

SEPTEMBER 2018

M.Sc. in Mechanical Engineering

MOHANNAD CHAAR

**UNIVERSITY OF GAZİANTEP
GRADUATE SCHOOL OF
NATURAL & APPLIED SCIENCES**

**A SIMULATION STUDY ON ECONOMIC FEASIBILITY OF CONVERTING
TURKISH COAL TO LIQUID FUELS**

**M. Sc. THESIS
IN
MECHANICAL ENGINEERING**

**BY
MOHANNAD CHAAR
SEPTEMBER 2018**

**A SIMULATION STUDY ON ECONOMIC FEASIBILITY OF CONVERTING TURKISH
COAL TO LIQUID FUELS**

M.Sc. Thesis

In

Mechanical Engineering

University of Gaziantep

Supervisor

Prof.Dr. Mehmet.Sait SÖYLEMEZ

By

Mohannad CHAAR

September 2018



© 2018 [Mohannad CHAAR].

REPUBLIC OF TURKEY
UNIVERSITY OF GAZİANTEP
GRADUATE SCHOOL OF NATURAL & APPLIED SCIENCES
MECHANICAL ENGINEERING DEPARTMENT

Name of the thesis: A SIMULATION STUDY ON ECONOMIC FEASIBILITY OF
CONVERTING TURKISH COAL TO LIQUID FUELS

Name of the student: Mohannad CHAAR

Exam date:

Approval of the Graduate School of Natural and Applied Sciences

(Title and Name)

Director

I certify that this thesis satisfies all the requirements as a thesis for the degree of Master of
Science.

(Title and Name)

Head of Department

This is to certify that we have read this thesis and that in our consensus/majority opinion it is
fully adequate, in scope and quality, as a thesis for the degree of Master of Science.

Prof. Dr. M.SAİT SÖYLEMEZ

Supervisor

Examining Committee Members

Signature

Prof. Dr. M.SAİT SÖYLEMEZ

.....

Prof. Dr. RECEP YUMRUTAŞ

.....

Asst. Prof. Dr. İBRAHİM H. YILMAZ

.....

Declaration

I hereby declare that all information in this document has been obtained and presented in accordance with academic rules and ethical conduct. I also declare that, as required by these rules and conduct, I have fully cited and referenced all material and results that are not original to this work.

Mohannad CHAAR

Signature

ABSTRACT

A SIMULATION STUDY ON ECONOMIC FEASIBILITY OF CONVERTING TURKISH COAL TO LIQUID FUELS

CHAAR, MOHANNAD
M.Sc. in Mechanical Eng.
Supervisor: Prof. Dr. M. Sait SÖYLEMEZ
September 2018
210 pages

In this thesis, it is aimed to simulate the conversion of gasoline and diesel from Turkish coal using the ASPEN PLUS computer software and a comparison between converting Turkish coal to liquid fuel using the typical method and using the solar power had been done. The plant data is imported from a study done in Australia on a solar hybridized coal to liquid plant that has a production capacity of 1500 bbl/day. This thesis focuses on one of the richest in carbon coal in Turkey (Çatalağzı) through two different cases. The first case has processed the coal in a typical coal to liquid plant and the second case has the solar combined system as an improvement to the plant. This thesis used Çatalağzı coal proximate and ultimate analysis as an input data for both cases. The proposed coal to liquid plant has produced 1440 bbl/day of Fischer-Tropsch liquids with annual cost of \$82 million while solar coal to liquid plant has produced 1502 bbl/day of FT liquids with annual cost of \$80 million. The solar coal to liquid plant provided a reduction by 22% of coal feed rate. By comparing output data for both of the cases a 48% increase in total gain can be achieved by applying solar hybridized coal to liquid plant

Key Words: Coal to Liquid, Solar Energy, Solar gasifier, Indirect Coal Liquefaction, Economic Feasibility.

ÖZET

TÜRK KÖMÜRÜNÜ SIVI YAKITLARA DÖNÜŞTÜRÜLEN EKONOMİK FİZİBİLİTESİ ÜZERİNE BİR SİMÜLASYON ÇALIŞMASI

CHAAR, MOHANNAD
Yüksek Lisans Tezi, Makina Müh.
Tez Yöneticisi: Prof. Dr. M.Sait SÖYLEMEZ
Eylül 2018
210 sayfa

Bu tez kapsamında Türkiye’de üretilen kömürün benzin ve motorine dönüştürülmesi konusu teknik olarak ASPEN PLUS bilgisayar programı ile incelenmiş ve bilinen mevcutdönüş sistemi güneş enerjisi takviyeli olarak ayrıca çalışılmıştır. Avustralya’da mevcut çalışmadan daha önce yapılan bilgiler kullanılmış olup günlük kapasite 1500 varil olarak seçilmiştir. Özellikle Çatalağzı bölgesinde üretilen yüksek karbonlu kömür üzerine yoğunlaştırılmış ve bu bölgenin kömür analizleri kullanılmıştır. Çalışılan sistemde günlük 1440 varil kapasiteye yıllık 82 milyon dolar maliyetle veya güneş enerjisi destekli sistem kullanarak günlük 1502 varil kapasiteyle yıllık 80 milyon dolar ile üretim yapılabilir. Güneş enerjisi sistemi yakıt masrafından 22% tasarruf sağlayabilmektedir ve ayrıca toplam kazançta 48% arasında artış sağlanabilmektedir.

Anahtar Kelimeler: Kömür sıvılaştırması, Güneş Enerjisi, Güneş Gazlaştırıcısı,İndirekt Sıvılaştırma, Ekonomik Fizibilitesi.

Dedication

This Thesis is dedicated to my beloved wife who has provided the moral and emotional support to me to finish this work and to my little angel my daughter, to my parents who have always been a source of inspiration and encouragement to undertake my higher studies, to my family members to my sister and my brother, to all faithful friends, to my country Syria with all the warm wishes of peace and to my second country Turkey.

ACKNOWLEDGEMENTS

The author wishes to express his deepest gratitude to his supervisor Prof. Dr. M.SAİT SÖYLEMEZ for his guidance, advice, criticism, encouragements and insight throughout the research.

The author would also like to thank Prof. Dr. RECEP YUMRUTAŞ for his suggestions and comments.

TABLE OF CONTENTS

ABSTRACT.....	v
ÖZET	vi
TABLE OF CONTENTS	ix
LIST OF TABLES	xi
LIST OF FIGURES	xii
LIST OF SYMBOLS/ABREVIATIONS.....	xiii
CHAPTER 1	1
INTRODUCTION	1
1.1 Coal History:.....	1
1.2 Coal Ranks:	2
1.3 Coal Use in Production of Energy Today:	3
1.4 Fischer-Tropsch Process	4
1.5 The Fischer-Tropsch Schematic:	5
1.6 Industrial Technology of Coal to Liquid Process	6
1.7 Environmental obligation.....	7
1.8 Coal in Turkey:	8
1.8.1 Hard coal (Anthracite)	10
1.8.2 Lignite	10
1.9 Direct & Indirect Coal Liquefaction	11
1.10 Solar Coal to Liquid Technology:.....	12
CHAPTER 2	14
PROBLEM STATEMENT	14
2.1 Introduction.....	14
2.2 Case 1: CTL Plant Input Data	15
2.3 Case 2: SCTL plant Input Data	16
2.4 Cost Estimation Approach	18

CHAPTER 3.....	19
METHODOLOGY	19
3.1 Cryogenic Air Separation Unit	19
3.2 Gasification Unit.....	20
3.2.1 Main Reactions & Reactions kinetics:	20
3.2.2 Coal Decomposition.....	20
3.2.3 Volatile Reactions	21
3.2.4 Char Gasification	21
3.3 CO ₂ & H ₂ S Absorber.....	21
3.4 Fischer Tropsch Reactor	22
3.5 Solar Hybridized system	25
3.6 CTL & SCTL Cost Calculations.....	28
CHAPTER 4.....	29
RESULTS AND VALIDATION.....	29
4.1 CTL and SCTL Plant Simulation Results	29
4.2 Cost Comparison.....	30
4.3 Validation of Simulation Results	31
CHAPTER 5.....	32
CONCLUSION AND DISCUSSION	32
5.1 Conclusion and Discussion	32
REFERENCES	33
APPENDIX.....	35
ASPEN PLUS PROGRAM LISTING	35

LIST OF TABLES

	Page
Table 2.1. Proximate and ultimate analysis of Çatalağzı coal used in the present study	14
Table 2.2 CTL Plant Input Data.	16
Table 2.4 a: Cost Estimation Data	18
Table 2.4 b: Economic assumptions for the CTL and SCTL plants	18
Table 3.2.1: Heats of gasifier reactions	20
Table 3.6 a: CTL Plant Cost Calculations	28
Table 3.6 a: SCTL Plant Cost Calculations	28
Table 4.3 CTL Plant Input Data	31

LIST OF FIGURES

	Page
Figure 1.2 : Coal Types	3
Figure1.4: FT Reactor	5
Figure 1.5: Simple Schematic of FT Coal to Liquid Plant	6
Figure 1.6 : An Overview of Fischer-Tropsch Process	7
Figure 1.8: Coal Distribution in Turkey	8
Figure 1.9: Indirect Coal Liquefaction Scheme	11
Figure 1.10: Solar Hybrid Coal Power Plant Scheme	13
Figure 2.2 Scheme of basic processes for CTL integrated with FT liquids plant	15
Figure 2.3 Scheme of basic processes for SCTL integrated with FT liquids plant.	17
Figure 3.4: Fischer-Tropsch Liquids Compounds Distribution	23
Figure 4.1: Simulation Results for CTL & SCTL Plants	29
Figure 4.2: Total Cost drop & Total Plant income rise between CTL & SCTL	30

LIST OF SYMBOLS/ABBREVIATIONS

CTL	Coal to Liquid
DCL	Direct Coal to Liquid
DSSN	dry small steam nuts
EIA	Energy Information Administration
EU	European Union
EÜAŞ	Electricity Generation Company
FT	Fischer-Tropsch
GDP	Gross Domestic Product
GHG	Greenhouse Gas Emissions
ICL	Indirect Coal to Liquid
IGCC	Integrated Gasification Combine
MEA	Monoethanolamides
MENR	the Ministry of Energy and Natural Resources
M&O	Maintenance and Operational
MTG	Methanol to Gasoline
PD	Parabolic Dish
SCTL	Solar Coal to Liquid
SNG	substitute natural gas
SRC	Solvent Refined Coal
ST	Solar Tower
TKİ	Turkish Coal Enterprises
TL	Turkish Lira
TTK	Turkish Hard Coal Enterprises
TÜBİTAK	the Turkish Scientific and Technical Research Council
USD	United State Dollar
WGS	Water-Gas Shift

CHAPTER 1

INTRODUCTION

1.1 Coal History:

Coal is the remains of dead plants that have been buried in the depths of the earth, buried deep, in great depths, and in an oxygen-free environment millions of years ago, to become a black or brown matter, as a result of the massive concentration of carbon in them, in addition to other elements such as hydrogen, sulfur, oxygen, nitrogen, and many other elements. Coal is found in the earth in the form of layers or veins. It is a flammable substance, and when burned, it gives thermal energy.

Before the discovery of oil, coal was the only source of energy in the world, until the industrial revolution occurred, and the demand for energy increased. After oil was discovered, it took the place of coal because of the problems and difficulties associated with coal extraction and the pollution caused.

The origin of coal is of organic origins and marine life died and buried in the ground, and because of pressure and temperature decreased the proportion of oxygen, and increased the proportion of carbon dioxide, it got harder, access to layers of coal need to drill in deep depths, which is dangerous to mineworker's lives.

Coal is a source of energy, used for heating, and was used extensively in the era when the steam engine was invented as a fuel for trains that were an important transport at the time. It is also a major source of power generation in today's power plants. In contrast coal has also disadvantages whereas, pollutants are responsible for lung cancer, leukemia, immunodeficiency, all respiratory diseases, fetal deformities, and diseases of the nervous system. Coal mining is dangerous at all stages of treatment when extracted. While transporting and storing it. The burning of coal leads

to an increase in the percentage of greenhouse emission in the atmosphere, which increases the temperature of the Earth dramatically, it is the most energy source of any of these gases when burned, and the emission of toxic mercury in the atmosphere makes them enter mainly in the food chain of humans [1].

1.2 Coal Ranks:

Mainly there are four types of coal, this classification depends on the degree of conversion exposed to the known plant residues, and each type of coal is called a special name as follows:

- Lignite Coal

This type contains a high percentage of volatiles, has a high percentage of moisture, and in general its heat value is low. Logically, its price is cheap.

- Sub-Bituminous coal

This type of coal contains an average amount of fixed carbon, up to about 40% of its weight, and contains an average amount of moisture, which may reach up to about 25% of the total weight, and represents an advanced stage in the process of carbonization of plant residues, Therefore, the ratio of the fixed carbon increases significantly. Sometimes it may reach about 70% of the total weight, while the humidity is less than previous lower ranking Lignite, and not more than 15% in usual.

- Bituminous coal

The bituminous coal ignites with a yellow smoky flame, is accompanied by a rise of bad smell, because it contains a small percentage of sulfur, which oxidizes when burned, and turns into sulfur dioxide gas, which causes bad smell and pollution to the air and surrounding environment.

- Anthracite coal

The anthracite coal is one of the highest and finest types of coal in the world, with a very high degree of carbonization, where the percentage of fixed carbon is about 90% or more, accordingly

the humidity is reduced to a large range, while it is less than 5% of the total weight, and it means approximately complete carbonization.

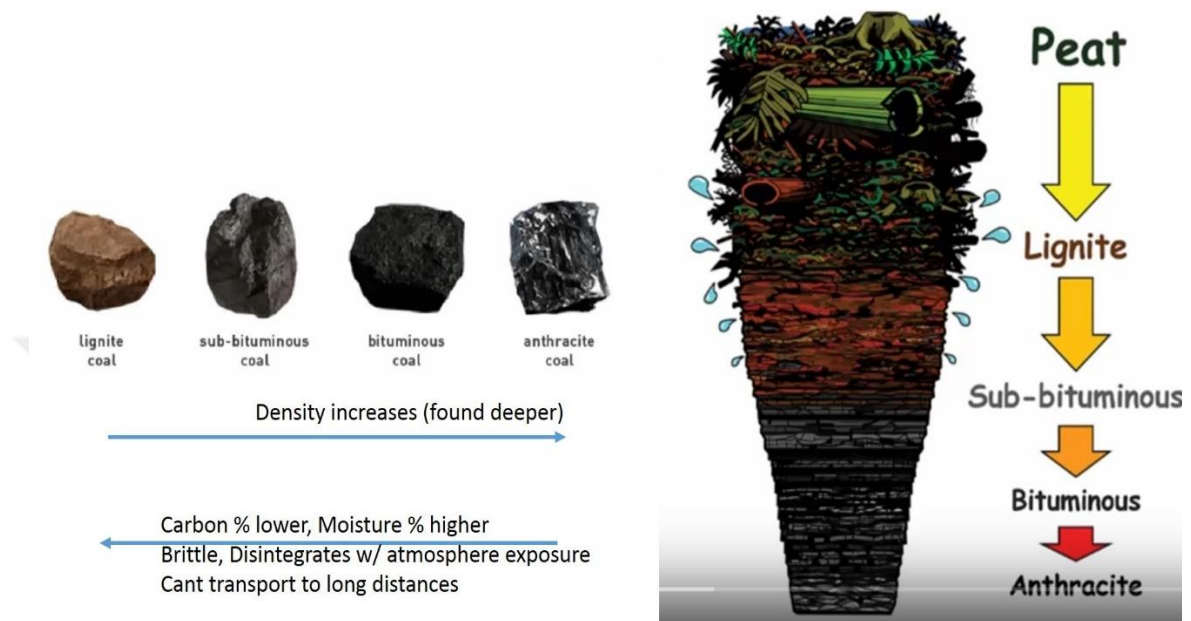


Figure 1.2 : Coal Types[2]

1.3 Coal Use in Production of Energy Today:

- **Coal as fuel**, the main purpose of using coal is to produce electricity and heat through combustion of a solid fuel. According to the EIA (Energy Information Administration), the consumption of coal in the world is planned to be increased in the next few decades. However, The general perspective of the world now is to decrease coal which makes some regions head to use natural gas instead.[3]
- **Natural gas as an alternative**, a lot of countries have started using natural gas instead of coal and it became an essential fuel for electricity producing power plants to reach about half of the power produced by coal-fired power plants worldwide, in addition, it is widely used for heating and as vehicles fuel.[4]
- **Gasification**, this process aims to convert hard coal into a mixture of gases called syngas, which consists of Hydrogen and Carbon monoxide. Then these gases can be used to produce electricity by burning it in gas turbines. Another use of syngas is known as liquefaction, converting syngas to real liquid fuels such as Diesel & gasoline, the process

mainly can be based on two different method of processing. The first one is Fischer-Tropsch process that this thesis will be focusing on. The second method is to convert syngas to methanol to use it later in the well-known methanol to gasoline process.

The hydrogen that comes from such process could be used for many things such as Hydrogen economy powering, as an alternative solution to upgrade fossil fuels or to make ammonia.

The transaction of coal can be achieved by burning coal in a reactor called gasifier, which has specific conditions of temperature, pressure and flow, wild range of output gases results from the reactions such as carbon monoxide, carbon dioxide, methane, hydrogen, nitrogen, hydrogen sulfide and other various secondary products depending on utilized coal type.

- **Liquefaction**, coal can be converted into different kinds of fuels like diesel and gasoline by two main methods direct & indirect coal liquefaction. Direct coal liquefaction uses multiple ways such as carbonization, pyrolysis and hydrogenation. The Second method is based on one of the most common chemical processes called Fischer-Tropsch process (which is the main case thesis). The process was first used by Germans in Second World War 1925 when the need of liquid fuels was massive to provide fuel for vehicle and tanks. Two of German scientists Franz Fischer and Hans Tropsch at that time developed this process and it was then attributed to them. Then more studies and technologies were done in this field to become nowadays the focus of many countries that have huge coal reserves such as USA, South Africa and China[5].

1.4 Fischer-Tropsch Process

Fischer-Tropsch process is the key process in coal to liquid plants; it is a complex process that the transaction of syngas to liquid occurs in with the existence of metal catalyst, which can be iron or cobalt. However, the catalyst type depends in the multiple factors like temperature, H_2 /CO ratio and the needed output liquids.

For high H_2 / CO ratios, about 2.2, iron based Fischer Tropsch reactor is used and the main reaction occurring is the reaction of carbon monoxide + hydrogen to form water and hydrocarbons.

Whereas, in cobalt another reaction happens easily, the water gas shift reactor that causes the conversion of carbon monoxide and water to hydrogen and carbon dioxide. This will change the ratio. There are two operating temperatures in FT reactors, low FT temperature around $220\text{ }^{\circ}\text{C}$ is used with iron or cobalt based reactors to produce waxes while high temperature FT reactor around $330\text{ }^{\circ}\text{C}$ is being used with only iron catalyst to produce olefins and gasoline.

Fischer Tropsch reactions produce huge amounts of heat that in case of the reactor was not cooled properly will result in deactivation of the catalyst in addition to decreasing liquids outputs, as methane gas will start being formed increasingly. To avoid this and maintain a sufficient amount of heat released from the gasifier tiny tubes with high velocity of gas flow is used. Fig. 1.4 shows two types of FT reactors[6].

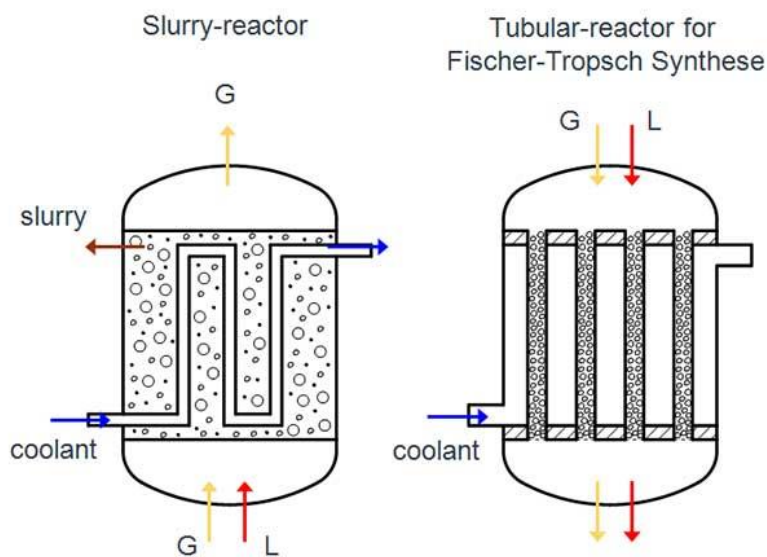


Figure1.4: FT Reactor

1.5 The Fischer-Tropsch Schematic:

Simple schematic of coal to liquid plant is shown in Figure 1.5. The process starts with the coal gasification, that coal is treated with steam and oxygen at high temperatures around $1250\text{ }^{\circ}\text{C}$ and high pressures between 30-40 bar is needed to create a hydrogen mixture, carbon dioxide and carbon monoxide. A gas consists mainly of the first two of these constituents which is called

synthesis gas. Then synthesis gas is given to FT reactor, and there, syngas is converted to hydrocarbons. This combination usually consists of hydrocarbon gases, such as propane and methane gas; we can find hydrocarbons in gasoline, diesel, and jet fuel; and waxes. However, refinery work will be still needed to treat FT reactor's products and convert them to liquid vehicles fuels.

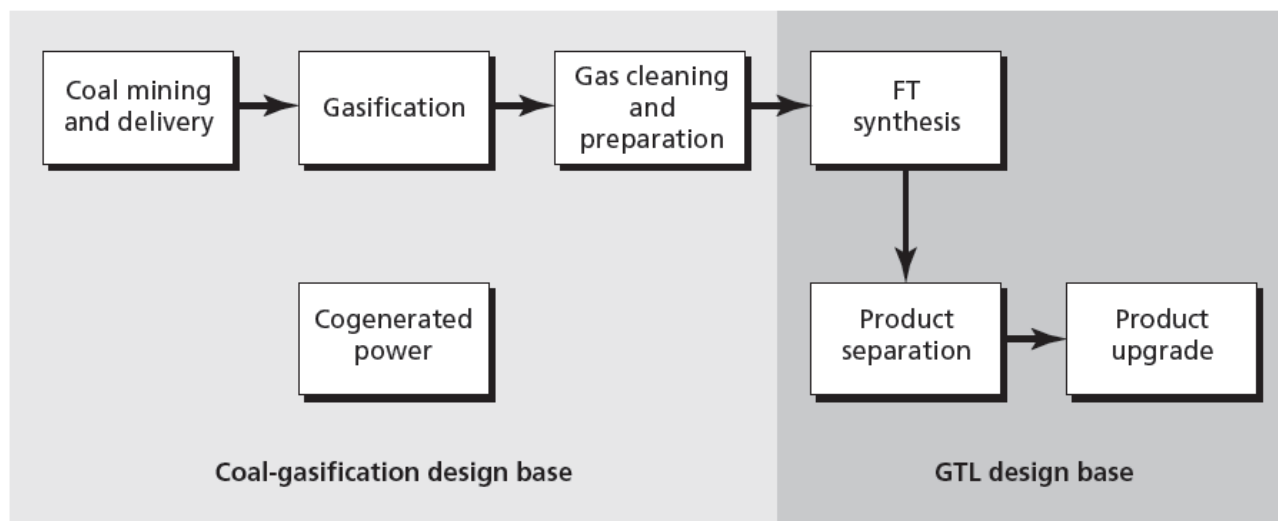


Figure 1.5 : Simple Schematic of FT Coal to Liquid Plant.[7]

1.6 Industrial Technology of Coal to Liquid Process

Dried coal is sent to a gasifier for gasification. In the gasifier, the carbon contained in the coal reacts with water vapor and oxygen to form mostly carbon monoxide and hydrogen. Then the raw gas is sent into a heat exchanger. In exchanger, raw gas is cooled by counter floating cold water and at the same time steam is generated from water. After that, the raw gas is sent into a deduster, which removes ash particle through a deduster and passes the raw gas to water gas shift reactor. The reactor is employed to adjust the hydrogen and carbon mono oxide ratio. In a reactor vapor water and carbon mono oxide react to form carbon dioxide and hydrogen. The raw gas is then sent into scrubber, which removes Sulphur, and releases a pure gas called syngas. The syngas is then send to Fisher- Tropsch reactor, which catalytically converts carbon mono oxide and hydrogen into long paraffin's chains. It is the main chamber of liquid processing. After this

the mixture of hydrocarbon and water is separated and liquid hydrocarbon is sent to hydrocracker that produces short chains paraffin such as diesel and gasoline, finally syncrude is stored[8].

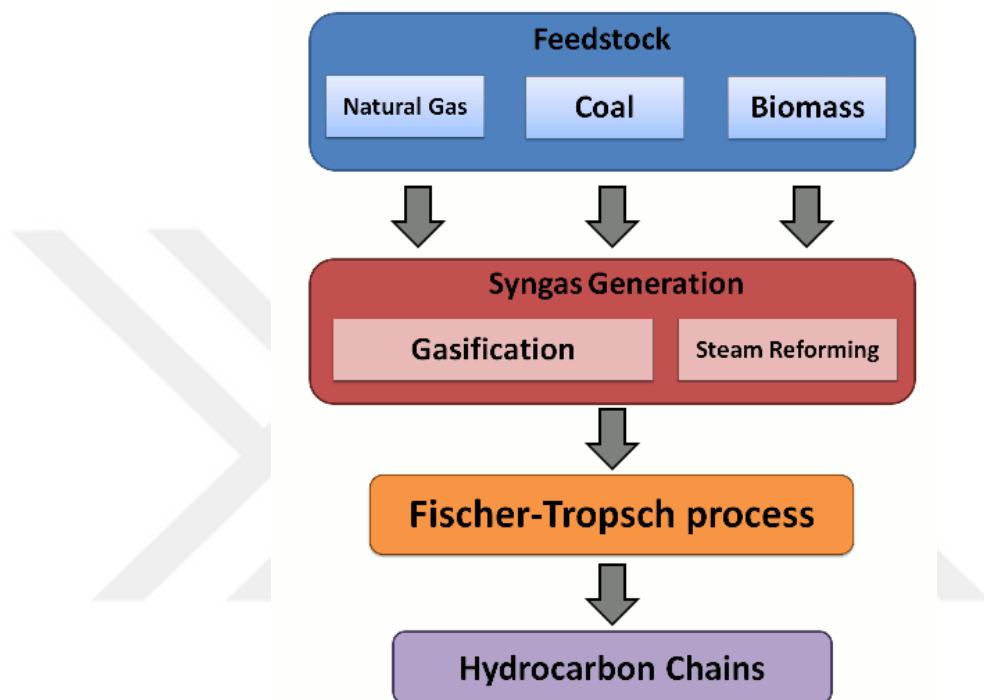


Figure 1.6 : An Overview of Ficsher-Tropsch Process[9].

1.7 Environmental obligation

The coal liquefaction process is associated with carbon dioxide emission which results in the process of gasification or heat and electricity generation. Another environmental impact is high level of the consumption of water in water gas shift and reforming of methane steam. The liquid coal can be cleaner than nature occurring crude as hetero atom compounds are removed from final products.

Carbonisation which occurs through parolysis, produces polycyclic aromatic hydrocarbon which is also called carcinogen. There is also possibility in comparison to global warming, necessarily if liquefaction coal is consumed without capturing carbon and store technologies.

The fuel produced by coal liquefaction is Sulphur free, which is good for environment; on further processing, it is converted into electricity or other energy resources. the inorganic residue obtained in liquefaction process can be used as an aggregate for fertilizer, building construction materials, tires of motor vehicles, landfills material, etc.[8].

1.8 Coal in Turkey:

Turkey has a high GDP growth in 2015 was about 7.3% and in the period from 2000 to 2015, the averaged GDP was 5.5%. It has many lignite coalmines locations and one location of hard coal mines in Zonguldak. Figure 1.8 show coal spread areas over the country.

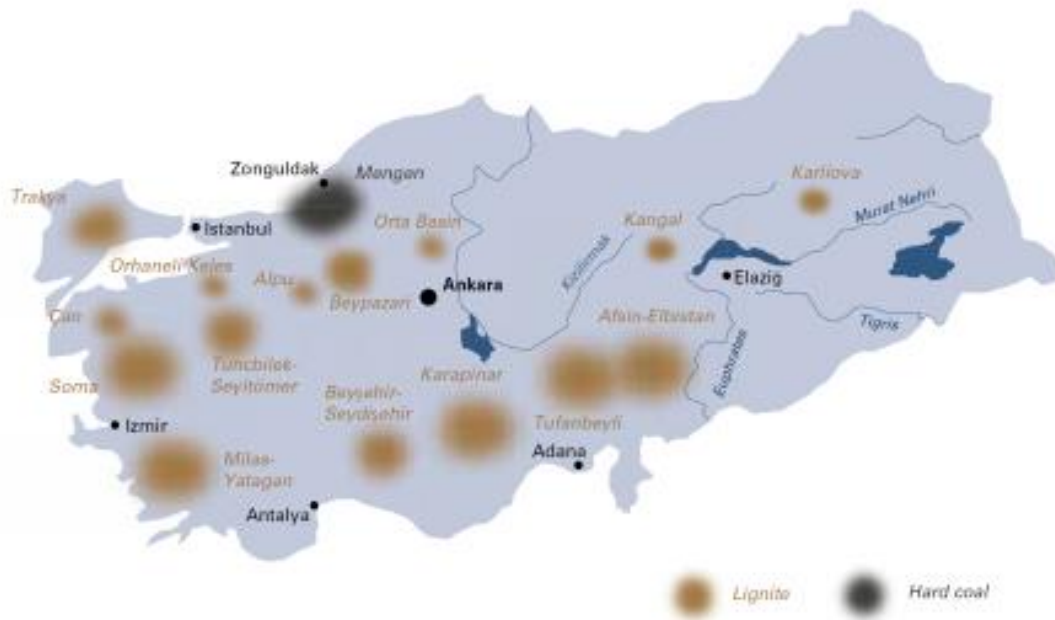


Figure 1.8: Coal Distribution in Turkey

The major energy supply in 2015 was 185 Mtce. Turkey still has comparatively low per person energy use at 1.7 tons of oil equivalent (in comparison with Europe it is 3.2 tons), according to the growing economy of Turkey, it is expected that the energy demand will grow quickly.

Most of Turkey's domestic internal resources of energy depend on lignite and small quantities of black hard coal. Lignite and coal met 27 % of Turkey's total primary energy supply with coal imports together. At 30 %, while the highest share in the energy mix goes for natural gas, which is 99%, imported. Oil is counted to be 30% of energy supply in 2015, 89% imported. In total, Turkey's import dependency was 80% in 2015[10].

The country has a huge coal resource in comparison to the difference to its small gas and oil resources. In 2015, 1.5 million tons of hard coal and 42 million tons of lignite was extracted by The Turkish coal sector, all these amounts consist only 42% of total primary energy production which most of it was used for the purpose of generating power. Since 2005, coal imports have increased massively and reached doubled amount of 31.5 million tons in 2015, which was mostly used for generating power[10].

Overall, the installed capacity of Turkish coal-fired power plants was about 15200 MW at the end of 2015, which is 20.6% of total capacity. The installed hard coal-fired power plant capacity was 6 500 MW (8.8%) while power plants which uses domestic lignite was 8 700 MW (11.8%) as an installed capacity. Turkey has begun a pretentious program to build new power plants, some with the most recent technology of supercritical and circulating fluidized bed boiler to burn mainly lignite and imported coal.

In addition to other power plants are still in constructing process, the program is considered as the largest construction program in the world outside China and India. Another 7000 MW of coal-fired power plants are under construction, this being the largest such construction programme outside China and India. In 2015 alone, the Turkish government approved the construction of three new coal-fired power plants that will increase capacity by 2480 MW: in Çanakkale, İskenderun and Adana provinces. In 2016, another MW power plant had been given an approval to start the construction, in total about 3600 MW capacity increase will be reached[10].

In 2015, 28% of generated electricity power was from only coal. More than 38% was provided by natural gas and about 26% was supplied by hydropower. However, the remaining amount went to other energy sources such as solar, wind, waste...etc.

1.8.1 Hard coal (Anthracite)

The biggest hard coal reserves in Turkey are in the location of Zonguldak. It has about 1.3 billion tons. The heat value of hard coal is around 28450 kJ/kg. Because of the complex geological structure in Zonguldak the mechanized coal production can be impossible to be applied thus labor-intensive coal production methods are required.

The Turkish Hard Coal Enterprises (TTK) whose ownership is by the state has in fact a monopolist role in extracting, processing and hard coal distribution, even though the state is not applying any restrictions on the involvement of private sector. This company's operation areas are taken place in five locations in Zonguldak coal basin and in 2015 could produce more than 1.5 million tons of coal.

Coal imports to Turkey are expected to continue to grow significantly in the next few years. At Şırnak province exactly in the city of Silopi near the Iraqi border, Ciner Group's has got the commission of the third 400 MW plant in 2015 by Chinese company.[10]

1.8.2 Lignite

Lignite is one of the most important domestic energy resource in Turkey, with a certain reserves of 15.6 billion tons. Deposits are distributed over the country parts; the largest reserves Afşin-Elbistan lignite basin in south-eastern Anatolia is located near the city of Maraş with an estimated reserve of about 7 billion tons. The second-largest lignite mining area is The Soma basin. Other exploited deposits are located in Kütahya, Çanakkale, Bursa and Konya provinces in different facilities. Turkish lignite has a very poor quality in general and small amount of existing reserves have a heating value of more than 12 500 kJ/kg. However, in 2005 Turkey initiated a project to explore new mines and by 2015, could prove reserves of about 7 billion tons.[10]

1.9 Direct & Indirect Coal Liquefaction

Present concerns in liquid fuels converted from coal are mostly based on gasification process and there are two types of coal liquefaction: indirect liquefaction and direct liquefaction. Indirect method uses Fischer-Tropsch (FT) liquefaction, which is the key process in this study.

While in direct liquefaction, coal is converted directly to hydrocarbons at high temperatures about 400 °C.

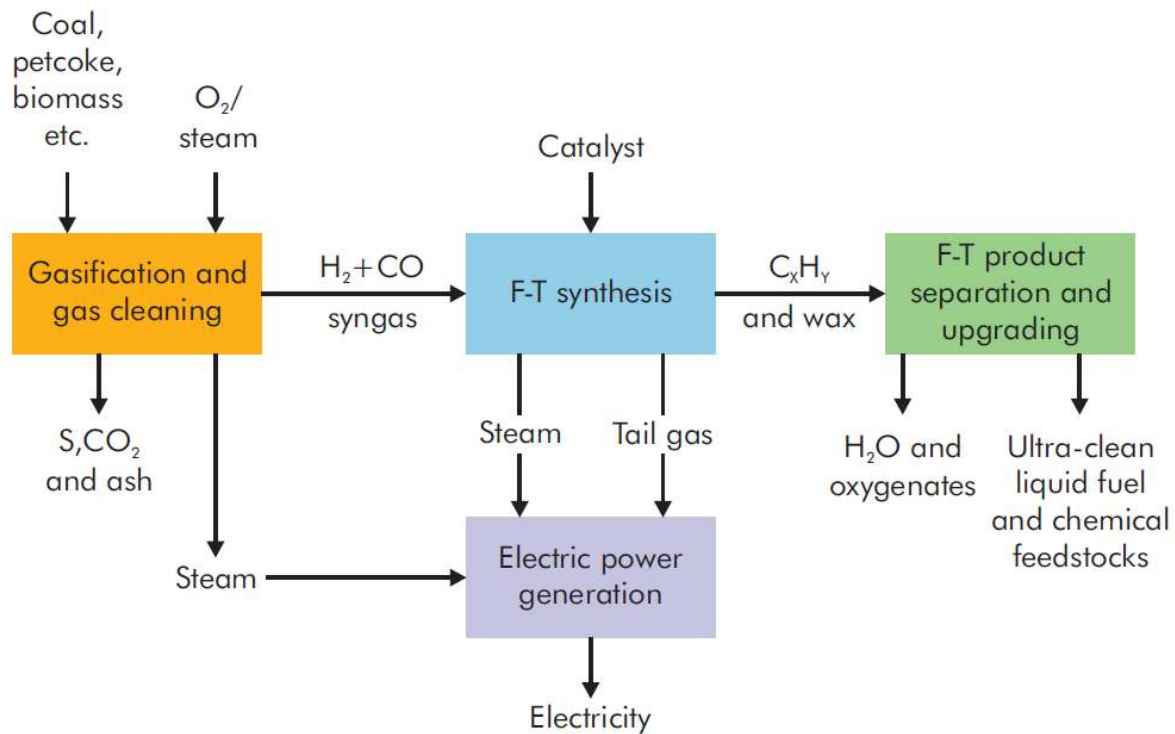


Figure 1.9: Indirect Coal Liquefaction Scheme[11]

The U.S. government made very large investments over the 1970s and 1980s in the direct liquefaction development, but it has not been used effectively. However, China is building a huge direct coal to liquid plant.[12], this study used direct coal liquefaction because of the following advantages of ICL method:

- In case of production efficiencies, both methods have the same efficiency.
- Indirect method has less greenhouse gases GHG emissions

- Studies, researches and developments had been done more on indirect than direct liquefaction.[7]

1.10 Solar Coal to Liquid Technology:

The technology uses solar power in gasifiers to drive extremely endothermic gasification reactions by exploiting solar energy for the conversion of coal feedstocks syngas. Currently, there are several types of solar gasifier reactors such as, fluidized bed, vortex flow and packed bed gasifier.

The solar hybridized coal-to-liquids plants (SCTL) were found to enhance the productivity of Fischer-Tropsch liquids by reducing input coal feed rate in comparison to normal CTL plant.

Geographically, as Turkey has a large coal deposits with a comparatively cheap coal feedstocks and extensive solar resource. Moreover, by producing liquid fuels more commercial benefit can be reached than selling electricity. Therefore, there is an acceptable feasibility of using solar power to increase fuel productivity even though this will make the plant to cost more.[13]

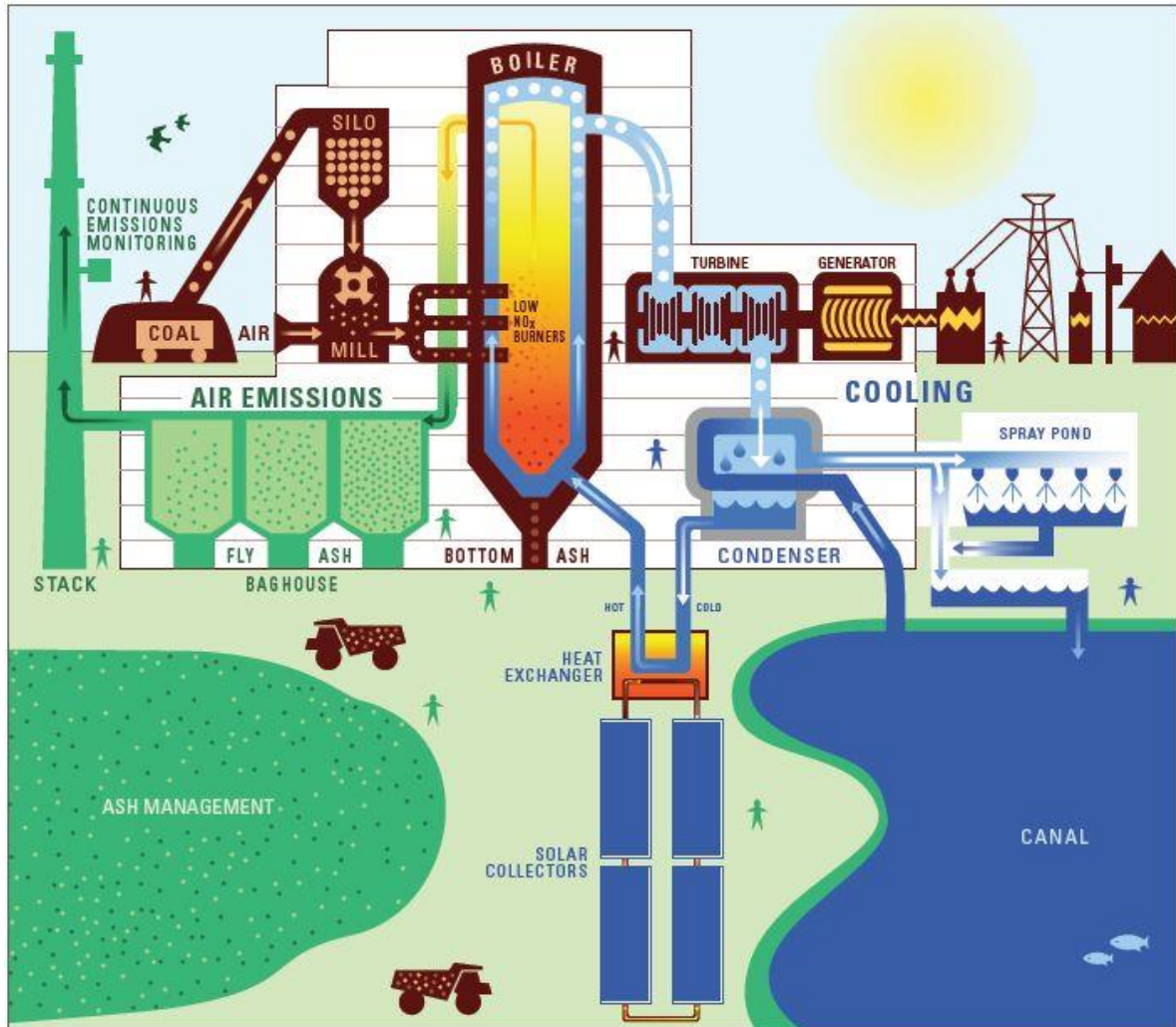


Figure 1.10: Solar Hybrid Coal Power Plant Scheme

CHAPTER 2

PROBLEM STATEMENT

2.1 Introduction

The aim of this thesis is to do a comparison between converting Turkish coal to liquid fuel using the typical method and using the solar power. The plant data is imported from similar study that has a production capacity of 1500 bbl/day. A model had been done using ASPEN PLUS software for chemical processing.

In this thesis, the simulation is based on one of the richest in carbon coal in Turkey (Çatalağzı) through two different cases.

Çatalağzı coal proximate and ultimate analysis (Table 2.1) is used as an input data for both cases while the amount of Fischer-Tropsch liquids produced per day is the output data.

Table 2.1 Proximate and ultimate analysis of Çatalağzı coal used in the present study[14].

Çatalağzı	
Proximate analysis	
Fixed carbon	56.0
Volatile matter	27.0
Ash	14.0
Moisture	3.0
Ultimate analysis	
C	77.0
H	5.0
N	1.2
S	0.8
O (by the difference)	16.0

This thesis also aims to clarify of economic feasibility of using a hybrid solar coal to liquid plant by comparing the amount of Fischer-Tropsch Liquids and coal feed rate for both cases. There are two cases with two different coal-processing methods. Case 1 is based on regular coal to liquid (CTL) processing plant while Case 2 is solar coal to liquid plant (SCTL).

2.2 Case 1: CTL Plant Input Data

In coal to liquid plants, there are two main processes, which are the gasifying reactor and the Fischer-Tropsch reactor in addition to many minor processes; anyway, in CTL plants the process is very common. Figure 2.2 shows the basic process schemes for CTL plant that its processes had been simulated.

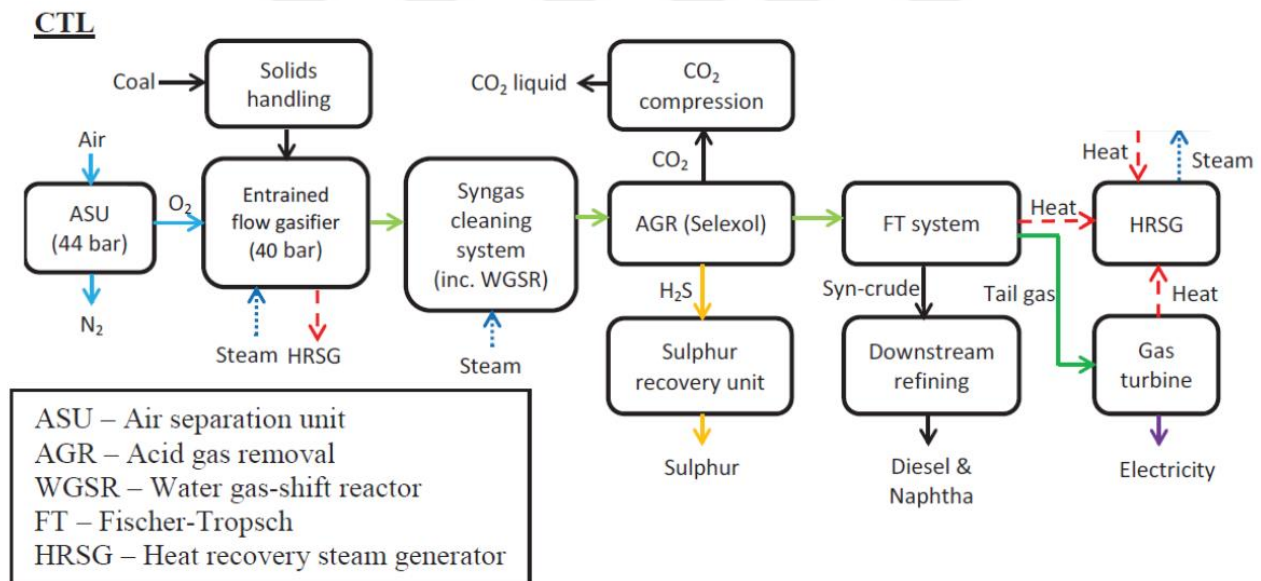


Figure 2.2 scheme of basic processes for CTL plant integrated with FT liquids plant.

The model input data are the following:

Table 2.2 CTL Plant Input Data

No.	Input data	amount	unit
1	Coal flow Rate	8.70	kg/s
2	Coal HHV[14]	31.4	MJ/kg

2.3 Case 2: SCTL plant Input Data

The process of solar gasification is to utilize the solar power as source of heat to be added to the gasifier reactions that absorbs heat to produce more syngas or to decrease coal feed rate by lowering the amount of coal burned to provide reactions with heat.

The syngas produced from a solar gasifier reactor can then be converted to high value transportation liquid fuels via the established Fischer-Tropsch (FT) synthesis process. However, the FT process requires a stringent syngas composition and steady-steady operation. Therefore, extensive number of gas cleaning and upgrading of syngas systems is required prior to the FT reactor. Nowadays, the output from the current solar gasifier reactors vary due to the intermittent nature of solar input. To ignore this issue, a solar hybridized, oxygen blown, atmospheric pressure vortex-flow gasifier is proposed with the aim of obtaining steady operation of the FT liquids poly-generation plant instead of the auto thermal entrained flow gasifier. Figure 2.3 show the basic process schemes for SCTL plant that its processes will be simulated as well.

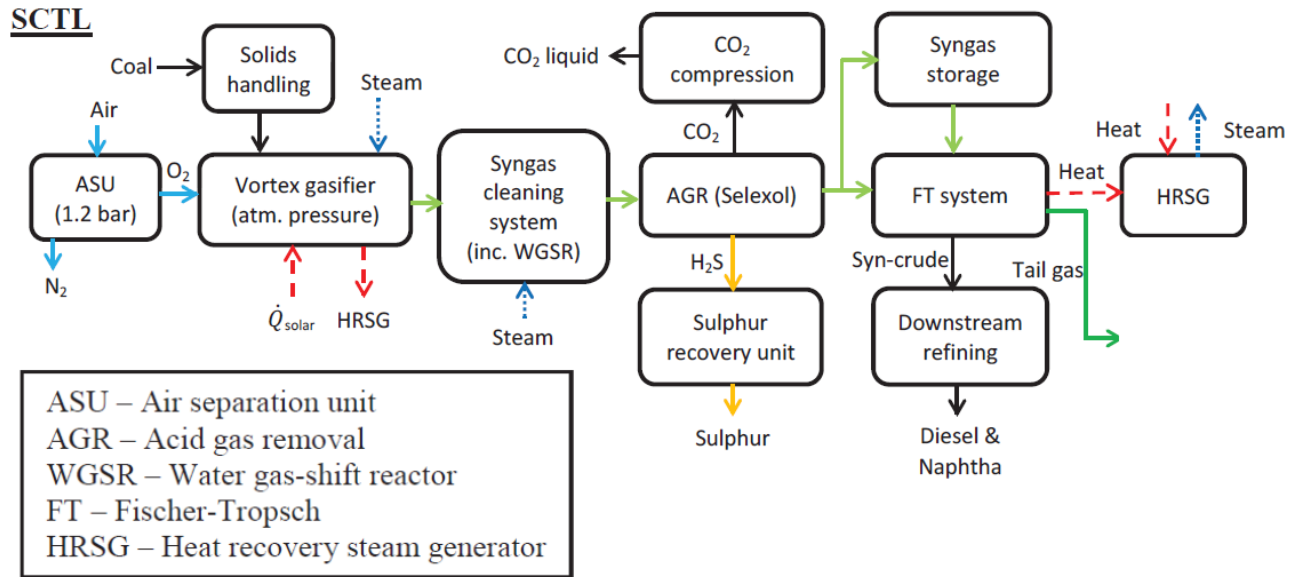


Figure 2.3 scheme of basic SCTL processes integrated with FT liquids plant.

A quantity of heat will be added as heat stream in ASPEN PLUS to the gasifier reactor to present solar heat energy in order to decrease coal feed rate to get an improvement to the plant and save part of operational costs.

2.4 Cost Estimation Approach

Total initiating, operational maintenance and insurance cost estimation had been done in this study for both of CTL & SCTL according to the following table:

Table 2.4 a : Cost Estimation Data

Type	Unit	CTL	SCTL	Reference
Total Capital Cost	\$M	380	460	[13]
Capital Cost of Solar Energy (Concentrated)	\$M/MW	-	2.5	[13]
Çatalağzı Coal price	\$M/Ton	186		http://www.taskomuru.gov.tr
maintenance, operational and Insurance cost	\$M/Year	20	20	[13]
Solar System operational cost	\$M/Year	-	2	[13]
Gasoline Prices in Turkey	\$/bbl	205		https://www.globalpetrolprices.com
Diesel Price in Turkey	\$/bbl	187		https://www.globalpetrolprices.com
TL to USD price in march-2018	-	3.8		https://xe.com/currencycharts

Economic feasibility related data and assumptions are listed in the table 2.4 b.

Table 2.4 b: Economic assumptions for the CTL and SCTL plants[13].

Parameter	Unit
Plant size	1500 bbl/day FT liquids
Construction period	3 years
Plant life	20 years
Load factor	85%

CHAPTER 3

METHODOLOGY

In this chapter, a discussion on the system analysis is described. In order to understand the technical feasibility of using Çatalağzı coal modeling the CTL and SCTL various processes a commercially available modelling tool, Aspen Plus, was used in two different cases.

3.1 Cryogenic Air Separation Unit

The air separation unit takes atmospheric air at 25°C and 1 atm and separates it into nitrogen and oxygen of high purity. In this process known as air liquefaction the atmospheric air is first compressed to 40 bar, the advantage of using this pressure is because the critical pressure of nitrogen is 34 bar and oxygen 50.43 bar, this means that working at this pressure nitrogen behaves like a “gas” instead of oxygen which behaves like a condensable vapor. The compression is performed in 4 stages to keep a compression ratio in the range 2-3 (2.5 used in this case) which is a recommended value for good performance, each stage is equipped with an intercooler which reduces the temperature of compressed air sent to next stage to ensure high performance of compression system.

Once the air reaches 40 bar is sent to cryogenic cooling, the saturation temperature of oxygen at 40 bar is -124.7 °C, so if air is cooled below this value the oxygen is separated like liquid and nitrogen like gas, this corresponds to operation in cryogenic system, the air is cooled to -130 °C to ensure that oxygen is being separated in liquid phase. Part of the heat removed to cool the air is recovered with outlet streams nitrogen and oxygen that are sent to following process of the plant.

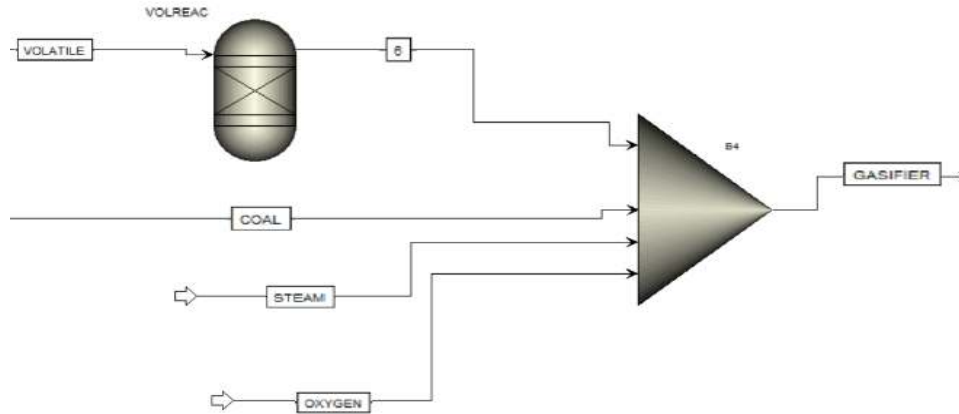
3.2 Gasification Unit

3.2.1 Main Reactions & Reactions kinetics:

Gasification process had been under 40 bar and 1500 °C simulating and entrained flow gasifier conditions, the major conversion reactions in gasifier and reactions heats is given in Table 5.

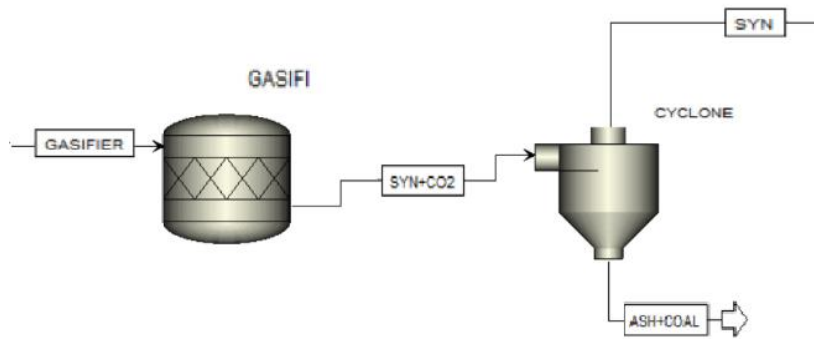
Table 3.2.1: Heats of gasifier reactions[15].

	$\Delta H^{\circ}_{800^{\circ}\text{C}} \{ \text{KJ/mol} \}$
$\text{C(s)} + \text{H}_2 \rightarrow \text{CO} + \text{H}_2$	136
$\text{C(s)} + \text{CO}_2 \rightarrow 2 \text{CO}$	173
$\text{C(s)} + 2\text{H}_2 \rightarrow \text{CH}_4$	-87
$\text{CO} + \text{H}_2\text{O} \rightarrow \text{CO}_2 + \text{H}_2$	-37
$\text{CH}_4 + \text{H}_2\text{O} \rightarrow \text{CO} + 3\text{H}_2$	228



3.2.2 Coal Decomposition

The ASPEN PLUS yield reactor, RYIELD, is used to simulate the decomposition of the feed. In this step, coal is converted into its constituting components including carbon, hydrogen, oxygen, sulfur, nitrogen, and ash, by specifying the yield distribution according to the ultimate analysis.



3.2.3 Volatile Reactions

Gibbs reactor in ASPEN PLUS, RGIBBS, is used for the disturbance of volatile, in confrontation with the expectation that volatile reactions follow the Gibbs equilibrium. Mass consists mainly of C, H, N, O, S, Cl, ash, and moisture. Gas to carbon combination, which participate in volatilization, and the carbon compresses some of the solid phase (char) and accordingly, results in char. The quantity of volatile material can be identified from the coal approximate analysis. Also taking into consideration the consumption that char contains only carbon and ash, the amount of carbon in the volatile portion can be calculated by deducting the total amount of carbon in char from the total carbon in coal.

3.2.4 Char Gasification

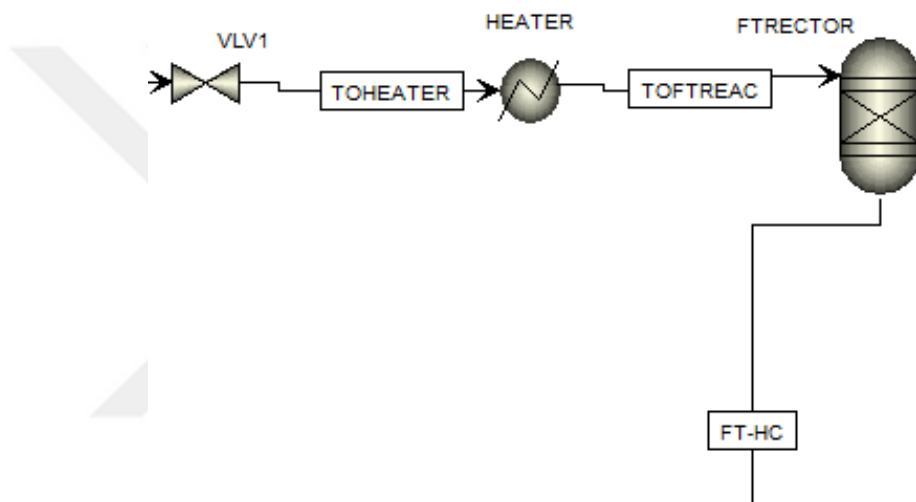
To simulate char gasification the stoichiometric reactor, RSTOIC, can be used by distinguishing reactions happening in the gasifier .[16]

3.3 CO₂ & H₂S Absorber

The CO₂ and H₂S removal is done by MEA (Monoethanolamides), by two columns, first for H₂S and second for CO₂. The chemical process used to remove acid gas (CO₂ and H₂S) from syngas streams using physical solvent. A physical solvent means that there are not chemical reactions

between the solvent and components absorbed, this constitutes an advantage because there are not significant changes in physical properties of solvent due to absorption.

3.4 Fischer Tropsch Reactor



Fischer Tropsch reactor is the equipment where take place the main reactions to recover synthetic fuel from syngas. The main reactants involved in these reactions are CO and H₂. In the present case, H₂/CO ratio is equal to 3. For ratios above 1 it is preferable to use Iron catalyst based FT reactor with low temperature conditions done at 15 atm and 240 C to increase the yield of the gasoline and diesel. The yield reactor is used to simulate the reaction in ASPEN PLUS.[17]

While if the high temperature FT process was used the outputs of the reactor would have consisted mainly from olefins to produce petrochemicals and the purpose of this thesis is obviously the production of liquid vehicles fuels[6].

Figure 3.4 shows FT reactor's products distribution, which will go then to refinery system to form diesel and gasoline.

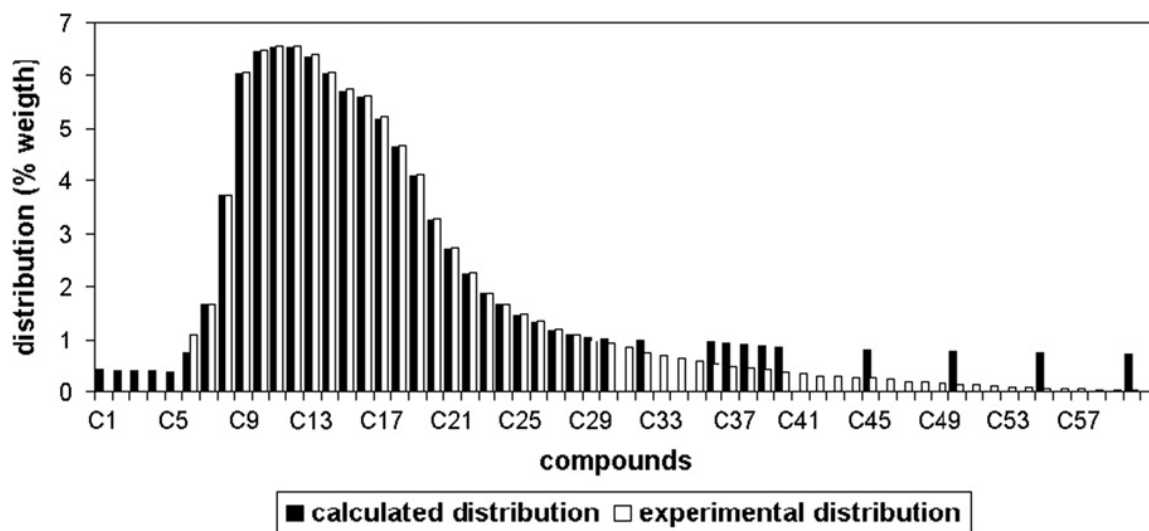


Figure 3.4: Fischer-Tropsch Liquids Compounds Distribution[18].

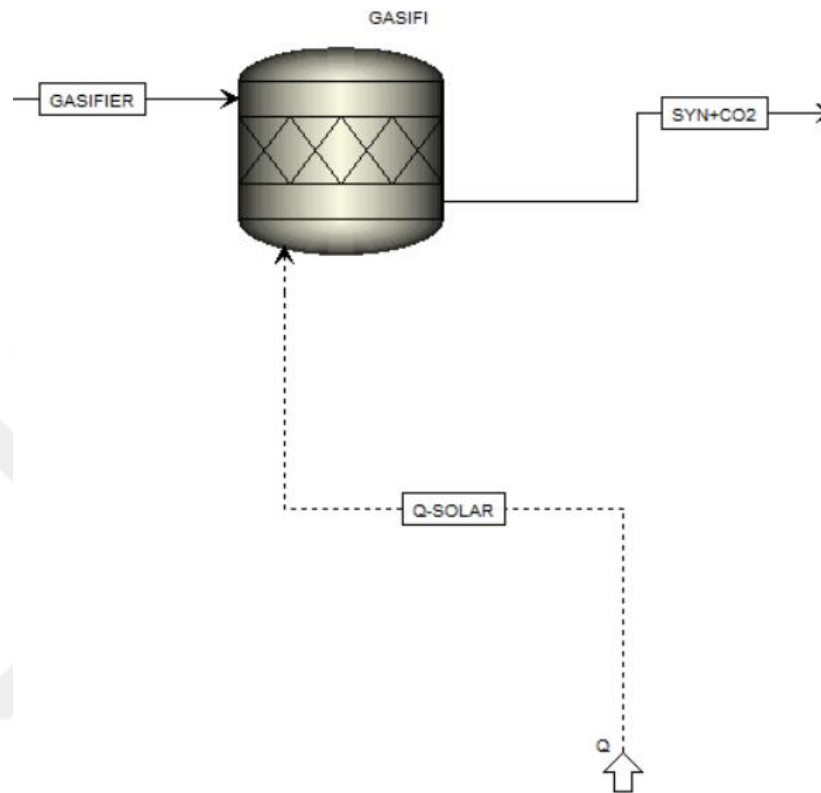
3.5 Solar Hybridized system

The solar system is nearly the same equipment of autothermal process, but the source of heat needed is not combustion of coal, it is the solar concentrated energy. The coal used in the solar is less due to the absence of combustion reactions to supply the gasification reactions heat. The coal feed rate will be reduced using the solar gasifier.

In the autothermal process, the H_2/CO is 3 while in solar gasification is 1.75, which is near to 2 (the optimum ratio).

In the solar gasification simulation, an energy stream to indicate the energy supplied by the solar radiation concentration system had been used. The least energy needed is 30 MW. However, for keeping the high temperature gasification reactions the used energy is 50 MW with outlet gas temperature (gasifier temperature is 850 °C) and concentrated solar power is used to provide high temperature in the gasifier.

The temperature reached on the receiver is related to the concentration ratio of the collector. Thus, in parabolic dish (PD) and solar tower (ST) Systems, mirrors concentrate the sunlight on a single focal point with higher concentration factors and operating temperatures (high-concentration technologies). On one hand, central receivers achieve a concentration ratio of around 600 and temperatures of 800 °C, and, on the other hand, parabolic dishes reach concentration ratios greater than 1000 that lead to temperatures of 1600 °C and for these extreme high temperatures synthetic oil or molten salt is used as the primary heat transfer fluid [19].



The water gas shift is not needed due to the good H_2/CO ratios and there is no need for any adjustment, it is conventional to neglect it as in (Integrated Gasification Combined Cycle) IGCC unit design. [20]

3.6 CTL & SCTL Cost Calculations

A simple cost calculations per year is shown in figures 3.6 (a,b) after the simulation was successfully executed.

Table 3.6 a: CTL Plant Cost Calculations

CTL Cost Calculations over 20 Years for 8.7 kg/s Coal Feed rate		
Type	Unit	Amount
Coal feed cost	M\$/year	43.00
Operational & maintenance cost	M\$/year	20.00
Plant total cost	M\$/year	19.00
Total yearly cost	M\$/year	82.00
CTL Yearly Income Calculations		
475 bbl/d Diesel Production	M\$/year	36.00
965 bbl/d Gasoline Production	M\$/year	65.00
Total income	M\$/year	101.00

Table 3.6 b: SCTL Plant Cost Calculations

SCTL Cost Calculations over 20 Years for 6.8 kg/s Coal Feed rate		
Type	Unit	Amount
Coal feed cost	M\$/year	33.75
Operational & maintenance cost	M\$/year	20.00
Plant total cost	M\$/year	19.00
Solar system total cost	M\$/year	6.00
Solar system operational & maintenance cost	M\$/year	1.25
Total cost	M\$/year	80.00
SCTL Yearly Income Calculations		
878 bbl/d Diesel Production	M\$/year	66.00
624 bbl/d Gasoline Production	M\$/year	42.00
Total yearly income	M\$/year	108.00

CHAPTER 4

RESULTS AND VALIDATION

4.1 CTL and SCTL Plant Simulation Results

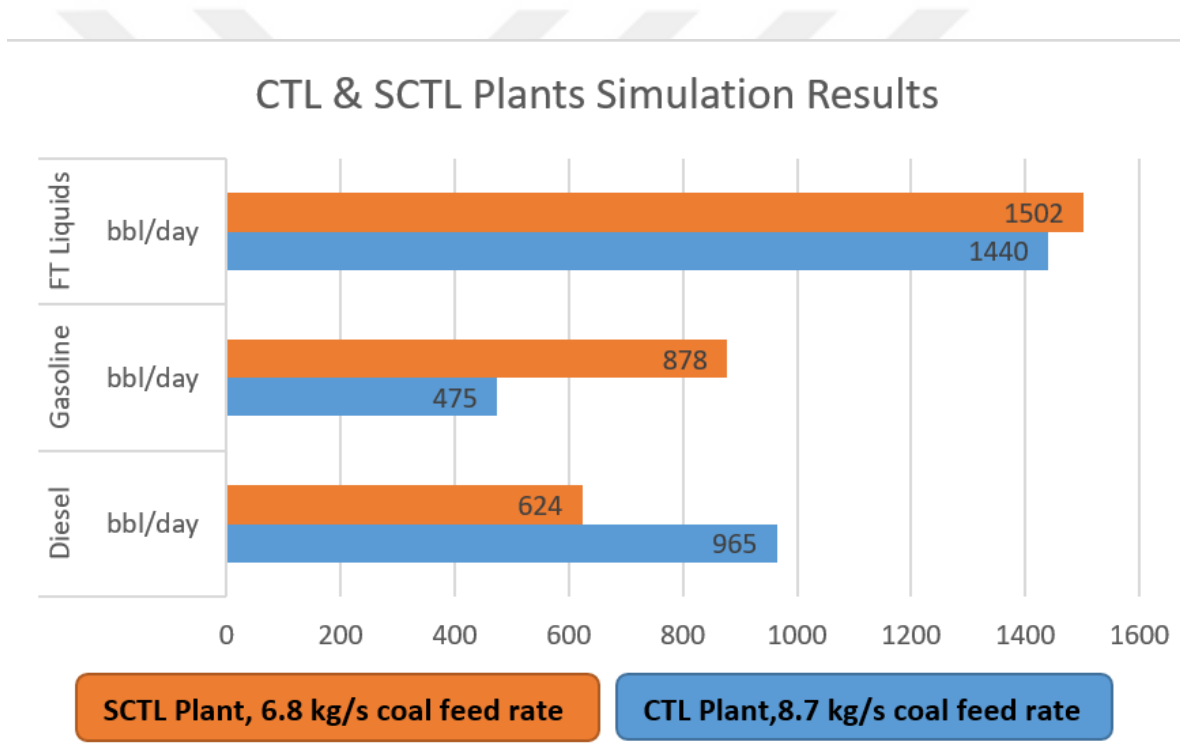


Figure 4.1 : Simulation Results for CTL & SCTL Plants

In this work a comparison of 2 models predictions with each other has been done and were found that using 8.7 kg/s Çatalağzı coal the plant can produce 1440 bbl/day of Fischer-Tropsch liquids in coal to liquid plant while using only 6.8 kg/s can produce 1502 bbl/day of Fischer-Tropsch liquids by using solar coal to liquid plant.

4.2 Cost Comparison

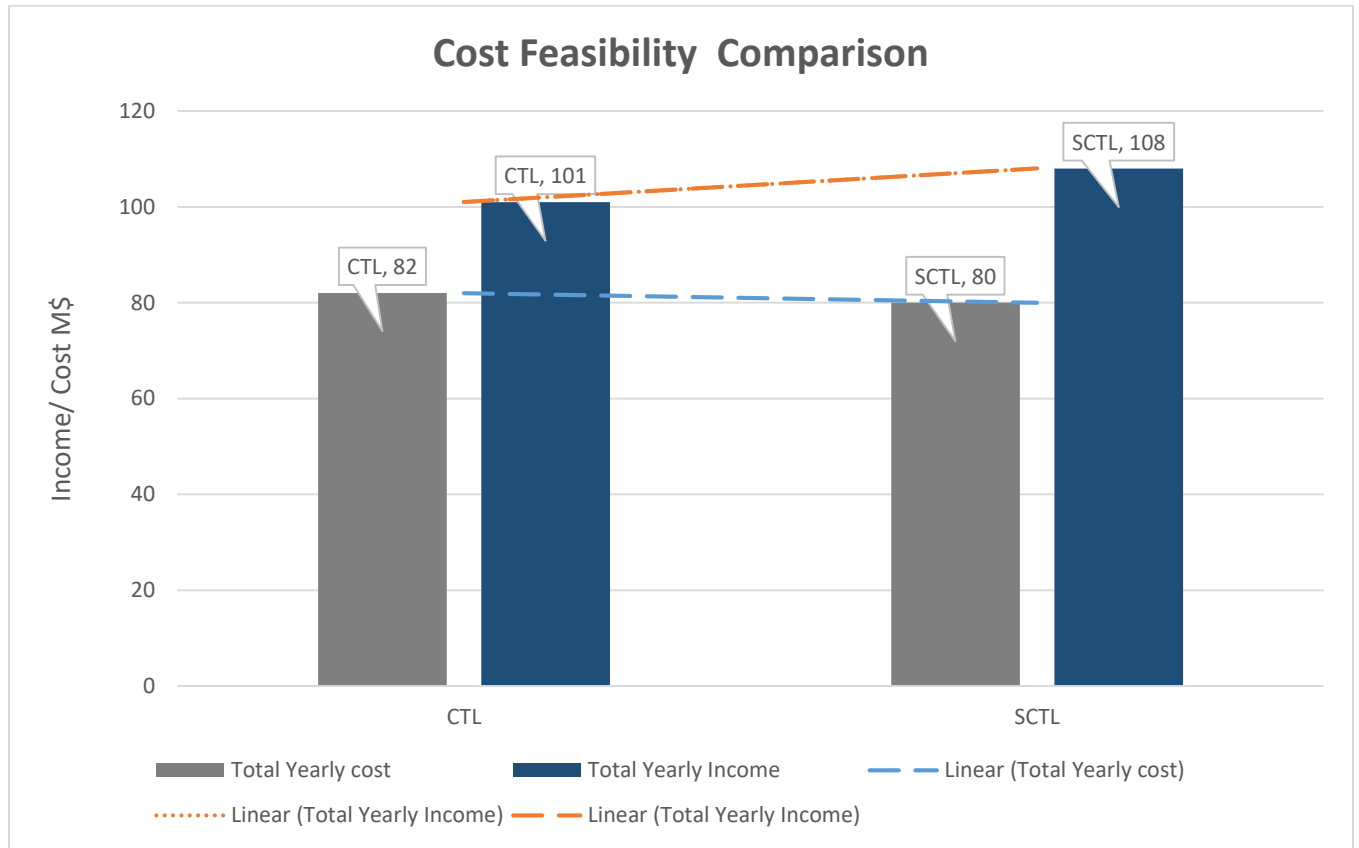


Figure 4.2 : Total Cost drop & Total Plant income rise between CTL & SCTL

Figure 4.2 shows the total cost and total income in taking in consideration all different components within CTL & SCTL plants. The total cost for a production of 1440 bbl/day of FT liquids in CTL plant was calculated to be \$82M per year and for the SCTL plant to achieve a production of 1502 bbl/day of FT liquids the total cost was calculated to be \$80M. With more than 7 Million USD increase of total income per year. Using solar power, 2 million USD per year reduction of total cost can be achieved including solar system cost. The production of FT liquids in SCTL plant can be increased, which provides the plant of an extra income of 7 million USD per year in comparison to normal CTL plant. A total gain of 9 million USD per year can be achieved by comparing CTL & SCTL plants.

4.3 Validation of Simulation Results

The validation process was carried out progressively as the model was developed from CTL to SCTL to ensure the model obtained and maintained accuracy until the results was established the percentage difference was found for the output characteristics with the maximum allowable variation set to 2%. Table 4.3 shows a summary of the simulated result, the validation data and the variation and the comparison was done between the simulation data and a reliable plant at Geraldton, Western Australia[13]. the small inaccuracies that were recorded can be assumed to have originated from the differences in coal analysis between the reliable plant and the simulated plant in the simulated and validation fuel liquids production .The developed model coincides with the validation data within the accepted error limits of 2%. With this the case, the model is deemed as valid

Table 4.3 CTL Plant Input Data

Plant Type	Simulation Data FT Liquids bbl./d	Validation Data	Differences (%)
CTL	1440	1500	0.042
Plant Type	Simulation Data Coal feed Rate kg/s	Validation Data	Differences (%)
SCTL	6.8	7.2	0.059

CHAPTER 5

CONCLUSION AND DISCUSSION

5.1 Conclusion and Discussion

The improvement of the CTL plant by installing the solar system were found to be effective as it could increase the plant productivity by reducing the input feeding rate of coal by 22% in addition to the increment in FT liquids productivity by 4% in comparison with the normal coal-to-liquids (CTL) plants. However, the additional solar system, solar gasifier and its various components in SCTL plant were found to increase the initiating and operational & maintenance cost for CTL plant by at least 13% but, over the 20 years plant life cycle SCTL plant could achieve an increase in the yearly profit of around 47%.

This thesis has used two main reactors in processing the coal the gasifier reactor. The first one the gasifier reactor which has multiple types but, unfortunately in computer simulation no gasifier type can be selected so the thesis only reflected the results of gasifier reactions and the second reactor is FT reactor which also has multiple types under high and low reaction temperature and the thesis has selected the low reaction temperature in order to produce vehicle fuels.

For further researches the other types of reactors is suggested to be studied and high FT reactor temperature outcomes could be the aim of a further study.

A study on Turkish Lignite coal liquefaction is recommended for future studies and the impact of reducing CO₂ emissions on the plant efficiency is important to know the exact investment interest of implementing the coal to liquid technology in Turkey.

REFERENCES

- [1] US Energy Information Administration, “Coal - Energy Explained, Your Guide To Understanding Energy - Energy Information Administration,” *Energy Explained*, 2016. .
- [2] S. Kalyanaraman, “Understanding Coal / Thermal Power Supply Chain in India,” 2017. [Online]. Available: <https://www.linkedin.com/pulse/understanding-coal-thermal-power-supply-chain-india-kalyanaraman>. [Accessed: 06-Aug-2018].
- [3] EIA, “International Energy Outlook 2016: Chapter 4 - Coal,” vol. 2016, pp. 61–79, 2016.
- [4] IEA, “Achievements of appliance energy efficiency standards and labelling programs,” https://www.iea.org/publications/freepublications/publication/4E_S_L_Report_180915.pdf, 2015.
- [5] M. Höök and K. Aleklett, “A review on coal-to-liquid fuels and its coal consumption,” *Int. J. Energy Res.*, 2010.
- [6] M. E. Dry, “The Fischer-Tropsch process: 1950-2000,” *Catal. Today*, vol. 71, no. 3–4, pp. 227–241, 2002.
- [7] R. H. Williams and E. D. Larson, “A comparison of direct and indirect liquefaction technologies for making fluid fuels from coal,” *Energy Sustain. Dev.*, vol. 7, no. 4, pp. 103–129, 2003.
- [8] S. Prakash, G. Paswan, and K. Nikhil, “LIQUID COAL AS A GREEN ENERGY : A,” no. 3, pp. 141–143, 2014.
- [9] M. Liu, “Fischer-Tropsch Sustainability,” 2010. [Online]. Available: <http://large.stanford.edu/courses/2010/ph240/liu1/>. [Accessed: 06-Aug-2018].
- [10] E. COAL, “The Voice Of Coal in Turkey,” 2015. [Online]. Available: <https://euracoal.eu/info/country-profiles/turkey/>. [Accessed: 06-Aug-2018].
- [11] C. Technologies, *Resources to reserves 2013: Oil, gas and coal technologies for the energy markets of the future*, vol. 9789264090705. 2013.
- [12] J. T. Bartis, F. Camm, and D. S. Ortiz, *Producing Liquid Fuels from Coal*. 2008.
- [13] W. Saw, A. Kaniyal, P. Van Eyk, G. Nathan, and P. Ashman, “Solar Hybridized Coal-to-liquids via Gasification in Australia: Techno-economic Assessment,” *Energy Procedia*, vol. 69, pp. 1819–1827, 2015.
- [14] E. Sources, “Second Law Analysis of Various Types of Coal and Woody Biomass in Turkey Second Law Analysis of Various Types of Coal and Woody Biomass in Turkey,”

- no. September 2004, 2014.
- [15] M. S. Eikeland, R. K. Thapa, and B. M. Halvorsen, “Aspen Plus Simulation of Biomass Gasification with Known Reaction Kinetic,” pp. 149–156, 2015.
 - [16] R. Nayak and R. Mewada, “Simulation of Coal Gasification Process using ASPEN PLUS,” *Int. Conf. Curr. trends Technol.*, pp. 8–10, 2011.
 - [17] M. Sudiro and A. Bertucco, “Production of synthetic gasoline and diesel fuel by alternative processes using natural gas and coal: Process simulation and optimization,” *Energy*, vol. 34, no. 12, pp. 2206–2214, 2009.
 - [18] M. Sudiro and A. Bertucco, “Production of synthetic gasoline and diesel fuel by alternative processes using natural gas and coal: Process simulation and optimization,” *Energy*, vol. 34, no. 12, pp. 2206–2214, Dec. 2009.
 - [19] M. I. Roldán Serrano, “Concentrating Solar Thermal Technologies,” 2017.
 - [20] D. Nordstrand, N. B. D. Dao, and G. M. Bruce, *Combustion Engineering Issues for Solid Fuel Systems*. 2008.

APPENDIX
ASPEN PLUS PROGRAM LISTING

ASPEN PLUS PLAT: WIN32 VER: 11.1 08/05/2018 PAGE 1

FT

RUN CONTROL SECTION

RUN CONTROL INFORMATION

THIS COPY OF ASPEN PLUS LICENSED TO

TYPE OF RUN: EDIT

INPUT FILE NAME: _4202dki.inm

INPUT PROBLEM DATA FILE NAME : _4202dki VERSION NO. 1

OUTPUT PROBLEM DATA FILE NAME: _3106hms VERSION NO. 1

LOCATED IN:

PDF SIZE USED FOR INPUT TRANSLATION:

NUMBER OF FILE RECORDS (PSIZE) = 0

NUMBER OF IN-CORE RECORDS = 256

PSIZE NEEDED FOR SIMULATION = 1

CALLING PROGRAM NAME: apmain

LOCATED IN: C:\PROGRA~1\ASPENT~1\ASPENP~1.1\Engine\xeq

SIMULATION REQUESTED FOR ENTIRE FLOWSHEET

ASPEN PLUS PLAT: WIN32 VER: 11.1 08/05/2018 PAGE 2

FT

FLOWSHEET SECTION

FLOWSHEET CONNECTIVITY BY STREAMS

STREAM	SOURCE	DEST	STREAM	SOURCE	DEST
GHGHHG	----	GASIFI	BIOMASS	----	YIELDGAS
STEAM	----	B4	AMINECO ₂	----	COABSORB
COAL-VOL	YIELDGAS	SPRTR	COAL	SPRTR	B4
VOLATILE	SPRTR	VOLREAC	6	VOLREAC	B4
GASIFIER	B4	GASIFI	SYN	CYCLONE	COOLER
ASH+COAL	CYCLONE	----	SOURSYN	COOLER	N2SPRTR
SOURSYN2	N2SPRTR	COABSORB	N2	N2SPRTR	----
SWEETSYN	COABSORB	B16	RICH ₂	COABSORB	----
TOHEATER	VLV1	HEATER	TOFTREAC	HEATER	FTRECTOR
SYNGAS	B16	VLV1	WATER	B16	----

FT-HC	FTRECTOR	B29	TO-FRAC	B29	FRA1
NO-REACT	FRA1	----	HC	FRA1	FRA2
C1-C4	FRA2	----	DISL+GAS	FRA2	FRA3
GASOLINE	FRA3	B1	DIESEL	FRA3	B7
VAPOR	B2	----	PUREGASO	B2	----
WATERFLA	B2	----	PUREDESL	B7	B8
C8+	B7	----	COLDDSL	B8	----
TO3SPRTR	B1	B2	3	GASIFI	CYCLONE

FLWSHEET CONNECTIVITY BY BLOCKS

BLOCK	INLETS	OUTLETS
YIELDGAS	BIOMASS	COAL-VOL
SPRTR	COAL-VOL	COAL VOLATILE
VOLREAC	VOLATILE	6
GASIFI	GASIFIER GHGHHG	3
B4	COAL 6 STEAM	GASIFIER
CYCLONE	3	SYN ASH+COAL
COOLER	SYN	SOURSYN
N2SPRTR	SOURSYN	SOURSYN2 N2
COABSORB	AMINECO ₂ SOURSYN2	SWEETSYN RICH ₂
VLV1	SYNGAS	TOHEATER
HEATER	TOHEATER	TOFTREAC
B16	SWEETSYN	SYNGAS WATER
FTRECTOR	TOFTREAC	FT-HC
B29	FT-HC	TO-FRAC
FRA1	TO-FRAC	NO-REACT HC

FRA2	HC	C1-C4 DISL+GAS
FRA3	DISL+GAS	GASOLINE DIESEL
B1	GASOLINE	TO3SPRTR
B2	TO3SPRTR	VAPOR PUREGASO WATERFLA
B7	DIESEL	PUREDESL C8+
B8	PUREDESL	COLDDSL

COMPUTATIONAL SEQUENCE

SEQUENCE USED WAS:

YIELDGAS SPRTR VOLREAC B4 *GASIFI CYCLONE COOLER N2SPRTR COABSORB B16

VLV1 HEATER FTRECTOR B29 FRA1 FRA2 FRA3 B1 B2 B7 B8

ASPEN PLUS PLAT: WIN32 VER: 11.1 08/05/2018 PAGE 3

FT

FLOWSHEET SECTION

OVERALL FLOWSHEET BALANCE

*** MASS AND ENERGY BALANCE ***

	IN	OUT	RELATIVE DIFF.
--	----	-----	----------------

CONVENTIONAL COMPONENTS (KMOL/HR)

O2	0.000000E+00	0.000000E+00	0.000000E+00
N2	0.000000E+00	5.24319	-1.00000
CO	0.000000E+00	19.7002	-1.00000
CO ₂	0.000000E+00	202.516	-1.00000
H ₂	0.000000E+00	273.302	-1.00000

WATER	18053.2	17242.6	0.448983E-01
H ₂ S	0.000000E+00	13.6471	-1.00000
MEA	890.483	890.483	0.510675E-15
1	0.000000E+00	124.449	-1.00000
2	0.000000E+00	18.3204	-1.00000
3	0.000000E+00	12.4928	-1.00000
4	0.000000E+00	9.47789	-1.00000
5	0.000000E+00	7.63528	-1.00000
6	0.000000E+00	6.39250	-1.00000
7	0.000000E+00	5.49766	-1.00000
8	0.000000E+00	4.82258	-1.00000
9	0.000000E+00	4.29516	-1.00000
10	0.000000E+00	3.87173	-1.00000
11	0.000000E+00	3.52429	-1.00000
12	0.000000E+00	3.23408	-1.00000
13	0.000000E+00	2.98802	-1.00000
14	0.000000E+00	2.77676	-1.00000
15	0.000000E+00	2.59340	-1.00000
16	0.000000E+00	2.43275	-1.00000
17	0.000000E+00	2.29085	-1.00000
18	0.000000E+00	2.16459	-1.00000
19	0.000000E+00	2.05152	-1.00000
20	0.000000E+00	1.94967	-1.00000
21	0.000000E+00	1.85746	-1.00000
22	0.000000E+00	1.77358	-1.00000
23	0.000000E+00	1.69695	-1.00000
24	0.000000E+00	1.62666	-1.00000
25	0.000000E+00	1.56197	-1.00000

26	0.000000E+00	1.50222	-1.00000
27	0.000000E+00	1.44688	-1.00000
28	0.000000E+00	1.39547	-1.00000
29	0.000000E+00	0.000000E+00	0.000000E+00
C	0.000000E+00	679.151	-1.00000
SUBTOTAL(KMOL/HR) 18943.6 19562.8 -0.316482E-01			
(KG/HR) 379627. 400680. -0.525427E-01			

NON-CONVENTIONAL COMPONENTS (KG/HR)

29COAL	24480.0	0.000000E+00	1.00000
ASH	0.000000E+00	3427.20	-1.00000
SUBTOTAL(KG/HR) 24480.0 3427.20 0.860000			

ASPEN PLUS PLAT: WIN32 VER: 11.1 08/05/2018 PAGE 4

FT

FLOWSHEET SECTION

OVERALL FLOWSHEET BALANCE (CONTINUED)

TOTAL BALANCE

MASS(KG/HR)	404107.	404107.	-0.956225E-08
ENTHALPY(CAL/SEC)	-0.346245E+09	-0.348470E+09	0.638619E-02

ASPEN PLUS PLAT: WIN32 VER: 11.1 08/05/2018 PAGE 5

FT

PHYSICAL PROPERTIES SECTION

COMPONENTS

ID	TYPE	FORMULA	NAME OR ALIAS	REPORT NAME
O2	C	O2	O2	O2
N2	C	N2	N2	N2
CO	C	CO	CO	CO
CO ₂	C	CO ₂	CO ₂	CO ₂
H ₂	C	H ₂	H ₂	H ₂
WATER	C	H ₂ O	H ₂ O	WATER
H ₂ S	C	H ₂ S	H ₂ S	H ₂ S
MEA	C	C ₂ H ₇ NO	C ₂ H ₇ NO	MEA
1	C	CH ₄	CH ₄	1
2	C	C ₂ H ₆	C ₂ H ₆	2
3	C	C ₃ H ₈	C ₃ H ₈	3
4	C	C ₄ H ₁₀ -1	C ₄ H ₁₀ -1	4
5	C	C ₅ H ₁₂ -1	C ₅ H ₁₂ -1	5
6	C	C ₆ H ₁₄ -1	C ₆ H ₁₄ -1	6
7	C	C ₇ H ₁₆ -1	C ₇ H ₁₆ -1	7
8	C	C ₈ H ₁₈ -1	C ₈ H ₁₈ -1	8
9	C	C ₉ H ₂₀ -1	C ₉ H ₂₀ -1	9
10	C	C ₁₀ H ₂₂ -1	C ₁₀ H ₂₂ -1	10
11	C	C ₁₁ H ₂₄	C ₁₁ H ₂₄	11
12	C	C ₁₂ H ₂₆	C ₁₂ H ₂₆	12
13	C	C ₁₃ H ₂₈	C ₁₃ H ₂₈	13
14	C	C ₁₄ H ₃₀	C ₁₄ H ₃₀	14
15	C	C ₁₅ H ₃₂	C ₁₅ H ₃₂	15
16	C	C ₁₆ H ₃₄	C ₁₆ H ₃₄	16
17	C	C ₁₇ H ₃₆	C ₁₇ H ₃₆	17
18	C	C ₁₈ H ₃₈	C ₁₈ H ₃₈	18
19	C	C ₁₉ H ₄₀	C ₁₉ H ₄₀	19

20	C	C20H42	C20H42	20
21	C	C21H44	C21H44	21
22	C	C22H46	C22H46	22
23	C	C23H48	C23H48	23
24	C	C24H50	C24H50	24
25	C	C25H52	C25H52	25
26	C	C26H54	C26H54	26
27	C	C27H56	C27H56	27
28	C	C28H58	C28H58	28
29	C	C29H60	C29H60	29
29COAL	NC	MISSING	29COAL	
ASH	NC	MISSING	ASH	
C	C	C	C	

ID ATTRIBUTE TYPES

29COAL SULFANAL ULTANAL PROXANAL

ASH PROXANAL ULTANAL SULFANAL

ASPEN PLUS PLAT: WIN32 VER: 11.1 08/05/2018 PAGE 6

FT

U-O-S BLOCK SECTION

BLOCK: B1 MODEL: HEATER

INLET STREAM: GASOLINE

OUTLET STREAM: TO3SPRTR

PROPERTY OPTION SET: PR-BM PENG-ROBINSON EQUATION OF STATE

*** MASS AND ENERGY BALANCE ***

	IN	OUT	RELATIVE DIFF.
CONV. COMP.(KMOL/HR)	65.0000	65.0000	0.000000E+00
(KG/HR)	4991.85	4991.85	0.000000E+00
NONCONV. COMP(KG/HR)	0.000000E+00	0.000000E+00	0.000000E+00
TOTAL BALANCE			
MASS(KG/HR)	4991.85	4991.85	0.000000E+00
ENTHALPY(CAL/SEC)	-925776.	-0.110915E+07	0.165328

*** INPUT DATA ***

TWO PHASE TP FLASH

SPECIFIED TEMPERATURE	K	293.150
SPECIFIED PRESSURE	ATM	1.00000
MAXIMUM NO. ITERATIONS		30
CONVERGENCE TOLERANCE		0.000100000

*** RESULTS ***

OUTLET TEMPERATURE	K	293.15
OUTLET PRESSURE	ATM	1.0000
HEAT DUTY	CAL/SEC	-0.18337E+06
OUTLET VAPOR FRACTION		0.00000E+00
PRESSURE-DROP CORRELATION PARAMETER		0.00000E+00

V-L PHASE EQUILIBRIUM :

COMP	F(I)	X(I)	Y(I)	K(I)
CO	0.13327E-05	0.13327E-05	0.14732E-02	591.29
CO ₂	0.75840E-04	0.75840E-04	0.79380E-02	55.985
H ₂	0.68491E-06	0.68491E-06	0.15848E-02	1237.7
WATER	0.38991	0.38991	0.63833	0.87568
1	0.12865E-04	0.12865E-04	0.53257E-02	221.43
2	0.25840E-03	0.25840E-03	0.15186E-01	31.436
3	0.21001E-02	0.21001E-02	0.32328E-01	8.2338
4	0.37612E-01	0.37612E-01	0.15313	2.1777
5	0.89552E-01	0.89552E-01	0.10347	0.61801
6	0.88821E-01	0.88821E-01	0.29590E-01	0.17819
7	0.79844E-01	0.79844E-01	0.83844E-02	0.56168E-01

ASPEN PLUS PLAT: WIN32 VER: 11.1 08/05/2018 PAGE 7

FT

U-O-S BLOCK SECTION

BLOCK: B1 MODEL: HEATER (CONTINUED)

V-L PHASE EQUILIBRIUM :

COMP	F(I)	X(I)	Y(I)	K(I)
8	0.70113E-01	0.70113E-01	0.23255E-02	0.17741E-01
9	0.61256E-01	0.61256E-01	0.66932E-03	0.58444E-02
10	0.52920E-01	0.52920E-01	0.18893E-03	0.19096E-02
11	0.44903E-01	0.44903E-01	0.57226E-04	0.68168E-03
12	0.36973E-01	0.36973E-01	0.16173E-04	0.23397E-03

13	0.28658E-01	0.28658E-01	0.47935E-05	0.89466E-04
14	0.16988E-01	0.16988E-01	0.11874E-05	0.37385E-04
16	0.53146E-05	0.53146E-05	0.57587E-10	0.57956E-05

BLOCK: B16 MODEL: SEP

INLET STREAM: SWEETSYN

OUTLET STREAMS: SYNGAS WATER

PROPERTY OPTION SET: PR-BM PENG-ROBINSON EQUATION OF STATE

*** MASS AND ENERGY BALANCE ***

	IN	OUT	RELATIVE DIFF.
CONV. COMP.(KMOL/HR)	1633.40	1633.40	-0.139203E-15
(KG/HR)	19283.8	19283.8	0.188655E-15
NONCONV. COMP(KG/HR)	0.000000E+00	0.000000E+00	0.000000E+00
TOTAL BALANCE			
MASS(KG/HR)	19283.8	19283.8	0.188655E-15
ENTHALPY(CAL/SEC)	-0.455671E+07	-0.456744E+07	0.234949E-02

*** INPUT DATA ***

FLASH SPECS FOR STREAM SYNGAS

TWO PHASE TP FLASH

PRESSURE DROP	ATM	0.0
MAXIMUM NO. ITERATIONS		30
CONVERGENCE TOLERANCE		0.000100000

FLASH SPECS FOR STREAM WATER

TWO PHASE TP FLASH

PRESSURE DROP ATM 0.0
MAXIMUM NO. ITERATIONS 30
CONVERGENCE TOLERANCE 0.000100000

ASPEN PLUS PLAT: WIN32 VER: 11.1 08/05/2018 PAGE 8

FT

U-O-S BLOCK SECTION

BLOCK: B16 MODEL: SEP (CONTINUED)

FRACTION OF FEED

SUBSTREAM= MIXED

STREAM= SYNGAS CPT= O2 FRACTION= 0.0

N2	0.0
CO	1.00000
CO ₂	0.0
H ₂	1.00000
WATER	0.0
H ₂ S	0.0
MEA	0.0

SUBSTREAM= CIPSD

STREAM= SYNGAS CPT= C FRACTION= 0.0

SUBSTREAM= NCPSD

STREAM= SYNGAS CPT= 29COAL FRACTION= 0.0

ASH	0.0
-----	-----

*** RESULTS ***

HEAT DUTY CAL/SEC -10731.

COMPONENT = N₂

STREAM	SUBSTREAM	SPLIT FRACTION
WATER	MIXED	1.00000

COMPONENT = CO

STREAM	SUBSTREAM	SPLIT FRACTION
SYNGAS	MIXED	1.00000

COMPONENT = CO₂

STREAM	SUBSTREAM	SPLIT FRACTION
WATER	MIXED	1.00000

COMPONENT = H₂

STREAM	SUBSTREAM	SPLIT FRACTION
SYNGAS	MIXED	1.00000

COMPONENT = WATER

STREAM	SUBSTREAM	SPLIT FRACTION
WATER	MIXED	1.00000

COMPONENT = H₂S

STREAM	SUBSTREAM	SPLIT FRACTION
WATER	MIXED	1.00000

COMPONENT = MEA

STREAM	SUBSTREAM	SPLIT FRACTION
--------	-----------	----------------

WATER	MIXED	1.00000
-------	-------	---------

COMPONENT = 1

STREAM	SUBSTREAM	SPLIT FRACTION
--------	-----------	----------------

WATER	MIXED	1.00000
-------	-------	---------

ASPEN PLUS PLAT: WIN32 VER: 11.1 08/05/2018 PAGE 9

FT

U-O-S BLOCK SECTION

BLOCK: B2 MODEL: FLASH3

INLET STREAM: TO3SPRTR

OUTLET VAPOR STREAM: VAPOR

FIRST LIQUID OUTLET: PUREGASO

SECOND LIQUID OUTLET: WATERFLA

PROPERTY OPTION SET: PR-BM PENG-ROBINSON EQUATION OF STATE

*** MASS AND ENERGY BALANCE ***

	IN	OUT	RELATIVE DIFF.
CONV. COMP.(KMOL/HR)	65.0000	65.0000	0.655886E-15
(KG/HR)	4991.85	4991.86	-0.774094E-06
NONCONV. COMP(KG/HR)	0.000000E+00	0.000000E+00	0.000000E+00

TOTAL BALANCE

MASS(KG/HR)	4991.85	4991.86	-0.774094E-06
--------------	---------	---------	---------------

ENTHALPY(CAL/SEC) -0.110915E+07 -0.114168E+07 0.284969E-01

*** INPUT DATA ***

THREE PHASE TP FLASH

SPECIFIED TEMPERATURE K	293.150
SPECIFIED PRESSURE ATM	1.00000
MAXIMUM NO. ITERATIONS	30
CONVERGENCE TOLERANCE	0.000100000
NO KEY COMPONENT IS SPECIFIED	
KEY LIQUID STREAM:	WATERFLA
KEY STREAM FOR SOLIDS:	WATERFLA

*** RESULTS ***

OUTLET TEMPERATURE K	293.15
OUTLET PRESSURE ATM	1.0000
HEAT DUTY CAL/SEC	-32534.
VAPOR FRACTION	0.00000E+00
1ST LIQUID/TOTAL LIQUID	0.61880

ASPEN PLUS PLAT: WIN32 VER: 11.1 08/05/2018 PAGE 10

FT

U-O-S BLOCK SECTION

BLOCK: B2 MODEL: FLASH3 (CONTINUED)

V-L1-L2 PHASE EQUILIBRIUM :

COMP	F(I)	X1(I)	X2(I)	Y(I)	K1(I)	K2(I)
------	------	-------	-------	------	-------	-------

CO	0.133E-05	0.215E-05	0.863E-10	0.292E-02	420.	0.105E+08
CO ₂	0.758E-04	0.123E-03	0.731E-07	0.190E-01	48.1	0.807E+05
H ₂	0.685E-06	0.111E-05	0.238E-09	0.306E-02	856.	0.398E+07
WATER	0.390	0.141E-01	1.00	0.628E-01	1.38	0.195E-01
1	0.129E-04	0.208E-04	0.289E-08	0.118E-01	177.	0.127E+07
2	0.258E-03	0.418E-03	0.955E-08	0.375E-01	27.8	0.122E+07
3	0.210E-02	0.339E-02	0.222E-08	0.824E-01	7.53	0.115E+08
4	0.376E-01	0.608E-01	0.965E-09	0.401	2.04	0.129E+09
5	0.896E-01	0.145	0.264E-10	0.272	0.583	0.320E+10
6	0.888E-01	0.144	0.208E-12	0.774E-01	0.167	0.116E+12
7	0.798E-01	0.129	0.114E-14	0.217E-01	0.520E-01	0.588E+13
8	0.701E-01	0.113	0.367E-17	0.586E-02	0.160E-01	0.495E+15
9	0.613E-01	0.990E-01	0.108E-19	0.164E-02	0.513E-02	0.471E+17
10	0.529E-01	0.855E-01	0.855E-21	0.445E-03	0.161E-02	0.676E+19
11	0.449E-01	0.726E-01	0.726E-21	0.127E-03	0.543E-03	0.100E+21
12	0.370E-01	0.597E-01	0.597E-21	0.342E-04	0.178E-03	0.100E+21
13	0.287E-01	0.463E-01	0.463E-21	0.925E-05	0.619E-04	0.100E+21
14	0.170E-01	0.275E-01	0.275E-21	0.207E-05	0.234E-04	0.100E+21
16	0.531E-05	0.859E-05	0.859E-25	0.852E-10	0.308E-05	0.100E+21

BLOCK: B29 MODEL: VALVE

INLET STREAM: FT-HC

OUTLET STREAM: TO-FRAC

PROPERTY OPTION SET: PR-BM PENG-ROBINSON EQUATION OF STATE

*** MASS AND ENERGY BALANCE ***

IN	OUT	RELATIVE DIFF.
----	-----	----------------

CONV. COMP.(KMOL/HR) 482.049 482.049 0.000000E+00

(KG/HR) 17628.4 17628.4 0.000000E+00

NONCONV. COMP(KG/HR) 0.000000E+00 0.000000E+00 0.000000E+00

TOTAL BALANCE

MASS(KG/HR) 17628.4 17628.4 0.000000E+00

ENTHALPY(CAL/SEC) -0.240596E+07 -0.240596E+07 0.151361E-06

*** INPUT DATA ***

VALVE OUTLET PRESSURE ATM 1.00000

VALVE FLOW COEF CALC. NO

FLASH SPECIFICATIONS:

NPHASE 2

MAX NUMBER OF ITERATIONS 30

CONVERGENCE TOLERANCE 0.000100000

ASPEN PLUS PLAT: WIN32 VER: 11.1 08/05/2018 PAGE 11

FT

U-O-S BLOCK SECTION

BLOCK: B29 MODEL: VALVE (CONTINUED)

*** RESULTS ***

VALVE PRESSURE DROP ATM 13.8038

BLOCK: B4 MODEL: MIXER

INLET STREAMS: COAL 6 STEAM

OUTLET STREAM: GASIFIER

PROPERTY OPTION SET: PR-BM PENG-ROBINSON EQUATION OF STATE

*** MASS AND ENERGY BALANCE ***

	IN	OUT	RELATIVE DIFF.
CONV. COMP.(KMOL/HR)	2795.51	2795.51	0.000000E+00
(KG/HR)	38052.8	38052.8	0.000000E+00
NONCONV. COMP(KG/HR)	3427.20	3427.20	0.000000E+00
TOTAL BALANCE			
MASS(KG/HR)	41480.0	41480.0	0.000000E+00
ENTHALPY(CAL/SEC)	-0.187082E+08	-0.187082E+08	-0.705001E-09

*** INPUT DATA ***

TWO PHASE FLASH

MAXIMUM NO. ITERATIONS 30

CONVERGENCE TOLERANCE 0.000100000

OUTLET PRESSURE ATM 39.4769

BLOCK: B7 MODEL: RADFRAC

INLETS - DIESEL STAGE 12

OUTLETS - PUREDESL STAGE 1

C8+ STAGE 15

PROPERTY OPTION SET: PENG-ROB STANDARD PR EQUATION OF STATE

*** MASS AND ENERGY BALANCE ***

	IN	OUT	RELATIVE DIFF.
CONV. COMP.(KMOL/HR)	32.0490	32.0490	0.221705E-15
(KG/HR)	8640.34	8640.34	0.987353E-13
NONCONV. COMP(KG/HR)	0.000000E+00	0.000000E+00	0.000000E+00
TOTAL BALANCE			
MASS(KG/HR)	8640.34	8640.34	0.987353E-13
ENTHALPY(CAL/SEC)	-832931.	-603504.	-0.275445

ASPEN PLUS PLAT: WIN32 VER: 11.1 08/05/2018 PAGE 12

FT

U-O-S BLOCK SECTION

BLOCK: B7 MODEL: RADFRAC (CONTINUED)

**** INPUT DATA ****

**** INPUT PARAMETERS ****

NUMBER OF STAGES	15
ALGORITHM OPTION	STANDARD
ABSORBER OPTION	NO
INITIALIZATION OPTION	STANDARD
HYDRAULIC PARAMETER CALCULATIONS	NO
INSIDE LOOP CONVERGENCE METHOD	BROYDEN

DESIGN SPECIFICATION METHOD	NESTED
MAXIMUM NO. OF OUTSIDE LOOP ITERATIONS	200
MAXIMUM NO. OF INSIDE LOOP ITERATIONS	10
MAXIMUM NUMBER OF FLASH ITERATIONS	50
FLASH TOLERANCE	0.000100000
OUTSIDE LOOP CONVERGENCE TOLERANCE	0.000100000

**** COL-SPECS ****

MOLAR VAPOR DIST / TOTAL DIST	1.00000
MOLAR REFLUX RATIO	0.50000
MOLAR DISTILLATE RATE	KMOL/HR 15.0000

**** PROFILES ****

P-SPEC	STAGE 1 PRES, ATM	1.00000
--------	-------------------	---------

**** RESULTS ****

*** COMPONENT SPLIT FRACTIONS ***

OUTLET STREAMS

PUREDESL C8+

COMPONENT:

CO	1.0000	.35499E-09
CO ₂	1.0000	.34137E-08
H ₂	1.0000	.12794E-09
WATER	1.0000	.88434E-07

ASPEN PLUS PLAT: WIN32 VER: 11.1

08/05/2018 PAGE 13

FT

U-O-S BLOCK SECTION

BLOCK: B7 MODEL: RADFRAC (CONTINUED)

*** COMPONENT SPLIT FRACTIONS ***

OUTLET STREAMS

PUREDESL C8+

COMPONENT:

1	1.0000	.15016E-08
2	1.0000	.82646E-08
3	1.0000	.31018E-07
4	1.0000	.11544E-06
5	1.0000	.39645E-06
6	1.0000	.13224E-05
7	1.0000	.41794E-05
8	.99999	.13071E-04
9	.99996	.40093E-04
10	.99988	.12330E-03
11	.99963	.37052E-03

12	.99890	.10954E-02
13	.99683	.31651E-02
14	.99037	.96262E-02
15	.97333	.26674E-01
16	.92776	.72241E-01
17	.82403	.17597
18	.64432	.35568
19	.40222	.59778
20	.17642	.82358
21	.40769E-01	.95923
22	.39960E-02	.99600
23	.15083E-03	.99985
24	.64982E-05	.99999
25	.34402E-06	1.0000
26	.14040E-07	1.0000
27	.49479E-09	1.0000
28	.42093E-10	1.0000

*** SUMMARY OF KEY RESULTS ***

TOP STAGE TEMPERATURE	K	557.412
BOTTOM STAGE TEMPERATURE	K	635.266
TOP STAGE LIQUID FLOW	KMOL/HR	7.50000
BOTTOM STAGE LIQUID FLOW	KMOL/HR	17.0490
TOP STAGE VAPOR FLOW	KMOL/HR	15.0000
BOTTOM STAGE VAPOR FLOW	KMOL/HR	48.1186
MOLAR REFLUX RATIO		0.50000

MOLAR BOILUP RATIO	2.82238
CONDENSER DUTY (W/O SUBCOOL) CAL/SEC	-34,946.4
REBOILER DUTY CAL/SEC	264,371.

ASPEN PLUS PLAT: WIN32 VER: 11.1 08/05/2018 PAGE 14

FT

U-O-S BLOCK SECTION

BLOCK: B7 MODEL: RADFRAC (CONTINUED)

**** MAXIMUM FINAL RELATIVE ERRORS ****

DEW POINT	0.15860E-05	STAGE= 15
BUBBLE POINT	0.92817E-06	STAGE= 15
COMPONENT MASS BALANCE	0.29729E-05	STAGE= 12 COMP=28
ENERGY BALANCE	0.13632E-05	STAGE= 12

**** PROFILES ****

****NOTE**** REPORTED VALUES FOR STAGE LIQUID AND VAPOR RATES ARE THE FLOWS FROM THE STAGE EXCLUDING ANY SIDE PRODUCT. FOR THE FIRST STAGE, THE REPORTED VAPOR FLOW IS THE VAPOR DISTILLATE FLOW. FOR THE LAST STAGE, THE REPORTED LIQUID FLOW IS THE LIQUID BOTTOMS FLOW.

ENTHALPY

STAGE TEMPERATURE	PRESSURE	CAL/MOL	HEAT DUTY
K	ATM	LIQUID VAPOR	CAL/SEC

1	557.41	1.0000	-74456.	-55445.	-.34946+05
2	566.30	1.0000	-74733.	-56191.	
10	575.28	1.0000	-76737.	-55897.	
11	576.99	1.0000	-77566.	-55682.	
12	580.11	1.0000	-79173.	-55254.	
13	600.39	1.0000	-78239.	-57366.	
14	616.91	1.0000	-78384.	-58181.	
15	635.27	1.0000	-78653.	-58510.	.26437+06

STAGE	FLOW RATE		FEED RATE		PRODUCT RATE		
	KMOL/HR		KMOL/HR		KMOL/HR		
	LIQUID	VAPOR	LIQUID	VAPOR	MIXED	LIQUID	VAPOR
1	7.500	15.00			15.0000		
2	7.467	22.50					
10	6.144	21.50					
11	5.510	21.14					
12	60.29	20.51	32.0489				
13	64.85	43.24					
14	65.17	47.80					
15	17.05	48.12			17.0489		

**** MASS FLOW PROFILES ****

STAGE	FLOW RATE		FEED RATE		PRODUCT RATE		
	KG/HR		KG/HR		KG/HR		
	LIQUID	VAPOR	LIQUID	VAPOR	MIXED	LIQUID	VAPOR
1	1792.	3124.			3123.5623		

2 1836. 4915.
 10 1596. 4795.
 11 1455. 4719.
 12 0.1644E+05 4579. 8640.3352

ASPEN PLUS PLAT: WIN32 VER: 11.1 08/05/2018 PAGE 15

FT

U-O-S BLOCK SECTION

BLOCK: B7 MODEL: RADFRAC (CONTINUED)

**** MASS FLOW PROFILES ****

STAGE	FLOW RATE		FEED RATE		PRODUCT RATE		
	KG/HR		KG/HR		KG/HR		
	LIQUID	VAPOR	LIQUID	VAPOR	MIXED	LIQUID	VAPOR
13	0.1856E+05	0.1093E+05					
14	0.1971E+05	0.1304E+05					
15	5517.	0.1419E+05			5516.7728		

**** MOLE-X-PROFILE ****

STAGE	CO	CO ₂	H ₂	WATER	1
1	0.28566E-11	0.81534E-09	0.19895E-12	0.27926E-03	0.67893E-10
2	0.19645E-11	0.54706E-09	0.13843E-12	0.18192E-03	0.46185E-10
10	0.21086E-11	0.57205E-09	0.15033E-12	0.18350E-03	0.48990E-10
11	0.21541E-11	0.58150E-09	0.15391E-12	0.18529E-03	0.49934E-10
12	0.22397E-11	0.59926E-09	0.16066E-12	0.18865E-03	0.51706E-10
13	0.10904E-13	0.52249E-11	0.00000E+00	0.37953E-05	0.36401E-12

14	0.00000E+00	0.45286E-13	0.00000E+00	0.72005E-07	0.26010E-14
15	0.00000E+00	0.00000E+00	0.00000E+00	0.13227E-08	0.00000E+00

**** MOLE-X-PROFILE ****

STAGE	2	3	4	5	6
1	0.68967E-08	0.20119E-06	0.11567E-04	0.78987E-04	0.21350E-03
2	0.46113E-08	0.13290E-06	0.75565E-05	0.51115E-04	0.13714E-03
10	0.48006E-08	0.13640E-06	0.76431E-05	0.50951E-04	0.13467E-03
11	0.48761E-08	0.13819E-06	0.77234E-05	0.51359E-04	0.13542E-03
12	0.50178E-08	0.14155E-06	0.78745E-05	0.52129E-04	0.13685E-03
13	0.54767E-10	0.21701E-08	0.16920E-06	0.15380E-05	0.55019E-05
14	0.58963E-12	0.32122E-10	0.34361E-08	0.42018E-07	0.20080E-06
15	0.64487E-14	0.47197E-12	0.67673E-10	0.10884E-08	0.67947E-08

**** MOLE-X-PROFILE ****

STAGE	7	8	9	10	11
1	0.48195E-03	0.10452E-02	0.20539E-02	0.41605E-02	0.82390E-02
2	0.30800E-03	0.66649E-03	0.13126E-02	0.26799E-02	0.53863E-02
10	0.29774E-03	0.63328E-03	0.12242E-02	0.24469E-02	0.48002E-02
11	0.29866E-03	0.63361E-03	0.12217E-02	0.24353E-02	0.47635E-02
12	0.30048E-03	0.63457E-03	0.12179E-02	0.24161E-02	0.47012E-02
13	0.16237E-04	0.45963E-04	0.11762E-03	0.31120E-03	0.80255E-03
14	0.78113E-06	0.29061E-05	0.97279E-05	0.33673E-04	0.11287E-03
15	0.34075E-07	0.16285E-06	0.69710E-06	0.30840E-05	0.13121E-04

**** MOLE-X-PROFILE ****

STAGE	12	13	14	15	16
1	0.15665E-01	0.29458E-01	0.60742E-01	0.12695	0.15534

2	0.10495E-01	0.20427E-01	0.44384E-01	0.99057E-01	0.13203
10	0.91110E-02	0.17153E-01	0.35977E-01	0.77363E-01	0.99731E-01
11	0.90143E-02	0.16905E-01	0.35305E-01	0.75509E-01	0.96677E-01
12	0.88496E-02	0.16483E-01	0.34165E-01	0.72397E-01	0.91624E-01
13	0.19916E-02	0.48622E-02	0.13349E-01	0.36563E-01	0.59419E-01
14	0.36259E-03	0.11354E-02	0.40480E-02	0.14045E-01	0.28816E-01
15	0.53344E-04	0.20886E-03	0.94431E-03	0.40574E-02	0.10307E-01

ASPEN PLUS PLAT: WIN32 VER: 11.1 08/05/2018 PAGE 16

FT

U-O-S BLOCK SECTION

BLOCK: B7 MODEL: RADFRAC (CONTINUED)

**** MOLE-X-PROFILE ****

STAGE	17	18	19	20	21
1	0.17757	0.17501	0.13876	0.78192E-01	0.22824E-01
2	0.16770	0.18616	0.17011	0.11329	0.39469E-01
10	0.12378	0.13902	0.13943	0.12879	0.10296
11	0.11881	0.13165	0.12901	0.11477	0.92981E-01
12	0.11078	0.12016	0.11370	0.94893E-01	0.73990E-01
13	0.90226E-01	0.11851	0.13167	0.12336	0.10186
14	0.54239E-01	0.86267E-01	0.11471	0.12625	0.11900
15	0.23645E-01	0.45158E-01	0.71932E-01	0.94183E-01	0.10451

**** MOLE-X-PROFILE ****

STAGE	22	23	24	25	26
1	0.27818E-02	0.13657E-03	0.74633E-05	0.49156E-06	0.25591E-07

2	0.57671E-02	0.35476E-03	0.24145E-04	0.19673E-05	0.13020E-06
10	0.59869E-01	0.27713E-01	0.13973E-01	0.76513E-02	0.41130E-02
11	0.62913E-01	0.37915E-01	0.24709E-01	0.17187E-01	0.11984E-01
12	0.56745E-01	0.44294E-01	0.37201E-01	0.32777E-01	0.29550E-01
13	0.78751E-01	0.59694E-01	0.47697E-01	0.39844E-01	0.33996E-01
14	0.10175	0.83780E-01	0.70232E-01	0.59967E-01	0.51322E-01
15	0.10361	0.99519E-01	0.95411E-01	0.91617E-01	0.88112E-01

**** MOLE-X-PROFILE ****

STAGE	27	28
1	0.11695E-08	0.11902E-09
2	0.77117E-08	0.95266E-09
10	0.22067E-02	0.13895E-02
11	0.84348E-02	0.64957E-02
12	0.27183E-01	0.25555E-01
13	0.29789E-01	0.27117E-01
14	0.44359E-01	0.39554E-01
15	0.84866E-01	0.81851E-01

**** MOLE-Y-PROFILE ****

STAGE	CO	CO ₂	H ₂	WATER	1
1	0.94596E-09	0.13396E-06	0.90444E-10	0.17000E-01	0.14731E-07
2	0.63160E-09	0.89580E-07	0.60362E-10	0.11426E-01	0.98431E-08
10	0.66064E-09	0.93638E-07	0.63149E-10	0.11916E-01	0.10292E-07
11	0.67169E-09	0.95200E-07	0.64206E-10	0.12113E-01	0.10464E-07
12	0.69242E-09	0.98130E-07	0.66188E-10	0.12483E-01	0.10787E-07
13	0.31229E-11	0.83556E-09	0.22401E-12	0.26304E-03	0.72095E-10
14	0.14793E-13	0.70883E-11	0.00000E+00	0.51485E-05	0.49384E-12

15 0.00000E+00 0.61189E-13 0.00000E+00 0.97048E-07 0.35156E-14

**** MOLE-Y-PROFILE ****

STAGE	2	3	4	5	6
1	0.88686E-06	0.17294E-04	0.66630E-03	0.31203E-02	0.58401E-02
2	0.59354E-06	0.11597E-04	0.44806E-03	0.21065E-02	0.39645E-02
10	0.62022E-06	0.12107E-04	0.46719E-03	0.21924E-02	0.41153E-02
11	0.63055E-06	0.12308E-04	0.47490E-03	0.22284E-02	0.41822E-02
12	0.64992E-06	0.12685E-04	0.48938E-03	0.22958E-02	0.43076E-02
13	0.69963E-08	0.19737E-06	0.10980E-04	0.72684E-04	0.19080E-03
14	0.74298E-10	0.29440E-08	0.22952E-06	0.20862E-05	0.74618E-05
15	0.79626E-12	0.43336E-10	0.46296E-08	0.56520E-07	0.26954E-06

ASPEN PLUS PLAT: WIN32 VER: 11.1 08/05/2018 PAGE 17

FT

U-O-S BLOCK SECTION

BLOCK: B7 MODEL: RADFRAC (CONTINUED)

**** MOLE-Y-PROFILE ****

STAGE	7	8	9	10	11
1	0.92667E-02	0.14161E-01	0.19761E-01	0.28425E-01	0.40235E-01
2	0.63385E-02	0.97892E-02	0.13859E-01	0.20337E-01	0.29569E-01
10	0.65554E-02	0.10072E-01	0.14158E-01	0.20575E-01	0.29531E-01
11	0.66604E-02	0.10230E-01	0.14374E-01	0.20876E-01	0.29938E-01
12	0.68575E-02	0.10527E-01	0.14781E-01	0.21443E-01	0.30706E-01
13	0.41894E-03	0.88472E-03	0.16979E-02	0.33676E-02	0.65498E-02
14	0.22016E-04	0.62298E-04	0.15932E-03	0.42109E-03	0.10841E-02

15 0.10458E-05 0.38781E-05 0.12928E-04 0.44511E-04 0.14821E-03

**** MOLE-Y-PROFILE ****

STAGE	12	13	14	15	16
1	0.55287E-01	0.74763E-01	0.11042	0.16828	0.15045
2	0.42080E-01	0.59662E-01	0.93863E-01	0.15450	0.15208
10	0.41348E-01	0.57397E-01	0.88050E-01	0.14116	0.13572
11	0.41869E-01	0.58023E-01	0.88790E-01	0.14186	0.13571
12	0.42856E-01	0.59220E-01	0.90243E-01	0.14336	0.13600
13	0.12318E-01	0.22900E-01	0.47264E-01	0.99344E-01	0.12369
14	0.26829E-02	0.65219E-02	0.17774E-01	0.48156E-01	0.76936E-01
15	0.47217E-03	0.14637E-02	0.51476E-02	0.17584E-01	0.35374E-01

**** MOLE-Y-PROFILE ****

STAGE	17	18	19	20	21
1	0.12585	0.92979E-01	0.55010E-01	0.22931E-01	0.50484E-02
2	0.14309	0.12032	0.82926E-01	0.41351E-01	0.10974E-01
10	0.12623	0.10846	0.82865E-01	0.57960E-01	0.35626E-01
11	0.12525	0.10636	0.79541E-01	0.53692E-01	0.33500E-01
12	0.12396	0.10337	0.74891E-01	0.47602E-01	0.28671E-01
13	0.14514	0.14973	0.13017	0.95173E-01	0.61957E-01
14	0.11397	0.14467	0.15297	0.13376	0.10092
15	0.65079E-01	0.10083	0.12987	0.13761	0.12414

**** MOLE-Y-PROFILE ****

STAGE	22	23	24	25	26
1	0.47248E-03	0.17064E-04	0.70469E-06	0.35823E-07	0.14061E-08
2	0.12422E-02	0.56900E-04	0.29576E-05	0.18774E-06	0.94678E-08

10	0.16182E-01	0.56414E-02	0.21938E-02	0.94407E-03	0.39057E-03
11	0.17732E-01	0.80651E-02	0.40609E-02	0.22234E-02	0.11952E-02
12	0.17247E-01	0.10198E-01	0.66384E-02	0.46172E-02	0.32193E-02
13	0.38265E-01	0.22518E-01	0.14248E-01	0.95763E-02	0.64583E-02
14	0.69884E-01	0.45489E-01	0.30679E-01	0.21378E-01	0.14695E-01
15	0.10109	0.78204E-01	0.61311E-01	0.48754E-01	0.38287E-01

**** MOLE-Y-PROFILE ****

STAGE	27	28
1	0.47726E-10	0.39160E-11
2	0.42167E-09	0.42283E-10
10	0.15939E-03	0.81970E-04
11	0.64125E-03	0.40376E-03
12	0.22660E-02	0.17450E-02
13	0.44382E-02	0.33567E-02
14	0.10145E-01	0.75952E-02
15	0.30007E-01	0.24567E-01

ASPEN PLUS PLAT: WIN32 VER: 11.1 08/05/2018 PAGE 18

FT

U-O-S BLOCK SECTION

BLOCK: B7 MODEL: RADFRAC (CONTINUED)

**** K-VALUES ****

STAGE	CO	CO ₂	H ₂	WATER	1
1	331.15	164.30	454.60	60.875	216.97
2	321.50	163.75	436.05	62.809	213.12

10	313.31	163.69	420.07	64.938	210.09
11	311.82	163.71	417.17	65.375	209.57
12	309.15	163.75	411.98	66.169	208.62
13	286.40	159.92	372.47	69.306	198.06
14	269.44	156.52	344.12	71.502	189.87
15	251.32	152.08	315.04	73.372	180.65

**** K-VALUES ****					
STAGE	2	3	4	5	6
1	128.59	85.958	57.605	39.504	27.354
2	128.71	87.255	59.294	41.211	28.909
10	129.20	88.761	61.126	43.030	30.558
11	129.31	89.066	61.489	43.388	30.883
12	129.52	89.616	62.147	44.041	31.477
13	127.75	90.949	64.890	47.258	34.680
14	126.01	91.650	66.797	49.649	37.160
15	123.48	91.819	68.412	51.932	39.669

**** K-VALUES ****					
STAGE	7	8	9	10	11
1	19.227	13.549	9.6213	6.8323	4.8834
2	20.580	14.688	10.558	7.5889	5.4897
10	22.017	15.905	11.566	8.4085	6.1520
11	22.301	16.146	11.766	8.5723	6.2849
12	22.822	16.589	12.136	8.8752	6.5315
13	25.802	19.249	14.436	10.821	8.1612
14	28.185	21.437	16.377	12.505	9.6048
15	30.692	23.814	18.545	14.433	11.296

**** K-VALUES ****

STAGE	12	13	14	15	16
1	3.5293	2.5380	1.8179	1.3255	0.96852
2	4.0096	2.9208	2.1148	1.5598	1.1518
10	4.5382	3.3462	2.4474	1.8246	1.3609
11	4.6447	3.4323	2.5150	1.8787	1.4037
12	4.8427	3.5929	2.6414	1.9802	1.4843
13	6.1849	4.7097	3.5406	2.7171	2.0816
14	7.3992	5.7439	4.3908	3.4287	2.6699
15	8.8514	7.0084	5.4512	4.3338	3.4321

**** K-VALUES ****

STAGE	17	18	19	20	21
1	0.70873	0.53127	0.39645	0.29326	0.22119
2	0.85325	0.64636	0.48749	0.36499	0.27803
10	1.0198	0.78017	0.59432	0.45004	0.34601
11	1.0542	0.80788	0.61654	0.46783	0.36029
12	1.1190	0.86027	0.65865	0.50164	0.38750
13	1.6086	1.2635	0.98865	0.77151	0.60823
14	2.1013	1.6770	1.3336	1.0595	0.84805
15	2.7524	2.2329	1.8054	1.4611	1.1879

ASPEN PLUS PLAT: WIN32 VER: 11.1 08/05/2018 PAGE 19

FT

U-O-S BLOCK SECTION

BLOCK: B7 MODEL: RADFRAC (CONTINUED)

**** K-VALUES ****

STAGE	22	23	24	25	26
1	0.16985	0.12494	0.94421E-01	0.72876E-01	0.54944E-01
2	0.21540	0.16039	0.12249	0.95429E-01	0.72719E-01
10	0.27029	0.20357	0.15700	0.12339	0.94959E-01
11	0.28185	0.21272	0.16435	0.12937	0.99735E-01
12	0.30393	0.23024	0.17845	0.14086	0.10895
13	0.48590	0.37723	0.29871	0.24035	0.18997
14	0.68680	0.54296	0.43682	0.35649	0.28633
15	0.97569	0.78582	0.64259	0.53215	0.43452

**** K-VALUES ****

STAGE	27	28
1	0.40808E-01	0.32903E-01
2	0.54679E-01	0.44384E-01
10	0.72231E-01	0.58994E-01
11	0.76024E-01	0.62158E-01
12	0.83358E-01	0.68285E-01
13	0.14899	0.12379
14	0.22869	0.19202
15	0.35357	0.30015

**** MASS-X-PROFILE ****

STAGE	CO	CO ₂	H ₂	WATER	1
1	0.33492E-12	0.15019E-09	0.16787E-14	0.21058E-04	0.45591E-11
2	0.22384E-12	0.97937E-10	0.11352E-14	0.13332E-04	0.30140E-11
10	0.22745E-12	0.96950E-10	0.11670E-14	0.12731E-04	0.30266E-11

11	0.22843E-12	0.96891E-10	0.11747E-14	0.12638E-04	0.30329E-11
12	0.23001E-12	0.96694E-10	0.11874E-14	0.12460E-04	0.30413E-11
13	0.10674E-14	0.80363E-12	0.00000E+00	0.23895E-06	0.20409E-13
14	0.00000E+00	0.65899E-14	0.00000E+00	0.42891E-08	0.13797E-15
15	0.00000E+00	0.00000E+00	0.00000E+00	0.73640E-10	0.00000E+00

**** MASS-X-PROFILE ****

STAGE	2	3	4	5	6
1	0.86804E-09	0.37136E-07	0.28141E-05	0.23854E-04	0.77011E-04
2	0.56404E-09	0.23840E-07	0.17866E-05	0.15002E-04	0.48075E-04
10	0.55589E-09	0.23163E-07	0.17108E-05	0.14157E-04	0.44693E-04
11	0.55511E-09	0.23072E-07	0.16996E-05	0.14029E-04	0.44183E-04
12	0.55318E-09	0.22885E-07	0.16781E-05	0.13789E-04	0.43237E-04
13	0.57554E-11	0.33444E-09	0.34370E-07	0.38781E-06	0.16570E-05
14	0.58624E-13	0.46835E-11	0.66037E-09	0.10024E-07	0.57217E-07
15	0.59926E-15	0.64318E-13	0.12156E-10	0.24267E-09	0.18096E-08

**** MASS-X-PROFILE ****

STAGE	7	8	9	10	11
1	0.20214E-03	0.49976E-03	0.11026E-02	0.24778E-02	0.53906E-02
2	0.12554E-03	0.30970E-03	0.68482E-03	0.15511E-02	0.34249E-02
10	0.11489E-03	0.27858E-03	0.60463E-03	0.13407E-02	0.28895E-02
11	0.11330E-03	0.27402E-03	0.59323E-03	0.13119E-02	0.28190E-02
12	0.11039E-03	0.26576E-03	0.57271E-03	0.12604E-02	0.26942E-02
13	0.56861E-05	0.18349E-04	0.52721E-04	0.15475E-03	0.43842E-03
14	0.25881E-06	0.10977E-05	0.41255E-05	0.15842E-04	0.58337E-04
15	0.10552E-07	0.57490E-07	0.27631E-06	0.13561E-05	0.63383E-05

FT

U-O-S BLOCK SECTION

BLOCK: B7 MODEL: RADFRAC (CONTINUED)

**** MASS-X-PROFILE ****

STAGE	12	13	14	15	16
1	0.11169E-01	0.22733E-01	0.50440E-01	0.11288	0.14723
2	0.72719E-02	0.15319E-01	0.35819E-01	0.85593E-01	0.12162
10	0.59765E-02	0.12178E-01	0.27487E-01	0.63284E-01	0.86969E-01
11	0.58134E-02	0.11800E-01	0.26518E-01	0.60726E-01	0.82884E-01
12	0.55267E-02	0.11141E-01	0.24850E-01	0.56382E-01	0.76069E-01
13	0.11856E-02	0.31329E-02	0.92557E-02	0.27143E-01	0.47024E-01
14	0.20422E-03	0.69217E-03	0.26554E-02	0.98647E-02	0.21576E-01
15	0.28081E-04	0.11900E-03	0.57896E-03	0.26635E-02	0.72127E-02

**** MASS-X-PROFILE ****

STAGE	17	18	19	20	21
1	0.17873	0.18643	0.15596	0.92476E-01	0.28334E-01
2	0.16404	0.19272	0.18581	0.13022	0.47617E-01
10	0.11462	0.13624	0.14418	0.14014	0.11759
11	0.10817	0.12685	0.13116	0.12277	0.10440
12	0.97667E-01	0.11212	0.11194	0.98302E-01	0.80454E-01
13	0.75827E-01	0.10540	0.12357	0.12181	0.10558
14	0.43127E-01	0.72594E-01	0.10185	0.11795	0.11670
15	0.17572E-01	0.35517E-01	0.59693E-01	0.82240E-01	0.95786E-01

**** MASS-X-PROFILE ****

STAGE	22	23	24	25	26
1	0.36166E-02	0.18558E-03	0.10579E-04	0.72567E-06	0.39281E-07
2	0.72867E-02	0.46848E-03	0.33262E-04	0.28224E-05	0.19422E-06
10	0.71611E-01	0.34645E-01	0.18223E-01	0.10392E-01	0.58085E-02
11	0.73984E-01	0.46600E-01	0.31681E-01	0.22949E-01	0.16638E-01
12	0.64621E-01	0.52719E-01	0.46190E-01	0.42383E-01	0.39730E-01
13	0.85486E-01	0.67725E-01	0.56452E-01	0.49111E-01	0.43570E-01
14	0.10450	0.89930E-01	0.78644E-01	0.69932E-01	0.62230E-01
15	0.99458E-01	0.99842E-01	0.99856E-01	0.99857E-01	0.99857E-01

**** MASS-X-PROFILE ****

STAGE	27	28
1	0.18639E-08	0.19666E-09
2	0.11944E-07	0.15298E-08
10	0.32355E-02	0.21123E-02
11	0.12159E-01	0.97085E-02
12	0.37946E-01	0.36987E-01
13	0.39638E-01	0.37412E-01
14	0.55844E-01	0.51629E-01
15	0.99857E-01	0.99857E-01

**** MASS-Y-PROFILE ****

STAGE	CO	CO ₂	H ₂	WATER	1
1	0.12724E-09	0.28312E-07	0.87556E-12	0.14707E-02	0.11349E-08
2	0.80981E-10	0.18046E-07	0.55700E-12	0.94227E-03	0.72283E-09
10	0.82961E-10	0.18475E-07	0.57072E-12	0.96243E-03	0.74027E-09
11	0.84299E-10	0.18773E-07	0.57993E-12	0.97777E-03	0.75219E-09

12	0.86874E-10	0.19344E-07	0.59765E-12	0.10073E-02	0.77513E-09
13	0.34614E-12	0.14551E-09	0.17869E-14	0.18751E-04	0.45768E-11
14	0.15190E-14	0.11436E-11	0.00000E+00	0.34002E-06	0.29044E-13
15	0.00000E+00	0.91303E-14	0.00000E+00	0.59278E-08	0.19123E-15

ASPEN PLUS PLAT: WIN32 VER: 11.1 08/05/2018 PAGE 21

FT

U-O-S BLOCK SECTION

BLOCK: B7 MODEL: RADFRAC (CONTINUED)

**** MASS-Y-PROFILE ****

STAGE	2	3	4	5	6
1	0.12806E-06	0.36622E-05	0.18598E-03	0.10811E-02	0.24169E-02
2	0.81697E-07	0.23408E-05	0.11921E-03	0.69571E-03	0.15639E-02
10	0.83610E-07	0.23936E-05	0.12174E-03	0.70916E-03	0.15899E-02
11	0.84953E-07	0.24319E-05	0.12368E-03	0.72038E-03	0.16148E-02
12	0.87537E-07	0.25056E-05	0.12741E-03	0.74196E-03	0.16628E-02
13	0.83249E-09	0.34440E-07	0.25253E-05	0.20752E-04	0.65067E-04
14	0.81902E-11	0.47591E-09	0.48907E-07	0.55179E-06	0.23573E-05
15	0.81179E-13	0.64791E-11	0.91235E-09	0.13826E-07	0.78755E-07

**** MASS-Y-PROFILE ****

STAGE	7	8	9	10	11
1	0.44592E-02	0.77683E-02	0.12171E-01	0.19423E-01	0.30202E-01
2	0.29073E-02	0.51187E-02	0.81364E-02	0.13246E-01	0.21157E-01
10	0.29449E-02	0.51581E-02	0.81411E-02	0.13125E-01	0.20694E-01
11	0.29904E-02	0.52360E-02	0.82606E-02	0.13309E-01	0.20968E-01

12	0.30779E-02	0.53864E-02	0.84914E-02	0.13666E-01	0.21499E-01
13	0.16612E-03	0.39992E-03	0.86173E-03	0.18961E-02	0.40513E-02
14	0.80874E-05	0.26088E-04	0.74909E-04	0.21965E-03	0.62123E-03
15	0.35531E-06	0.15020E-05	0.56217E-05	0.21473E-04	0.78550E-04

**** MASS-Y-PROFILE ****

STAGE	12	13	14	15	16
1	0.45225E-01	0.66193E-01	0.10520	0.17166	0.16360
2	0.32810E-01	0.50350E-01	0.85240E-01	0.15023	0.15763
10	0.31576E-01	0.47441E-01	0.78315E-01	0.13443	0.13778
11	0.31955E-01	0.47930E-01	0.78927E-01	0.13502	0.13769
12	0.32699E-01	0.48905E-01	0.80194E-01	0.13640	0.13795
13	0.83029E-02	0.16707E-01	0.37105E-01	0.83505E-01	0.11083
14	0.16754E-02	0.44080E-02	0.12927E-01	0.37500E-01	0.63868E-01
15	0.27269E-03	0.91498E-03	0.34625E-02	0.12664E-01	0.27159E-01

**** MASS-Y-PROFILE ****

STAGE	17	18	19	20	21
1	0.14533	0.11364	0.70937E-01	0.31114E-01	0.71902E-02
2	0.15751	0.14017	0.10193	0.53482E-01	0.14898E-01
10	0.13609	0.12375	0.99758E-01	0.73421E-01	0.47369E-01
11	0.13495	0.12128	0.95701E-01	0.67974E-01	0.44517E-01
12	0.13352	0.11784	0.90078E-01	0.60246E-01	0.38088E-01
13	0.13811	0.15079	0.13832	0.10641	0.72712E-01
14	0.10047	0.13497	0.15059	0.13856	0.10973
15	0.53060E-01	0.87006E-01	0.11824	0.13183	0.12483

**** MASS-Y-PROFILE ****

STAGE	22	23	24	25	26
1	0.70475E-03	0.26602E-04	0.11461E-05	0.60673E-07	0.24761E-08
2	0.17662E-02	0.84554E-04	0.45848E-05	0.30309E-06	0.15893E-07
10	0.22533E-01	0.82105E-02	0.33307E-02	0.14927E-02	0.64212E-03
11	0.24678E-01	0.11731E-01	0.61620E-02	0.35135E-02	0.19638E-02
12	0.23995E-01	0.14829E-01	0.10070E-01	0.72941E-02	0.52881E-02
13	0.47032E-01	0.28927E-01	0.19093E-01	0.13365E-01	0.93718E-02
14	0.79575E-01	0.54137E-01	0.38088E-01	0.27641E-01	0.19756E-01
15	0.10646	0.86077E-01	0.70399E-01	0.58299E-01	0.47604E-01

ASPEN PLUS PLAT: WIN32 VER: 11.1 08/05/2018 PAGE 22

FT

U-O-S BLOCK SECTION

BLOCK: B7 MODEL: RADFRAC (CONTINUED)

***** MASS-Y-PROFILE *****

STAGE	27	28
1	0.87263E-10	0.74238E-11
2	0.73489E-09	0.76408E-10
10	0.27207E-03	0.14507E-03
11	0.10939E-02	0.71417E-03
12	0.38644E-02	0.30857E-02
13	0.66868E-02	0.52437E-02
14	0.14160E-01	0.10992E-01
15	0.38736E-01	0.32882E-01

BLOCK: B8 MODEL: HEATER

INLET STREAM: PUREDESL

OUTLET STREAM: COLDDSL

PROPERTY OPTION SET: PR-BM PENG-ROBINSON EQUATION OF STATE

*** MASS AND ENERGY BALANCE ***

	IN	OUT	RELATIVE DIFF.
CONV. COMP.(KMOL/HR)	15.0000	15.0000	0.000000E+00
(KG/HR)	3123.56	3123.56	0.000000E+00
NONCONV. COMP(KG/HR)	0.000000E+00	0.000000E+00	0.000000E+00
TOTAL BALANCE			
MASS(KG/HR)	3123.56	3123.56	0.000000E+00
ENTHALPY(CAL/SEC)	-231022.	-419669.	0.449515

*** INPUT DATA ***

TWO PHASE TP FLASH

SPECIFIED TEMPERATURE	K	293.150
SPECIFIED PRESSURE	ATM	1.00000
MAXIMUM NO. ITERATIONS		30
CONVERGENCE TOLERANCE		0.000100000

*** RESULTS ***

OUTLET TEMPERATURE	K	293.15
OUTLET PRESSURE	ATM	1.0000
HEAT DUTY	CAL/SEC	-0.18865E+06
OUTLET VAPOR FRACTION		0.00000E+00

ASPEN PLUS PLAT: WIN32 VER: 11.1

08/05/2018 PAGE 23

FT

U-O-S BLOCK SECTION

BLOCK: B8 MODEL: HEATER (CONTINUED)

V-L PHASE EQUILIBRIUM :

COMP	F(I)	X(I)	Y(I)	K(I)	
CO	0.94596E-09	0.94596E-09	0.10424E-04	378.26	
CO ₂	0.13396E-06	0.13396E-06	0.14899E-03	38.177	
H ₂	0.90444E-10	0.90444E-10	0.20750E-05	787.55	
WATER	0.17000E-01	0.17000E-01	0.84584	1.7080	
1	0.14731E-07	0.14731E-07	0.65158E-04	151.84	
2	0.88686E-06	0.88686E-06	0.69209E-03	26.788	
3	0.17294E-04	0.17294E-04	0.36989E-02	7.3419	
4	0.66630E-03	0.66630E-03	0.39530E-01	2.0366	
5	0.31203E-02	0.31203E-02	0.53463E-01	0.58817	
6	0.58401E-02	0.58401E-02	0.29763E-01	0.17494	
7	0.92667E-02	0.92667E-02	0.14484E-01	0.53655E-01	
8	0.14161E-01	0.14161E-01	0.67865E-02	0.16451E-01	
9	0.19761E-01	0.19761E-01	0.30092E-02	0.52274E-02	

10	0.28425E-01	0.28425E-01	0.13423E-02	0.16210E-02
11	0.40235E-01	0.40235E-01	0.63252E-03	0.53965E-03
12	0.55287E-01	0.55287E-01	0.28077E-03	0.17433E-03
13	0.74763E-01	0.74763E-01	0.12847E-03	0.58984E-04
14	0.11042	0.11042	0.69458E-04	0.21592E-04
15	0.16828	0.16828	0.35732E-04	0.72888E-05
16	0.15045	0.15045	0.11816E-04	0.26961E-05
17	0.12585	0.12585	0.30819E-05	0.84063E-06
18	0.92979E-01	0.92979E-01	0.83744E-06	0.30918E-06
19	0.55010E-01	0.55010E-01	0.17980E-06	0.11220E-06
20	0.22931E-01	0.22931E-01	0.23641E-07	0.35391E-07
21	0.50484E-02	0.50484E-02	0.20265E-08	0.13779E-07
22	0.47248E-03	0.47248E-03	0.81548E-10	0.59247E-08
23	0.17064E-04	0.17064E-04	0.92008E-12	0.18509E-08
24	0.70469E-06	0.70469E-06	0.13859E-13	0.67510E-09
25	0.35823E-07	0.35823E-07	0.28977E-15	0.27767E-09
26	0.14061E-08	0.14061E-08	0.40690E-17	0.99339E-10
27	0.47726E-10	0.47726E-10	0.42410E-19	0.30503E-10
28	0.39160E-11	0.39160E-11	0.18206E-20	0.15959E-10

BLOCK: COABSORB MODEL: RADFRAC

INLETS - AMINECO₂ STAGE 1

SOURSYN2 STAGE 2

OUTLETS - SWEETSYN STAGE 1

RICH₂ STAGE 2

PROPERTY OPTION SET: AMINES AMINE / REDLICH-KWONG

FT

U-O-S BLOCK SECTION

BLOCK: COABSORB MODEL: RADFRAC (CONTINUED)

*** MASS AND ENERGY BALANCE ***

	IN	OUT	RELATIVE DIFF.
CONV. COMP.(KMOL/HR)	19837.4	19837.4	0.000000E+00
(KG/HR)	390743.	390743.	0.148966E-15
NONCONV. COMP(KG/HR)	0.000000E+00	0.000000E+00	0.000000E+00
TOTAL BALANCE			
MASS(KG/HR)	390743.	390743.	0.148966E-15
ENTHALPY(CAL/SEC)	-0.348464E+09	-0.348464E+09	-0.431285E-07

**** INPUT DATA ****

**** INPUT PARAMETERS ****

NUMBER OF STAGES	2
ALGORITHM OPTION	STANDARD
ABSORBER OPTION	NO
INITIALIZATION OPTION	STANDARD
HYDRAULIC PARAMETER CALCULATIONS	NO

INSIDE LOOP CONVERGENCE METHOD	BROYDEN
DESIGN SPECIFICATION METHOD	NESTED
MAXIMUM NO. OF OUTSIDE LOOP ITERATIONS	25
MAXIMUM NO. OF INSIDE LOOP ITERATIONS	10
MAXIMUM NUMBER OF FLASH ITERATIONS	50
FLASH TOLERANCE	0.000100000
OUTSIDE LOOP CONVERGENCE TOLERANCE	0.000100000

**** COL-SPECS ****

MOLAR VAPOR DIST / TOTAL DIST	1.00000
CONDENSER DUTY (W/O SUBCOOL) CAL/SEC	0.0
REBOILER DUTY CAL/SEC	0.0

**** PROFILES ****

P-SPEC	STAGE 1 PRES, ATM	39.4769
--------	-------------------	---------

ASPEN PLUS PLAT: WIN32 VER: 11.1 08/05/2018 PAGE 25

FT

U-O-S BLOCK SECTION

BLOCK: COABSORB MODEL: RADFRAC (CONTINUED)

**** RESULTS ****

*** COMPONENT SPLIT FRACTIONS ***

OUTLET STREAMS

SWEETSYN RICH₂

COMPONENT:

N ₂	.99998	.19818E-04
CO	.99994	.58590E-04
CO ₂	.14971E-10	1.0000
H ₂	.99997	.28092E-04
WATER	.20311E-03	.99980
H ₂ S	.33378E-07	1.0000
MEA	.53302E-05	.99999
1	.99999	.11482E-04

*** SUMMARY OF KEY RESULTS ***

TOP STAGE TEMPERATURE	K	313.638
BOTTOM STAGE TEMPERATURE	K	325.056
TOP STAGE LIQUID FLOW	KMOL/HR	18,002.7
BOTTOM STAGE LIQUID FLOW	KMOL/HR	18,204.0
TOP STAGE VAPOR FLOW	KMOL/HR	1,633.40
BOTTOM STAGE VAPOR FLOW	KMOL/HR	1,636.09
CONDENSER DUTY (W/O SUBCOOL)	CAL/SEC	0.0
REBOILER DUTY	CAL/SEC	0.0

**** MAXIMUM FINAL RELATIVE ERRORS ****

DEW POINT 0.12227E-08 STAGE= 1
 BUBBLE POINT 0.11513E-06 STAGE= 1
 COMPONENT MASS BALANCE 0.71339E-06 STAGE= 1 COMP=CO
 ENERGY BALANCE 0.35162E-06 STAGE= 1

ASPEN PLUS PLAT: WIN32 VER: 11.1 08/05/2018 PAGE 26

FT

U-O-S BLOCK SECTION

BLOCK: COABSORB MODEL: RADFRAC (CONTINUED)

**** PROFILES ****

****NOTE**** REPORTED VALUES FOR STAGE LIQUID AND VAPOR RATES ARE THE FLOWS
 FROM THE STAGE EXCLUDING ANY SIDE PRODUCT. FOR THE FIRST STAGE,
 THE REPORTED VAPOR FLOW IS THE VAPOR DISTILLATE FLOW. FOR THE
 LAST STAGE, THE REPORTED LIQUID FLOW IS THE LIQUID BOTTOMS FLOW.

ENTHALPY

STAGE	TEMPERATURE	PRESSURE	CAL/MOL		HEAT DUTY
K	ATM	LIQUID	VAPOR	CAL/SEC	
1	313.64	39.477	-67773.	-10043.	
2	325.06	39.477	-68011.	-10038.	

STAGE	FLOW RATE		FEED RATE		PRODUCT RATE	
	LIQUID	VAPOR	LIQUID	VAPOR	MIXED	LIQUID VAPOR
1	0.1800E+05	1633.	.18000+05			1633.4013
2	0.1820E+05	1636.		1837.4131	.18204+05	

**** MASS FLOW PROFILES ****

STAGE	FLOW RATE		FEED RATE		PRODUCT RATE	
	LIQUID	VAPOR	LIQUID	VAPOR	MIXED	LIQUID VAPOR
1	0.3627E+06	0.1928E+05	.36263+06			.19284+05
2	0.3715E+06	0.1933E+05		.28117+05	.37146+06	

**** MOLE-X-PROFILE ****

STAGE	N ₂	CO	CO ₂	H ₂	WATER	
1	0.33042E-08	0.10687E-05	0.89752E-06	0.87877E-06	0.95053	
2	0.57080E-08	0.17997E-05	0.10437E-01	0.15053E-05	0.93989	

**** MOLE-X-PROFILE ****

STAGE	H ₂ S	MEA	1
1	0.14641E-05	0.49464E-01	0.32291E-07
2	0.74907E-03	0.48917E-01	0.56834E-07

**** MOLE-Y-PROFILE ****

STAGE	N ₂	CO	CO ₂	H ₂	WATER	
1	0.32099E-02	0.34232	0.17414E-11	0.59717	0.21280E-02	

2	0.32047E-02	0.34177	0.98758E-05	0.59620	0.37157E-02
---	-------------	---------	-------------	---------	-------------

**** MOLE-Y-PROFILE ****

STAGE	H ₂ S	MEA	1
1	0.27865E-09	0.29059E-05	0.55167E-01
2	0.16110E-04	0.63789E-05	0.55076E-01

ASPEN PLUS PLAT: WIN32 VER: 11.1 08/05/2018 PAGE 27

FT

U-O-S BLOCK SECTION

BLOCK: COABSORB MODEL: RADFRAC (CONTINUED)

**** K-VALUES ****

STAGE	N ₂	CO	CO ₂	H ₂	WATER
1	0.97147E+06	0.32031E+06	0.19403E-05	0.67955E+06	0.22388E-02
2	0.56144E+06	0.18990E+06	0.94624E-03	0.39608E+06	0.39533E-02

**** K-VALUES ****

STAGE	H ₂ S	MEA	1
1	0.19032E-03	0.58747E-04	0.17084E+07
2	0.21507E-01	0.13040E-03	0.96908E+06

**** MASS-X-PROFILE ****

STAGE	N ₂	CO	CO ₂	H ₂	WATER
1	0.45946E-08	0.14859E-05	0.19607E-05	0.87935E-07	0.85001
2	0.78362E-08	0.24705E-05	0.22510E-01	0.14871E-06	0.82980

**** MASS-X-PROFILE ****

STAGE	H ₂ S	MEA	1
1	0.24769E-05	0.14998	0.25715E-07
2	0.12511E-02	0.14643	0.44683E-07

**** MASS-Y-PROFILE ****

STAGE	N ₂	CO	CO ₂	H ₂	WATER
1	0.76166E-02	0.81219	0.64917E-11	0.10197	0.32473E-02
2	0.75972E-02	0.81014	0.36781E-04	0.10171	0.56648E-02

**** MASS-Y-PROFILE ****

STAGE	H ₂ S	MEA	1
1	0.80442E-09	0.15035E-04	0.74965E-01
2	0.46465E-04	0.32974E-04	0.74773E-01

BLOCK: COOLER MODEL: HEATER

INLET STREAM: SYN

OUTLET STREAM: SOURSYN

PROPERTY OPTION SET: PR-BM PENG-ROBINSON EQUATION OF STATE

*** MASS AND ENERGY BALANCE ***

	IN	OUT	RELATIVE DIFF.
CONV. COMP.(KMOL/HR)	1936.14	1936.14	0.000000E+00
(KG/HR)	29895.5	29895.5	0.000000E+00
NONCONV. COMP(KG/HR)	0.000000E+00	0.000000E+00	0.000000E+00
TOTAL BALANCE			
MASS(KG/HR)	29895.5	29895.5	0.000000E+00

ENTHALPY(CAL/SEC) -0.758994E+07 -0.114771E+08 0.338690

ASPEN PLUS PLAT: WIN32 VER: 11.1 08/05/2018 PAGE 28

FT

U-O-S BLOCK SECTION

BLOCK: COOLER MODEL: HEATER (CONTINUED)

*** INPUT DATA ***

TWO PHASE TP FLASH

SPECIFIED TEMPERATURE K 303.150

SPECIFIED PRESSURE ATM 39.4769

MAXIMUM NO. ITERATIONS 30

CONVERGENCE TOLERANCE 0.000100000

*** RESULTS ***

OUTLET TEMPERATURE K 303.15

OUTLET PRESSURE ATM 39.477

HEAT DUTY CAL/SEC -0.38872E+07

OUTLET VAPOR FRACTION 0.94818

PRESSURE-DROP CORRELATION PARAMETER -18584.

V-L PHASE EQUILIBRIUM :

COMP	F(I)	X(I)	Y(I)	K(I)
N2	0.27081E-02	0.14513E-07	0.28561E-02	0.19680E+06
CO	0.28881	0.15917E-05	0.30460	0.19137E+06
CO ₂	0.98133E-01	0.49164E-04	0.10349	2105.1
H ₂	0.50381	0.76056E-05	0.53135	69862.
WATER	0.52945E-01	0.99983	0.11907E-02	0.11909E-02
H ₂ S	0.70486E-02	0.10745E-03	0.74280E-02	69.129
1	0.46541E-01	0.19026E-05	0.49085E-01	25799.

BLOCK: CYCLONE MODEL: SSPLIT

INLET STREAM: 3

OUTLET STREAMS: SYN ASH+COAL

PROPERTY OPTION SET: PR-BM PENG-ROBINSON EQUATION OF STATE

*** MASS AND ENERGY BALANCE ***

	IN	OUT	RELATIVE DIFF.
CONV. COMP.(KMOL/HR)	2615.29	2615.29	0.000000E+00
(KG/HR)	38052.8	38052.8	0.000000E+00
NONCONV. COMP(KG/HR)	3427.20	3427.20	0.000000E+00
TOTAL BALANCE			
MASS(KG/HR)	41480.0	41480.0	0.000000E+00
ENTHALPY(CAL/SEC)	-0.676595E+07	-0.676595E+07	0.000000E+00

ASPEN PLUS PLAT: WIN32 VER: 11.1 08/05/2018 PAGE 29

FT

U-O-S BLOCK SECTION

BLOCK: CYCLONE MODEL: SSPLIT (CONTINUED)

*** INPUT DATA ***

FRACTION OF FLOW

SUBSTRM=	STRM=	FRAC=
MIXED	SYN	1.00000
CIPSD	SYN	0.0
NCPSD	SYN	0.0

*** RESULTS ***

STRM= SYN	SUBSTRM= MIXED	SPLIT FRACT=	1.00000
	CIPSD		0.0
	NCPSD		0.0

STRM= ASH+COAL	SUBSTRM= MIXED	SPLIT FRACT=	0.0
	CIPSD		1.00000
	NCPSD		1.00000

BLOCK: FRA1 MODEL: RADFRAC

INLETS - TO-FRAC STAGE 5

OUTLETS - NO-REACT STAGE 1

HC STAGE 5

PROPERTY OPTION SET: NRTL RENON (NRTL) / IDEAL GAS

*** MASS AND ENERGY BALANCE ***

	IN	OUT	RELATIVE DIFF.
CONV. COMP.(KMOL/HR)	482.049	482.049	-0.353761E-15
(KG/HR)	17628.4	17628.4	-0.127124E-12
NONCONV. COMP(KG/HR)	0.000000E+00	0.000000E+00	0.000000E+00
TOTAL BALANCE			
MASS(KG/HR)	17628.4	17628.4	-0.127124E-12
ENTHALPY(CAL/SEC)	-0.240596E+07	-0.334609E+07	0.280964

ASPEN PLUS PLAT: WIN32 VER: 11.1 08/05/2018 PAGE 30

FT

U-O-S BLOCK SECTION

BLOCK: FRA1 MODEL: RADFRAC (CONTINUED)

**** INPUT DATA ****

**** INPUT PARAMETERS ****

NUMBER OF STAGES	5
ALGORITHM OPTION	STANDARD
ABSORBER OPTION	NO
INITIALIZATION OPTION	STANDARD
HYDRAULIC PARAMETER CALCULATIONS	NO
INSIDE LOOP CONVERGENCE METHOD	BROYDEN

DESIGN SPECIFICATION METHOD	NESTED
MAXIMUM NO. OF OUTSIDE LOOP ITERATIONS	100
MAXIMUM NO. OF INSIDE LOOP ITERATIONS	10
MAXIMUM NUMBER OF FLASH ITERATIONS	50
FLASH TOLERANCE	0.000100000
OUTSIDE LOOP CONVERGENCE TOLERANCE	0.000100000

**** COL-SPECS ****

MOLAR VAPOR DIST / TOTAL DIST	1.00000
MOLAR REFLUX RATIO	0.50000
MOLAR DISTILLATE RATE	KMOL/HR 375.000

**** PROFILES ****

P-SPEC	STAGE 1 PRES, ATM	1.00000
--------	-------------------	---------

**** RESULTS ****

*** COMPONENT SPLIT FRACTIONS ***

OUTLET STREAMS

NO-REACT HC

COMPONENT:

CO	.99957	.43003E-03
CO ₂	.99445	.55476E-02
H ₂	.99997	.29126E-04
WATER	.92803E-07	1.0000

ASPEN PLUS PLAT: WIN32 VER: 11.1

08/05/2018 PAGE 31

FT

U-O-S BLOCK SECTION

BLOCK: FRA1 MODEL: RADFRAC (CONTINUED)

*** COMPONENT SPLIT FRACTIONS ***

OUTLET STREAMS

NO-REACT HC

COMPONENT:

1	.99896	.10430E-02
2	.99129	.87094E-02
3	.96014	.39856E-01
4	.52669	.47331
5	.23175E-01	.97683
6	.70178E-05	.99999
7	.16328E-09	1.0000
8	.29820E-11	1.0000
9	.22779E-14	1.0000
10	.82450E-18	1.0000
11	.39073E-21	1.0000

12	.35059E-24	1.0000
13	.30475E-27	1.0000
14	.33562E-30	1.0000
15	.23641E-34	1.0000
16	.29047E-36	1.0000
17	.14413E-40	1.0000
18	.26905E-43	1.0000
19	.77687E-47	1.0000
20	.47755E-50	1.0000
21	.44770E-52	1.0000
22	.29101E-55	1.0000
23	.69736E-59	1.0000
24	.10702E-60	1.0000
25	.29368E-63	1.0000
26	.19598E-65	1.0000
27	.19882E-68	1.0000
28	.18128E-74	1.0000

*** SUMMARY OF KEY RESULTS ***

TOP STAGE TEMPERATURE	K	202.188
BOTTOM STAGE TEMPERATURE	K	305.834
TOP STAGE LIQUID FLOW	KMOL/HR	187.500
BOTTOM STAGE LIQUID FLOW	KMOL/HR	107.049
TOP STAGE VAPOR FLOW	KMOL/HR	375.000
BOTTOM STAGE VAPOR FLOW	KMOL/HR	527.833
MOLAR REFLUX RATIO		0.50000

MOLAR BOILUP RATIO	4.93076
CONDENSER DUTY (W/O SUBCOOL) CAL/SEC	-426,661.
REBOILER DUTY CAL/SEC	-513,469.

ASPEN PLUS PLAT: WIN32 VER: 11.1 08/05/2018 PAGE 32

FT

U-O-S BLOCK SECTION

BLOCK: FRA1 MODEL: RADFRAC (CONTINUED)

**** MAXIMUM FINAL RELATIVE ERRORS ****

DEW POINT	0.51949E-06	STAGE= 5
BUBBLE POINT	0.11134E-05	STAGE= 5
COMPONENT MASS BALANCE	0.86347E-06	STAGE= 4 COMP=10
ENERGY BALANCE	0.81721E-06	STAGE= 5

**** PROFILES ****

****NOTE**** REPORTED VALUES FOR STAGE LIQUID AND VAPOR RATES ARE THE FLOWS FROM THE STAGE EXCLUDING ANY SIDE PRODUCT. FOR THE FIRST STAGE, THE REPORTED VAPOR FLOW IS THE VAPOR DISTILLATE FLOW. FOR THE LAST STAGE, THE REPORTED LIQUID FLOW IS THE LIQUID BOTTOMS FLOW.

ENTHALPY

STAGE TEMPERATURE	PRESSURE	CAL/MOL	HEAT DUTY
K	ATM	LIQUID VAPOR	CAL/SEC

1	202.19	1.0000	-39253.	-9052.8	-.42666+06
2	259.31	1.0000	-40761.	-16389.	
3	272.78	1.0000	-42477.	-17353.	
4	278.73	1.0000	-47171.	-17763.	
5	305.83	1.0000	-80815.	-17180.	-.51347+06

STAGE	FLOW RATE		FEED RATE		PRODUCT RATE	
	KMOL/HR		KMOL/HR		KMOL/HR	
	LIQUID	VAPOR	LIQUID	VAPOR	MIXED	LIQUID VAPOR
1	187.5	375.0			375.0000	
2	198.6	562.5				
3	194.3	573.6				
4	152.8	569.3				
5	107.0	527.8	14.0334	468.0154		107.0489

**** MASS FLOW PROFILES ****

STAGE	FLOW RATE		FEED RATE		PRODUCT RATE	
	KG/HR		KG/HR		KG/HR	
	LIQUID	VAPOR	LIQUID	VAPOR	MIXED	LIQUID VAPOR
1	0.1094E+05	3578.			3577.6052	
2	0.1283E+05	0.1452E+05				
3	0.1307E+05	0.1641E+05				
4	9634.	0.1664E+05				
5	0.1405E+05	0.1321E+05	4480.5471	.13148+05		.14051+05

FT

U-O-S BLOCK SECTION

BLOCK: FRA1 MODEL: RADFRAC (CONTINUED)

**** MOLE-X-PROFILE ****

STAGE	CO	CO ₂	H ₂	WATER	1
1	0.20753E-03	0.13062E-01	0.52600E-04	0.95328E-03	0.14895E-02
2	0.68911E-04	0.13555E-02	0.40917E-04	0.22521E-01	0.35284E-03
3	0.74111E-04	0.99342E-03	0.51147E-04	0.43483E-01	0.35561E-03
4	0.11376E-03	0.13799E-02	0.83474E-04	0.17632	0.53250E-03
5	0.79005E-04	0.64869E-03	0.74353E-04	0.28565	0.33458E-03

**** MOLE-X-PROFILE ****

STAGE	2	3	4	5	6
1	0.21048E-01	0.14528	0.59427	0.22306	0.57660E-03
2	0.28405E-02	0.27916E-01	0.38848	0.54864	0.77598E-02
3	0.21362E-02	0.10085E-01	0.20188	0.69266	0.46418E-01
4	0.30014E-02	0.10956E-01	0.17121	0.46462	0.12572
5	0.14905E-02	0.46512E-02	0.41905E-01	0.69672E-01	0.59715E-01

**** MOLE-X-PROFILE ****

STAGE	7	8	9	10	11
1	0.21179E-06	0.11873E-07	0.76956E-10	0.18029E-12	0.00000E+00
2	0.30686E-04	0.29761E-05	0.83750E-07	0.87314E-09	0.18199E-10
3	0.15586E-02	0.26558E-03	0.28317E-04	0.12160E-05	0.10052E-06
4	0.31508E-01	0.10024E-01	0.34963E-02	0.72588E-03	0.21595E-03

5 0.51356E-01 0.45050E-01 0.40123E-01 0.36168E-01 0.32922E-01

**** MOLE-X-PROFILE ****

STAGE	12	13	14	15	16
1	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
2	0.41452E-12	0.10188E-13	0.00000E+00	0.00000E+00	0.00000E+00
3	0.85829E-08	0.77748E-09	0.70840E-10	0.51033E-12	0.56130E-12
4	0.66298E-04	0.20576E-04	0.65281E-05	0.56226E-06	0.65559E-06
5	0.30211E-01	0.27913E-01	0.25939E-01	0.24226E-01	0.22726E-01

**** MOLE-X-PROFILE ****

STAGE	17	18	19	20	21
1	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
2	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
3	0.38929E-14	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
4	0.55716E-07	0.19302E-07	0.56031E-08	0.17441E-08	0.69266E-09
5	0.21400E-01	0.20221E-01	0.19164E-01	0.18213E-01	0.17352E-01

**** MOLE-X-PROFILE ****

STAGE	22	23	24	25	26
1	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
2	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
3	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
4	0.22305E-09	0.63577E-10	0.29221E-10	0.10399E-10	0.43168E-11
5	0.16568E-01	0.15852E-01	0.15196E-01	0.14591E-01	0.14033E-01

FT

U-O-S BLOCK SECTION

BLOCK: FRA1 MODEL: RADFRAC (CONTINUED)

**** MOLE-X-PROFILE ****

STAGE	27	28
1	0.00000E+00	0.00000E+00
2	0.00000E+00	0.00000E+00
3	0.00000E+00	0.00000E+00
4	0.13831E-11	0.22817E-12
5	0.13516E-01	0.13036E-01

**** MOLE-Y-PROFILE ****

STAGE	CO	CO ₂	H ₂	WATER	1
1	0.52423E-01	0.33194E-01	0.72871	0.75675E-08	0.91474E-01
2	0.35018E-01	0.26484E-01	0.48582	0.31777E-03	0.61479E-01
3	0.34297E-01	0.22171E-01	0.47643	0.77973E-02	0.59926E-01
4	0.34556E-01	0.22204E-01	0.48000	0.14842E-01	0.60374E-01
5	0.37277E-01	0.23983E-01	0.51774	0.51053E-01	0.65142E-01

**** MOLE-Y-PROFILE ****

STAGE	2	3	4	5	6
1	0.48429E-01	0.31986E-01	0.13312E-01	0.47185E-03	0.11963E-06
2	0.39302E-01	0.69750E-01	0.20697	0.74667E-01	0.19228E-03
3	0.32645E-01	0.30577E-01	0.14320	0.19026	0.26867E-02
4	0.32628E-01	0.24511E-01	0.77675E-01	0.23673	0.15844E-01

5 0.35275E-01 0.25897E-01 0.59031E-01 0.13486 0.36402E-01

**** MOLE-Y-PROFILE ****

STAGE	7	8	9	10	11
1	0.23937E-11	0.38350E-13	0.00000E+00	0.00000E+00	0.00000E+00
2	0.70599E-07	0.39575E-08	0.25652E-10	0.60096E-13	0.00000E+00
3	0.10624E-04	0.10304E-05	0.28996E-07	0.30230E-09	0.63008E-11
4	0.53197E-03	0.90646E-04	0.96650E-05	0.41505E-06	0.34308E-07
5	0.91232E-02	0.29024E-02	0.10123E-02	0.21018E-03	0.62527E-04

**** MOLE-Y-PROFILE ****

STAGE	12	13	14	15	16
1	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
2	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
3	0.14352E-12	0.35272E-14	0.00000E+00	0.00000E+00	0.00000E+00
4	0.29295E-08	0.26537E-09	0.24179E-10	0.17419E-12	0.19158E-12
5	0.19196E-04	0.59577E-05	0.18902E-05	0.16280E-06	0.18982E-06

**** MOLE-Y-PROFILE ****

STAGE	17	18	19	20	21
1	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
2	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
3	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
4	0.13287E-14	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
5	0.16132E-07	0.55889E-08	0.16224E-08	0.50500E-09	0.20056E-09

FT

U-O-S BLOCK SECTION

BLOCK: FRA1 MODEL: RADFRAC (CONTINUED)

**** MOLE-Y-PROFILE ****

STAGE	22	23	24	25	26
1	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
2	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
3	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
4	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
5	0.64584E-10	0.18409E-10	0.84608E-11	0.30109E-11	0.12499E-11

**** MOLE-Y-PROFILE ****

STAGE	27	28
1	0.00000E+00	0.00000E+00
2	0.00000E+00	0.00000E+00
3	0.00000E+00	0.00000E+00
4	0.00000E+00	0.00000E+00
5	0.40048E-12	0.66065E-13

**** K-VALUES ****

STAGE	CO	CO ₂	H ₂	WATER	1
1	252.60	2.5414	13854.	0.79384E-05	61.412
2	508.16	19.538	11873.	0.14110E-01	174.24
3	462.79	22.318	9314.9	0.17932	168.52
4	303.76	16.090	5750.3	0.84175E-01	113.38

5	471.83	36.971	6963.3	0.17872	194.70
---	--------	--------	--------	---------	--------

**** K-VALUES ****

STAGE	2	3	4	5	6
1	2.3008	0.22017	0.22400E-01	0.21154E-02	0.20748E-03
2	13.836	2.4986	0.53277	0.13610	0.24779E-01
3	15.282	3.0319	0.70932	0.27467	0.57879E-01
4	10.871	2.2372	0.45368	0.50952	0.12602
5	23.666	5.5678	1.4087	1.9357	0.60960

**** K-VALUES ****

STAGE	7	8	9	10	11
1	0.11302E-04	0.32301E-05	0.33904E-06	0.47217E-07	0.45165E-08
2	0.23007E-02	0.13298E-02	0.30629E-03	0.68827E-04	0.14892E-04
3	0.68166E-02	0.38798E-02	0.10240E-02	0.24860E-03	0.62684E-04
4	0.16883E-01	0.90429E-02	0.27644E-02	0.57179E-03	0.15887E-03
5	0.17764	0.64427E-01	0.25231E-01	0.58111E-02	0.18992E-02

**** K-VALUES ****

STAGE	12	13	14	15	16
1	0.68425E-09	0.92968E-10	0.14926E-10	0.28039E-11	0.30633E-12
2	0.35533E-05	0.85461E-06	0.21701E-06	0.54001E-07	0.13524E-07
3	0.16721E-04	0.45367E-05	0.12499E-05	0.24418E-06	0.93525E-07
4	0.44187E-04	0.12897E-04	0.37038E-05	0.30980E-06	0.29223E-06
5	0.63541E-03	0.21344E-03	0.72871E-04	0.67201E-05	0.83529E-05

FT

U-O-S BLOCK SECTION

BLOCK: FRA1 MODEL: RADFRAC (CONTINUED)

**** K-VALUES ****

STAGE	17	18	19	20	21
1	0.48834E-13	0.88629E-14	0.77341E-15	0.91255E-16	0.32224E-16
2	0.30979E-08	0.88341E-09	0.17416E-09	0.39901E-10	0.15695E-10
3	0.17253E-07	0.53243E-08	0.12104E-08	0.31141E-09	0.12482E-09
4	0.23848E-07	0.76026E-08	0.18326E-08	0.49454E-09	0.19977E-09
5	0.75385E-06	0.27640E-06	0.84655E-07	0.27727E-07	0.11559E-07

**** K-VALUES ****

STAGE	22	23	24	25	26
1	0.37204E-17	0.30676E-18	0.11090E-18	0.24275E-19	0.66451E-20
2	0.36371E-11	0.69113E-12	0.30019E-12	0.92528E-13	0.34054E-13
3	0.32673E-10	0.71843E-11	0.32222E-11	0.10544E-11	0.40867E-12
4	0.54977E-10	0.12836E-10	0.58337E-11	0.19565E-11	0.77463E-12
5	0.38981E-08	0.11613E-08	0.55679E-09	0.20635E-09	0.89070E-10

**** K-VALUES ****

STAGE	27	28
1	0.10106E-20	0.99044E-23
2	0.86136E-14	0.54152E-15
3	0.11298E-12	0.98297E-14
4	0.22214E-12	0.22089E-13

5 0.29630E-10 0.50680E-11

**** MASS-X-PROFILE ****

STAGE	CO	CO ₂	H ₂	WATER	1
1	0.99633E-04	0.98523E-02	0.18174E-05	0.29434E-03	0.40956E-03
2	0.29868E-04	0.92308E-03	0.12763E-05	0.62781E-02	0.87589E-04
3	0.30870E-04	0.65017E-03	0.15333E-05	0.11649E-01	0.84840E-04
4	0.50550E-04	0.96345E-03	0.26695E-05	0.50392E-01	0.13552E-03
5	0.16860E-04	0.21750E-03	0.11419E-05	0.39207E-01	0.40894E-04

**** MASS-X-PROFILE ****

STAGE	2	3	4	5	6
1	0.10848E-01	0.10980	0.59201	0.27583	0.85164E-03
2	0.13217E-02	0.19048E-01	0.34939	0.61252	0.10348E-01
3	0.95524E-03	0.66135E-02	0.17450	0.74320	0.59487E-01
4	0.14318E-02	0.76645E-02	0.15787	0.53181	0.17188
5	0.34147E-03	0.15626E-02	0.18557E-01	0.38298E-01	0.39207E-01

**** MASS-X-PROFILE ****

STAGE	7	8	9	10	11
1	0.36374E-06	0.23244E-07	0.16917E-09	0.43966E-12	0.00000E+00
2	0.47580E-04	0.52605E-05	0.16621E-06	0.19224E-08	0.44018E-10
3	0.23225E-02	0.45114E-03	0.54009E-04	0.25730E-05	0.23365E-06
4	0.50088E-01	0.18165E-01	0.71140E-02	0.16385E-02	0.53550E-03
5	0.39207E-01	0.39207E-01	0.39207E-01	0.39207E-01	0.39207E-01

FT

U-O-S BLOCK SECTION

BLOCK: FRA1 MODEL: RADFRAC (CONTINUED)

**** MASS-X-PROFILE ****

STAGE	12	13	14	15	16
1	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
2	0.10926E-11	0.29064E-13	0.00000E+00	0.00000E+00	0.00000E+00
3	0.21741E-07	0.21316E-08	0.20900E-09	0.16121E-11	0.18902E-11
4	0.17916E-03	0.60181E-04	0.20546E-04	0.18948E-05	0.23551E-05
5	0.39207E-01	0.39207E-01	0.39207E-01	0.39207E-01	0.39207E-01

**** MASS-X-PROFILE ****

STAGE	17	18	19	20	21
1	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
2	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
3	0.13921E-13	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
4	0.21255E-06	0.77932E-07	0.23869E-07	0.78179E-08	0.32590E-08
5	0.39207E-01	0.39207E-01	0.39207E-01	0.39207E-01	0.39207E-01

**** MASS-X-PROFILE ****

STAGE	22	23	24	25	26
1	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
2	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
3	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
4	0.10991E-08	0.32743E-09	0.15699E-09	0.58183E-10	0.25114E-10

5 0.39207E-01 0.39207E-01 0.39207E-01 0.39207E-01 0.39207E-01

**** MASS-X-PROFILE ****

STAGE 27 28

1 0.00000E+00 0.00000E+00
 2 0.00000E+00 0.00000E+00
 3 0.00000E+00 0.00000E+00
 4 0.83543E-11 0.14289E-11
 5 0.39207E-01 0.39207E-01

**** MASS-Y-PROFILE ****

STAGE	CO	CO ₂	H ₂	WATER	1
1	0.15392	0.15313	0.15398	0.14290E-07	0.15382
2	0.38005E-01	0.45160E-01	0.37947E-01	0.22181E-03	0.38216E-01
3	0.33577E-01	0.34103E-01	0.33568E-01	0.49095E-02	0.33601E-01
4	0.33107E-01	0.33424E-01	0.33097E-01	0.91455E-02	0.33129E-01
5	0.41717E-01	0.42169E-01	0.41699E-01	0.36746E-01	0.41753E-01

**** MASS-Y-PROFILE ****

STAGE	2	3	4	5	6
1	0.15264	0.14785	0.81102E-01	0.35685E-02	0.10806E-05
2	0.45791E-01	0.11917	0.46610	0.20874	0.64203E-03
3	0.34309E-01	0.47126E-01	0.29090	0.47977	0.80921E-02
4	0.33559E-01	0.36970E-01	0.15443	0.58422	0.46701E-01
5	0.42379E-01	0.45625E-01	0.13708	0.38876	0.12533

FT

U-O-S BLOCK SECTION

BLOCK: FRA1 MODEL: RADFRAC (CONTINUED)

**** MASS-Y-PROFILE ****

STAGE	7	8	9	10	11
1	0.25142E-10	0.45918E-12	0.00000E+00	0.00000E+00	0.00000E+00
2	0.27411E-06	0.17516E-07	0.12748E-09	0.33131E-12	0.00000E+00
3	0.37208E-04	0.41137E-05	0.12998E-06	0.15033E-08	0.34422E-10
4	0.18233E-02	0.35417E-03	0.42400E-04	0.20199E-05	0.18343E-06
5	0.36524E-01	0.13246E-01	0.51875E-02	0.11948E-02	0.39049E-03

**** MASS-Y-PROFILE ****

STAGE	12	13	14	15	16
1	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
2	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
3	0.85441E-12	0.22728E-13	0.00000E+00	0.00000E+00	0.00000E+00
4	0.17068E-07	0.16734E-08	0.16408E-09	0.12656E-11	0.14839E-11
5	0.13064E-03	0.43884E-04	0.14982E-04	0.13817E-05	0.17174E-05

**** MASS-Y-PROFILE ****

STAGE	17	18	19	20	21
1	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
2	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
3	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
4	0.10929E-13	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00

5 0.15499E-06 0.56828E-07 0.17405E-07 0.57008E-08 0.23765E-08

**** MASS-Y-PROFILE ****

STAGE	22	23	24	25	26
1	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
2	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
3	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
4	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
5	0.80146E-09	0.23876E-09	0.11448E-09	0.42427E-10	0.18313E-10

**** MASS-Y-PROFILE ****

STAGE	27	28
1	0.00000E+00	0.00000E+00
2	0.00000E+00	0.00000E+00
3	0.00000E+00	0.00000E+00
4	0.00000E+00	0.00000E+00
5	0.60920E-11	0.10420E-11

BLOCK: FRA2 MODEL: RADFRAC

INLETS - HC STAGE 8

OUTLETS - C1-C4 STAGE 1

DISL+GAS STAGE 8

PROPERTY OPTION SET: PR-BM PENG-ROBINSON EQUATION OF STATE

FT

U-O-S BLOCK SECTION

BLOCK: FRA2 MODEL: RADFRAC (CONTINUED)

*** MASS AND ENERGY BALANCE ***

	IN	OUT	RELATIVE DIFF.
CONV. COMP.(KMOL/HR)	107.049	107.049	0.132751E-15
(KG/HR)	14050.8	14050.8	-0.129458E-15
NONCONV. COMP(KG/HR)	0.000000E+00	0.000000E+00	0.000000E+00
TOTAL BALANCE			
MASS(KG/HR)	14050.8	14050.8	-0.129458E-15
ENTHALPY(CAL/SEC)	-0.240309E+07	-0.231234E+07	-0.377634E-01

**** INPUT DATA ****

**** INPUT PARAMETERS ****

NUMBER OF STAGES	8
ALGORITHM OPTION	STANDARD
ABSORBER OPTION	NO
INITIALIZATION OPTION	STANDARD
HYDRAULIC PARAMETER CALCULATIONS	NO

INSIDE LOOP CONVERGENCE METHOD	BROYDEN
DESIGN SPECIFICATION METHOD	NESTED
MAXIMUM NO. OF OUTSIDE LOOP ITERATIONS	200
MAXIMUM NO. OF INSIDE LOOP ITERATIONS	10
MAXIMUM NUMBER OF FLASH ITERATIONS	50
FLASH TOLERANCE	0.000100000
OUTSIDE LOOP CONVERGENCE TOLERANCE	0.000100000

**** COL-SPECS ****

MOLAR VAPOR DIST / TOTAL DIST	1.00000
MOLAR REFLUX RATIO	1.00000
MOLAR DISTILLATE RATE	KMOL/HR 10.0000

**** PROFILES ****

P-SPEC	STAGE 1 PRES, ATM	1.00000
--------	-------------------	---------

ASPEN PLUS PLAT: WIN32 VER: 11.1 08/05/2018 PAGE 40

FT

U-O-S BLOCK SECTION

BLOCK: FRA2 MODEL: RADFRAC (CONTINUED)

**** RESULTS ****

*** COMPONENT SPLIT FRACTIONS ***

OUTLET STREAMS

C1-C4 DISL+GAS

COMPONENT:

CO	.98976	.10244E-01
CO ₂	.92898	.71019E-01
H ₂	.99441	.55935E-02
WATER	.16286	.83714
1	.97665	.23354E-01
2	.89465	.10535
3	.72532	.27468
4	.45279	.54721
5	.21327	.78673
6	.83144E-01	.91686
7	.30708E-01	.96929
8	.10944E-01	.98906
9	.39715E-02	.99603
10	.14123E-02	.99859
11	.53218E-03	.99947
12	.19601E-03	.99980
13	.75643E-04	.99992
14	.31122E-04	.99997
15	.11974E-04	.99999
16	.49862E-05	1.0000
17	.17865E-05	1.0000

18	.74621E-06	1.0000
19	.30755E-06	1.0000
20	.11198E-06	1.0000
21	.49154E-07	1.0000
22	.23654E-07	1.0000
23	.85546E-08	1.0000
24	.35606E-08	1.0000
25	.16379E-08	1.0000
26	.67464E-09	1.0000
27	.24033E-09	1.0000
28	.13859E-09	1.0000

ASPEN PLUS PLAT: WIN32 VER: 11.1

08/05/2018 PAGE 41

FT

U-O-S BLOCK SECTION

BLOCK: FRA2 MODEL: RADFRAC (CONTINUED)

*** SUMMARY OF KEY RESULTS ***

TOP STAGE TEMPERATURE	K	356.416
BOTTOM STAGE TEMPERATURE	K	315.028
TOP STAGE LIQUID FLOW	KMOL/HR	10.0000
BOTTOM STAGE LIQUID FLOW	KMOL/HR	97.0490
TOP STAGE VAPOR FLOW	KMOL/HR	10.0000
BOTTOM STAGE VAPOR FLOW	KMOL/HR	21.6487
MOLAR REFLUX RATIO		1.00000

MOLAR BOILUP RATIO 0.22307

CONDENSER DUTY (W/O SUBCOOL) CAL/SEC -29,259.2

REBOILER DUTY CAL/SEC 120,007.

**** MAXIMUM FINAL RELATIVE ERRORS ****

DEW POINT 0.37558E-08 STAGE= 8

BUBBLE POINT 0.14687E-09 STAGE= 8

COMPONENT MASS BALANCE 0.65277E-08 STAGE= 4 COMP=4

ENERGY BALANCE 0.36305E-08 STAGE= 4

**** PROFILES ****

****NOTE**** REPORTED VALUES FOR STAGE LIQUID AND VAPOR RATES ARE THE FLOWS
FROM THE STAGE EXCLUDING ANY SIDE PRODUCT. FOR THE FIRST STAGE,
THE REPORTED VAPOR FLOW IS THE VAPOR DISTILLATE FLOW. FOR THE
LAST STAGE, THE REPORTED LIQUID FLOW IS THE LIQUID BOTTOMS FLOW.

ENTHALPY

STAGE TEMPERATURE		PRESSURE		CAL/MOL		HEAT DUTY
K	ATM	LIQUID	VAPOR	CAL/SEC		
1	356.42	1.0000	-67550.	-44577.	-.29259+05	
2	366.81	1.0000	-67346.	-50797.		
7	366.89	1.0000	-67345.	-50860.		
8	315.03	1.0000	-81182.	-51962.	.12001+06	

	FLOW RATE		FEED RATE		PRODUCT RATE	
	LIQUID	VAPOR	LIQUID	VAPOR	MIXED	
1	10.00	10.00			10.0000	
2	10.20	20.00				
7	11.65	20.20				
8	97.05	21.65	107.0489		97.0489	

ASPEN PLUS PLAT: WIN32 VER: 11.1 08/05/2018 PAGE 42

FT

U-O-S BLOCK SECTION

BLOCK: FRA2 MODEL: RADFRAC (CONTINUED)

**** MASS FLOW PROFILES ****

	FLOW RATE		FEED RATE		PRODUCT RATE	
	LIQUID	VAPOR	LIQUID	VAPOR	MIXED	
1	180.2	418.6			418.5940	
2	183.7	598.7				
7	209.9	602.4				
8	0.1363E+05	628.4	.14051+05		.13632+05	

**** MOLE-X-PROFILE ****

STAGE	CO	CO ₂	H ₂	WATER	1
1	0.73973E-09	0.19463E-06	0.17494E-08	1.0000	0.17272E-07
2	0.49850E-09	0.11052E-06	0.11622E-08	1.0000	0.11030E-07

7	0.49476E-09	0.10954E-06	0.11533E-08	1.0000	0.10942E-07
8	0.89273E-06	0.50816E-04	0.45874E-06	0.26377	0.86188E-05

**** MOLE-X-PROFILE ****

STAGE	2	3	4	5	6
1	0.88471E-07	0.55306E-07	0.68087E-07	0.65340E-08	0.20406E-09
2	0.57898E-07	0.40382E-07	0.55840E-07	0.61916E-08	0.22649E-09
7	0.57450E-07	0.40105E-07	0.55510E-07	0.61624E-08	0.22571E-09
8	0.17320E-03	0.14092E-02	0.25294E-01	0.60461E-01	0.60392E-01

**** MOLE-X-PROFILE ****

STAGE	7	8	9	10	11
1	0.47236E-11	0.74825E-13	0.11336E-14	0.00000E+00	0.00000E+00
2	0.62161E-11	0.11893E-12	0.21882E-14	0.00000E+00	0.00000E+00
7	0.62034E-11	0.11887E-12	0.21906E-14	0.00000E+00	0.00000E+00
8	0.54909E-01	0.49148E-01	0.44082E-01	0.39838E-01	0.36295E-01

**** MOLE-X-PROFILE ****

STAGE	12	13	14	15	16
1	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
2	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
7	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
8	0.33318E-01	0.30786E-01	0.28611E-01	0.26722E-01	0.25067E-01

**** MOLE-X-PROFILE ****

STAGE	17	18	19	20	21
1	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
2	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00

7	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
8	0.23605E-01	0.22304E-01	0.21139E-01	0.20090E-01	0.19139E-01

**** MOLE-X-PROFILE ****

STAGE	22	23	24	25	26
1	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
2	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
7	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
8	0.18275E-01	0.17485E-01	0.16761E-01	0.16095E-01	0.15479E-01

ASPEN PLUS PLAT: WIN32 VER: 11.1 08/05/2018 PAGE 43

FT

U-O-S BLOCK SECTION

BLOCK: FRA2 MODEL: RADFRAC (CONTINUED)

**** MOLE-X-PROFILE ****

STAGE	27	28
1	0.00000E+00	0.00000E+00
2	0.00000E+00	0.00000E+00
7	0.00000E+00	0.00000E+00
8	0.14909E-01	0.14379E-01

**** MOLE-Y-PROFILE ****

STAGE	CO	CO ₂	H ₂	WATER	1
1	0.83708E-03	0.64510E-02	0.79148E-03	0.49800	0.34980E-02
2	0.41854E-03	0.32256E-02	0.39574E-03	0.74900	0.17490E-02
7	0.41438E-03	0.31935E-02	0.39181E-03	0.75149	0.17316E-02

8 0.38666E-03 0.29799E-02 0.36560E-03 0.76812 0.16158E-02

**** MOLE-Y-PROFILE ****

STAGE	2	3	4	5	6
1	0.14275E-01	0.36114E-01	0.20312	0.15906	0.53149E-01
2	0.71376E-02	0.18057E-01	0.10156	0.79532E-01	0.26575E-01
7	0.70667E-02	0.17878E-01	0.10055	0.78742E-01	0.26311E-01
8	0.65940E-02	0.16682E-01	0.93825E-01	0.73475E-01	0.24551E-01

**** MOLE-Y-PROFILE ****

STAGE	7	8	9	10	11
1	0.16882E-01	0.52776E-02	0.17058E-02	0.54682E-03	0.18756E-03
2	0.84411E-02	0.26388E-02	0.85292E-03	0.27341E-03	0.93778E-04
7	0.83573E-02	0.26126E-02	0.84445E-03	0.27070E-03	0.92847E-04
8	0.77983E-02	0.24379E-02	0.78796E-03	0.25259E-03	0.86636E-04

**** MOLE-Y-PROFILE ****

STAGE	12	13	14	15	16
1	0.63390E-04	0.22602E-04	0.86417E-05	0.31053E-05	0.12130E-05
2	0.31695E-04	0.11301E-04	0.43209E-05	0.15527E-05	0.60651E-06
7	0.31380E-04	0.11189E-04	0.42779E-05	0.15372E-05	0.60049E-06
8	0.29281E-04	0.10440E-04	0.39918E-05	0.14344E-05	0.56032E-06

**** MOLE-Y-PROFILE ****

STAGE	17	18	19	20	21
1	0.40925E-06	0.16152E-06	0.63095E-07	0.21833E-07	0.91302E-08
2	0.20463E-06	0.80762E-07	0.31548E-07	0.10916E-07	0.45651E-08
7	0.20259E-06	0.79960E-07	0.31234E-07	0.10808E-07	0.45198E-08

8 0.18904E-06 0.74612E-07 0.29145E-07 0.10085E-07 0.42175E-08

**** MOLE-Y-PROFILE ****

STAGE	22	23	24	25	26
1	0.41952E-08	0.14517E-08	0.57919E-09	0.25583E-09	0.10135E-09
2	0.20976E-08	0.72583E-09	0.28959E-09	0.12792E-09	0.50673E-10
7	0.20768E-08	0.71862E-09	0.28672E-09	0.12665E-09	0.50169E-10
8	0.19379E-08	0.67056E-09	0.26754E-09	0.11817E-09	0.46814E-10

ASPEN PLUS PLAT: WIN32 VER: 11.1 08/05/2018 PAGE 44

FT

U-O-S BLOCK SECTION

BLOCK: FRA2 MODEL: RADFRAC (CONTINUED)

**** MOLE-Y-PROFILE ****

STAGE	27	28
1	0.34772E-10	0.19339E-10
2	0.17386E-10	0.96696E-11
7	0.17214E-10	0.95736E-11
8	0.16062E-10	0.89332E-11

**** K-VALUES ****

STAGE	CO	CO ₂	H ₂	WATER	1
1	0.11316E+07	33144.	0.45244E+06	0.49800	0.20253E+06
2	0.83960E+06	29185.	0.34052E+06	0.74900	0.15857E+06
7	0.83754E+06	29154.	0.33973E+06	0.75149	0.15825E+06
8	433.13	58.641	796.97	2.9120	187.47

```

      **** K-VALUES      ****
STAGE  2      3      4      5      6
1  0.16135E+06  0.65299E+06  0.29832E+07  0.24344E+08  0.26046E+09
2  0.12328E+06  0.44716E+06  0.18188E+07  0.12845E+08  0.11733E+09
7  0.12301E+06  0.44577E+06  0.18114E+07  0.12778E+08  0.11657E+09
8  38.071      11.838      3.7094      1.2153      0.40653

```

```

      **** K-VALUES      ****
STAGE  7      8      9      10      11
1  0.35740E+10  0.70533E+11  0.15048E+13  0.43520E+14  0.20315E+16
2  0.13579E+10  0.22188E+11  0.38978E+12  0.91516E+13  0.33610E+15
7  0.13472E+10  0.21978E+11  0.38549E+12  0.90354E+13  0.33118E+15
8  0.14202      0.49602E-01  0.17875E-01  0.63404E-02  0.23870E-02

```

```

      **** K-VALUES      ****
STAGE  12      13      14      15      16
1  0.74715E+17  0.98423E+19  0.10000E+21  0.10000E+21  0.10000E+21
2  0.99126E+16  0.97153E+18  0.95634E+20  0.10000E+21  0.10000E+21
7  0.97499E+16  0.95328E+18  0.93604E+20  0.10000E+21  0.10000E+21
8  0.87885E-03  0.33913E-03  0.13952E-03  0.53679E-04  0.22353E-04

```

```

      **** K-VALUES      ****
STAGE  17      18      19      20      21
1  0.10000E+21  0.10000E+21  0.10000E+21  0.10000E+21  0.10000E+21
2  0.10000E+21  0.10000E+21  0.10000E+21  0.10000E+21  0.10000E+21
7  0.10000E+21  0.10000E+21  0.10000E+21  0.10000E+21  0.10000E+21
8  0.80086E-05  0.33452E-05  0.13787E-05  0.50200E-06  0.22035E-06

```

**** K-VALUES ****

STAGE	22	23	24	25	26
1	0.10000E+21	0.10000E+21	0.10000E+21	0.10000E+21	0.10000E+21
2	0.10000E+21	0.10000E+21	0.10000E+21	0.10000E+21	0.10000E+21
7	0.10000E+21	0.10000E+21	0.10000E+21	0.10000E+21	0.10000E+21
8	0.10604E-06	0.38349E-07	0.15962E-07	0.73425E-08	0.30243E-08

ASPEN PLUS PLAT: WIN32 VER: 11.1 08/05/2018 PAGE 45

FT

U-O-S BLOCK SECTION

BLOCK: FRA2 MODEL: RADFRAC (CONTINUED)

**** K-VALUES ****

STAGE	27	28
1	0.10000E+21	0.10000E+21
2	0.10000E+21	0.10000E+21
7	0.10000E+21	0.10000E+21
8	0.10774E-08	0.62127E-09

**** MASS-X-PROFILE ****

STAGE	CO	CO ₂	H ₂	WATER	1
1	0.11501E-08	0.47547E-06	0.19575E-09	1.0000	0.15380E-07
2	0.77507E-09	0.27000E-06	0.13004E-09	1.0000	0.98220E-08
7	0.76926E-09	0.26759E-06	0.12905E-09	1.0000	0.97440E-08
8	0.17802E-06	0.15921E-04	0.65835E-08	0.33830E-01	0.98436E-06

**** MASS-X-PROFILE ****

STAGE	2	3	4	5	6
1	0.14767E-06	0.13537E-06	0.21967E-06	0.26168E-07	0.97614E-09
2	0.96639E-07	0.98843E-07	0.18016E-06	0.24797E-07	0.10834E-08
7	0.95891E-07	0.98166E-07	0.17909E-06	0.24680E-07	0.10797E-08
8	0.37077E-04	0.44240E-03	0.10466E-01	0.31056E-01	0.37051E-01

**** MASS-X-PROFILE ****

STAGE	7	8	9	10	11
1	0.26273E-10	0.47445E-12	0.80704E-14	0.00000E+00	0.00000E+00
2	0.34575E-10	0.75412E-12	0.15579E-13	0.00000E+00	0.00000E+00
7	0.34504E-10	0.75374E-12	0.15596E-13	0.00000E+00	0.00000E+00
8	0.39170E-01	0.39969E-01	0.40250E-01	0.40354E-01	0.40389E-01

**** MASS-X-PROFILE ****

STAGE	12	13	14	15	16
1	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
2	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
7	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
8	0.40403E-01	0.40408E-01	0.40410E-01	0.40410E-01	0.40411E-01

**** MASS-X-PROFILE ****

STAGE	17	18	19	20	21
1	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
2	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
7	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
8	0.40411E-01	0.40411E-01	0.40411E-01	0.40411E-01	0.40411E-01

**** MASS-X-PROFILE ****

STAGE	22	23	24	25	26
1	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
2	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
7	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
8	0.40411E-01	0.40411E-01	0.40411E-01	0.40411E-01	0.40411E-01

ASPEN PLUS PLAT: WIN32 VER: 11.1 08/05/2018 PAGE 46

FT

U-O-S BLOCK SECTION

BLOCK: FRA2 MODEL: RADFRAC (CONTINUED)

**** MASS-X-PROFILE ****

STAGE	27	28
1	0.00000E+00	0.00000E+00
2	0.00000E+00	0.00000E+00
7	0.00000E+00	0.00000E+00
8	0.40411E-01	0.40411E-01

**** MASS-Y-PROFILE ****

STAGE	CO	CO ₂	H ₂	WATER	1
1	0.56013E-03	0.67823E-02	0.38117E-04	0.21433	0.13406E-02
2	0.39160E-03	0.47418E-02	0.26648E-04	0.45072	0.93725E-03
7	0.38925E-03	0.47133E-02	0.26488E-04	0.45402	0.93163E-03
8	0.37309E-03	0.45176E-02	0.25389E-04	0.47668	0.89295E-03

**** MASS-Y-PROFILE ****

STAGE	2	3	4	5	6
1	0.10255E-01	0.38044E-01	0.28204	0.27417	0.10942
2	0.71691E-02	0.26597E-01	0.19718	0.19168	0.76497E-01
7	0.71261E-02	0.26438E-01	0.19599	0.19053	0.76038E-01
8	0.68303E-02	0.25340E-01	0.18786	0.18262	0.72882E-01

**** MASS-Y-PROFILE ****

STAGE	7	8	9	10	11
1	0.40413E-01	0.14402E-01	0.52267E-02	0.18587E-02	0.70037E-03
2	0.28254E-01	0.10069E-01	0.36541E-02	0.12995E-02	0.48964E-03
7	0.28084E-01	0.10008E-01	0.36322E-02	0.12917E-02	0.48671E-03
8	0.26918E-01	0.95930E-02	0.34814E-02	0.12380E-02	0.46650E-03

**** MASS-Y-PROFILE ****

STAGE	12	13	14	15	16
1	0.25795E-03	0.99550E-04	0.40957E-04	0.15758E-04	0.65621E-05
2	0.18034E-03	0.69597E-04	0.28634E-04	0.11017E-04	0.45877E-05
7	0.17926E-03	0.69179E-04	0.28462E-04	0.10951E-04	0.45601E-05
8	0.17182E-03	0.66307E-04	0.27281E-04	0.10496E-04	0.43708E-05

**** MASS-Y-PROFILE ****

STAGE	17	18	19	20	21
1	0.23511E-05	0.98205E-06	0.40475E-06	0.14737E-06	0.64689E-07
2	0.16437E-05	0.68657E-06	0.28297E-06	0.10303E-06	0.45225E-07
7	0.16338E-05	0.68245E-06	0.28127E-06	0.10241E-06	0.44954E-07
8	0.15660E-05	0.65412E-06	0.26960E-06	0.98161E-07	0.43088E-07

**** MASS-Y-PROFILE ****

STAGE	22	23	24	25	26
1	0.31130E-07	0.11258E-07	0.46859E-08	0.21555E-08	0.88785E-09
2	0.21763E-07	0.78708E-08	0.32760E-08	0.15070E-08	0.62071E-09
7	0.21633E-07	0.78236E-08	0.32563E-08	0.14979E-08	0.61699E-09
8	0.20735E-07	0.74988E-08	0.31211E-08	0.14357E-08	0.59137E-09

ASPEN PLUS PLAT: WIN32 VER: 11.1 08/05/2018 PAGE 47

FT
U-O-S BLOCK SECTION

BLOCK: FRA2 MODEL: RADFRAC (CONTINUED)

**** MASS-Y-PROFILE ****

STAGE	27	28
1	0.31628E-09	0.18238E-09
2	0.22112E-09	0.12751E-09
7	0.21979E-09	0.12674E-09
8	0.21067E-09	0.12148E-09

BLOCK: FRA3 MODEL: RADFRAC

INLETS - DISL+GAS STAGE 17

OUTLETS - GASOLINE STAGE 1

DIESEL STAGE 17

PROPERTY OPTION SET: NRTL RENON (NRTL) / IDEAL GAS

*** MASS AND ENERGY BALANCE ***

IN	OUT	RELATIVE DIFF.
----	-----	----------------

CONV. COMP.(KMOL/HR)	97.0490	97.0490	-0.292860E-15
(KG/HR)	13632.2	13632.2	0.693854E-14
NONCONV. COMP(KG/HR)	0.000000E+00	0.000000E+00	0.000000E+00
TOTAL BALANCE			
MASS(KG/HR)	13632.2	13632.2	0.693854E-14
ENTHALPY(CAL/SEC)	-0.218852E+07	-0.175871E+07	-0.196393

ASPEN PLUS PLAT: WIN32 VER: 11.1 08/05/2018 PAGE 48

FT

U-O-S BLOCK SECTION

BLOCK: FRA3 MODEL: RADFRAC (CONTINUED)

**** INPUT DATA ****

**** INPUT PARAMETERS ****

NUMBER OF STAGES	17
ALGORITHM OPTION	STANDARD
ABSORBER OPTION	NO
INITIALIZATION OPTION	STANDARD
HYDRAULIC PARAMETER CALCULATIONS	NO
INSIDE LOOP CONVERGENCE METHOD	BROYDEN
DESIGN SPECIFICATION METHOD	NESTED

MAXIMUM NO. OF OUTSIDE LOOP ITERATIONS	25
MAXIMUM NO. OF INSIDE LOOP ITERATIONS	10
MAXIMUM NUMBER OF FLASH ITERATIONS	50
FLASH TOLERANCE	0.000100000
OUTSIDE LOOP CONVERGENCE TOLERANCE	0.000100000

**** COL-SPECS ****

MOLAR VAPOR DIST / TOTAL DIST	1.00000
MOLAR REFLUX RATIO	0.80000
MOLAR DISTILLATE RATE	65.0000

**** PROFILES ****

P-SPEC	STAGE 1 PRES, ATM	1.00000
--------	-------------------	---------

**** RESULTS ****

*** COMPONENT SPLIT FRACTIONS ***

OUTLET STREAMS

GASOLINE DIESEL

COMPONENT:

CO	.99984	.16378E-03
----	--------	------------

CO ₂	.99959	.40746E-03
H ₂	.99997	.30473E-04
WATER	.99004	.99613E-02

ASPEN PLUS PLAT: WIN32 VER: 11.1

08/05/2018 PAGE 49

FT

U-O-S BLOCK SECTION

BLOCK: FRA3 MODEL: RADFRAC (CONTINUED)

*** COMPONENT SPLIT FRACTIONS ***

OUTLET STREAMS

GASOLINE DIESEL

COMPONENT:

1	.99974	.26417E-03
2	.99921	.79142E-03
3	.99810	.18968E-02
4	.99593	.40715E-02
5	.99202	.79766E-02
6	.98505	.14947E-01
7	.97392	.26085E-01
8	.95547	.44535E-01
9	.93071	.69290E-01
10	.88970	.11030
11	.82860	.17140
12	.74324	.25676

13	.62346	.37654
14	.39768	.60232
15	.13672E-17	1.0000
16	.14200E-03	.99986
17	.21129E-26	1.0000
18	.16059E-30	1.0000
19	.78190E-35	1.0000
20	.37111E-39	1.0000
21	.26809E-43	1.0000
22	.29507E-47	1.0000
23	.85156E-52	1.0000
24	.18296E-55	1.0000
25	.10124E-59	1.0000
26	.10790E-63	1.0000
27	.21615E-68	1.0000
28	.18129E-72	1.0000

*** SUMMARY OF KEY RESULTS ***

TOP STAGE TEMPERATURE	K	348.884
BOTTOM STAGE TEMPERATURE	K	505.016
TOP STAGE LIQUID FLOW	KMOL/HR	52.0000
BOTTOM STAGE LIQUID FLOW	KMOL/HR	32.0490
TOP STAGE VAPOR FLOW	KMOL/HR	65.0000
BOTTOM STAGE VAPOR FLOW	KMOL/HR	74.1243
MOLAR REFLUX RATIO		0.80000
MOLAR BOILUP RATIO		2.31285

CONDENSER DUTY (W/O SUBCOOL) CAL/SEC -153,676.

REBOILER DUTY CAL/SEC 583,484.

ASPEN PLUS PLAT: WIN32 VER: 11.1 08/05/2018 PAGE 50

FT

U-O-S BLOCK SECTION

BLOCK: FRA3 MODEL: RADFRAC (CONTINUED)

**** MAXIMUM FINAL RELATIVE ERRORS ****

DEW POINT 0.18567E-06 STAGE= 16

BUBBLE POINT 0.78799E-06 STAGE= 7

COMPONENT MASS BALANCE 0.13478E-05 STAGE= 14 COMP=21

ENERGY BALANCE 0.29453E-06 STAGE= 16

**** PROFILES ****

****NOTE**** REPORTED VALUES FOR STAGE LIQUID AND VAPOR RATES ARE THE FLOWS
FROM THE STAGE EXCLUDING ANY SIDE PRODUCT. FOR THE FIRST STAGE,
THE REPORTED VAPOR FLOW IS THE VAPOR DISTILLATE FLOW. FOR THE
LAST STAGE, THE REPORTED LIQUID FLOW IS THE LIQUID BOTTOMS FLOW.

ENTHALPY

STAGE	TEMPERATURE	PRESSURE	CAL/MOL	HEAT DUTY
K	ATM	LIQUID	VAPOR	CAL/SEC

1	348.88	1.0000	-67162.	-51274.	-.15368+06
2	361.92	1.0000	-67020.	-53607.	
3	362.11	1.0000	-67021.	-53672.	
4	362.11	1.0000	-67021.	-53674.	
5	362.11	1.0000	-67021.	-53674.	
6	362.16	1.0000	-67069.	-53672.	
15	482.64	1.0000	-75993.	-49091.	
16	488.12	1.0000	-79485.	-48721.	
17	505.02	1.0000	-93562.	-47283.	.58348+06

STAGE	FLOW RATE		FEED RATE		PRODUCT RATE		
	KMOL/HR		KMOL/HR		KMOL/HR		
	LIQUID	VAPOR	LIQUID	VAPOR	MIXED	LIQUID	VAPOR
1	52.00	65.00			65.0000		
2	53.12	117.0					
3	53.14	118.1					
4	53.14	118.1					
5	53.13	118.1					
6	36.73	118.1					
15	14.20	81.05					
16	9.124	79.20					
17	32.05	74.12	97.0489		32.0489		

**** MASS FLOW PROFILES ****

STAGE	FLOW RATE		FEED RATE		PRODUCT RATE		
	KG/HR		KG/HR		KG/HR		
	LIQUID	VAPOR	LIQUID	VAPOR	MIXED	LIQUID	VAPOR

1	957.2	4992.	4991.8537
2	966.5	5949.	
3	966.4	5958.	

ASPEN PLUS PLAT: WIN32 VER: 11.1 08/05/2018 PAGE 51

FT

U-O-S BLOCK SECTION

BLOCK: FRA3 MODEL: RADFRAC (CONTINUED)

**** MASS FLOW PROFILES ****

STAGE	FLOW RATE		FEED RATE			PRODUCT RATE	
	KG/HR		KG/HR		KG/HR		
	LIQUID	VAPOR	LIQUID	VAPOR	MIXED	LIQUID	VAPOR
4	966.4	5958.					
5	966.2	5958.					
6	680.5	5958.					
15	2885.	8172.					
16	1973.	7876.					
17	8640.	6964.	.13632+05		8640.3352		

**** MOLE-X-PROFILE ****

STAGE	CO	CO ₂	H ₂	WATER	1
1	0.10371E-08	0.45162E-06	0.49537E-10	0.99337	0.21361E-07
2	0.52215E-09	0.20031E-06	0.27026E-10	0.99697	0.10417E-07
3	0.51632E-09	0.19727E-06	0.26762E-10	0.99710	0.10293E-07
4	0.51625E-09	0.19722E-06	0.26758E-10	0.99710	0.10291E-07

5	0.51625E-09	0.19722E-06	0.26758E-10	0.99710	0.10291E-07
6	0.51630E-09	0.19716E-06	0.26768E-10	0.99534	0.10291E-07
15	0.43667E-09	0.69475E-07	0.38853E-10	0.54470E-02	0.69999E-08
16	0.43847E-09	0.67732E-07	0.39730E-10	0.62714E-02	0.69773E-08
17	0.44274E-09	0.62699E-07	0.42331E-10	0.79565E-02	0.68945E-08

**** MOLE-X-PROFILE ****

STAGE	2	3	4	5	6
1	0.25735E-05	0.75861E-04	0.42544E-02	0.33786E-06	0.62458E-06
2	0.11653E-05	0.33522E-04	0.19137E-02	0.98389E-07	0.20766E-06
3	0.11459E-05	0.32575E-04	0.18030E-02	0.95817E-07	0.20302E-06
4	0.11456E-05	0.32557E-04	0.17985E-02	0.95752E-07	0.20291E-06
5	0.11456E-05	0.32557E-04	0.17984E-02	0.95780E-07	0.20298E-06
6	0.11453E-05	0.32543E-04	0.17974E-02	0.10938E-06	0.23305E-06
15	0.45290E-06	0.92255E-05	0.37124E-03	0.18113E-02	0.35770E-02
16	0.44327E-06	0.89299E-05	0.35540E-03	0.17153E-02	0.33550E-02
17	0.41508E-06	0.80943E-05	0.31185E-03	0.14604E-02	0.27334E-02

**** MOLE-X-PROFILE ****

STAGE	7	8	9	10	11
1	0.12128E-02	0.56068E-05	0.10693E-02	0.19008E-05	0.72179E-06
2	0.68728E-03	0.22501E-05	0.39397E-03	0.49515E-06	0.62210E-07
3	0.67704E-03	0.22086E-05	0.38423E-03	0.48005E-06	0.58352E-07
4	0.67688E-03	0.22076E-05	0.38407E-03	0.47964E-06	0.58240E-07
5	0.67690E-03	0.22082E-05	0.38409E-03	0.47991E-06	0.58315E-07
6	0.68650E-03	0.24647E-05	0.39307E-03	0.61338E-06	0.10171E-06
15	0.57011E-02	0.90877E-02	0.13341E-01	0.20266E-01	0.30648E-01
16	0.53176E-02	0.83965E-02	0.12134E-01	0.18150E-01	0.26920E-01

17 0.43372E-02 0.66280E-02 0.92492E-02 0.13306E-01 0.18838E-01

ASPEN PLUS PLAT: WIN32 VER: 11.1 08/05/2018 PAGE 52

FT

U-O-S BLOCK SECTION

BLOCK: FRA3 MODEL: RADFRAC (CONTINUED)

**** MOLE-X-PROFILE ****

STAGE	12	13	14	15	16
1	0.12110E-05	0.19732E-05	0.23739E-05	0.00000E+00	0.32708E-08
2	0.89972E-07	0.12754E-06	0.12994E-06	0.53310E-13	0.13540E-09
3	0.83996E-07	0.11854E-06	0.12010E-06	0.22687E-10	0.12395E-09
4	0.83821E-07	0.11828E-06	0.11981E-06	0.96538E-08	0.12361E-09
5	0.83939E-07	0.11845E-06	0.12001E-06	0.41079E-05	0.12384E-09
6	0.15329E-06	0.22600E-06	0.24162E-06	0.17434E-02	0.27334E-09
15	0.46799E-01	0.77291E-01	0.21196	0.34322	0.13994
16	0.39773E-01	0.61120E-01	0.13465	0.25514	0.15989
17	0.25905E-01	0.35103E-01	0.52184E-01	0.80919E-01	0.75896E-01

**** MOLE-X-PROFILE ****

STAGE	17	18	19	20	21
1	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
2	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
3	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
4	0.88039E-14	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
5	0.18496E-10	0.59162E-13	0.00000E+00	0.00000E+00	0.00000E+00
6	0.38740E-07	0.26199E-09	0.16731E-11	0.92183E-14	0.00000E+00

15	0.52654E-01	0.22105E-01	0.92239E-02	0.37390E-02	0.15843E-02
16	0.96612E-01	0.61714E-01	0.39353E-01	0.24757E-01	0.15988E-01
17	0.71480E-01	0.67540E-01	0.64012E-01	0.60834E-01	0.57957E-01

**** MOLE-X-PROFILE ****

STAGE	22	23	24	25	26
1	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
2	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
3	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
4	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
5	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
6	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
15	0.72302E-03	0.28354E-03	0.12389E-03	0.53877E-04	0.22611E-04
16	0.10696E-01	0.66504E-02	0.43544E-02	0.28647E-02	0.18447E-02
17	0.55340E-01	0.52949E-01	0.50756E-01	0.48737E-01	0.46873E-01

**** MOLE-X-PROFILE ****

STAGE	27	28
1	0.00000E+00	0.00000E+00
2	0.00000E+00	0.00000E+00
3	0.00000E+00	0.00000E+00
4	0.00000E+00	0.00000E+00
5	0.00000E+00	0.00000E+00
6	0.00000E+00	0.00000E+00
15	0.86376E-05	0.46887E-05
16	0.11388E-02	0.83353E-03
17	0.45146E-01	0.43542E-01

FT

U-O-S BLOCK SECTION

BLOCK: FRA3 MODEL: RADFRAC (CONTINUED)

**** MOLE-Y-PROFILE ****

STAGE	CO	CO ₂	H ₂	WATER	1
1	0.13327E-05	0.75840E-04	0.68491E-06	0.38991	0.12865E-04
2	0.74084E-06	0.42334E-04	0.38053E-06	0.65811	0.71567E-05
3	0.73356E-06	0.41822E-04	0.37689E-06	0.66292	0.70839E-05
4	0.73348E-06	0.41816E-04	0.37685E-06	0.66302	0.70830E-05
5	0.73347E-06	0.41816E-04	0.37685E-06	0.66302	0.70830E-05
6	0.73355E-06	0.41820E-04	0.37689E-06	0.66299	0.70837E-05
15	0.10688E-05	0.60833E-04	0.54926E-06	0.31367	0.10318E-04
16	0.10938E-05	0.62253E-04	0.56210E-06	0.32096	0.10559E-04
17	0.11687E-05	0.66513E-04	0.60061E-06	0.34268	0.11282E-04

**** MOLE-Y-PROFILE ****

STAGE	2	3	4	5	6
1	0.25840E-03	0.21001E-02	0.37612E-01	0.89552E-01	0.88821E-01
2	0.14470E-03	0.12004E-02	0.22786E-01	0.49751E-01	0.49345E-01
3	0.14271E-03	0.11707E-02	0.21557E-01	0.49277E-01	0.48875E-01
4	0.14269E-03	0.11701E-02	0.21505E-01	0.49272E-01	0.48870E-01
5	0.14268E-03	0.11701E-02	0.21503E-01	0.49272E-01	0.48869E-01
6	0.14270E-03	0.11702E-02	0.21505E-01	0.49277E-01	0.48875E-01
15	0.20731E-03	0.16860E-02	0.30237E-01	0.72184E-01	0.71959E-01
16	0.21214E-03	0.17251E-02	0.30934E-01	0.73818E-01	0.73535E-01

17 0.22664E-03 0.18427E-02 0.33026E-01 0.78740E-01 0.78300E-01

**** MOLE-Y-PROFILE ****

STAGE	7	8	9	10	11
1	0.79844E-01	0.70113E-01	0.61256E-01	0.52920E-01	0.44903E-01
2	0.44897E-01	0.38954E-01	0.34507E-01	0.29401E-01	0.24946E-01
3	0.44244E-01	0.38582E-01	0.33885E-01	0.29121E-01	0.24708E-01
4	0.44235E-01	0.38578E-01	0.33876E-01	0.29117E-01	0.24706E-01
5	0.44235E-01	0.38578E-01	0.33876E-01	0.29117E-01	0.24706E-01
6	0.44239E-01	0.38582E-01	0.33880E-01	0.29120E-01	0.24708E-01
15	0.65201E-01	0.58100E-01	0.51903E-01	0.46699E-01	0.42530E-01
16	0.66548E-01	0.59170E-01	0.52664E-01	0.47065E-01	0.42346E-01
17	0.70670E-01	0.62516E-01	0.55210E-01	0.48640E-01	0.42689E-01

**** MOLE-Y-PROFILE ****

STAGE	12	13	14	15	16
1	0.36973E-01	0.28658E-01	0.16988E-01	0.00000E+00	0.53146E-05
2	0.20541E-01	0.15922E-01	0.94388E-02	0.00000E+00	0.29540E-05
3	0.20345E-01	0.15770E-01	0.93480E-02	0.23975E-13	0.29245E-05
4	0.20343E-01	0.15768E-01	0.93469E-02	0.10205E-10	0.29242E-05
5	0.20342E-01	0.15768E-01	0.93469E-02	0.43423E-08	0.29242E-05
6	0.20345E-01	0.15769E-01	0.93479E-02	0.18475E-05	0.29245E-05
15	0.39838E-01	0.40915E-01	0.70113E-01	0.70322E-01	0.18475E-01
16	0.38735E-01	0.37379E-01	0.51950E-01	0.61546E-01	0.25099E-01
17	0.37317E-01	0.32654E-01	0.31472E-01	0.31406E-01	0.19686E-01

FT

U-O-S BLOCK SECTION

BLOCK: FRA3 MODEL: RADFRAC (CONTINUED)

**** MOLE-Y-PROFILE ****

STAGE	17	18	19	20	21
1	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
2	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
3	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
4	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
5	0.39600E-14	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
6	0.83182E-11	0.26608E-13	0.00000E+00	0.00000E+00	0.00000E+00
15	0.42859E-02	0.11710E-02	0.31663E-03	0.81929E-04	0.22520E-04
16	0.94420E-02	0.39638E-02	0.16540E-02	0.67047E-03	0.28409E-03
17	0.11892E-01	0.75967E-02	0.48442E-02	0.30474E-02	0.19681E-02

**** MOLE-Y-PROFILE ****

STAGE	22	23	24	25	26
1	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
2	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
3	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
4	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
5	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
6	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
15	0.69451E-05	0.17005E-05	0.49200E-06	0.13967E-06	0.37857E-07
16	0.12965E-03	0.50844E-04	0.22217E-04	0.96612E-05	0.40547E-05

17 0.13166E-02 0.81863E-03 0.53600E-03 0.35263E-03 0.22707E-03

**** MOLE-Y-PROFILE ****

STAGE 27 28

1	0.00000E+00	0.00000E+00
2	0.00000E+00	0.00000E+00
3	0.00000E+00	0.00000E+00
4	0.00000E+00	0.00000E+00
5	0.00000E+00	0.00000E+00
6	0.00000E+00	0.00000E+00
15	0.88420E-08	0.35275E-08
16	0.15489E-05	0.84079E-06
17	0.14018E-03	0.10260E-03

**** K-VALUES ****

STAGE	CO	CO ₂	H ₂	WATER	1
1	1285.0	167.93	13826.	0.39251	602.27
2	1418.8	211.34	14080.	0.66011	687.00
3	1420.7	212.01	14083.	0.66485	688.25
4	1420.8	212.02	14083.	0.66495	688.27
5	1420.8	212.02	14083.	0.66495	688.27
6	1420.8	212.11	14080.	0.66609	688.34
15	2447.6	875.61	14137.	57.585	1474.1
16	2494.6	919.10	14148.	51.179	1513.4
17	2639.6	1060.8	14188.	43.069	1636.4

FT

U-O-S BLOCK SECTION

BLOCK: FRA3 MODEL: RADFRAC (CONTINUED)

**** K-VALUES ****

STAGE	2	3	4	5	6
1	100.41	27.683	8.8407	0.26505E+06	0.14221E+06
2	124.18	35.810	11.907	0.50566E+06	0.23762E+06
3	124.54	35.938	11.956	0.51429E+06	0.24074E+06
4	124.55	35.940	11.957	0.51458E+06	0.24084E+06
5	124.55	35.941	11.957	0.51443E+06	0.24076E+06
6	124.59	35.959	11.965	0.45051E+06	0.20972E+06
15	457.73	182.75	81.449	39.852	20.117
16	478.58	193.19	87.039	43.035	21.918
17	546.02	227.65	105.90	53.917	28.646

**** K-VALUES ****

STAGE	7	8	9	10	11
1	65.836	12505.	57.286	27841.	62210.
2	65.325	17313.	87.586	59378.	0.40100E+06
3	65.349	17469.	88.188	60661.	0.42344E+06
4	65.351	17475.	88.203	60706.	0.42421E+06
5	65.349	17470.	88.198	60672.	0.42366E+06
6	64.442	15654.	86.192	47475.	0.24292E+06
15	11.437	6.3933	3.8906	2.3043	1.3877
16	12.515	7.0470	4.3403	2.5931	1.5731

17 16.294 9.4321 5.9691 3.6556 2.2661

**** K-VALUES ****

STAGE	12	13	14	15	16
1	30531.	14524.	7156.2	0.43576E-03	1624.9
2	0.22830E+06	0.12484E+06	72640.	0.10442E-02	21816.
3	0.24221E+06	0.13303E+06	77834.	0.10568E-02	23595.
4	0.24269E+06	0.13331E+06	78014.	0.10570E-02	23657.
5	0.24235E+06	0.13311E+06	77886.	0.10571E-02	23613.
6	0.13272E+06	69777.	38688.	0.10597E-02	10699.
15	0.85126	0.52937	0.33078	0.20489	0.13201
16	0.97389	0.61157	0.38582	0.24123	0.15698
17	1.4406	0.93024	0.60309	0.38812	0.25938

**** K-VALUES ****

STAGE	17	18	19	20	21
1	0.78591E-04	0.35298E-04	0.14632E-04	0.62361E-05	0.28443E-05
2	0.21117E-03	0.99794E-04	0.44363E-04	0.20110E-04	0.95004E-05
3	0.21404E-03	0.10122E-03	0.45041E-04	0.20434E-04	0.96586E-05
4	0.21410E-03	0.10125E-03	0.45054E-04	0.20441E-04	0.96618E-05
5	0.21410E-03	0.10125E-03	0.45055E-04	0.20441E-04	0.96620E-05
6	0.21472E-03	0.10156E-03	0.45202E-04	0.20512E-04	0.96965E-05
15	0.81398E-01	0.52973E-01	0.34327E-01	0.21912E-01	0.14215E-01
16	0.97731E-01	0.64228E-01	0.42030E-01	0.27082E-01	0.17769E-01
17	0.16638	0.11248	0.75676E-01	0.50094E-01	0.33957E-01

FT

U-O-S BLOCK SECTION

BLOCK: FRA3 MODEL: RADFRAC (CONTINUED)

**** K-VALUES ****

STAGE	22	23	24	25	26
1	0.12545E-05	0.50953E-06	0.26642E-06	0.11428E-06	0.55565E-07
2	0.44721E-05	0.19482E-05	0.10467E-05	0.47077E-06	0.23687E-06
3	0.45506E-05	0.19842E-05	0.10665E-05	0.47999E-06	0.24162E-06
4	0.45522E-05	0.19850E-05	0.10669E-05	0.48017E-06	0.24172E-06
5	0.45523E-05	0.19850E-05	0.10669E-05	0.48018E-06	0.24172E-06
6	0.45695E-05	0.19929E-05	0.10713E-05	0.48223E-06	0.24278E-06
15	0.96057E-02	0.59973E-02	0.39712E-02	0.25923E-02	0.16743E-02
16	0.12122E-01	0.76453E-02	0.51021E-02	0.33725E-02	0.21980E-02
17	0.23791E-01	0.15461E-01	0.10560E-01	0.72353E-02	0.48444E-02

**** K-VALUES ****

STAGE	27	28
1	0.22496E-07	0.76140E-08
2	0.10118E-06	0.39944E-07
3	0.10328E-06	0.40859E-07
4	0.10333E-06	0.40877E-07
5	0.10333E-06	0.40878E-07
6	0.10380E-06	0.41084E-07
15	0.10237E-02	0.75232E-03
16	0.13601E-02	0.10087E-02

17 0.31051E-02 0.23564E-02

**** MASS-X-PROFILE ****

STAGE	CO	CO ₂	H ₂	WATER	1
1	0.15781E-08	0.10798E-05	0.54251E-11	0.97221	0.18617E-07
2	0.80391E-09	0.48456E-06	0.29946E-11	0.98722	0.91860E-08
3	0.79521E-09	0.47736E-06	0.29663E-11	0.98769	0.90792E-08
4	0.79511E-09	0.47726E-06	0.29660E-11	0.98771	0.90779E-08
5	0.79507E-09	0.47724E-06	0.29659E-11	0.98766	0.90775E-08
6	0.78057E-09	0.46833E-06	0.29126E-11	0.96783	0.89110E-08
15	0.60222E-10	0.15054E-07	0.38563E-12	0.48315E-03	0.55291E-09
16	0.56809E-10	0.13788E-07	0.37046E-12	0.52260E-03	0.51776E-09
17	0.46000E-10	0.10235E-07	0.31652E-12	0.53168E-03	0.41026E-09

**** MASS-X-PROFILE ****

STAGE	2	3	4	5	6
1	0.42040E-05	0.18173E-03	0.13434E-01	0.13243E-05	0.29241E-05
2	0.19259E-05	0.81251E-04	0.61138E-02	0.39019E-06	0.98366E-06
3	0.18946E-05	0.78983E-04	0.57623E-02	0.38012E-06	0.96201E-06
4	0.18942E-05	0.78940E-04	0.57480E-02	0.37987E-06	0.96150E-06
5	0.18941E-05	0.78936E-04	0.57472E-02	0.37996E-06	0.96176E-06
6	0.18589E-05	0.77456E-04	0.56387E-02	0.42595E-06	0.10840E-05
15	0.67052E-07	0.20030E-05	0.10624E-03	0.64344E-03	0.15177E-02
16	0.61653E-07	0.18214E-05	0.95550E-04	0.57245E-03	0.13373E-02
17	0.46296E-07	0.13239E-05	0.67233E-04	0.39083E-03	0.87372E-03

FT

U-O-S BLOCK SECTION

BLOCK: FRA3 MODEL: RADFRAC (CONTINUED)

**** MASS-X-PROFILE ****

STAGE	7	8	9	10	11
1	0.66019E-02	0.34794E-04	0.74507E-02	0.14693E-04	0.61293E-05
2	0.37854E-02	0.14128E-04	0.27774E-02	0.38724E-05	0.53449E-06
3	0.37303E-02	0.13872E-04	0.27097E-02	0.37557E-05	0.50152E-06
4	0.37294E-02	0.13866E-04	0.27086E-02	0.37525E-05	0.50056E-06
5	0.37294E-02	0.13869E-04	0.27086E-02	0.37545E-05	0.50119E-06
6	0.37129E-02	0.15196E-04	0.27211E-02	0.47106E-05	0.85813E-06
15	0.28127E-02	0.51111E-02	0.84246E-02	0.14198E-01	0.23587E-01
16	0.24647E-02	0.44365E-02	0.71984E-02	0.11945E-01	0.19463E-01
17	0.16120E-02	0.28084E-02	0.44002E-02	0.70223E-02	0.10922E-01

**** MASS-X-PROFILE ****

STAGE	12	13	14	15	16
1	0.11206E-04	0.19763E-04	0.25585E-04	0.00000E+00	0.40237E-07
2	0.84238E-06	0.12925E-05	0.14170E-05	0.62243E-12	0.16853E-08
3	0.78671E-06	0.12017E-05	0.13101E-05	0.26498E-09	0.15433E-08
4	0.78508E-06	0.11990E-05	0.13070E-05	0.11276E-06	0.15391E-08
5	0.78615E-06	0.12008E-05	0.13091E-05	0.47978E-04	0.15419E-08
6	0.14093E-05	0.22489E-05	0.25873E-05	0.19988E-01	0.33408E-08
15	0.39249E-01	0.70160E-01	0.20704	0.35896	0.15603
16	0.31337E-01	0.52122E-01	0.12356	0.25069	0.16747

17 0.16367E-01 0.24005E-01 0.38401E-01 0.63757E-01 0.63748E-01

**** MASS-X-PROFILE ****

STAGE	17	18	19	20	21
1	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
2	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
3	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
4	0.11641E-12	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
5	0.24455E-09	0.82787E-12	0.00000E+00	0.00000E+00	0.00000E+00
6	0.50282E-06	0.35988E-08	0.24249E-10	0.14058E-12	0.00000E+00
15	0.62342E-01	0.27698E-01	0.12195E-01	0.52015E-02	0.23134E-02
16	0.10746	0.72649E-01	0.48880E-01	0.32356E-01	0.21933E-01
17	0.63757E-01	0.63758E-01	0.63758E-01	0.63758E-01	0.63758E-01

**** MASS-X-PROFILE ****

STAGE	22	23	24	25	26
1	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
2	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
3	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
4	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
5	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
6	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
15	0.11057E-02	0.45320E-03	0.20658E-03	0.93556E-04	0.40826E-04
16	0.15367E-01	0.99862E-02	0.68211E-02	0.46733E-02	0.31290E-02
17	0.63758E-01	0.63758E-01	0.63758E-01	0.63758E-01	0.63758E-01

FT

U-O-S BLOCK SECTION

BLOCK: FRA3 MODEL: RADFRAC (CONTINUED)

**** MASS-X-PROFILE ****

STAGE	27	28
1	0.00000E+00	0.00000E+00
2	0.00000E+00	0.00000E+00
3	0.00000E+00	0.00000E+00
4	0.00000E+00	0.00000E+00
5	0.00000E+00	0.00000E+00
6	0.00000E+00	0.00000E+00
15	0.16192E-04	0.91134E-05
16	0.20056E-02	0.15220E-02
17	0.63758E-01	0.63758E-01

**** MASS-Y-PROFILE ****

STAGE	CO	CO ₂	H ₂	WATER	1
1	0.48607E-06	0.43461E-04	0.17978E-07	0.91464E-01	0.26875E-05
2	0.40811E-06	0.36642E-04	0.15087E-07	0.23317	0.22580E-05
3	0.40735E-06	0.36490E-04	0.15063E-07	0.23676	0.22530E-05
4	0.40736E-06	0.36489E-04	0.15063E-07	0.23683	0.22530E-05
5	0.40736E-06	0.36489E-04	0.15063E-07	0.23683	0.22530E-05
6	0.40737E-06	0.36490E-04	0.15063E-07	0.23680	0.22531E-05
15	0.29692E-06	0.26553E-04	0.10982E-07	0.56044E-01	0.16418E-05
16	0.30808E-06	0.27550E-04	0.11394E-07	0.58144E-01	0.17034E-05

17 0.34841E-06 0.31155E-04 0.12886E-07 0.65706E-01 0.19264E-05

**** MASS-Y-PROFILE ****

STAGE	2	3	4	5	6
1	0.10117E-03	0.12058E-02	0.28466E-01	0.84133E-01	0.99669E-01
2	0.85571E-04	0.10411E-02	0.26047E-01	0.70596E-01	0.83633E-01
3	0.85074E-04	0.10234E-02	0.24840E-01	0.70486E-01	0.83502E-01
4	0.85070E-04	0.10231E-02	0.24783E-01	0.70487E-01	0.83503E-01
5	0.85070E-04	0.10231E-02	0.24781E-01	0.70487E-01	0.83503E-01
6	0.85073E-04	0.10231E-02	0.24782E-01	0.70489E-01	0.83506E-01
15	0.61825E-04	0.73736E-03	0.17431E-01	0.51653E-01	0.61503E-01
16	0.64145E-04	0.76496E-03	0.18080E-01	0.53556E-01	0.63723E-01
17	0.72534E-04	0.86482E-03	0.20430E-01	0.60465E-01	0.71817E-01

**** MASS-Y-PROFILE ****

STAGE	7	8	9	10	11
1	0.10418	0.10429	0.10230	0.98047E-01	0.91393E-01
2	0.88478E-01	0.87514E-01	0.87041E-01	0.82274E-01	0.76689E-01
3	0.87893E-01	0.87374E-01	0.86159E-01	0.82143E-01	0.76568E-01
4	0.87886E-01	0.87375E-01	0.86149E-01	0.82144E-01	0.76570E-01
5	0.87886E-01	0.87376E-01	0.86149E-01	0.82144E-01	0.76570E-01
6	0.87888E-01	0.87378E-01	0.86151E-01	0.82147E-01	0.76572E-01
15	0.64798E-01	0.65824E-01	0.66024E-01	0.65900E-01	0.65934E-01
16	0.67055E-01	0.67967E-01	0.67922E-01	0.67338E-01	0.66560E-01
17	0.75369E-01	0.76007E-01	0.75365E-01	0.73659E-01	0.71020E-01

FT

U-O-S BLOCK SECTION

BLOCK: FRA3 MODEL: RADFRAC (CONTINUED)

**** MASS-Y-PROFILE ****

STAGE	12	13	14	15	16
1	0.82006E-01	0.68799E-01	0.43885E-01	0.00000E+00	0.15671E-04
2	0.68813E-01	0.57732E-01	0.36828E-01	0.00000E+00	0.13156E-04
3	0.68704E-01	0.57639E-01	0.36767E-01	0.10097E-12	0.13129E-04
4	0.68705E-01	0.57640E-01	0.36767E-01	0.42979E-10	0.13129E-04
5	0.68705E-01	0.57640E-01	0.36767E-01	0.18289E-07	0.13129E-04
6	0.68707E-01	0.57642E-01	0.36769E-01	0.77806E-05	0.13130E-04
15	0.67303E-01	0.74815E-01	0.13796	0.14815	0.41492E-01
16	0.66347E-01	0.69297E-01	0.10364	0.13146	0.57152E-01
17	0.67655E-01	0.64075E-01	0.66453E-01	0.71004E-01	0.47445E-01

**** MASS-Y-PROFILE ****

STAGE	17	18	19	20	21
1	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
2	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
3	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
4	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
5	0.18881E-13	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
6	0.39658E-10	0.13426E-12	0.00000E+00	0.00000E+00	0.00000E+00
15	0.10222E-01	0.29556E-02	0.84326E-03	0.22959E-03	0.66241E-04
16	0.22832E-01	0.10144E-01	0.44662E-02	0.19050E-02	0.84725E-03

17 0.30438E-01 0.20577E-01 0.13845E-01 0.91644E-02 0.62123E-02

**** MASS-Y-PROFILE ****

STAGE	22	23	24	25	26
1	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
2	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
3	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
4	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
5	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
6	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00	0.00000E+00
15	0.21395E-04	0.54749E-05	0.16525E-05	0.48854E-06	0.13769E-06
16	0.40495E-03	0.16598E-03	0.75658E-04	0.34263E-04	0.14952E-04
17	0.43525E-02	0.28285E-02	0.19320E-02	0.13237E-02	0.88627E-03

**** MASS-Y-PROFILE ****

STAGE	27	28
1	0.00000E+00	0.00000E+00
2	0.00000E+00	0.00000E+00
3	0.00000E+00	0.00000E+00
4	0.00000E+00	0.00000E+00
5	0.00000E+00	0.00000E+00
6	0.00000E+00	0.00000E+00
15	0.33389E-07	0.13811E-07
16	0.59301E-05	0.33376E-05
17	0.56806E-03	0.43110E-03

FT

U-O-S BLOCK SECTION

BLOCK: FTRECTOR MODEL: RYIELD

INLET STREAM: TOFTREAC

OUTLET STREAM: FT-HC

PROPERTY OPTION SET: PR-BM PENG-ROBINSON EQUATION OF STATE

*** MASS AND ENERGY BALANCE ***

	IN	OUT	GENERATION	RELATIVE DIFF.
CONV. COMP.(KMOL/HR)	1534.57	482.049	-1052.52	0.259294E-15
(KG/HR)	17628.4	17628.4	0.000000E+00	
NONCONV COMP(KG/HR)	0.000000E+00	0.000000E+00	0.000000E+00	
TOTAL BALANCE				
MASS(KG/HR)	17628.4	17628.4	0.000000E+00	
ENTHALPY(CAL/SEC)	-0.346013E+07	-0.240596E+07	-0.304662	

FT

U-O-S BLOCK SECTION

BLOCK: FTRECTOR MODEL: RYIELD (CONTINUED)

*** INPUT DATA ***

TWO PHASE TP FLASH

SPECIFIED TEMPERATURE K 513.150

SPECIFIED PRESSURE	ATM	14.8038
MAXIMUM NO. ITERATIONS		30
CONVERGENCE TOLERANCE		0.000100000

MASS-YIELD

SUBSTREAM MIXED :

CO	0.313E-01	CO ₂	0.313E-01	H ₂	0.313E-01
WATER	0.313E-01	1	0.313E-01	2	0.313E-01
3	0.313E-01	4	0.313E-01	5	0.313E-01
6	0.313E-01	7	0.313E-01	8	0.313E-01
9	0.313E-01	10	0.313E-01	11	0.313E-01
12	0.313E-01	13	0.313E-01	14	0.313E-01
15	0.313E-01	16	0.313E-01	17	0.313E-01
18	0.313E-01	19	0.313E-01	20	0.313E-01
21	0.313E-01	22	0.313E-01	23	0.313E-01
24	0.313E-01	25	0.313E-01	26	0.313E-01
27	0.313E-01	28	0.313E-01		

ASPEN PLUS PLAT: WIN32 VER: 11.1 08/05/2018 PAGE 62

FT

U-O-S BLOCK SECTION

BLOCK: FTRECTOR MODEL: RYIELD (CONTINUED)

*** RESULTS ***

OUTLET TEMPERATURE	K	513.15
OUTLET PRESSURE	ATM	14.804
HEAT DUTY	CAL/SEC	0.10542E+07

VAPOR FRACTION

0.93263

V-L PHASE EQUILIBRIUM :

COMP	F(I)	X(I)	Y(I)	K(I)
CO	0.40799E-01	0.17341E-02	0.43621E-01	25.154
CO ₂	0.25967E-01	0.23374E-02	0.27674E-01	11.840
H ₂	0.56690	0.21816E-01	0.60627	27.791
WATER	0.63435E-01	0.17869E-01	0.66727E-01	3.7341
1	0.71235E-01	0.44855E-02	0.76056E-01	16.956
2	0.38005E-01	0.44070E-02	0.40432E-01	9.1745
3	0.25916E-01	0.47812E-02	0.27443E-01	5.7397

ASPEN PLUS PLAT: WIN32 VER: 11.1

08/05/2018 PAGE 63

FT

U-O-S BLOCK SECTION

BLOCK: FTRECTOR MODEL: RYIELD (CONTINUED)

V-L PHASE EQUILIBRIUM :

COMP	F(I)	X(I)	Y(I)	K(I)
4	0.19662E-01	0.57093E-02	0.20670E-01	3.6203
5	0.15839E-01	0.71126E-02	0.16470E-01	2.3156
6	0.13261E-01	0.89797E-02	0.13570E-01	1.5112
7	0.11405E-01	0.11392E-01	0.11406E-01	1.0012

8	0.10004E-01	0.14568E-01	0.96747E-02	0.66410
9	0.89102E-02	0.18481E-01	0.82189E-02	0.44472
10	0.80318E-02	0.23255E-01	0.69322E-02	0.29810
11	0.73111E-02	0.28635E-01	0.57708E-02	0.20153
12	0.67090E-02	0.34334E-01	0.47136E-02	0.13729
13	0.61986E-02	0.40034E-01	0.37545E-02	0.93784E-01
14	0.57603E-02	0.45349E-01	0.29007E-02	0.63964E-01
15	0.53799E-02	0.49554E-01	0.21891E-02	0.44177E-01
16	0.50467E-02	0.52550E-01	0.16153E-02	0.30739E-01
17	0.47523E-02	0.54537E-01	0.11562E-02	0.21200E-01
18	0.44904E-02	0.55116E-01	0.83352E-03	0.15123E-01
19	0.42558E-02	0.55003E-01	0.59023E-03	0.10731E-01
20	0.40446E-02	0.54399E-01	0.40727E-03	0.74866E-02
21	0.38533E-02	0.53226E-01	0.28692E-03	0.53906E-02
22	0.36793E-02	0.51767E-01	0.20573E-03	0.39741E-02
23	0.35203E-02	0.50334E-01	0.13874E-03	0.27565E-02
24	0.33745E-02	0.48754E-01	0.96593E-04	0.19812E-02
25	0.32403E-02	0.47144E-01	0.68986E-04	0.14633E-02
26	0.31163E-02	0.45597E-01	0.47814E-04	0.10486E-02
27	0.30015E-02	0.44107E-01	0.32346E-04	0.73335E-03
28	0.28949E-02	0.42633E-01	0.24461E-04	0.57375E-03

BLOCK: GASIFI MODEL: RSTOIC

INLET STREAM: GASIFIER

INLET HEAT STREAM: GHGHHG

OUTLET STREAM: 3

PROPERTY OPTION SET: PR-BM PENG-ROBINSON EQUATION OF STATE

*

*

* ONE OR MORE REACTIONS WERE DROPPED

*

*

*

*** MASS AND ENERGY BALANCE ***

	IN	OUT	GENERATION	RELATIVE DIFF.
CONV. COMP.(KMOL/HR)	2795.51	2615.29	-180.221	0.508346E-16
(KG/HR)	38052.8	38052.8		0.382414E-15
NONCONV COMP(KG/HR)	3427.20	3427.20		0.000000E+00

ASPEN PLUS PLAT: WIN32 VER: 11.1 08/05/2018 PAGE 64

FT

U-O-S BLOCK SECTION

BLOCK: GASIFI MODEL: RSTOIC (CONTINUED)

TOTAL BALANCE

MASS(KG/HR)	41480.0	41480.0	0.350818E-15
ENTHALPY(CAL/SEC)	-0.676595E+07	-0.676595E+07	0.254498E-11

*** INPUT DATA ***

STOICHIOMETRY MATRIX:

REACTION # 1:

SUBSTREAM MIXED :

CO 2.00 CO₂ -1.00

SUBSTREAM CISOLID :

C -1.00

SUBSTREAM NC :

NO PARTICIPATING COMPONENTS

REACTION # 2:

SUBSTREAM MIXED :

CO 1.00 H₂ 1.00 WATER -1.00

SUBSTREAM CISOLID :

C -1.00

SUBSTREAM NC :

NO PARTICIPATING COMPONENTS

REACTION # 3:

SUBSTREAM MIXED :

H₂ -2.00 1 1.00

SUBSTREAM CISOLID :

C -1.00

SUBSTREAM NC :

NO PARTICIPATING COMPONENTS

REACTION # 4:

SUBSTREAM MIXED :

CO -1.00 CO₂ 1.00 H₂ 1.00 WATER -1.00

SUBSTREAM CISOLID :

NO PARTICIPATING COMPONENTS

SUBSTREAM NC :

NO PARTICIPATING COMPONENTS

REACTION # 5:

SUBSTREAM MIXED :

CO 1.00 H₂ 3.00 WATER -1.00 1 -1.00

SUBSTREAM CISOLID :

NO PARTICIPATING COMPONENTS

SUBSTREAM NC :

NO PARTICIPATING COMPONENTS

ASPEN PLUS PLAT: WIN32 VER: 11.1 08/05/2018 PAGE 65

FT

U-O-S BLOCK SECTION

BLOCK: GASIFI MODEL: RSTOIC (CONTINUED)

REACTION CONVERSION SPECS: NUMBER= 5

REACTION # 1:

SUBSTREAM:CISOLID KEY COMP:C CONV FRAC: 0.1000E-01

REACTION # 2:

SUBSTREAM:MIXED KEY COMP:WATER CONV FRAC: 0.7000

REACTION # 3:

SUBSTREAM:CISOLID KEY COMP:C CONV FRAC: 0.6000E-01

REACTION # 4:

SUBSTREAM:MIXED KEY COMP:WATER CONV FRAC: 0.2000

REACTION # 5:

SUBSTREAM:MIXED KEY COMP:WATER CONV FRAC: 0.1000

TWO PHASE PQ FLASH

SPECIFIED PRESSURE	ATM	0.98692
DUTY FROM INLET HEAT STREAM(S)	CAL/SEC	0.119423+08
MAXIMUM NO. ITERATIONS		30
CONVERGENCE TOLERANCE		0.000100000
SIMULTANEOUS REACTIONS		
GENERATE COMBUSTION REACTIONS FOR FEED SPECIES		NO

*** RESULTS ***

OUTLET TEMPERATURE	K	1122.9
OUTLET PRESSURE	ATM	0.98692
VAPOR FRACTION		1.0000

REACTION EXTENTS:

REACTION NUMBER	REACTION EXTENT KMOL/HR
1	15.018
2	717.56
3	90.110

4 205.02
5 0.00000E+00

ASPEN PLUS PLAT: WIN32 VER: 11.1 08/05/2018 PAGE 66

FT

U-O-S BLOCK SECTION

BLOCK: GASIFI MODEL: RSTOIC (CONTINUED)

V-L PHASE EQUILIBRIUM :

COMP	F(I)	X(I)	Y(I)	K(I)
N2	0.27081E-02	0.99209E-09	0.27081E-02	1481.9
CO	0.28881	0.11118E-06	0.28881	1490.7
CO ₂	0.98133E-01	0.32546E-05	0.98133E-01	1457.2
H ₂	0.50381	0.38909E-06	0.50381	1317.2
WATER	0.52945E-01	0.99999	0.52945E-01	1215.2
H ₂ S	0.70486E-02	0.55411E-05	0.70486E-02	1386.6
1	0.46541E-01	0.12817E-06	0.46541E-01	1465.8

BLOCK: HEATER MODEL: HEATER

INLET STREAM: TOHEATER

OUTLET STREAM: TOFTREAC

PROPERTY OPTION SET: PR-BM PENG-ROBINSON EQUATION OF STATE

*** MASS AND ENERGY BALANCE ***

IN OUT RELATIVE DIFF.

CONV. COMP.(KMOL/HR)	1534.57	1534.57	0.000000E+00
(KG/HR)	17628.4	17628.4	0.000000E+00
NONCONV. COMP(KG/HR)	0.000000E+00	0.000000E+00	0.000000E+00
TOTAL BALANCE			
MASS(KG/HR)	17628.4	17628.4	0.000000E+00
ENTHALPY(CAL/SEC)	-0.405654E+07	-0.346013E+07	-0.147026

*** INPUT DATA ***

TWO PHASE TP FLASH		
SPECIFIED TEMPERATURE	K	513.150
SPECIFIED PRESSURE	ATM	14.8038
MAXIMUM NO. ITERATIONS		30
CONVERGENCE TOLERANCE		0.000100000

*** RESULTS ***

OUTLET TEMPERATURE	K	513.15
OUTLET PRESSURE	ATM	14.804
HEAT DUTY	CAL/SEC	0.59642E+06
OUTLET VAPOR FRACTION		1.0000
PRESSURE-DROP CORRELATION PARAMETER		0.00000E+00

ASPEN PLUS PLAT: WIN32 VER: 11.1 08/05/2018 PAGE 67

FT

U-O-S BLOCK SECTION

BLOCK: HEATER MODEL: HEATER (CONTINUED)

V-L PHASE EQUILIBRIUM :

COMP	F(I)	X(I)	Y(I)	K(I)
CO	0.36437	0.36437	0.36437	MISSING
H ₂	0.63563	0.63563	0.63563	MISSING

BLOCK: N2SPRTR MODEL: FLASH₂

INLET STREAM: SOURSYN

OUTLET VAPOR STREAM: SOURSYN2

OUTLET LIQUID STREAM: N2

PROPERTY OPTION SET: PR-BM PENG-ROBINSON EQUATION OF STATE

*** MASS AND ENERGY BALANCE ***

	IN	OUT	RELATIVE DIFF.
CONV. COMP.(KMOL/HR)	1936.14	1936.14	0.000000E+00
(KG/HR)	29895.5	29895.5	-0.365069E-15
NONCONV. COMP(KG/HR)	0.000000E+00	0.000000E+00	0.000000E+00
TOTAL BALANCE			
MASS(KG/HR)	29895.5	29895.5	-0.365069E-15
ENTHALPY(CAL/SEC)	-0.114771E+08	-0.114287E+08	-0.421958E-02

*** INPUT DATA ***

TWO PHASE TP FLASH

SPECIFIED TEMPERATURE K 313.150

SPECIFIED PRESSURE	ATM	39.4769
MAXIMUM NO. ITERATIONS		30
CONVERGENCE TOLERANCE		0.000100000

*** RESULTS ***

OUTLET TEMPERATURE	K	313.15
OUTLET PRESSURE	ATM	39.477
HEAT DUTY	CAL/SEC	48429.
VAPOR FRACTION		0.94901

ASPEN PLUS PLAT: WIN32 VER: 11.1 08/05/2018 PAGE 68

FT

U-O-S BLOCK SECTION

BLOCK: N2SPRTR MODEL: FLASH₂ (CONTINUED)

V-L PHASE EQUILIBRIUM :

COMP	F(I)	X(I)	Y(I)	K(I)
N2	0.27081E-02	0.21469E-07	0.28536E-02	0.13292E+06
CO	0.28881	0.23504E-05	0.30433	0.12948E+06
CO ₂	0.98133E-01	0.57886E-04	0.10340	1786.3
H ₂	0.50381	0.11127E-04	0.53088	47709.
WATER	0.52945E-01	0.99981	0.20693E-02	0.20697E-02
H ₂ S	0.70486E-02	0.11196E-03	0.74213E-02	66.288
1	0.46541E-01	0.26341E-05	0.49042E-01	18618.

BLOCK: SPRTR MODEL: SEP

INLET STREAM: COAL-VOL

OUTLET STREAMS: COAL VOLATILE

PROPERTY OPTION SET: PR-BM PENG-ROBINSON EQUATION OF STATE

*** MASS AND ENERGY BALANCE ***

	IN	OUT	RELATIVE DIFF.
CONV. COMP.(KMOL/HR)	1793.88	1793.88	0.000000E+00
(KG/HR)	21052.8	21052.8	-0.172803E-15
NONCONV. COMP(KG/HR)	3427.20	3427.20	0.000000E+00
TOTAL BALANCE			
MASS(KG/HR)	24480.0	24480.0	-0.148610E-15
ENTHALPY(CAL/SEC)	-0.165864E+07	-0.167909E+07	0.121794E-01

*** INPUT DATA ***

FLASH SPECS FOR STREAM COAL

ONE PHASE TP FLASH SPECIFIED PHASE IS VAPOR

PRESSURE DROP	ATM	0.0
MAXIMUM NO. ITERATIONS		30
CONVERGENCE TOLERANCE		0.000100000

FLASH SPECS FOR STREAM VOLATILE

TWO PHASE TP FLASH

PRESSURE DROP	ATM	0.0
---------------	-----	-----

MAXIMUM NO. ITERATIONS 30
CONVERGENCE TOLERANCE 0.000100000

ASPEN PLUS PLAT: WIN32 VER: 11.1 08/05/2018 PAGE 69

FT

U-O-S BLOCK SECTION

BLOCK: SPRTR MODEL: SEP (CONTINUED)

FRACTION OF FEED

SUBSTREAM= MIXED

STREAM= VOLATILE CPT= O2 FRACTION= 1.00000

N2 1.00000

CO 0.0

CO₂ 1.00000

H₂ 0.0

WATER 1.00000

H₂S 1.00000

C 0.0

SUBSTREAM= NCPSD

STREAM= VOLATILE CPT= ASH FRACTION= 1.00000

*** RESULTS ***

HEAT DUTY CAL/SEC -20450.

COMPONENT = N2

STREAM	SUBSTREAM	SPLIT FRACTION
VOLATILE	MIXED	1.00000

COMPONENT = CO

STREAM	SUBSTREAM	SPLIT FRACTION
COAL	MIXED	1.00000

COMPONENT = CO₂

STREAM	SUBSTREAM	SPLIT FRACTION
VOLATILE	MIXED	1.00000

COMPONENT = H₂

STREAM	SUBSTREAM	SPLIT FRACTION
COAL	MIXED	1.00000

COMPONENT = WATER

STREAM	SUBSTREAM	SPLIT FRACTION
VOLATILE	MIXED	1.00000

COMPONENT = H₂S

STREAM	SUBSTREAM	SPLIT FRACTION
VOLATILE	MIXED	1.00000

COMPONENT = 1

STREAM	SUBSTREAM	SPLIT FRACTION
VOLATILE	MIXED	1.00000

COMPONENT = C

STREAM SUBSTREAM SPLIT FRACTION
VOLATILE CIPSD 1.00000

COMPONENT = ASH

STREAM SUBSTREAM SPLIT FRACTION
VOLATILE NCPSD 1.00000

ASPEN PLUS PLAT: WIN32 VER: 11.1 08/05/2018 PAGE 70

FT

U-O-S BLOCK SECTION

BLOCK: VLV1 MODEL: VALVE

INLET STREAM: SYNGAS

OUTLET STREAM: TOHEATER

PROPERTY OPTION SET: PR-BM PENG-ROBINSON EQUATION OF STATE

*** MASS AND ENERGY BALANCE ***

	IN	OUT	RELATIVE DIFF.
CONV. COMP.(KMOL/HR)	1534.57	1534.57	0.000000E+00
(KG/HR)	17628.4	17628.4	0.000000E+00
NONCONV. COMP(KG/HR)	0.000000E+00	0.000000E+00	0.000000E+00
TOTAL BALANCE			
MASS(KG/HR)	17628.4	17628.4	0.000000E+00
ENTHALPY(CAL/SEC)	-0.405654E+07	-0.405654E+07	-0.149414E-11

*** INPUT DATA ***

VALVE FLOW COEF CALC. NO

FLASH SPECIFICATIONS:

NPHASE	2
MAX NUMBER OF ITERATIONS	30
CONVERGENCE TOLERANCE	0.000100000

*** RESULTS ***

VALVE PRESSURE DROP	ATM	24.6731
---------------------	-----	---------

BLOCK: VOLREAC MODEL: RGIBBS

INLET STREAM: VOLATILE

OUTLET STREAM: 6

PROPERTY OPTION SET: PR-BM PENG-ROBINSON EQUATION OF STATE

*** MASS AND ENERGY BALANCE ***

	IN	OUT	GENERATION	RELATIVE DIFF.
CONV. COMP.(KMOL/HR)	1546.55	1604.53	57.9850	0.309984E-16
(KG/HR)	20122.6	20122.6	0.361582E-15	
NONCONV COMP(KG/HR)	3427.20	3427.20	0.000000E+00	
TOTAL BALANCE				
MASS(KG/HR)	23549.8	23549.8	0.308961E-15	
ENTHALPY(CAL/SEC)	-0.155731E+07	-0.150857E+07	-0.312972E-01	

FT

U-O-S BLOCK SECTION

BLOCK: VOLREAC MODEL: RGIBBS (CONTINUED)

*** INPUT DATA ***

EQUILIBRIUM SPECIFICATIONS:

ONLY CHEMICAL EQUILIBRIUM IS CONSIDERED, THE FLUID PHASE IS VAPOR

SYSTEM TEMPERATURE K 298.15

TEMPERATURE FOR FREE ENERGY EVALUATION K 298.15

SYSTEM PRESSURE ATM 1.0003

FLUID PHASE SPECIES IN PRODUCT LIST:

O2 N2 CO CO₂ H₂ WATER H₂S

SOLIDS IN PRODUCT LIST:

C

ASPEN PLUS PLAT: WIN32 VER: 11.1 08/05/2018 PAGE 72

FT

U-O-S BLOCK SECTION

BLOCK: VOLREAC MODEL: RGIBBS (CONTINUED)

ATOM MATRIX:

ELEMENT H C N O S

O2 0.00 0.00 0.00 2.00 0.00

N2	0.00	0.00	2.00	0.00	0.00
CO	0.00	1.00	0.00	1.00	0.00
CO ₂	0.00	1.00	0.00	2.00	0.00
H ₂	2.00	0.00	0.00	0.00	0.00
WATER	2.00	0.00	0.00	1.00	0.00
H ₂ S	2.00	0.00	0.00	0.00	1.00
MEA	7.00	2.00	1.00	1.00	0.00
1	4.00	1.00	0.00	0.00	0.00
2	6.00	2.00	0.00	0.00	0.00
3	8.00	3.00	0.00	0.00	0.00
4	10.00	4.00	0.00	0.00	0.00
5	12.00	5.00	0.00	0.00	0.00
6	14.00	6.00	0.00	0.00	0.00
7	16.00	7.00	0.00	0.00	0.00
8	18.00	8.00	0.00	0.00	0.00
9	20.00	9.00	0.00	0.00	0.00
10	22.00	10.00	0.00	0.00	0.00
11	24.00	11.00	0.00	0.00	0.00
12	26.00	12.00	0.00	0.00	0.00
13	28.00	13.00	0.00	0.00	0.00
14	30.00	14.00	0.00	0.00	0.00
15	32.00	15.00	0.00	0.00	0.00
16	34.00	16.00	0.00	0.00	0.00
17	36.00	17.00	0.00	0.00	0.00
18	38.00	18.00	0.00	0.00	0.00
19	40.00	19.00	0.00	0.00	0.00
20	42.00	20.00	0.00	0.00	0.00
21	44.00	21.00	0.00	0.00	0.00

22	46.00	22.00	0.00	0.00	0.00
23	48.00	23.00	0.00	0.00	0.00
24	50.00	24.00	0.00	0.00	0.00
25	52.00	25.00	0.00	0.00	0.00
26	54.00	26.00	0.00	0.00	0.00
27	56.00	27.00	0.00	0.00	0.00
28	58.00	28.00	0.00	0.00	0.00
29	60.00	29.00	0.00	0.00	0.00
C	0.00	1.00	0.00	0.00	0.00

*** RESULTS ***

TEMPERATURE	K	298.15
PRESSURE	ATM	1.0003
HEAT DUTY	CAL/SEC	48739.
VAPOR FRACTION		1.0000
NUMBER OF FLUID PHASES		1

ASPEN PLUS PLAT: WIN32 VER: 11.1 08/05/2018 PAGE 73

FT

U-O-S BLOCK SECTION

BLOCK: VOLREAC MODEL: RGIBBS (CONTINUED)

FLUID PHASE MOLE FRACTIONS:

PHASE	VAPOR
OF TYPE	VAPOR
PHASE FRACTION	1.000000

PLACED IN STREAM 6

O2 0.0000000E+00

N2 0.5105672E-01

CO 0.3195697E-14

H₂ 0.2299137E-01

H₂S 0.1328920

WATER 0.7930599

CO₂ 0.1123401E-07

KMOL/HR 102.6934

SOLIDS PRESENT AT EQUILIBRIUM, PLACED IN STREAM 6

SOLID FLOW RATES (KMOL/HR) :

C 1501.840

BLOCK: YIELDGAS MODEL: RYIELD

INLET STREAM: BIOMASS

OUTLET STREAM: COAL-VOL

PROPERTY OPTION SET: PR-BM PENG-ROBINSON EQUATION OF STATE

*** MASS AND ENERGY BALANCE ***

	IN	OUT	GENERATION	RELATIVE DIFF.
--	----	-----	------------	----------------

CONV. COMP.(KMOL/HR)	0.000000E+00	1793.88	1793.88	0.000000E+00
-----------------------	--------------	---------	---------	--------------

(KG/HR)	0.000000E+00	21052.8		-1.00000
----------	--------------	---------	--	----------

NONCONV COMP(KG/HR)	24480.0	3427.20		0.860000
----------------------	---------	---------	--	----------

TOTAL BALANCE

MASS(KG/HR) 24480.0 24480.0 -0.148610E-15

ENTHALPY(CAL/SEC)-0.219854E+07 -0.165864E+07 -0.245572

ASPEN PLUS PLAT: WIN32 VER: 11.1 08/05/2018 PAGE 74

FT

U-O-S BLOCK SECTION

BLOCK: YIELDGAS MODEL: RYIELD (CONTINUED)

*** INPUT DATA ***

TWO PHASE TP FLASH

SPECIFIED TEMPERATURE K 298.150

SPECIFIED PRESSURE ATM 1.00000

MAXIMUM NO. ITERATIONS 30

CONVERGENCE TOLERANCE 0.000100000

MASS-YIELD

SUBSTREAM MIXED :

N2 0.600E-02 CO 0.190E-01 CO₂ 0.500E-01

H₂ 0.190E-01 WATER 0.190E-01 H₂S 0.190E-01

1 0.190E-01

SUBSTREAM CISOLID :

C 0.709

SUBSTREAM NC :

ASH 0.140

FT

U-O-S BLOCK SECTION

BLOCK: YIELDGAS MODEL: RYIELD (CONTINUED)

*** RESULTS ***

OUTLET TEMPERATURE	K	298.15
OUTLET PRESSURE	ATM	1.0000
HEAT DUTY	CAL/SEC	0.53990E+06
VAPOR FRACTION		0.95120

V-L PHASE EQUILIBRIUM :

COMP	F(I)	X(I)	Y(I)	K(I)
N2	0.15030E-01	0.17537E-08	0.15801E-01	0.90102E+07
CO	0.47601E-01	0.57515E-08	0.50043E-01	0.87008E+07
CO ₂	0.79726E-01	0.11115E-05	0.83816E-01	75410.
H ₂	0.66140	0.20918E-06	0.69534	0.33240E+07
WATER	0.74010E-01	0.99998	0.26503E-01	0.26503E-01
H ₂ S	0.39121E-01	0.17979E-04	0.41127E-01	2287.5
1	0.83110E-01	0.80493E-07	0.87374E-01	0.10855E+07

FT

STREAM SECTION

SUBSTREAM ATTR PSD TYPE: PSD

INTERVAL	LOWER LIMIT		UPPER LIMIT	
1	0.0	METER	2.0000-05	METER
2	2.0000-05	METER	4.0000-05	METER
3	4.0000-05	METER	6.0000-05	METER
4	6.0000-05	METER	8.0000-05	METER
5	8.0000-05	METER	1.0000-04	METER
6	1.0000-04	METER	1.2000-04	METER
7	1.2000-04	METER	1.4000-04	METER
8	1.4000-04	METER	1.6000-04	METER
9	1.6000-04	METER	1.8000-04	METER
10	1.8000-04	METER	2.0000-04	METER

FT

STREAM SECTION

3 6 AMINECO₂ ASH+COAL BIOMASS

STREAM ID 3 6 AMINECO₂ ASH+COAL BIOMASS
 FROM : GASIFI VOLREAC ---- CYCLONE ----
 TO : CYCLONE B4 COABSORB ---- YIELDGAS
 CLASS: MCINCPSD MCINCPSD MCINCPSD MCINCPSD MCINCPSD

TOTAL STREAM:

KG/HR 4.1480+04 2.3550+04 3.6263+05 1.1584+04 2.4480+04
 CAL/SEC -6.7659+06 -1.5086+06 -3.3891+08 8.2399+05 -2.1985+06

SUBSTREAM: MIXED

PHASE: VAPOR VAPOR LIQUID MISSING MISSING

COMPONENTS: KMOL/HR

O ₂	0.0	0.0	0.0	0.0	0.0
N ₂	5.2432	5.2432	0.0	0.0	0.0
CO	559.1848	3.2818-13	0.0	0.0	0.0
CO ₂	189.9987	1.1537-06	0.0	0.0	0.0
H ₂	975.4452	2.3611	0.0	0.0	0.0
WATER	102.5085	81.4421	1.7110+04	0.0	0.0
H ₂ S	13.6471	13.6471	0.0	0.0	0.0
MEA	0.0	0.0	890.4830	0.0	0.0
1	90.1104	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	0.0

4	0.0	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0
11	0.0	0.0	0.0	0.0	0.0
12	0.0	0.0	0.0	0.0	0.0
13	0.0	0.0	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0	0.0
15	0.0	0.0	0.0	0.0	0.0
16	0.0	0.0	0.0	0.0	0.0
17	0.0	0.0	0.0	0.0	0.0
18	0.0	0.0	0.0	0.0	0.0
19	0.0	0.0	0.0	0.0	0.0
20	0.0	0.0	0.0	0.0	0.0
21	0.0	0.0	0.0	0.0	0.0
22	0.0	0.0	0.0	0.0	0.0
23	0.0	0.0	0.0	0.0	0.0
24	0.0	0.0	0.0	0.0	0.0
25	0.0	0.0	0.0	0.0	0.0
26	0.0	0.0	0.0	0.0	0.0
27	0.0	0.0	0.0	0.0	0.0
28	0.0	0.0	0.0	0.0	0.0
29	0.0	0.0	0.0	0.0	0.0
C	0.0	0.0	0.0	0.0	0.0

TOTAL FLOW:

KMOL/HR	1936.1379	102.6934	1.8000+04	0.0	0.0
KG/HR	2.9896+04	2083.9611	3.6263+05	0.0	0.0
L/MIN	3.0134+06	4.1331+04	6060.4543	0.0	0.0

ASPEN PLUS PLAT: WIN32 VER: 11.1 08/05/2018 PAGE 78

FT

STREAM SECTION

3 6 AMINECO₂ ASH+COAL BIOMASS (CONTINUED)

STREAM ID	3	6	AMINECO ₂	ASH+COAL	BIOMASS
-----------	---	---	----------------------	----------	---------

STATE VARIABLES:

TEMP K	1122.9353	298.1500	313.1500	MISSING	MISSING
PRES ATM	0.9869	1.0003	39.4769	MISSING	1.0000
VFRAC	1.0000	1.0000	0.0	MISSING	MISSING
LFRAC	0.0	0.0	1.0000	MISSING	MISSING
SFRAC	0.0	0.0	0.0	MISSING	MISSING

ENTHALPY:

CAL/MOL	-1.4113+04	-4.6478+04	-6.7782+04	MISSING	MISSING
CAL/GM	-913.9757	-2290.3554	-3364.5575	MISSING	MISSING
CAL/SEC	-7.5899+06	-1.3258+06	-3.3891+08	MISSING	MISSING

ENTROPY:

CAL/MOL-K	17.8881	-5.7061	-41.5947	MISSING	MISSING
CAL/GM-K	1.1585	-0.2812	-2.0647	MISSING	MISSING

DENSITY:

MOL/CC	1.0709-05	4.1411-05	4.9501-02	MISSING	MISSING
GM/CC	1.6535-04	8.4035-04	0.9972	MISSING	MISSING

AVG MW 15.4408 20.2930 20.1459 MISSING MISSING

SUBSTREAM: CIPSD STRUCTURE: CONVENTIONAL

COMPONENTS: KMOL/HR

O2	0.0	0.0	0.0	0.0	0.0
N2	0.0	0.0	0.0	0.0	0.0
CO	0.0	0.0	0.0	0.0	0.0
CO ₂	0.0	0.0	0.0	0.0	0.0
H ₂	0.0	0.0	0.0	0.0	0.0
WATER	0.0	0.0	0.0	0.0	0.0
H ₂ S	0.0	0.0	0.0	0.0	0.0
MEA	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0
11	0.0	0.0	0.0	0.0	0.0
12	0.0	0.0	0.0	0.0	0.0
13	0.0	0.0	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0	0.0
15	0.0	0.0	0.0	0.0	0.0
16	0.0	0.0	0.0	0.0	0.0

17	0.0	0.0	0.0	0.0	0.0
18	0.0	0.0	0.0	0.0	0.0
19	0.0	0.0	0.0	0.0	0.0
20	0.0	0.0	0.0	0.0	0.0
21	0.0	0.0	0.0	0.0	0.0
22	0.0	0.0	0.0	0.0	0.0
23	0.0	0.0	0.0	0.0	0.0
24	0.0	0.0	0.0	0.0	0.0

ASPEN PLUS PLAT: WIN32 VER: 11.1 08/05/2018 PAGE 79

FT

STREAM SECTION

3 6 AMINECO₂ ASH+COAL BIOMASS (CONTINUED)

STREAM ID	3	6	AMINECO ₂	ASH+COAL	BIOMASS
-----------	---	---	----------------------	----------	---------

25	0.0	0.0	0.0	0.0	0.0
26	0.0	0.0	0.0	0.0	0.0
27	0.0	0.0	0.0	0.0	0.0
28	0.0	0.0	0.0	0.0	0.0
29	0.0	0.0	0.0	0.0	0.0

C	679.1513	1501.8399	0.0	679.1513	0.0
---	----------	-----------	-----	----------	-----

TOTAL FLOW:

KMOL/HR	679.1513	1501.8399	0.0	679.1513	0.0
---------	----------	-----------	-----	----------	-----

KG/HR	8157.2860	1.8039+04	0.0	8157.2860	0.0
-------	-----------	-----------	-----	-----------	-----

L/MIN	60.4238	133.6180	0.0	60.4238	0.0
-------	---------	----------	-----	---------	-----

STATE VARIABLES:

TEMP K 1122.9353 298.1500 MISSING 1122.9353 MISSING

PRES ATM 0.9869 1.0003 39.4769 0.9869 1.0000

VFRAC 0.0 0.0 MISSING 0.0 MISSING

LFRAC 0.0 0.0 MISSING 0.0 MISSING

SFRAC 1.0000 1.0000 MISSING 1.0000 MISSING

ENTHALPY:

CAL/MOL 4332.3139 -3.8171-06 MISSING 4332.3139 MISSING

CAL/GM 360.6955 -3.1780-07 MISSING 360.6955 MISSING

CAL/SEC 8.1730+05 -1.5924-03 MISSING 8.1730+05 MISSING

ENTROPY:

CAL/MOL-K 6.0477 -1.2803-08 MISSING 6.0477 MISSING

CAL/GM-K 0.5035 -1.0659-09 MISSING 0.5035 MISSING

DENSITY:

MOL/CC 0.1873 0.1873 MISSING 0.1873 MISSING

GM/CC 2.2500 2.2500 MISSING 2.2500 MISSING

AVG MW 12.0110 12.0110 MISSING 12.0110 MISSING

SUBSTREAM ATTRIBUTES:

PSD

FRAC1 0.1000 0.1000 MISSING 0.1000 MISSING

FRAC2 0.2000 0.2000 MISSING 0.2000 MISSING

FRAC3 0.3000 0.3000 MISSING 0.3000 MISSING

FRAC4 0.4000 0.4000 MISSING 0.4000 MISSING

SUBSTREAM: NCPSD STRUCTURE: NON CONVENTIONAL

COMPONENTS: KG/HR

29COAL 0.0 0.0 0.0 0.0 2.4480+04

ASH 3427.2000 3427.2000 0.0 3427.2000 0.0

TOTAL FLOW:

KG/HR 3427.2000 3427.2000 0.0 3427.2000 2.4480+04

STATE VARIABLES:

TEMP K 1122.9353 298.1500 MISSING 1122.9353 298.1500

PRES ATM 0.9869 1.0003 39.4769 0.9869 1.0000

VFRAC 0.0 0.0 MISSING 0.0 0.0

LFRAC 0.0 0.0 MISSING 0.0 0.0

SFRAC 1.0000 1.0000 MISSING 1.0000 1.0000

ENTHALPY:

CAL/GM 7.0220 -191.9450 MISSING 7.0220 -323.3143

CAL/SEC 6684.9871 -1.8273+05 MISSING 6684.9871 -2.1985+06

DENSITY:

GM/CC 3.4869 3.4869 MISSING 3.4869 1.3209

AVG MW 1.0000 1.0000 1.0000 1.0000 1.0000

ASPEN PLUS PLAT: WIN32 VER: 11.1 08/05/2018 PAGE 80

FT

STREAM SECTION

3 6 AMINECO₂ ASH+COAL BIOMASS (CONTINUED)

STREAM ID 3 6 AMINECO₂ ASH+COAL BIOMASS

COMPONENT ATTRIBUTES:

29COAL SULFANAL

PYRITIC MISSING MISSING MISSING MISSING 0.0

SULFATE MISSING MISSING MISSING MISSING 0.0

ORGANIC MISSING MISSING MISSING MISSING 0.0

ULTANAL

ASH	MISSING	MISSING	MISSING	MISSING	0.0
CARBON	MISSING	MISSING	MISSING	MISSING	77.0000
HYDROGEN	MISSING	MISSING	MISSING	MISSING	5.0000
NITROGEN	MISSING	MISSING	MISSING	MISSING	1.2000
CHLORINE	MISSING	MISSING	MISSING	MISSING	0.0
SULFUR	MISSING	MISSING	MISSING	MISSING	0.8000
OXYGEN	MISSING	MISSING	MISSING	MISSING	16.0000

PROXANAL

MOISTURE	MISSING	MISSING	MISSING	MISSING	3.0000
FC	MISSING	MISSING	MISSING	MISSING	56.0000
VM	MISSING	MISSING	MISSING	MISSING	27.0000
ASH	MISSING	MISSING	MISSING	MISSING	14.0000

ASH PROXANAL

MOISTURE	0.0	0.0	MISSING	0.0	MISSING
FC	0.0	0.0	MISSING	0.0	MISSING
VM	0.0	0.0	MISSING	0.0	MISSING
ASH	100.0000	100.0000	MISSING	100.0000	MISSING

ULTANAL

ASH	100.0000	100.0000	MISSING	100.0000	MISSING
CARBON	0.0	0.0	MISSING	0.0	MISSING
HYDROGEN	0.0	0.0	MISSING	0.0	MISSING
NITROGEN	0.0	0.0	MISSING	0.0	MISSING
CHLORINE	0.0	0.0	MISSING	0.0	MISSING
SULFUR	0.0	0.0	MISSING	0.0	MISSING
OXYGEN	0.0	0.0	MISSING	0.0	MISSING

SULFANAL

PYRITIC	0.0	0.0	MISSING	0.0	MISSING
SULFATE	0.0	0.0	MISSING	0.0	MISSING

ORGANIC 0.0 0.0 MISSING 0.0 MISSING

SUBSTREAM ATTRIBUTES:

PSD

FRAC1	0.1000	0.1000	MISSING	0.1000	0.1000
FRAC2	0.2000	0.2000	MISSING	0.2000	0.2000
FRAC3	0.3000	0.3000	MISSING	0.3000	0.3000
FRAC4	0.4000	0.4000	MISSING	0.4000	0.4000
FRAC5	0.0	0.0	MISSING	0.0	0.0
FRAC6	0.0	0.0	MISSING	0.0	0.0
FRAC7	0.0	0.0	MISSING	0.0	0.0
FRAC8	0.0	0.0	MISSING	0.0	0.0
FRAC9	0.0	0.0	MISSING	0.0	0.0
FRAC10	0.0	0.0	MISSING	0.0	0.0

ASPEN PLUS PLAT: WIN32 VER: 11.1 08/05/2018 PAGE 81

FT

STREAM SECTION

C1-C4 C8+ COAL COAL-VOL COLDDSL

STREAM ID	C1-C4	C8+	COAL	COAL-VOL	COLDDSL
FROM :	FRA2	B7	SPRTR	YIELDGAS	B8
TO :	----	----	B4	SPRTR	----
CLASS:	MCINCPSD	MCINCPSD	MCINCPSD	MCINCPSD	MCINCPSD
TOTAL STREAM:					
KG/HR	418.5941	5516.7728	930.2400	2.4480+04	3123.5624
CAL/SEC	-1.2383+05	-3.7248+05	-1.2178+05	-1.6586+06	-4.1967+05

SUBSTREAM: MIXED

PHASE: VAPOR MIXED VAPOR MIXED LIQUID

COMPONENTS: KMOL/HR

O2	0.0	0.0	0.0	0.0	0.0
N2	0.0	0.0	0.0	5.2432	0.0
CO	8.3708-03	5.0371-18	16.6053	16.6053	1.4189-08
CO ₂	6.4510-02	6.8596-15	0.0	27.8120	2.0094-06
H ₂	7.9148-03	1.7358-19	230.7280	230.7280	1.3567-09
WATER	4.9800	2.2550-08	0.0	25.8181	0.2550
H ₂ S	0.0	0.0	0.0	13.6471	0.0
MEA	0.0	0.0	0.0	0.0	0.0
1	3.4980-02	3.3179-16	0.0	28.9925	2.2096-07
2	0.1428	1.0994-13	0.0	0.0	1.3303-05
3	0.3611	8.0466-12	0.0	0.0	2.5941-04
4	2.0312	1.1538-09	0.0	0.0	9.9945-03
5	1.5906	1.8555-08	0.0	0.0	4.6804-02
6	0.5315	1.1584-07	0.0	0.0	8.7601-02
7	0.1688	5.8094-07	0.0	0.0	0.1390
8	5.2776-02	2.7765-06	0.0	0.0	0.2124
9	1.7058-02	1.1885-05	0.0	0.0	0.2964
10	5.4682-03	5.2580-05	0.0	0.0	0.4264
11	1.8756-03	2.2370-04	0.0	0.0	0.6035
12	6.3390-04	9.0945-04	0.0	0.0	0.8293
13	2.2602-04	3.5608-03	0.0	0.0	1.1215
14	8.6417-05	1.6099-02	0.0	0.0	1.6564
15	3.1053-05	6.9174-02	0.0	0.0	2.5242
16	1.2130-05	0.1757	0.0	0.0	2.2567
17	4.0925-06	0.4031	0.0	0.0	1.8877

18	1.6152-06	0.7699	0.0	0.0	1.3947
19	6.3095-07	1.2264	0.0	0.0	0.8252
20	2.1833-07	1.6057	0.0	0.0	0.3440
21	9.1302-08	1.7817	0.0	0.0	7.5726-02
22	4.1952-08	1.7665	0.0	0.0	7.0872-03
23	1.4517-08	1.6967	0.0	0.0	2.5596-04
24	5.7919-09	1.6267	0.0	0.0	1.0570-05
25	2.5583-09	1.5620	0.0	0.0	5.3735-07
26	1.0135-09	1.5022	0.0	0.0	2.1091-08
27	3.4772-10	1.4469	0.0	0.0	7.1590-10
28	1.9339-10	1.3955	0.0	0.0	5.8740-11
29	0.0	0.0	0.0	0.0	0.0
C	0.0	0.0	0.0	0.0	0.0

TOTAL FLOW:

KMOL/HR	10.0000	17.0490	247.3333	348.8462	15.0000
KG/HR	418.5941	5516.7728	930.2400	3696.4800	3123.5624
L/MIN	4801.9161	145.8665	1.0088+05	1.3524+05	81.5181

ASPEN PLUS PLAT: WIN32 VER: 11.1 08/05/2018 PAGE 82

FT

STREAM SECTION

C1-C4 C8+ COAL COAL-VOL COLDDSL (CONTINUED)

STREAM ID	C1-C4	C8+	COAL	COAL-VOL	COLDDSL
-----------	-------	-----	------	----------	---------

STATE VARIABLES:

TEMP K	356.4164	635.2658	298.1500	298.1500	293.1500
--------	----------	----------	----------	----------	----------

PRES ATM	1.0000	1.0000	1.0000	1.0000	1.0000
----------	--------	--------	--------	--------	--------

VFRAC	1.0000	2.4496-05	1.0000	0.9512	0.0
-------	--------	-----------	--------	--------	-----

LFRAC	0.0	1.0000	0.0	4.8802-02	1.0000
-------	-----	--------	-----	-----------	--------

SFRAC	0.0	0.0	0.0	0.0	0.0
-------	-----	-----	-----	-----	-----

ENTHALPY:

CAL/MOL	-4.4577+04	-7.8652+04	-1772.5491	-1.5231+04	-1.0072+05
---------	------------	------------	------------	------------	------------

CAL/GM	-1064.9230	-243.0658	-471.2874	-1437.3845	-483.6813
--------	------------	-----------	-----------	------------	-----------

CAL/SEC	-1.2383+05	-3.7248+05	-1.2178+05	-1.4759+06	-4.1967+05
---------	------------	------------	------------	------------	------------

ENTROPY:

CAL/MOL-K	-48.7013	-413.5313	1.9195	-0.2432	-365.6401
-----------	----------	-----------	--------	---------	-----------

CAL/GM-K	-1.1634	-1.2780	0.5104	-2.2948-02	-1.7559
----------	---------	---------	--------	------------	---------

DENSITY:

MOL/CC	3.4708-05	1.9480-03	4.0864-05	4.2990-05	3.0668-03
--------	-----------	-----------	-----------	-----------	-----------

GM/CC	1.4529-03	0.6303	1.5369-04	4.5554-04	0.6386
-------	-----------	--------	-----------	-----------	--------

AVG MW	41.8594	323.5842	3.7611	10.5963	208.2375
--------	---------	----------	--------	---------	----------

SUBSTREAM: CIPSD STRUCTURE: CONVENTIONAL

COMPONENTS: KMOL/HR

O2	0.0	0.0	0.0	0.0	0.0
----	-----	-----	-----	-----	-----

N2	0.0	0.0	0.0	0.0	0.0
----	-----	-----	-----	-----	-----

CO	0.0	0.0	0.0	0.0	0.0
----	-----	-----	-----	-----	-----

CO ₂	0.0	0.0	0.0	0.0	0.0
-----------------	-----	-----	-----	-----	-----

H ₂	0.0	0.0	0.0	0.0	0.0
----------------	-----	-----	-----	-----	-----

WATER	0.0	0.0	0.0	0.0	0.0
-------	-----	-----	-----	-----	-----

H ₂ S	0.0	0.0	0.0	0.0	0.0
------------------	-----	-----	-----	-----	-----

MEA	0.0	0.0	0.0	0.0	0.0
-----	-----	-----	-----	-----	-----

1	0.0	0.0	0.0	0.0	0.0
---	-----	-----	-----	-----	-----

2	0.0	0.0	0.0	0.0	0.0
---	-----	-----	-----	-----	-----

3	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0
11	0.0	0.0	0.0	0.0	0.0
12	0.0	0.0	0.0	0.0	0.0
13	0.0	0.0	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0	0.0
15	0.0	0.0	0.0	0.0	0.0
16	0.0	0.0	0.0	0.0	0.0
17	0.0	0.0	0.0	0.0	0.0
18	0.0	0.0	0.0	0.0	0.0
19	0.0	0.0	0.0	0.0	0.0
20	0.0	0.0	0.0	0.0	0.0
21	0.0	0.0	0.0	0.0	0.0
22	0.0	0.0	0.0	0.0	0.0
23	0.0	0.0	0.0	0.0	0.0
24	0.0	0.0	0.0	0.0	0.0

ASPEN PLUS PLAT: WIN32 VER: 11.1

08/05/2018 PAGE 83

FT

STREAM SECTION

C1-C4 C8+ COAL COAL-VOL COLDDSL (CONTINUED)

STREAM ID	C1-C4	C8+	COAL	COAL-VOL	COLDDSL
-----------	-------	-----	------	----------	---------

25	0.0	0.0	0.0	0.0	0.0
----	-----	-----	-----	-----	-----

26	0.0	0.0	0.0	0.0	0.0
----	-----	-----	-----	-----	-----

27	0.0	0.0	0.0	0.0	0.0
----	-----	-----	-----	-----	-----

28	0.0	0.0	0.0	0.0	0.0
----	-----	-----	-----	-----	-----

29	0.0	0.0	0.0	0.0	0.0
----	-----	-----	-----	-----	-----

C	0.0	0.0	0.0	1445.0354	0.0
---	-----	-----	-----	-----------	-----

TOTAL FLOW:

KMOL/HR	0.0	0.0	0.0	1445.0354	0.0
---------	-----	-----	-----	-----------	-----

KG/HR	0.0	0.0	0.0	1.7356+04	0.0
-------	-----	-----	-----	-----------	-----

L/MIN	0.0	0.0	0.0	128.5642	0.0
-------	-----	-----	-----	----------	-----

STATE VARIABLES:

TEMP K	MISSING	MISSING	MISSING	298.1500	MISSING
--------	---------	---------	---------	----------	---------

PRES ATM	MISSING	1.0000	1.0000	1.0000	1.0000
----------	---------	--------	--------	--------	--------

VFRAC	MISSING	MISSING	MISSING	0.0	MISSING
-------	---------	---------	---------	-----	---------

LFRAC	MISSING	MISSING	MISSING	0.0	MISSING
-------	---------	---------	---------	-----	---------

SFRAC	MISSING	MISSING	MISSING	1.0000	MISSING
-------	---------	---------	---------	--------	---------

ENTHALPY:

CAL/MOL	MISSING	MISSING	MISSING	-3.8171-06	MISSING
---------	---------	---------	---------	------------	---------

CAL/GM	MISSING	MISSING	MISSING	-3.1780-07	MISSING
--------	---------	---------	---------	------------	---------

CAL/SEC	MISSING	MISSING	MISSING	-1.5322-03	MISSING
---------	---------	---------	---------	------------	---------

ENTROPY:

CAL/MOL-K	MISSING	MISSING	MISSING	-1.2803-08	MISSING
-----------	---------	---------	---------	------------	---------

CAL/GM-K	MISSING	MISSING	MISSING	-1.0659-09	MISSING
----------	---------	---------	---------	------------	---------

DENSITY:

MOL/CC	MISSING	MISSING	MISSING	0.1873	MISSING
--------	---------	---------	---------	--------	---------

GM/CC	MISSING	MISSING	MISSING	2.2500	MISSING
AVG MW	MISSING	MISSING	MISSING	12.0110	MISSING

SUBSTREAM ATTRIBUTES:

PSD

FRAC1	MISSING	MISSING	0.1000	0.1000	MISSING
FRAC2	MISSING	MISSING	0.2000	0.2000	MISSING
FRAC3	MISSING	MISSING	0.3000	0.3000	MISSING
FRAC4	MISSING	MISSING	0.4000	0.4000	MISSING

SUBSTREAM: NCPSD STRUCTURE: NON CONVENTIONAL

COMPONENTS: KG/HR

29COAL	0.0	0.0	0.0	0.0	0.0
ASH	0.0	0.0	0.0	3427.2000	0.0

TOTAL FLOW:

KG/HR	0.0	0.0	0.0	3427.2000	0.0
-------	-----	-----	-----	-----------	-----

STATE VARIABLES:

TEMP K	MISSING	MISSING	MISSING	298.1500	MISSING
PRES ATM	MISSING	1.0000	1.0000	1.0000	1.0000
VFRAC	MISSING	MISSING	MISSING	0.0	MISSING
LFRAC	MISSING	MISSING	MISSING	0.0	MISSING
SFRAC	MISSING	MISSING	MISSING	1.0000	MISSING

ENTHALPY:

CAL/GM	MISSING	MISSING	MISSING	-191.9450	MISSING
CAL/SEC	MISSING	MISSING	MISSING	-1.8273+05	MISSING

DENSITY:

GM/CC	MISSING	MISSING	MISSING	3.4869	MISSING
AVG MW	1.0000	1.0000	1.0000	1.0000	1.0000

FT

STREAM SECTION

C1-C4 C8+ COAL COAL-VOL COLDDSL (CONTINUED)

STREAM ID	C1-C4	C8+	COAL	COAL-VOL	COLDDSL
-----------	-------	-----	------	----------	---------

COMPONENT ATTRIBUTES:

29COAL SULFANAL

ULTANAL

PROXANAL

ASH PROXANAL

MOISTURE	MISSING	MISSING	MISSING	0.0	MISSING
----------	---------	---------	---------	-----	---------

FC	MISSING	MISSING	MISSING	0.0	MISSING
----	---------	---------	---------	-----	---------

VM	MISSING	MISSING	MISSING	0.0	MISSING
----	---------	---------	---------	-----	---------

ASH	MISSING	MISSING	MISSING	100.0000	MISSING
-----	---------	---------	---------	----------	---------

ULTANAL

ASH	MISSING	MISSING	MISSING	100.0000	MISSING
-----	---------	---------	---------	----------	---------

CARBON	MISSING	MISSING	MISSING	0.0	MISSING
--------	---------	---------	---------	-----	---------

HYDROGEN	MISSING	MISSING	MISSING	0.0	MISSING
----------	---------	---------	---------	-----	---------

NITROGEN	MISSING	MISSING	MISSING	0.0	MISSING
----------	---------	---------	---------	-----	---------

CHLORINE	MISSING	MISSING	MISSING	0.0	MISSING
----------	---------	---------	---------	-----	---------

SULFUR	MISSING	MISSING	MISSING	0.0	MISSING
--------	---------	---------	---------	-----	---------

OXYGEN	MISSING	MISSING	MISSING	0.0	MISSING
--------	---------	---------	---------	-----	---------

SULFANAL

PYRITIC	MISSING	MISSING	MISSING	0.0	MISSING
---------	---------	---------	---------	-----	---------

SULFATE	MISSING	MISSING	MISSING	0.0	MISSING
---------	---------	---------	---------	-----	---------

ORGANIC MISSING MISSING MISSING 0.0 MISSING

SUBSTREAM ATTRIBUTES:

PSD

FRAC1	MISSING	MISSING	0.1000	0.1000	MISSING
FRAC2	MISSING	MISSING	0.2000	0.2000	MISSING
FRAC3	MISSING	MISSING	0.3000	0.3000	MISSING
FRAC4	MISSING	MISSING	0.4000	0.4000	MISSING
FRAC5	MISSING	MISSING	0.0	0.0	MISSING
FRAC6	MISSING	MISSING	0.0	0.0	MISSING
FRAC7	MISSING	MISSING	0.0	0.0	MISSING
FRAC8	MISSING	MISSING	0.0	0.0	MISSING
FRAC9	MISSING	MISSING	0.0	0.0	MISSING
FRAC10	MISSING	MISSING	0.0	0.0	MISSING

ASPEN PLUS PLAT: WIN32 VER: 11.1 08/05/2018 PAGE 85

FT

STREAM SECTION

DIESEL DISL+GAS FT-HC GASIFIER GASOLINE

STREAM ID	DIESEL	DISL+GAS	FT-HC	GASIFIER	GASOLINE
FROM :	FRA3	FRA2	FTRECTOR	B4	FRA3
TO :	B7	FRA3	B29	GASIFI	B1
CLASS:	MCINCPSD	MCINCPSD	MCINCPSD	MCINCPSD	MCINCPSD

TOTAL STREAM:

KG/HR	8640.3352	1.3632+04	1.7628+04	4.1480+04	4991.8538
CAL/SEC	-8.3293+05	-2.1885+06	-2.4060+06	-1.8708+07	-9.2578+05

SUBSTREAM: MIXED

PHASE:	LIQUID	MIXED	MIXED	MIXED	VAPOR
COMPONENTS: KMOL/HR					
O2	0.0	0.0	0.0	0.0	0.0
N2	0.0	0.0	0.0	5.2432	0.0
CO	1.4189-08	8.6638-05	19.6672	16.6053	8.6624-05
CO ₂	2.0094-06	4.9316-03	12.5174	1.1537-06	4.9296-03
H ₂	1.3567-09	4.4520-05	273.2738	233.0891	4.4519-05
WATER	0.2550	25.5989	30.5789	1025.0855	25.3439
H ₂ S	0.0	0.0	0.0	13.6471	0.0
MEA	0.0	0.0	0.0	0.0	0.0
1	2.2096-07	8.3645-04	34.3387	0.0	8.3623-04
2	1.3303-05	1.6809-02	18.3204	0.0	1.6796-02
3	2.5941-04	0.1368	12.4928	0.0	0.1365
4	9.9945-03	2.4548	9.4779	0.0	2.4448
5	4.6804-02	5.8677	7.6353	0.0	5.8209
6	8.7601-02	5.8610	6.3925	0.0	5.7734
7	0.1390	5.3288	5.4977	0.0	5.1898
8	0.2124	4.7698	4.8226	0.0	4.5574
9	0.2964	4.2781	4.2952	0.0	3.9817
10	0.4264	3.8663	3.8717	0.0	3.4398
11	0.6037	3.5224	3.5243	0.0	2.9187
12	0.8302	3.2334	3.2341	0.0	2.4032
13	1.1250	2.9878	2.9880	0.0	1.8628
14	1.6725	2.7767	2.7768	0.0	1.1042
15	2.5934	2.5934	2.5934	0.0	3.5457-18
16	2.4324	2.4327	2.4328	0.0	3.4545-04
17	2.2908	2.2908	2.2908	0.0	4.8403-27
18	2.1646	2.1646	2.1646	0.0	3.4760-31

19	2.0515	2.0515	2.0515	0.0	1.6041-35
20	1.9497	1.9497	1.9497	0.0	0.0
21	1.8575	1.8575	1.8575	0.0	0.0
22	1.7736	1.7736	1.7736	0.0	0.0
23	1.6969	1.6969	1.6969	0.0	0.0
24	1.6267	1.6267	1.6267	0.0	0.0
25	1.5620	1.5620	1.5620	0.0	0.0
26	1.5022	1.5022	1.5022	0.0	0.0
27	1.4469	1.4469	1.4469	0.0	0.0
28	1.3955	1.3955	1.3955	0.0	0.0
29	0.0	0.0	0.0	0.0	0.0
C	0.0	0.0	0.0	0.0	0.0

TOTAL FLOW:

KMOL/HR	32.0490	97.0490	482.0490	1293.6701	65.0000
KG/HR	8640.3352	1.3632+04	1.7628+04	2.0014+04	4991.8538
L/MIN	211.8024	367.1930	2.1417+04	5267.4818	3.1014+04

ASPEN PLUS PLAT: WIN32 VER: 11.1 08/05/2018 PAGE 86

FT

STREAM SECTION

DIESEL DISL+GAS FT-HC GASIFIER GASOLINE (CONTINUED)

STREAM ID	DIESEL	DISL+GAS	FT-HC	GASIFIER	GASOLINE
-----------	--------	----------	-------	----------	----------

STATE VARIABLES:

TEMP K	505.0162	315.0285	513.1500	435.6565	348.8843
PRES ATM	1.0000	1.0000	14.8038	39.4769	1.0000

VFRAC	0.0	3.3626-06	0.9326	0.2520	1.0000
-------	-----	-----------	--------	--------	--------

LFRAC	1.0000	1.0000	6.7367-02	0.7480	0.0
-------	--------	--------	-----------	--------	-----

SFRAC	0.0	0.0	0.0	0.0	0.0
-------	-----	-----	-----	-----	-----

ENTHALPY:

CAL/MOL	-9.3562+04	-8.1182+04	-1.7968+04	-5.2033+04	-5.1274+04
---------	------------	------------	------------	------------	------------

CAL/GM	-347.0409	-577.9449	-491.3353	-3363.2668	-667.6462
--------	-----------	-----------	-----------	------------	-----------

CAL/SEC	-8.3293+05	-2.1885+06	-2.4060+06	-1.8698+07	-9.2578+05
---------	------------	------------	------------	------------	------------

ENTROPY:

CAL/MOL-K	-388.6713	-239.2055	-42.0092	-25.1275	-104.8834
-----------	-----------	-----------	----------	----------	-----------

CAL/GM-K	-1.4417	-1.7029	-1.1487	-1.6242	-1.3657
----------	---------	---------	---------	---------	---------

DENSITY:

MOL/CC	2.5219-03	4.4050-03	3.7513-04	4.0933-03	3.4931-05
--------	-----------	-----------	-----------	-----------	-----------

GM/CC	0.6799	0.6188	1.3718-02	6.3326-02	2.6826-03
-------	--------	--------	-----------	-----------	-----------

AVG MW	269.5980	140.4671	36.5697	15.4709	76.7978
--------	----------	----------	---------	---------	---------

SUBSTREAM: CIPSD STRUCTURE: CONVENTIONAL

COMPONENTS: KMOL/HR

O2	0.0	0.0	0.0	0.0	0.0
----	-----	-----	-----	-----	-----

N2	0.0	0.0	0.0	0.0	0.0
----	-----	-----	-----	-----	-----

CO	0.0	0.0	0.0	0.0	0.0
----	-----	-----	-----	-----	-----

CO ₂	0.0	0.0	0.0	0.0	0.0
-----------------	-----	-----	-----	-----	-----

H ₂	0.0	0.0	0.0	0.0	0.0
----------------	-----	-----	-----	-----	-----

WATER	0.0	0.0	0.0	0.0	0.0
-------	-----	-----	-----	-----	-----

H ₂ S	0.0	0.0	0.0	0.0	0.0
------------------	-----	-----	-----	-----	-----

MEA	0.0	0.0	0.0	0.0	0.0
-----	-----	-----	-----	-----	-----

1	0.0	0.0	0.0	0.0	0.0
---	-----	-----	-----	-----	-----

2	0.0	0.0	0.0	0.0	0.0
---	-----	-----	-----	-----	-----

3	0.0	0.0	0.0	0.0	0.0
---	-----	-----	-----	-----	-----

4	0.0	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0
11	0.0	0.0	0.0	0.0	0.0
12	0.0	0.0	0.0	0.0	0.0
13	0.0	0.0	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0	0.0
15	0.0	0.0	0.0	0.0	0.0
16	0.0	0.0	0.0	0.0	0.0
17	0.0	0.0	0.0	0.0	0.0
18	0.0	0.0	0.0	0.0	0.0
19	0.0	0.0	0.0	0.0	0.0
20	0.0	0.0	0.0	0.0	0.0
21	0.0	0.0	0.0	0.0	0.0
22	0.0	0.0	0.0	0.0	0.0
23	0.0	0.0	0.0	0.0	0.0
24	0.0	0.0	0.0	0.0	0.0

ASPEN PLUS PLAT: WIN32 VER: 11.1

08/05/2018 PAGE 87

FT

STREAM SECTION

DIESEL DISL+GAS FT-HC GASIFIER GASOLINE (CONTINUED)

STREAM ID	DIESEL	DISL+GAS	FT-HC	GASIFIER	GASOLINE
-----------	--------	----------	-------	----------	----------

25	0.0	0.0	0.0	0.0	0.0
----	-----	-----	-----	-----	-----

26	0.0	0.0	0.0	0.0	0.0
----	-----	-----	-----	-----	-----

27	0.0	0.0	0.0	0.0	0.0
----	-----	-----	-----	-----	-----

28	0.0	0.0	0.0	0.0	0.0
----	-----	-----	-----	-----	-----

29	0.0	0.0	0.0	0.0	0.0
----	-----	-----	-----	-----	-----

C	0.0	0.0	0.0	1501.8399	0.0
---	-----	-----	-----	-----------	-----

TOTAL FLOW:

KMOL/HR	0.0	0.0	0.0	1501.8399	0.0
---------	-----	-----	-----	-----------	-----

KG/HR	0.0	0.0	0.0	1.8039+04	0.0
-------	-----	-----	-----	-----------	-----

L/MIN	0.0	0.0	0.0	133.6180	0.0
-------	-----	-----	-----	----------	-----

STATE VARIABLES:

TEMP K	MISSING	MISSING	MISSING	435.6565	MISSING
--------	---------	---------	---------	----------	---------

PRES ATM	1.0000	1.0000	14.8038	39.4769	MISSING
----------	--------	--------	---------	---------	---------

VFRAC	MISSING	MISSING	MISSING	0.0	MISSING
-------	---------	---------	---------	-----	---------

LFRAC	MISSING	MISSING	MISSING	0.0	MISSING
-------	---------	---------	---------	-----	---------

SFRAC	MISSING	MISSING	MISSING	1.0000	MISSING
-------	---------	---------	---------	--------	---------

ENTHALPY:

CAL/MOL	MISSING	MISSING	MISSING	353.0656	MISSING
---------	---------	---------	---------	----------	---------

CAL/GM	MISSING	MISSING	MISSING	29.3952	MISSING
--------	---------	---------	---------	---------	---------

CAL/SEC	MISSING	MISSING	MISSING	1.4729+05	MISSING
---------	---------	---------	---------	-----------	---------

ENTROPY:

CAL/MOL-K	MISSING	MISSING	MISSING	0.9609	MISSING
-----------	---------	---------	---------	--------	---------

CAL/GM-K	MISSING	MISSING	MISSING	8.0005-02	MISSING
----------	---------	---------	---------	-----------	---------

DENSITY:

MOL/CC	MISSING	MISSING	MISSING	0.1873	MISSING
--------	---------	---------	---------	--------	---------

GM/CC	MISSING	MISSING	MISSING	2.2500	MISSING
-------	---------	---------	---------	--------	---------

AVG MW MISSING MISSING MISSING 12.0110 MISSING

SUBSTREAM ATTRIBUTES:

PSD

FRAC1	MISSING	MISSING	0.0	0.1000	MISSING
FRAC2	MISSING	MISSING	0.0	0.2000	MISSING
FRAC3	MISSING	MISSING	0.0	0.3000	MISSING
FRAC4	MISSING	MISSING	0.0	0.4000	MISSING
FRAC5	MISSING	MISSING	0.0	MISSING	MISSING
FRAC6	MISSING	MISSING	0.0	MISSING	MISSING
FRAC7	MISSING	MISSING	0.0	MISSING	MISSING
FRAC8	MISSING	MISSING	0.0	MISSING	MISSING
FRAC9	MISSING	MISSING	0.0	MISSING	MISSING
FRAC10	MISSING	MISSING	0.0	MISSING	MISSING

SUBSTREAM: NCPSD STRUCTURE: NON CONVENTIONAL

COMPONENTS: KG/HR

29COAL	0.0	0.0	0.0	0.0	0.0
ASH	0.0	0.0	0.0	3427.2000	0.0

TOTAL FLOW:

KG/HR	0.0	0.0	0.0	3427.2000	0.0
-------	-----	-----	-----	-----------	-----

STATE VARIABLES:

TEMP K	MISSING	MISSING	MISSING	435.6565	MISSING
PRES ATM	1.0000	1.0000	14.8038	39.4769	MISSING
VFRAC	MISSING	MISSING	MISSING	0.0	MISSING
LFRAC	MISSING	MISSING	MISSING	0.0	MISSING
SFRAC	MISSING	MISSING	MISSING	1.0000	MISSING

FT

STREAM SECTION

DIESEL DISL+GAS FT-HC GASIFIER GASOLINE (CONTINUED)

STREAM ID	DIESEL	DISL+GAS	FT-HC	GASIFIER	GASOLINE
-----------	--------	----------	-------	----------	----------

ENTHALPY:

CAL/GM	MISSING	MISSING	MISSING	-165.3890	MISSING
--------	---------	---------	---------	-----------	---------

CAL/SEC	MISSING	MISSING	MISSING	-1.5745+05	MISSING
---------	---------	---------	---------	------------	---------

DENSITY:

GM/CC	MISSING	MISSING	MISSING	3.4869	MISSING
-------	---------	---------	---------	--------	---------

AVG MW	1.0000	1.0000	1.0000	1.0000	1.0000
--------	--------	--------	--------	--------	--------

COMPONENT ATTRIBUTES:

29COAL SULFANAL

ULTANAL

PROXANAL

ASH PROXANAL

MOISTURE	MISSING	MISSING	MISSING	0.0	MISSING
----------	---------	---------	---------	-----	---------

FC	MISSING	MISSING	MISSING	0.0	MISSING
----	---------	---------	---------	-----	---------

VM	MISSING	MISSING	MISSING	0.0	MISSING
----	---------	---------	---------	-----	---------

ASH	MISSING	MISSING	MISSING	100.0000	MISSING
-----	---------	---------	---------	----------	---------

ULTANAL

ASH	MISSING	MISSING	MISSING	100.0000	MISSING
-----	---------	---------	---------	----------	---------

CARBON	MISSING	MISSING	MISSING	0.0	MISSING
--------	---------	---------	---------	-----	---------

HYDROGEN	MISSING	MISSING	MISSING	0.0	MISSING
----------	---------	---------	---------	-----	---------

NITROGEN	MISSING	MISSING	MISSING	0.0	MISSING
----------	---------	---------	---------	-----	---------

CHLORINE	MISSING	MISSING	MISSING	0.0	MISSING
----------	---------	---------	---------	-----	---------

SULFUR	MISSING	MISSING	MISSING	0.0	MISSING
OXYGEN	MISSING	MISSING	MISSING	0.0	MISSING
SULFANAL					
PYRITIC	MISSING	MISSING	MISSING	0.0	MISSING
SULFATE	MISSING	MISSING	MISSING	0.0	MISSING
ORGANIC	MISSING	MISSING	MISSING	0.0	MISSING

SUBSTREAM ATTRIBUTES:

PSD

FRAC1	MISSING	MISSING	0.0	0.1000	MISSING
FRAC2	MISSING	MISSING	0.0	0.2000	MISSING
FRAC3	MISSING	MISSING	0.0	0.3000	MISSING
FRAC4	MISSING	MISSING	0.0	0.4000	MISSING
FRAC5	MISSING	MISSING	0.0	0.0	MISSING
FRAC6	MISSING	MISSING	0.0	0.0	MISSING
FRAC7	MISSING	MISSING	0.0	0.0	MISSING
FRAC8	MISSING	MISSING	0.0	0.0	MISSING
FRAC9	MISSING	MISSING	0.0	0.0	MISSING
FRAC10	MISSING	MISSING	0.0	0.0	MISSING

ASPEN PLUS PLAT: WIN32 VER: 11.1 08/05/2018 PAGE 89

FT

STREAM SECTION

HC N2 NO-REACT PUREDESL PUREGASO

STREAM ID	HC	N2	NO-REACT	PUREDESL	PUREGASO
FROM :	FRA1	N2SPRTR	FRA1	B7	B2

TO : FRA2 ---- B8 ----

CLASS: MCINCPSD MCINCPSD MCINCPSD MCINCPSD MCINCPSD

TOTAL STREAM:

KG/HR 1.4051+04 1778.8650 3577.6052 3123.5624 4545.4695

CAL/SEC -2.4031+06 -1.8749+06 -9.4300+05 -2.3102+05 -6.6828+05

SUBSTREAM: MIXED

PHASE: LIQUID LIQUID VAPOR VAPOR LIQUID

COMPONENTS: KMOL/HR

O2	0.0	0.0	0.0	0.0	0.0
N2	0.0	2.1195-06	0.0	0.0	0.0
CO	8.4574-03	2.3204-04	19.6588	1.4189-08	8.6622-05
CO ₂	6.9441-02	5.7148-03	12.4479	2.0094-06	4.9278-03
H ₂	7.9594-03	1.0986-03	273.2658	1.3567-09	4.4513-05
WATER	30.5789	98.7064	2.8378-06	0.2550	0.5655
H ₂ S	0.0	1.1053-02	0.0	0.0	0.0
MEA	0.0	0.0	0.0	0.0	0.0
1	3.5816-02	2.6005-04	34.3029	2.2096-07	8.3616-04
2	0.1596	0.0	18.1608	1.3303-05	1.6795-02
3	0.4979	0.0	11.9949	2.5941-04	0.1365
4	4.4859	0.0	4.9920	9.9945-03	2.4448
5	7.4583	0.0	0.1769	4.6804-02	5.8209
6	6.3925	0.0	4.4861-05	8.7601-02	5.7734
7	5.4977	0.0	8.9765-10	0.1390	5.1898
8	4.8226	0.0	1.4381-11	0.2124	4.5574
9	4.2952	0.0	9.7841-15	0.2964	3.9817
10	3.8717	0.0	3.1922-18	0.4264	3.4398
11	3.5243	0.0	1.3770-21	0.6035	2.9187
12	3.2341	0.0	1.1338-24	0.8293	2.4032

13	2.9880	0.0	9.1060-28	1.1215	1.8628
14	2.7768	0.0	9.3192-31	1.6564	1.1042
15	2.5934	0.0	6.1310-35	2.5242	0.0
16	2.4328	0.0	0.0	2.2567	3.4545-04
17	2.2908	0.0	0.0	1.8877	0.0
18	2.1646	0.0	0.0	1.3947	0.0
19	2.0515	0.0	0.0	0.8252	0.0
20	1.9497	0.0	0.0	0.3440	0.0
21	1.8575	0.0	0.0	7.5726-02	0.0
22	1.7736	0.0	0.0	7.0872-03	0.0
23	1.6969	0.0	0.0	2.5596-04	0.0
24	1.6267	0.0	0.0	1.0570-05	0.0
25	1.5620	0.0	0.0	5.3735-07	0.0
26	1.5022	0.0	0.0	2.1091-08	0.0
27	1.4469	0.0	0.0	7.1590-10	0.0
28	1.3955	0.0	0.0	5.8740-11	0.0
29	0.0	0.0	0.0	0.0	0.0
C	0.0	0.0	0.0	0.0	0.0

TOTAL FLOW:

KMOL/HR	107.0490	98.7248	375.0000	15.0000	40.2217
KG/HR	1.4051+04	1778.8650	3577.6052	3123.5624	4545.4695
L/MIN	322.6924	35.2852	1.0369+05	1.0750+04	114.0314

ASPEN PLUS PLAT: WIN32 VER: 11.1 08/05/2018 PAGE 90

FT

STREAM SECTION

HC N2 NO-REACT PUREDESL PUREGASO (CONTINUED)

STREAM ID	HC	N2	NO-REACT	PUREDESL	PUREGASO
-----------	----	----	----------	----------	----------

STATE VARIABLES:

TEMP K	305.8344	313.1500	202.1885	557.4117	293.1500
--------	----------	----------	----------	----------	----------

PRES ATM	1.0000	39.4769	1.0000	1.0000	1.0000
----------	--------	---------	--------	--------	--------

VFRAC	0.0	0.0	1.0000	1.0000	0.0
-------	-----	-----	--------	--------	-----

LFRAC	1.0000	1.0000	0.0	0.0	1.0000
-------	--------	--------	-----	-----	--------

SFRAC	0.0	0.0	0.0	0.0	0.0
-------	-----	-----	-----	-----	-----

ENTHALPY:

CAL/MOL	-8.0815+04	-6.8370+04	-9052.7899	-5.5445+04	-5.9814+04
---------	------------	------------	------------	------------	------------

CAL/GM	-615.7038	-3794.4310	-948.9018	-266.2593	-529.2749
--------	-----------	------------	-----------	-----------	-----------

CAL/SEC	-2.4031+06	-1.8749+06	-9.4300+05	-2.3102+05	-6.6828+05
---------	------------	------------	------------	------------	------------

ENTROPY:

CAL/MOL-K	-229.5490	-39.0715	-6.8197	-263.9387	-198.7506
-----------	-----------	----------	---------	-----------	-----------

CAL/GM-K	-1.7489	-2.1684	-0.7148	-1.2675	-1.7587
----------	---------	---------	---------	---------	---------

DENSITY:

MOL/CC	5.5289-03	4.6632-02	6.0274-05	2.3256-05	5.8787-03
--------	-----------	-----------	-----------	-----------	-----------

GM/CC	0.7257	0.8402	5.7503-04	4.8428-03	0.6644
-------	--------	--------	-----------	-----------	--------

AVG MW	131.2557	18.0184	9.5403	208.2375	113.0104
--------	----------	---------	--------	----------	----------

ASPEN PLUS PLAT: WIN32 VER: 11.1 08/05/2018 PAGE 91

FT

STREAM SECTION

RICH₂ SOURSYN SOURSYN2 STEAM SWEETSYN

STREAM ID	RICH ₂	SOURSYN	SOURSYN2	STEAM	SWEETSYN
FROM :	COABSORB	COOLER	N2SPRTR	----	COABSORB
TO :	----	N2SPRTR	COABSORB	B4	B16
CLASS:	MCINCPSD	MCINCPSD	MCINCPSD	MCINCPSD	MCINCPSD

TOTAL STREAM:

KG/HR	3.7146+05	2.9896+04	2.8117+04	1.7000+04	1.9284+04
CAL/SEC	-3.4391+08	-1.1477+07	-9.5538+06	-1.7078+07	-4.5567+06

SUBSTREAM: MIXED

PHASE:	LIQUID	MIXED	VAPOR	LIQUID	VAPOR
COMPONENTS: KMOL/HR					
O ₂	0.0	0.0	0.0	0.0	0.0
N ₂	1.0391-04	5.2432	5.2432	0.0	5.2431
CO	3.2763-02	559.1848	559.1846	0.0	559.1518
CO ₂	189.9930	189.9987	189.9930	0.0	2.8445-09
H ₂	2.7402-02	975.4452	975.4441	0.0	975.4167
WATER	1.7110+04	102.5085	3.8021	943.6434	3.4760
H ₂ S	13.6361	13.6471	13.6361	0.0	4.5515-07
MEA	890.4782	0.0	0.0	0.0	4.7465-03
1	1.0346-03	90.1104	90.1101	0.0	90.1091
2	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0

11	0.0	0.0	0.0	0.0	0.0
12	0.0	0.0	0.0	0.0	0.0
13	0.0	0.0	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0	0.0
15	0.0	0.0	0.0	0.0	0.0
16	0.0	0.0	0.0	0.0	0.0
17	0.0	0.0	0.0	0.0	0.0
18	0.0	0.0	0.0	0.0	0.0
19	0.0	0.0	0.0	0.0	0.0
20	0.0	0.0	0.0	0.0	0.0
21	0.0	0.0	0.0	0.0	0.0
22	0.0	0.0	0.0	0.0	0.0
23	0.0	0.0	0.0	0.0	0.0
24	0.0	0.0	0.0	0.0	0.0
25	0.0	0.0	0.0	0.0	0.0
26	0.0	0.0	0.0	0.0	0.0
27	0.0	0.0	0.0	0.0	0.0
28	0.0	0.0	0.0	0.0	0.0
29	0.0	0.0	0.0	0.0	0.0
C	0.0	0.0	0.0	0.0	0.0

TOTAL FLOW:

KMOL/HR	1.8204+04	1936.1379	1837.4132	943.6434	1633.4014
KG/HR	3.7146+05	2.9896+04	2.8117+04	1.7000+04	1.9284+04
L/MIN	6263.1308	1.9135+04	1.9789+04	399.1050	1.8011+04

ASPEN PLUS PLAT: WIN32 VER: 11.1

08/05/2018 PAGE 92

FT

STREAM SECTION

RICH₂ SOURSYN SOURSYN2 STEAM SWEETSYN (CONTINUED)

STREAM ID	RICH ₂	SOURSYN	SOURSYN2	STEAM	SWEETSYN
-----------	-------------------	---------	----------	-------	----------

STATE VARIABLES:

TEMP K	325.0558	303.1500	313.1500	473.1500	313.6384
--------	----------	----------	----------	----------	----------

PRES ATM	39.4769	39.4769	39.4769	39.4769	39.4769
----------	---------	---------	---------	---------	---------

VFRAC	0.0	0.9482	1.0000	0.0	1.0000
-------	-----	--------	--------	-----	--------

LFRAC	1.0000	5.1825-02	0.0	1.0000	0.0
-------	--------	-----------	-----	--------	-----

SFRAC	0.0	0.0	0.0	0.0	0.0
-------	-----	-----	-----	-----	-----

ENTHALPY:

CAL/MOL	-6.8011+04	-2.1340+04	-1.8718+04	-6.5152+04	-1.0043+04
---------	------------	------------	------------	------------	------------

CAL/GM	-3332.9810	-1382.0677	-1223.2433	-3616.4951	-850.6712
--------	------------	------------	------------	------------	-----------

CAL/SEC	-3.4391+08	-1.1477+07	-9.5538+06	-1.7078+07	-4.5567+06
---------	------------	------------	------------	------------	------------

ENTROPY:

CAL/MOL-K	-40.9121	-1.4515	0.8778	-30.7965	0.9334
-----------	----------	---------	--------	----------	--------

CAL/GM-K	-2.0050	-9.4003-02	5.7362-02	-1.7095	7.9063-02
----------	---------	------------	-----------	---------	-----------

DENSITY:

MOL/CC	4.8442-02	1.6864-03	1.5475-03	3.9407-02	1.5114-03
--------	-----------	-----------	-----------	-----------	-----------

GM/CC	0.9885	2.6039-02	2.3681-02	0.7099	1.7844-02
-------	--------	-----------	-----------	--------	-----------

AVG MW	20.4054	15.4408	15.3023	18.0153	11.8059
--------	---------	---------	---------	---------	---------

ASPEN PLUS PLAT: WIN32 VER: 11.1 08/05/2018 PAGE 93

FT

STREAM SECTION

SYN SYNGAS TO-FRAC TO3SPRTR TOFTREAC

STREAM ID	SYN	SYNGAS	TO-FRAC	TO3SPRTR	TOFTREAC
FROM :	CYCLONE	B16	B29	B1	HEATER
TO :	COOLER	VLV1	FRA1	B2	FTRECTOR
CLASS:	MCINCPSD	MCINCPSD	MCINCPSD	MCINCPSD	MCINCPSD

TOTAL STREAM:

KG/HR	2.9896+04	1.7628+04	1.7628+04	4991.8538	1.7628+04
CAL/SEC	-7.5899+06	-4.0565+06	-2.4060+06	-1.1091+06	-3.4601+06

SUBSTREAM: MIXED

PHASE:	VAPOR	VAPOR	MIXED	LIQUID	VAPOR
--------	-------	-------	-------	--------	-------

COMPONENTS: KMOL/HR

O2	0.0	0.0	0.0	0.0	0.0
N2	5.2432	0.0	0.0	0.0	0.0
CO	559.1848	559.1518	19.6672	8.6624-05	559.1518
CO ₂	189.9987	0.0	12.5174	4.9296-03	0.0
H ₂	975.4452	975.4167	273.2738	4.4519-05	975.4167
WATER	102.5085	0.0	30.5789	25.3439	0.0
H ₂ S	13.6471	0.0	0.0	0.0	0.0
MEA	0.0	0.0	0.0	0.0	0.0
1	90.1104	0.0	34.3387	8.3623-04	0.0
2	0.0	0.0	18.3204	1.6796-02	0.0
3	0.0	0.0	12.4928	0.1365	0.0
4	0.0	0.0	9.4779	2.4448	0.0
5	0.0	0.0	7.6353	5.8209	0.0
6	0.0	0.0	6.3925	5.7734	0.0
7	0.0	0.0	5.4977	5.1898	0.0
8	0.0	0.0	4.8226	4.5574	0.0

9	0.0	0.0	4.2952	3.9817	0.0
10	0.0	0.0	3.8717	3.4398	0.0
11	0.0	0.0	3.5243	2.9187	0.0
12	0.0	0.0	3.2341	2.4032	0.0
13	0.0	0.0	2.9880	1.8628	0.0
14	0.0	0.0	2.7768	1.1042	0.0
15	0.0	0.0	2.5934	3.5457-18	0.0
16	0.0	0.0	2.4328	3.4545-04	0.0
17	0.0	0.0	2.2908	4.8403-27	0.0
18	0.0	0.0	2.1646	3.4760-31	0.0
19	0.0	0.0	2.0515	1.6041-35	0.0
20	0.0	0.0	1.9497	0.0	0.0
21	0.0	0.0	1.8575	0.0	0.0
22	0.0	0.0	1.7736	0.0	0.0
23	0.0	0.0	1.6969	0.0	0.0
24	0.0	0.0	1.6267	0.0	0.0
25	0.0	0.0	1.5620	0.0	0.0
26	0.0	0.0	1.5022	0.0	0.0
27	0.0	0.0	1.4469	0.0	0.0
28	0.0	0.0	1.3955	0.0	0.0
29	0.0	0.0	0.0	0.0	0.0
C	0.0	0.0	0.0	0.0	0.0

TOTAL FLOW:

KMOL/HR	1936.1379	1534.5685	482.0490	65.0000	1534.5685
KG/HR	2.9896+04	1.7628+04	1.7628+04	4991.8538	1.7628+04
L/MIN	3.0134+06	1.6904+04	3.1591+05	125.8338	7.3066+04

FT
STREAM SECTION

SYN SYNGAS TO-FRAC TO3SPRTR TOFTREAC (CONTINUED)

STREAM ID	SYN	SYNGAS	TO-FRAC	TO3SPRTR	TOFTREAC
-----------	-----	--------	---------	----------	----------

STATE VARIABLES:

TEMP K	1122.9353	315.5236	493.2270	293.1500	513.1500
PRES ATM	0.9869	39.4769	1.0000	1.0000	14.8038
VFRAC	1.0000	1.0000	0.9724	0.0	1.0000
LFRAC	0.0	0.0	2.7615-02	1.0000	0.0
SFRAC	0.0	0.0	0.0	0.0	0.0

ENTHALPY:

CAL/MOL	-1.4113+04	-9516.3924	-1.7968+04	-6.1430+04	-8117.2392
CAL/GM	-913.9757	-828.4113	-491.3354	-799.8903	-706.6136
CAL/SEC	-7.5899+06	-4.0565+06	-2.4060+06	-1.1091+06	-3.4601+06

ENTROPY:

CAL/MOL-K	17.8881	2.0969	-36.9011	-134.0338	7.5022
CAL/GM-K	1.1585	0.1825	-1.0091	-1.7453	0.6531

DENSITY:

MOL/CC	1.0709-05	1.5130-03	2.5432-05	8.6092-03	3.5004-04
GM/CC	1.6535-04	1.7381-02	9.3002-04	0.6612	4.0211-03
AVG MW	15.4408	11.4875	36.5697	76.7978	11.4875

ASPEN PLUS PLAT: WIN32 VER: 11.1 08/05/2018 PAGE 95

FT
STREAM SECTION

TOHEATER VAPOR VOLATILE WATER WATERFLA

STREAM ID TOHEATER VAPOR VOLATILE WATER WATERFLA

FROM : VLV1 B2 SPRTR B16 B2

TO : HEATER ---- VOLREAC ---- ----

CLASS: MCINCPSD MCINCPSD MCINCPSD MCINCPSD MCINCPSD

TOTAL STREAM:

KG/HR 1.7628+04 0.0 2.3550+04 1655.3858 446.3881

CAL/SEC -4.0565+06 0.0 -1.5573+06 -5.1090+05 -4.7340+05

SUBSTREAM: MIXED

PHASE: VAPOR MISSING MIXED MIXED LIQUID

COMPONENTS: KMOL/HR

O2 0.0 0.0 0.0 0.0 0.0

N2 0.0 0.0 5.2432 5.2431 0.0

CO 559.1518 0.0 0.0 0.0 2.1374-09

CO₂ 0.0 0.0 27.8120 2.8445-09 1.8115-06

H₂ 975.4167 0.0 0.0 0.0 5.8937-09

WATER 0.0 0.0 25.8181 3.4760 24.7783

H₂S 0.0 0.0 13.6471 4.5515-07 0.0

MEA 0.0 0.0 0.0 4.7465-03 0.0

1 0.0 0.0 28.9925 90.1091 7.1625-08

2 0.0 0.0 0.0 0.0 2.3670-07

3 0.0 0.0 0.0 0.0 5.5104-08

4 0.0 0.0 0.0 0.0 2.3908-08

5 0.0 0.0 0.0 0.0 6.5400-10

6 0.0 0.0 0.0 0.0 5.1453-12

7	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0
11	0.0	0.0	0.0	0.0	0.0
12	0.0	0.0	0.0	0.0	0.0
13	0.0	0.0	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0	0.0
15	0.0	0.0	0.0	0.0	0.0
16	0.0	0.0	0.0	0.0	0.0
17	0.0	0.0	0.0	0.0	0.0
18	0.0	0.0	0.0	0.0	0.0
19	0.0	0.0	0.0	0.0	0.0
20	0.0	0.0	0.0	0.0	0.0
21	0.0	0.0	0.0	0.0	0.0
22	0.0	0.0	0.0	0.0	0.0
23	0.0	0.0	0.0	0.0	0.0
24	0.0	0.0	0.0	0.0	0.0
25	0.0	0.0	0.0	0.0	0.0
26	0.0	0.0	0.0	0.0	0.0
27	0.0	0.0	0.0	0.0	0.0
28	0.0	0.0	0.0	0.0	0.0
29	0.0	0.0	0.0	0.0	0.0
C	0.0	0.0	0.0	0.0	0.0

TOTAL FLOW:

KMOL/HR	1534.5685	0.0	101.5129	98.8329	24.7783
KG/HR	1.7628+04	0.0	2766.2400	1655.3858	446.3881
L/MIN	4.4627+04	0.0	3.1588+04	980.0583	8.7422

FT

STREAM SECTION

TOHEATER VAPOR VOLATILE WATER WATERFLA (CONTINUED)

STREAM ID	TOHEATER	VAPOR	VOLATILE	WATER	WATERFLA
-----------	----------	-------	----------	-------	----------

STATE VARIABLES:

TEMP K	314.0509	MISSING	298.1500	315.5236	293.1500
PRES ATM	14.8038	1.0000	1.0000	39.4769	1.0000
VFRAC	1.0000	MISSING	0.7661	0.9674	0.0
LFRAC	0.0	MISSING	0.2339	3.2576-02	1.0000
SFRAC	0.0	MISSING	0.0	0.0	0.0

ENTHALPY:

CAL/MOL	-9516.3924	MISSING	-4.8747+04	-1.8609+04	-6.8780+04
CAL/GM	-828.4113	MISSING	-1788.8807	-1111.0562	-3817.8797
CAL/SEC	-4.0565+06	MISSING	-1.3746+06	-5.1090+05	-4.7340+05

ENTROPY:

CAL/MOL-K	4.0534	MISSING	-11.5127	-25.3381	-40.3477
CAL/GM-K	0.3529	MISSING	-0.4225	-1.5128	-2.2396

DENSITY:

MOL/CC	5.7311-04	MISSING	5.3560-05	1.6807-03	4.7239-02
GM/CC	6.5836-03	MISSING	1.4595-03	2.8151-02	0.8510
AVG MW	11.4875	MISSING	27.2501	16.7493	18.0153

SUBSTREAM: CIPSD STRUCTURE: CONVENTIONAL

COMPONENTS: KMOL/HR

O2	0.0	0.0	0.0	0.0	0.0
N2	0.0	0.0	0.0	0.0	0.0
CO	0.0	0.0	0.0	0.0	0.0
CO ₂	0.0	0.0	0.0	0.0	0.0
H ₂	0.0	0.0	0.0	0.0	0.0
WATER	0.0	0.0	0.0	0.0	0.0
H ₂ S	0.0	0.0	0.0	0.0	0.0
MEA	0.0	0.0	0.0	0.0	0.0
1	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.0	0.0
8	0.0	0.0	0.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0
10	0.0	0.0	0.0	0.0	0.0
11	0.0	0.0	0.0	0.0	0.0
12	0.0	0.0	0.0	0.0	0.0
13	0.0	0.0	0.0	0.0	0.0
14	0.0	0.0	0.0	0.0	0.0
15	0.0	0.0	0.0	0.0	0.0
16	0.0	0.0	0.0	0.0	0.0
17	0.0	0.0	0.0	0.0	0.0
18	0.0	0.0	0.0	0.0	0.0
19	0.0	0.0	0.0	0.0	0.0

20	0.0	0.0	0.0	0.0	0.0
21	0.0	0.0	0.0	0.0	0.0
22	0.0	0.0	0.0	0.0	0.0
23	0.0	0.0	0.0	0.0	0.0
24	0.0	0.0	0.0	0.0	0.0

ASPEN PLUS PLAT: WIN32 VER: 11.1 08/05/2018 PAGE 97

FT
STREAM SECTION

TOHEATER VAPOR VOLATILE WATER WATERFLA (CONTINUED)

STREAM ID	TOHEATER	VAPOR	VOLATILE	WATER	WATERFLA
25	0.0	0.0	0.0	0.0	0.0
26	0.0	0.0	0.0	0.0	0.0
27	0.0	0.0	0.0	0.0	0.0
28	0.0	0.0	0.0	0.0	0.0
29	0.0	0.0	0.0	0.0	0.0
C	0.0	0.0	1445.0354	0.0	0.0

TOTAL FLOW:

KMOL/HR	0.0	0.0	1445.0354	0.0	0.0
KG/HR	0.0	0.0	1.7356+04	0.0	0.0
L/MIN	0.0	0.0	128.5642	0.0	0.0

STATE VARIABLES:

SUBSTREAM: NCPSD STRUCTURE: NON CONVENTIONAL

COMPONENTS: KG/HR

29COAL	0.0	0.0	0.0	0.0	0.0
ASH	0.0	0.0	3427.2000	0.0	0.0

TOTAL FLOW:

KG/HR	0.0	0.0	3427.2000	0.0	0.0
-------	-----	-----	-----------	-----	-----

ASPEN PLUS PLAT: WIN32 VER: 11.1 08/05/2018 PAGE 98

FT
STREAM SECTION

TOHEATER VAPOR VOLATILE WATER WATERFLA (CONTINUED)

STREAM ID	TOHEATER	VAPOR	VOLATILE	WATER	WATERFLA
-----------	----------	-------	----------	-------	----------

COMPONENT ATTRIBUTES:

29COAL SULFANAL

ULTANAL

PROXANAL

ASH PROXANAL

FT
STREAM SECTION

GHGHHG

STREAM ID GHGHHG

FROM : ----

TO : GASIFI

CLASS: HEAT

STREAM ATTRIBUTES:

HEAT

Q CAL/SEC 1.1942+07

TBEG K 1773.1500

ASPEN PLUS PLAT: WIN32 VER: 11.1 08/05/2018 PAGE 100

FT

PROBLEM STATUS SECTION

BLOCK STATUS

```
*
*
* Calculations were completed with warnings
*
*
* The following Unit Operation blocks were
* completed with warnings:
*   GASIFI
*
* All streams were flashed normally
*
```
