Simulation and Optimization of Refrigeration Based Natural Gas Liquid Recovery Process: Exergy and Economic Analysis

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2022

Simulation and Optimization of Refrigeration Based Natural Gas Liquid Recovery Process: Exergy and Economic Analysis

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This thesis is submitted as a partial fulfillment of the requirements for the degree of

''MS in Chemical Engineering''

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June 2022

Dedication

By the mercy of Almighty Allah, the Most Merciful and Most Beneficent, this study is dedicated to my parents, who have always provided me with direction and support. To my supervisor, who shared her knowledge, provided me guidance, and pushed me to complete my objectives. And to all my coworkers with whom I've enjoyed wonderful memories.

Acknowledgment

There is none other but Almighty Allah, whose will be required for everything and anything in this world, who blessed us with the ability to think and made us willing to explore the entire universe. Infinite greetings to the Holy Prophet Muhammad (PBUH), the cause of the universe's creation and a fountain of knowledge and blessing for all of humanity.

Dr. Erum Pervaiz, my renowned supervisor, deserves credit for trusting in my talents. His constant guidance, encouragement, and support were vital to the project's success. I'd want to express my heartfelt gratitude to my deserving Co-Supervisor and GEC members, Dr. Iftikhar Ahmed, Dr. Muhammad Ahsan, and Dr. Syed Rafay Hussain. I've never given it much thought. Having said that, the unwavering moral support that my family and friends have always provided will always be my light in the dark. My heartfelt gratitude goes out to all the personnel and lab attendants' Thank you!

Abstract

The raw natural gas from the well head contains methane, gaseous hydrocarbon, water, and condensate. Most natural gas (NG) processing plants separate the dry gas and liquid condensate without extracting the high-priced natural gas liquids. And thus, natural gas liquids (NGL) are sold along with the cheaper dry gas and liquid condensate. The NGLs are separated from the NG to control the dew point and also yield a source of revenue. Due to the storage of condensate at atmospheric pressure, the lighter components like propane and butane are escaped from the breathing valve and harm the environment. A comprehensive literature review has been presented on the NGL recovery process with a focus on process description, energy requirements, NGL production, operating cost, and propane recovery. The conventional industrial single-stage process was considered as a base case for simulation and modeling on Aspen Hysys and compared with the optimized process in terms of exergy and economic analysis. In the optimized process, two modifications are proposed, recycling of gas condensate for more butane and propane absorption and the use of mixed refrigerant for the refrigeration loop. The results show that reabsorption of NGLs due to condensate recycling improves the overall recovery of propane and butane and also better the quality of sales gas. The mixed refrigerant reduces the exergy destruction and capital cost of the refrigeration loop. Optimized flow sheet shows better economic results compared to a conventional process.

Key Words: Gas Processing; Natural gas liquids; NGL recovery; LPG recovery; Economic and Exergy analysis;

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Abbreviations

BTU	British thermal unit
HCDP	Hydrocarbon Dew Point
H	Enthalpy
ISS	Industry-Standard Single-Stage
JT	Joule Thomson
LNG	Liquefied Natural Gas
LPG	Liquefied Petroleum Gas
MMSCFD	Metric Million Standard cubic feet per Day
NG	Natural Gas
NGLs	Natural Gas Liquids
RVP	Reid Vapour Pressure
S	Entropy
TCF	Trillion Cubic Feet
TEG	Tri-Ethylene Glycol

Chapter 1

Introduction

Natural gas is increasing rapidly due to a significant energy source, particularly in East Asia [1]. A 2,400 years ago, the Chinese were the first to use natural gas commercially. It produces from shallow wells, transported with the help of bamboo pipes, and used in gas-fired evaporators to produce salt from brine [2]. After world war II, a major boom in the usage of natural gas was observed due to the advanced engineering which allowed to transport of gas with the help of large-distance pipelines [3]. In 2004 the United States had ~ 297,000 miles of natural gas for transportation. Almost 9.8% of Natural gas is supplied as LNG and the demand growth for LNG increases in Asia countries [4].

Natural gas is primarily used as a fuel, feedstock for petrochemical, and many industrial chemicals [5], [6]. Natural gas is more sustainable as an energy source than coal and oil. Carbon dioxide, which is the cause of the greenhouse effect, is produced 1.4 to 1.75 times higher in oil and coal than in natural gas [7].

Natural gas (NG) is extremely playing a significant role in the energy use of the United States, up to approximately 23%. Figure 1-1 shows the relationships between the different energy sources in the United States. Petroleum has the highest peak in energy consumption, and natural gas has the second-highest energy consumption, which increases noticeably with time [8]. The consumption of nuclear and hydroelectric sources is almost flat, and non-hydro renewables are not playing a role through 2025 [9].

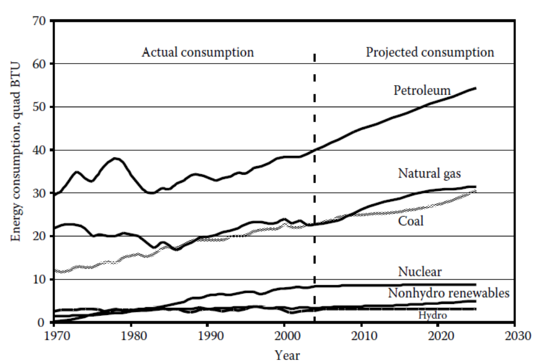

Figure 1-1 Energy consumption of different fuels in the United States [8].

The natural gas liquids (NGLs) like ethane, propane, butanes, and condensate are removed from the NG to control the dew point (To meet the specification for safe transportation) and also yield a source of revenue [10]. NGLs separately have a larger marketable value than as a part of natural gas. When the NGL have better economic values, peoples extract heavy hydrocarbons. For natural gas transportation, it's necessary to meet the gas pipeline requirements and also help to meet the dew point of sales gas [11]. The lighter fractions of NGLs like ethane, propane, and butanes, are sold as a feed to petrochemicals and refineries, while the heavier fraction like condensate is used as gasoline blending stock [12], burned for space cooling and heating.

Ethane is mostly used for ethylene production, which is then used in the petrochemical industry to produce intermediate products like plastics. Ethane is used as a fuel for power generation. Most of the propane is consumed as a fuel generally in the areas where NG is not available. It is used for water and space heating, electric welders, and propylene production. Butanes are used as fuel in lighters. Normal butane can be converted to Isobutane in isomerization. In petrochemical cracking, n-butane yields the butadiene which is used in synthetic rubber. Natural gasoline, which is pentane plus, can be blended with fuel to use in combustion engines[13].

Energy usage is a metric that measures a country's industrial growth and advancement. Energy supplies are fast diminishing because of rising globalization and urbanization. There has been a tremendous growth in per capita energy use, which has resulted in an increase in global energy demand [14]. The Natural gas is a blend of methane, ethane, propane, butane, and heavier hydrocarbon, is among the clean energy resources. Since the 1900s, natural gas processing technology has advanced dramatically [15]. Moreover, natural gas's role as an energy store has increased in rich countries over the last several years and is growing in emerging ones. Natural gas liquids (NGLs), also known as natural gas condensates, are a kind of dried natural gas that includes sulfur and liquefied petroleum gas. Propane and butane are liquefied petroleum gases in the engineering world (LPG) ([2], [16]). LPG is derived from natural gas and utilized as a fuels for a variety of reasons, including providing energy to automobiles, heating and cooking appliances, and as a refrigeration and aerosol propellant, all of which help to protect the ozone layer [2], [17],

[18]. Dr. Walter Snelling was the key source for preparing it on a lab scale in 1910, according to its previous preparation. The afore mentioned gas is a cleaner gas that emits no soot and has just a little amount of sulfur when burned. It is transported in pressurized steel vessels, with a maximum of 80–85 percent LPG permitted to be filled in the stated containers to accommodate for thermal expansion due to temperature changes [19].

1.1 NGLs Recovery in Pakistan

Pakistan has a serious energy shortage, and certain areas of the country are still without electricity. The state's fossil resources are rapidly depleting, putting a strain on imports (WAPDA, 2021) [20]. There really are relatively brief plans to enhance the nation's thermal power output due to rising industrialization and interest in the energy industry following the China–Pakistan Economic Corridor (CPEC) investment [21]. Komal and Abbas studied the finance-energy and energy-growth nexus [22], and discovered that industrialization and urbanization had a beneficial influence on energy demand. Furthermore, fossil fuels and their byproducts play a significant role in the country's energy economy. Natural gas is utilized as a residential fuel, in energy and power generation production systems, and in the industry to generate valuable goods in Pakistan. It accounts for around 42% of electricity-generating plants [23]. Due to Pakistan's agronomic character, 16% of natural gas is used in the fertilizer sector, 7% for commercial applications, and 3% for other applications [24]. Natural gas reserves are projected to be 29.671 trillion cubic feet(TCF) [25]. Natural gas consumption in the country is rising at a rate of roughly 10% per year, owing to the country's growing industrial sector and population. Pakistan's government has also established new legislation to help the LPG industry grow. Currently, 26 organizations, both commercial and public, offer services related to natural gas exploration and production. Due to its only use in vehicles, LPG was presented to the market as autogas. In Pakistan, over ten firms are involved in the manufacture of LPG, while more than 80 companies are involved in its marketing. [26].The Natural gas processing facilities that are located in the Pakistan are mostly industrial single stage process i.e. Zamzama Gas field (Orient Petroleum), Qadirpur gas field (OGDCL).

Table 1-1 End product use of Natural gas liquids [4], [13].

Natural Gas Liquids	Chemical Formula	Uses	End-use products	End-Use Sectors
Ethane	C_2H_6	Feedstock for petrochemical plants Power generation	Detergents, Plastics, Anti-freeze	Industrial
Propane	C_3H_8	Use as fuel for water heating, space heating, drying, transportation, and cooking.	Plastics and Fuel	Industrial (includes agriculture and manufacturing), transportation, residential, commercial
n-butane, Iso-butane	C_4H_{10}	Feedstock for petroleum refinery and petrochemical, Blending of motor gasoline	Lighter fuel, motor gasoline, synthetic rubber, and plastics	Transportation and Industrial
Natural gasoline (C5+)	C_5H_{12} and heavier	Diluent for heavy crude oil Additive to motor gasoline	Solvents, Motor gasoline, ethanol denaturant	Transportation and Industrial

Specifications for the sales gas and condensate

- Sale Gas Water content = < 7 LB/MMSCFD
- Sale Gas HCDP **(Cricondentherm)** = $\leq$ 32°F
- Sales gas Higher heating value = >1100 BTU/SCF
- Treated condensate RVP = 7 PSIA
- NG Dew point = - 4 °C

However, there has been minimal study on increasing LPG output in natural gas processing. The optimized process flow diagram is purposed in this thesis. The mixed refrigeration loop and condensate injection are included in the optimized flow sheet. We start by extracting characteristics from a traditional natural gas processing flowsheet and evaluating the distribution of output and energy usage. Then, using the operating conditions and same feedstock, an optimized flow sheet is presented. The process simulation is used to gather the necessary data for the comparisons.

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1.2 Exergy Analysis

In a true process, energy is never lost; rather, it shifts from one form to another, making it more difficult to employ for driving a necessary process. As a result, the concept of energy utility appears to be more appropriate in this situation (s). In these instances, the ability of energy to do beneficial work, known as exergy, should be assessed. Exergy analysis, which is based on both the first and second laws of thermodynamics, may be used to determine a system's real thermodynamic efficiency. As a result, process designers and engineers can identify the key sources of exergy losses and devise strategies to address them. Because process irreversibilities are the primary source of exergy/energy loss, they should be assessed and their impact reduced.

1.3 Scope

The scope of this work is to provide opportunities to NGLs recovery plants to enhance the LPG production, and Plant profit by simple modification of condensate recycling for absorption of butane and propane and use of mixed refrigerant for refrigeration loop.

1.4 Objective

1. Comparison of different NGL recovery processes based on a process description, energy requirements, NGL production, and profitability.

2. Simulation and optimization of NGL recovery unit to improve the production according to the results of the modifications and sensitivity analysis.

3. Exergy analysis to reduce the exergy destruction of the refrigeration loop and suggestions for further process optimization will be provided.

4. Economic analysis of conventional and optimized process simulation

Chapter 2

Literature Review

Various studies were published in the literature that includes changes to the gas recovery system. A notable example is a comparison of the gas subcooled method with cold residues recycling with a standard turbo expander for ethane recovery from NG [27]. Various natural gas drying techniques, such as solid desiccant, tri-ethylene glycol and condensation, were also evaluated[8]. The addition of more equipment, as well as flow separation, has been observed to reduce the recovery of some components [27]. In some research [28] [23] also documented the construction of optimal process modeling in Aspen HYSYS for natural gas processing plants, as well as initial capital costs for gas purification and processing. The influence of feed compositions on several process methods, gas subcooled, recycling vapour split, and cold residue on the turbo expander for optimum NGL recovery has also been described [15]. Exergy evaluation of the NGL recovery methods using modeling and simulation in Aspen HYSYS revealed that the air cooler and column in the flowsheet destroy the majority of the exergy [14]. In the LPG manufacturing process, exergy is destroyed in the distillation columns [29]. Exergy analysis performed in a modified refrigeration unit for the extraction of LPG from a natural gas plant in Egypt revealed a 15.95 % improvement in overall LPG recovery [30]. Modeling and Simulations of a natural gas processing plant have been presented in great detail in order to offer insights into containment elimination as well as a cost analysis of several turbo expander systems [31][33]. Product collection, energy needs, and capital investment cost for LPG manufacture from NGLs have all been evaluated, and a single column with an overhead recycle has been shown to be more cost-effective than a standard fractional column[34]. The impact of vapour recompression and self-heat recuperation for propane and propylene separation has been improved in separate research [35].

A comprehensive evaluation of the oil and gas sector's processes intensification has been published in the literature[36]. To eliminate conflict between execution and research in the oil and gas industry, a lean process intensification framework has been provided. The conceptual procedures have been observed to be substantially more sophisticated than the large-scale commercial applications[37]. The feed conditions, product recovery and purity, economics, specific energy consumption, and implementation through accessible software have all been examined in depth for natural gas liquid processes[37]. For such six distinct technical choices, including gas to hydrate, combined heat and power generation, gas to liquid, and liquefied natural gas, it was discovered that LPG and CNG recovery is the least expensive and most lucrative option[38]. To address the need for gasoline in the automobile, industrial, and home sectors, an effort was made to develop a technology for recovering LPG from fuel oil refinery off gases[26]. The combination of a dehydration recovery unit with a natural gas liquid unit increases LPG profit and capacity [30].

The NGL separation in gas processing is energy-intensive, and requires optimization to reduce energy consumption and to identify the optimum solution for recovery [39]. The exergy and pinch analysis are both required to optimize the process [40], [41]. The studies that were done on NGL recovery are mostly based on the rich and normal feed that compares the economic analysis, NGL recovery, and energy analysis [42], [44]. The plant of ethane recovery located in south pars was simulated at rich feed conditions with an exergy analysis and without economic analysis [45]. The new design was proposed for retrofitting the existing NGL recovery plants, The major goal was to reduce the energy requirement and increase the capacity, and the reported methodology could save the operating cost up to 45.55% compared to the base case and with less CO_2 emissions and short payback time [46]. The existing Sirri island-based plant of NGL recovery was analyzed based on exergy and energy analysis with normal and rich feeds. The results of simulation and exergy analysis showed that the efficiency of the compressor and heat exchanger was reduced by increasing the heavier components than methane [10].

The turbo expander technology was used to maximize the NGL recovery of the Iraq's natural gas resources, that are rich with C2+ hydrocarbons. Aspen Hysys was used to assess the pressure change effect of demethanizer feed. The capital cost was not included in the study [47]. The co-production NGL/LNG configuration was introduced to analyze the mixed refrigeration cost of liquification and maximization of ethane recovery [48]. The results showed that the ethane recovery is higher than 93% from a rich feed along with good liquefication efficiency [44]. Another co-production liquid recovery plant was optimized using rich feed and different process conditions, plant performance was analyzed to maximize the net profit [49]. The integrated shale gas processing and NGL regasification were analyzed to save the energy requirements. The proposed conceptual design did not cover the economic analysis [50]. The demethanizer and depropanizer were replaced with the driving wall column to reduce the footprint, hardware, weight, and energy requirement of the NGL recovery unit [51]. The economic problem of the turboexpander process was solved by a hybrid genetic algorithm [52]. The multicomponent mixture is separated by a new optimized proposed distillation system which obtains a good efficient separation [39]. The CRR process was optimized for rich feed to obtain maximum ethane recovery and compared with turbo expander and GSP processes. The result of optimization showed that adding more equipment will reduce ethane recovery [53]. The [54] performed the techno-economic analysis on nine Patented NGL recovery processes and modified their heat integration for offshore application and also proposed a new NGL recovery process which is most efficient in terms of operating and capital cost. The new process scheme is inspired by the ISS process due to its simple operation and less amount of equipment. Although the propane recovery of the proposed scheme is less than the IPSI scheme. Modification in the existing plant (Salam gas plant in Egypt) to produce LPG instead of producing Hydrocarbon gasses in the NGL stabilization was done by [55]. The co-production for LNG/NGL was introduced and investigated, the results showed that the integration process has high efficiencies. It recovers ethane up to 93% from rich feed [56].

2.1 NGL Recovery Processes

Previous industrial experience and research have shown that the most cost-effective way of NGL separation is cryogenic processes. In the absorption processes, the extraction of NGL is up to 85 – 90% [57]. And for cryogenic methods using Turbo expanders its reaches up to 100% [58] [36]. A combination of both of these is also improving the recovery and energy efficiency [59]. The industry-standard single-stage (ISS) process uses a turbo expander as a substitute for the JT valve for better cooling [60] [61]. JT valve is usually a control valve with fixed or variable orifice, inexpensive, simple, and widely used to reduce gas temperature [49]. But this process has problematic carbon dioxide frizzing and comparatively low NGL recovery [62]. The single mixed refrigeration process is also suitable for NGL liquification [63]. The many innovative processes have been introduced and developed which are more economical for example [64][65]:

- Gas subcooled process (GSP)
- Cold residue reflux process (CRR)
- Recycle Vapor Split (RSV)
- IPSI process
- Fluor Process [66]
- HHC Separator and Scrub column scheme [67]

The ISS scheme is shown in (Figure 2-1) the feed first passes to the Feed/Product heat exchanger, where the feed is cooled by the product stream. The feed then flows into the two-phase separator. The vapor and liquid stream before it introduce to de-methanizer is expanded by turbo expander and JT valve. Its configuration is simple and low CAPEX that why it's used as a base for further development [15][68].

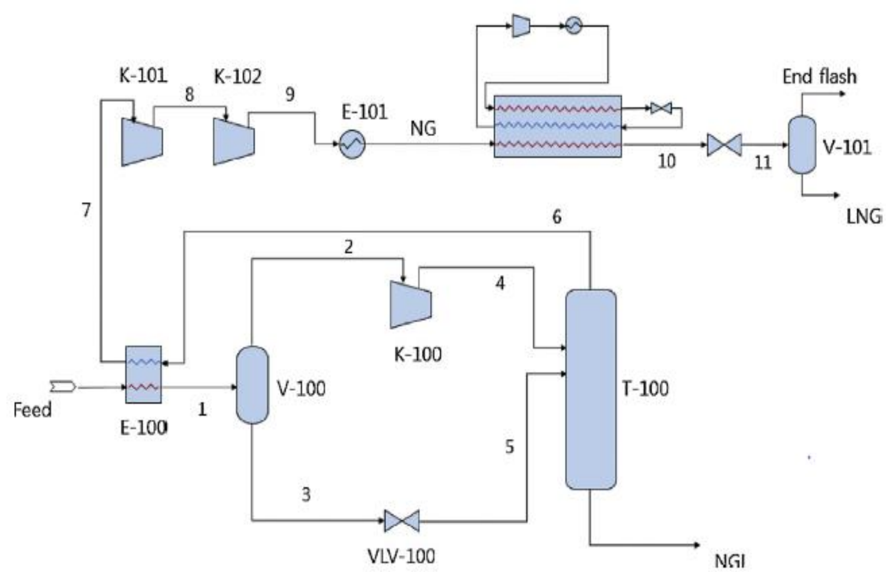

Figure 2-1 The ISS process scheme [62]

The improved form of the ISS Process is GSP (Figure 2-2), developed by [61]. The split vapor stream uses as reflux in the rectification unit of the de methanizer column. The reflux increases the recovery of the column by absorbing the ethane and propane that rising and it's also minimized the risk of solid formation due to carbon dioxide. It is because of the high temperature in the tower. This process is efficient as to recover +95% of ethane [69].

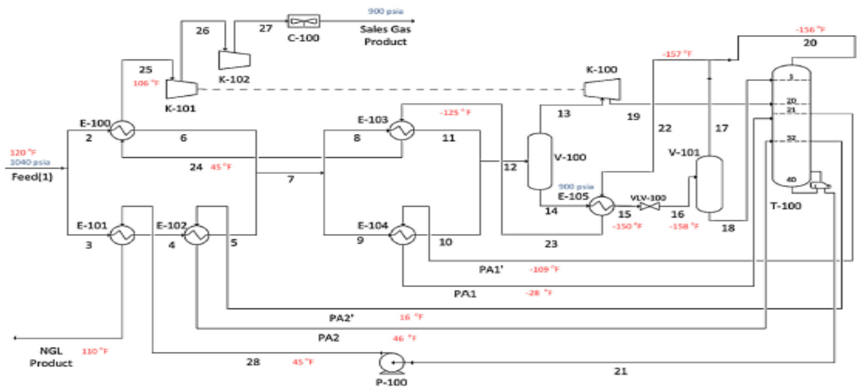

Figure 2-2 The sub-cooled (GSP) process scheme [15]

To advance the ethane recovery productivity the CRR process (Figure 2-3) was introduced by [70]. To boost the overhead of the cold tower, an extra compressor has been introduced. The overhead stream is subcooled by divided vapor feed and then flashed at the pressure of the column and use as reflux to the de-methanizer tower. Due to reflux, a clean separation increases the recovery of ethane and propane up to 99 percent [71]. Even after the high efficiency of propane and ethane recovery, less recycle flow rate, and less compression prerequisite, the cryogenic compressor capital cost might be high. CRR process is the most feasible solution for ethane recovery of 99.9% and at low demethanizer pressure [27].

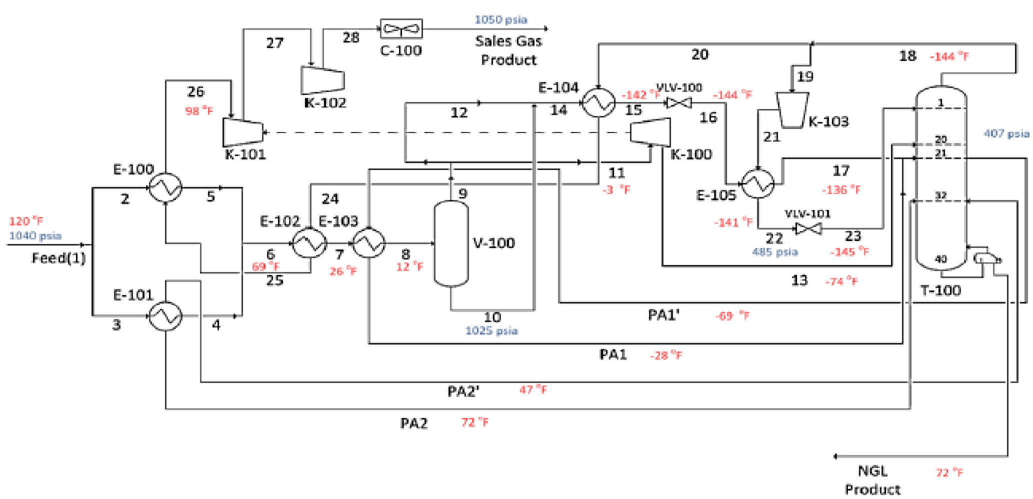

Figure 2-3 The cold residue gas-recycle (CRR) process scheme [15]

For high NGL recovery, another alternative is the RSV process (Figure 2-4), which is developed by [72]. In the RSV process, the top stream of the de-methanizer column is split and warmed, and compressed to increase its pressure. The stream is further cooled to condense more. Then this stream introduces at the top of the column. The recycle stream is compressor by residue gas compressor and hence no need for a separate compressor. RSV has the advantage of switching between ethane rejection and recovery operation. By disallowing the reflux flow, it can be operated as GSP mode. Both CRR & RSV have an improved carbon dioxide tolerance than the GSP due to high operating pressure in de methanizer.

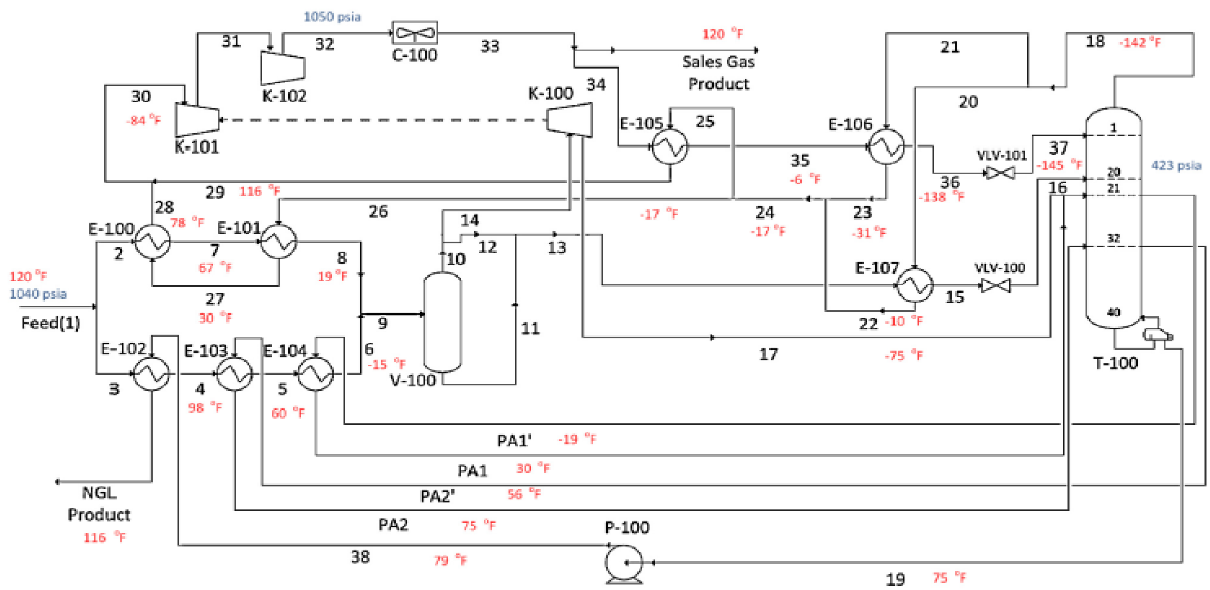

Figure 2-4 Process flow diagram of RSV scheme [15]

The improved NGL extraction process (IPSI-1) (Figure 2-5) presented by [73] gives improvements in the bottom of the demethanizer. The inlet feed is cool by using the slipstream from the demethanizer column bottom, which makes this process self-refrigeration. Due to self-refrigeration, the requirement for propane refrigeration is reduced. But there are some limitations regarding this process as the increase in plant capacity and for richer feed, require added refrigeration to sustain a good NGL recovery [16].

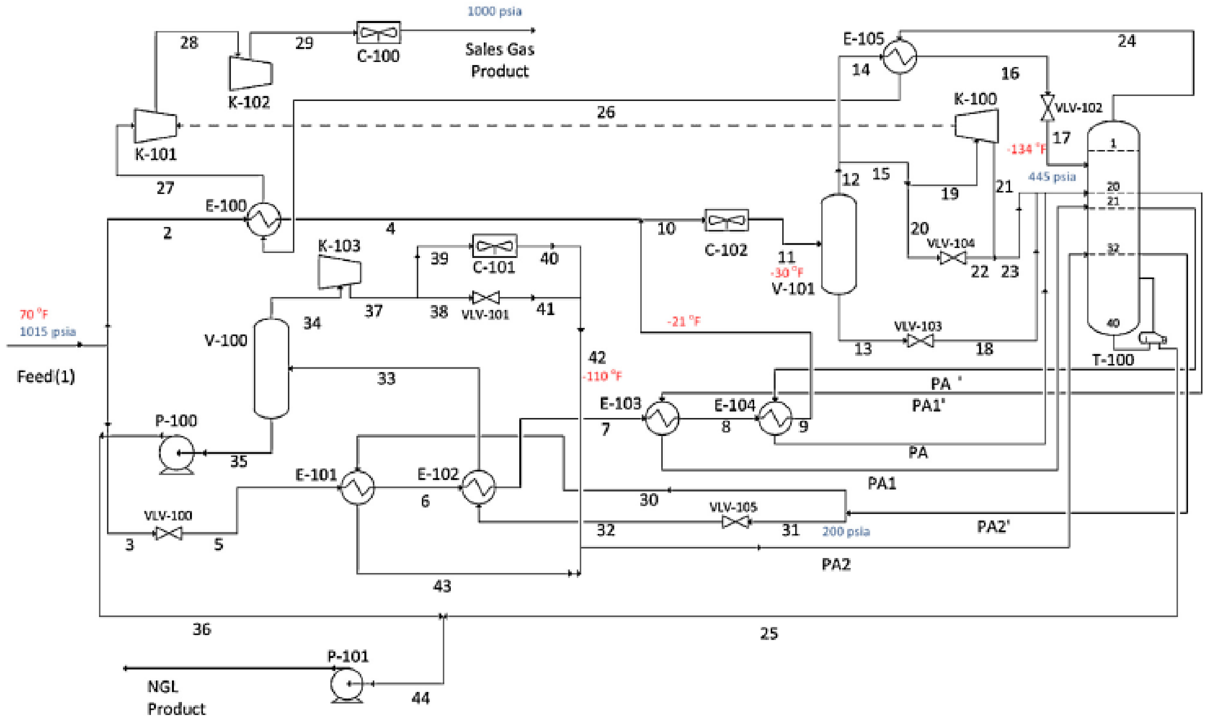

Figure 2-5 Process flow diagram of IPSI scheme [15]

The Fluor process consists of the absorber, which operates at a higher pressure than the fractionator, this scheme has 60 – 80 % of propane recovery. The Fluor process operates at a higher cost than the ISS process but has a lower capital cost [66].

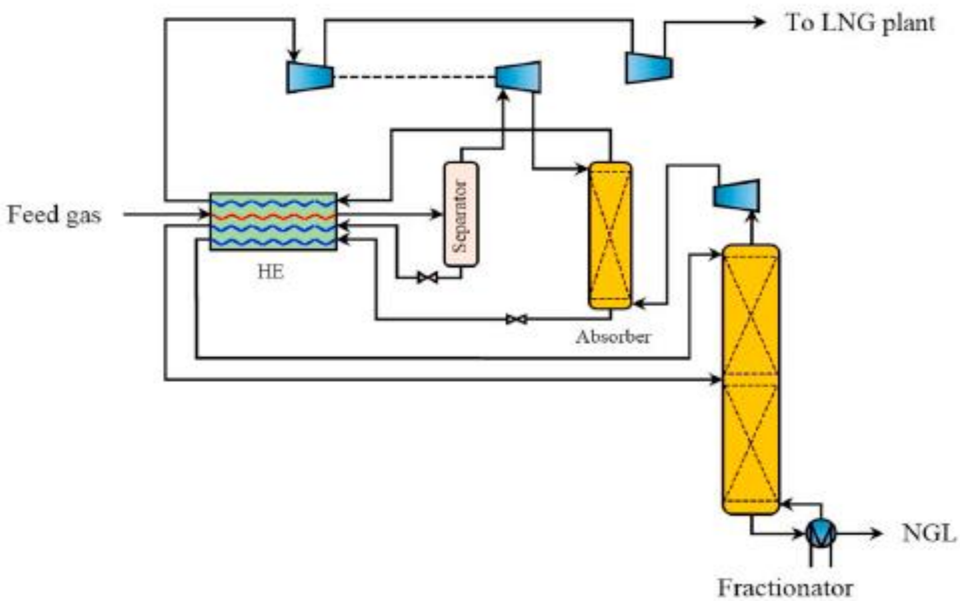

Figure 2-6 Fluor process scheme [66]

HHC separator and Scrub column scheme [74] is most economical in terms of capital cost for lean feeds but not suitable for rich feeds. These processes are integrated with the Liquification scheme for NGL recovery. The raw material cost required for the HHC separator is more due to the less efficient separation of C1 and C2. The separation efficiency of the scrub column scheme is much better than the HHC separator scheme due to the use of a column instead of a separator [62].

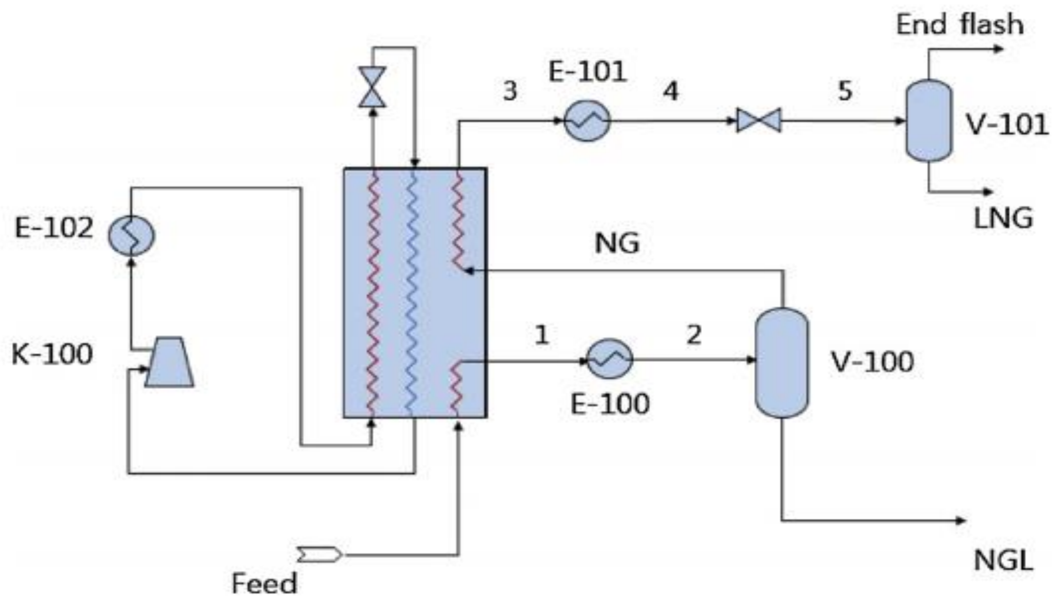

Figure 2-7 The HHC separator Process Scheme [62]

2.2 Comparison

Table 2-1 compares all the above described NGL recovery process schemes in terms of their invention, merits, and demerits.

Table 2-1 Natural Gas Liquid recovery process.

Process	Invention Year	Detail	Merits	Demerits
Industry-standard single stage (ISS) process [69]	1976	Turbo expander & JT valve is used to expand the gas and liquid to meet the demethanizer conditions	Low Capex Less footprint	Freezing of carbon dioxide in demethanizer

Process	Invention Year	Detail	Merits	Demerits
Gas subcooled process (GSP) [15]	1981	The ethane component discharges with the top product in ISS is avoided in GSP by adding a sub-cooler and separator just before the demethanizer.	Rectifying reflux increase the recovery of ethane and propane and avoid the risk of solid formation due to carbon dioxide	Less efficient in terms of ethane recovery as compared to CRR Process.
Cold residue reflux process (CRR) [70]	1989	To boost the overhead of the cold tower, an extra compressor has been introduced, which delivers the reflux free from ethane.	CRR process recovers better ethane than GSP scheme, most feasible solution for ethane recovery of 99.9% and at low demethanizer	Cryogenic compressor capital cost might be high
Recycle Vapor Split (RSV) [75]	1996	The recycle stream is compressor by residue gas compressor and hence no need for a separate compressor	RSV has the advantage of switching between ethane rejection and recovery operation. The capital cost of RSV is less then CRR	The total annual cost of RSV was the highest among the others
Enhanced NGL Recovery IPSI process [73]	1999	Improved the stripping section of the demethanizer by using the pump around	Self-refrigeration. Less raw material cost. Best among the all-other process for rich feed	An increase in plant capacity and for richer feed requires added refrigeration to sustain a good NGL recovery. Not efficient for lean feed.
HHC Separator [62]	2013	Separator integrated with liquefication Unit	Lowest capital cost among all other processes	C1 and C2 loss is more in the HHC separator The limitations of less NGL recovery efficiency. High Raw material cost
Scrub Column Scheme [62]	2013	Column integrated with liquefication Unit	Most efficient for lean feeds as compared to ISS and IPSI process	Not efficient for rich feeds.
Fluor Process [66]	2014	Addition of an absorber just before the demethanizer operated at a relatively higher pressure than the fractionator.	Lower Capital cost than ISS process scheme	Operates at a higher cost than the ISS process

2.2.1 Energy Consumption

The column reboiler and sales gas compressor are the two most energy-intensive equipment in NGL recovery. As the number of heavy components increases in the feed, the energy required in the reboiler is also increased, as seen in Figure 2-8. For lean feeds, the IPSI-1 reboiler duty is lower than the CRR, GSP, and RSV processes. The advantage of the IPSI-1's self-regeneration technology is that it saves energy and even decreases reboiler workload for rich feeds [15] [76]. The [54] results show that the IPSI process scheme has the lowest reboiler duty among the GSP, ISS, and CRR processes for feed that contains C1 88.98%, C2 5.99%. HHC separator and scrub column scheme should have additional refrigeration costs. The utility requirement of a scrub column and HHC separator scheme is higher than the ISS and IPSI scheme [62].

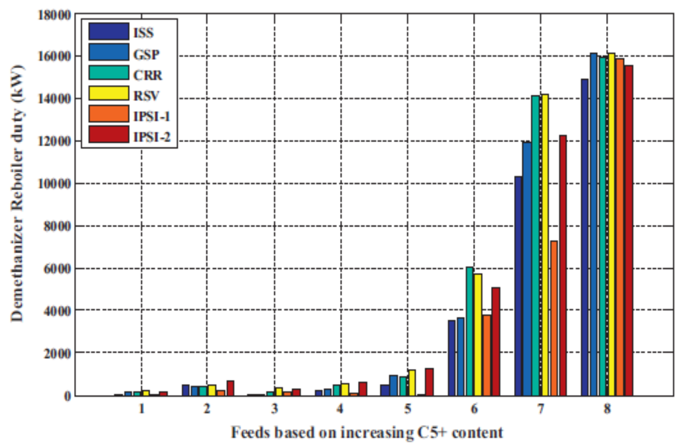

Figure 2-8: Demethanizer reboiler energy requirement [15]

2.2.2 NGL Production

The production of NGL with the different processes is represented in Figure 2-9. The IPSI-1 scheme recovers the higher NGLs, especially from feeds with higher hydrocarbons (6–8). This is due to the stripping gas stream PA2 that is consists of propane and ethane which absorb the components in the column. The rich hydrocarbons are directly separated in the separator and remove with NGLs product [15]. For lean feeds (GPM value lower than 2.3) the NGL recovery of HHC separator and scrub column is better than the IPSI scheme but these processes are not efficient for rich feed. By product credit of the Scrub, the column scheme is less than the ISS, IPSI, and HHC separator scheme [62].

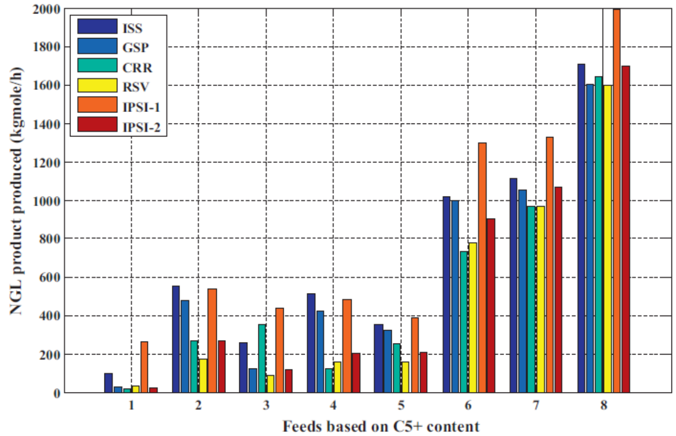

Figure 2-9: NGL Production [15]

2.2.3 Propane Recovery

The propane recovery of IPSI-1 is higher than the other processes like ISS, GSP, CRR, RSV. The [54] was compared the propane recovery with the capital cost, results showed that the IPSI process is best in terms of propane recovery but with the higher capital cost. Figure 2-10 shows the comparison of propane recovery for NGL recovery processes [54]. It also notes that for the high recovery of propane, the operating cost and capital cost required for IPSI and GSP scheme are also high. If the main emphasis is propane recovery and Capital and operating costs are not the issues of the NGL recovery scheme then the CRR and ISS scheme are also competitive of the IPSI scheme [54].

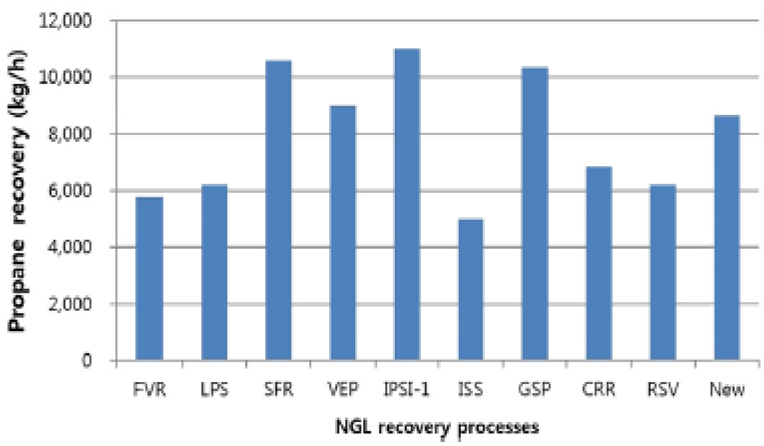

Figure 2-10: Propane recovery for different NGL recovery technologies [54]

The ethane and propane recovery for normal and lean feed gas for fluor and ISS was compared and shown in Figure 2-11. The graph represents the propane and ethane recovery for lean and normal feed. For both lean and normal feed, the ethane and propane recovery of the fluor process is greater than the ISS process. The ethane recovery for ISS is 30 – 36 % while for fluor process 38 – 46 % but it's lower than the IPSI process. The Propane recovery for ISS is 78 – 92 % while for fluor process 88 – 90 % [66].

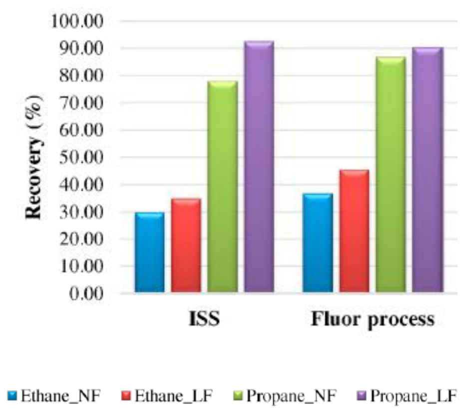

Figure 2-11: Propane recovery of ISS and Fluor process [66]

2.2.4 Operating Cost

The estimation of operating cost is not easy it can be varied with area by area and year by year. It relies on energy cost, raw material cost, utility costs such as refrigeration and electricity. The overall annual running cost for the process is represented in Figure 2-12. Richer feeds with higher hydrocarbon content have higher running costs. It's because of the extra refrigeration costs associated with condensing the heavier hydrocarbons needed to accomplish the optimum separation. In most circumstances, the GSP, CRR, RSV process schemes are more costly than the IPSI-1 process scheme. It's because of the IPSI-1's self-refrigeration mechanism, which drastically reduces the cost of refrigeration for rich feed. The RSV process scheme, on the other hand, has the greatest running cost of all the process schemes. The additional cost of the RSV process is primarily due to the sales gas compression duty explained in the preceding section [15].

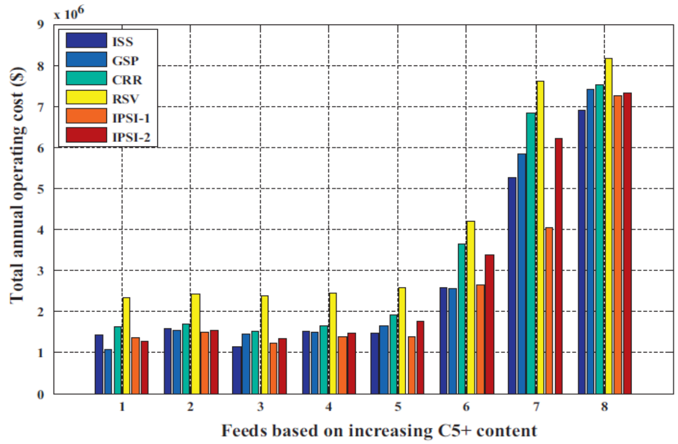

Figure 2-12: Overall Annual operating cost [15]

The operating cost for the Fluor process is higher for both rich and lean feed than the ISS process but the capital cost of the fluor process is less than the ISS process [66]. The total operating cost of the HHC separator and Scrub column scheme is higher than the IPSI and ISS scheme while the capital cost of the HHC separator is lowest than the all-other processes. The raw material cost has a lower impact than the capital cost, it means that IPSI has offset its economic performance due to high capital and operating cost. Even though HHC has a lower capital cost but higher operating costs offset its economic performance.

2.3 Exergy Analysis

Natural gas processing units have undergone significant exergy study. The exergy of tiny liquefied natural gas liquefaction operations was studied by Remeljej and Hoadley [77]The compressors accounted for the most exergy degradation in a natural gas liquefaction process, according to an exergy analysis [78][79]. Exergy destruction mitigation measures were also suggested. By using the exergy approach, Mehrpooya et al. [41][80]. Studied the behaviour of an industrial refrigeration cycle in NGL recovery units and assessed hydrocarbon recovery processes using mixed-fluid cascade, dual mixed-refrigerant, and propane-mixed refrigerant systems. The exergy efficiency of the designed processes, cycles, and processes components was studied, and the findings revealed that compressors and multi-stream heat exchangers caused the most damage. Vatani [77] used traditional and advanced exergy analysis to examine five NGL processes and discovered that the preventable inefficiency was larger in compressors than in other components, despite the existence of heat exchangers[81].

2.3.1 Theory

Kinetic exergy, Potential exergy, chemical exergy, and physical exergy are the four main components of exergy [82]. The kinetic and potential exergy is frequently overlooked. Chemical exergy is not taken into account in this study since no chemical reactions take place in the system and no chemical compounds are released into the environment [83][84]

Therefore, only the physical exergy is computed as a result.

A stream's physical exergy (Ex) can be described following. [79]:

$$E_x = H - H_0 - T_0\ (S - S_0)$$

Where 'S' and 'H' denote the stream's entropy and enthalpy, respectively; the subscript 0 denotes the physical equilibrium condition (of pressure and temperature) in the environment, and T0 is the reference ambient temperature. The ambient pressure and temperature are considered to be 101.325 kPa and 298.15 K (77 F), respectively, based on earlier research.

Exergy destruction is caused by irreversibility inside a process or system. The exergy balancing equation may be used to determine exergy destruction. The formula for a steady-state constant volume is as follows [85][84]:

$$E_{xin} = E_{xout} + W_{Sh} + \mathit{\Delta} E_x$$

Where E_{xin} denotes the exergy of input energy, and material streams a E_{xout} denotes the exergy of output energy stream and materials streams, W_{sh} denotes shaft work, and Ex denotes exergy destruction.

Another essential element in an exergy study is exergy efficiency. This study employs different definitions of exergy efficiency [86]. The first description is the exergy leaving the system divided by the total exergy delivered to the system. [14].

$$\varepsilon = \frac{E_{xout}}{E_{xin}}$$

Where ε is the exergy efficiency.

The refrigeration loop in the hydrocarbon dew point control unit is one of the most exergy destructive area. To analyze the exergy of the refrigeration loop, the first mass exergy and exergy destruction of the most extensively used propane refrigeration loop was considered. Based on the exergy analysis, the recommendation of a new refrigerant was considered to improve the overall exergy of the system.

2.3.2 Comparison of Energy and Exergy Analysis

Any form of energy can be subdivided in two main components;

- One which can produce work, Known as Exergy
- While the other which cannot be used in any real process to generate work, known as anergy.

Chapter 3

Development of Process Simulation

Aspen Hysys V-11 is used for simulation of propane and butane (NGLs) extraction unit. Two simulations were developed, Conventional ISS process simulation and Optimized process simulation based on sensitivity and Exergy analysis.

3.1 Process Description

A process flow diagram of a conventional NGLs recovery plant is shown in Figure 3-1. The PFD shows the process scheme to produce LPG, Gas condensate and dry natural gas. The raw gas from wellhead is transported through pipelines to the phase separation which is done in three-phase separator and slug catcher.

3.1.1 Three Phase Separator

The purpose of three-phase separator is to separate the gas, condensate and water on the basis of density difference and gravitational force. The gas from three-phase separator contains the moisture which is dehydrated in the Triethylene glycol (TEG) unit to produce pipeline-quality dry natural gas.

3.1.2 TEG Dehydration Unit

Triethylene glycol is used to dehydrate the gas. The removal of water from gas is required to prevent hydrate formation at low temperature. The unit consists of TEG Contractor, Glycol Circulation Pump, Glycol Knockout vessel, Lean rich glycol Exchanger.

3.1.3 Chiller and Low-temperature Separator

Chiller contains a refrigeration loop, which is used to lower the temperature of natural gas. At low temperatures the condensate is formed, and lighter gases i.e. methane, are separated.

3.1.4 De-Ethanizer and De-Butanizer

In the De-Ethanizer column the methane and ethane are separated as a top product and condensate which is heavier than C2 (Ethane) obtained as a bottom product and its charge to De-Butanizer to extract the LPG from top and RVP maintained condensate as a bottom product.

3.2 Process Flow Diagram

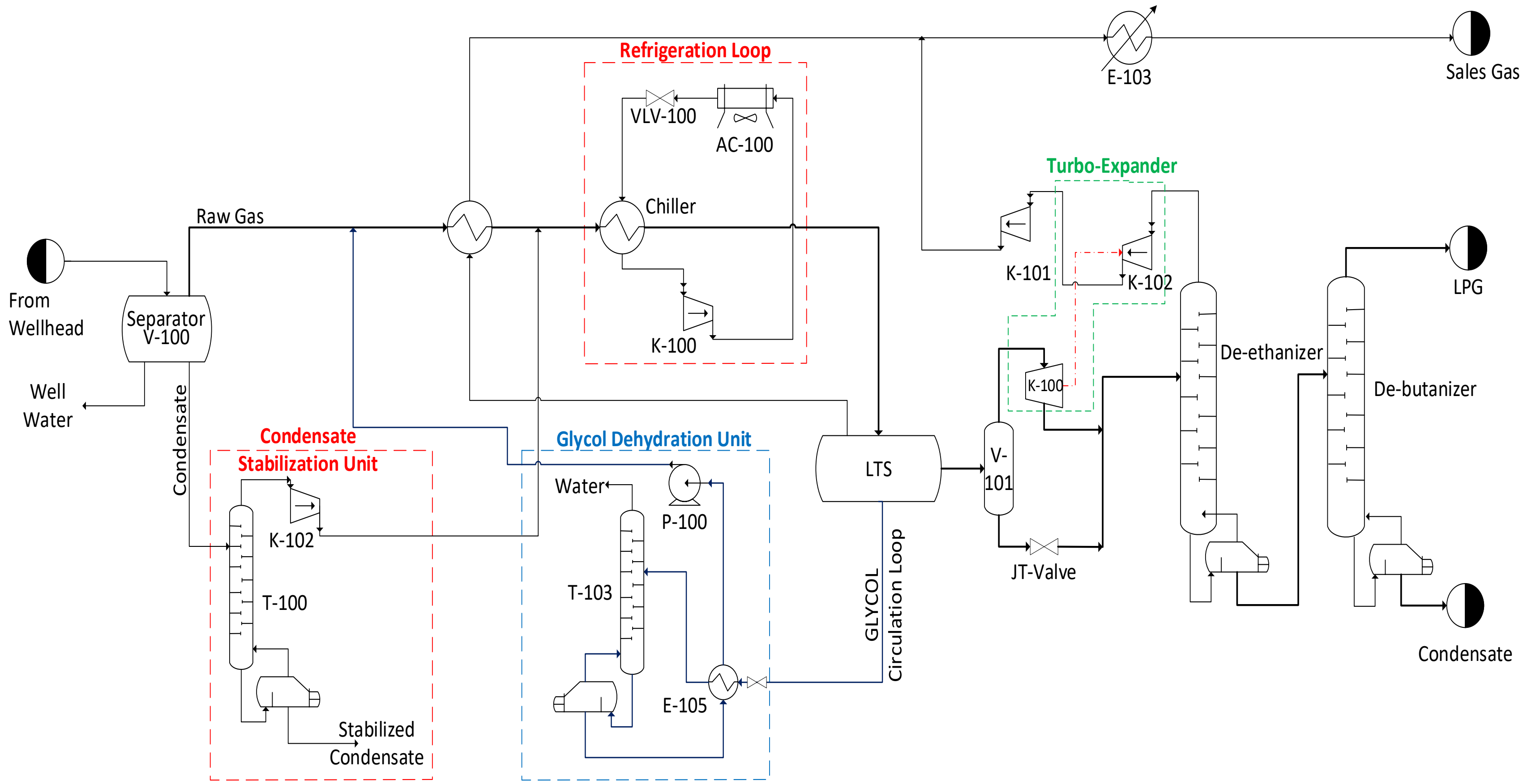

Figure 3-1: Process Flow Diagram

3.2.1 Condensate Stabilizer Unit

Condensate from the three-phase separator flows to the stabilizer column to meet the Reid vapour pressure (RVP) Spec of 7 Psi.

3.3 Components List

The well head condensate and gas analysis of Zainab filed obtained from the Petroleum Exploration Limited-Pakistan.

3.3.1 Gas Composition Analysis

Table 3-1: Gas composition of Well head

Compositional Analysis of Gas Sample to C11+

Sampling Date	**16-Jul-2017**
Sampling Location	**Zainab-1 (Choke: 48/64")**
Cylinder Number	**N/A**
Sampling Conditions	**473 psig @ 117°F**

	Component	Mole %	Weight %
H_2	Hydrogen	0.00	0.00
H_2S	Hydrogen Sulphide	0.00	0.00
CO_2	Carbon Dioxide	2.02	4.24
N_2	Nitrogen	1.35	1.81
C_1	Methane	78.72	60.41
C_2	Ethane	10.40	14.96
C_3	Propane	4.56	9.63
IC_4	i-Butane	0.96	2.68
nC_4	n-Butane	1.10	3.05
C_5	Neo-Pentane	0.00	0.00
IC_5	i-Pentane	0.41	1.42
nC_5	n-Pentane	0.26	0.91
C_6	Hexanes	0.21	0.85
	M-C-Pentane	0.00	0.00
	Benzene	0.00	0.01
	Cyclohexane	0.00	0.00
C_7	Heptanes	0.01	0.03
	M-C-Hexane	0.00	0.00
	Toluene	0.00	0.00
C_8	Octanes	0.00	0.00
	E-Benzene	0.00	0.00
	M/P-Xylene	0.00	0.00
	O-Xylene	0.00	0.00
C_9	Nonanes	0.00	0.00
C_{10}	Decanes	0.00	0.00
$C_{11}+$	Undecanes Plus	0.00	0.00
	Totals :	100.00	100.00

Note: 0.00 means less than 0.005.

Calculated Whole Gas Properties	
Real Relative Density (Air=1 @ 14.73 psia and 60°F)	0.724
Molecular Weight (g mol-1)	20.91
Ideal Gross Calorific Value BTU/ft3 @ 14.73psia, 60°F (15.6°C) (ISO6976 Data in imperial Units)	1201.5
Ideal Net Calorific Value BTU/ft3 @ 14.73psia, 60°F (15.6°C) (ISO6976 Data in imperial Units)	1088.9

3.3.2 Condensate Analysis

To accurately describe the raw gas compositions, a pseudo components blend is employed to represent the complicated heavy components. The distillation curves type of blend is determined using the ASTM D86 test technique, and the specific gravity of the blend is 0.7434. Table 3-2 shows the blend distillation percent as a function of temperature.

Table 3-2: Distillation Percent of blend with varying temperature

TEST REPORT			Page 01 of 02
Customer's Name	M/s. Petroleum Exploration Pvt Ltd	Test Report No.	104/2017-2018
Customer's Ref	Email	Reporting Date	21-07-2017
Date	17-07-2017	Sample Code	313
Sample Description	Condensate. (ZAINAB)	Receiving Date	18-07-2017

TEST METHOD	TEST PARAMETERS	TEST RESULTS
D-1298	Specific Gravity 60/60 °F	0.7434
D-1298	API Gravity 60/60 °F	58.84
D-4294	Total Sulphur Content, Wt.%	0.069
D-96	B.S. & W, Vol.%	<0.05
D-95	Water Content by D&S Vol.%	<0.05
D-3230	Salt Content, lbs/1000bbl	Nil
D-445	Kin Viscosity at 50 °C, cSt	0.71
D-445	Kin Viscosity at 40 °C, cSt	0.77
D-97	Pour Point, °C	<-24
D-189	Con. Carbon Residue, Wt.%	0.021
D-323	R.V.P. @ 37.8 °C,	6.6
D-130	Copper Strip Corrosion @ 50 °C	1a
USB-97	Calorific Value (Gross), Btu/lb	20208
USB-97	Calorific Value (Net), Btu/lbs	18862
D-86	**Distillation**	
	I.B.P. °C	42
	05/10 % Recovery °C	63/71
	20/30 % Recovery °C	85/96
	40/50 % Recovery °C	107/120
	60/70 % Recovery °C	136/159
	80 /90 % Recovery °C	189/244
	FBP	296
	Recovery @ 360 °C	96
	Loss %	1.8
	Residue %	2.2

For condensate, the assay is defined in Aspen Hysys, Oil Manager, with the bulk properties as provided above.

3.4 Fluid Package Selection

3.4.1 Significance and Potential Benefits

To comprehend the relevance of property packaging, it is necessary to first comprehend what a fluid package is. A fluid package is a set of governing equations that assist us in determining various variable characteristics under specified process circumstances. Which fluid package is most suitable for our situation is a critical decision. As a chemical engineer, you must appreciate the complexity and difficulties of choosing a property package in Aspen Hysys.

Thermo-physical qualities are necessary to solve the energy and material balances. The phase transition behaviours and energy level of individual components and mixtures are calculated using these thermodynamics models. Each approach is appropriate for a certain collection of components and circumstances. Poor decisions will either fail or provide unreliable outcomes.

Once the pressure, temperature , and composition of the stream have been specified, the Aspen Hysys uses equations from the property package to determine the other parameters. The outcomes will suffer if the proper fluid package is not chosen based on the process's conditions.

3.4.2 Methodology

The choice of a property package has been made using two methods.

1. Based on Process
2. Based on Components Type

Based on Process

Process	Fluid package
Sour water	Sour Peng Robson , Peng Robson
TEG dehydration	Peng Robson
Cryogenic gas processing	PRSV, Peng Robson
Crude tower, atm	Peng Robson, Peng Robson options, GS
Air separation	PRSV, Peng Robson
Vacuum towers	Peng Robson, Peng Robson options, GS
Hugh H_2 systems	Peng Robson,GS
Ethylene towers	Lee Kesler locker
Chemical systems	PRSV, Activity model
Hydrates inhibition	Peng Robson
HF alkylation	PRSV, NRTL
TEG dehydration with aromatics	Peng Robson

Based on Components

The fluid package selection depends on gases, nonpolar, polar, solvating, electrolyte, and associating are all components in the process that are chosen. The aspen technology symbol engineer created a more recognizable decision tree.

Figure 3-2 shows the first set of requirements for thermodynamics models. Due to the obvious molecular interaction, the first task is to decide if the components are non-polar or polar. The next stage is to determine if the ingredients are non-electrolyte or electrolyte. Acid formation, neutralization, and salt precipitation all need electrolyte mixtures [87].

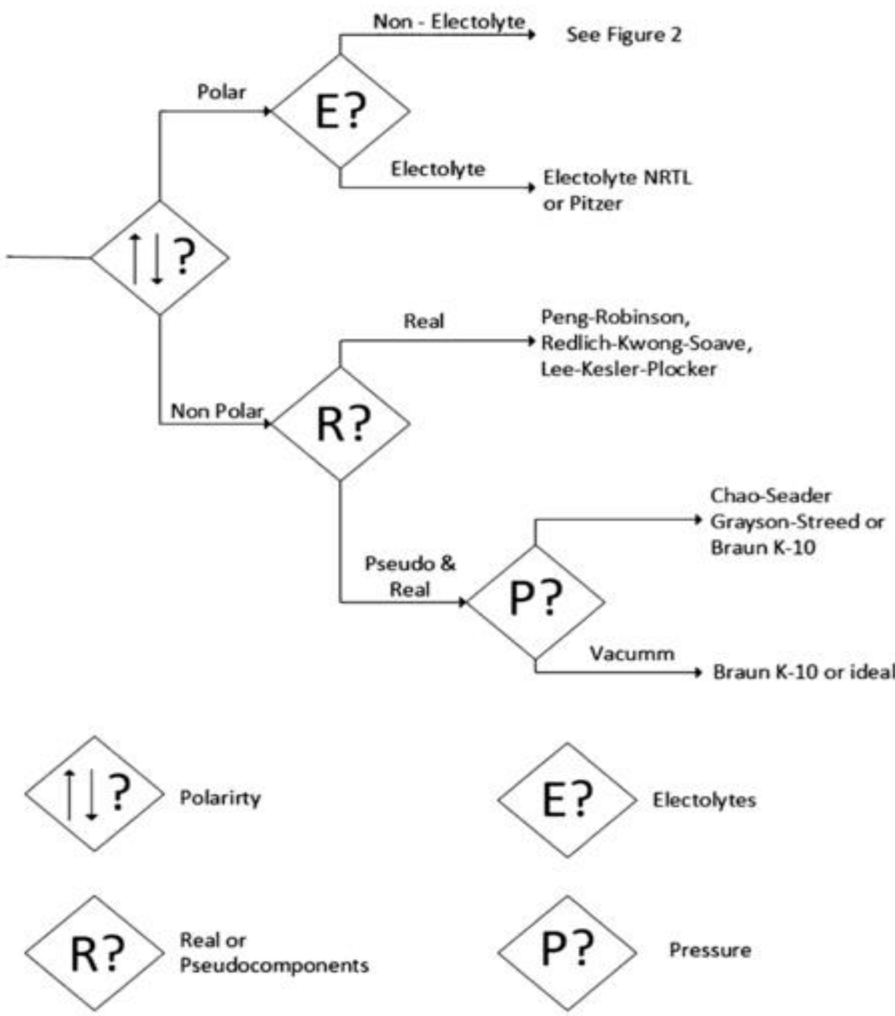

Figure 3-2: Procedure to select Property package

For non-polar substances, the presence of actual or faux components is evaluated. Figure 3-3 is utilized as a decision tree for non-electrolyte and polar systems. The next task is to decide whether the system pressure is higher than or less than 10 bar. The next step is to determine whether interaction parameters are present. The final step is to choose a property package based on whether the phase is vapours or liquid

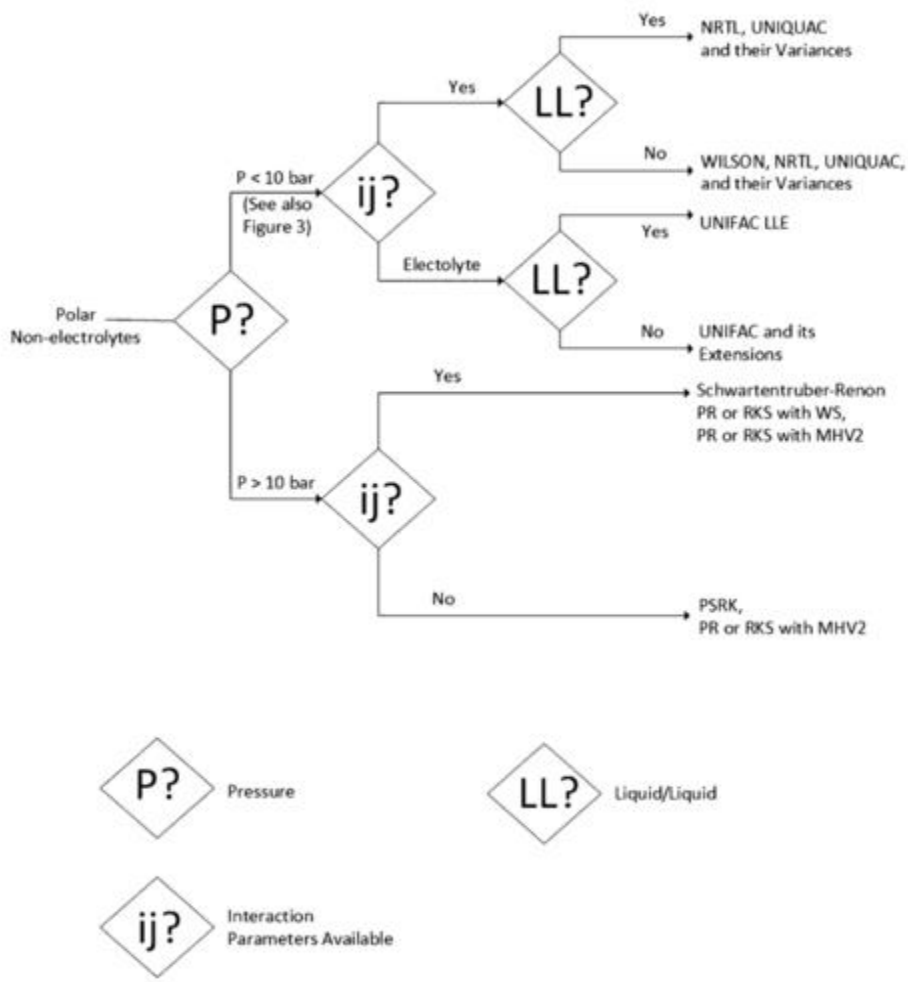

Figure 3-3: Decision tree for Polar Non-electrolytic compound

In Aspen Hysys, the home tab contains a method assistant tab; try clicking on it and then pick the property package depending on the process kinds and applications. Each approach is described in depth, as well as the components necessary. Oil and gas treatment are among the process types and applications discussed.

Based on Process

Based on the process Peng Robinson is the most appropriate fluid package. The components that are present in a simulation are hydrocarbons.

Based on the Decision Tree

Step 1: Polarity

Polar molecules like Cl^- and H^+ are oppositely charged, whereas non-polar molecules like CO_2 are equally charged. Most of the hydrocarbons are carbon-based, non-polar mixtures. As a result of the preceding explanation, most of our components are non-polar.

Step 2: Real or Pseudo components

Pseudo components are the separate phase that exists under standard circumstances. Because there are no pseudo constituents in the recovery of NGLs, all the components are actual.

Because LPG extraction involves real and non-polar components, the decision tree suggests Peng Robinson as the best property package. The hydrocarbon family encompasses all the components employed. For hydrocarbons systems, Peng Robinson is extensively utilized.

3.4.3 Peng-Robinson

The Peng Robinson equation is a frequently employed equation of state for hydrocarbons at higher pressure and temperature. It has the world's largest binary interaction database (Bis). For petrochemicals and oil & gas sectors, this property package is suggested. Cryogenic gas processing, crude distillation unit, vacuum towers, TEG dehydration, and high hydrogen system are the best applications.

3.5 Conventional ISS process Simulation Diagram

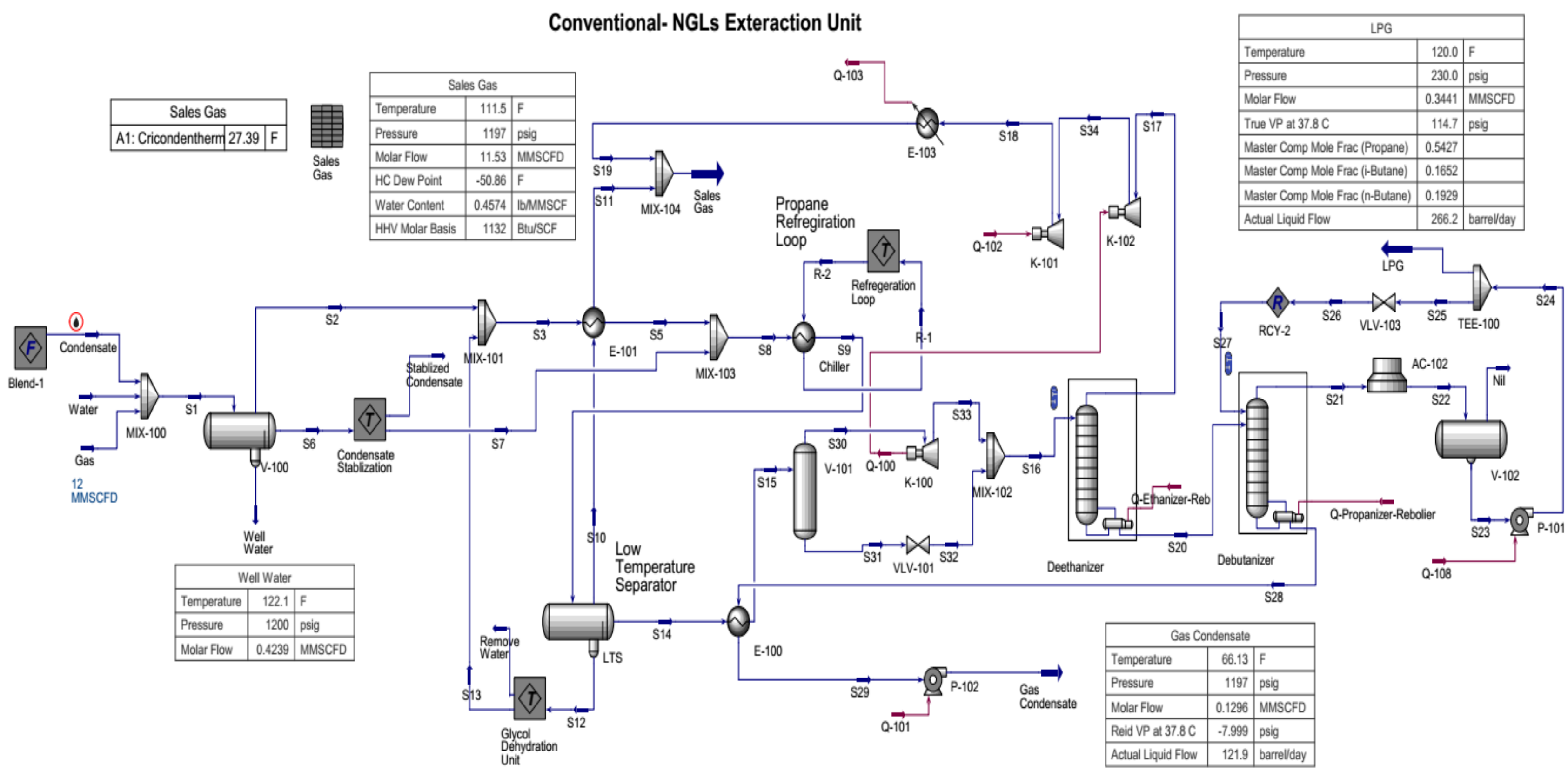

Figure 3-4: Conventional ISS-Process Simulation diagram

Table 3-3 is the description of the design specifications for columns. The number of trays and feed location are estimated based on the output of the shortcut column.

Table 3-3 Specification of C2 and C4 column

Columns	Pressure (Psig)	Stages	Feed Stage	Design Specifications
Deethanizer	390	20	1	C2 Mole fraction 0.01 in bottom
Debutanizer	230	18	13	RVP of condensate -8 Psig in Reboiler

3.5.1 Component Recovery

Table 3-4 is the material balance of the conventional flowsheet, from which we can find out the propane and butane distribution. The top product of deethanizer is sale gas which contains 81.5 mol% methane, 10 mol% ethane, 3 mol% propane, traces of butane, and other components. The bottom of deethanizer is propane and heavier components which is the feed of debutanizer column. In debutanizer the LPG obtain as a top product which contain 55 mol% propane and 35 mol% butane. The production of LPG is more profitable than both natural gas and gas condensate. The condensate is heavy NGLs which meets the Reid vapour pressure spec of 7 psia so that it can store easily without any vapour loss.

3.5.2 Hydrate Formation

Another consideration that needs to be checked is the hydrate formation. At the low temperature, the hydrate can be formed. So, the hydrate formation temperature is the lowest temperature that we can achieve after the turbo expander and JT valve. At low temperatures the extraction can be done more efficiently but the hydrate formation limits this temperature. The hydrate formation temperature after the JT Valve is -24.73 F and the temperature that we achieve from the turbo expander and JT valve is -24 F which is less than the hydrate formation temperature.

Table 3-4 Parameters of conventional process flow sheet

Description	Feed Stream	Product streams			
	S1	Sales Gas	LPG	Gas Condensate	Stabilized Condensate
Vapour / Phase Fraction	0.90	1.00	0.00	0.00	0.00
Temperature [F]	122.06	111.46	120.00	66.13	331.01
Pressure [psig]	1200.00	1197.00	230.00	1197.00	100.00
Molar Flow [MMSCFD]	12.85	11.53	0.34	0.13	0.40
Mass Flow [tonne/d]	370.49	271.41	21.18	13.67	54.47
Component Mass Flow [tonne/d]					
CO2	12.65	12.57	0.00	0.00	0.00
Nitrogen	5.40	5.40	0.00	0.00	0.00
Methane	180.29	180.28	0.00	0.00	0.00
Ethane	44.65	44.47	0.17	0.00	0.00
Propane	28.74	18.92	9.84	0.00	0.00
i-Butane	8.00	3.57	3.95	0.00	0.47
n-Butane	9.10	3.16	4.61	0.01	1.31
i-Pentane	4.25	0.82	1.69	0.44	1.28
n-Pentane	3.11	0.48	0.66	0.88	1.11
n-Hexane	4.44	0.27	0.00	1.75	2.55
n-Heptane	1.96	0.04	0.00	0.54	1.52
H2O	9.66	0.00	0.00	0.00	0.00
Blend	45.94	1.09	0.25	7.03	37.56

3.6 Development of Optimized Process Simulation

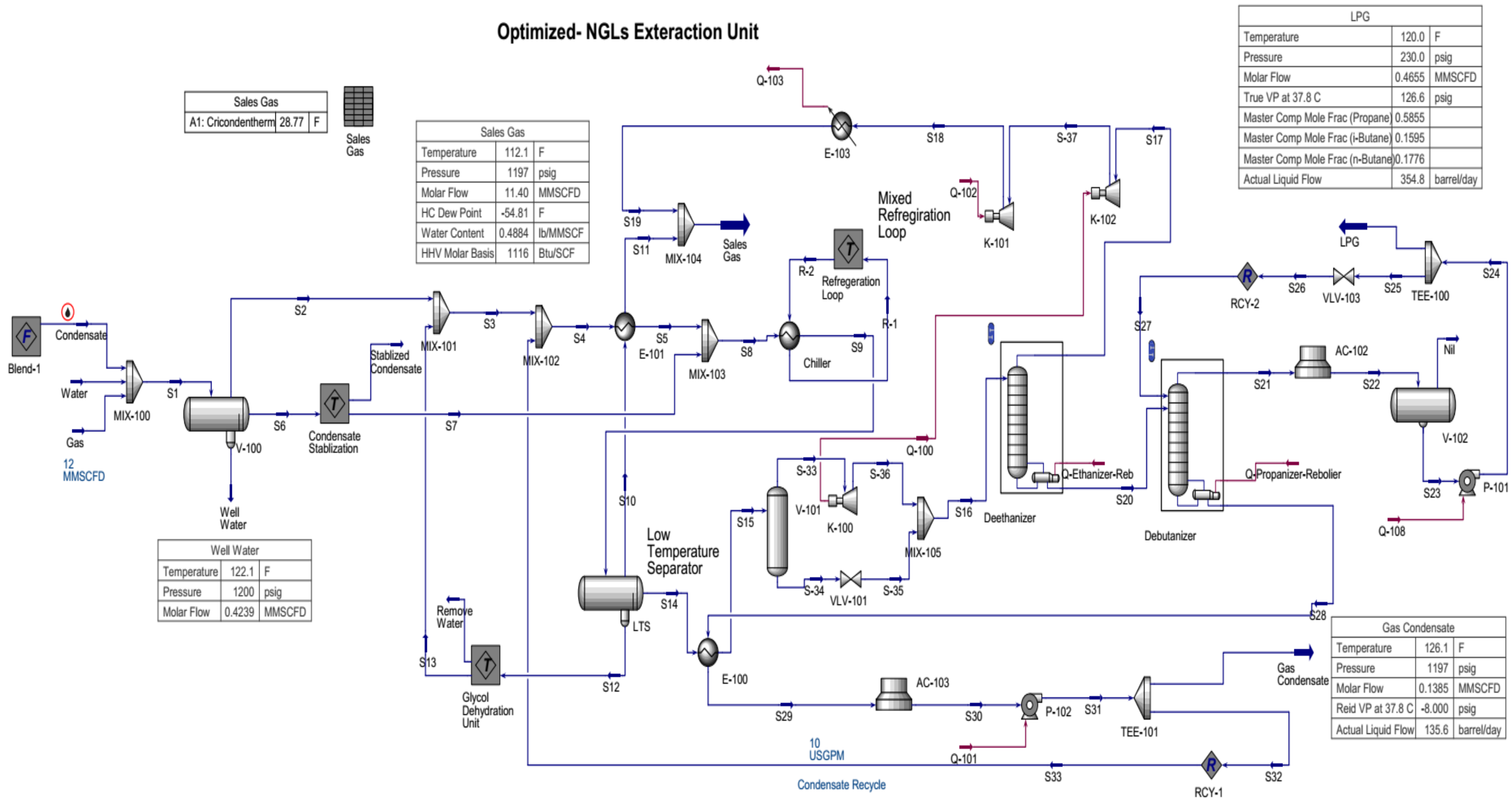

Figure 3-5 Optimized Process Simulation diagram

Table 3-5 is the description of the design specifications for columns. The number of trays and feed location. For comparison bases the specs of Conventional and optimized plant remain same.

Table 3-5 Specification of C2 and C4 column

Columns	Pressure (Psig)	Stages	Feed Stage	Design Specifications
Deethanizer	390	20	1	C2 Mole fraction 0.01 in bottom
Debutanizer	230	18	13	RVP of condensate -8 Psig in Reboiler

What's new

- The condensate recycles before the Low-temperature separator, which absorbs the butane and propane from the sales gas and helps to get 89 BBL/day of more LPG.
- A mixed Refrigeration loop, which contains 60% propane and 40% R-600a helps to reduce the exergy destruction, energy utilization and also reduce the capital cost.

The operating parameters on both processes are same to check the impact of condensate recycle and mixed refrigerant. The LPG purity is also increased up to 3% in the optimized process, 58.5 mol% Propane, 34 mol% butane and 8 mol% other components. Due to the condensate recycling the number of heavier components is also reduced in the sales gas.

The lowest temperature at the outlet of turbo expander and JT valve is -23.23 F and the hydrate formation temperature is -23.87 F, so that no hydrate will form.

Table 3-6 Parameters of Optimized process flow sheet

Description	Feed Stream	Product streams			
	S1	Sales Gas	LPG	Gas Condensate	Stabilized Condensate
Vapour / Phase Fraction	0.90	1.00	0.00	0.00	0.00
Temperature [F]	122.10	112.09	120.00	126.05	330.85
Pressure [psig]	1200.00	1197.00	230.00	1197.00	100.00
Molar Flow [MMSCFD]	12.87	11.40	0.47	0.14	0.41
Mass Flow [tonne/d]	370.52	264.66	27.85	14.63	53.61
Component Mass Flow [tonne/d]					
CO2	12.65	12.57	0.00	0.00	0.00
Nitrogen	5.40	5.40	0.00	0.00	0.00
Methane	180.28	180.28	0.00	0.00	0.00
Ethane	44.65	44.30	0.37	0.00	0.00
Propane	28.74	14.41	14.37	0.00	0.00
i-Butane	8.00	2.31	5.16	0.01	0.47
n-Butane	9.10	1.91	5.75	0.04	1.34
i-Pentane	4.25	0.66	1.63	0.65	1.31
n-Pentane	3.14	0.51	0.52	0.95	1.10
n-Hexane	4.58	0.31	0.00	1.49	2.35
n-Heptane	2.10	0.04	0.00	0.42	1.22
H2O	9.66	0.00	0.00	0.00	0.00
Blend	45.94	1.65	0.06	8.78	38.90

Chapter 4

Results and Discussion

The LPG products, stable light hydrocarbons, and natural gas produced by the condensate recovery unit are usually sold commercially and therefore; they must fulfill certain quality standards. The butane and propane recovery rate, which may be calculated as follows, is a key indicator of an NGL production:

Propane recovery rate = moles propane in products/moles propane in feed gas ×100%

Butane recovery rate = moles butane in products/moles butane in feed gas ×100%

A greater energy consumption corresponds to higher production. The overall energy usage of the NGL equipment is made up of two separate forms of energy: heat and electricity (for example, from reboilers and compressors). Exergy assessment is another parameter for comparing conventional and improved NGL recovery processes.

To evaluate the capital and operating cost of the conventional and optimized process scheme, an economic analysis is performed on the Aspen economic analyzer.

4.1 Optimization and Sensitivity Analysis

A greater recovery rate for NGL extraction units means more energy usage and higher running costs. Furthermore, there should be a specific operating condition that improves unit profitability.

Several parameters, such as the deethanizer pressure, debutanizer pressure, and condensate recycling rate, affect the unit energy consumption and product recovery. These variables are interconnected and have an influence on product recovery and, consequently plant profit. A sensitivity study should be carried out before the optimization.

To study the impact of operating parameters on unit profit, HYSYS was used to conduct a sensitivity analysis.

4.1.1 Deethanizer Pressure

When deethanizer pressure is increased, the product recovery rate falls, and when deethanizer pressure is decreased, the product recovery rate increases. As tower pressure rises, the energy necessary to drive the deethanizer over compressor decreases. While light component separation becomes much more difficult as reboiler duty increases, the lower compressing power reduces total energy use. According to modelling results, deethanizer pressures must be between 380-400 Psig.

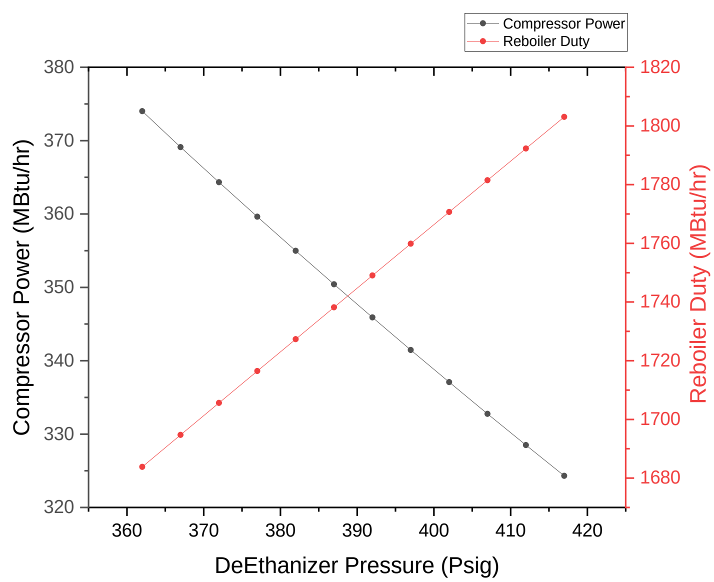

Figure 4-1 Impact of deethanizer pressure on compressor and reboiler duty

4.1.2 Debutanizer Pressure

The debutanizer distils the C_3 and higher hydrocarbons that collected in the bottom of the deethanizer, and its operating parameters determine whether such hydrocarbons are transformed into natural gasoline or LPG. Due to the obvious varying product prices, this results in a disparity in plant profitability. Natural gas is often less expensive than LPG on the open market. The debutanizer pressure, that must be greater than 170 Psig to reduce the formation of non - condensable overhead gas, is also important in the recovery. Moreover, to guarantee that the stream flows into the debutanizer without external effort, the debutanizer pressure must be at least 72 Psig lower than the deethanizer pressure, with a recommended operating range of 170 – 250 Psig.

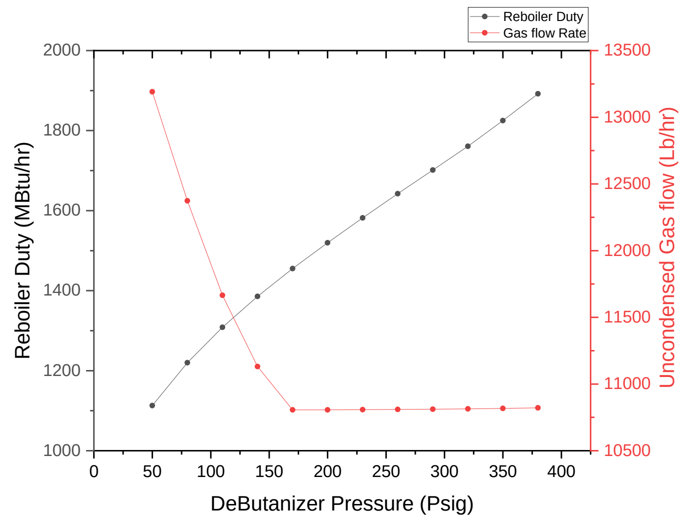

Figure 4-2 Impact of debutanizer pressure on gas flow and reboiler duty

4.1.3 Condensate Recycling

Condensate Recycling should be set to the optimum range. As the amount of condensate recycling increases, the LPG production, equipment sizes and energy utilization are increases. The graph below represents the duty of chiller and deethanizer reboiler is dramatically increase with the increase in recycle Condensate flow rate. There is a minor increase in the debutanizer reboiler duty. The rise in duty means an increase of utility cost and operating costs. The optimum recycles flow rate should be in the range of 5 to 10 gpm.

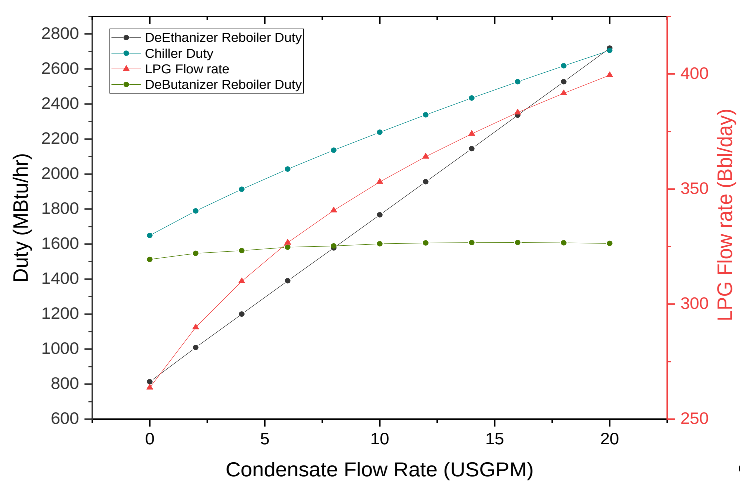

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Figure 4-3 Impact of condensate recycle flow rate on LPG flow rate and Chiller, Deethanizer & Debutanizer reboiler Duties

4.2 Propane and Butane Recovery Rate

The feed flow rate of propane and butane is the same for conventional and optimized flow schemes.

	Feed Stream S1	Conventional LPG	Optimized LPG
Propane [lbmol/hr]	59.87	20.51	29.93
i-Butane [lbmol/hr]	12.64	6.24	8.15
n-Butane [lbmol/hr]	14.38	7.29	9.08

4.2.1 Conventional

Propane recovery rate = moles propane in products/moles propane in feed gas ×100%

Propane recovery rate = 20.51 / 59.87 * 100 = 34.3 %

Butane recovery rate = moles butane in products/moles butane in feed gas ×100%

Butane recovery rate = 13.53 / 27.02 * 100 = 50.1 %

4.2.2 Optimized

Propane recovery rate = moles propane in products/moles propane in feed gas ×100%

Propane recovery rate = 29.93 / 59.87 * 100 = 50 %

Butane recovery rate = moles butane in products/moles butane in feed gas ×100%

Butane recovery rate = 17.23 / 27.02 * 100 = 64 %

The propane recovery rate of propane is 34.3% for the conventional ISS scheme and for Optimized flow scheme is 50% which is 16% more due to the injection of 10 USgpm of condensate back to the system. Also, the butane recovery of conventional is 50%, while for optimization is 64%. Overall, the recovery becomes better due to recycle of condensate.

4.3 Exergy Analysis

4.3.1 Objective

To reduce the exergy destruction of the refrigeration loop that is used for the hydrocarbon dew point control unit.

Refrigeration loop in hydrocarbon dew point control unit is one of the most exergy destructive areas. To analyze the exergy of the refrigeration loop, the first mass exergy and exergy destruction of the most extensively used propane refrigeration loop was considered. Based on the exergy analysis, recommendation of a new refrigerant was considered to improve the overall exergy of the system.

4.3.2 Exergy analysis of Propane Refrigeration Loop

The components in the refrigeration loop, including Chiller, compressors, air cooler and JT valve (Expansion), all cause irreversibility, leading to exergy destruction. The exergy destruction in the components is calculated according to the equations listed below[14][88].

Compressors

$$\Delta E_x = E_{xin} + W_{com} - E_{xout} = (H_{out} - H_{in})(1/\eta_c - 1) + T_1(S_{out} - S_{in}) \text{ [14]}$$

Air Cooler

$$\Delta E_x = E_{xin} - E_{xout} = \sum(\dot{m}e)_{in} - \sum(\dot{m}e)_{out} + W + E_{ain} - E_{aout} \text{ [14]}$$

Joule- Thomson expansion

$$\Delta E_x = E_{xin} - E_{xout} = \sum(\dot{m}e)_{in} - \sum(\dot{m}e)_{out} \text{ [14]}$$

Chiller

$$\Delta E_x = E_{xin} - E_{xout} + E_{xq}$$

$$E_{xq} = \left(1 - \frac{T_0}{T_b}\right) Q$$

ΔE_x is the equipment exergy destruction; The intake exergy is known as E_{xin}. The output exergy is referred to as E_{xout}. The inlet enthalpy is H_{in}. The output enthalpy is H_{out}. The inlet entropy is called S_{in}. The output entropy is S_{out}, while the irreversible rise in entropy is S_{irre}. ή is the effectiveness; The molar flow is denoted by m, while the exergy of streams is denoted by E. The enthalpy of flow of air before and after the exchange of heat is E_{ain} and E_{aout}, respectively. The temperature of the environment is T_O; The work done on the equipment by the external environment is denoted by W, while the lost work is denoted by LW. The heat exchanged between the components and environment is denoted by Q [29].

Before conducting the exergy analysis, a rigorous process simulation was needed to be accomplished by a conventional process simulator such as HYSYS. The whole plant was simulated via HYSYS. HYSYS simulation was performed by the Penge Robinson equation selected as the thermodynamic model.

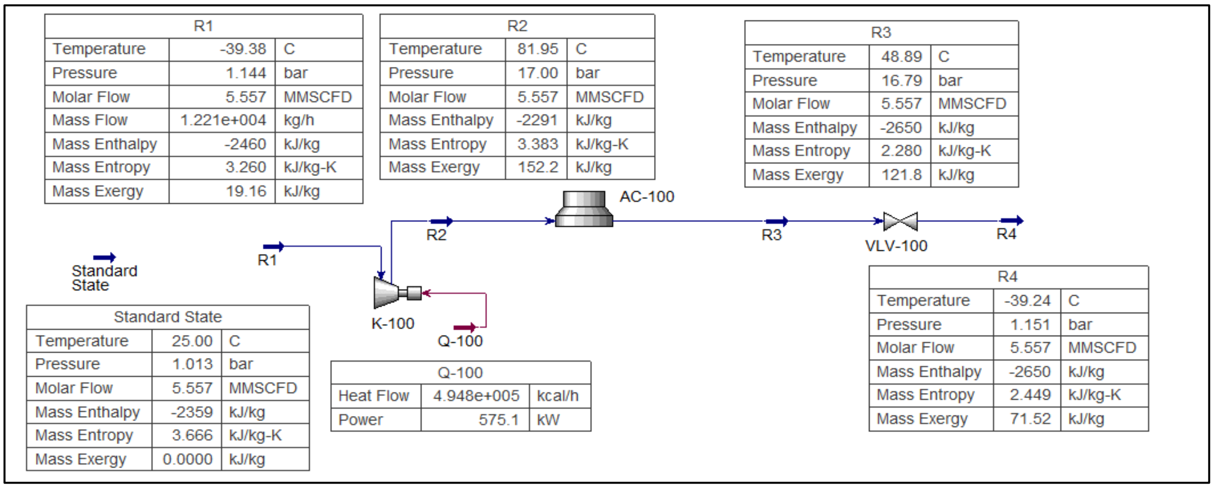

Figure 4-4 Sub-flow sheet of Propane refrigeration loop

4.3.3 Exergy of Streams

Table 4-1 Exergy of streams

State	P (bar)	T (C)	h (kJ/Kg)	s (kJ/kg.k)	Ex (kJ/kg)	Exergy KW
Standard State	1.0	25.0	-2359.0	3.7	0.0	0.0
R1	1.1	-39.4	-2460.0	3.3	20.0	67.8
R2	17.0	82.0	-2291.0	3.4	152.3	516.5
R3	16.8	48.9	-2650.0	2.3	122.0	413.7
R4	1.2	-39.2	-2650.0	2.4	71.7	243.0

Mass flow rate of refrigerant used = 12205 Kg/hr

P is the pressure, T is the temperature, h is the enthalpy, s is the entropy and Ex is the physical exergy of the stream.

Table 4-2 Exergy Analysis Results

Components	Component identifier	Exergy Destruction (KW)
Compressor	K-100	126.40
Condenser	AC-100	102.75
JT-Valve	VLV-100	170.75
Chiller	HX-100	9.86

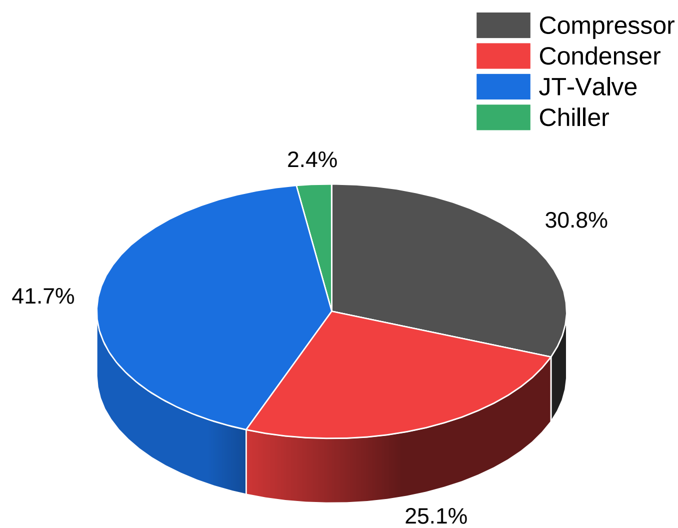

Figure 4-5 exergy destruction distribution of the components in propane refrigeration loop.

The major component of the exergy destruction in the propane refrigeration loop is the JT-valve which is 42% of the total exergy destruction, 31% in a compressor, 25% in a condenser, and 2% in a chiller.

Total Exergy Destruction = 409.75 KW

4.3.4 Exergy analysis of Mixed Refrigeration Loop

Mixed refrigeration loop contains 60% propane and 40% R-600a [88].

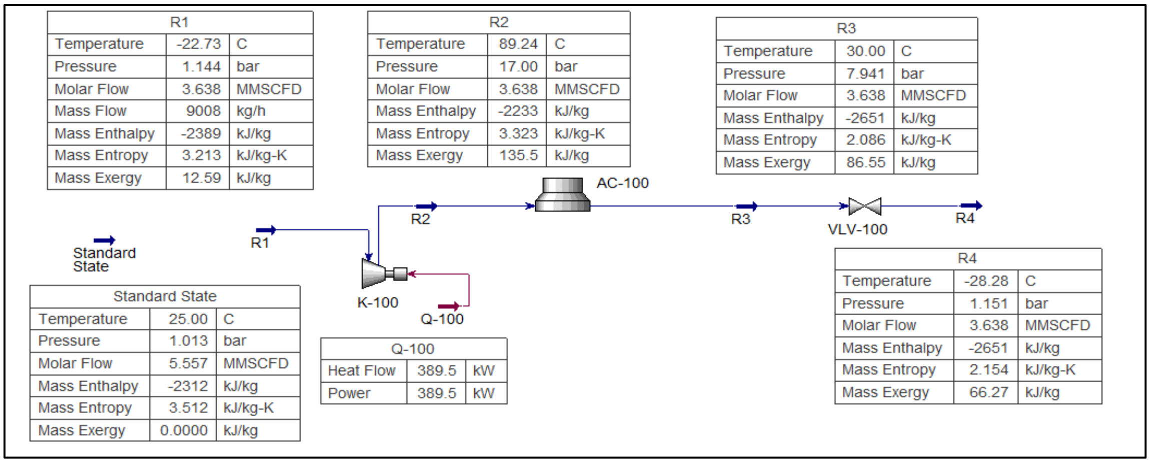

Figure 4-6 Sub-flow sheet of Mixed refrigeration loop

4.3.5 Exergy of Streams

Table 4-3 Exergy of streams

State	P (bar)	T ©	h (kJ/Kg)	s (kJ/kg.k)	ef (kJ/kg)	Exergy KW
Standard State	1.0	25.0	-2312.0	3.5	0.0	0.0
R1	1.1	-22.7	-2389.0	3.2	12.1	30.3
R2	17.0	89.2	-2233.0	3.3	135.3	338.6
R3	7.9	30.0	-2651.0	2.1	85.9	215.1
R4	1.2	-28.3	-2651.0	2.2	65.7	164.4

The mass flow rate of refrigerant used = 9008 Kg/hr

Table 4-4 Exergy analysis results of the mixed refrigeration loop

Components	Component identifier	Exergy Destruction (KW)
Compressor	K-100	81.18
Condenser	AC-100	123.54
JT-Valve	VLV-100	50.71
Chiller	HX-100	8.93

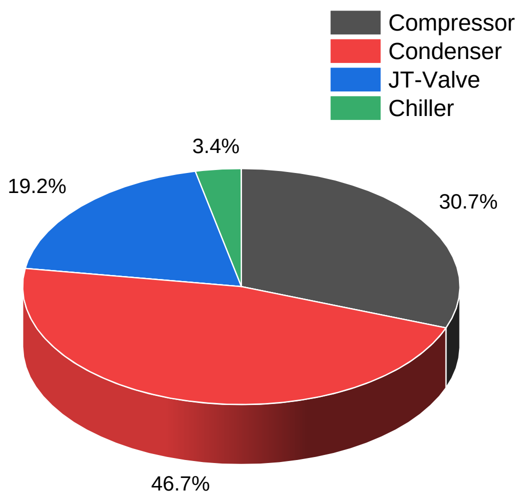

Figure 4-7 Exergy destruction distribution of the components in mixed refrigeration loop.

The major component of the exergy destruction in a mixed refrigeration loop is the condenser which is 47% of the total exergy destruction, 31% in the compressor, 19% in JT-Valve, and 3% in a chiller.

Total Exergy Destruction = 264.35 KW

The maximum exergy destruction component of the propane refrigeration loop is JT valve which is 170 KW that need to be reduced with the help of a mixed refrigeration loop. In a mixed refrigeration loop the exergy destruction of JT- Valve is 50.71 KW. The overall reduction in the exergy destruction is 145.4 KW which is 35% of total exergy.

4.4 Economic Analysis

The entire cost of the plants is directly related to the plants and equipment material for construction, cold and hot utilities, and relative plant sizes. Two kinds of expenses are linked to a plant's feasibility (i.e., from commissioning to operation). The first is stated to as the capital cost, whereas the second is stated to as the operating cost.

4.4.1 Capital Cost

The capital cost of the major parts and components needed for the process is generally estimated as a component of the equipment cost, and additional expenditures such as construction, design, installation, and starting its equipment are commonly calculated as elements of the equipment cost [89].

4.4.2 Operating Cost

To determine a project's feasibility and choose amongst possible substitute processing procedures, an estimate of operational expenses or the cost of creating the product is required. The flow diagram, which depicts the activities and feedstock requirements and the capital cost estimate, may be used to estimate these expenses.

The elements mentioned below will be included in the expenses of making a chemical product. They've been there before.

Split into two groups

1. Fixed operating costs: Expenses that are constant regardless of manufacturing rate. These are the bills that must be paid regardless of production quantity.

- Maintenance (labour and materials).
- Operating labour.
- Laboratory costs.
- Supervision.
- Plant overheads.
- Capital charges.
- Rates (and any other local taxes).
- Insurance.
- License fees and royalty payments.

2. Variable operating costs: costs that are proportional to the quantity of goods produced.

- Raw materials.
- Miscellaneous operating materials.
- Utilities (Services).
- Shipping and packaging.

4.4.3 Equipment Cost

Overall equipment cost of optimized flow sheet is 0.32% higher than the conventional due to the recycling of condensate. After the exergy analysis, the exergy destruction of propane refrigeration is reduced by the replacement of propane with mixed refrigerant which also reduces the refrigeration loop capital cost and added a profit of 87000 USD.

Table 4-5 Equipment cost for conventional and Optimized Processes

Equipment Name	Tag	Optimized Flow sheet Equipment Cost [USD]	Conventional Flow sheet Equipment Cost [USD]
	K-100	$89,900	$89,800
Three Phase Separator	V-100	$42,000	$42,000
Two Phase Separator	V-101	$47,700	$36,600
Low Temperature Separator	LTS	$47,700	$36,600
Feed/Condensate Exchanger	E-100	$9,500	$9,900
Feed/Sales gas heat exchanger	E-101	$33,000	$48,700
Deethanizer	Deethanizer	$75,300	$64,800
Debutanizer	Debutanizer	$115,600	$114,200
Debutanizer Reflux Pump	P-101	$5,500	$5,500
Reflux Accumulator	V-102	$23,800	$22,300
Condensate Pump	P-102	$107,500	$99,200
Condensate- Air Cooler	AC-103	$53,700	-
Sales gas after cooler	E-103	$10,000	$9,400
Sales gas compressor	K-101	$1,016,000	$994,500
Sales gas compressor	K-102	$587,300	$588,700
Chiller	Chiller	$30,900	$11,800
Refrigeration Compressor	K-100@TPL1	$1,035,300	$1,141,400
Glycol Knockout vessel	V-104@TPL2	$16,300	$16,300
Glycol Circulation Pump	P-100@TPL2	$74,500	$74,600
TEG Column	T-103@TPL2	$48,200	$48,200
Lean/Rich glycol Exchanger	E-105@TPL2	$8,400	$8,400
Condense Stabilizer	T-100@TPL3	$47,400	$47,400
Condensate stabilizer overhead compressor	K-102@TPL3	$1,283,800	$1,283,800
Total		$4,809,300	$4,794,100

Table 4-6 shows the results of two process flowsheet products flowrate, and the price is offered by the enterprise. The adding profit after the payback period for the optimized flowsheet is 3076 $/day.

Table 4-6 Cost and Production rate of products

Flowsheet	Sales Gas tonne/day	Sales Gas USD/tonne	LPG tonne/day	LPG USD/tonne	Condensate tonne/day	Condensate USD/tonne
Conventional	271.48	621.68	21.11	783.86	68.13	473.02
Optimized	264.82		27.69		68.23	

The capital cost of the optimized process is 2.62% higher than the conventional process, but that cost recovers in 0.58 years of project life, and after that the profit of 3076 $/day is obtained from the optimized flow sheet. The operating cost is only 3.4 % higher, which is negligible in terms of higher LPG recovery and product cost. The overall summary of both processes are shown below.

Table 4-7 Cost Summary

Description	Optimized	Conventional
Total Capital Cost [USD]	$24,700,100	$24,051,600
Total Operating Cost [USD/Year]	$3,623,300	$3,499,860
Total Product Sales [USD/Year]	$83,286,800	$82,055,700
Total Utilities Cost [USD/Year]	$1,020,960	$909,950
Equipment Cost [USD]	$4,809,300	$4,794,100
Total Installed Cost [USD]	$7,590,000	$7,337,200

Conclusion

In this work, a Focus is devoted on the Optimization of NGLs recovery processing facilities. A conventional ISS process is considered as a base case. Conventional and optimized process are fully simulated on Aspen Hysys under the same product and feedstock specifications. The optimized process contains two modifications, Recycle of gas condensate and use of mixed refrigerant instead of propane in refrigeration loop. The results of both simulations are extracted for economic analysis. The exergy analysis of refrigeration loop was also performed for propane and mixed refrigerant. Three conclusion that drawn from these simulations. Firstly, due to recycle of gas condensate the reabsorption of butane and propane increased so that the LPG recovery is enhanced up to 88.6 Bbl./day, also the better quality of sales gas obtained due to the enhanced recovery of NGLs. Secondly the capital cost of optimized process is 2.62% higher than the conventional process but that cost recover in 0.58 years of project life and after that the profit of 3076 $/day is obtained from the optimized flow sheet. The operating cost is only 3.4 % higher which is negligible in terms of higher LPG recovery and product cost. Thirdly due to the use of mixed refrigerant the overall exergy destruction is reduced up to 35% also its lower the capital cost of refrigeration loop.

Future Prospectus

Despite the immense developments and many successes, there is still a long way to go for the optimization of natural gas liquid recovery. The most of the modified process focus on the improvement in rectifying section of the demethanizer column. There is still a space for modification in stripping section. Also, a lot of research is required for the reabsorption of butane and propane in recycle gas condensate i.e., the favorable conditions for absorption, location of reinjection.

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Appendices

Appendix A: Mass & Energy balance of Conventional Simulation Diagram

Appendix B: Mass & Energy balance of Optimized Simulation Diagram

Annexure A

Mass & Energy balance of Conventional Simulation Diagram

Muhammad Usman Islamabad, Pakistan	Case Name:	Conventional-NGL Recovery Simulation.hsc
	Unit Set:	Thesis, FPS
	Date/Time:	Thu Jun 2 16:19:31 2022

Workbook: Case (Main)

Compositions

Fluid Pkg: All

Name		Condensate	Gas	Gas Condensate	LPG	Nil
Vapour Fraction		0.0000	0.9971	0.0000	0.0000	1.0000
Temperature	(F)	120.0 *	120.0 *	75.73	120.0	120.0
Pressure	(psig)	1200 *	1200 *	1197 *	230.0	230.0
Mass Flow	(tonne/d)	62.67	299.6	13.92	20.90	0.0000
Heat Flow	(MMBtu/hr)	-5.236	-48.97	-1.220	-2.130	-0.0000
Molar Flow	(MMSCFD)	0.4582	12.00 *	0.1316	0.3415	0.0000
Comp Mole Frac (CO2)		0.0000	0.0200 *	0.0000	0.0000	0.0000
Comp Mole Frac (Nitrogen)		0.0000	0.0134 *	0.0000	0.0000	0.0000
Comp Mole Frac (Methane)		0.0000	0.7834 *	0.0000	0.0000	0.0000
Comp Mole Frac (Ethane)		0.0000	0.1035 *	0.0000	0.0138	0.0444
Comp Mole Frac (Propane)		0.0000	0.0454 *	0.0001	0.5465	0.7150
Comp Mole Frac (i-Butane)		0.0000	0.0096 *	0.0005	0.1662	0.1144
Comp Mole Frac (n-Butane)		0.0000	0.0109 *	0.0015	0.1940	0.1048
Comp Mole Frac (i-Pentane)		0.0002	0.0041 *	0.0435	0.0564	0.0160
Comp Mole Frac (n-Pentane)		0.0108	0.0026 *	0.0831	0.0210	0.0049
Comp Mole Frac (n-Hexane)		0.0434	0.0021 *	0.1292	0.0000	0.0000
Comp Mole Frac (n-Heptane)		0.0367	0.0001 *	0.0341	0.0000	0.0000
Comp Mole Frac (H2O)		0.0000	0.0048 *	0.0000	0.0000	0.0000
Comp Mole Frac (EGlycol)		0.0000	0.0000 *	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]32*)		0.0000	0.0000 *	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]60*)		0.0000	0.0000 *	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]86*)		0.0000	0.0000 *	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]109*)		0.0219	0.0000 *	0.0329	0.0012	0.0002
Comp Mole Frac (NBP[0]134*)		0.1350	0.0000 *	0.2084	0.0008	0.0001
Comp Mole Frac (NBP[0]159*)		0.0718	0.0000 *	0.1012	0.0000	0.0000
Comp Mole Frac (NBP[0]184*)		0.0929	0.0000 *	0.1108	0.0000	0.0000
Comp Mole Frac (NBP[0]209*)		0.0636	0.0000 *	0.0633	0.0000	0.0000
Comp Mole Frac (NBP[0]234*)		0.0823	0.0000 *	0.0656	0.0000	0.0000
Comp Mole Frac (NBP[0]259*)		0.0779	0.0000 *	0.0483	0.0000	0.0000
Comp Mole Frac (NBP[0]284*)		0.0645	0.0000 *	0.0309	0.0000	0.0000
Comp Mole Frac (NBP[0]309*)		0.0547	0.0000 *	0.0187	0.0000	0.0000
Comp Mole Frac (NBP[0]336*)		0.0489	0.0000 *	0.0123	0.0000	0.0000
Comp Mole Frac (NBP[0]359*)		0.0364	0.0000 *	0.0065	0.0000	0.0000
Comp Mole Frac (NBP[0]384*)		0.0334	0.0000 *	0.0042	0.0000	0.0000
Comp Mole Frac (NBP[0]410*)		0.0274	0.0000 *	0.0024	0.0000	0.0000
Comp Mole Frac (NBP[0]435*)		0.0215	0.0000 *	0.0012	0.0000	0.0000
Comp Mole Frac (NBP[0]463*)		0.0194	0.0000 *	0.0007	0.0000	0.0000
Comp Mole Frac (NBP[0]486*)		0.0132	0.0000 *	0.0003	0.0000	0.0000
Comp Mole Frac (NBP[0]506*)		0.0093	0.0000 *	0.0002	0.0000	0.0000
Comp Mole Frac (NBP[0]540*)		0.0115	0.0000 *	0.0001	0.0000	0.0000
Comp Mole Frac (NBP[0]570*)		0.0083	0.0000 *	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]593*)		0.0040	0.0000 *	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]615*)		0.0029	0.0000 *	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]636*)		0.0022	0.0000 *	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]661*)		0.0018	0.0000 *	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]687*)		0.0039	0.0000 *	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]713*)		0.0002	0.0000 *	0.0000	0.0000	0.0000

* Specified by user.

Workbook: Case (Main) (continued)

Compositions (continued)

Fluid Pkg: All

Name		R-1	R-2	Remove Water	S1	S2
Vapour Fraction		1.0000 *	0.5500	1.0000	0.9016	1.0000
Temperature	(F)	-38.88	-38.62	222.4	122.3	122.3
Pressure	(psig)	1.900	2.000	5.000e-002	1200	1200
Mass Flow	(tonne/d)	216.5	216.5	0.6089	370.7	291.4
Heat Flow	(MMBtu/hr)	-21.03	-22.65	-0.3041	-59.45	-46.98
Molar Flow	(MMSCFD)	4.106	4.106	2.606e-002	12.85	11.58
Comp Mole Frac (CO2)		0.0000	0.0000	0.0468	0.0187	0.0198
Comp Mole Frac (Nitrogen)		0.0000	0.0000	0.0001	0.0126	0.0138
Comp Mole Frac (Methane)		0.0000	0.0000	0.0000	0.7317	0.7922
Comp Mole Frac (Ethane)		0.0000	0.0000	0.0000	0.0967	0.1001
Comp Mole Frac (Propane)		1.0000	1.0000	0.0000	0.0424	0.0407
Comp Mole Frac (i-Butane)		0.0000	0.0000	0.0000	0.0090	0.0078
Comp Mole Frac (n-Butane)		0.0000	0.0000	0.0000	0.0102	0.0084
Comp Mole Frac (i-Pentane)		0.0000	0.0000	0.0000	0.0038	0.0027
Comp Mole Frac (n-Pentane)		0.0000	0.0000	0.0000	0.0028	0.0018
Comp Mole Frac (n-Hexane)		0.0000	0.0000	0.0000	0.0035	0.0016
Comp Mole Frac (n-Heptane)		0.0000	0.0000	0.0000	0.0014	0.0004
Comp Mole Frac (H2O)		0.0000	0.0000	0.9459	0.0349	0.0020
Comp Mole Frac (EGlycol)		0.0000	0.0000	0.0072	0.0000	0.0000
Comp Mole Frac (NBP[0]32*)		0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]60*)		0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]86*)		0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]109*)		0.0000	0.0000	0.0000	0.0008	0.0005
Comp Mole Frac (NBP[0]134*)		0.0000	0.0000	0.0000	0.0048	0.0027
Comp Mole Frac (NBP[0]159*)		0.0000	0.0000	0.0000	0.0026	0.0013
Comp Mole Frac (NBP[0]184*)		0.0000	0.0000	0.0000	0.0033	0.0013
Comp Mole Frac (NBP[0]209*)		0.0000	0.0000	0.0000	0.0023	0.0007
Comp Mole Frac (NBP[0]234*)		0.0000	0.0000	0.0000	0.0029	0.0008
Comp Mole Frac (NBP[0]259*)		0.0000	0.0000	0.0000	0.0028	0.0006
Comp Mole Frac (NBP[0]284*)		0.0000	0.0000	0.0000	0.0023	0.0004
Comp Mole Frac (NBP[0]309*)		0.0000	0.0000	0.0000	0.0020	0.0002
Comp Mole Frac (NBP[0]336*)		0.0000	0.0000	0.0000	0.0017	0.0001
Comp Mole Frac (NBP[0]359*)		0.0000	0.0000	0.0000	0.0013	0.0001
Comp Mole Frac (NBP[0]384*)		0.0000	0.0000	0.0000	0.0012	0.0000
Comp Mole Frac (NBP[0]410*)		0.0000	0.0000	0.0000	0.0010	0.0000
Comp Mole Frac (NBP[0]435*)		0.0000	0.0000	0.0000	0.0008	0.0000
Comp Mole Frac (NBP[0]463*)		0.0000	0.0000	0.0000	0.0007	0.0000
Comp Mole Frac (NBP[0]486*)		0.0000	0.0000	0.0000	0.0005	0.0000
Comp Mole Frac (NBP[0]506*)		0.0000	0.0000	0.0000	0.0003	0.0000
Comp Mole Frac (NBP[0]540*)		0.0000	0.0000	0.0000	0.0004	0.0000
Comp Mole Frac (NBP[0]570*)		0.0000	0.0000	0.0000	0.0003	0.0000
Comp Mole Frac (NBP[0]593*)		0.0000	0.0000	0.0000	0.0001	0.0000
Comp Mole Frac (NBP[0]615*)		0.0000	0.0000	0.0000	0.0001	0.0000
Comp Mole Frac (NBP[0]636*)		0.0000	0.0000	0.0000	0.0001	0.0000
Comp Mole Frac (NBP[0]661*)		0.0000	0.0000	0.0000	0.0001	0.0000
Comp Mole Frac (NBP[0]687*)		0.0000	0.0000	0.0000	0.0001	0.0000
Comp Mole Frac (NBP[0]713*)		0.0000	0.0000	0.0000	0.0000	0.0000

* Specified by user.

Workbook: Case (Main) (continued)

Compositions (continued)

Fluid Pkg: All

Name		S3	S5	S6	S7	S8
Vapour Fraction		0.9915	0.9391	0.0000	1.0000	0.9491
Temperature	(F)	124.2	31.83	122.3	407.4	47.11
Pressure	(psig)	1200	1200	1200	1197	1197
Mass Flow	(tonne/d)	296.7	296.7	70.25	15.42	312.1
Heat Flow	(MMBtu/hr)	-48.62	-50.57	-6.777	-1.797	-52.36
Molar Flow	(MMSCFD)	11.67	11.67	0.8409	0.4410	12.11
Comp Mole Frac (CO2)		0.0197	0.0197	0.0126	0.0241	0.0199
Comp Mole Frac (Nitrogen)		0.0137	0.0137	0.0022	0.0042	0.0133
Comp Mole Frac (Methane)		0.7865	0.7865	0.2669	0.5089	0.7764
Comp Mole Frac (Ethane)		0.0993	0.0993	0.0986	0.1880	0.1026
Comp Mole Frac (Propane)		0.0404	0.0404	0.0877	0.1673	0.0450
Comp Mole Frac (i-Butane)		0.0078	0.0078	0.0293	0.0396	0.0089
Comp Mole Frac (n-Butane)		0.0084	0.0084	0.0396	0.0323	0.0092
Comp Mole Frac (i-Pentane)		0.0027	0.0027	0.0218	0.0077	0.0028
Comp Mole Frac (n-Pentane)		0.0018	0.0018	0.0180	0.0050	0.0019
Comp Mole Frac (n-Hexane)		0.0016	0.0016	0.0312	0.0031	0.0016
Comp Mole Frac (n-Heptane)		0.0004	0.0004	0.0154	0.0005	0.0004
Comp Mole Frac (H2O)		0.0034	0.0034	0.0014	0.0027	0.0034
Comp Mole Frac (EGlycol)		0.0057	0.0057	0.0000	0.0000	0.0055
Comp Mole Frac (NBP[0]32*)		0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]60*)		0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]86*)		0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]109*)		0.0005	0.0005	0.0054	0.0013	0.0005
Comp Mole Frac (NBP[0]134*)		0.0027	0.0027	0.0363	0.0066	0.0028
Comp Mole Frac (NBP[0]159*)		0.0012	0.0012	0.0218	0.0028	0.0013
Comp Mole Frac (NBP[0]184*)		0.0013	0.0013	0.0324	0.0024	0.0014
Comp Mole Frac (NBP[0]209*)		0.0007	0.0007	0.0244	0.0012	0.0008
Comp Mole Frac (NBP[0]234*)		0.0008	0.0008	0.0344	0.0010	0.0008
Comp Mole Frac (NBP[0]259*)		0.0006	0.0006	0.0348	0.0006	0.0006
Comp Mole Frac (NBP[0]284*)		0.0004	0.0004	0.0303	0.0003	0.0004
Comp Mole Frac (NBP[0]309*)		0.0002	0.0002	0.0269	0.0002	0.0002
Comp Mole Frac (NBP[0]336*)		0.0001	0.0001	0.0247	0.0001	0.0001
Comp Mole Frac (NBP[0]359*)		0.0001	0.0001	0.0188	0.0000	0.0001
Comp Mole Frac (NBP[0]384*)		0.0000	0.0000	0.0176	0.0000	0.0000
Comp Mole Frac (NBP[0]410*)		0.0000	0.0000	0.0145	0.0000	0.0000
Comp Mole Frac (NBP[0]435*)		0.0000	0.0000	0.0115	0.0000	0.0000
Comp Mole Frac (NBP[0]463*)		0.0000	0.0000	0.0105	0.0000	0.0000
Comp Mole Frac (NBP[0]486*)		0.0000	0.0000	0.0071	0.0000	0.0000
Comp Mole Frac (NBP[0]506*)		0.0000	0.0000	0.0050	0.0000	0.0000
Comp Mole Frac (NBP[0]540*)		0.0000	0.0000	0.0062	0.0000	0.0000
Comp Mole Frac (NBP[0]570*)		0.0000	0.0000	0.0045	0.0000	0.0000
Comp Mole Frac (NBP[0]593*)		0.0000	0.0000	0.0022	0.0000	0.0000
Comp Mole Frac (NBP[0]615*)		0.0000	0.0000	0.0016	0.0000	0.0000
Comp Mole Frac (NBP[0]636*)		0.0000	0.0000	0.0012	0.0000	0.0000
Comp Mole Frac (NBP[0]661*)		0.0000	0.0000	0.0010	0.0000	0.0000
Comp Mole Frac (NBP[0]687*)		0.0000	0.0000	0.0021	0.0000	0.0000
Comp Mole Frac (NBP[0]713*)		0.0000	0.0000	0.0001	0.0000	0.0000

* Specified by user.

Workbook: Case (Main) (continued)

Compositions (continued)

Fluid Pkg: All

Name		S9	S10	S11	S12	S13
Vapour Fraction		0.8073	1.0000	1.0000	0.0000	0.0000
Temperature	(F)	-10.00 *	-10.00	110.0 *	-10.00	140.3
Pressure	(psig)	1197	1197	1197	1197	1200
Mass Flow	(tonne/d)	312.1	226.8	226.8	5.922	5.315
Heat Flow	(MMBtu/hr)	-53.98	-40.45	-38.50	-2.039	-1.632
Molar Flow	(MMSCFD)	12.11	9.776	9.776	0.1096	8.349e-002
Comp Mole Frac (CO2)		0.0199	0.0192	0.0192	0.0132	0.0000
Comp Mole Frac (Nitrogen)		0.0133	0.0153	0.0153	0.0001	0.0000
Comp Mole Frac (Methane)		0.7764	0.8346	0.8346	0.0001	0.0000
Comp Mole Frac (Ethane)		0.1026	0.0893	0.0893	0.0000	0.0000
Comp Mole Frac (Propane)		0.0450	0.0297	0.0297	0.0000	0.0000
Comp Mole Frac (i-Butane)		0.0089	0.0045	0.0045	0.0000	0.0000
Comp Mole Frac (n-Butane)		0.0092	0.0041	0.0041	0.0000	0.0000
Comp Mole Frac (i-Pentane)		0.0028	0.0009	0.0009	0.0000	0.0000
Comp Mole Frac (n-Pentane)		0.0019	0.0005	0.0005	0.0000	0.0000
Comp Mole Frac (n-Hexane)		0.0016	0.0003	0.0003	0.0000	0.0000
Comp Mole Frac (n-Heptane)		0.0004	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (H2O)		0.0034	0.0000	0.0000	0.3770	0.2000
Comp Mole Frac (EGlycol)		0.0055	0.0000	0.0000	0.6096	0.8000
Comp Mole Frac (NBP[0]32*)		0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]60*)		0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]86*)		0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]109*)		0.0005	0.0001	0.0001	0.0000	0.0000
Comp Mole Frac (NBP[0]134*)		0.0028	0.0006	0.0006	0.0000	0.0000
Comp Mole Frac (NBP[0]159*)		0.0013	0.0002	0.0002	0.0000	0.0000
Comp Mole Frac (NBP[0]184*)		0.0014	0.0002	0.0002	0.0000	0.0000
Comp Mole Frac (NBP[0]209*)		0.0008	0.0001	0.0001	0.0000	0.0000
Comp Mole Frac (NBP[0]234*)		0.0008	0.0001	0.0001	0.0000	0.0000
Comp Mole Frac (NBP[0]259*)		0.0006	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]284*)		0.0004	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]309*)		0.0002	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]336*)		0.0001	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]359*)		0.0001	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]384*)		0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]410*)		0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]435*)		0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]463*)		0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]486*)		0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]506*)		0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]540*)		0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]570*)		0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]593*)		0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]615*)		0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]636*)		0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]661*)		0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]687*)		0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]713*)		0.0000	0.0000	0.0000	0.0000	0.0000

* Specified by user.

Workbook: Case (Main) (continued)

Compositions (continued)

Fluid Pkg: All

Name		S14	S15	S16	S17	S18
Vapour Fraction		0.0000	0.3137	0.5678	1.0000	1.0000
Temperature	(F)	-10.00	25.00 *	-24.92	0.4174	160.4
Pressure	(psig)	1197	1192	395.0	390.0	1197 *
Mass Flow	(tonne/d)	79.36	79.36	79.36	44.56	44.56
Heat Flow	(MMBtu/hr)	-11.49	-11.24	-11.27	-7.453	-7.211
Molar Flow	(MMSCFD)	2.224	2.224	2.224	1.750	1.750
Comp Mole Frac (CO2)		0.0230	0.0230	0.0230	0.0292	0.0292
Comp Mole Frac (Nitrogen)		0.0052	0.0052	0.0052	0.0066	0.0066
Comp Mole Frac (Methane)		0.5586	0.5586	0.5586	0.7096	0.7096
Comp Mole Frac (Ethane)		0.1658	0.1658	0.1658	0.2079	0.2079
Comp Mole Frac (Propane)		0.1145	0.1145	0.1145	0.0386	0.0386
Comp Mole Frac (i-Butane)		0.0287	0.0287	0.0287	0.0039	0.0039
Comp Mole Frac (n-Butane)		0.0323	0.0323	0.0323	0.0030	0.0030
Comp Mole Frac (i-Pentane)		0.0115	0.0115	0.0115	0.0004	0.0004
Comp Mole Frac (n-Pentane)		0.0082	0.0082	0.0082	0.0002	0.0002
Comp Mole Frac (n-Hexane)		0.0077	0.0077	0.0077	0.0001	0.0001
Comp Mole Frac (n-Heptane)		0.0020	0.0020	0.0020	0.0000	0.0000
Comp Mole Frac (H2O)		0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (EGlycol)		0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]32*)		0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]60*)		0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]86*)		0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]109*)		0.0022	0.0022	0.0022	0.0000	0.0000
Comp Mole Frac (NBP[0]134*)		0.0126	0.0126	0.0126	0.0002	0.0002
Comp Mole Frac (NBP[0]159*)		0.0060	0.0060	0.0060	0.0001	0.0001
Comp Mole Frac (NBP[0]184*)		0.0065	0.0065	0.0065	0.0000	0.0000
Comp Mole Frac (NBP[0]209*)		0.0038	0.0038	0.0038	0.0000	0.0000
Comp Mole Frac (NBP[0]234*)		0.0039	0.0039	0.0039	0.0000	0.0000
Comp Mole Frac (NBP[0]259*)		0.0029	0.0029	0.0029	0.0000	0.0000
Comp Mole Frac (NBP[0]284*)		0.0018	0.0018	0.0018	0.0000	0.0000
Comp Mole Frac (NBP[0]309*)		0.0011	0.0011	0.0011	0.0000	0.0000
Comp Mole Frac (NBP[0]336*)		0.0007	0.0007	0.0007	0.0000	0.0000
Comp Mole Frac (NBP[0]359*)		0.0004	0.0004	0.0004	0.0000	0.0000
Comp Mole Frac (NBP[0]384*)		0.0002	0.0002	0.0002	0.0000	0.0000
Comp Mole Frac (NBP[0]410*)		0.0001	0.0001	0.0001	0.0000	0.0000
Comp Mole Frac (NBP[0]435*)		0.0001	0.0001	0.0001	0.0000	0.0000
Comp Mole Frac (NBP[0]463*)		0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]486*)		0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]506*)		0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]540*)		0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]570*)		0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]593*)		0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]615*)		0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]636*)		0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]661*)		0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]687*)		0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]713*)		0.0000	0.0000	0.0000	0.0000	0.0000

* Specified by user.

Workbook: Case (Main) (continued)

Compositions (continued)

Fluid Pkg: All

Name		S19	S20	S21	S22	S23
Vapour Fraction		1.0000	0.0000	1.0000	0.0000	0.0000
Temperature	(F)	120.0 *	251.4	181.3	120.0 *	120.0
Pressure	(psig)	1197	400.0	230.0	230.0	230.0
Mass Flow	(tonne/d)	44.56	34.80	112.7	112.7	112.7
Heat Flow	(MMBtu/hr)	-7.317	-3.042	-9.894	-11.49	-11.49
Molar Flow	(MMSCFD)	1.750	0.4731	1.841	1.841	1.841
Comp Mole Frac (CO2)		0.0292	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (Nitrogen)		0.0066	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (Methane)		0.7096	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (Ethane)		0.2079	0.0100	0.0138	0.0138	0.0138
Comp Mole Frac (Propane)		0.0386	0.3950	0.5465	0.5465	0.5465
Comp Mole Frac (i-Butane)		0.0039	0.1202	0.1662	0.1662	0.1662
Comp Mole Frac (n-Butane)		0.0030	0.1407	0.1940	0.1940	0.1940
Comp Mole Frac (i-Pentane)		0.0004	0.0525	0.0564	0.0564	0.0564
Comp Mole Frac (n-Pentane)		0.0002	0.0379	0.0210	0.0210	0.0210
Comp Mole Frac (n-Hexane)		0.0001	0.0360	0.0000	0.0000	0.0000
Comp Mole Frac (n-Heptane)		0.0000	0.0095	0.0000	0.0000	0.0000
Comp Mole Frac (H2O)		0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (EGlycol)		0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]32*)		0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]60*)		0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]86*)		0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]109*)		0.0000	0.0100	0.0012	0.0012	0.0012
Comp Mole Frac (NBP[0]134*)		0.0002	0.0586	0.0008	0.0008	0.0008
Comp Mole Frac (NBP[0]159*)		0.0001	0.0282	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]184*)		0.0000	0.0306	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]209*)		0.0000	0.0176	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]234*)		0.0000	0.0182	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]259*)		0.0000	0.0134	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]284*)		0.0000	0.0086	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]309*)		0.0000	0.0052	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]336*)		0.0000	0.0034	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]359*)		0.0000	0.0018	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]384*)		0.0000	0.0012	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]410*)		0.0000	0.0007	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]435*)		0.0000	0.0003	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]463*)		0.0000	0.0002	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]486*)		0.0000	0.0001	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]506*)		0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]540*)		0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]570*)		0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]593*)		0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]615*)		0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]636*)		0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]661*)		0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]687*)		0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]713*)		0.0000	0.0000	0.0000	0.0000	0.0000

* Specified by user.

Workbook: Case (Main) (continued)

Compositions (continued)

Fluid Pkg: All

Name		S24	S25	S26	S27	S28
Vapour Fraction		---	0.0000	0.0000	0.0000	0.0000
Temperature	(F)	---	120.0	120.0	120.0 *	388.9
Pressure	(psig)	230.0 *	230.0	230.0 *	230.0 *	235.0
Mass Flow	(tonne/d)	112.7	91.79	91.79	91.80	13.92
Heat Flow	(MMBtu/hr)	-11.49	-9.358	-9.358	-9.359	-0.9751
Molar Flow	(MMSCFD)	1.841	1.500 *	1.500	1.500 *	0.1316
Comp Mole Frac (CO2)		0.0000	0.0000	0.0000	0.0000 *	0.0000
Comp Mole Frac (Nitrogen)		0.0000	0.0000	0.0000	0.0000 *	0.0000
Comp Mole Frac (Methane)		0.0000	0.0000	0.0000	0.0000 *	0.0000
Comp Mole Frac (Ethane)		0.0138	0.0138	0.0138	0.0138 *	0.0000
Comp Mole Frac (Propane)		0.5465	0.5465	0.5465	0.5464 *	0.0001
Comp Mole Frac (i-Butane)		0.1662	0.1662	0.1662	0.1662 *	0.0005
Comp Mole Frac (n-Butane)		0.1940	0.1940	0.1940	0.1940 *	0.0015
Comp Mole Frac (i-Pentane)		0.0564	0.0564	0.0564	0.0565 *	0.0435
Comp Mole Frac (n-Pentane)		0.0210	0.0210	0.0210	0.0212 *	0.0831
Comp Mole Frac (n-Hexane)		0.0000	0.0000	0.0000	0.0000 *	0.1292
Comp Mole Frac (n-Heptane)		0.0000	0.0000	0.0000	0.0000 *	0.0341
Comp Mole Frac (H2O)		0.0000	0.0000	0.0000	0.0000 *	0.0000
Comp Mole Frac (EGlycol)		0.0000	0.0000	0.0000	0.0000 *	0.0000
Comp Mole Frac (NBP[0]32*)		0.0000	0.0000	0.0000	0.0000 *	0.0000
Comp Mole Frac (NBP[0]60*)		0.0000	0.0000	0.0000	0.0000 *	0.0000
Comp Mole Frac (NBP[0]86*)		0.0000	0.0000	0.0000	0.0000 *	0.0000
Comp Mole Frac (NBP[0]109*)		0.0012	0.0012	0.0012	0.0012 *	0.0329
Comp Mole Frac (NBP[0]134*)		0.0008	0.0008	0.0008	0.0008 *	0.2084
Comp Mole Frac (NBP[0]159*)		0.0000	0.0000	0.0000	0.0000 *	0.1012
Comp Mole Frac (NBP[0]184*)		0.0000	0.0000	0.0000	0.0001 *	0.1108
Comp Mole Frac (NBP[0]209*)		0.0000	0.0000	0.0000	0.0000 *	0.0633
Comp Mole Frac (NBP[0]234*)		0.0000	0.0000	0.0000	0.0000 *	0.0656
Comp Mole Frac (NBP[0]259*)		0.0000	0.0000	0.0000	0.0000 *	0.0483
Comp Mole Frac (NBP[0]284*)		0.0000	0.0000	0.0000	0.0000 *	0.0309
Comp Mole Frac (NBP[0]309*)		0.0000	0.0000	0.0000	0.0000 *	0.0187
Comp Mole Frac (NBP[0]336*)		0.0000	0.0000	0.0000	0.0000 *	0.0123
Comp Mole Frac (NBP[0]359*)		0.0000	0.0000	0.0000	0.0000 *	0.0065
Comp Mole Frac (NBP[0]384*)		0.0000	0.0000	0.0000	0.0000 *	0.0042
Comp Mole Frac (NBP[0]410*)		0.0000	0.0000	0.0000	0.0000 *	0.0024
Comp Mole Frac (NBP[0]435*)		0.0000	0.0000	0.0000	0.0000 *	0.0012
Comp Mole Frac (NBP[0]463*)		0.0000	0.0000	0.0000	0.0000 *	0.0007
Comp Mole Frac (NBP[0]486*)		0.0000	0.0000	0.0000	0.0000 *	0.0003
Comp Mole Frac (NBP[0]506*)		0.0000	0.0000	0.0000	0.0000 *	0.0002
Comp Mole Frac (NBP[0]540*)		0.0000	0.0000	0.0000	0.0000 *	0.0001
Comp Mole Frac (NBP[0]570*)		0.0000	0.0000	0.0000	0.0000 *	0.0000
Comp Mole Frac (NBP[0]593*)		0.0000	0.0000	0.0000	0.0000 *	0.0000
Comp Mole Frac (NBP[0]615*)		0.0000	0.0000	0.0000	0.0000 *	0.0000
Comp Mole Frac (NBP[0]636*)		0.0000	0.0000	0.0000	0.0000 *	0.0000
Comp Mole Frac (NBP[0]661*)		0.0000	0.0000	0.0000	0.0000 *	0.0000
Comp Mole Frac (NBP[0]687*)		0.0000	0.0000	0.0000	0.0000 *	0.0000
Comp Mole Frac (NBP[0]713*)		0.0000	0.0000	0.0000	0.0000 *	0.0000

* Specified by user.

Workbook: Case (Main) (continued)

Compositions (continued)

Fluid Pkg: All

Name		S29	S30	S31	S32	S33
Vapour Fraction		0.0000	1.0000	0.0000	0.4234	0.8867
Temperature	(F)	70.33	25.00	25.00	-15.76	-53.82
Pressure	(psig)	230.0	1192	1192	395.0 *	395.0 *
Mass Flow	(tonne/d)	13.92	17.09	62.27	62.27	17.09
Heat Flow	(MMBtu/hr)	-1.227	-2.938	-8.299	-8.299	-2.974
Molar Flow	(MMSCFD)	0.1316	0.6975	1.526	1.526	0.6975
Comp Mole Frac (CO2)		0.0000	0.0228	0.0231	0.0231	0.0228
Comp Mole Frac (Nitrogen)		0.0000	0.0102	0.0029	0.0029	0.0102
Comp Mole Frac (Methane)		0.0000	0.7893	0.4531	0.4531	0.7893
Comp Mole Frac (Ethane)		0.0000	0.1166	0.1883	0.1883	0.1166
Comp Mole Frac (Propane)		0.0001	0.0432	0.1470	0.1470	0.0432
Comp Mole Frac (i-Butane)		0.0005	0.0068	0.0386	0.0386	0.0068
Comp Mole Frac (n-Butane)		0.0015	0.0063	0.0442	0.0442	0.0063
Comp Mole Frac (i-Pentane)		0.0435	0.0014	0.0161	0.0161	0.0014
Comp Mole Frac (n-Pentane)		0.0831	0.0008	0.0116	0.0116	0.0008
Comp Mole Frac (n-Hexane)		0.1292	0.0004	0.0110	0.0110	0.0004
Comp Mole Frac (n-Heptane)		0.0341	0.0001	0.0029	0.0029	0.0001
Comp Mole Frac (H2O)		0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (EGlycol)		0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]32*)		0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]60*)		0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]86*)		0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]109*)		0.0329	0.0002	0.0031	0.0031	0.0002
Comp Mole Frac (NBP[0]134*)		0.2084	0.0010	0.0180	0.0180	0.0010
Comp Mole Frac (NBP[0]159*)		0.1012	0.0004	0.0086	0.0086	0.0004
Comp Mole Frac (NBP[0]184*)		0.1108	0.0003	0.0094	0.0094	0.0003
Comp Mole Frac (NBP[0]209*)		0.0633	0.0001	0.0054	0.0054	0.0001
Comp Mole Frac (NBP[0]234*)		0.0656	0.0001	0.0056	0.0056	0.0001
Comp Mole Frac (NBP[0]259*)		0.0483	0.0001	0.0041	0.0041	0.0001
Comp Mole Frac (NBP[0]284*)		0.0309	0.0000	0.0027	0.0027	0.0000
Comp Mole Frac (NBP[0]309*)		0.0187	0.0000	0.0016	0.0016	0.0000
Comp Mole Frac (NBP[0]336*)		0.0123	0.0000	0.0011	0.0011	0.0000
Comp Mole Frac (NBP[0]359*)		0.0065	0.0000	0.0006	0.0006	0.0000
Comp Mole Frac (NBP[0]384*)		0.0042	0.0000	0.0004	0.0004	0.0000
Comp Mole Frac (NBP[0]410*)		0.0024	0.0000	0.0002	0.0002	0.0000
Comp Mole Frac (NBP[0]435*)		0.0012	0.0000	0.0001	0.0001	0.0000
Comp Mole Frac (NBP[0]463*)		0.0007	0.0000	0.0001	0.0001	0.0000
Comp Mole Frac (NBP[0]486*)		0.0003	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]506*)		0.0002	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]540*)		0.0001	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]570*)		0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]593*)		0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]615*)		0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]636*)		0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]661*)		0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]687*)		0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]713*)		0.0000	0.0000	0.0000	0.0000	0.0000

* Specified by user.

Workbook: Case (Main) (continued)

Compositions (continued)

Fluid Pkg: All

Name		S34	Sales Gas	Stablized Condensate	Water	Well Water
Vapour Fraction		1.0000	1.0000	0.0000	0.0000	0.0000
Temperature	(F)	25.07	111.5	335.6	120.0 *	122.3
Pressure	(psig)	469.9	1197	100.0	1200 *	1200
Mass Flow	(tonne/d)	44.56	271.4	54.83	8.414	9.131
Heat Flow	(MMBtu/hr)	-7.417	-45.82	-4.018	-5.243	-5.685
Molar Flow	(MMSCFD)	1.750	11.53	0.3999	0.3907	0.4238
Comp Mole Frac (CO2)		0.0292	0.0207	0.0000	0.0000 *	0.0003
Comp Mole Frac (Nitrogen)		0.0066	0.0140	0.0000	0.0000 *	0.0000
Comp Mole Frac (Methane)		0.7096	0.8156	0.0000	0.0000 *	0.0000
Comp Mole Frac (Ethane)		0.2079	0.1074	0.0000	0.0000 *	0.0000
Comp Mole Frac (Propane)		0.0386	0.0311	0.0000	0.0000 *	0.0000
Comp Mole Frac (i-Butane)		0.0039	0.0044	0.0179	0.0000 *	0.0000
Comp Mole Frac (n-Butane)		0.0030	0.0039	0.0476	0.0000 *	0.0000
Comp Mole Frac (i-Pentane)		0.0004	0.0008	0.0373	0.0000 *	0.0000
Comp Mole Frac (n-Pentane)		0.0002	0.0005	0.0323	0.0000 *	0.0000
Comp Mole Frac (n-Hexane)		0.0001	0.0002	0.0622	0.0000 *	0.0000
Comp Mole Frac (n-Heptane)		0.0000	0.0000	0.0318	0.0000 *	0.0000
Comp Mole Frac (H2O)		0.0000	0.0000	0.0000	1.0000 *	0.9997
Comp Mole Frac (EGlycol)		0.0000	0.0000	0.0000	0.0000 *	0.0000
Comp Mole Frac (NBP[0]32*)		0.0000	0.0000	0.0000	0.0000 *	0.0000
Comp Mole Frac (NBP[0]60*)		0.0000	0.0000	0.0000	0.0000 *	0.0000
Comp Mole Frac (NBP[0]86*)		0.0000	0.0000	0.0000	0.0000 *	0.0000
Comp Mole Frac (NBP[0]109*)		0.0000	0.0001	0.0099	0.0000 *	0.0000
Comp Mole Frac (NBP[0]134*)		0.0002	0.0006	0.0691	0.0000 *	0.0000
Comp Mole Frac (NBP[0]159*)		0.0001	0.0002	0.0427	0.0000 *	0.0000
Comp Mole Frac (NBP[0]184*)		0.0000	0.0002	0.0655	0.0000 *	0.0000
Comp Mole Frac (NBP[0]209*)		0.0000	0.0001	0.0500	0.0000 *	0.0000
Comp Mole Frac (NBP[0]234*)		0.0000	0.0001	0.0711	0.0000 *	0.0000
Comp Mole Frac (NBP[0]259*)		0.0000	0.0000	0.0725	0.0000 *	0.0000
Comp Mole Frac (NBP[0]284*)		0.0000	0.0000	0.0633	0.0000 *	0.0000
Comp Mole Frac (NBP[0]309*)		0.0000	0.0000	0.0564	0.0000 *	0.0000
Comp Mole Frac (NBP[0]336*)		0.0000	0.0000	0.0519	0.0000 *	0.0000
Comp Mole Frac (NBP[0]359*)		0.0000	0.0000	0.0395	0.0000 *	0.0000
Comp Mole Frac (NBP[0]384*)		0.0000	0.0000	0.0369	0.0000 *	0.0000
Comp Mole Frac (NBP[0]410*)		0.0000	0.0000	0.0306	0.0000 *	0.0000
Comp Mole Frac (NBP[0]435*)		0.0000	0.0000	0.0242	0.0000 *	0.0000
Comp Mole Frac (NBP[0]463*)		0.0000	0.0000	0.0220	0.0000 *	0.0000
Comp Mole Frac (NBP[0]486*)		0.0000	0.0000	0.0150	0.0000 *	0.0000
Comp Mole Frac (NBP[0]506*)		0.0000	0.0000	0.0106	0.0000 *	0.0000
Comp Mole Frac (NBP[0]540*)		0.0000	0.0000	0.0131	0.0000 *	0.0000
Comp Mole Frac (NBP[0]570*)		0.0000	0.0000	0.0095	0.0000 *	0.0000
Comp Mole Frac (NBP[0]593*)		0.0000	0.0000	0.0045	0.0000 *	0.0000
Comp Mole Frac (NBP[0]615*)		0.0000	0.0000	0.0034	0.0000 *	0.0000
Comp Mole Frac (NBP[0]636*)		0.0000	0.0000	0.0025	0.0000 *	0.0000
Comp Mole Frac (NBP[0]661*)		0.0000	0.0000	0.0021	0.0000 *	0.0000
Comp Mole Frac (NBP[0]687*)		0.0000	0.0000	0.0045	0.0000 *	0.0000
Comp Mole Frac (NBP[0]713*)		0.0000	0.0000	0.0002	0.0000 *	0.0000

Energy Streams

Fluid Pkg: All

Name		Q-Ethanizer-Reb	Q-102	Q-103	Q-Propanizer-Rebolier	Q-108
Heat Flow	(MMBtu/hr)	0.7783	0.2062	0.1063	1.532	0.0000

* Specified by user.

Workbook: Case (Main) (continued)

Energy Streams (continued)

Fluid Pkg: All

Name		Q-101	Q-100			
Heat Flow	(MMBtu/hr)	7.030e-003	3.557e-002			

* Specified by user.

Annexure B

Mass & Energy balance of Optimized Simulation Diagram

Workbook: Case (Main)

Compositions

Fluid Pkg: All

Name		Condensate	Gas	Gas Condensate	LPG	Nil
Vapour Fraction		0.0000	0.9971	0.0000	0.0000	1.0000
Temperature	(F)	120.0 *	120.0 *	126.0	120.0	120.0
Pressure	(psig)	1200 *	1200 *	1197	230.0	230.0
Mass Flow	(tonne/d)	62.24	299.6	13.93	28.47	0.0000
Heat Flow	(MMBtu/hr)	-5.200	-48.97	-1.186	-2.911	-0.0000
Molar Flow	(MMSCFD)	0.4633	12.00 *	0.1314	0.4722	0.0000
Comp Mole Frac (CO2)		0.0000	0.0200 *	0.0000	0.0000	0.0000
Comp Mole Frac (Nitrogen)		0.0000	0.0134 *	0.0000	0.0000	0.0000
Comp Mole Frac (Methane)		0.0000	0.7834 *	0.0000	0.0000	0.0000
Comp Mole Frac (Ethane)		0.0000	0.1035 *	0.0000	0.0203	0.0627
Comp Mole Frac (Propane)		0.0000	0.0454 *	0.0003	0.5752	0.7229
Comp Mole Frac (i-Butane)		0.0000	0.0096 *	0.0012	0.1589	0.1048
Comp Mole Frac (n-Butane)		0.0000	0.0109 *	0.0034	0.1783	0.0924
Comp Mole Frac (i-Pentane)		0.0002	0.0041 *	0.0430	0.0461	0.0125
Comp Mole Frac (n-Pentane)		0.0099	0.0026 *	0.0721	0.0182	0.0041
Comp Mole Frac (n-Hexane)		0.0398	0.0021 *	0.1203	0.0000	0.0000
Comp Mole Frac (n-Heptane)		0.0337	0.0001 *	0.0315	0.0000	0.0000
Comp Mole Frac (H2O)		0.0000	0.0048 *	0.0000	0.0000	0.0000
Comp Mole Frac (EGlycol)		0.0000	0.0000 *	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]32*)		0.0000	0.0000 *	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]60*)		0.0000	0.0000 *	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]86*)		0.0002	0.0000 *	0.0001	0.0001	0.0000
Comp Mole Frac (NBP[0]109*)		0.0299	0.0000 *	0.0405	0.0019	0.0004
Comp Mole Frac (NBP[0]134*)		0.1237	0.0000 *	0.1779	0.0010	0.0002
Comp Mole Frac (NBP[0]159*)		0.1052	0.0000 *	0.1418	0.0000	0.0000
Comp Mole Frac (NBP[0]184*)		0.0855	0.0000 *	0.0994	0.0000	0.0000
Comp Mole Frac (NBP[0]209*)		0.0858	0.0000 *	0.0852	0.0000	0.0000
Comp Mole Frac (NBP[0]234*)		0.0816	0.0000 *	0.0655	0.0000	0.0000
Comp Mole Frac (NBP[0]259*)		0.0714	0.0000 *	0.0449	0.0000	0.0000
Comp Mole Frac (NBP[0]284*)		0.0591	0.0000 *	0.0289	0.0000	0.0000
Comp Mole Frac (NBP[0]309*)		0.0501	0.0000 *	0.0176	0.0000	0.0000
Comp Mole Frac (NBP[0]336*)		0.0448	0.0000 *	0.0116	0.0000	0.0000
Comp Mole Frac (NBP[0]359*)		0.0333	0.0000 *	0.0061	0.0000	0.0000
Comp Mole Frac (NBP[0]384*)		0.0306	0.0000 *	0.0039	0.0000	0.0000
Comp Mole Frac (NBP[0]410*)		0.0251	0.0000 *	0.0023	0.0000	0.0000
Comp Mole Frac (NBP[0]435*)		0.0197	0.0000 *	0.0011	0.0000	0.0000
Comp Mole Frac (NBP[0]463*)		0.0178	0.0000 *	0.0007	0.0000	0.0000
Comp Mole Frac (NBP[0]486*)		0.0121	0.0000 *	0.0003	0.0000	0.0000
Comp Mole Frac (NBP[0]506*)		0.0085	0.0000 *	0.0001	0.0000	0.0000
Comp Mole Frac (NBP[0]540*)		0.0105	0.0000 *	0.0001	0.0000	0.0000
Comp Mole Frac (NBP[0]570*)		0.0076	0.0000 *	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]593*)		0.0036	0.0000 *	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]615*)		0.0027	0.0000 *	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]636*)		0.0020	0.0000 *	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]661*)		0.0017	0.0000 *	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]687*)		0.0036	0.0000 *	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]713*)		0.0002	0.0000 *	0.0000	0.0000	0.0000
Comp Mole Frac (Refrig-600a)		0.0000	0.0000 *	0.0000	0.0000	0.0000

* Specified by user.

Workbook: Case (Main) (continued)

Compositions (continued)

Fluid Pkg: All

Name		R-1	R-2	Remove Water	S1	S2
Vapour Fraction		1.0000 *	0.3653	1.0000	0.9016	1.0000
Temperature	(F)	-8.909	-18.90	222.5	122.1	122.1
Pressure	(psig)	1.900	2.000	5.000e-002	1200	1200
Mass Flow	(tonne/d)	216.6	216.6	0.6048	370.3	292.1
Heat Flow	(MMBtu/hr)	-20.43	-22.67	-0.3022	-59.41	-47.04
Molar Flow	(MMSCFD)	3.645	3.645	2.591e-002	12.85	11.59
Comp Mole Frac (CO2)		0.0000	0.0000	0.0461	0.0187	0.0198
Comp Mole Frac (Nitrogen)		0.0000	0.0000	0.0001	0.0125	0.0138
Comp Mole Frac (Methane)		0.0000	0.0000	0.0000	0.7314	0.7917
Comp Mole Frac (Ethane)		0.0000	0.0000	0.0000	0.0966	0.1000
Comp Mole Frac (Propane)		0.6000	0.6000	0.0000	0.0424	0.0407
Comp Mole Frac (i-Butane)		0.0000	0.0000	0.0000	0.0090	0.0078
Comp Mole Frac (n-Butane)		0.0000	0.0000	0.0000	0.0102	0.0084
Comp Mole Frac (i-Pentane)		0.0000	0.0000	0.0000	0.0038	0.0027
Comp Mole Frac (n-Pentane)		0.0000	0.0000	0.0000	0.0028	0.0018
Comp Mole Frac (n-Hexane)		0.0000	0.0000	0.0000	0.0034	0.0015
Comp Mole Frac (n-Heptane)		0.0000	0.0000	0.0000	0.0013	0.0004
Comp Mole Frac (H2O)		0.0000	0.0000	0.9466	0.0349	0.0020
Comp Mole Frac (EGlycol)		0.0000	0.0000	0.0072	0.0000	0.0000
Comp Mole Frac (NBP[0]32*)		0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]60*)		0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]86*)		0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]109*)		0.0000	0.0000	0.0000	0.0011	0.0007
Comp Mole Frac (NBP[0]134*)		0.0000	0.0000	0.0000	0.0045	0.0025
Comp Mole Frac (NBP[0]159*)		0.0000	0.0000	0.0000	0.0038	0.0019
Comp Mole Frac (NBP[0]184*)		0.0000	0.0000	0.0000	0.0031	0.0012
Comp Mole Frac (NBP[0]209*)		0.0000	0.0000	0.0000	0.0031	0.0010
Comp Mole Frac (NBP[0]234*)		0.0000	0.0000	0.0000	0.0029	0.0008
Comp Mole Frac (NBP[0]259*)		0.0000	0.0000	0.0000	0.0026	0.0005
Comp Mole Frac (NBP[0]284*)		0.0000	0.0000	0.0000	0.0021	0.0003
Comp Mole Frac (NBP[0]309*)		0.0000	0.0000	0.0000	0.0018	0.0002
Comp Mole Frac (NBP[0]336*)		0.0000	0.0000	0.0000	0.0016	0.0001
Comp Mole Frac (NBP[0]359*)		0.0000	0.0000	0.0000	0.0012	0.0001
Comp Mole Frac (NBP[0]384*)		0.0000	0.0000	0.0000	0.0011	0.0000
Comp Mole Frac (NBP[0]410*)		0.0000	0.0000	0.0000	0.0009	0.0000
Comp Mole Frac (NBP[0]435*)		0.0000	0.0000	0.0000	0.0007	0.0000
Comp Mole Frac (NBP[0]463*)		0.0000	0.0000	0.0000	0.0006	0.0000
Comp Mole Frac (NBP[0]486*)		0.0000	0.0000	0.0000	0.0004	0.0000
Comp Mole Frac (NBP[0]506*)		0.0000	0.0000	0.0000	0.0003	0.0000
Comp Mole Frac (NBP[0]540*)		0.0000	0.0000	0.0000	0.0004	0.0000
Comp Mole Frac (NBP[0]570*)		0.0000	0.0000	0.0000	0.0003	0.0000
Comp Mole Frac (NBP[0]593*)		0.0000	0.0000	0.0000	0.0001	0.0000
Comp Mole Frac (NBP[0]615*)		0.0000	0.0000	0.0000	0.0001	0.0000
Comp Mole Frac (NBP[0]636*)		0.0000	0.0000	0.0000	0.0001	0.0000
Comp Mole Frac (NBP[0]661*)		0.0000	0.0000	0.0000	0.0001	0.0000
Comp Mole Frac (NBP[0]687*)		0.0000	0.0000	0.0000	0.0001	0.0000
Comp Mole Frac (NBP[0]713*)		0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (Refrig-600a)		0.4000	0.4000	0.0000	0.0000	0.0000

* Specified by user.

Workbook: Case (Main) (continued)

Compositions (continued)

Fluid Pkg: All

Name		S3	S4	S5	S6	S7
Vapour Fraction		0.9915	0.9450	0.8758	0.0000	1.0000
Temperature	(F)	124.0	124.2	54.54	122.1	406.2
Pressure	(psig)	1200	1197	1197	1200	1197
Mass Flow	(tonne/d)	297.4	335.2	335.2	69.09	15.62
Heat Flow	(MMBtu/hr)	-48.66	-51.88	-53.56	-6.685	-1.815
Molar Flow	(MMSCFD)	11.67	12.03	12.03	0.8404	0.4448
Comp Mole Frac (CO2)		0.0197	0.0191	0.0191	0.0127	0.0239
Comp Mole Frac (Nitrogen)		0.0137	0.0133	0.0133	0.0022	0.0042
Comp Mole Frac (Methane)		0.7860	0.7627	0.7627	0.2689	0.5080
Comp Mole Frac (Ethane)		0.0993	0.0963	0.0963	0.0990	0.1871
Comp Mole Frac (Propane)		0.0404	0.0392	0.0392	0.0879	0.1661
Comp Mole Frac (i-Butane)		0.0078	0.0076	0.0076	0.0293	0.0409
Comp Mole Frac (n-Butane)		0.0084	0.0082	0.0082	0.0396	0.0331
Comp Mole Frac (i-Pentane)		0.0027	0.0038	0.0038	0.0217	0.0077
Comp Mole Frac (n-Pentane)		0.0018	0.0039	0.0039	0.0178	0.0050
Comp Mole Frac (n-Hexane)		0.0015	0.0051	0.0051	0.0301	0.0030
Comp Mole Frac (n-Heptane)		0.0004	0.0013	0.0013	0.0143	0.0005
Comp Mole Frac (H2O)		0.0034	0.0033	0.0033	0.0014	0.0027
Comp Mole Frac (EGlycol)		0.0057	0.0055	0.0055	0.0000	0.0000
Comp Mole Frac (NBP[0]32*)		0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]60*)		0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]86*)		0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]109*)		0.0007	0.0018	0.0018	0.0074	0.0017
Comp Mole Frac (NBP[0]134*)		0.0025	0.0077	0.0077	0.0336	0.0061
Comp Mole Frac (NBP[0]159*)		0.0019	0.0060	0.0060	0.0321	0.0041
Comp Mole Frac (NBP[0]184*)		0.0012	0.0041	0.0041	0.0301	0.0022
Comp Mole Frac (NBP[0]209*)		0.0010	0.0035	0.0035	0.0331	0.0016
Comp Mole Frac (NBP[0]234*)		0.0008	0.0027	0.0027	0.0344	0.0010
Comp Mole Frac (NBP[0]259*)		0.0005	0.0018	0.0018	0.0322	0.0006
Comp Mole Frac (NBP[0]284*)		0.0003	0.0012	0.0012	0.0280	0.0003
Comp Mole Frac (NBP[0]309*)		0.0002	0.0007	0.0007	0.0249	0.0001
Comp Mole Frac (NBP[0]336*)		0.0001	0.0005	0.0005	0.0229	0.0001
Comp Mole Frac (NBP[0]359*)		0.0001	0.0002	0.0002	0.0174	0.0000
Comp Mole Frac (NBP[0]384*)		0.0000	0.0002	0.0002	0.0163	0.0000
Comp Mole Frac (NBP[0]410*)		0.0000	0.0001	0.0001	0.0135	0.0000
Comp Mole Frac (NBP[0]435*)		0.0000	0.0000	0.0000	0.0107	0.0000
Comp Mole Frac (NBP[0]463*)		0.0000	0.0000	0.0000	0.0097	0.0000
Comp Mole Frac (NBP[0]486*)		0.0000	0.0000	0.0000	0.0066	0.0000
Comp Mole Frac (NBP[0]506*)		0.0000	0.0000	0.0000	0.0047	0.0000
Comp Mole Frac (NBP[0]540*)		0.0000	0.0000	0.0000	0.0058	0.0000
Comp Mole Frac (NBP[0]570*)		0.0000	0.0000	0.0000	0.0042	0.0000
Comp Mole Frac (NBP[0]593*)		0.0000	0.0000	0.0000	0.0020	0.0000
Comp Mole Frac (NBP[0]615*)		0.0000	0.0000	0.0000	0.0015	0.0000
Comp Mole Frac (NBP[0]636*)		0.0000	0.0000	0.0000	0.0011	0.0000
Comp Mole Frac (NBP[0]661*)		0.0000	0.0000	0.0000	0.0009	0.0000
Comp Mole Frac (NBP[0]687*)		0.0000	0.0000	0.0000	0.0020	0.0000
Comp Mole Frac (NBP[0]713*)		0.0000	0.0000	0.0000	0.0001	0.0000
Comp Mole Frac (Refrig-600a)		0.0000	0.0000	0.0000	0.0000	0.0000

* Specified by user.

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Workbook: Case (Main) (continued)

Compositions (continued)

Fluid Pkg: All

Name		S8	S9	S10	S11	S12
Vapour Fraction		0.8870	0.7121	1.0000	1.0000	0.0000
Temperature	(F)	68.62	-10.00 *	-10.00	110.0 *	-10.00
Pressure	(psig)	1197	1197	1197	1197	1197
Mass Flow	(tonne/d)	350.8	350.8	201.0	201.0	5.885
Heat Flow	(MMBtu/hr)	-55.37	-57.62	-36.26	-34.58	-2.027
Molar Flow	(MMSCFD)	12.47	12.47	8.882	8.882	0.1089
Comp Mole Frac (CO2)		0.0193	0.0193	0.0181	0.0181	0.0127
Comp Mole Frac (Nitrogen)		0.0129	0.0129	0.0164	0.0164	0.0001
Comp Mole Frac (Methane)		0.7537	0.7537	0.8556	0.8556	0.0001
Comp Mole Frac (Ethane)		0.0996	0.0996	0.0788	0.0788	0.0000
Comp Mole Frac (Propane)		0.0437	0.0437	0.0219	0.0219	0.0000
Comp Mole Frac (i-Butane)		0.0087	0.0087	0.0029	0.0029	0.0000
Comp Mole Frac (n-Butane)		0.0091	0.0091	0.0025	0.0025	0.0000
Comp Mole Frac (i-Pentane)		0.0040	0.0040	0.0007	0.0007	0.0000
Comp Mole Frac (n-Pentane)		0.0039	0.0039	0.0005	0.0005	0.0000
Comp Mole Frac (n-Hexane)		0.0050	0.0050	0.0004	0.0004	0.0000
Comp Mole Frac (n-Heptane)		0.0013	0.0013	0.0000	0.0000	0.0000
Comp Mole Frac (H2O)		0.0033	0.0033	0.0000	0.0000	0.3773
Comp Mole Frac (EGlycol)		0.0053	0.0053	0.0000	0.0000	0.6098
Comp Mole Frac (NBP[0]32*)		0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]60*)		0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]86*)		0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]109*)		0.0018	0.0018	0.0002	0.0002	0.0000
Comp Mole Frac (NBP[0]134*)		0.0076	0.0076	0.0008	0.0008	0.0000
Comp Mole Frac (NBP[0]159*)		0.0059	0.0059	0.0005	0.0005	0.0000
Comp Mole Frac (NBP[0]184*)		0.0041	0.0041	0.0002	0.0002	0.0000
Comp Mole Frac (NBP[0]209*)		0.0034	0.0034	0.0002	0.0002	0.0000
Comp Mole Frac (NBP[0]234*)		0.0026	0.0026	0.0001	0.0001	0.0000
Comp Mole Frac (NBP[0]259*)		0.0018	0.0018	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]284*)		0.0011	0.0011	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]309*)		0.0007	0.0007	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]336*)		0.0005	0.0005	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]359*)		0.0002	0.0002	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]384*)		0.0002	0.0002	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]410*)		0.0001	0.0001	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]435*)		0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]463*)		0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]486*)		0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]506*)		0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]540*)		0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]570*)		0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]593*)		0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]615*)		0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]636*)		0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]661*)		0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]687*)		0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]713*)		0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (Refrig-600a)		0.0000	0.0000	0.0000	0.0000	0.0000

* Specified by user.

Workbook: Case (Main) (continued)

Compositions (continued)

Fluid Pkg: All

Name		S13	S14	S15	S16	S17
Vapour Fraction		0.0000	0.0000	0.2035	0.4942	1.0000
Temperature	(F)	140.2	-10.00	19.00 *	-23.38	4.128
Pressure	(psig)	1200	1197	1192	395.0 *	390.0
Mass Flow	(tonne/d)	5.285	143.9	143.9	143.9	63.71
Heat Flow	(MMBtu/hr)	-1.623	-19.33	-19.01	-19.04	-10.76
Molar Flow	(MMSCFD)	8.301e-002	3.483	3.483	3.483	2.523
Comp Mole Frac (CO2)		0.0000	0.0224	0.0224	0.0224	0.0309
Comp Mole Frac (Nitrogen)		0.0000	0.0044	0.0044	0.0044	0.0061
Comp Mole Frac (Methane)		0.0000	0.5172	0.5172	0.5172	0.7140
Comp Mole Frac (Ethane)		0.0000	0.1558	0.1558	0.1558	0.2112
Comp Mole Frac (Propane)		0.0000	0.1007	0.1007	0.1007	0.0311
Comp Mole Frac (i-Butane)		0.0000	0.0238	0.0238	0.0238	0.0029
Comp Mole Frac (n-Butane)		0.0000	0.0263	0.0263	0.0263	0.0022
Comp Mole Frac (i-Pentane)		0.0000	0.0125	0.0125	0.0125	0.0004
Comp Mole Frac (n-Pentane)		0.0000	0.0126	0.0126	0.0126	0.0003
Comp Mole Frac (n-Hexane)		0.0000	0.0169	0.0169	0.0169	0.0001
Comp Mole Frac (n-Heptane)		0.0000	0.0044	0.0044	0.0044	0.0000
Comp Mole Frac (H2O)		0.2000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (EGlycol)		0.8000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]32*)		0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]60*)		0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]86*)		0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]109*)		0.0000	0.0060	0.0060	0.0060	0.0001
Comp Mole Frac (NBP[0]134*)		0.0000	0.0253	0.0253	0.0253	0.0004
Comp Mole Frac (NBP[0]159*)		0.0000	0.0200	0.0200	0.0200	0.0002
Comp Mole Frac (NBP[0]184*)		0.0000	0.0140	0.0140	0.0140	0.0001
Comp Mole Frac (NBP[0]209*)		0.0000	0.0120	0.0120	0.0120	0.0000
Comp Mole Frac (NBP[0]234*)		0.0000	0.0092	0.0092	0.0092	0.0000
Comp Mole Frac (NBP[0]259*)		0.0000	0.0063	0.0063	0.0063	0.0000
Comp Mole Frac (NBP[0]284*)		0.0000	0.0041	0.0041	0.0041	0.0000
Comp Mole Frac (NBP[0]309*)		0.0000	0.0025	0.0025	0.0025	0.0000
Comp Mole Frac (NBP[0]336*)		0.0000	0.0016	0.0016	0.0016	0.0000
Comp Mole Frac (NBP[0]359*)		0.0000	0.0009	0.0009	0.0009	0.0000
Comp Mole Frac (NBP[0]384*)		0.0000	0.0006	0.0006	0.0006	0.0000
Comp Mole Frac (NBP[0]410*)		0.0000	0.0003	0.0003	0.0003	0.0000
Comp Mole Frac (NBP[0]435*)		0.0000	0.0002	0.0002	0.0002	0.0000
Comp Mole Frac (NBP[0]463*)		0.0000	0.0001	0.0001	0.0001	0.0000
Comp Mole Frac (NBP[0]486*)		0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]506*)		0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]540*)		0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]570*)		0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]593*)		0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]615*)		0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]636*)		0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]661*)		0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]687*)		0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]713*)		0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (Refrig-600a)		0.0000	0.0000	0.0000	0.0000	0.0000

* Specified by user.

Workbook: Case (Main) (continued)

Compositions (continued)

Fluid Pkg: All

Name		S18	S19	S20	S21	S22
Vapour Fraction		1.0000	1.0000	0.0000	1.0000	0.0000
Temperature	(F)	165.4	120.0 *	297.5	176.3	120.0 *
Pressure	(psig)	1197 *	1197	400.0	230.0	230.0
Mass Flow	(tonne/d)	63.71	63.71	80.19	118.9	118.9
Heat Flow	(MMBtu/hr)	-10.41	-10.58	-6.488	-10.50	-12.16
Molar Flow	(MMSCFD)	2.523	2.523	0.9601	1.972	1.972
Comp Mole Frac (CO2)		0.0309	0.0309	0.0000	0.0000	0.0000
Comp Mole Frac (Nitrogen)		0.0061	0.0061	0.0000	0.0000	0.0000
Comp Mole Frac (Methane)		0.7140	0.7140	0.0000	0.0000	0.0000
Comp Mole Frac (Ethane)		0.2112	0.2112	0.0100	0.0203	0.0203
Comp Mole Frac (Propane)		0.0311	0.0311	0.2836	0.5752	0.5752
Comp Mole Frac (i-Butane)		0.0029	0.0029	0.0789	0.1589	0.1589
Comp Mole Frac (n-Butane)		0.0022	0.0022	0.0896	0.1783	0.1783
Comp Mole Frac (i-Pentane)		0.0004	0.0004	0.0444	0.0461	0.0461
Comp Mole Frac (n-Pentane)		0.0003	0.0003	0.0450	0.0182	0.0182
Comp Mole Frac (n-Hexane)		0.0001	0.0001	0.0611	0.0000	0.0000
Comp Mole Frac (n-Heptane)		0.0000	0.0000	0.0160	0.0000	0.0000
Comp Mole Frac (H2O)		0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (EGlycol)		0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]32*)		0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]60*)		0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]86*)		0.0000	0.0000	0.0001	0.0001	0.0001
Comp Mole Frac (NBP[0]109*)		0.0001	0.0001	0.0214	0.0019	0.0019
Comp Mole Frac (NBP[0]134*)		0.0004	0.0004	0.0908	0.0010	0.0010
Comp Mole Frac (NBP[0]159*)		0.0002	0.0002	0.0721	0.0000	0.0000
Comp Mole Frac (NBP[0]184*)		0.0001	0.0001	0.0505	0.0000	0.0000
Comp Mole Frac (NBP[0]209*)		0.0000	0.0000	0.0433	0.0000	0.0000
Comp Mole Frac (NBP[0]234*)		0.0000	0.0000	0.0333	0.0000	0.0000
Comp Mole Frac (NBP[0]259*)		0.0000	0.0000	0.0228	0.0000	0.0000
Comp Mole Frac (NBP[0]284*)		0.0000	0.0000	0.0147	0.0000	0.0000
Comp Mole Frac (NBP[0]309*)		0.0000	0.0000	0.0089	0.0000	0.0000
Comp Mole Frac (NBP[0]336*)		0.0000	0.0000	0.0059	0.0000	0.0000
Comp Mole Frac (NBP[0]359*)		0.0000	0.0000	0.0031	0.0000	0.0000
Comp Mole Frac (NBP[0]384*)		0.0000	0.0000	0.0020	0.0000	0.0000
Comp Mole Frac (NBP[0]410*)		0.0000	0.0000	0.0012	0.0000	0.0000
Comp Mole Frac (NBP[0]435*)		0.0000	0.0000	0.0006	0.0000	0.0000
Comp Mole Frac (NBP[0]463*)		0.0000	0.0000	0.0004	0.0000	0.0000
Comp Mole Frac (NBP[0]486*)		0.0000	0.0000	0.0002	0.0000	0.0000
Comp Mole Frac (NBP[0]506*)		0.0000	0.0000	0.0001	0.0000	0.0000
Comp Mole Frac (NBP[0]540*)		0.0000	0.0000	0.0001	0.0000	0.0000
Comp Mole Frac (NBP[0]570*)		0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]593*)		0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]615*)		0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]636*)		0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]661*)		0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]687*)		0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]713*)		0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (Refrig-600a)		0.0000	0.0000	0.0000	0.0000	0.0000

* Specified by user.

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Workbook: Case (Main) (continued)

Compositions (continued)

Fluid Pkg: All

Name		S23	S24	S25	S26	S27
Vapour Fraction		0.0000	0.0000	0.0000	0.0000	0.0000
Temperature	(F)	120.0	120.0	120.0	120.0	120.0 *
Pressure	(psig)	230.0	230.0 *	230.0	230.0 *	230.0 *
Mass Flow	(tonne/d)	118.9	118.9	90.44	90.44	90.46
Heat Flow	(MMBtu/hr)	-12.16	-12.16	-9.248	-9.248	-9.249
Molar Flow	(MMSCFD)	1.972	1.972	1.500 *	1.500	1.500 *
Comp Mole Frac (CO2)		0.0000	0.0000	0.0000	0.0000	0.0000 *
Comp Mole Frac (Nitrogen)		0.0000	0.0000	0.0000	0.0000	0.0000 *
Comp Mole Frac (Methane)		0.0000	0.0000	0.0000	0.0000	0.0000 *
Comp Mole Frac (Ethane)		0.0203	0.0203	0.0203	0.0203	0.0203 *
Comp Mole Frac (Propane)		0.5752	0.5752	0.5752	0.5752	0.5749 *
Comp Mole Frac (i-Butane)		0.1589	0.1589	0.1589	0.1589	0.1588 *
Comp Mole Frac (n-Butane)		0.1783	0.1783	0.1783	0.1783	0.1782 *
Comp Mole Frac (i-Pentane)		0.0461	0.0461	0.0461	0.0461	0.0461 *
Comp Mole Frac (n-Pentane)		0.0182	0.0182	0.0182	0.0182	0.0185 *
Comp Mole Frac (n-Hexane)		0.0000	0.0000	0.0000	0.0000	0.0000 *
Comp Mole Frac (n-Heptane)		0.0000	0.0000	0.0000	0.0000	0.0000 *
Comp Mole Frac (H2O)		0.0000	0.0000	0.0000	0.0000	0.0000 *
Comp Mole Frac (EGlycol)		0.0000	0.0000	0.0000	0.0000	0.0000 *
Comp Mole Frac (NBP[0]32*)		0.0000	0.0000	0.0000	0.0000	0.0000 *
Comp Mole Frac (NBP[0]60*)		0.0000	0.0000	0.0000	0.0000	0.0000 *
Comp Mole Frac (NBP[0]86*)		0.0001	0.0001	0.0001	0.0001	0.0001 *
Comp Mole Frac (NBP[0]109*)		0.0019	0.0019	0.0019	0.0019	0.0020 *
Comp Mole Frac (NBP[0]134*)		0.0010	0.0010	0.0010	0.0010	0.0010 *
Comp Mole Frac (NBP[0]159*)		0.0000	0.0000	0.0000	0.0000	0.0000 *
Comp Mole Frac (NBP[0]184*)		0.0000	0.0000	0.0000	0.0000	0.0000 *
Comp Mole Frac (NBP[0]209*)		0.0000	0.0000	0.0000	0.0000	0.0000 *
Comp Mole Frac (NBP[0]234*)		0.0000	0.0000	0.0000	0.0000	0.0000 *
Comp Mole Frac (NBP[0]259*)		0.0000	0.0000	0.0000	0.0000	0.0000 *
Comp Mole Frac (NBP[0]284*)		0.0000	0.0000	0.0000	0.0000	0.0000 *
Comp Mole Frac (NBP[0]309*)		0.0000	0.0000	0.0000	0.0000	0.0000 *
Comp Mole Frac (NBP[0]336*)		0.0000	0.0000	0.0000	0.0000	0.0000 *
Comp Mole Frac (NBP[0]359*)		0.0000	0.0000	0.0000	0.0000	0.0000 *
Comp Mole Frac (NBP[0]384*)		0.0000	0.0000	0.0000	0.0000	0.0000 *
Comp Mole Frac (NBP[0]410*)		0.0000	0.0000	0.0000	0.0000	0.0000 *
Comp Mole Frac (NBP[0]435*)		0.0000	0.0000	0.0000	0.0000	0.0000 *
Comp Mole Frac (NBP[0]463*)		0.0000	0.0000	0.0000	0.0000	0.0000 *
Comp Mole Frac (NBP[0]486*)		0.0000	0.0000	0.0000	0.0000	0.0000 *
Comp Mole Frac (NBP[0]506*)		0.0000	0.0000	0.0000	0.0000	0.0000 *
Comp Mole Frac (NBP[0]540*)		0.0000	0.0000	0.0000	0.0000	0.0000 *
Comp Mole Frac (NBP[0]570*)		0.0000	0.0000	0.0000	0.0000	0.0000 *
Comp Mole Frac (NBP[0]593*)		0.0000	0.0000	0.0000	0.0000	0.0000 *
Comp Mole Frac (NBP[0]615*)		0.0000	0.0000	0.0000	0.0000	0.0000 *
Comp Mole Frac (NBP[0]636*)		0.0000	0.0000	0.0000	0.0000	0.0000 *
Comp Mole Frac (NBP[0]661*)		0.0000	0.0000	0.0000	0.0000	0.0000 *
Comp Mole Frac (NBP[0]687*)		0.0000	0.0000	0.0000	0.0000	0.0000 *
Comp Mole Frac (NBP[0]713*)		0.0000	0.0000	0.0000	0.0000	0.0000 *
Comp Mole Frac (Refrig-600a)		0.0000	0.0000	0.0000	0.0000	0.0000 *

* Specified by user.

Workbook: Case (Main) (continued)

Compositions (continued)

Fluid Pkg: All

Name		S28	S29	S30	S31	S32
Vapour Fraction		0.0000	0.0000	0.0000	0.0000	0.0000
Temperature	(F)	389.1	295.5	120.0 *	126.0	126.0
Pressure	(psig)	235.0	230.0	225.0	1197 *	1197
Mass Flow	(tonne/d)	51.74	51.74	51.74	51.74	37.81
Heat Flow	(MMBtu/hr)	-3.612	-3.937	-4.433	-4.405	-3.219
Molar Flow	(MMSCFD)	0.4879	0.4879	0.4879	0.4879	0.3565
Comp Mole Frac (CO2)		0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (Nitrogen)		0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (Methane)		0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (Ethane)		0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (Propane)		0.0003	0.0003	0.0003	0.0003	0.0003
Comp Mole Frac (i-Butane)		0.0012	0.0012	0.0012	0.0012	0.0012
Comp Mole Frac (n-Butane)		0.0034	0.0034	0.0034	0.0034	0.0034
Comp Mole Frac (i-Pentane)		0.0430	0.0430	0.0430	0.0430	0.0430
Comp Mole Frac (n-Pentane)		0.0721	0.0721	0.0721	0.0721	0.0721
Comp Mole Frac (n-Hexane)		0.1203	0.1203	0.1203	0.1203	0.1203
Comp Mole Frac (n-Heptane)		0.0315	0.0315	0.0315	0.0315	0.0315
Comp Mole Frac (H2O)		0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (EGlycol)		0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]32*)		0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]60*)		0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]86*)		0.0001	0.0001	0.0001	0.0001	0.0001
Comp Mole Frac (NBP[0]109*)		0.0405	0.0405	0.0405	0.0405	0.0405
Comp Mole Frac (NBP[0]134*)		0.1779	0.1779	0.1779	0.1779	0.1779
Comp Mole Frac (NBP[0]159*)		0.1418	0.1418	0.1418	0.1418	0.1418
Comp Mole Frac (NBP[0]184*)		0.0994	0.0994	0.0994	0.0994	0.0994
Comp Mole Frac (NBP[0]209*)		0.0852	0.0852	0.0852	0.0852	0.0852
Comp Mole Frac (NBP[0]234*)		0.0655	0.0655	0.0655	0.0655	0.0655
Comp Mole Frac (NBP[0]259*)		0.0449	0.0449	0.0449	0.0449	0.0449
Comp Mole Frac (NBP[0]284*)		0.0289	0.0289	0.0289	0.0289	0.0289
Comp Mole Frac (NBP[0]309*)		0.0176	0.0176	0.0176	0.0176	0.0176
Comp Mole Frac (NBP[0]336*)		0.0116	0.0116	0.0116	0.0116	0.0116
Comp Mole Frac (NBP[0]359*)		0.0061	0.0061	0.0061	0.0061	0.0061
Comp Mole Frac (NBP[0]384*)		0.0039	0.0039	0.0039	0.0039	0.0039
Comp Mole Frac (NBP[0]410*)		0.0023	0.0023	0.0023	0.0023	0.0023
Comp Mole Frac (NBP[0]435*)		0.0011	0.0011	0.0011	0.0011	0.0011
Comp Mole Frac (NBP[0]463*)		0.0007	0.0007	0.0007	0.0007	0.0007
Comp Mole Frac (NBP[0]486*)		0.0003	0.0003	0.0003	0.0003	0.0003
Comp Mole Frac (NBP[0]506*)		0.0001	0.0001	0.0001	0.0001	0.0001
Comp Mole Frac (NBP[0]540*)		0.0001	0.0001	0.0001	0.0001	0.0001
Comp Mole Frac (NBP[0]570*)		0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]593*)		0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]615*)		0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]636*)		0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]661*)		0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]687*)		0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]713*)		0.0000	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (Refrig-600a)		0.0000	0.0000	0.0000	0.0000	0.0000

* Specified by user.

Workbook: Case (Main) (continued)

Compositions (continued)

Fluid Pkg: All

Name		S33	S-33	S-34	S-35	S-36
Vapour Fraction		0.0000	1.0000	0.0000	0.3882	0.9117
Temperature	(F)	126.0 *	19.00	19.00	-16.70	-65.54
Pressure	(psig)	1197 *	1192	1192	395.0 *	395.0 *
Mass Flow	(tonne/d)	37.81	16.66	127.2	127.2	16.66
Heat Flow	(MMBtu/hr)	-3.219	-2.936	-16.07	-16.07	-2.972
Molar Flow	(MMSCFD)	0.3565	0.7089	2.774	2.774	0.7089
Comp Mole Frac (CO2)		0.0000 *	0.0215	0.0226	0.0226	0.0215
Comp Mole Frac (Nitrogen)		0.0000 *	0.0113	0.0027	0.0027	0.0113
Comp Mole Frac (Methane)		0.0000 *	0.8255	0.4384	0.4384	0.8255
Comp Mole Frac (Ethane)		0.0000 *	0.0990	0.1702	0.1702	0.0990
Comp Mole Frac (Propane)		0.0003 *	0.0298	0.1188	0.1188	0.0298
Comp Mole Frac (i-Butane)		0.0012 *	0.0041	0.0289	0.0289	0.0041
Comp Mole Frac (n-Butane)		0.0033 *	0.0035	0.0321	0.0321	0.0035
Comp Mole Frac (i-Pentane)		0.0430 *	0.0010	0.0155	0.0155	0.0010
Comp Mole Frac (n-Pentane)		0.0715 *	0.0008	0.0156	0.0156	0.0008
Comp Mole Frac (n-Hexane)		0.1206 *	0.0005	0.0211	0.0211	0.0005
Comp Mole Frac (n-Heptane)		0.0315 *	0.0001	0.0055	0.0055	0.0001
Comp Mole Frac (H2O)		0.0000 *	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (EGlycol)		0.0000 *	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]32*)		0.0000 *	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]60*)		0.0000 *	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]86*)		0.0001 *	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]109*)		0.0405 *	0.0003	0.0074	0.0074	0.0003
Comp Mole Frac (NBP[0]134*)		0.1780 *	0.0012	0.0314	0.0314	0.0012
Comp Mole Frac (NBP[0]159*)		0.1417 *	0.0007	0.0249	0.0249	0.0007
Comp Mole Frac (NBP[0]184*)		0.0996 *	0.0003	0.0175	0.0175	0.0003
Comp Mole Frac (NBP[0]209*)		0.0853 *	0.0002	0.0150	0.0150	0.0002
Comp Mole Frac (NBP[0]234*)		0.0656 *	0.0001	0.0115	0.0115	0.0001
Comp Mole Frac (NBP[0]259*)		0.0449 *	0.0001	0.0079	0.0079	0.0001
Comp Mole Frac (NBP[0]284*)		0.0289 *	0.0000	0.0051	0.0051	0.0000
Comp Mole Frac (NBP[0]309*)		0.0176 *	0.0000	0.0031	0.0031	0.0000
Comp Mole Frac (NBP[0]336*)		0.0116 *	0.0000	0.0020	0.0020	0.0000
Comp Mole Frac (NBP[0]359*)		0.0061 *	0.0000	0.0011	0.0011	0.0000
Comp Mole Frac (NBP[0]384*)		0.0039 *	0.0000	0.0007	0.0007	0.0000
Comp Mole Frac (NBP[0]410*)		0.0023 *	0.0000	0.0004	0.0004	0.0000
Comp Mole Frac (NBP[0]435*)		0.0011 *	0.0000	0.0002	0.0002	0.0000
Comp Mole Frac (NBP[0]463*)		0.0007 *	0.0000	0.0001	0.0001	0.0000
Comp Mole Frac (NBP[0]486*)		0.0003 *	0.0000	0.0001	0.0001	0.0000
Comp Mole Frac (NBP[0]506*)		0.0001 *	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]540*)		0.0001 *	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]570*)		0.0000 *	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]593*)		0.0000 *	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]615*)		0.0000 *	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]636*)		0.0000 *	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]661*)		0.0000 *	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]687*)		0.0000 *	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (NBP[0]713*)		0.0000 *	0.0000	0.0000	0.0000	0.0000
Comp Mole Frac (Refrig-600a)		0.0000 *	0.0000	0.0000	0.0000	0.0000

* Specified by user.

Workbook: Case (Main) (continued)

Compositions (continued)

Fluid Pkg: All

Name		S-37	Sales Gas	Stablized Condensate	Water	Well Water
Vapour Fraction		1.0000	1.0000	0.0000	0.0000	0.0000
Temperature	(F)	21.31	112.1	332.9	120.0 *	122.1
Pressure	(psig)	443.8	1197	100.0	1200 *	1200
Mass Flow	(tonne/d)	63.71	264.7	53.47	8.414	9.133
Heat Flow	(MMBtu/hr)	-10.73	-45.16	-3.924	-5.243	-5.687
Molar Flow	(MMSCFD)	2.523	11.40	0.3956	0.3907	0.4239
Comp Mole Frac (CO2)		0.0309	0.0210	0.0000	0.0000 *	0.0003
Comp Mole Frac (Nitrogen)		0.0061	0.0141	0.0000	0.0000 *	0.0000
Comp Mole Frac (Methane)		0.7140	0.8243	0.0000	0.0000 *	0.0000
Comp Mole Frac (Ethane)		0.2112	0.1081	0.0000	0.0000 *	0.0000
Comp Mole Frac (Propane)		0.0311	0.0239	0.0000	0.0000 *	0.0000
Comp Mole Frac (i-Butane)		0.0029	0.0029	0.0163	0.0000 *	0.0000
Comp Mole Frac (n-Butane)		0.0022	0.0024	0.0469	0.0000 *	0.0000
Comp Mole Frac (i-Pentane)		0.0004	0.0006	0.0375	0.0000 *	0.0000
Comp Mole Frac (n-Pentane)		0.0003	0.0005	0.0322	0.0000 *	0.0000
Comp Mole Frac (n-Hexane)		0.0001	0.0003	0.0606	0.0000 *	0.0000
Comp Mole Frac (n-Heptane)		0.0000	0.0000	0.0298	0.0000 *	0.0000
Comp Mole Frac (H2O)		0.0000	0.0000	0.0000	1.0000 *	0.9997
Comp Mole Frac (EGlycol)		0.0000	0.0000	0.0000	0.0000 *	0.0000
Comp Mole Frac (NBP[0]32*)		0.0000	0.0000	0.0000	0.0000 *	0.0000
Comp Mole Frac (NBP[0]60*)		0.0000	0.0000	0.0000	0.0000 *	0.0000
Comp Mole Frac (NBP[0]86*)		0.0000	0.0000	0.0001	0.0000 *	0.0000
Comp Mole Frac (NBP[0]109*)		0.0001	0.0002	0.0137	0.0000 *	0.0000
Comp Mole Frac (NBP[0]134*)		0.0004	0.0007	0.0645	0.0000 *	0.0000
Comp Mole Frac (NBP[0]159*)		0.0002	0.0004	0.0636	0.0000 *	0.0000
Comp Mole Frac (NBP[0]184*)		0.0001	0.0002	0.0614	0.0000 *	0.0000
Comp Mole Frac (NBP[0]209*)		0.0000	0.0001	0.0686	0.0000 *	0.0000
Comp Mole Frac (NBP[0]234*)		0.0000	0.0001	0.0719	0.0000 *	0.0000
Comp Mole Frac (NBP[0]259*)		0.0000	0.0000	0.0678	0.0000 *	0.0000
Comp Mole Frac (NBP[0]284*)		0.0000	0.0000	0.0592	0.0000 *	0.0000
Comp Mole Frac (NBP[0]309*)		0.0000	0.0000	0.0527	0.0000 *	0.0000
Comp Mole Frac (NBP[0]336*)		0.0000	0.0000	0.0485	0.0000 *	0.0000
Comp Mole Frac (NBP[0]359*)		0.0000	0.0000	0.0370	0.0000 *	0.0000
Comp Mole Frac (NBP[0]384*)		0.0000	0.0000	0.0346	0.0000 *	0.0000
Comp Mole Frac (NBP[0]410*)		0.0000	0.0000	0.0286	0.0000 *	0.0000
Comp Mole Frac (NBP[0]435*)		0.0000	0.0000	0.0226	0.0000 *	0.0000
Comp Mole Frac (NBP[0]463*)		0.0000	0.0000	0.0206	0.0000 *	0.0000
Comp Mole Frac (NBP[0]486*)		0.0000	0.0000	0.0140	0.0000 *	0.0000
Comp Mole Frac (NBP[0]506*)		0.0000	0.0000	0.0099	0.0000 *	0.0000
Comp Mole Frac (NBP[0]540*)		0.0000	0.0000	0.0123	0.0000 *	0.0000
Comp Mole Frac (NBP[0]570*)		0.0000	0.0000	0.0089	0.0000 *	0.0000
Comp Mole Frac (NBP[0]593*)		0.0000	0.0000	0.0043	0.0000 *	0.0000
Comp Mole Frac (NBP[0]615*)		0.0000	0.0000	0.0031	0.0000 *	0.0000
Comp Mole Frac (NBP[0]636*)		0.0000	0.0000	0.0024	0.0000 *	0.0000
Comp Mole Frac (NBP[0]661*)		0.0000	0.0000	0.0020	0.0000 *	0.0000
Comp Mole Frac (NBP[0]687*)		0.0000	0.0000	0.0042	0.0000 *	0.0000
Comp Mole Frac (NBP[0]713*)		0.0000	0.0000	0.0002	0.0000 *	0.0000
Comp Mole Frac (Refrig-600a)		0.0000	0.0000	0.0000	0.0000 *	0.0000

* Specified by user.

Workbook: Case (Main) (continued)

Energy Streams

Fluid Pkg: All

Name		Q-Ethanizer-Reb	Q-102	Q-103	Q-Propanizer-Rebolier	Q-108
Heat Flow	(MMBtu/hr)	1.793	0.3179	0.1699	1.623	0.0000
Name		Q-101	Q-100			
Heat Flow	(MMBtu/hr)	2.738e-002	3.596e-002			

* Specified by user.