548	3.549		
Specific Heat (kJ/kgmole-C)	880.5	880.5	880.4		
Std. Gas Flow (STD_m3/h)	1044	1044	0.0000		
Std. Ideal Liq. Mass Density (kg/m3)	803.2	803.2	803.2		
Act. Liq. Flow (m3/s)	—	—	—		
Z Factor	—	0.9947	0.9947		

* Specified by user.

Material Stream: cracked vapours (contin

Fluid Package: Basis-1
Property Package: Peng Robinson

PROPERTIES

	Overall	Vapour Phase	Liquid Phase
Watson K	—	—	—
User Property	—	—	—
Cp/(Cp - R)	1.010	1.010	1.010
Cp/Cv	1.010	1.010	1.010
Heat of Vap. (kJ/kgmole)	1.448e+005	1.448e+005	1.448e+005
Kinematic Viscosity (cSt)	3.838	3.838	0.5459
Liq. Mass Density (Std. Cond) (kg/m3)	879.0	879.0	878.9
Liq. Vol. Flow (Std. Cond) (m3/h)	11.38	11.38	0.0000
Liquid Fraction	0.0000	0.0000	1.000
Molar Volume (m3/kgmole)	44.70	44.70	44.70
Mass Heat of Vap. (kJ/kg)	639.8	639.8	639.8
Phase Fraction [Molar Basis]	1.0000	1.0000	0.0000
Surface Tension (dyne/cm)	—	—	0.0000
Thermal Conductivity (W/m-K)	7.508e-002	7.508e-002	1.804e-003
Viscosity (cP)	1.943e-002	1.943e-002	2.764e-003

K VALUE

COMPONENTS	MIXED	LIGHT	HEAVY
2244688-C10	1.000	1.000	—
s polyethyl*	—	—	—
liq polyeth*	1.001	1.001	—
n-Butane	0.9982	0.9982	—
I-Pentane	0.9984	0.9984	—
n-Pentane	0.9983	0.9983	—
liquid bott*	1.001	1.001	—
n-Hexane	0.9985	0.9985	—
n-Heptane	0.9987	0.9987	—
s polypropy*	—	—	—
liq polypro*	0.9998	0.9998	—

Material Stream: cooled vapors

Fluid Package: Basis-1
Property Package: Peng Robinson

CONDITIONS

	Overall	Vapour Phase
Vapour / Phase Fraction	1.0000	1.0000
Temperature: (C)	676.3	676.3
Pressure: (kPa)	202.6 *	202.6
Molar Flow (kgmole/h)	44.17	44.17
Mass Flow (kg/h)	9999	9999
Std Ideal Liq Vol Flow (m3/h)	12.45	12.45
Molar Enthalpy (kJ/kgmole)	4708	4708
Molar Entropy (kJ/kgmole-C)	938.2	938.2
Heat Flow (kJ/h)	2.080e+005	2.080e+005
Liq Vol Flow @Std Cond (m3/h)	11.38 *	11.38

PROPERTIES

	Overall	Vapour Phase
Molecular Weight	226.4	226.4
Molar Density (kgmole/m3)	2.601e-002	2.601e-002
Mass Density (kg/m3)	5.887	5.887
Act. Volume Flow (m3/h)	1699	1699
Mass Enthalpy (kJ/kg)	20.80	20.80
Mass Entropy (kJ/kg-C)	4.145	4.145
Heat Capacity (kJ/kgmole-C)	832.0	832.0
Mass Heat Capacity (kJ/kg-C)	3.676	3.676
Lower Heating Value (kJ/kgmole)	—	—
Mass Lower Heating Value (kJ/kg)	—	—
Phase Fraction [Vol. Basis]	—	1.000
Phase Fraction [Mass Basis]	4.941e-324	1.000
Partial Pressure of CO2 (kPa)	0.0000	—
Cost Based on Flow (Cost/s)	0.0000	0.0000

* Specified by user.

Material Stream: cooled vapors (continue

Fluid Package: Basis-1
Property Package: Peng Robinson

PROPERTIES

	Overall	Vapour Phase			
Act. Gas Flow (ACT_m3/h)	---	1699			
Avg. Liq. Density (kgmole/m3)	3.548	3.548			
Specific Heat (kJ/kgmole-C)	832.0	832.0			
Std. Gas Flow (STD_m3/h)	1044	1044			
Std. Ideal Liq. Mass Density (kg/m3)	803.2	803.2			
Act. Liq. Flow (m3/s)	---	---			
Z Factor	0.9871	0.9871			
Watson K	---	---			
User Property	---	---			
Cp/(Cp - R)	1.010	1.010			
Cp/Cv	1.011	1.011			
Heat of Vap. (kJ/kgmole)	1.448e+005	1.448e+005			
Kinematic Viscosity (cSt)	2.722	2.722			
Liq. Mass Density (Std. Cond) (kg/m3)	879.0	879.0			
Liq. Vol. Flow (Std. Cond) (m3/h)	11.38	11.38			
Liquid Fraction	0.0000	0.0000			
Molar Volume (m3/kgmole)	38.45	38.45			
Mass Heat of Vap. (kJ/kg)	639.8	639.8			
Phase Fraction [Molar Basis]	1.0000	1.0000			
Surface Tension (dyne/cm)	---	---			
Thermal Conductivity (W/m-K)	6.265e-002	6.265e-002			
Viscosity (cP)	1.602e-002	1.602e-002			

K VALUE

COMPONENTS	MIXED	LIGHT	HEAVY
2244688-C10	---	---	---
s polyethyl*	---	---	---
liq polyeth*	---	---	---
n-Butane	---	---	---
i-Pentane	---	---	---
n-Pentane	---	---	---
liquid bott*	---	---	---
n-Hexane	---	---	---
n-Heptane	---	---	---
s polypropy*	---	---	---
liq polypro*	---	---	---

Material Stream: lighters

Fluid Package: Basis-1
Property Package: Peng Robinson

CONDITIONS

	Overall	Vapour Phase	Liquid Phase		
Vapour / Phase Fraction	0.0000	0.0000	1.0000		
Temperature: (C)	30.64	30.64	30.64		
Pressure: (kPa)	152.0	152.0	152.0		
Molar Flow (kgmole/h)	3.911	7.090e-006	3.911		
Mass Flow (kg/h)	267.9	4.552e-004	267.9		
Std Ideal Liq Vol Flow (m3/h)	0.4345	7.544e-007	0.4345		
Molar Enthalpy (kJ/kgmole)	-1.677e+005	-1.366e+005	-1.677e+005		
Molar Entropy (kJ/kgmole-C)	67.98	138.6	67.98		
Heat Flow (kJ/h)	-6.559e+005	-0.9686	-6.559e+005		
Liq Vol Flow @Std Cond (m3/h)	0.4325 *	7.512e-007	0.4325		

PROPERTIES

	Overall	Vapour Phase	Liquid Phase		
Molecular Weight	68.52	64.20	68.52		
Molar Density (kgmole/m3)	8.798	6.325e-002	8.800		
Mass Density (kg/m3)	602.8	4.060	602.9		
Act. Volume Flow (m3/h)	0.4445	1.121e-004	0.4444		
Mass Enthalpy (kJ/kg)	-2448	-2128	-2448		
Mass Entropy (kJ/kg-C)	0.9922	2.159	0.9922		
Heat Capacity (kJ/kgmole-C)	158.6	110.8	158.6		

* Specified by user.
Licensed to: TEAM LND

Material Stream: lighters (continued)

Fluid Package: Basis-1
Property Package: Peng Robinson

PROPERTIES

	Overall	Vapour Phase	Liquid Phase		
Mass Heat Capacity (kJ/kg-C)	2.315	1.726	2.315		
Lower Heating Value (kJ/kgmole)	3.112e+006	2.924e+006	3.112e+006		
Mass Lower Heating Value (kJ/kg)	4.542e+004	4.554e+004	4.542e+004		
Phase Fraction [Vol. Basis]	1.736e-006	1.736e-006	1.000		
Phase Fraction [Mass Basis]	1.699e-006	1.699e-006	1.000		
Partial Pressure of CO2 (kPa)	0.0000	—	—		
Cost Based on Flow (Cost/s)	0.0000	0.0000	0.0000		
Act. Gas Flow (ACT_m3/h)	—	1.121e-004	—		
Avg. Liq. Density (kgmole/m3)	9.000	9.399	9.000		
Specific Heat (kJ/kgmole-C)	158.6	110.8	158.6		
Std. Gas Flow (STD_m3/h)	92.46	1.676e-004	92.46		
Std. Ideal Liq. Mass Density (kg/m3)	616.7	603.4	616.7		
Act. Liq. Flow (m3/s)	1.234e-004	—	1.234e-004		
Z Factor	—	0.9514	6.838e-003		
Watson K	—	—	—		
User Property	—	—	—		
Cp/(Cp - R)	1.055	1.081	1.055		
Cp/Cv	1.666	1.097	1.055		
Heat of Vap. (kJ/kgmole)	2.561e+004	2.561e+004	2.561e+004		
Kinematic Viscosity (cSt)	—	1.752	0.3225		
Liq. Mass Density (Std. Cond) (kg/m3)	619.5	605.9	619.5		
Liq. Vol. Flow (Std. Cond) (m3/h)	0.4325	7.512e-007	0.4325		
Liquid Fraction	1.000	0.0000	1.000		
Molar Volume (m3/kgmole)	0.1137	15.81	0.1138		
Mass Heat of Vap. (kJ/kg)	373.8	373.8	373.8		
Phase Fraction [Molar Basis]	0.0000	0.0000	1.0000		
Surface Tension (dyne/cm)	13.42	—	13.42		
Thermal Conductivity (W/m-K)	9.902e-002	1.544e-002	9.902e-002		
Viscosity (cP)	0.1944	7.116e-003	0.1944		

K VALUE

COMPONENTS	MIXED	LIGHT	HEAVY
2244688-C10	—	—	—
s polyethyl*	—	—	—
liq polyeth*	—	—	—
n-Butane	1.824	1.824	—
i-Pentane	0.7473	0.7473	—
n-Pentane	0.5676	0.5676	—
liquid bott*	—	—	—
n-Hexane	0.1847	0.1847	—
n-Heptane	6.265e-002	6.265e-002	—
s polypropy*	—	—	—
liq polypro*	—	—	—

Material Stream: crude diesel

Fluid Package: Basis-1
Property Package: Peng Robinson

CONDITIONS

	Overall	Liquid Phase	Vapour Phase		
Vapour / Phase Fraction	0.0000	1.0000	0.0000		
Temperature: (C)	271.2	271.2	271.2		
Pressure: (kPa)	202.6	202.6	202.6		
Molar Flow (kgmole/h)	40.26	40.26	0.0000		
Mass Flow (kg/h)	9731	9731	0.0000		
Std Ideal Liq Vol Flow (m3/h)	12.01	12.01	0.0000		
Molar Enthalpy (kJ/kgmole)	-3.563e+005	-3.563e+005	-2.378e+005		
Molar Entropy (kJ/kgmole-C)	483.1	483.1	386.8		
Heat Flow (kJ/h)	-1.435e+007	-1.435e+007	0.0000		
Liq Vol Flow @Std Cond (m3/h)	10.99 *	10.99	0.0000		

* Specified by user.

Material Stream: crude diesel (continued)

Fluid Package: Basis-1
Property Package: Peng Robinson

PROPERTIES

		Overall	Liquid Phase	Vapour Phase		
Molecular Weight		241.7	241.7	184.4		
Molar Density	(kgmole/m3)	2.761	2.761	4.859e-002		
Mass Density	(kg/m3)	667.3	667.3	8.961		
Act. Volume Flow	(m3/h)	14.58	14.58	0.0000		
Mass Enthalpy	(kJ/kg)	-1474	-1474	-1289		
Mass Entropy	(kJ/kg-C)	1.999	1.999	2.097		
Heat Capacity	(kJ/kgmole-C)	724.0	724.0	502.2		
Mass Heat Capacity	(kJ/kg-C)	2.995	2.995	2.723		
Lower Heating Value	(kJ/kgmole)	—	—	—		
Mass Lower Heating Value	(kJ/kg)	—	—	—		
Phase Fraction [Vol. Basis]		—	1.000	—		
Phase Fraction [Mass Basis]		2.122e-314	1.000	0.0000		
Partial Pressure of CO2	(kPa)	0.0000	—	—		
Cost Based on Flow	(Cost/s)	0.0000	0.0000	0.0000		
Act. Gas Flow	(ACT_m3/h)	—	—	—		
Avg. Liq. Density	(kgmole/m3)	3.351	3.351	4.172		
Specific Heat	(kJ/kgmole-C)	724.0	724.0	502.2		
Std. Gas Flow	(STD_m3/h)	952.0	952.0	0.0000		
Std. Ideal Liq. Mass Density	(kg/m3)	810.0	810.0	769.3		
Act. Liq. Flow	(m3/s)	4.051e-003	4.051e-003	—		
Z Factor		—	1.622e-002	0.9215		
Watson K		—	—	—		
User Property		—	—	—		
Cp/(Cp - R)		1.012	1.012	1.017		
Cp/Cv		1.012	1.012	1.024		
Heat of Vap.	(kJ/kgmole)	8.284e+004	8.284e+004	8.284e+004		
Kinematic Viscosity	(cSt)	0.2978	0.2978	0.9783		
Liq. Mass Density (Std. Cond)	(kg/m3)	885.8	885.8	847.9		
Liq. Vol. Flow (Std. Cond)	(m3/h)	10.99	10.99	0.0000		
Liquid Fraction		1.000	1.000	0.0000		
Molar Volume	(m3/kgmole)	0.3622	0.3622	20.58		
Mass Heat of Vap.	(kJ/kg)	342.7	342.7	342.7		
Phase Fraction [Molar Basis]		0.0000	1.0000	0.0000		
Surface Tension	(dyne/cm)	8.071	8.071	—		
Thermal Conductivity	(W/m-K)	8.559e-002	8.559e-002	2.929e-002		
Viscosity	(cP)	0.1987	0.1987	8.766e-003		

K VALUE

COMPONENTS	MIXED	LIGHT	HEAVY
2244688-C10	0.8592	0.8592	—
s polyethyl*	—	—	—
liq polyeth*	0.2119	0.2119	—
n-Butane	29.57	29.57	—
i-Pentane	20.95	20.95	—
n-Pentane	19.82	19.82	—
liquid bott*	0.1106	0.1106	—
n-Hexane	13.36	13.36	—
n-Heptane	9.168	9.168	—
s polypropy*	—	—	—
liq polypro*	0.8310	0.8310	—

Material Stream: diesel

Fluid Package: Basis-1
Property Package: Peng Robinson

CONDITIONS

		Overall	Vapour Phase	Liquid Phase		
Vapour / Phase Fraction		0.0000	0.0000	1.0000		
Temperature:	(C)	216.2	216.2	216.2		
Pressure:	(kPa)	101.3	101.3	101.3		
Molar Flow	(kgmole/h)	30.98	5.260e-006	30.98		
Mass Flow	(kg/h)	6900	8.416e-004	6900		
Std Ideal Liq Vol Flow	(m3/h)	8.780	1.120e-006	8.780		

Material Stream: diesel (continued)

Fluid Package: Basis-1
Property Package: Peng Robinson

CONDITIONS

	Overall	Vapour Phase	Liquid Phase		
Molar Enthalpy (kJ/kgmole)	-3.614e+005	-2.308e+005	-3.614e+005		
Molar Entropy (kJ/kgmole-C)	243.3	313.9	243.3		
Heat Flow (kJ/h)	-1.120e+007	-1.214	-1.120e+007		
Liq Vol Flow @Std Cond (m3/h)	7.813 *	1.028e-006	7.813		

PROPERTIES

	Overall	Vapour Phase	Liquid Phase		
Molecular Weight	222.7	160.0	222.7		
Molar Density (kgmole/m3)	3.179	2.598e-002	3.179		
Mass Density (kg/m3)	708.0	4.157	708.0		
Act. Volume Flow (m3/h)	9.745	2.024e-004	9.745		
Mass Enthalpy (kJ/kg)	-1623	-1443	-1623		
Mass Entropy (kJ/kg-C)	1.093	1.962	1.093		
Heat Capacity (kJ/kgmole-C)	633.6	402.3	633.6		
Mass Heat Capacity (kJ/kg-C)	2.845	2.514	2.845		
Lower Heating Value (kJ/kgmole)	—	—	—		
Mass Lower Heating Value (kJ/kg)	—	—	—		
Phase Fraction [Vol. Basis]	—	1.276e-007	1.000		
Phase Fraction [Mass Basis]	2.122e-314	1.220e-007	1.000		
Partial Pressure of CO2 (kPa)	0.0000	—	—		
Cost Based on Flow (Cost/s)	0.0000	0.0000	0.0000		
Act. Gas Flow (ACT_m3/h)	—	—	—		
Avg. Liq. Density (kgmole/m3)	3.529	4.695	3.529		
Specific Heat (kJ/kgmole-C)	633.6	402.3	633.6		
Std. Gas Flow (STD_m3/h)	732.6	1.244e-004	732.6		
Std. Ideal Liq. Mass Density (kg/m3)	785.9	751.2	785.9		
Act. Liq. Flow (m3/s)	2.707e-003	—	2.707e-003		
Z Factor	—	0.9586	7.833e-003		
Watson K	—	—	—		
User Property	—	—	—		
Cp/(Cp - R)	1.013	1.021	1.013		
Cp/Cv	1.013	1.025	1.013		
Heat of Vap. (kJ/kgmole)	6.241e+004	6.241e+004	6.241e+004		
Kinematic Viscosity (cSt)	0.3519	1.973	0.3519		
Liq. Mass Density (Std. Cond) (kg/m3)	883.1	819.0	883.1		
Liq. Vol. Flow (Std. Cond) (m3/h)	7.813	1.028e-006	7.813		
Liquid Fraction	1.000	0.0000	1.000		
Molar Volume (m3/kgmole)	0.3145	38.49	0.3145		
Mass Heat of Vap. (kJ/kg)	280.3	280.3	280.3		
Phase Fraction [Molar Basis]	0.0000	0.0000	1.0000		
Surface Tension (dyne/cm)	9.913	—	9.913		
Thermal Conductivity (W/m-K)	9.819e-002	2.555e-002	9.819e-002		
Viscosity (cP)	0.2492	8.201e-003	0.2492		

K VALUE

COMPONENTS	MIXED	LIGHT	HEAVY
2244688-C10	0.5163	0.5163	—
s polyethyl*	—	—	—
liq polyeth*	8.942e-002	8.942e-002	—
n-Butane	43.71	43.71	—
I-Pentane	28.55	28.55	—
n-Pentane	26.40	26.40	—
liquid bott*	3.978e-002	3.978e-002	—
n-Hexane	16.07	16.07	—
n-Heptane	9.972	9.972	—
s polypropy*	—	—	—
liq polypro*	0.4927	0.4927	—

Material Stream: bottoms

Fluid Package: Basis-1
Property Package: Peng Robinson

CONDITIONS

	Overall	Liquid Phase	Vapour Phase		
Vapour / Phase Fraction	0.0000	1.0000	0.0000		
Temperature: (C)	385.7	385.7	385.7		
Pressure: (kPa)	202.6	202.6	202.6		
Molar Flow (kgmole/h)	9.279	9.279	0.0000		
Mass Flow (kg/h)	2831	2831	0.0000		
Std Ideal Liq Vol Flow (m3/h)	3.234	3.234	0.0000		
Molar Enthalpy (kJ/kgmole)	-3.555e+005	-3.555e+005	-3.013e+005		
Molar Entropy (kJ/kgmole-C)	1205	1205	1296		
Heat Flow (kJ/h)	-3.299e+006	-3.299e+006	0.0000		
Liq Vol Flow @Std Cond (m3/h)	3.201 *	3.201	0.0000		

PROPERTIES

	Overall	Liquid Phase	Vapour Phase		
Molecular Weight	305.1	305.1	307.9		
Molar Density (kgmole/m3)	1.950	1.950	4.205e-002		
Mass Density (kg/m3)	595.0	595.0	12.95		
Act. Volume Flow (m3/h)	4.758	4.758	0.0000		
Mass Enthalpy (kJ/kg)	-1165	-1165	-978.3		
Mass Entropy (kJ/kg-C)	3.948	3.948	4.208		
Heat Capacity (kJ/kgmole-C)	980.4	980.4	888.5		
Mass Heat Capacity (kJ/kg-C)	3.213	3.213	2.885		
Lower Heating Value (kJ/kgmole)	—	—	—		
Mass Lower Heating Value (kJ/kg)	—	—	—		
Phase Fraction [Vol. Basis]	—	1.000	—		
Phase Fraction [Mass Basis]	2.122e-314	1.000	0.0000		
Partial Pressure of CO2 (kPa)	0.0000	—	—		
Cost Based on Flow (Cost/s)	0.0000	0.0000	0.0000		
Act. Gas Flow (ACT_m3/h)	—	—	—		
Avg. Liq. Density (kgmole/m3)	2.869	2.869	2.842		
Specific Heat (kJ/kgmole-C)	980.4	980.4	888.5		
Std. Gas Flow (STD_m3/h)	219.4	219.4	0.0000		
Std. Ideal Liq. Mass Density (kg/m3)	875.4	875.4	875.3		
Act. Liq. Flow (m3/s)	1.322e-003	1.322e-003	—		
Z Factor	—	1.897e-002	0.8798		
Watson K	—	—	—		
User Property	—	—	—		
Cp/(Cp - R)	1.009	1.009	1.009		
Cp/Cv	1.093	1.093	1.017		
Heat of Vap. (kJ/kgmole)	5.213e+004	5.213e+004	5.213e+004		
Kinematic Viscosity (cSt)	0.2383	0.2383	0.6318		
Liq. Mass Density (Std. Cond) (kg/m3)	884.4	884.4	889.0		
Liq. Vol. Flow (Std. Cond) (m3/h)	3.201	3.201	0.0000		
Liquid Fraction	1.000	1.000	0.0000		
Molar Volume (m3/kgmole)	0.5128	0.5128	23.78		
Mass Heat of Vap. (kJ/kg)	170.9	170.9	170.9		
Phase Fraction [Molar Basis]	0.0000	1.0000	0.0000		
Surface Tension (dyne/cm)	6.247	6.247	—		
Thermal Conductivity (W/m-K)	8.033e-002	8.033e-002	3.034e-002		
Viscosity (cP)	0.1418	0.1418	8.180e-003		

K VALUE

COMPONENTS	MIXED	LIGHT	HEAVY
2244688-C10	3.965	3.965	—
s polyethyl*	—	—	—
liq polyeth*	1.549	1.549	—
n-Butane	—	—	—
I-Pentane	—	—	—
n-Pentane	—	—	—
liquid bott*	1.000	1.000	—
n-Hexane	—	—	—
n-Heptane	—	—	—
s polypropy*	—	—	—

* Specified by user.

Licensed to: TEAM LND

Material Stream: bottoms (continued)

Fluid Package: Basis-1
Property Package: Peng Robinson

K VALUE

COMPONENTS	MIXED	LIGHT	HEAVY
liq polypro*	3.884	3.884	—

Energy Stream: Q-100

Fluid Package: Basis-1
Property Package: Peng Robinson

Energy Stream: Q-101

Fluid Package: Basis-1
Property Package: Peng Robinson

Energy Stream: Q-103

Fluid Package: Basis-1
Property Package: Peng Robinson

Energy Stream: Q-104

Fluid Package: Basis-1
Property Package: Peng Robinson

Energy Stream: Q-105

Fluid Package: Basis-1
Property Package: Peng Robinson

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Uttarakhand

Case Name: D:\RAK\SIMULATION\FINAL\PLASTICS TO DIESEL SIZING ADJU

Unit Set: SI

Date/Time: Mon Apr 20 18:46:00 2009

Material Stream: solids

Fluid Package: Basis-1

Property Package: Peng Robinson

CONDITIONS

		Overall	Solid Phase			
Vapour / Phase Fraction		0.0000 *	1.0000			
Temperature:	(C)	30.00 *	30.00			
Pressure:	(kPa)	101.3 *	101.3			
Molar Flow	(kgmole/h)	5.000e-002	5.000e-002			
Mass Flow	(kg/h)	1.000e+004 *	1.000e+004			
Std Ideal Liq Vol Flow	(m3/h)	10.96	10.96			
Molar Enthalpy	(kJ/kgmole)	4.182e+006	4.182e+006			
Molar Entropy	(kJ/kgmole-C)	4.779e+006	4.779e+006			
Heat Flow	(kJ/h)	2.091e+005	2.091e+005			
Liq Vol Flow @Std Cond	(m3/h)	10.96 *	10.96			

COMPOSITION

Overall Phase

Vapour Fraction 0.0000

COMPONENTS	MOLAR FLOW (kgmole/h)	MOLE FRACTION	MASS FLOW (kg/h)	MASS FRACTION	LIQUID VOLUME FLOW (m3/h)	LIQUID VOLUME FRACTION
2244688-C10	0.0000 *	0.0000 *	0.0000 *	0.0000 *	0.0000 *	0.0000
s polyethyl*	0.0250 *	0.5000 *	5000.0000 *	0.5000 *	5.4348 *	0.4959
liq polyeth*	0.0000 *	0.0000 *	0.0000 *	0.0000 *	0.0000 *	0.0000
n-Butane	0.0000 *	0.0000 *	0.0000 *	0.0000 *	0.0000 *	0.0000
i-Pentane	0.0000 *	0.0000 *	0.0000 *	0.0000 *	0.0000 *	0.0000
n-Pentane	0.0000 *	0.0000 *	0.0000 *	0.0000 *	0.0000 *	0.0000
liquid bott*	0.0000 *	0.0000 *	0.0000 *	0.0000 *	0.0000 *	0.0000
n-Hexane	0.0000 *	0.0000 *	0.0000 *	0.0000 *	0.0000 *	0.0000
n-Heptane	0.0000 *	0.0000 *	0.0000 *	0.0000 *	0.0000 *	0.0000
s polypropy*	0.0250 *	0.5000 *	5000.0000 *	0.5000 *	5.5249 *	0.5041
liq polypro*	0.0000 *	0.0000 *	0.0000 *	0.0000 *	0.0000 *	0.0000
Total	0.0500	1.0000	10000.0000	1.0000	10.9596	1.0000

Solid Phase

Phase Fraction 1.000

COMPONENTS	MOLAR FLOW (kgmole/h)	MOLE FRACTION	MASS FLOW (kg/h)	MASS FRACTION	LIQUID VOLUME FLOW (m3/h)	LIQUID VOLUME FRACTION
2244688-C10	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
s polyethyl*	0.0250	0.5000	5000.0000	0.5000	5.4348	0.4959
liq polyeth*	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
n-Butane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
i-Pentane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
n-Pentane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
liquid bott*	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
n-Hexane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
n-Heptane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
s polypropy*	0.0250	0.5000	5000.0000	0.5000	5.5249	0.5041
liq polypro*	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Total	0.0500	1.0000	10000.0000	1.0000	10.9596	1.0000

Energy Stream: melt heat

Fluid Package: Basis-1

Property Package: Peng Robinson

CONDITIONS

Duty Type:	Direct Q	Duty Calculation Operation:	melter		
Duty SP:	5.528e+006 kJ/h	Minimum Available Duty:	—	Maximum Available Duty:	—

COMPOSITION

(Not a material stream - No compositions exist)

Tank: melter

CONNECTIONS

Tank: melter (continued)

Inlet Stream

Stream Name	From Unit Operation
solids	

Outlet Stream

Stream Name	To Unit Operation
vapours	Conversion Reactor: cracker
liquid melt	

Energy Stream

Stream Name	From Unit Operation
melt heat	Cooler: E-100

PARAMETERS

Vessel Volume:	20.00 m3 *	Level SP:	50.00 % *	Liquid Volume:	10.00 m3		
Vessel Pressure:	169.0 kPa	Pressure Drop:	-67.72 kPa	Duty:	5.528e+006 kJ/h	Heat Transfer Mode:	Heating

User Variables

RESULTS

Reaction Set: Global Rxn Set

Reactor Component Information

Component	Total Inflow (kgmole/h)	Total Reaction (kgmole/h)	Total Outflow (kgmole/h)	Gibbs Energy (kJ/kgmole)
2244688-C10	0.0000	0.0000	0.0000	---
s polyethyl*	2.500e-002	-2.500e-002	2.500e-006	---
liq polyeth*	0.0000	2.500e-002	2.500e-002	---
n-Butane	0.0000	0.0000	0.0000	---
i-Pentane	0.0000	0.0000	0.0000	---
n-Pentane	0.0000	0.0000	0.0000	---
liquid bott*	0.0000	0.0000	0.0000	---
n-Hexane	0.0000	0.0000	0.0000	---
n-Heptane	0.0000	0.0000	0.0000	---
s polypropy*	2.500e-002	-2.500e-002	2.500e-006	---
liq polypro*	0.0000	2.500e-002	2.500e-002	---

Reactor Reaction Information

Reaction	% Conversion	Base Comp.	Equil Const.	Molar Extent (kgmole/h)	Est Extent (kgmole/h)
liquifaction	99.99	s polyethyl*	---	2.500e-002	---

Reaction Component Summary

	Total Inflow (kgmole/h)	Total Rxn (kgmole/h)	Total Outflow (kgmole/h)
2244688-C10	0.0000	0.0000	0.0000
s polyethyl*	2.500e-002	-2.500e-002	2.500e-006
liq polyeth*	0.0000	2.500e-002	2.500e-002
n-Butane	0.0000	0.0000	0.0000
i-Pentane	0.0000	0.0000	0.0000
n-Pentane	0.0000	0.0000	0.0000
liquid bott*	0.0000	0.0000	0.0000
n-Hexane	0.0000	0.0000	0.0000
n-Heptane	0.0000	0.0000	0.0000
s polypropy*	2.500e-002	-2.500e-002	2.500e-006
liq polypro*	0.0000	2.500e-002	2.500e-002

RATING

Sizing

Tank: melter (continued)

Cylinder		Vertical		Separator has a Boot: No	
Volume	20.00 m3 *	Diameter	2.570 m	Height	3.855

Material Stream: liquid melt

Fluid Package: Basis-1
Property Package: Peng Robinson

CONDITIONS

		Overall	Vapour Phase	Solid Phase	Liquid Phase	
Vapour / Phase Fraction		0.0000	0.0000	1.0000	0.0000	
Temperature:	(C)	320.0	320.0	320.0	320.0	
Pressure:	(kPa)	169.0	169.0	169.0	169.0	
Molar Flow	(kgmole/h)	5.000e-006	0.0000	5.000e-006	0.0000	
Mass Flow	(kg/h)	1.000	0.0000	1.000	0.0000	
Std Ideal Liq Vol Flow	(m3/h)	1.096e-003	0.0000	1.096e-003	0.0000	
Molar Enthalpy	(kJ/kgmole)	2.467e+008	1.147e+008	2.467e+008	1.149e+008	
Molar Entropy	(kJ/kgmole-C)	5.340e+006	7.986e+005	5.340e+006	8.036e+005	
Heat Flow	(kJ/h)	1234	0.0000	1234	0.0000	
Liq Vol Flow @Std Cond	(m3/h)	1.096e-003 *	0.0000	1.096e-003	0.0000	

COMPOSITION

Overall Phase

Vapour Fraction 0.0000

COMPONENTS	MOLAR FLOW (kgmole/h)	MOLE FRACTION	MASS FLOW (kg/h)	MASS FRACTION	LIQUID VOLUME FLOW (m3/h)	LIQUID VOLUME FRACTION
2244688-C10	0.0000 *	0.0000 *	0.0000 *	0.0000 *	0.0000 *	0.0000
s polyethyl*	0.0000 *	0.5000 *	0.5000 *	0.5000 *	0.0005 *	0.4959
liq polyeth*	0.0000 *	0.0000 *	0.0000 *	0.0000 *	0.0000 *	0.0009
n-Butane	0.0000 *	0.0000 *	0.0000 *	0.0000 *	0.0000 *	0.0000
i-Pentane	0.0000 *	0.0000 *	0.0000 *	0.0000 *	0.0000 *	0.0000
n-Pentane	0.0000 *	0.0000 *	0.0000 *	0.0000 *	0.0000 *	0.0000
liquid bott*	0.0000 *	0.0000 *	0.0000 *	0.0000 *	0.0000 *	0.0000
n-Hexane	0.0000 *	0.0000 *	0.0000 *	0.0000 *	0.0000 *	0.0000
n-Heptane	0.0000 *	0.0000 *	0.0000 *	0.0000 *	0.0000 *	0.0000
s polypropy*	0.0000 *	0.5000 *	0.5000 *	0.5000 *	0.0006 *	0.5041
liq polypro*	0.0000 *	0.0000 *	0.0000 *	0.0000 *	0.0000 *	0.0000
Total	0.0000	1.0000	1.0000	1.0000	0.0011	1.0000

Vapour Phase

Phase Fraction 0.0000

COMPONENTS	MOLAR FLOW (kgmole/h)	MOLE FRACTION	MASS FLOW (kg/h)	MASS FRACTION	LIQUID VOLUME FLOW (m3/h)	LIQUID VOLUME FRACTION
2244688-C10	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
s polyethyl*	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
liq polyeth*	0.0000	0.5000	0.0000	0.5000	0.0000	0.4910
n-Butane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
i-Pentane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
n-Pentane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
liquid bott*	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
n-Hexane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
n-Heptane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
s polypropy*	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
liq polypro*	0.0000	0.5000	0.0000	0.5000	0.0000	0.5090
Total	0.0000	1.0000	0.0000	1.0000	0.0000	1.0000

Solid Phase

Phase Fraction 1.000

COMPONENTS	MOLAR FLOW (kgmole/h)	MOLE FRACTION	MASS FLOW (kg/h)	MASS FRACTION	LIQUID VOLUME FLOW (m3/h)	LIQUID VOLUME FRACTION
2244688-C10	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
s polyethyl*	0.0000	0.5000	0.5000	0.5000	0.0005	0.4959
liq polyeth*	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
n-Butane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
i-Pentane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
n-Pentane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Material Stream: liquid melt (continued)

Fluid Package: Basis-1
Property Package: Peng Robinson

COMPOSITION

Solid Phase (continued)

Phase Fraction 1.000

COMPONENTS	MOLAR FLOW (kgmole/h)	MOLE FRACTION	MASS FLOW (kg/h)	MASS FRACTION	LIQUID VOLUME FLOW (m3/h)	LIQUID VOLUME FRACTION
liquid bott*	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
n-Hexane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
n-Heptane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
s polypropy*	0.0000	0.5000	0.5000	0.5000	0.0006	0.5041
liq polypro*	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Total	0.0000	1.0000	1.0000	1.0000	0.0011	1.0000

Liquid Phase

Phase Fraction 0.0000

COMPONENTS	MOLAR FLOW (kgmole/h)	MOLE FRACTION	MASS FLOW (kg/h)	MASS FRACTION	LIQUID VOLUME FLOW (m3/h)	LIQUID VOLUME FRACTION
2244688-C10	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
s polyethyl*	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
liq polyeth*	0.0000	0.7630	0.0000	0.7630	0.0000	0.7564
n-Butane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
i-Pentane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
n-Pentane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
liquid bott*	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
n-Hexane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
n-Heptane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
s polypropy*	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
liq polypro*	0.0000	0.2370	0.0000	0.2370	0.0000	0.2436
Total	0.0000	1.0000	0.0000	1.0000	0.0000	1.0000

Material Stream: vapours

Fluid Package: Basis-1
Property Package: Peng Robinson

CONDITIONS

		Overall	Vapour Phase	Liquid Phase		
Vapour / Phase Fraction		1.0000 *	1.0000	0.0000		
Temperature:	(C)	320.0 *	320.0	320.0		
Pressure:	(kPa)	169.0	169.0	169.0		
Molar Flow	(kgmole/h)	4.999e-002	4.999e-002	0.0000		
Mass Flow	(kg/h)	9999	9999	0.0000		
Std Ideal Liq Vol Flow	(m3/h)	11.80	11.80	0.0000		
Molar Enthalpy	(kJ/kgmole)	1.147e+008	1.147e+008	1.149e+008		
Molar Entropy	(kJ/kgmole-C)	7.986e+005	7.986e+005	8.036e+005		
Heat Flow	(kJ/h)	5.735e+006	5.735e+006	0.0000		
Liq Vol Flow @Std Cond	(m3/h)	11.73 *	11.73	0.0000		

COMPOSITION

Overall Phase

Vapour Fraction 1.0000

COMPONENTS	MOLAR FLOW (kgmole/h)	MOLE FRACTION	MASS FLOW (kg/h)	MASS FRACTION	LIQUID VOLUME FLOW (m3/h)	LIQUID VOLUME FRACTION
2244688-C10	0.0000 *	0.0000 *	0.0000 *	0.0000 *	0.0000 *	0.0000
s polyethyl*	0.0000 *	0.0000 *	0.0000 *	0.0000 *	0.0000 *	0.0000
liq polyeth*	0.0250 *	0.5000 *	4999.5000 *	0.5000 *	5.7938 *	0.4910
n-Butane	0.0000 *	0.0000 *	0.0000 *	0.0000 *	0.0000 *	0.0000
i-Pentane	0.0000 *	0.0000 *	0.0000 *	0.0000 *	0.0000 *	0.0000
n-Pentane	0.0000 *	0.0000 *	0.0000 *	0.0000 *	0.0000 *	0.0000
liquid bott*	0.0000 *	0.0000 *	0.0000 *	0.0000 *	0.0000 *	0.0000
n-Hexane	0.0000 *	0.0000 *	0.0000 *	0.0000 *	0.0000 *	0.0000
n-Heptane	0.0000 *	0.0000 *	0.0000 *	0.0000 *	0.0000 *	0.0000
s polypropy*	0.0250 *	0.5000 *	4999.5000 *	0.5000 *	6.0052 *	0.5090
liq polypro*	0.0500	1.0000	9999.0000	1.0000	11.7990	1.0000
Total						

Material Stream: vapours (continued)

Fluid Package: Basis-1
Property Package: Peng Robinson

COMPOSITION

Vapour Phase

Phase Fraction 1.000

COMPONENTS	MOLAR FLOW (kgmole/h)	MOLE FRACTION	MASS FLOW (kg/h)	MASS FRACTION	LIQUID VOLUME FLOW (m3/h)	LIQUID VOLUME FRACTION
2244688-C10	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
s polyethyl*	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
liq polyeth*	0.0250	0.5000	4999.5000	0.5000	5.7938	0.4910
n-Butane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
i-Pentane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
n-Pentane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
liquid bott*	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
n-Hexane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
n-Heptane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
s polypropy*	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
liq polypro*	0.0250	0.5000	4999.5000	0.5000	6.0052	0.5090
Total	0.0500	1.0000	9999.0000	1.0000	11.7990	1.0000

Liquid Phase

Phase Fraction 0.0000

COMPONENTS	MOLAR FLOW (kgmole/h)	MOLE FRACTION	MASS FLOW (kg/h)	MASS FRACTION	LIQUID VOLUME FLOW (m3/h)	LIQUID VOLUME FRACTION
2244688-C10	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
s polyethyl*	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
liq polyeth*	0.0000	0.7630	0.0000	0.7630	0.0000	0.7564
n-Butane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
i-Pentane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
n-Pentane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
liquid bott*	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
n-Hexane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
n-Heptane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
s polypropy*	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
liq polypro*	0.0000	0.2370	0.0000	0.2370	0.0000	0.2436
Total	0.0000	1.0000	0.0000	1.0000	0.0000	1.0000

Energy Stream: Q-104

Fluid Package: Basis-1
Property Package: Peng Robinson

CONDITIONS

Duty Type:	Direct Q	Duty Calculation Operation:	cracker		
Duty SP:	73.10 kJ/h *	Minimum Available Duty:	—	Maximum Available Duty:	—

COMPOSITION

(Not a material stream - No compositions exist)

Conversion Reactor: cracker

CONNECTIONS

Inlet Stream Connections

Stream Name	From Unit Operation	
vapours	Tank	melter

Outlet Stream Connections

Stream Name	To Unit Operation	
cracked vapours	Cooler:	E-100
cracked liquid bottoms		

Energy Stream Connections

Stream Name	From Unit Operation
Q-104	

Conversion Reactor: cracker (continued)

PARAMETERS

Physical Parameters		Optional Heat Transfer:	Heating
Delta P	**Vessel Volume**	**Duty**	**Energy Stream**
-33.61 kPa	126.8 m3	73.10 kJ/h *	Q-104

User Variables

REACTION DETAILS

Reaction: cracking

Component	Mole Weight	Stoichiometric Coeff.
liq polyeth*	2.000e+005	-1
2244688-C10	226.4	1200
n-Butane	58.12	50
i-Pentane	72.15	50
n-Pentane	72.15	50
liquid bott*	300.0	375
n-Hexane	86.18	25
n-Heptane	100.2	35
liq polypro*	2.000e+005	-1

REACTION RESULTS FOR : cracking

Extents

Name	Rank	Specified % Conversion	Use Default	Actual % Conversion	Base Component	Reaction Extent (kgmole/h)
cracking	0 *	99.00	Yes	99.00	liq polyeth*	2.475e-002

Balance

Components	Total Inflow (kgmole/h)	Total Reaction (kgmole/h)	Total Outflow (kgmole/h)
2244688-C10	0.0000	29.70	29.70
s polyethyl*	0.0000	0.0000	0.0000
liq polyeth*	2.500e-002	-2.475e-002	2.500e-004
n-Butane	0.0000	1.237	1.237
i-Pentane	0.0000	1.237	1.237
n-Pentane	0.0000	1.237	1.237
liquid bott*	0.0000	9.279	9.279
n-Hexane	0.0000	0.6187	0.6187
n-Heptane	0.0000	0.8662	0.8662
s polypropy*	0.0000	0.0000	0.0000
liq polypro*	2.500e-002	-2.475e-002	2.500e-004

RATING

Sizing

Cylinder		Vertical		Reactor has a Boot: No	
Volume	126.8 m3	Diameter	3.810 m *	Height	11.13

Material Stream: cracked liquid bottoms

Fluid Package: Basis-1
Property Package: Peng Robinson

CONDITIONS

	Overall	Vapour Phase	Liquid Phase		
Vapour / Phase Fraction	0.0000	0.0000	1.0000		
Temperature: (C)	822.3	822.3	822.3		
Pressure: (kPa)	202.6 *	202.6	202.6		
Molar Flow (kgmole/h)	0.0000	0.0000	0.0000		
Mass Flow (kg/h)	0.0000	0.0000	0.0000		
Std Ideal Liq Vol Flow (m3/h)	0.0000	0.0000	0.0000		
Molar Enthalpy (kJ/kgmole)	1.298e+005	1.298e+005	1.298e+005		

* Specified by user.

Material Stream: cracked liquid bottoms (conti

Fluid Package: Basis-1
Property Package: Peng Robinson

CONDITIONS

		Overall	Vapour Phase	Liquid Phase		
Molar Entropy	(kJ/kgmole-C)	1060	1061	1060		
Heat Flow	(kJ/h)	0.0000	0.0000	0.0000		
Liq Vol Flow @Std Cond	(m3/h)	0.0000 *	0.0000	0.0000		

COMPOSITION

Overall Phase

Vapour Fraction 0.0000

COMPONENTS	MOLAR FLOW (kgmole/h)	MOLE FRACTION	MASS FLOW (kg/h)	MASS FRACTION	LIQUID VOLUME FLOW (m3/h)	LIQUID VOLUME FRACTION
2244688-C10	0.0000	0.6723	0.0000	0.6727	0.0000	0.6858
s polyethyl*	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
liq polyeth*	0.0000	0.0000	0.0000	0.0050	0.0000	0.0047
n-Butane	0.0000	0.0281	0.0000	0.0072	0.0000	0.0099
i-Pentane	0.0000	0.0281	0.0000	0.0089	0.0000	0.0115
n-Pentane	0.0000	0.0281	0.0000	0.0089	0.0000	0.0114
liquid bott*	0.0000	0.2099	0.0000	0.2782	0.0000	0.2552
n-Hexane	0.0000	0.0140	0.0000	0.0053	0.0000	0.0065
n-Heptane	0.0000	0.0196	0.0000	0.0087	0.0000	0.0102
s polypropy*	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
liq polypro*	0.0000	0.0000	0.0000	0.0050	0.0000	0.0048
Total	0.0000	1.0000	0.0000	1.0000	0.0000	1.0000

Vapour Phase

Phase Fraction 0.0000

COMPONENTS	MOLAR FLOW (kgmole/h)	MOLE FRACTION	MASS FLOW (kg/h)	MASS FRACTION	LIQUID VOLUME FLOW (m3/h)	LIQUID VOLUME FRACTION
2244688-C10	0.0000	0.6723	0.0000	0.6725	0.0000	0.6857
s polyethyl*	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
liq polyeth*	0.0000	0.0000	0.0000	0.0050	0.0000	0.0047
n-Butane	0.0000	0.0280	0.0000	0.0072	0.0000	0.0099
i-Pentane	0.0000	0.0280	0.0000	0.0089	0.0000	0.0115
n-Pentane	0.0000	0.0280	0.0000	0.0089	0.0000	0.0114
liquid bott*	0.0000	0.2101	0.0000	0.2784	0.0000	0.2554
n-Hexane	0.0000	0.0140	0.0000	0.0053	0.0000	0.0065
n-Heptane	0.0000	0.0196	0.0000	0.0087	0.0000	0.0102
s polypropy*	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
liq polypro*	0.0000	0.0000	0.0000	0.0050	0.0000	0.0048
Total	0.0000	1.0000	0.0000	1.0000	0.0000	1.0000

Liquid Phase

Phase Fraction 1.000

COMPONENTS	MOLAR FLOW (kgmole/h)	MOLE FRACTION	MASS FLOW (kg/h)	MASS FRACTION	LIQUID VOLUME FLOW (m3/h)	LIQUID VOLUME FRACTION
2244688-C10	0.0000	0.6723	0.0000	0.6727	0.0000	0.6858
s polyethyl*	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
liq polyeth*	0.0000	0.0000	0.0000	0.0050	0.0000	0.0047
n-Butane	0.0000	0.0281	0.0000	0.0072	0.0000	0.0099
i-Pentane	0.0000	0.0281	0.0000	0.0089	0.0000	0.0115
n-Pentane	0.0000	0.0281	0.0000	0.0089	0.0000	0.0114
liquid bott*	0.0000	0.2099	0.0000	0.2782	0.0000	0.2552
n-Hexane	0.0000	0.0140	0.0000	0.0053	0.0000	0.0065
n-Heptane	0.0000	0.0196	0.0000	0.0087	0.0000	0.0102
s polypropy*	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
liq polypro*	0.0000	0.0000	0.0000	0.0050	0.0000	0.0048
Total	0.0000	1.0000	0.0000	1.0000	0.0000	1.0000

Material Stream: cracked vapours

Fluid Package: Basis-1
Property Package: Peng Robinson

CONDITIONS

		Overall	Vapour Phase	Liquid Phase		
Vapour / Phase Fraction		1.0000	1.0000	0.0000		
Temperature:	(C)	822.3	822.3	822.3		
Pressure:	(kPa)	202.6	202.6	202.6		
Molar Flow	(kgmole/h)	44.17	44.17	0.0000		
Mass Flow	(kg/h)	9999	9999	0.0000		
Std Ideal Liq Vol Flow	(m3/h)	12.45	12.45	0.0000		
Molar Enthalpy	(kJ/kgmole)	1.298e+005	1.298e+005	1.298e+005		
Molar Entropy	(kJ/kgmole-C)	1061	1061	1060		
Heat Flow	(kJ/h)	5.736e+006	5.736e+006	0.0000		
Liq Vol Flow @Std Cond	(m3/h)	11.38 *	11.38	0.0000		

COMPOSITION

Overall Phase

Vapour Fraction 1.0000

COMPONENTS	MOLAR FLOW (kgmole/h)	MOLE FRACTION	MASS FLOW (kg/h)	MASS FRACTION	LIQUID VOLUME FLOW (m3/h)	LIQUID VOLUME FRACTION
2244688-C10	29.6970	0.6723	6724.7736	0.6725	8.5364	0.6857
s polyethyl*	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
liq polyeth*	0.0002	0.0000	49.9950	0.0050	0.0579	0.0047
n-Butane	1.2374	0.0280	71.9213	0.0072	0.1233	0.0099
i-Pentane	1.2374	0.0280	89.2779	0.0089	0.1432	0.0115
n-Pentane	1.2374	0.0280	89.2779	0.0089	0.1418	0.0114
liquid bott*	9.2788	0.2101	2783.6481	0.2784	3.1791	0.2554
n-Hexane	0.6187	0.0140	53.3172	0.0053	0.0805	0.0065
n-Heptane	0.8662	0.0196	86.7939	0.0087	0.1264	0.0102
s polypropy*	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
liq polypro*	0.0002	0.0000	49.9950	0.0050	0.0601	0.0048
Total	44.1733	1.0000	9999.0000	1.0000	12.4486	1.0000

Vapour Phase

Phase Fraction 1.000

COMPONENTS	MOLAR FLOW (kgmole/h)	MOLE FRACTION	MASS FLOW (kg/h)	MASS FRACTION	LIQUID VOLUME FLOW (m3/h)	LIQUID VOLUME FRACTION
2244688-C10	29.6970	0.6723	6724.7736	0.6725	8.5364	0.6857
s polyethyl*	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
liq polyeth*	0.0002	0.0000	49.9950	0.0050	0.0579	0.0047
n-Butane	1.2374	0.0280	71.9213	0.0072	0.1233	0.0099
i-Pentane	1.2374	0.0280	89.2779	0.0089	0.1432	0.0115
n-Pentane	1.2374	0.0280	89.2779	0.0089	0.1418	0.0114
liquid bott*	9.2788	0.2101	2783.6481	0.2784	3.1791	0.2554
n-Hexane	0.6187	0.0140	53.3172	0.0053	0.0805	0.0065
n-Heptane	0.8662	0.0196	86.7939	0.0087	0.1264	0.0102
s polypropy*	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
liq polypro*	0.0002	0.0000	49.9950	0.0050	0.0601	0.0048
Total	44.1733	1.0000	9999.0000	1.0000	12.4486	1.0000

Liquid Phase

Phase Fraction 0.0000

COMPONENTS	MOLAR FLOW (kgmole/h)	MOLE FRACTION	MASS FLOW (kg/h)	MASS FRACTION	LIQUID VOLUME FLOW (m3/h)	LIQUID VOLUME FRACTION
2244688-C10	0.0000	0.6723	0.0000	0.6727	0.0000	0.6858
s polyethyl*	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
liq polyeth*	0.0000	0.0000	0.0000	0.0050	0.0000	0.0047
n-Butane	0.0000	0.0281	0.0000	0.0072	0.0000	0.0099
i-Pentane	0.0000	0.0281	0.0000	0.0089	0.0000	0.0115
n-Pentane	0.0000	0.0281	0.0000	0.0089	0.0000	0.0114
liquid bott*	0.0000	0.2099	0.0000	0.2782	0.0000	0.2552
n-Hexane	0.0000	0.0140	0.0000	0.0053	0.0000	0.0065
n-Heptane	0.0000	0.0196	0.0000	0.0087	0.0000	0.0102
s polypropy*	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
liq polypro*	0.0000	0.0000	0.0000	0.0050	0.0000	0.0048

* Specified by user.

Material Stream: cracked vapours (continued)

Fluid Package: Basis-1
Property Package: Peng Robinson

COMPOSITION

Liquid Phase (continued)

Phase Fraction 0.0000

Total	0.0000	1.0000	0.0000	1.0000	0.0000	1.0000

Cooler: E-100

CONNECTIONS

Inlet Stream

STREAM NAME	FROM UNIT OPERATION	
cracked vapours	Conversion Reactor	cracker

Outlet Stream

STREAM NAME	TO UNIT OPERATION	
cooled vapors	Shortcut Column	primary distillation

Energy Stream

STREAM NAME	TO UNIT OPERATION	
melt heat	Tank	melter

PARAMETERS

Pressure Drop:	0.0000 kPa	Duty:	5.528e+006 kJ/h	Volume:	0.1000 m3
Function:	Not Selected	Zones:	1		

User Variables

PROPERTIES

cracked vapours

		Overall	Vapour Phase	Liquid Phase		
Vapour/Phase Fraction		1.0000	1.0000	0.0000		
Temperature:	(C)	822.3	822.3	822.3		
Pressure:	(kPa)	202.6	202.6	202.6		
Molar Flow	(kgmole/h)	44.17	44.17	0.0000		
Mass Flow	(kg/h)	9999	9999	0.0000		
Std Ideal Liq Vol Flow	(m3/h)	12.45	12.45	0.0000		
Molar Enthalpy	(kJ/kgmole)	1.298e+005	1.298e+005	1.298e+005		
Mass Enthalpy	(kJ/kg)	573.6	573.6	573.6		
Molar Entropy	(kJ/kgmole-C)	1061	1061	1060		
Mass Entropy	(kJ/kg-C)	4.686	4.686	4.686		
Heat Flow	(kJ/h)	5.736e+006	5.736e+006	0.0000		
Molar Density	(kgmole/m3)	2.237e-002	2.237e-002	2.237e-002		
Mass Density	(kg/m3)	5.064	5.064	5.063		
Std Ideal Liq Mass Density	(kg/m3)	803.2	803.2	803.2		
Liq Mass Density @Std Cond	(kg/m3)	879.0	879.0	878.9		
Molar Heat Capacity	(kJ/kgmole-C)	880.5	880.5	880.4		
Mass Heat Capacity	(kJ/kg-C)	3.890	3.890	3.890		
Thermal Conductivity	(W/m-K)	7.508e-002	7.508e-002	1.804e-003		
Viscosity	(cP)	1.943e-002	1.943e-002	2.764e-003		
Surface Tension	(dyne/cm)	---	---	0.0000		
Molecular Weight		226.4	226.4	226.3		
Z Factor		0.9947	0.9947	0.9947		

cooled vapors

		Overall	Vapour Phase			
Vapour/Phase Fraction		1.0000	1.0000			
Temperature:	(C)	676.3	676.3			
Pressure:	(kPa)	202.6 *	202.6			
Molar Flow	(kgmole/h)	44.17	44.17			

* Specified by user.

Cooler: E-100 (continued)

PROPERTIES

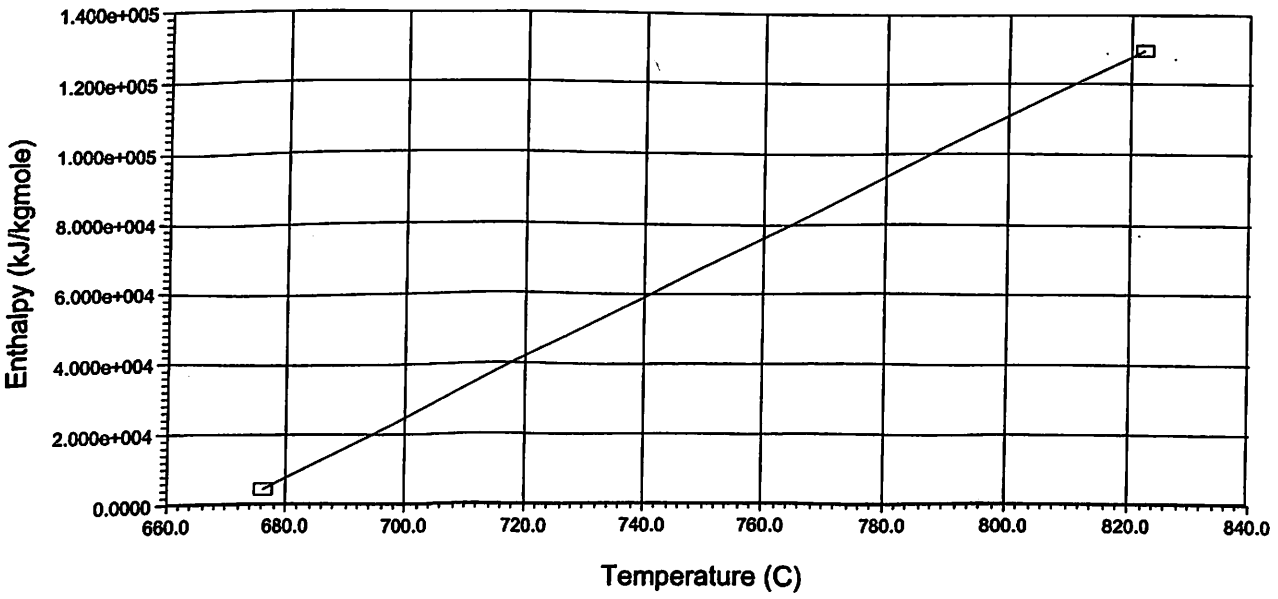
cooled vapors

		Overall	Vapour Phase			
Mass Flow	(kg/h)	9999	9999			
Std Ideal Liq Vol Flow	(m3/h)	12.45	12.45			
Molar Enthalpy	(kJ/kgmole)	4708	4708			
Mass Enthalpy	(kJ/kg)	20.80	20.80			
Molar Entropy	(kJ/kgmole-C)	938.2	938.2			
Mass Entropy	(kJ/kg-C)	4.145	4.145			
Heat Flow	(kJ/h)	2.080e+005	2.080e+005			
Molar Density	(kgmole/m3)	2.601e-002	2.601e-002			
Mass Density	(kg/m3)	5.887	5.887			
Std Ideal Liq Mass Density	(kg/m3)	803.2	803.2			
Liq Mass Density @Std Cond	(kg/m3)	879.0	879.0			
Molar Heat Capacity	(kJ/kgmole-C)	832.0	832.0			
Mass Heat Capacity	(kJ/kg-C)	3.676	3.676			
Thermal Conductivity	(W/m-K)	6.265e-002	6.265e-002			
Viscosity	(cP)	1.602e-002	1.602e-002			
Surface Tension	(dyne/cm)	---	---			
Molecular Weight		226.4	226.4			
Z Factor		0.9871	0.9871			

PERFORMANCE PROFILES

Zone	Pressure (kPa)	Temperature (C)	Vapour Fraction	Enthalpy (kJ/kgmole)
Inlet	202.65	822.26	1.0000	129843.25
0	202.65	676.32	1.0000	4707.90

PERFORMANCE PLOT



PERFORMANCE TABLE

Temperature (C)	Pressure (kPa)	Heat Flow (kJ/h)	Enthalpy (kJ/kgmole)	Vapour Fraction
822.26	202.65	0.00	129843.25	1.0000
676.32	202.65	-5527646.01	4707.90	1.0000

Material Stream: cooled vapors

Fluid Package: Basis-1
Property Package: Peng Robinson

CONDITIONS

		Overall	Vapour Phase			
Vapour / Phase Fraction		1.0000	1.0000			
Temperature:	(C)	676.3	676.3			
Pressure:	(kPa)	202.6 *	202.6			
Molar Flow	(kgmole/h)	44.17	44.17			
Mass Flow	(kg/h)	9999	9999			
Std Ideal Liq Vol Flow	(m3/h)	12.45	12.45			
Molar Enthalpy	(kJ/kgmole)	4708	4708			
Molar Entropy	(kJ/kgmole-C)	938.2	938.2			
Heat Flow	(kJ/h)	2.080e+005	2.080e+005			
Liq Vol Flow @Std Cond	(m3/h)	11.38 *	11.38			

COMPOSITION

Overall Phase

Vapour Fraction 1.0000

COMPONENTS	MOLAR FLOW (kgmole/h)	MOLE FRACTION	MASS FLOW (kg/h)	MASS FRACTION	LIQUID VOLUME FLOW (m3/h)	LIQUID VOLUME FRACTION
2244688-C10	29.6970	0.6723	6724.7736	0.6725	8.5364	0.6857
s polyethyl*	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
liq polyeth*	0.0002	0.0000	49.9950	0.0050	0.0579	0.0047
n-Butane	1.2374	0.0280	71.9213	0.0072	0.1233	0.0099
i-Pentane	1.2374	0.0280	89.2779	0.0089	0.1432	0.0115
n-Pentane	1.2374	0.0280	89.2779	0.0089	0.1418	0.0114
liquid bott*	9.2788	0.2101	2783.6481	0.2784	3.1791	0.2554
n-Hexane	0.6187	0.0140	53.3172	0.0053	0.0805	0.0065
n-Heptane	0.8662	0.0196	86.7939	0.0087	0.1264	0.0102
s polypropy*	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
liq polypro*	0.0002	0.0000	49.9950	0.0050	0.0601	0.0048
Total	44.1733	1.0000	9999.0000	1.0000	12.4486	1.0000

Vapour Phase

Phase Fraction 1.000

COMPONENTS	MOLAR FLOW (kgmole/h)	MOLE FRACTION	MASS FLOW (kg/h)	MASS FRACTION	LIQUID VOLUME FLOW (m3/h)	LIQUID VOLUME FRACTION
2244688-C10	29.6970	0.6723	6724.7736	0.6725	8.5364	0.6857
s polyethyl*	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
liq polyeth*	0.0002	0.0000	49.9950	0.0050	0.0579	0.0047
n-Butane	1.2374	0.0280	71.9213	0.0072	0.1233	0.0099
i-Pentane	1.2374	0.0280	89.2779	0.0089	0.1432	0.0115
n-Pentane	1.2374	0.0280	89.2779	0.0089	0.1418	0.0114
liquid bott*	9.2788	0.2101	2783.6481	0.2784	3.1791	0.2554
n-Hexane	0.6187	0.0140	53.3172	0.0053	0.0805	0.0065
n-Heptane	0.8662	0.0196	86.7939	0.0087	0.1264	0.0102
s polypropy*	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
liq polypro*	0.0002	0.0000	49.9950	0.0050	0.0601	0.0048
Total	44.1733	1.0000	9999.0000	1.0000	12.4486	1.0000

Shortcut Column: primary distillation

Connections

Feed	Condensor Duty	Distillate	Reboiler Duty	Bottoms
cooled vapors	Q-100	lighters	Q-101	crude diesel

Parameters

	Component	Mole Fraction
Light Key	n-Hexane	1.000e-002
Heavy Key	n-Heptane	1.000e-003

Pressures (kPa)		Reflux Ratios	
Condenser Pressure	152.0 *	External Reflux Ratio	1.000

* Specified by user.
Licensed to: TEAM LND

Shortcut Column: primary distillation (continued)

Parameters

Pressures (kPa)		Reflux Ratios	
Reboiler Pressure	202.6 *	Minimum Reflux Ratio	0.6533

User Variables

Results Summary

Trays / Temperatures		Flows		
Minimum # of Trays	8.078	Rectify Vapour (kgmole/h)		7.821
Actual # of Trays	16.59	Rectify Liquid (kgmole/h)		3.911
Optimal Feed Stage	13.56	Stripping Vapour (kgmole/h)		-36.35
Condenser Temperature (C)	30.64	Stripping Liquid (kgmole/h)		3.911
Reboiler Temperature (C)	271.2	Condenser Duty (kJ/h)		-2.003e+005
		Reboiler Duty (kJ/h)		-1.501e+007

Energy Stream: Q-100

Fluid Package: Basis-1
Property Package: Peng Robinson

CONDITIONS

Duty Type:	Direct Q	Duty Calculation Operation:	primary distillation		
Duty SP:	-2.003e+005 kJ/h	Minimum Available Duty:	—	Maximum Available Duty:	—

COMPOSITION

(Not a material stream - No compositions exist)

Energy Stream: Q-101

Fluid Package: Basis-1
Property Package: Peng Robinson

CONDITIONS

Duty Type:	Direct Q	Duty Calculation Operation:	primary distillation		
Duty SP:	-1.501e+007 kJ/h	Minimum Available Duty:	—	Maximum Available Duty:	—

COMPOSITION

(Not a material stream - No compositions exist)

Material Stream: lighters

Fluid Package: Basis-1
Property Package: Peng Robinson

CONDITIONS

		Overall	Vapour Phase	Liquid Phase		
Vapour / Phase Fraction		0.0000	0.0000	1.0000		
Temperature:	(C)	30.64	30.64	30.64		
Pressure:	(kPa)	152.0	152.0	152.0		
Molar Flow	(kgmole/h)	3.911	7.090e-006	3.911		
Mass Flow	(kg/h)	267.9	4.552e-004	267.9		
Std Ideal Liq Vol Flow	(m3/h)	0.4345	7.544e-007	0.4345		
Molar Enthalpy	(kJ/kgmole)	-1.677e+005	-1.366e+005	-1.677e+005		
Molar Entropy	(kJ/kgmole-C)	67.98	138.6	67.98		
Heat Flow	(kJ/h)	-6.559e+005	-0.9686	-6.559e+005		
Liq Vol Flow @Std Cond	(m3/h)	0.4325 *	7.512e-007	0.4325		

COMPOSITION

Overall Phase — Vapour Fraction 0.0000

COMPONENTS	MOLAR FLOW (kgmole/h)	MOLE FRACTION	MASS FLOW (kg/h)	MASS FRACTION	LIQUID VOLUME FLOW (m3/h)	LIQUID VOLUME FRACTION
2244688-C10	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
s polyethyl*	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
liq polyeth*	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
n-Butane	1.2373	0.3164	71.9158	0.2684	0.1233	0.2838
i-Pentane	1.2316	0.3149	88.8593	0.3316	0.1425	0.3280

* Specified by user.

Material Stream: lighters (continued)

Fluid Package: Basis-1
Property Package: Peng Robinson

COMPOSITION

Overall Phase (continued)

Vapour Fraction 0.0000

COMPONENTS	MOLAR FLOW (kgmole/h)	MOLE FRACTION	MASS FLOW (kg/h)	MASS FRACTION	LIQUID VOLUME FLOW (m3/h)	LIQUID VOLUME FRACTION
n-Pentane	1.2217	0.3124	88.1475	0.3290	0.1400	0.3222
liquid bott*	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
n-Hexane	0.2161	0.0553	18.6195	0.0695	0.0281	0.0647
n-Heptane	0.0039	0.0010	0.3918	0.0015	0.0006	0.0013
s polypropy*	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
liq polypro*	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Total	3.9105	1.0000	267.9340	1.0000	0.4345	1.0000

Vapour Phase

Phase Fraction 1.813e-006

COMPONENTS	MOLAR FLOW (kgmole/h)	MOLE FRACTION	MASS FLOW (kg/h)	MASS FRACTION	LIQUID VOLUME FLOW (m3/h)	LIQUID VOLUME FRACTION
2244688-C10	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
s polyethyl*	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
liq polyeth*	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
n-Butane	0.0000	0.5771	0.0002	0.5224	0.0000	0.5405
i-Pentane	0.0000	0.2353	0.0001	0.2645	0.0000	0.2560
n-Pentane	0.0000	0.1773	0.0001	0.1993	0.0000	0.1909
liquid bott*	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
n-Hexane	0.0000	0.0102	0.0000	0.0137	0.0000	0.0125
n-Heptane	0.0000	0.0001	0.0000	0.0001	0.0000	0.0001
s polypropy*	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
liq polypro*	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Total	0.0000	1.0000	0.0005	1.0000	0.0000	1.0000

Liquid Phase

Phase Fraction 1.000

COMPONENTS	MOLAR FLOW (kgmole/h)	MOLE FRACTION	MASS FLOW (kg/h)	MASS FRACTION	LIQUID VOLUME FLOW (m3/h)	LIQUID VOLUME FRACTION
2244688-C10	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
s polyethyl*	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
liq polyeth*	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
n-Butane	1.2373	0.3164	71.9155	0.2684	0.1233	0.2838
i-Pentane	1.2316	0.3149	88.8592	0.3316	0.1425	0.3280
n-Pentane	1.2217	0.3124	88.1474	0.3290	0.1400	0.3222
liquid bott*	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
n-Hexane	0.2161	0.0553	18.6195	0.0695	0.0281	0.0647
n-Heptane	0.0039	0.0010	0.3918	0.0015	0.0006	0.0013
s polypropy*	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
liq polypro*	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Total	3.9105	1.0000	267.9335	1.0000	0.4345	1.0000

Material Stream: crude diesel

Fluid Package: Basis-1
Property Package: Peng Robinson

CONDITIONS

		Overall	Liquid Phase	Vapour Phase		
Vapour / Phase Fraction		0.0000	1.0000	0.0000		
Temperature:	(C)	271.2	271.2	271.2		
Pressure:	(kPa)	202.6	202.6	202.6		
Molar Flow	(kgmole/h)	40.26	40.26	0.0000		
Mass Flow	(kg/h)	9731	9731	0.0000		
Std Ideal Liq Vol Flow	(m3/h)	12.01	12.01	0.0000		
Molar Enthalpy	(kJ/kgmole)	-3.563e+005	-3.563e+005	-2.378e+005		
Molar Entropy	(kJ/kgmole-C)	483.1	483.1	386.8		
Heat Flow	(kJ/h)	-1.435e+007	-1.435e+007	0.0000		
Liq Vol Flow @Std Cond	(m3/h)	10.99 *	10.99	0.0000		

Material Stream: crude diesel (continued)

Fluid Package: Basis-1
Property Package: Peng Robinson

COMPOSITION

Overall Phase

Vapour Fraction 0.0000

COMPONENTS	MOLAR FLOW (kgmole/h)	MOLE FRACTION	MASS FLOW (kg/h)	MASS FRACTION	LIQUID VOLUME FLOW (m3/h)	LIQUID VOLUME FRACTION
2244688-C10	29.6970	0.7376	6724.7736	0.6911	8.5364	0.7105
s polyethyl*	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
liq polyeth*	0.0002	0.0000	49.9950	0.0051	0.0579	0.0048
n-Butane	0.0001	0.0000	0.0055	0.0000	0.0000	0.0000
i-Pentane	0.0058	0.0001	0.4186	0.0000	0.0007	0.0001
n-Pentane	0.0157	0.0004	1.1305	0.0001	0.0018	0.0001
liquid bott*	9.2788	0.2305	2783.6481	0.2861	3.1791	0.2646
n-Hexane	0.4026	0.0100	34.6977	0.0036	0.0524	0.0044
n-Heptane	0.8623	0.0214	86.4021	0.0089	0.1258	0.0105
s polypropy*	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
liq polypro*	0.0002	0.0000	49.9950	0.0051	0.0601	0.0050
Total	40.2628	1.0000	9731.0660	1.0000	12.0141	1.0000

Liquid Phase

Phase Fraction 1.000

COMPONENTS	MOLAR FLOW (kgmole/h)	MOLE FRACTION	MASS FLOW (kg/h)	MASS FRACTION	LIQUID VOLUME FLOW (m3/h)	LIQUID VOLUME FRACTION
2244688-C10	29.6970	0.7376	6724.7736	0.6911	8.5364	0.7105
s polyethyl*	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
liq polyeth*	0.0002	0.0000	49.9950	0.0051	0.0579	0.0048
n-Butane	0.0001	0.0000	0.0055	0.0000	0.0000	0.0000
i-Pentane	0.0058	0.0001	0.4186	0.0000	0.0007	0.0001
n-Pentane	0.0157	0.0004	1.1305	0.0001	0.0018	0.0001
liquid bott*	9.2788	0.2305	2783.6481	0.2861	3.1791	0.2646
n-Hexane	0.4026	0.0100	34.6977	0.0036	0.0524	0.0044
n-Heptane	0.8623	0.0214	86.4021	0.0089	0.1258	0.0105
s polypropy*	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
liq polypro*	0.0002	0.0000	49.9950	0.0051	0.0601	0.0050
Total	40.2628	1.0000	9731.0660	1.0000	12.0141	1.0000

Vapour Phase

Phase Fraction 0.0000

COMPONENTS	MOLAR FLOW (kgmole/h)	MOLE FRACTION	MASS FLOW (kg/h)	MASS FRACTION	LIQUID VOLUME FLOW (m3/h)	LIQUID VOLUME FRACTION
2244688-C10	0.0000	0.6337	0.0000	0.7781	0.0000	0.7599
s polyethyl*	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
liq polyeth*	0.0000	0.0000	0.0000	0.0014	0.0000	0.0013
n-Butane	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000
i-Pentane	0.0000	0.0030	0.0000	0.0012	0.0000	0.0015
n-Pentane	0.0000	0.0077	0.0000	0.0030	0.0000	0.0037
liquid bott*	0.0000	0.0255	0.0000	0.0415	0.0000	0.0364
n-Hexane	0.0000	0.1336	0.0000	0.0625	0.0000	0.0725
n-Heptane	0.0000	0.1963	0.0000	0.1067	0.0000	0.1195
s polypropy*	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
liq polypro*	0.0000	0.0000	0.0000	0.0056	0.0000	0.0052
Total	0.0000	1.0000	0.0000	1.0000	0.0000	1.0000

Shortcut Column: diesel distillator

Connections

Feed	Condensor Duty	Distillate	Reboiler Duty	Bottoms
crude diesel	Q-103	diesel	Q-105	bottoms

Parameters

	Component	Mole Fraction
Light Key	2244688-C10	1.000e-005
Heavy Key	liquid bott*	1.000e-005

* Specified by user.

Shortcut Column: diesel distillator (continued)

Parameters

Pressures (kPa)		Reflux Ratios	
Condenser Pressure	101.3 *	External Reflux Ratio	1.000
Reboiler Pressure	202.6 *	Minimum Reflux Ratio	0.1965

User Variables

Results Summary

Trays / Temperatures			Flows		
Minimum # of Trays		11.51	Rectify Vapour	(kgmole/h)	61.97
Actual # of Trays		17.14	Rectify Liquid	(kgmole/h)	30.98
Optimal Feed Stage		6.518	Stripping Vapour	(kgmole/h)	61.97
Condenser Temperature	(C)	216.2	Stripping Liquid	(kgmole/h)	71.25
Reboiler Temperature	(C)	385.7	Condenser Duty	(kJ/h)	-3.867e+006
			Reboiler Duty	(kJ/h)	3.715e+006

Energy Stream: Q-103

Fluid Package: Basis-1
Property Package: Peng Robinson

CONDITIONS

Duty Type:	Direct Q	Duty Calculation Operation:	diesel distillator		
Duty SP:	-3.867e+006 kJ/h	Minimum Available Duty:	---	Maximum Available Duty:	---

COMPOSITION

(Not a material stream - No compositions exist)

Energy Stream: Q-105

Fluid Package: Basis-1
Property Package: Peng Robinson

CONDITIONS

Duty Type:	Direct Q	Duty Calculation Operation:	diesel distillator		
Duty SP:	3.715e+006 kJ/h	Minimum Available Duty:	---	Maximum Available Duty:	---

COMPOSITION

(Not a material stream - No compositions exist)

Material Stream: diesel

Fluid Package: Basis-1
Property Package: Peng Robinson

CONDITIONS

		Overall	Vapour Phase	Liquid Phase		
Vapour / Phase Fraction		0.0000	0.0000	1.0000		
Temperature:	(C)	216.2	216.2	216.2		
Pressure:	(kPa)	101.3	101.3	101.3		
Molar Flow	(kgmole/h)	30.98	5.260e-006	30.98		
Mass Flow	(kg/h)	6900	8.416e-004	6900		
Std Ideal Liq Vol Flow	(m3/h)	8.780	1.120e-006	8.780		
Molar Enthalpy	(kJ/kgmole)	-3.614e+005	-2.308e+005	-3.614e+005		
Molar Entropy	(kJ/kgmole-C)	243.3	313.9	243.3		
Heat Flow	(kJ/h)	-1.120e+007	-1.214	-1.120e+007		
Liq Vol Flow @Std Cond	(m3/h)	7.813 *	1.028e-006	7.813		

COMPOSITION

Overall Phase

Vapour Fraction 0.0000

COMPONENTS	MOLAR FLOW (kgmole/h)	MOLE FRACTION	MASS FLOW (kg/h)	MASS FRACTION	LIQUID VOLUME FLOW (m3/h)	LIQUID VOLUME FRACTION
2244688-C10	29.6969	0.9585	6724.7526	0.9746	8.5364	0.9723
s polyethyl*	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
liq polyeth*	0.0000	0.0000	2.3103	0.0003	0.0027	0.0003

* Specified by user.

Material Stream: diesel (continued)

Fluid Package: Basis-1
Property Package: Peng Robinson

COMPOSITION

Overall Phase (continued)

Vapour Fraction 0.0003

COMPONENTS	MOLAR FLOW (kgmole/h)	MOLE FRACTION	MASS FLOW (kg/h)	MASS FRACTION	LIQUID VOLUME FLOW (m3/h)	LIQUID VOLUME FRACTION
n-Butane	0.0001	0.0000	0.0055	0.0000	0.0000	0.0000
i-Pentane	0.0058	0.0002	0.4186	0.0001	0.0007	0.0001
n-Pentane	0.0157	0.0005	1.1305	0.0002	0.0018	0.0002
liquid bott*	0.0003	0.0000	0.0930	0.0000	0.0001	0.0000
n-Hexane	0.4026	0.0130	34.6977	0.0050	0.0524	0.0060
n-Heptane	0.8623	0.0278	86.4021	0.0125	0.1258	0.0143
s polypropy*	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
liq polypro*	0.0002	0.0000	49.9948	0.0072	0.0601	0.0068
Total	30.9840	1.0000	6899.8050	1.0000	8.7798	1.0000

Vapour Phase

Phase Fraction 1.698e-007

COMPONENTS	MOLAR FLOW (kgmole/h)	MOLE FRACTION	MASS FLOW (kg/h)	MASS FRACTION	LIQUID VOLUME FLOW (m3/h)	LIQUID VOLUME FRACTION
2244688-C10	0.0000	0.4948	0.0006	0.7002	0.0000	0.6677
s polyethyl*	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
liq polyeth*	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
n-Butane	0.0000	0.0001	0.0000	0.0000	0.0000	0.0001
i-Pentane	0.0000	0.0053	0.0000	0.0024	0.0000	0.0029
n-Pentane	0.0000	0.0134	0.0000	0.0060	0.0000	0.0072
liquid bott*	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
n-Hexane	0.0000	0.2088	0.0001	0.1125	0.0000	0.1275
n-Heptane	0.0000	0.2775	0.0001	0.1738	0.0000	0.1901
s polypropy*	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
liq polypro*	0.0000	0.0000	0.0000	0.0050	0.0000	0.0045
Total	0.0000	1.0000	0.0008	1.0000	0.0000	1.0000

Liquid Phase

Phase Fraction 1.000

COMPONENTS	MOLAR FLOW (kgmole/h)	MOLE FRACTION	MASS FLOW (kg/h)	MASS FRACTION	LIQUID VOLUME FLOW (m3/h)	LIQUID VOLUME FRACTION
2244688-C10	29.6969	0.9585	6724.7520	0.9746	8.5364	0.9723
s polyethyl*	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
liq polyeth*	0.0000	0.0000	2.3103	0.0003	0.0027	0.0003
n-Butane	0.0001	0.0000	0.0055	0.0000	0.0000	0.0000
i-Pentane	0.0058	0.0002	0.4186	0.0001	0.0007	0.0001
n-Pentane	0.0157	0.0005	1.1304	0.0002	0.0018	0.0002
liquid bott*	0.0003	0.0000	0.0930	0.0000	0.0001	0.0000
n-Hexane	0.4026	0.0130	34.6976	0.0050	0.0524	0.0060
n-Heptane	0.8623	0.0278	86.4019	0.0125	0.1258	0.0143
s polypropy*	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
liq polypro*	0.0002	0.0000	49.9948	0.0072	0.0601	0.0068
Total	30.9839	1.0000	6899.8041	1.0000	8.7798	1.0000

Material Stream: bottoms

Fluid Package: Basis-1
Property Package: Peng Robinson

CONDITIONS

		Overall	Liquid Phase	Vapour Phase		
Vapour / Phase Fraction		0.0000	1.0000	0.0000		
Temperature:	(C)	385.7	385.7	385.7		
Pressure:	(kPa)	202.6	202.6	202.6		
Molar Flow	(kgmole/h)	9.279	9.279	0.0000		
Mass Flow	(kg/h)	2831	2831	0.0000		
Std Ideal Liq Vol Flow	(m3/h)	3.234	3.234	0.0000		
Molar Enthalpy	(kJ/kgmole)	-3.555e+005	-3.555e+005	-3.013e+005		
Molar Entropy	(kJ/kgmole-C)	1205	1205	1296		
Heat Flow	(kJ/h)	-3.299e+006	-3.299e+006	0.0000		

Material Stream: bottoms (continued)

Fluid Package: Basis-1
Property Package: Peng Robinson

CONDITIONS

		Overall	Liquid Phase	Vapour Phase		
Liq Vol Flow @Std Cond	(m3/h)	3.201 *	3.201	0.0000		

COMPOSITION

Overall Phase

Vapour Fraction 0.0000

COMPONENTS	MOLAR FLOW (kgmole/h)	MOLE FRACTION	MASS FLOW (kg/h)	MASS FRACTION	LIQUID VOLUME FLOW (m3/h)	LIQUID VOLUME FRACTION
2244688-C10	0.0001	0.0000	0.0210	0.0000	0.0000	0.0000
s polyethyl*	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
liq polyeth*	0.0002	0.0000	47.6847	0.0168	0.0553	0.0171
n-Butane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
i-Pentane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
n-Pentane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
liquid bott*	9.2785	1.0000	2783.5551	0.9832	3.1790	0.9829
n-Hexane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
n-Heptane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
s polypropy*	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
liq polypro*	0.0000	0.0000	0.0002	0.0000	0.0000	0.0000
Total	9.2788	1.0000	2831.2611	1.0000	3.2343	1.0000

Liquid Phase

Phase Fraction 1.000

COMPONENTS	MOLAR FLOW (kgmole/h)	MOLE FRACTION	MASS FLOW (kg/h)	MASS FRACTION	LIQUID VOLUME FLOW (m3/h)	LIQUID VOLUME FRACTION
2244688-C10	0.0001	0.0000	0.0210	0.0000	0.0000	0.0000
s polyethyl*	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
liq polyeth*	0.0002	0.0000	47.6847	0.0168	0.0553	0.0171
n-Butane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
i-Pentane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
n-Pentane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
liquid bott*	9.2785	1.0000	2783.5551	0.9832	3.1790	0.9829
n-Hexane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
n-Heptane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
s polypropy*	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
liq polypro*	0.0000	0.0000	0.0002	0.0000	0.0000	0.0000
Total	9.2788	1.0000	2831.2611	1.0000	3.2343	1.0000

Vapour Phase

Phase Fraction 0.0000

COMPONENTS	MOLAR FLOW (kgmole/h)	MOLE FRACTION	MASS FLOW (kg/h)	MASS FRACTION	LIQUID VOLUME FLOW (m3/h)	LIQUID VOLUME FRACTION
2244688-C10	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
s polyethyl*	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
liq polyeth*	0.0000	0.0000	0.0000	0.0259	0.0000	0.0262
n-Butane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
i-Pentane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
n-Pentane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
liquid bott*	0.0000	0.9999	0.0000	0.9741	0.0000	0.9737
n-Hexane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
n-Heptane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
s polypropy*	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
liq polypro*	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Total	0.0000	1.0000	0.0000	1.0000	0.0000	1.0000

* Specified by user.

University Of Petroleum And Energy
UPES,
Bidholi,
Dehradun,
Uttarakhand

Case Name: D:\RAKI\SIMULATION\FINAL\WITH H2.HSC
Unit Set: SI
Date/Time: Fri Apr 24 08:04:18 2009

Material Stream: diesel

Fluid Package: Basis-1
Property Package: Peng Robinson

CONDITIONS

	Overall	Vapour Phase	Liquid Phase		
Vapour / Phase Fraction	0.0000	0.0000	1.0000		
Temperature: (C)	217.1	217.1	217.1		
Pressure: (kPa)	101.3	101.3	101.3		
Molar Flow (kgmole/h)	35.47	4.951e-006	35.47		
Mass Flow (kg/h)	7904	7.965e-004	7904		
Std Ideal Liq Vol Flow (m3/h)	10.06	1.059e-006	10.06		
Molar Enthalpy (kJ/kgmole)	-3.615e+005	-2.321e+005	-3.615e+005		
Molar Entropy (kJ/kgmole-C)	243.7	313.6	243.7		
Heat Flow (kJ/h)	-1.282e+007	-1.149	-1.282e+007		
Liq Vol Flow @Std Cond (m3/h)	8.956 *	9.704e-007	8.956		

PROPERTIES

	Overall	Vapour Phase	Liquid Phase		
Molecular Weight	222.9	160.9	222.9		
Molar Density (kgmole/m3)	3.172	2.594e-002	3.172		
Mass Density (kg/m3)	706.8	4.173	706.8		
Act. Volume Flow (m3/h)	11.18	1.909e-004	11.18		
Mass Enthalpy (kJ/kg)	-1622	-1442	-1622		
Mass Entropy (kJ/kg-C)	1.094	1.949	1.094		
Heat Capacity (kJ/kgmole-C)	635.0	405.2	635.0		
Mass Heat Capacity (kJ/kg-C)	2.850	2.519	2.850		
Lower Heating Value (kJ/kgmole)	—	—	—		
Mass Lower Heating Value (kJ/kg)	—	—	—		
Phase Fraction [Vol. Basis]	—	1.054e-007	1.000		
Phase Fraction [Mass Basis]	2.122e-314	1.008e-007	1.000		
Partial Pressure of CO2 (kPa)	0.0000	—	—		
Cost Based on Flow (Cost/s)	0.0000	0.0000	0.0000		
Act. Gas Flow (ACT_m3/h)	—	—	—		
Avg. Liq. Density (kgmole/m3)	3.527	4.673	3.527		
Specific Heat (kJ/kgmole-C)	635.0	405.2	635.0		
Std. Gas Flow (STD_m3/h)	838.6	1.171e-004	838.6		
Std. Ideal Liq. Mass Density (kg/m3)	786.0	751.8	786.0		
Act. Liq. Flow (m3/s)	3.106e-003	—	3.106e-003		
Z Factor	—	0.9585	7.838e-003		
Watson K	—	—	—		
User Property	—	—	—		
Cp/(Cp - R)	1.013	1.021	1.013		
Cp/Cv	1.013	1.025	1.013		
Heat of Vap. (kJ/kgmole)	6.199e+004	6.199e+004	6.199e+004		
Kinematic Viscosity (cSt)	0.3496	1.970	0.3496		
Liq. Mass Density (Std. Cond) (kg/m3)	882.6	820.8	882.6		
Liq. Vol. Flow (Std. Cond) (m3/h)	8.956	9.704e-007	8.956		
Liquid Fraction	1.000	0.0000	1.000		
Molar Volume (m3/kgmole)	0.3153	38.56	0.3153		
Mass Heat of Vap. (kJ/kg)	278.2	278.2	278.2		
Phase Fraction [Molar Basis]	0.0000	0.0000	1.0000		
Surface Tension (dyne/cm)	9.877	—	9.877		
Thermal Conductivity (W/m-K)	9.794e-002	2.564e-002	9.794e-002		
Viscosity (cP)	0.2471	8.219e-003	0.2471		

Material Stream: diesel (continued)

Fluid Package: Basis-1
Property Package: Peng Robinson

COMPOSITION

Overall Phase

Vapour Fraction 0.0000

COMPONENTS	MOLAR FLOW (kgmole/h)	MOLE FRACTION	MASS FLOW (kg/h)	MASS FRACTION	LIQUID VOLUME FLOW (m3/h)	LIQUID VOLUME FRACTION
2244688-C10	34.1034	0.9615	7722.5728	0.9770	9.8030	0.9748
s polyethyl*	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
liq polyeth*	0.0000	0.0000	2.6399	0.0003	0.0031	0.0003
n-Butane	0.0004	0.0000	0.0254	0.0000	0.0000	0.0000
i-Pentane	0.0164	0.0005	1.1843	0.0001	0.0019	0.0002
n-Pentane	0.0388	0.0011	2.8010	0.0004	0.0044	0.0004
liquid bott*	0.0004	0.0000	0.1064	0.0000	0.0001	0.0000
n-Hexane	0.4475	0.0126	38.5623	0.0049	0.0582	0.0058
n-Heptane	0.8612	0.0243	86.3015	0.0109	0.1257	0.0125
s polypropy*	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
liq polypro*	0.0002	0.0000	49.9948	0.0063	0.0601	0.0060
Hydrogen	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Total	35.4684	1.0000	7904.1884	1.0000	10.0565	1.0000

Vapour Phase

Phase Fraction 1.396e-007

COMPONENTS	MOLAR FLOW (kgmole/h)	MOLE FRACTION	MASS FLOW (kg/h)	MASS FRACTION	LIQUID VOLUME FLOW (m3/h)	LIQUID VOLUME FRACTION
2244688-C10	0.0000	0.5074	0.0006	0.7141	0.0000	0.6815
s polyethyl*	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
liq polyeth*	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
n-Butane	0.0000	0.0005	0.0000	0.0002	0.0000	0.0003
i-Pentane	0.0000	0.0133	0.0000	0.0060	0.0000	0.0072
n-Pentane	0.0000	0.0291	0.0000	0.0131	0.0000	0.0156
liquid bott*	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
n-Hexane	0.0000	0.2047	0.0001	0.1096	0.0000	0.1244
n-Heptane	0.0000	0.2449	0.0001	0.1525	0.0000	0.1670
s polypropy*	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
liq polypro*	0.0000	0.0000	0.0000	0.0044	0.0000	0.0040
Hydrogen	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Total	0.0000	1.0000	0.0008	1.0000	0.0000	1.0000

Liquid Phase

Phase Fraction 1.000

COMPONENTS	MOLAR FLOW (kgmole/h)	MOLE FRACTION	MASS FLOW (kg/h)	MASS FRACTION	LIQUID VOLUME FLOW (m3/h)	LIQUID VOLUME FRACTION
2244688-C10	34.1034	0.9615	7722.5723	0.9770	9.8030	0.9748
s polyethyl*	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
liq polyeth*	0.0000	0.0000	2.6399	0.0003	0.0031	0.0003
n-Butane	0.0004	0.0000	0.0254	0.0000	0.0000	0.0000
i-Pentane	0.0164	0.0005	1.1843	0.0001	0.0019	0.0002
n-Pentane	0.0388	0.0011	2.8010	0.0004	0.0044	0.0004
liquid bott*	0.0004	0.0000	0.1064	0.0000	0.0001	0.0000
n-Hexane	0.4475	0.0126	38.5622	0.0049	0.0582	0.0058
n-Heptane	0.8612	0.0243	86.3014	0.0109	0.1257	0.0125
s polypropy*	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
liq polypro*	0.0002	0.0000	49.9948	0.0063	0.0601	0.0060
Hydrogen	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Total	35.4684	1.0000	7904.1876	1.0000	10.0565	1.0000

Material Stream: diesel (continued)

Fluid Package: Basis-1
Property Package: Peng Robinson

K VALUE

COMPONENTS	MIXED	LIGHT	HEAVY
2244688-C10	0.5277	0.5277	—
s polyethyl*	—	—	—
liq polyeth*	9.204e-002	9.204e-002	—
n-Butane	43.96	43.96	—
i-Pentane	28.76	28.76	—
n-Pentane	26.61	26.61	—
liquid bott*	4.106e-002	4.106e-002	—
n-Hexane	16.23	16.23	—
n-Heptane	10.09	10.09	—
s polypropy*	—	—	—
liq polypro*	0.5040	0.5040	—
Hydrogen	—	—	—

UNIT OPERATIONS

FEED TO	PRODUCT FROM	LOGICAL CONNECTION
	Shortcut Column: diesel distillator	

UTILITIES

Boiling Point Curves: diesel

DYNAMICS

Pressure Specification (Inactive): 101.3 kPa
Flow Specification (Inactive) Molar: 35.47 kgmole/h Mass: 7904 kg/h Std Ideal Liq Volume: 10.06 m3/h

Stream: cooled vapors

Boiling Point Curves: cooled vapors

BOILING POINT CURVES

Basis	Stream
Liquid Volume	cooled vapors

RESULTS

BP Curves Results

Cut Point (%)	TBP (C)	ASTM D86 (C)	D86 Crack Reduced (C)	ASTM D1160(Vac) (C)	ASTM D1160(Atm) (C)	ASTM D2887 (C)
0.00	-57.72	11.84	11.84	-113.44	-48.05	-47.83
1.00	9.00	62.03	62.03	-64.86	17.17	-32.47
2.00	30.04	74.78	74.78	-48.95	38.22	-15.59
3.50	69.14	97.66	97.66	-18.66	77.88	11.35
5.00	101.53	121.37	121.37	6.55	110.47	38.64
7.50	111.77	130.08	130.08	14.21	120.30	79.88
10.00	122.01	138.80	138.80	21.87	130.10	95.62
12.50	132.25	147.52	147.52	29.53	139.86	108.90
15.00	142.49	156.23	156.23	37.19	149.59	116.73
17.50	152.73	164.95	164.95	44.86	159.29	127.67
20.00	162.97	173.67	173.67	52.52	168.96	138.79
25.00	183.45	191.10	191.10	67.84	188.19	161.49
30.00	203.93	208.53	208.53	83.16	207.29	184.58
35.00	224.40	225.96	225.96	98.48	226.26	207.52
40.00	244.88	243.40	243.40	113.80	245.10	229.62
45.00	246.82	244.97	244.97	115.27	246.91	249.18
50.00	247.33	245.32	245.32	115.67	247.40	250.91

* Specified by user.

Stream: cooled vapors (continued)

Boiling Point Curves: cooled vapors (continued)

BP Curves Results

Cut Point (%)	TBP (C)	ASTM D86 (C)	D86 Crack Reduced (C)	ASTM D1160(Vac) (C)	ASTM D1160(Atm) (C)	ASTM D2887 (C)
55.00	247.84	245.67	245.67	116.08	247.90	252.16
60.00	248.35	246.03	246.03	116.48	248.39	252.88
65.00	248.86	246.38	246.38	116.89	248.89	253.45
70.00	249.37	246.73	246.73	117.29	249.38	254.13
75.00	249.87	247.08	247.08	117.70	249.88	273.07
80.00	328.50	318.15	309.23	182.86	328.50	315.22
85.00	341.24	331.01	320.00	193.59	341.24	340.72
90.00	353.98	343.39	329.98	204.38	353.98	356.94
92.50	360.35	349.39	334.68	209.79	360.35	367.39
95.00	366.72	355.28	339.20	215.21	366.72	380.22
96.50	370.55	358.75	341.82	218.47	370.55	388.69
98.00	374.37	362.17	344.38	221.73	374.37	397.71
99.00	376.92	364.43	346.04	223.91	376.92	404.01
100.00	379.46	366.67	347.68	226.09	379.46	410.53

CRITICAL PROPERTIES

Cut Point (%)	Critical Temperature (C)	Critical Pressure (kPa)	Acentricity Factor	Molecular Weight	Liquid Density (kg/m3)
0.00	-339.52	1818.80	-0.2124	-13.587	-77.46
1.00	166.69	3627.95	0.2072	62.819	600.38
2.00	189.78	3347.70	0.2308	72.151	625.72
3.50	235.21	3027.44	0.3013	86.362	663.03
5.00	270.19	2694.75	0.3540	102.854	689.51
7.50	280.71	2564.84	0.3677	111.593	698.22
10.00	291.22	2446.87	0.3814	120.331	706.67
12.50	301.73	2339.28	0.3952	129.070	714.85
15.00	312.24	2240.75	0.4089	137.808	722.76
17.50	322.75	2150.18	0.4226	146.547	730.40
20.00	333.26	2066.66	0.4363	155.285	737.77
25.00	354.28	1917.67	0.4638	172.763	751.70
30.00	375.30	1788.71	0.4913	190.240	764.56
35.00	396.32	1676.01	0.5187	207.717	776.34
40.00	417.34	1576.67	0.5462	225.194	787.05
45.00	420.95	1608.49	0.5496	26074.519	793.57
50.00	423.20	1652.13	0.5512	53917.574	799.80
55.00	425.46	1698.19	0.5527	81760.629	812.73
60.00	427.72	1746.90	0.5543	109603.684	819.13
65.00	429.98	1798.49	0.5558	137446.739	824.47
70.00	432.23	1853.21	0.5574	193630.148	828.72
75.00	434.49	1911.37	0.5589	199685.555	831.90
80.00	510.63	1531.30	0.6696	143390.811	866.50
85.00	522.09	1463.13	0.6882	98409.621	871.89
90.00	533.55	1400.77	0.7069	-26217.445	877.29
92.50	539.28	1371.54	0.7162	-68619.509	879.98
95.00	545.01	1343.51	0.7255	-111021.573	882.68
96.50	548.44	1327.23	0.7311	-136462.812	884.30
98.00	551.88	1311.35	0.7367	-161904.050	885.91
99.00	554.17	1300.96	0.7404	-178864.876	886.99
100.00	556.46	1290.75	0.7442	-195825.701	888.07

COLD PROPERTIES

True VP at 37.8 C (kPa)	2492.1966	Cetane Index	34.0809

Stream: cooled vapors (continued)

Boiling Point Curves: cooled vapors (continued)

Reid VP at 37.8 C	(kPa)	70.2261	Research Octane Number		—
ASTM D93 Flash Point	(C)	26.9677	Viscosity at 37.8 C	(cP)	2.61558
ASTM D97 Pour Point	(C)	-10.6897	Viscosity at 97.8 C	(cP)	0.94932
Refractive Index		1.4913			

P:N:A

Paraffins [mol%]	32.1298	Naphthas [mol%]	27.9106	Aromatics [mol%]	39.9596

Stream: crude diesel

Boiling Point Curves: crude diesel

BOILING POINT CURVES

Basis	Stream
Liquid Volume	crude diesel

RESULTS

BP Curves Results

Cut Point (%)	TBP (C)	ASTM D86 (C)	D86 Crack Reduced (C)	ASTM D1160(Vac) (C)	ASTM D1160(Atm) (C)	ASTM D2887 (C)
0.00	82.30	118.20	118.20	8.84	113.41	71.69
1.00	98.59	126.29	126.29	16.19	122.84	79.96
2.00	102.55	129.46	129.46	18.84	126.23	86.50
3.50	108.49	134.22	134.22	22.82	131.31	93.79
5.00	114.43	138.98	138.98	26.80	136.38	99.00
7.50	124.33	146.92	146.92	33.42	144.81	107.72
10.00	134.23	154.85	154.85	40.05	153.21	117.79
12.50	144.13	162.79	162.79	46.67	161.59	128.19
15.00	154.03	170.72	170.72	53.30	169.94	138.81
17.50	163.93	178.65	178.65	59.92	178.27	149.60
20.00	173.83	186.59	186.59	66.55	186.58	160.46
25.00	193.64	202.45	202.45	79.80	203.11	182.62
30.00	213.44	218.32	218.32	93.05	219.56	204.71
35.00	233.24	234.19	234.19	106.30	235.90	224.55
40.00	246.52	244.81	244.81	115.20	246.83	241.13
45.00	247.01	245.15	245.15	115.57	247.27	250.30
50.00	247.50	245.48	245.48	115.93	247.72	251.05
55.00	247.99	245.82	245.82	116.30	248.17	251.83
60.00	248.48	246.16	246.16	116.67	248.62	252.62
65.00	248.98	246.49	246.49	117.03	249.07	253.43
70.00	249.47	246.83	246.83	117.40	249.51	254.25
75.00	249.96	247.17	247.17	117.76	249.96	281.30
80.00	330.19	319.76	310.60	184.28	330.19	323.19
85.00	342.51	332.12	320.91	194.66	342.51	345.55
90.00	354.83	344.04	330.49	205.09	354.83	358.93
92.50	360.99	349.83	335.02	210.33	360.99	368.57
95.00	367.15	355.51	339.37	215.57	367.15	380.70
96.50	370.84	358.86	341.91	218.72	370.84	388.85
98.00	374.54	362.18	344.38	221.88	374.54	397.64
99.00	377.00	364.36	345.99	223.98	377.00	403.84
100.00	379.46	366.53	347.58	226.09	379.46	410.30

CRITICAL PROPERTIES

Cut Point (%)	Critical Temperature (C)	Critical Pressure (kPa)	Acentricity Factor	Molecular Weight	Liquid Density (kg/m3)
0.00	151.09	3811.40	0.2005	57.735	582.12

* Specified by user.

Streamcrude diesel (continued)

Boiling Point Curves: crude diesel (continued)

Cut Point (%)	Critical Temperature (C)	Critical Pressure (kPa)	Acentricity Factor	Molecular Weight	Liquid Density (kg/m3)
1.00	267.18	2734.53	0.3500	100.345	686.96
2.00	271.24	2681.23	0.3553	103.724	690.39
3.50	277.34	2605.06	0.3633	108.794	695.46
5.00	283.44	2533.10	0.3713	113.863	700.45
7.50	293.60	2421.62	0.3845	122.313	708.55
10.00	303.76	2319.53	0.3978	130.762	716.40
12.50	313.92	2225.70	0.4111	139.211	724.00
15.00	324.09	2139.17	0.4244	147.660	731.35
17.50	334.25	2059.11	0.4376	156.110	738.45
20.00	344.41	1984.83	0.4509	164.559	745.29
25.00	364.74	1851.27	0.4775	181.457	758.23
30.00	385.06	1734.55	0.5040	198.356	770.17
35.00	405.39	1631.67	0.5306	215.254	781.09
40.00	419.59	1583.33	0.5487	9316.917	789.81
45.00	421.77	1624.15	0.5502	36236.184	795.84
50.00	423.95	1667.13	0.5517	63155.451	801.87
55.00	426.14	1712.45	0.5532	90074.718	814.75
60.00	428.32	1760.30	0.5547	116993.985	820.65
65.00	430.50	1810.91	0.5562	143913.253	825.55
70.00	432.68	1864.51	0.5577	195447.009	829.44
75.00	434.87	1921.38	0.5592	199948.421	832.33
80.00	512.15	1521.89	0.6721	132136.153	867.22
85.00	523.23	1456.68	0.6901	86234.329	872.43
90.00	534.31	1396.82	0.7081	-31844.774	877.64
92.50	539.85	1368.70	0.7171	-72840.006	880.25
95.00	545.39	1341.69	0.7261	-113835.238	882.86
96.50	548.71	1325.99	0.7315	-138432.377	884.42
98.00	552.03	1310.65	0.7369	-163029.516	885.99
99.00	554.25	1300.62	0.7405	-179427.609	887.03
100.00	556.46	1290.75	0.7442	-195825.701	888.07

COLD PROPERTIES

True VP at 37.8 C	(kPa)	0.8463	Cetane Index		32.0269
Reid VP at 37.8 C	(kPa)	---	Research Octane Number		---
ASTM D93 Flash Point	(C)	39.0035	Viscosity at 37.8 C	(cP)	3.12213
ASTM D97 Pour Point	(C)	-4.7601	Viscosity at 97.8 C	(cP)	1.07225
Refractive Index		1.4949			

P:N:A

Paraffins [mol%]	30.2767	Naphthas [mol%]	29.6729	Aromatics [mol%]	40.0504

Stream: diesel

Boiling Point Curves: diesel

BOILING POINT CURVES

Basis	Stream
Liquid Volume	diesel

RESULTS

BP Curves Results

Cut Point (%)	TBP (C)	ASTM D86 (C)	D86 Crack Reduced (C)	ASTM D1160(Vac) (C)	ASTM D1160(Atm) (C)	ASTM D2887 (C)
0.00	77.11	113.14	113.14	4.70	108.08	66.26

* Specified by user.

Stream: diesel (continued)

Boiling Point Curves: diesel (continued)

BP Curves Results

Cut Point (%)	TBP (C)	ASTM D86 (C)	D86 Crack Reduced (C)	ASTM D1160(Vac) (C)	ASTM D1160(Atm) (C)	ASTM D2887 (C)
1.00	94.01	122.75	122.75	12.43	118.01	78.08
2.00	100.63	127.03	127.03	15.94	122.52	86.52
3.50	105.12	130.63	130.63	18.99	126.42	92.26
5.00	109.62	134.23	134.23	22.04	130.31	97.74
7.50	117.11	140.24	140.24	27.12	136.80	103.56
10.00	124.60	146.24	146.24	32.21	143.26	110.81
12.50	132.09	152.24	152.24	37.29	149.71	118.17
15.00	139.58	158.24	158.24	42.37	156.15	125.62
17.50	147.07	164.25	164.25	47.45	162.58	133.13
20.00	154.56	170.25	170.25	52.54	168.98	140.70
25.00	169.55	182.25	182.25	62.70	181.76	156.03
30.00	184.53	194.26	194.26	72.87	194.48	171.63
35.00	199.51	206.26	206.26	83.03	207.13	187.43
40.00	214.49	218.27	218.27	93.20	219.74	203.67
45.00	229.48	230.27	230.27	103.37	232.29	220.91
50.00	244.46	242.28	242.28	113.53	244.78	239.34
55.00	246.55	243.93	243.93	114.98	246.55	249.92
60.00	246.78	244.08	244.08	115.17	246.78	251.35
65.00	247.01	244.23	244.23	115.35	247.01	251.98
70.00	247.24	244.39	244.39	115.54	247.24	252.19
75.00	247.47	244.54	244.54	115.73	247.47	253.09
80.00	247.70	244.70	244.70	115.92	247.70	254.66
85.00	247.93	244.85	244.85	116.11	247.93	256.44
90.00	248.16	245.00	245.00	116.29	248.16	258.04
92.50	248.28	245.08	245.08	116.39	248.28	259.77
95.00	248.39	245.16	245.16	116.48	248.39	262.01
96.50	248.46	245.20	245.20	116.54	248.46	263.59
98.00	248.53	245.25	245.25	116.60	248.53	265.40
99.00	248.58	245.28	245.28	116.63	248.58	266.76
100.00	248.62	245.31	245.31	116.67	248.62	268.26

CRITICAL PROPERTIES

Cut Point (%)	Critical Temperature (C)	Critical Pressure (kPa)	Acentricity Factor	Molecular Weight	Liquid Density (kg/m3)
0.00	151.09	3811.40	0.2005	57.735	582.12
1.00	257.59	2816.79	0.3355	96.108	679.76
2.00	269.26	2706.91	0.3527	102.080	688.72
3.50	273.88	2647.77	0.3588	105.916	692.59
5.00	278.49	2591.16	0.3648	109.752	696.41
7.50	286.18	2502.00	0.3748	116.145	702.66
10.00	293.87	2418.77	0.3849	122.538	708.76
12.50	301.56	2340.91	0.3949	128.932	714.72
15.00	309.25	2267.90	0.4050	135.325	720.54
17.50	316.94	2199.30	0.4150	141.718	726.21
20.00	324.63	2134.74	0.4251	148.111	731.73
25.00	340.01	2016.35	0.4452	160.898	742.36
30.00	355.39	1910.40	0.4653	173.685	752.41
35.00	370.77	1815.03	0.4854	186.471	761.88
40.00	386.15	1728.73	0.5054	199.258	770.77
45.00	401.53	1650.26	0.5255	212.045	779.10
50.00	416.91	1578.61	0.5456	224.831	786.84
55.00	420.29	1596.30	0.5492	18023.099	791.76

Stream: diesel (continued)

Boiling Point Curves: diesel (continued)

Cut Point (%)	Critical Temperature (C)	Critical Pressure (kPa)	Acentricity Factor	Molecular Weight	Liquid Density (kg/m3)
60.00	421.94	1627.51	0.5503	38392.221	796.33
65.00	423.60	1659.96	0.5514	58761.343	800.89
70.00	425.25	1693.73	0.5526	79130.465	812.07
75.00	426.90	1728.91	0.5537	99499.587	816.93
80.00	428.55	1765.57	0.5548	119868.709	821.23
85.00	430.20	1803.83	0.5560	140237.831	824.94
90.00	431.85	1843.78	0.5571	160606.952	828.08
92.50	432.68	1864.42	0.5577	195570.928	829.44
95.00	433.51	1885.54	0.5582	198078.962	830.65
96.50	434.00	1898.44	0.5586	199088.506	831.30
98.00	434.50	1911.51	0.5589	199726.593	831.91
99.00	434.83	1920.33	0.5592	199945.619	832.29
100.00	531.00	1414.20	0.7027	-7329.492	876.09

COLD PROPERTIES

True VP at 37.8 C	(kPa)	1.0577	Cetane Index		31.8152
Reid VP at 37.8 C	(kPa)	—	Research Octane Number		—
ASTM D93 Flash Point	(C)	32.6006	Viscosity at 37.8 C	(cP)	2.10911
ASTM D97 Pour Point	(C)	-10.9417	Viscosity at 97.8 C	(cP)	0.80691
Refractive Index		1.4944			

P:N:A

Paraffins [mol%]	26.5842	Naphthas [mol%]	30.3978	Aromatics [mol%]	43.0181

Vessel Sizing: melter

Vertical Seperator Properties: melter

L/D Ratio		5.000 *	Demister to Top	(m)	0.3048 *
Liq. Res. Time	(seconds)	1.035e+005 *	Tot. Length - Height	(m)	1.676 *

Construction Information

Chem Eng Fab Index		252.5	Allowable Stress	(kPa)	9.446e+004
Material Type		Carbon Steel	Shell Thickness	(mm)	6.350
Mass Density	(kg/m3)	7861	Corrosion Thickness	(mm)	3.175
FMC		1.000	Joint Efficiency		1.000

Costing Coefficients

Shell Thick		Shell Mass		Base Cost		Accessories	
A1:	0.4000 *	A4:	0.8116 *	A5:	8.600 *	A8:	1017 *
A2:	2.000 *			A6:	-0.2165 *	A9:	0.7396 *
A3:	0.2000 *			A7:	4.580e-002 *	A10:	0.7068 *

Costing Results

Base Cost ($US)	5205	Associated Cost ($US)	608.5	Total Cost (FOB $US)	5814

Sizing Results

Diameter	(m)	0.3048	Liquid Residence Time	(seconds)	1.035e+005
Total Length	(m)	1.676	Liquid Surge Height	(m)	0.4572
L/D Ratio		5.000	LLSD	(m)	0.4572
Max. Allowable Vapour Velocity	(m/s)	—	Liquid Res. Time at LLSD	(seconds)	1.035e+005
Demister Thickness	(mm)	0.0000			

Vapour Space

Vessel Sizing: melter (continued)

Sump To Inlet Nozzle	(m)	0.3048	Demister To Head	(m)	0.3048
Inlet Nozzle to Demister	(m)	0.5334	Ellipsoidal Head	(m)	7.620e-002
Demister Thickness	(mm)	0.0000	Total Vapour Height	(m)	1.219