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Forbedret forbehandling i LNG anlegg

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MASTER THESIS

for

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Improved pretreatment in LNG plants

Forbedret forbehandling i LNG anlegg.

Background and objective

Feed gas pretreatment in an LNG plant is important to prevent blockage of the heat exchangers in the cryogenic part of the process. Several issues related to performance and operations of the gas pretreatment facilities have led to reduced regularity and availability of LNG plants.

The objective of this thesis is to analyze the performance of the pretreatment system and to propose improvements.

The following tasks are to be considered:

1. Establish a mass balance of recirculation of heavy hydrocarbons (C5+) from the condensate treatment back to the inlet facilities and up to the Heavy Hydrocarbon scrub column. The mass balance shall be based on various design cases.
2. Establish the same mass balance as above based on typical plant performance data.
3. Suggest an improved design of the condensate treatment and stabilizer column with the purpose to reduce recirculation of heavy components. Develop a Hysys model for the modified/new stabilizer
4. Perform preliminary sizing of the column with associated reboiler and reflux system. Describe the effect on energy supply (cooling water and hot oil)

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☐ Work to be done in lab (Water power lab, Fluids engineering lab, Thermal engineering lab)
☐ Field work

Department of Energy and Process Engineering, 20. August 2012

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Preface

This report is the result of my work at Norwegian University of Science and Technology during fall of 2012. The work has been carried out at the Faculty of Engineering Science and Technology at the Department of Energy and Process Technology. This thesis completes the final semester in the master program of Energy and Environmental Engineering. Personal interests within the field of gas processing and an unresolved research given by the Statoil team have made this thesis both interesting and challenging.

I would like to thank my main supervisor Geir Owren for inspiration and guidance while working on this thesis. Also thanks to Sigbjørn Svenes, Knut Håvard Nordstad and Svein Puntervold at Statoil for showing interest in this work and offering to share their knowledge.

In conclusion I wish to thank my fellow students and family for valuable conversations throughout my work, support and for five incredible years.

Trondheim, January 2013

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Abstract

The world's energy demand is growing constantly and towards 2035 there is expected an increase of 40 % compared to current level. Oil and gas will also in the future be an important part of the energy sector where natural gas takes an increasingly marked share. Today gas produced in Norway is delivered by large pipes to the European continent and LNG on ships to distant markets. LNG is a flexible way of transporting large quantum of energy.

There are several challenges related to LNG plants at remote locations. This includes capacity demand in the plant, the desire to extract gas resources in artic climate and heating value requirements of the end product. Pretreatment of the gas is important to prevent blockage in the heat exchangers in the cryogenic part of the process and to meet specifications. Issues related to performance and operation of the pretreatment facilities can in worst case lead to reduced regularity and availability of the LNG plant. The main objective of this thesis is to analyze the pretreatment system with the respect of the heavy hydrocarbon flow and propose improvements.

It is obvious that in order to optimize and reduce the heavy hydrocarbon flow the non-refluxed condensate stabilizer need to be optimized. Four simulation models of the pretreatment facilities in a LNG plant have therefor been established; *Existing Pretreatment Facilities*, *Modification of Existing Stabilizer I*, *Modification of Existing Stabilizer II* and *New Stabilizer with Reflux*. Each model has been simulated with three feed gas cases Case A, Case B and Case C which have different compositions. The heavy hydrocarbon flow has been analyzed from the condensate treatment unit back to the inlet facilities and up to the heavy hydrocarbon scrub column.

The *Existing Pretreatment Facilities* is modeled in HYSYS and are based on existing process flow diagrams. The results from the simulations shows that the heavy hydrocarbons, HHC, from the non-refluxed stabilizer contributes to 1.1 %, 1.03 % and 1.39 % respectively for Case A, Case B and Case C, of the total mass flow in the main process stream in the inlet facilities, upstream the slug catcher. It is therefore desirable to perform modifications of the stabilizer or to the routing of the overhead from the demethanizer in order to reduce the HHC stream.

By lowering the temperature in the non-refluxed condensate stabilizer, in the model *Modification of Existing Stabilizer I,* it has been achieved a small reduction of the HHC flow. For this case the heavy hydrocarbon flow from the stabilizer contributes to 1.06 %, 0.97 % and 1.13 % recently for Case A, Case B and Case C, of the total mass flow in the main process stream.

It has been achieved even better results in *Modification of Existing Stabilizer II* by routing the overhead flow from the demethanizer directly to the compressor and a separate unit and avoiding the stabilizer. The heavy hydrocarbon flow from this model contributes to 0.51 % for Case A and Case B and 0.75 % for Case C of the total mass flow in the main process stream. The best result is obtained by installing a new refluxed condensate column, i.e. a conventional distillation column, in the simulation model *New Stabilizer with Reflux*. The column provides a sharp component split and the flow of heavy hydrocarbons from overhead and contributes to 0.00036 %, 0.00016 % and 0.0011 % respectively for Case A, Case B and Case C, of the total mass flow in the main process stream, upstream the slug catcher.

To verify the simulation model of the *Existing Pretreatment Facilities* some typical plant performance data has been provided from the actual plant discussed. The data states that the established model of the pretreatment facilities is a robust model close to normal operation of the plant. It is expected that the heavy hydrocarbon stream from overhead the condensate stabilizer is somewhat less than in the simulation model. This is due to a lower temperature than assumed of this stream. From the data provided it is impossible to determine how much lower the heavy hydrocarbons contribute in the stream as there is no metering of the composition.

Based on the simulations of *New Stabilizer with Reflux* preliminary sizing of the distillation column has been performed with associated reboiler, condenser and reflux accumulator. It is selected a packed column with pall rings and the packed height is found to be 13.66 m whit a diameter of 3.353 m. As reboiler a Kettle reboiler is chosen where the resulting heat exchange area is 1 240.2 m^2. The condenser is a shell and tube heat exchanger where actual heat exchange area is found to be 6 738.3 m^3. As reflux accumulator it is selected a horizontal separator with a length of 8.534 m and a diameter of 2.438 m.

Sammendrag

Verdens energibehov øker og frem mot 2035 forventes det en økning på omkring 40 % i forhold til dagens nivå. Olje og gass vil også i fremtiden prege energisektoren hvor naturgass tar en stadig økende markedsandel. I dag blir gassen som produseres i Norge sendt til det europeiske kontinentet gjennom rør eller på skip som LNG til fjernere strøk. LNG er en fleksibel måte å transportere store mengder energi på.

Det er flere utfordringer knyttet til LNG anlegg. Dette inkluderer krav om kapasitet i anlegget, ønske om å utvinne gassen i arktiske strøk og varmeverdien på sluttproduktet. Forbehandling av gassen er sentralt for å forhindre utfrysning av komponenter som kan skape blokkeringer i de kryogeniske delene av prosessen og for å tilfredsstille andre spesifikasjoner. Utfordringer knyttet til ytelse og drift av forbehandlingsprosessene kan i verste fall føre til redusert regularitet og tilgjengelighet i LNG anlegget. Hovedfokuset i denne masteroppgaven er å analysere forbehandlingen med fokus på massestrømmen av tyngre hydrokarboner og dermed komme med forslag til forbedringer.

Det er fra simuleringene opplagt at en optimalisering og reduksjon av tyngre hydrokarboner krever en optimalisering av den ikke-reflukse kondensatstabilisatoren. Det er etablert fire simuleringsmodeller med forbehandling av LNG i denne rapporten; *Existing Pretreatment Facilities*, *Modification of Existing Stabilizer I*, *Modification of Existing Stabilizer II* og *New Stabilizer with Reflux*. Hver modell har blitt simulert med tre ulike fødegasser, Case A, Case B og Case C som inneholder ulik komposisjon. Massestrømmen av tyngre hydrokarboner har blitt analyser fra kondensatstabilisatoren, tilbake til innløpsprosessen og opp til den tyngre hydrokarbon *scrub* kolonnen.

Modellen *Existing Pretreatment Facilities* er basert på flytskjemaer for prosessen. Resultatet viser at strømmen av tyngre hydrokarboner fra kondensatstabilisatoren bidrar til 1,1 %, 1,03 % og 1,39 % for Case A, Case B and Case B, av den totale massestrømmen i hovedstrømmen ved innløpet, etter *slug catcheren*. Det er derfor gunstig å utføre en modifikasjon av stabilisatoren eller endre rørføring fra metantårnet for å redusere denne massestrømmen.

Ved å senke temperaturen i bunnen av kondensatstabilisatoren har en liten reduksjon av de tyngre hydrokarbonene blitt oppnådd. De tyngre hydrokarbonene fra stabilisatoren utgjør nå 1,06 %, 0,97 % og 1,13 % for Case A, Case B and Case C, av den totale massestrømmen i hovedstrømmen. Det er oppnådd enda bedre resultater ved å endre rørføringen fra metantårnet ved å direkte føre denne til kompressor- og seperasjonsenhetene ved å unngå stabilisatoren. Massestrømmen av tyngre hydrokarboner bidrar med 0,51 % for Case A og Case B og 0,75 % for Case C av den totale massestrømmen i hovedstrømmen. Det beste resultatet er oppnådd ved å installere en ny kolonne med refluks. Kolonnen gir en skarp komponentsplitt og massestrømmen av tyngre hydrokarboner fra kolonnen bidrar med 0,00036 %, 0,00016 % og 0,0011 % for Case A, Case B og Case C, av den totale massestrømmen i hovedstrømmen, oppstrøms av *slug catcheren*.

For å kunne verifisere simuleringsmodellen for det eksisterende anlegget er det gitt typiske data for en stabil driftsperiode for anlegget. Dataene bekrefter at simuleringsmodellen er robust og nær virkelig drift. Det forventes derimot at topproduktet fra kondensatkolonnen inneholder noe mindre tyngre hydrokarboner enn forventet fra resultatene i simuleringsmodellen. Dette er på bakgrunn av noe lavere temperatur på denne strømmen enn antatt. På bakgrunn av disse dataene er det umulig å

si noe om mengden av tyngre hydrokarboner da det ikke finnes noen målestasjon som måler komposisjon i dette området.

Basert på simulering med modellen *New Stabilizer with Reflux* har innledende dimensjonering av destillasjonskolonnen, kokeren, kondenser og refluks akkumulatoren blitt utført. Det er valgt en *packed* kolonne med *pall rings*, noe som resulterer i en pakkehøyde på 13,66 m med en diameter på 3,353 m. En Kettle koker er valgt hvor varmevekslingsområde er funnet til 1 240,2m^2. Kondenseren er en *Shell and Tube*- type hvor resulterende varmevekslerområde er 6 738.3 m^3. En horisontal refluks akkumulator er valgt med en lengde på 8,534 og en diameter på 2,438 m.

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Nomenclature

AGRU	*Acid Gas Remover Unit*
Atm	*Atmosphere*
EoS	*Equation of State*
HHC	*Heavy Hydrocarbon*
HHV	*Higher Heating Value*
LMTD	*Log mean temperature difference*
LNG	*Liquefied Natural Gas*
LPG	*Liquid Natural Gas*
MEG	*Mono Ethylene Glycol*
NG	*Natural Gas*
NGL	*Natural Gas Liquid*
PFD	*Process Flow Diagram*
P&ID	*Piping and Instrumentation Diagram*
Std	*Standard*
TVP	*True Vapor Pressure*
VLE	*Vapor and Liquid Equilibrium*

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1 Introduction

The demand for energy in the world is constantly growing. The most important cause is the increase in welfare all over with a simultaneously growth in the world's population. Towards 2035 the international energy agency IAE expect that the world will need about 40 % more energy than we use today (IAE 2011). Renewable energy sources cannot yet cower all of the demand, and oil and gas will also in the future have significant importance. Gas will in addition precede the need for coal, shown in Figure 1.1.

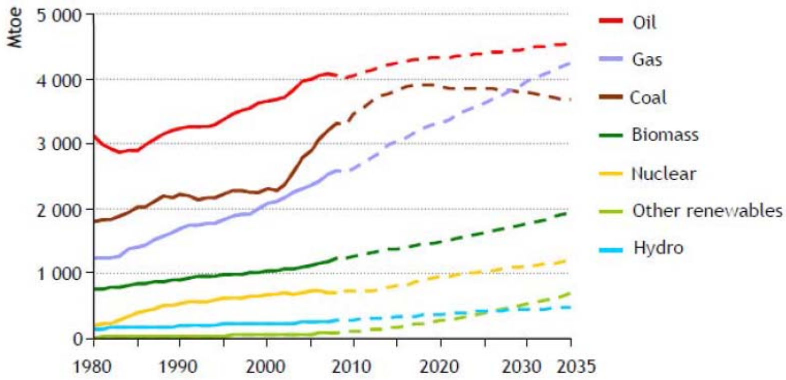

Figure 1.1 Worlds energy need in fuel (IAE 2011)

Norwegian gas production makes a growing part of the Norwegian petroleum activities and the amount of gas exported has grown the last years (Oljedirektoratet 2011). With the ongoing drilling activities in the North Sea and the Norwegian Sea, and the increased focus towards the Barents Sea, this trend will most likely continue. This requires big investments in solutions for transportation in the future. Today gas is piped to the European continental shelf and as LNG on ship to USA, Japan, South-Korea and some EU countries. LNG on ship contributes to 4.3 % of all gas export from Norway (Oljedirektoratet 2012).

Transportation of gas as LNG is a flexible method to reach markets that are far away from the production facilities. Benefits are reduction of volume compared to natural gas, together with the possibility for storage and transportation of large quantity of energy. LNG ships have in addition the advantage that they can be routed where the income of the LNG is greatest.

There are several process design challenges in LNG plants at remote locations. This includes capacity demand, the desire to extract gas resources in the artic and heating value requirements of the end product. To prevent blockage in the heat exchangers in the cryogenic part of the process the feed gas pretreatment of the feed gas is an important part of a LNG plant. Challenges related to performance and operation of the pretreatment facilities can in worst case lead to reduced regularity and availability.

There has not been any laboratory work involved while working on this thesis. It has therefore not been necessary to perform a risk assessment according to the institutes' procedures.

1.1 Objective

The objective of this thesis is to analyze the performance of the pretreatment system for a LNG plant and to propose improvements.

1.2 Scope

The thesis is processed regarding following points:

1. Establish a mass balance of recirculation of heavy hydrocarbons (C_5+) from the condensate treatment back to the inlet facilities and up to the Heavy Hydrocarbon scrub column. The mass balance shall be based on various design cases.

2. Establish the same mass balance as above based on typical plant performance data.

3. Suggest an improved design of the condensate treatment and stabilizer column with the purpose to reduce recirculation of heavy components. Develop a HYSYS model for the modified/new stabilizer.

4. Perform preliminary sizing of the column with associated reboiler and reflux system. Describe the effect on energy supply (cooling and hot oil).

2 Background

A LNG plant is a complex facility where every process interferes with each other. A change upstream will have consequences downstream of the process. An optimization of the pretreatment facilities will therefore influence other systems in the plant. This chapter is provides an introduction to the main part of a LNG facility and motivation for pretreatment of the gas. A brief description of the processes from the gas arrives at the plant to it is shipped out follows.

2.1 From Well to Market

If the reservoir were able to produce pure methane, a LNG plant would only be a big refrigeration system. But nature is never that simple. Gas produced from reservoirs is saturated with water vapor that will plug the cryogenic heat exchangers. In addition the gas will contain CO_2, H_2S, mercury and heavy hydrocarbons. A simplified block diagram for a typical LNG plant is shown in Figure 2.1.

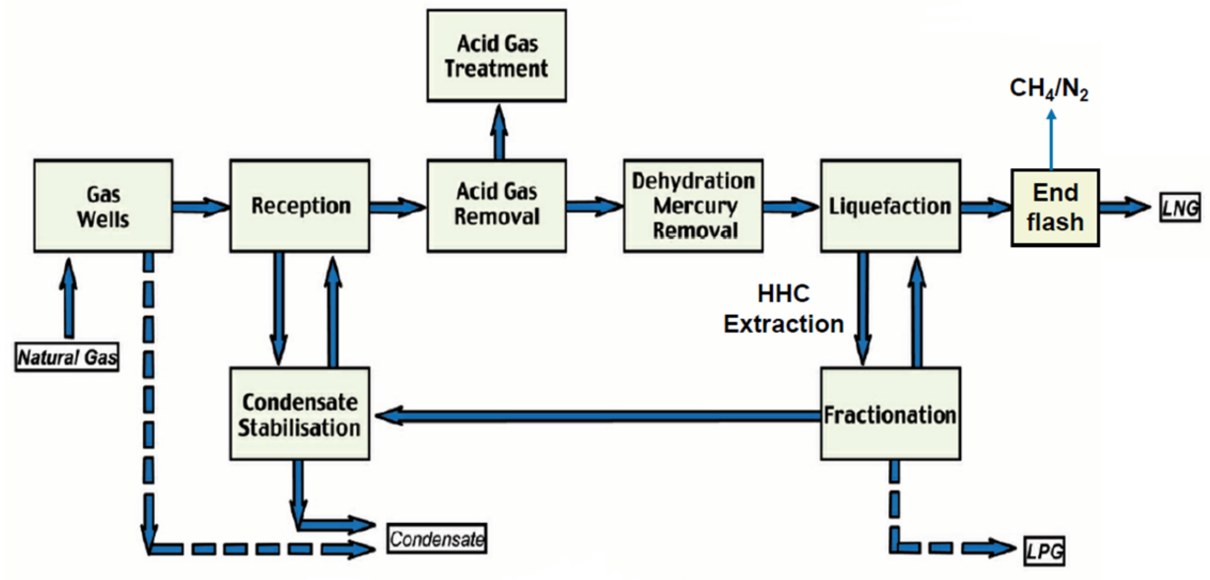

Figure 2.1 Block Diagram for a Typical LNG Plant (Fredheim, Solbaa et al. 2011)

The feed gas undergoes several steps before it is liquefied and ready for export. The most important reasons for pretreatment of the gas are listed below (Fredheim, Solbaa et al. 2011):

- Components with high freezing point must be removed in order to prevent blockage in the cryogenic heat exchangers.
- Specifications on the HHV in the LNG product
- CO_2 and H_2S are highly corrosive when it is mixed with water and can damage process equipment.

Pretreatment of the gas is therefore necessary in order to prevent violating the liquefaction facilities and to meet LNG specifications. Typically specifications that need to be met prior to the liquefaction are listed in Table 2.1.

Table 2.1 Specification in the LNG Product (Fredheim 2011)

	Typical limit
CO_2	50-100 ppmv
H_2S	4 ppmv
Water	< 0,1-0,5 ppmv
Mercury	< 0,01 micro-g/Nm^3
Aromatic (benzene/toluene) and heavy hydrocarbons	1-10 ppmv

Over the years, the LNG product specification has become more stringent. This is due to environmental regulations, especially for sulphur and carbon dioxide components. In previous plants it was normal to vent of the CO_2 to the atmosphere, together with other containments such as H_2S. In recent design plants it is common practice to eliminate unwanted components and also re-inject CO_2 in wells underground.

2.1.1 Slug Catcher and Inlet Facilities

The inlet facilities consist of branch pipes and an inlet separator. For gas entering the plant in multiphase pipelines or from offshore facilities, it also requires a pig receiver and slug catcher. The slug catcher is designed as a declining piping arrangement, where the gas exits at the top, condensate in the intermediate stage and liquids exits at the bottom (Reimers 2010). Water is treated and sent to disposal while hydrocarbon liquid is sent to condensate treatment (Choi 2011). The condensate enters a three phase separator where gas, MEG/water and condensate are separated. MEG is sent to MEG recovery and condensate is sent to the condensate stabilizer.

2.1.2 Condensate Stabilization

Condensate stabilization and treatment is installed to reduce light components and increase the amount of intermediates, C_3 to C_5, and heavier components from C_6+. The scope is to separate the light hydrocarbon gases, especially methane and ethane, from the heavier components (Ibrahim). The feed to the condensate stabilizer in the plant that is considered in this report comes from the slug catcher and the overhead of the demethanizer. Condensate stabilization will be further discussed in chapter 3.

2.1.3 Acid Gas Removal Unit

For LNG plants all acid needs to be removed from the feed gas (Fredheim 2011). Both CO_2 and H_2S are harmful gases, especially H_2S which gives SO_2 and SO_3 if its burned. In addition they are both corrosive in presence of water and CO_2 contributes to a lower heating value to the gas (Ibrahim). The two substances have similar acid characteristic and are therefore removed in the same unit. A typical amine unit consists of an absorber column and a regeneration column and uses chemical solvents such as MEA and MDEA. The amine process is shown in Figure 2.2.

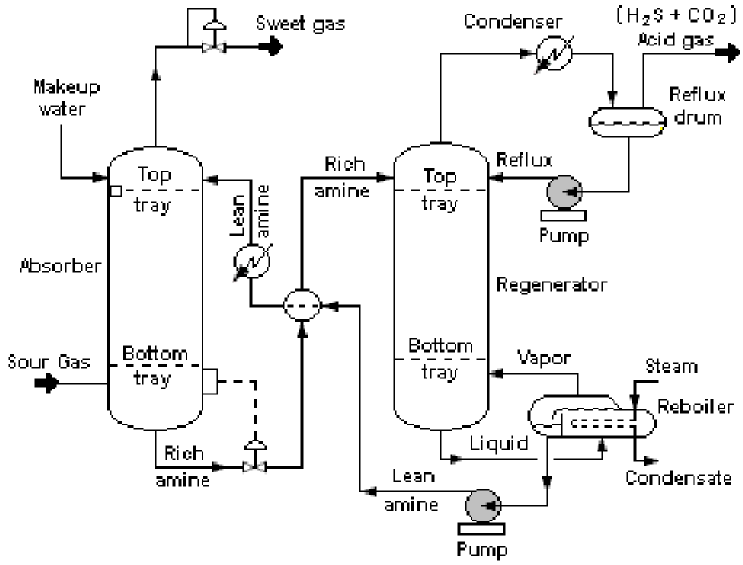

Figure 2.2 Amine Unit for Acid Gas Removal (Ibrahim)

The gas runs through the absorber column containing amine solution. The acid gas reacts with the amines and is sent to the regeneration column. By adding heat the chemical reaction splits and the amines are sent back to the absorber, while the acid gas leaves the regeneration column in the top.

2.1.4 Dehydration

For prevention of freeze out in the heat exchangers in the liquefaction process water needs to be removed. A typical LNG plant has adsorption columns which is design to remove smaller amount of water to extreme dryness (Fredheim, Solbaa et al. 2011). The adsorption process takes place in solid material like *alumina*, *silica gel* or *molecular sieve*. A system like this has two, three or more adsorption beds. In a two bed system one of the beds are in operation while the other one is in regeneration mode. If the dehydration system consists of more than two beds they are operation in different stages. A two bed system is shown in Figure 2.3.

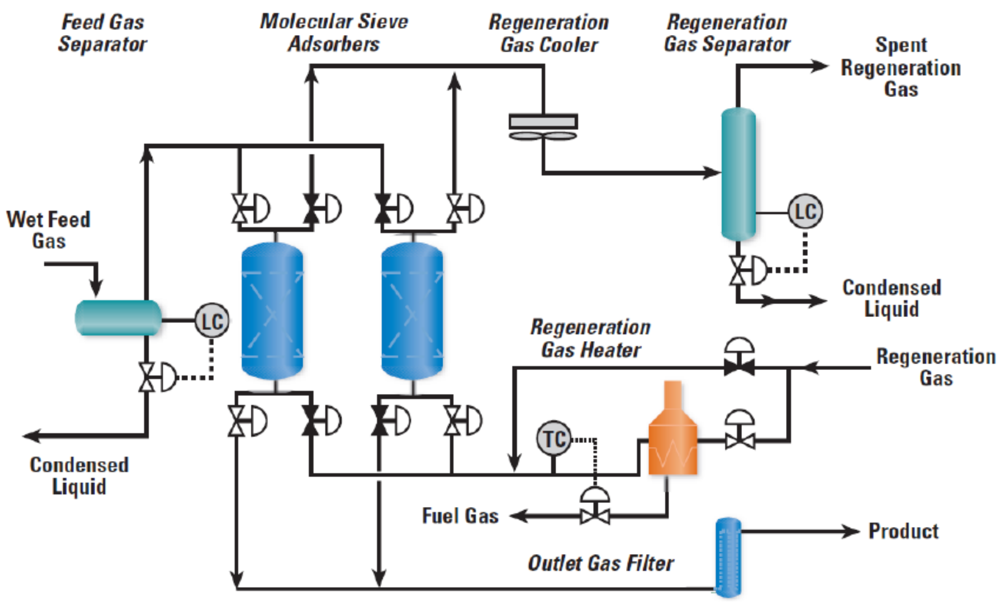

Figure 2.3 Adsorption unit with molecular sieve (Fredheim 2011)

The feed gas enters at the top and a mass transport occurs downstream the bed. The water adsorbs into the material while the gas passes through and leaves the bed at the bottom. At the same time the other bed is regenerating. Heat is added and the driving forces for mass transport are reversed as water is removed (Fredheim, Solbaa et al. 2011).

2.1.5 Mercury Removal

Mercury will together with aluminum alloys cause corrosion problems in the aluminum heat exchangers, and are therefore removed (Choi 2011). The mercury removal unit in a LNG plant is normally a fixed bed adsorption system were mercury reacts with sulphur to form mercury sulphide (Fredheim, Solbaa et al. 2011). It is sized for the maximum amount of mercury expected in the gas. The bed will be saturated after a while of operation. In difference to the dehydration unit this system cannot regenerate. The internal of the mercury removal bed needs to be replaced.

2.1.6 NGL Extraction and LPG production

Discharge from the mercury removal unit enters a heavy hydrocarbon scrub column where the NGL is extracted and LNG flows overhead. The bottom product is further fractionated in several columns, i.e. demethanizer, deethaniser, depropanizer and debutanizer. Gas from overhead of the demethanizer is sent to the condensate stabilizer.

NGL is extracted for several reasons. In large concentration the heavier hydrocarbons may freeze out in the cryogenic heat exchangers because they have a higher boiling point than the LNG product. This will lead to blockage and thereby pressure increases in the heat exchangers. In addition, there are specifications in the heating value, HHV, driven by the market with claims and boundaries. Heavier hydrocarbons have higher HHV than lighter hydrocarbons, and a deep extraction in the HHC column thereby provides a LNG product with a low HHV (Pillarella, Liu et al. 2007). These specification will differ some from market to market, with for example Asia which tolerates a HHV above 41 MJ/m^3 (Fredheim, Solbaa et al. 2011), illustrated in Figure 2.4. To obtain such a high HHV a significant amount of propane needs to remain in the LNG product.

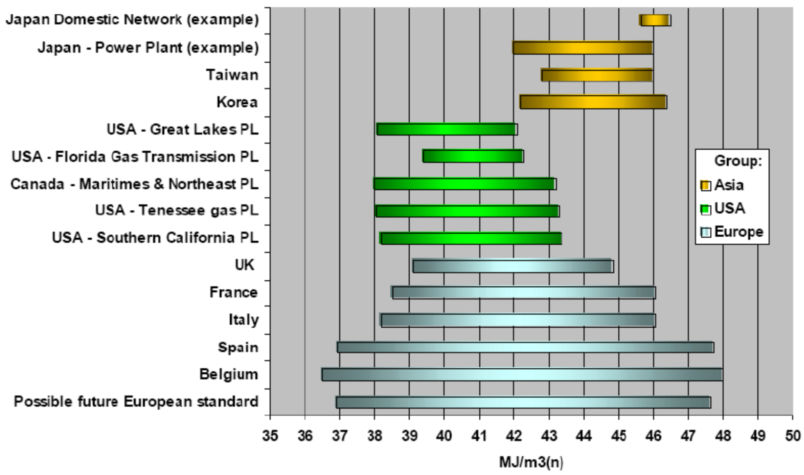

Figure 2.4 HHV around the world (Fredheim, Solbaa et al. 2011)

Another reason for separation of heavier hydrocarbons from the feed gas is production of NGL and LPG products, with the possibilities for increased economical incomes. LPG mainly consists of propane and butane and is a part of the product from the bottom of the HHC column, along with the heavier hydrocarbons and some methane and ethane. The lighter products can be fractioned and utilized as refrigerants for the cool-down process for LNG or stored and transported as LPG, while the heavier are sent to condensation stabilization.

2.1.7 Natural Gas Liquefaction

A number of configurations for liquefactions technology exist today. The main goal is to cool down the gas to -163 °C with gliding temperatures. This can be done in two basic principles (Fredheim, Solbaa et al. 2011):

- Several stages, each stage with a lower temperature. The temperature levels can either be obtained by different pressure levels or use of different refrigerants.
- Since mixed refrigerant vaporize at gliding temperatures can these refrigerants, with the right composition and pressure level, be used to liquefy gas.

At Hammerfest LNG the Mixed Fluid Cascade process, developed by Statoil and Linde, is implemented (Pettersen 2011). The process uses mixed refrigerants in the pre-cooling, liquefaction and sub-cooling cycles, illustrated in the flow diagram in Figure 2.5.

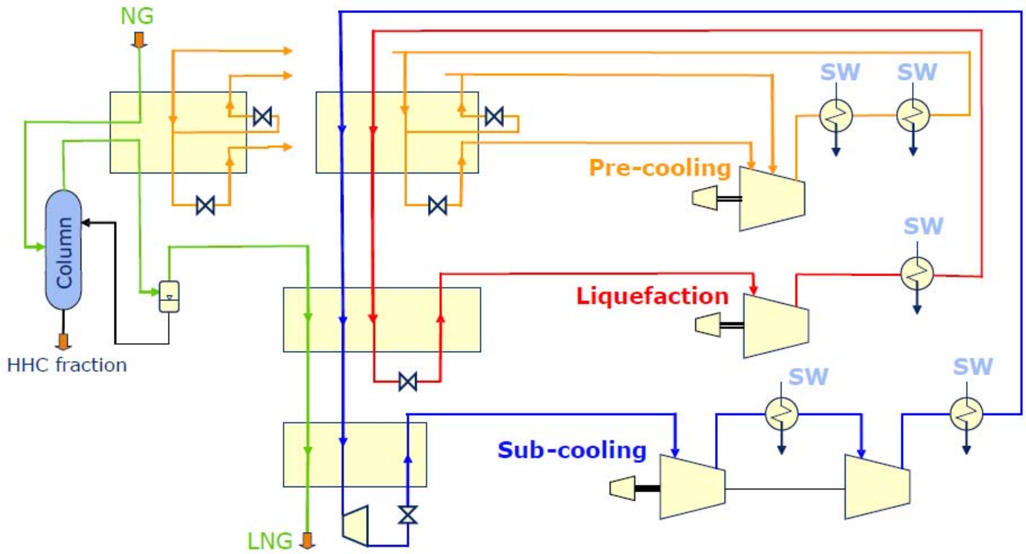

Figure 2.5 Mixed Fluid Cascade Process in Hammerfest LNG (Fredheim, Solbaa et al. 2011)

2.1.8 Storage and Transportation

LNG, LPG and condensate are stored in large tanks at atmospheric pressure at site before it is shipped out. The density of LNG is high and the amount of energy transported as LNG is 600 times that of natural gas in gaseous form at atmospheric pressure (Pettersen 2011). This allows large quantities of energy to be transported in one shipload. The ships are specially design to handle this kind of operation, both with the transportation and on- and offloading in mind and keeping the temperature at -163 °C.

2.2 Motivation for improved pretreatment in LNG plants

Pretreatment is the processes prior to the liquefaction process. The intention is to prepare the gas before liquefaction by removing unwanted components. The main focus of the report is the condensate treatment with the respect to the flow loop of heavy hydrocarbons through the pretreatment facilities. An analyse is performed from the condensate stabilizer back to the inlet facilities and up to the heavy hydrocarbon scrub column. An overview of the pretreatment facilities is shown in Figure 2.6, with the loop described over marked in red.

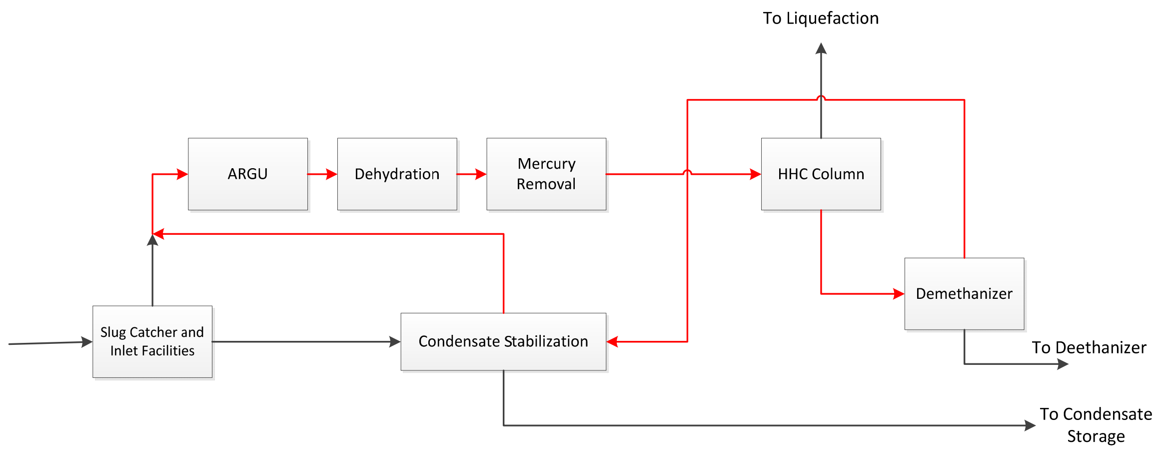

Figure 2.6 The Pretreatment Facilities and the Flow Loop of Heavy Hydrocarbons

In order to optimize the pretreatment facilities in the plant it is desirable to consider the possibility to reduce the flow of heavy hydrocarbons that are recycled in the loop.

The condensate treatment unit is essential when it comes to reduction of the heavier hydrocarbons in the process. The two feeds to the stabilizer are the bottom product from the slug catcher and the top product from the demethanizer. The top product from the stabilizer is feed back to the main process gas streamline from the slug catcher prior to the AGRU, while the bottom product is sent to condensate storage.

By optimizing the stabilizer less C_5+ hydrocarbons flows back to the main process stream and thereby an optimization of the heavy hydrocarbons in the loop are possible. It may from this thesis be possible to gain some free volume in the main process streamline and provide the opportunity to increase production. In addition, achieve good regularity and availability in the LNG plant.

3 Condensate Stabilization

From existing process flow diagrams of the LNG plant the condensate from the slug catcher meets the overhead from the demethanizer in the condensate stabilizer. The flow will consist of both light and heavy hydrocarbons. The recovered hydrocarbons need to be stabilized to avoid flash off when the condensate is brought to atmospheric pressure in the storage tank. Stabilization can thereby be defined as the process to bring down the vapor pressure of the hydrocarbon liquid to required specification (Benoy and Kale 2010). The lighter hydrocarbons is recovered and sent back to the process upstream of the AGRU and the heavy hydrocarbons are sent to storage.

There are several considerations that need to be taken into account both when designing and operating a condensate stabilizer. This chapter will cover some of the challenges that need to be considered.

3.1 The Condensate Stabilizer

Condensate stabilization can be accomplished either by flashing or fractionating. Stabilization through flashing, shown in Figure 3.1, is a simple process employing only two or three flash tanks. It provides a sufficient separation of the light and heavy hydrocarbons. To get a sharper split between components it is common in the industry to utilize a fractionator (Campbell 2004).

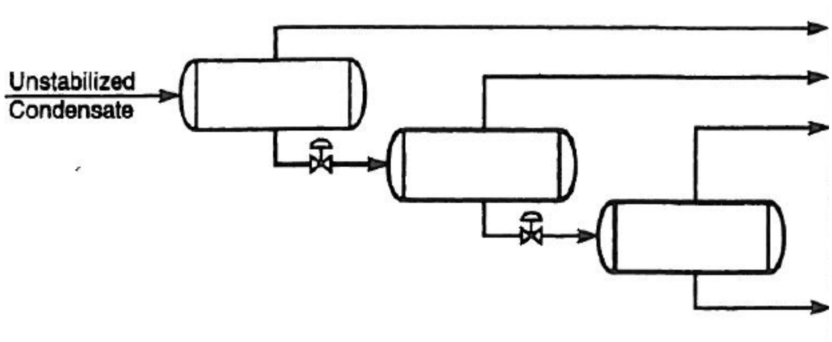

Figure 3.1 Stabilization by Flashing (Campbell 2004)

Stabilization by fractionation or distillation is a more comprehensive process than flashing and requires an external energy source. There are two different configurations that can provide for a good solution for such a column; a non-refluxed stabilizer and a refluxed stabilizer.

The non-refluxed stabilizer is similar to a stripping column and comprise a vertical column and a reboiler. A refluxed stabilizer is similar to a conventional distillation column, illustrated in Figure 3.2. In comparison to a non-reflux column it requires additional equipment, as the column consists of both a reboiler and a condenser. This will increase the cost and complexity of the control system compared to the non-reflux stabilizer (Benoy and Kale 2010). In most cases a non-refluxed stabilizer is satisfying, but it is less efficient than the reflux requiring distillation column (Ibrahim). The design of a column is a capital cost (CAPEX) versus energy cost (OPEX) problem and requires thorough overall instrument considerations.

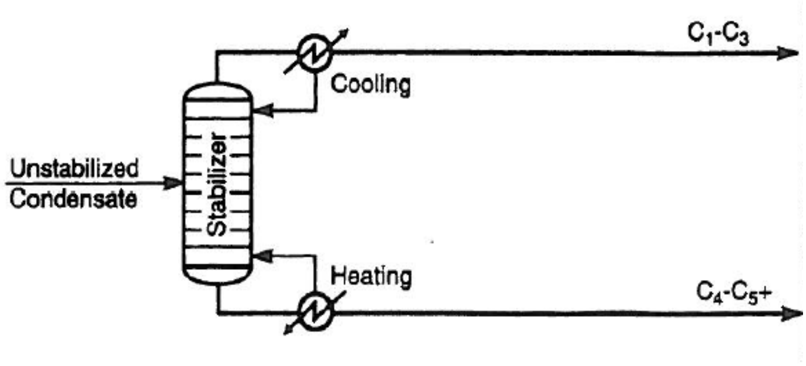

Figure 3.2 Stabilization by Fraction (Campbell 2004)

In relative to traditional stage flash stabilizers, fraction type stabilizers can be economical favorable. They provide high efficiency and are capable to control the vapor pressure for storage conditions (Campbell 2001). During production and storage it is important to test the vapor pressure in order to fall within specification. In comparison to the stage flash stabilizers, a fractionation type stabilizer provides better control.

The design of a refluxed stabilizer is done using normal distillation methods that are covered in chapter 4 and 11. In general, the bottom product will be specified, limited by the specification of the vapor pressure. The same short cut calculations cannot be done for non-refluxed stabilizers. Without the external reflux one degree of control is lost over the tower (Campbell 2004). The existing condensate stabilizer discussed in this thesis is a non-refluxed stabilizer.

3.2 Condensate Stabilizer Considerations

In order to do simulations of the condensate treatment unit in chapter 6 to 9 there is some considerations of importance that need to be clarified. This applies to containments in the feed gas and true vapor pressure. These considerations are also taken into account when a new refluxed stabilizer is designed in chapter 11.

3.2.1 Containments in the feed

Due to the composition in the feed gas from the reservoir and pipeline there are several considerations that need to be taken into account. The gas which is separated in the slug catcher can contain components that are not wanted in the condensate end product. In addition the feed from the overhead demethanizer contains components that are beneficial to be sent back to the liquefaction process. Following points should therefore be considered when designing a stabilizer (Bras, van der Zwet et al. 2007):

- It is desirable to have H_2S in the top product as it is easier to remove H_2S by the AGRU than the condensate stabilizer.

- Water that flows with the stream from the slug catcher has to exit overhead as it is an unwanted component in the condensate. This requires that the operating temperature of the bottom of the column must be higher than the bubble point of water at the operating pressure.

- If water follows the stream there is likely that it contains dissolved salts. This salt will deposit in the stabilizer or in the reboiler tubes. With high temperatures these salts will form hydrochloric acid. If this is not taken in account when choosing material it can cause material failure.

- If too much of the heavier hydrocarbons follows the overhead stream it may condense downstream of the HHC column in the demethanizer and be returned to the stabilizer. Even if this is a part of the originally design it is an inefficient process. It may be preferred to install a reflux column.

- If corrosion inhibitors are present upstream it should be monitored in what extent they are present in the condensate phase. These components can degrade at the bottom if they are not thermally stable and severe fouling in the reboiler and tubes may occur.

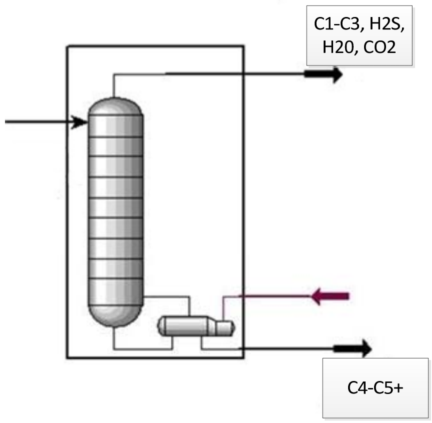

Figure 3.3 Component Split in the Stabilizer

It is important to evaluate the composition in the feed in order to make proper solutions for a stabilizer column. If this is not taken into account it can damage the process equipment and in worst case lead to plant shut down.

3.2.2 True Vapor Pressure

As mentioned in section 3.1 it is important to test the vapor pressure during production and storage of condensate in such a way that specifications are met. The vapor pressure indicates the performance of the condensate during handling. It highlights under which conditions bubbles are likely to appear and provides information on where pressure build-ups of escaping light components could happen (Pichler and Hense 2012). If this is not monitored and followed it can in worst case lead to damage to the transportation system or pumps and produce a product which is unsafe to transport by vessels to further treatment.

According to *Det Norske Veritas* the specification for TVP is 1 atmosphere at 100^{o}F (14.69 psia at 37.8 ^{o}C). During designing this value should be some lower than the specification to deal with varying flow. (Svenes 2012).

Several aspects influence the decision of the TVP value, for instance (Svenes 2012):

- If the condensate is too stable the amount of heat necessary can exceed optimal.
- If the condensate is too stable more of the heavy hydrocarbons follow overhead and flows the main process stream. This is an unwanted situation.
- Economic aspects influence the extraction in regards of most volume to the product that is more valuable within specification boundaries.

4 Distillation Theory

Regardless of specification of the final liquid/heavy hydrocarbon product, the gas needs to be treated and fractionated to achieve sales and market specifications. In this thesis such columns is utilized in the simulations for the heavy hydrocarbon scrub column, the demethanizer and in the condensate stabilizer.

Distillation is processes were separation occur because of different boiling temperatures in the gas composition. The number of fractionation column defines what kind of product the producer wants to reach. Several columns normally produces cleaner products (Campbell 2001). Distillation is a common method for separation and is used worldwide. However it is an energy demanding process, were the condenser and the boiler require energy. Even so, if the kinetic and thermodynamically relationships are analyzed there are few processes that can replace a distillation column. But some exceptions exists, and one should not use distillation columns if (Reimers 2010):

- The difference in relative volatility between the components is low.
- The amount of the component is low and it has a high boiling point.
- The component is unstable, even in vacuum.
- The component has corrosive properties or can lead to fouling in the equipment.

Columns are designed based on the assumption of equilibrium between the components that shall be separated. Even though the gas consists of several components the separation only takes place between two of them. Volatile components are called the light key components L, and less volatile components are called the heavy key components H. The degree of separation is given from the factor S in equation (4.1) (Halvorsen and Skogestad 2000).

$$S = \frac{(x_L/x_H)_T}{(x_L/x_H)_B} \tag{4.1}$$

x represent the mole fraction for a component, respectively L and H components, and T represent the top of the column and B the bottom.

4.1 Basic Distillation Theory

A column is in theory a series of separators in equilibrium, as shown in Figure 4.1. Vapor and liquid flows in opposite direction and approaches theoretical equilibrium in each separator or stage. Each separator can be seen as a stage in the column. Saturated liquid leaves the stage in the bottom while saturated vapor leaves the stage in the top, known as the vapor-liquid equilibrium, VLE. This is a good description of the physics and applies for trayed columns, but it does not hold for packed columns. Still it is well approved that calculations based on equilibrium stage fits and approaches data from real columns reasonably even for packed columns (Halvorsen and Skogestad 2000). Thermodynamically relations and equations in this chapter is from *Destillation Theory (*Halvorsen and Skogestad 2000).

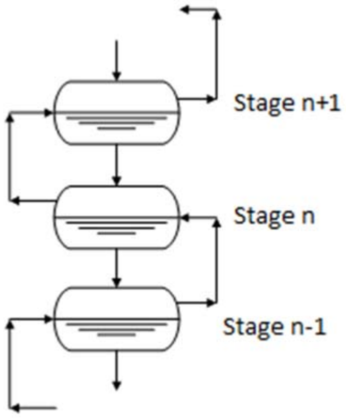

Figure 4.1 Theoretically Presentation of a Distillation Column

The condition in a system with n_C components that don`t react with each other are determent by the degree of freedom $f$. This is given from Gibb`s phase rule:

$$f = n_C + 2 - phases \tag{4.2}$$

In a system with two phases the degree of freedom is given by n_C. If one use the pressure p and molar fraction x in such a system, then the temperature T and molar fraction y can be defined. The fraction y and x is given respectively for the vapor and liquid fraction were $\sum_{i=1}^{n} y_i = 1$ and $\sum_{i=1}^{n} x_i = 1$. A general equation for the vapor and liquid fraction then becomes:

$$\begin{gathered}[y_1, y_2, \dots, y_{n_C - 1}, T] = f(p, x_1, x_2, \dots, x_{n_C - 1}) \\ [y, T] = f[p, x]\end{gathered} \tag{4.3}$$

From Raoult`s law the vapor and liquid equilibrium can be determent. With the partial pressure p_i for a component i, it follows from the law that p_i is proportional with the liquid fraction x and the evaporation pressure p_i^0 to a clean component, wich is a function of the temperature $p_i^0 = p_i^0(T)$.

$$p_i = x_i p_i^0(T) \tag{4.4}$$

According to Dalton`s law for ideal gasses the partial pressure for a component is proportional to the molar fraction and the total pressure P:

$$p_i = y_i P \tag{4.5}$$

The total pressure can thereby be defined as following:

$$P = p_1 + p_2 + \dots + p_{n_C} = \sum_i p_i = \sum_i x_i p_i^0(T) \tag{4.6}$$

The relation between liquid and gas can now be defined by combining equation (4.4), (4.5) and (4.6):

$$y_i = \frac{p_i}{P} = x_i \frac{p_i^0(T)}{P} = \frac{x_i p_i^0(T)}{\sum_i x_i p_i^0(T)} \tag{4.7}$$

In order to find the evaporation pressure to clean components the following empirical equation can be used:

$$ln\, p^0(T) \approx a + \frac{b}{c+T} + d\ln(T) + eT^f \tag{4.8}$$

The coefficients *a, b, c* and *d* are given from data sheets were the components properties are defined. By setting the coefficients *d* and *e* equal to zero the equation can be called *Antoines* equation. The pressure is an important parameter for determination of the K-value.

K-value is the value which indicates the evaporating tendency of a component. The value is sometimes referred to as an equilibrium constant even though it can be misleading. The K-value is highly dependent on pressure, temperature and composition of the feed gas.

$$K_i = \frac{y_i}{x_i} \tag{4.9}$$

A high K-value according to equation (4.9) indicates high volatile of components, and a low K-value indicates low volatile. The relative volatility between to components *i* and *j* can be defined from equation (4.10):

$$\alpha_{ij} = \frac{(y_i/x_i)}{(y_j/x_j)} = \frac{K_i}{K_j} \tag{4.10}$$

According to Raoult`s law to satisfy an ideal mixture of components the equation (4.11) are defined as followed:

$$\alpha_{ij} = \frac{(y_i/x_i)}{(y_j/x_j)} = \frac{K_i}{K_j} = \frac{p_i^0(T)}{p_j^0(T)} \tag{4.11}$$

$p_i^0(T)$ is dependent on the temperature and the K-value will therefore be constant on the end points of the column, were the temperature is approximately constant.

Generally the least volatile component, the heavy key component, is being used as a reference:

$$\alpha_i = \alpha_{ir} = \frac{p_i^0(T)}{p_r^0(T)} \tag{4.12}$$

This leads to the vapor-liquid relation defined in equation (4.7) now can be rewritten:

$$y_i = \frac{\alpha_i x_i}{\sum_i \alpha_i x_i} \tag{4.13}$$

When separation occurs between two components can the equation be written in a form were the heavy components is being left out. One can define $x = x_1$ for the light component, and $x_2 = x - 1$ for the heavy component. The relation between the vapor-liquid equilibrium can then be written as equation (4.14).

$$y = \frac{\alpha x}{1 + (\alpha - 1)x} \tag{4.14}$$

A feed gas with high volatile will not need as many steps in the column to produce a clean product as a feed gas with low volatile. The amount of components separated is fixed from the relation between *x* and *y*, illustrated in Figure 4.2. The diagram indicate the vapor and liquid equilibrium for feed gasses with different relative volatilities (Reimers 2010).

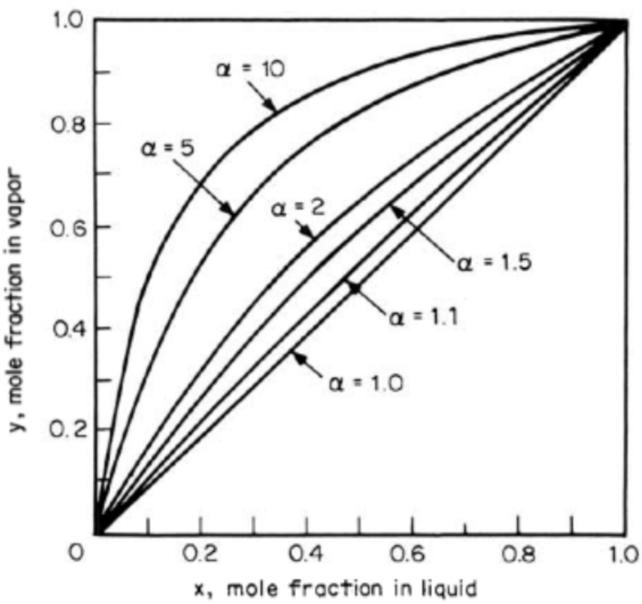

Figure 4.2 VLE with different relative volatilities (Reimers 2010)

4.2 The Distillation Column

A distillation column has several important components. The main component is the vertical column where separation occurs. It consists of plates and packing to promote separation. A boiler provides the necessary heat to evaporate the distillated product, and a condenser provides cooling of the top product.

A typical distillation column is shown in Figure 4.3. Vapor is entering at a separation stage, and trays and packing promote the contact between liquid and vapor streams. The vapor will be cooled which results in separation of heavier components. The liquid phase will be heated and some of the lighter components will be vaporized (GPSA 2004). All of the heavier components are eventually concentrated in the liquid phase as the bottom product, and the lighter products are enriched as vapor and will make the overhead product.

The bottom product leaves the column at bubble point. The vapor exiting overhead enters the condenser where heat is removed. To limit the loss of heavier components overhead the liquid is returned to the column as reflux (GPSA 2004). In cases were a total condenser is implemented, the top product will leave the reflux accumulator as liquid at bubble point. The reflux and the distillated product will then have the same composition. When a partial condenser is used the top product will leave the reflux accumulator as gas at dew point. The reflux will then be at bubble point and in equilibrium with the gas phase to the distillated product (Campbell 2001).

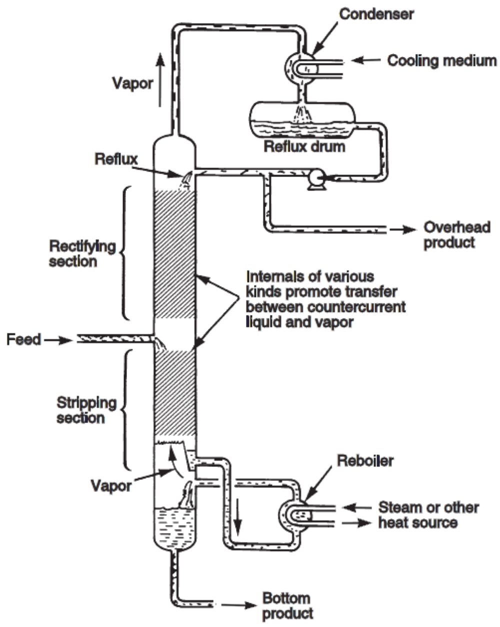

Figure 4.3 Schematic Diagram of a Distillation Column (GPSA 2004)

The choice between a total and a partial condenser has to been seen in relation to the condensing temperature and the intention of the distillation process. In a total condenser all overhead vapor is condensed to liquid (GPSA 2004). The reflux back to the column has the same composition as the distillated product. If the product should be further processed, stored and transported as liquid, a total condenser is usually preferred (Campbell 2001). In a partial condenser only some of the vapor is liquefied. In most cases only sufficient liquid is condensed to be provided as reflux for the column. However, in some other cases, more liquid than necessary is condensed and there will be two overhead products. The liquid will have the same composition as the reflux, and the vapor will be in equilibrium with the liquid reflux (GPSA 2004).

4.3 Mass balance

A mass balance around a column is the first step in fractionation calculation and determines the top product, the bottom product and the composition out of the distillation column. This require some assumption of distribution of components (Campbell 2001):

- Components that are lighter than the light key components will together with these components be a part of the top product.
- Components that are heavier than the heavy key components will together with these components be a part of the bottom product.

This will for instance lead to that in a demethanizer nitrogen will follow the top product together with methane because it is a lighter component. There are three ways to specify a desired product from the column (GPSA 2004):

- A percentage recovery of a component in the top or bottom product.
- A composition of one component in either product.
- A specific physical property.

When the feed gas composition is given, feed rate and the product specification is known, the material balance is stationary and known. The equation (4.15) is valid when both of the products are clean and the column operates stationary (Campbell 2001).

$$\frac{D}{F} = \frac{x_F - x_B}{x_D - x_B} \quad og \quad \frac{B}{F} = \frac{x_F - x_D}{x_B - x_D} \tag{4.15}$$

Where:

D = distillated product, top product, mole

B = bottom product, mole

F = feed gas, mole

x_D = mole fraction of the component at the top product

x_B = mole fraction of the component at the bottom product

x_F =mole fraction of the component in the feed gas

The material balance will from equation (4.15) be dependent of the overhead and bottom product when the feed gas composition is known. By this it is evident that there will be only one solution for a given specification for the overhead and bottom product. In actual operation there is some flexibility in relation to these products, the light and heavy key components will not be perfectly separated.

4.4 Energy Balance

For analyzing and determination of a reboiler and reflux system it is convenient to perform an energy balance around the column. It is advantageous that the column operates as energy effectively as possible. The energy balance around a distillation column is as followed (Campbell 2004):

$$Q_B + Q_C = h_D D + h_B B - h_F F \tag{4.16}$$

Where

Q_B	Reboiler heat load
Q_C	Condenser heat load
h_D	Enthalpy, distillated product
h_B	Enthalpy, bottoms product

h_F Enthalpy, feed

D, B, F Flow rate: Distillate, Bottoms, Feed

The two unknown in the equation above is the reboiler and the condenser heat load. If the column is a non-refluxed column the energy balance is therefore as follows:

$$Q_B = h_D D + h_B B - h_F F \tag{4.17}$$

The energy balance for a condenser in a refluxed distillation column can be written as:

$$Q_C = L(h_L - h_1) + D(h_D - h_1) \tag{4.18}$$

Where:

h_L Enthalpy, reflux stream

h_1 Enthalpy, vapor from top tray

L Reflux rate

For a total condenser $h_D = h_L$ can be applied and the equation can be simplified by putting L + D = V_1, and the equation becomes as followed:

$$Q_C = V_1(h_D - h_1) \tag{4.19}$$

It is stated by the equation that the dimensionless reflux ratio has an impact on the energy requirements and it is therefore often used as a measure for energy needs. An increase in the reflux ratio will increase V_1 and thereby also increase Q_C. If Q_C increases this will affect the reboiler duty Q_B by requiring more heat load. $Q_B$has a direct impact on the operation costs because it is normally supplied by boilers. In our case the reboiler is supplied by hot oil and the column is thereby dependent on being operated in a sensible way in order to reduce energy costs. (Campbell 2004)

For a given feed rate and product specification it is sated that there is a unique duty for the reboiler and the condenser. This means that if the condenser duty changes, the reboiler duty must change accordingly in order to keep the bottom product within its specifications. (Campbell 2004)

The energy supply to the column must be seen in coherence with the energy supply to the whole plant. Usually there is a limit in the heat input to not overload the plant or not influence other systems or facilities in the plant that share the same energy source. This is especially true for hot oil for the reboiler as it is provided in a specific quantum and distributed to different locations in the plant. If there is need for more hot oil than designed it will affect the hot oil supply in other systems. Sea water for the condenser is seen upon as an unlimited source as it is provided in large quantum if the LNG plant is located in a remote location by the sea.

5 Introduction to modeling of the pretreatment facilities

To be able to analyze the performance of the pretreatment facilities and the recirculation of heavy hydrocarbons (C_5+) it has been established several simulation models. This chapter gives an introduction to the modeling and aspects that needs to be taken in consideration when modeling the process.

5.1 Feed Gases

The composition of the feed gas to a plant can change over time. Either because new wells are tied in to the production pipe or the composition of the wells connected can change. Three different feed gases have been chosen for this report, Case A, Case B and Case C. They have different molar fractions for each component, but especially for methane and ethane. The three feed gases are presented in Table 5.1.

Table 5.1 Feed Gases

	Case A (mole%)	Case B (mole%)	Case C (mole%)
Nitrogen	2.5234	2.7811	2.4858
CO2	5.2588	5.9269	5.1990
Methane	80.9561	80.4270	79.8692
Ethane	5.0239	5.0117	4.9946
Propane	2.5324	2.4482	2.5646
i-Butane	0.3998	0.3798	0.4179
n-Butane	0.8295	0.7896	0.8848
i-Pentane	0.2808	0.2616	0.3222
n-Pentane	0.3078	0.2893	0.3621
n-Hexane	0.3518	0.3211	0.4569
n-Heptane	0.3908	0.3506	0.6554
n-Octane	0.3168	0.2813	0.6065
n-Nonane	0.1419	0.1247	0.3132
Benzene	0.0780	0.0687	0.0778
Toluene	0.0899	0.0805	0.0898
m-Xylene	0.0610	0.0550	0.0609
n-Decane	0.1409	0.1234	0.1287
n-C11	0.0630	0.0551	0.1018
n-C12	0.0620	0.0542	0.0808
n-C13	0.0490	0.0429	0.0639
n-C14	0.0330	0.0289	0.0509
n-C15	0.0250	0.0219	0.0449
n-C16	0.0150	0.0131	0.0269
n-C17	0.0150	0.0131	0.0269
n-C18	0.0100	0.0087	0.0180
n-C19	0.0070	0.0061	0.0130
n-C20	0.0170	0.0149	0.0629
H2S	0.0005	0.0005	0.0005

Phenol	0.0002	0.0002	0.0002
Helium	0.0200	0.0200	0.0200

5.2 Cases

The design of the pretreatment facilities is based on process flow diagrams provided by the supervisor of this thesis. Some simplifications are done in order to modify the process facilities to suit the simulation program. The cases to be evaluated are listed in Table 5.2. It has been established 12 simulations where the four designs are implemented with the three feed gas cases.

Table 5.2 Simulation Models

Design	Modification	Feed Gas
Existing pretreatment facilities	None	Case A Case B Case C
Modification of existing Stabilizer I	Temperature reduction in condensate stabilizer reboiler	Case A Case B Case C
Modification of existing Stabilizer II	Change of pipe alignment of the overhead demethanizer	Case A Case B Case C
New Stabilizer with reflux	Installation of new refluxed condensate stabilizer	Case A Case B Case C

5.3 Heating Value Requirements

The selected specification for the higher heating value is 40 MJ/m^3 in this thesis. The heating value will affect downstream processes according to the amount of heavier hydrocarbons that follows the LNG product.

Table 5.3 Chosen Specification for the HHV

	HHV (MJ/m^3)
LNG	40

Because heavier hydrocarbons have a higher heating value than lighter hydrocarbons the control of the gas composition is essential in the LNG product. Since LNG mostly contains methane and ethane, which has relatively low HHV, the key component to control the HHV is propane.

5.4 True Vapor Pressure

The true vapor pressure is an important specification to take into account during a design. If the TVP is not taken in consideration and monitored, it can lead to damage of equipment and an unsafe transportation of the condensate end product.

According to *Det Norske Veritas* the true vapor pressure should not exceed 14.69 psia at 37.8 ^{o}C. In this thesis it is recommended by the author not to exceed 12 psia in order to handle varying flow.

Table 5.4 Chosen Specification for the TVP

	TVP at 37.5 ^{o}C
True Vapor Pressure	< 12

5.5 Process Simulation Software

AspenTech HYSYS version 7.3 is used as simulation tool for modeling of the process. The program is in use in the process industry, both in oil, gas and refining. HYSYS can provide stationary and dynamic conditions, monitor, debug and optimize different processes. By utilizing contexts between energy and mass balances, phase and chemical equilibrium and reaction kinetics, the software gives the engineer the opportunity to predict how a process will behave.

The model for this thesis is made from standards in the inbuilt library. Peng-Robinson equations of state is selected as the preferred and recommended EoS for determination of thermodynamic relations between variables in the process. Based on this HYSYS utilize mathematical models for determination of energy use, mass balances and equilibrium compositions.

5.6 General Modeling Method

In this subchapter the assumptions and restriction for the model is presented. A summary is given in chapter 5.6.3.

5.6.1 Assumptions

- The feed gas condition is 70 bar and -1 ^{o}C when arriving at the plant.

- The feed gas composition in the simulation model from the subsea pipeine does not contain any MEG and water. These components have therefore not been taken into account during establishment of the simulations. MEG removal and dehydration unit is not included in the simulation models for simplicity.

- It is assumed that CO_2 and H_2S are completely removed in the AGRU. This is represented in the simulation with a component split which acts like an ideal split and removes all of the acid gases.

- In reality there is some recovery of from the depropanizer and back to the heavy hydrocarbon scrub column. This is not covered in this thesis as the flow rate is quite low. In addition the depropanizer has products exiting both in the bottom and in the middle of the column which makes it difficult to simulate.

- No irreversible pressure drop, besides the throttle valve.

- No heat leakage to the environment. All process equipment and piping is ideally thermally insulated.

- No pressure drops in separators, heat exchangers and columns is included.

- In order to have realistically flow rates for a large LNG plant, and in order to avoid loss of values because of too small scaling, it is assumed a feed rate of 20 million Sm^3/day of natural gas into the plant. This correspond to a rate of 35 243.33 kgmol/h into the system.

5.6.2 General Description of the Models

The feed gas enters the slug catcher at -1 ^{0}C and 70 bar. The slug catcher is in the HYSYS model represented by a separator which separates gas and liquid. The gas flows overhead and liquid as the bottom product. The gas is in the actual plant is sent to dehydration. Since the feed gas does not include any water the dehydration system has not been modeled. The gas is therefore sent strait to the AGRU. The acid gas removal unit is represented in the model as a component split where CO_2 and H_2S are removed from the feed.

The gas enters the precooling unit for the first step of the liquefaction process to LNG. Before the gas is further liquefied it enters the heavy hydrocarbon scrub column. The column separates the lighter and heavier components and provides the specified higher heating value for the LNG product. The LNG product flows overhead and the bottom product is sent to the demethanizer. In the demethanizer most of the methane and ethane are reclaimed and sent to the condensate treatment facilities. The bottom product from the demethanizer is sent to further fractionation. Further modeling of the fractionation processes has not been necessary.

The liquids from the slug catcher are sent to the condensate stabilizer. MEG is not part of the feed gas composition in these simulations and therefore the MEG removal unit is not implemented upstream the stabilizer. The overhead product from the condensate stabilizer is compressed and sent back to the main process stream in front of the AGRU. The bottom product is sent to condensate storage.

5.6.2.1 Slug Catcher and Inlet Facilities

The slug catcher is the first process equipment the gas meets in the plant. In reality it is a three phase separation, where rich MEG and water exits in the bottom, condensate exits in the middle and gas exits overhead. Because of the composition in the feed gas the slug catcher is in the simulations represented as a two phase separator. Any pressure drops is done after the separator over the control valves. Overhead there is a reduction from 70 bar to 60 bar, and in the bottom there is a reduction to 20 bar after the slug catcher. In reality this is done by different process equipment which is not necessary to add to this simulation.

5.6.2.2 Precooling Cycle

The entire liquefaction process from gas to LNG has not been necessary to model because the main focus is the pretreatment of gas. Before entering the heavy hydrocarbon scrub column the gas is precooled. In the simulation this is represented as a heat exchanger with a temperature drop of -34.66 ^{0}C of the gas.

5.6.2.3 Heavy Hydrocarbon Scrub Column

The heavy hydrocarbon scrub column operates at 60 bar. At this pressure this column is very sensitive when performing simulations in HYSYS. The best result and most stable simulation has been obtained by implementing a reboiled absorber and then include a condenser and an accumulator that work as a reflux. The overhead product is the gas that is going to be further condensed to LNG and thereby has the product specification of 40 MJ/ m^3 for the HHV.

In the different feed gas cases the amount of hydrocarbons will vary some, and in order to make the column converge it has been necessary to tolerate some small variation in the higher heating value.

5.6.2.4 Demethanizer

The bottom flow from the HHC is depressurized before entering the demethanizer at 34.2 bar. The objective of the column is to recover methane that followed the bottom flow. The specification for the column is accomplished when the overhead temperature of the flow is -49 ^oC. This is a very strict specification that means than almost only methane and ethane will be recovered in the column. In order to get the column to converge in HYSYS it is necessary to tolerate a temperature differenece of 1 ^oC in the temperature overhead. The bottom product will in go to further fractionating, but this has not been necessary to implement. This means that the total condensate product from the stabilizer does not include the entire amount of condensate produced. Condensate will also be a bottom product from the depropanizer and meet the bottom stream from the stabilizer before storage.

5.6.2.5 Condensate Stabilizer

The existing condensate stabilizer operates at 15.2 bar and a bottom outlet of 215 ^oC. The bottom outlet needs to comply with a specification of the true vapor pressure of 1 atmosphere at 100 ^oF (37.8 ^oC).

5.6.2.6 Adiabatic Efficiency

An adiabatic efficiency of 75 % has been used for the compressors in the simulations.

5.6.3 Summary of the General Modeling

A summary of the assumptions and general modeling is given in Table 5.5.

Table 5.5 Summary of the General Modeling Specifications

Specifications	
Thermodynamic model	Peng-Robinson
Feed gas conditions	P = 70 bar T = - 1 ^oC Flow Rate: 20 million Sm^3/day
Heavy Hydrocarbon Scrub Column	P = 60 bar HHV_{LNG} = 40 MJ/m^3
Demethanizer	P = 34.2 bar T_{top}= - 49 ^oC
Condensate Stabilizer	P = 15.2 bar T_{bottom}= 215 ^oC TVP < 12 psia
Adiabatic efficiency for the compressors	η = 75 %

6 Existing Pretreatment Facilities

The simulation model of the existing plant is based on process flow diagrams and described in section 5.6.2. The simulation model is presented in Figure 6.1 and in appendix A.1.

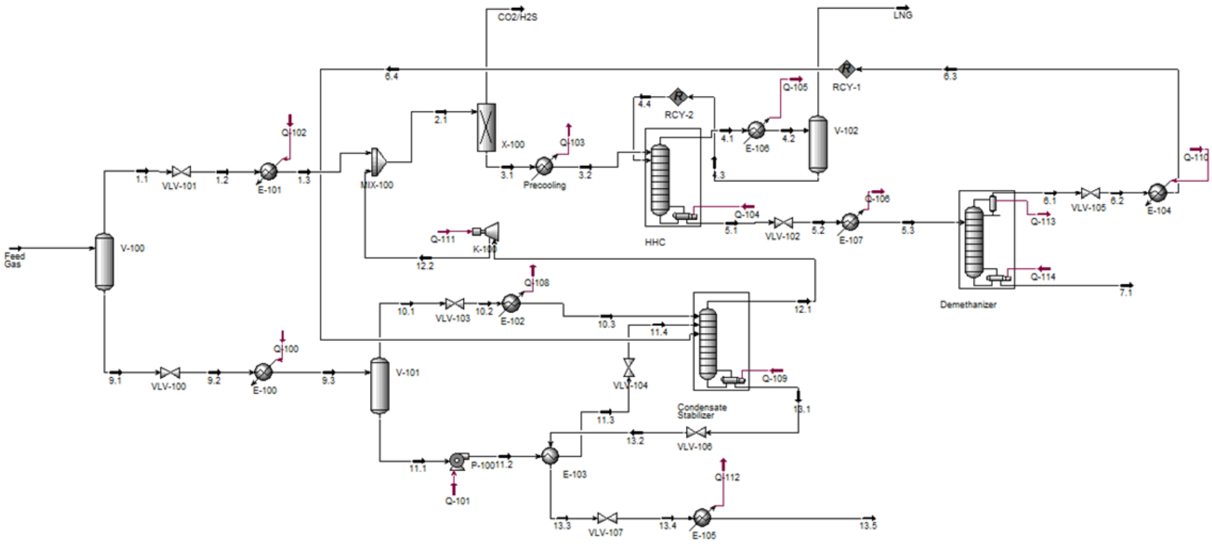

Figure 6.1 Simulation Model of the Existing Plant

At the existing plant the condensate stabilizer is a non-refluxed stabilizer, and the main specification is given by control of the temperature in the reboiler. In addition, specifications in the heavy hydrocarbon scrub column, demethanizer and TVP have to be met. Achieved specification values in the model are given in Table 6.1.

Table 6.1 Achieved Specifications

		Case A	Case B	Case C
HHC	HHV (MJ/m^3)	40.2	39.94	40.3
Demethanizer	T_{top} (^oC)	- 49.17	- 49.08	- 49.84
Condensate Stabilizer	T_{bottom} (^oC)	215.01	215.0	214.99
TVP at 37.8 ^oC	psia	8.297	7.629	8.309

6.1 Mass Balance

Based on the simulation model of the existing plant A mass balance can be established from the condensate treatment back to the inlet facilities and up to the heavy hydrocarbon scrub column. This makes a loop that is presented in Figure 6.2 with tags which refers to the simulation model. A complete heat and mass balance for the modeled pretreatment facility is given in appendix A2-A.10 for Case A, Case B and Case C.

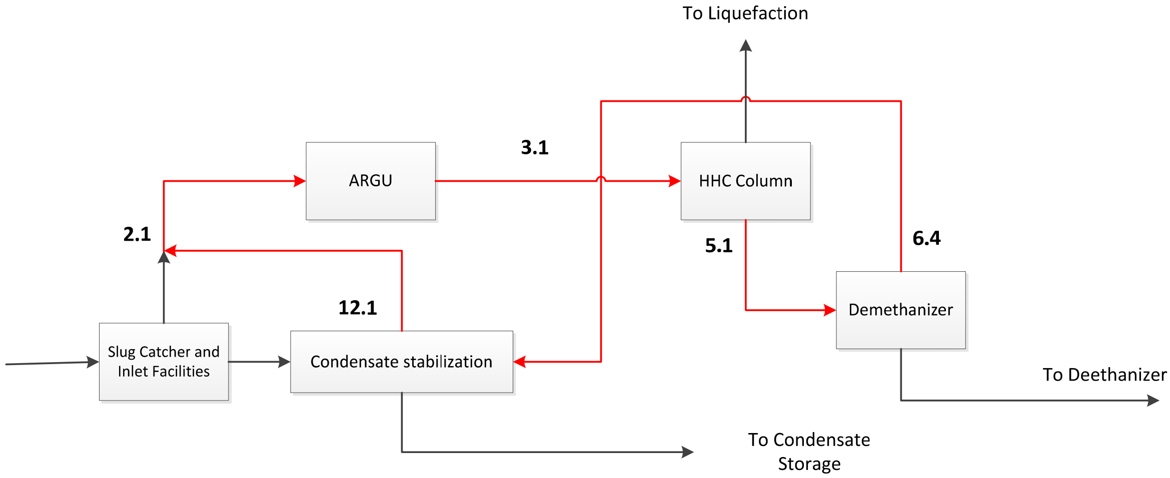

Figure 6.2 Flow Loop of the Existing Pretreatment Facilities

The total mass flow in the loop is presented in Table 6.2 and illustrated in Figure 6.3.

Table 6.2 Total Mass Flow in the Loop

	Case A kg/h	Case B kg/h	Case C kg/h
12.1	50 653.36	43 844.52	59 688.93
2.1	684 842.52	743 080.87	687 251.21
3.1	604 162.63	646 326.69	607 074.51
5.1	30 034.02	40 354.22	35 319.32
6.4	1 113.26	3 262.13	2 684.28

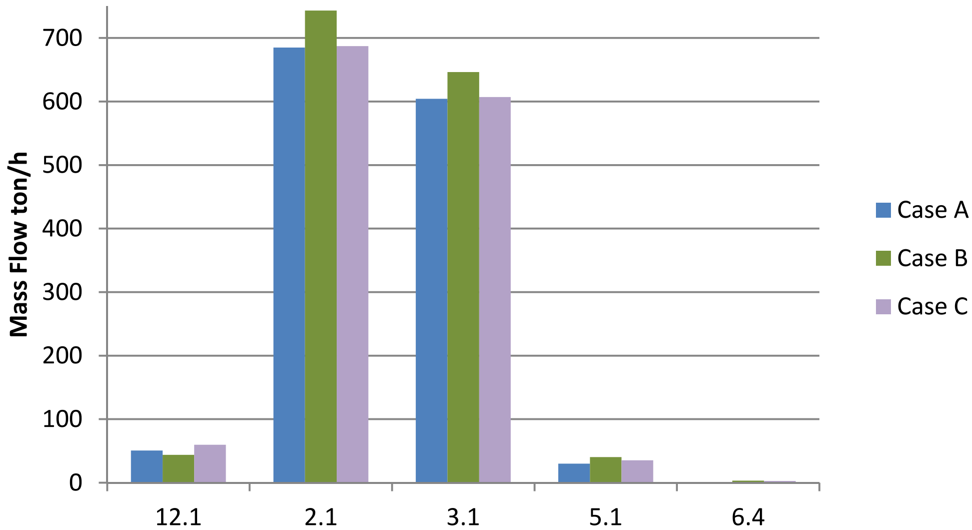

Figure 6.3 Total Mass Flow in the Loop

The total flow in stream 12.1 is 50 ton/h for Case A, 43 ton/h for Case B and 59 ton/h for Case C. This will contribute to respectively 7 %, 5.7 % and 8.5 % of the total mass flow in stream 2.1. The flow in stream 2.1 to the AGRU includes the overhead product from the condensate stabilizer stream 12.1 and the overhead product from the slug catcher.

In the AGRU about 80 ton/h of acid gas is removed before the gas is sent to the heavy hydrocarbon scurb column (HHC). In the HHC 30 ton/h for Case A, 40.3 ton/h for Case B and 35.3 ton/ h for Case C is extracted as a bottom product before it is sent to the demethanizer. The flow from the demethanizer to the condensate stabilizer, stream 6.4, is depended on the temperature of the flow overhead. The flow consists mainly of methane and ethane and varies between 1.1 ton/h for Case A, 3.2 ton/h for Case B and 2.6 ton/h for Case C.

6.1.1 Heavy hydrocarbons

For the same loop presented over a mass balance of the recirculated heavy hydrocarbons (C_5 to n-C20) can be established. A detailed mass balance regarding components can be found in appendix A.4, A.7 and A.10. The C_5+ flow is presented in Table 6.3 and in Figure 6.4.

Table 6.3 C_5+ Mass Flow in the Loop

	Case A kg/h	Case B kg/h	Case C kg/h
12.1	7 545.20	7 689.01	9 592.95
2.1	15 002.75	17 266.47	17 738.17
3.1	15 002.75	17 266.47	17 738.17
5.1	12 448.71	14 720.60	14 662.59
6.4	0.00	0.00	0.00

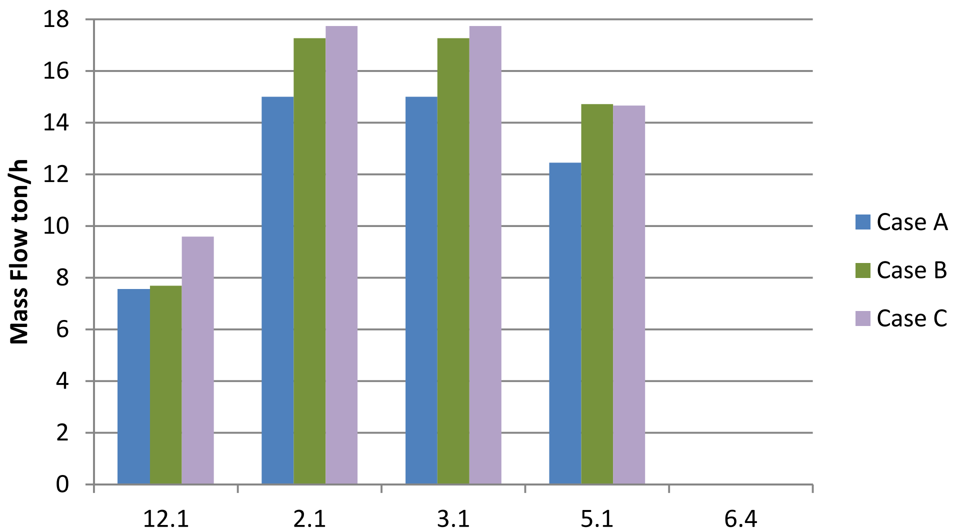

Figure 6.4 C_5+ Mass Flow in the Loop

Since there are no heavy hydrocarbons in stream 6.4, from the demethanizer to the condensate stabilizer it is concluded that all heavy hydrocarbons in stream 12.1 has to come from the separation in the slug catcher and follows the overhead stream in the condensate stabilizer. Stream 12.1 contains 7.5 ton/h of heavy hydrocarbons for Case A, 7.6 ton/h for Case B and 9.5 ton/h of heavy hydrocarbons for Case C. This is sent from the stabilizer and into the main process stream, stream 2.1. This contributes to 50 %, 44 % and 53 % respectively of the total amount of heavy hydrocarbons in stream 2.1. Relative to the total mass flow the flow of heavy hydrocarbons in stream 12.1 contributes to 1. 1 % for Case A, 1.03 % for Case B and 1.39 % for Case C of the total mass flow in stream 2.1.

Downstream the heavy hydrocarbon scrub column, stream 5.1, the flow will consist of 12.4 ton/h of C5+ hydrocarbons for Case A, 14.7 ton/h for Case B and 14.6 ton/h of C_5+ hydrocarbons for Case C. None of these will return to the condensate stabilizer, but will be further fractioned downstream.

6.2 Condensate Stabilizer Performance

The existing non-refluxed condensate stabilizer operates at 15.2 bar and has a reboiler temperature of 215 ^{0}C. The stabilizer is presented in Figure 6.5.

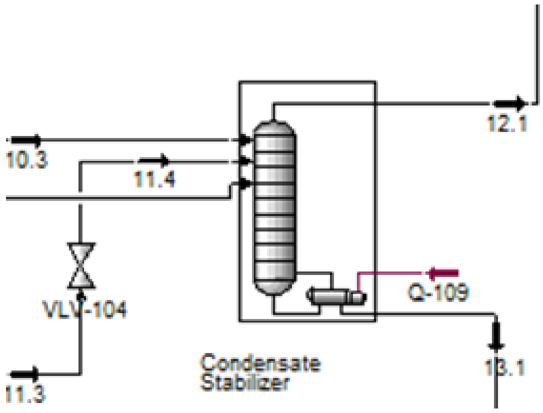

Figure 6.5 Existing non-refluxed Condensate Stabilizer

The column has three inlets locations where two streams are from the slug catcher and one is the overhead from the demethanizer. Stream 10.3 and 6.4 is pure vapor, while stream 11.4 consists of 90 % liquid. An overview of the total mass flow of the inlet streams are presented in Table 6.4.

Table 6.4 Total Mass Flow of the Inlet Streams

	Case A kg/h	Case B kg/h	Case C kg/h
10.3	24 090.59	18 430.93	27 521.76
11.4	155 102.48	95 714.95	158 298.19
6.4	1 113.26	3 262.13	2 684.28
Total	180 306.3	117 408.01	188 504.23

The overhead product, stream 12.1, goes back to the main process stream and 13.1 goes to condensate storage. The total mass flow is shown in Table 6.5 and the split in the condensate stabilizer is illustrated in Figure 6.6, Figure 6.7 and Figure 6.8.

Table 6.5 Total Mass Flow of the Outlet Streams

	Case A kg/h	Case B kg/h	Case C kg/h
12.1	50 653,36	43 844,52	59 688,93
13.1	129 652,98	73 563,50	128 815,31

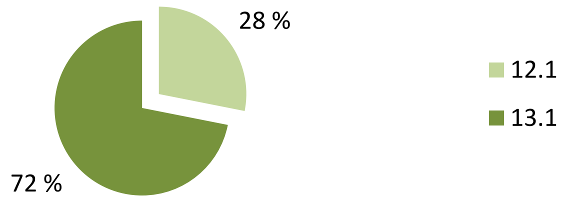

Figure 6.6 Split in Condensate Stabilizer Case A

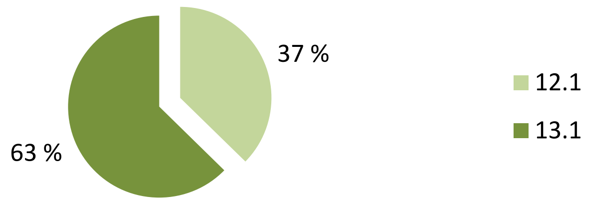

Figure 6.7 Split in Condensate Stabilizer Case B

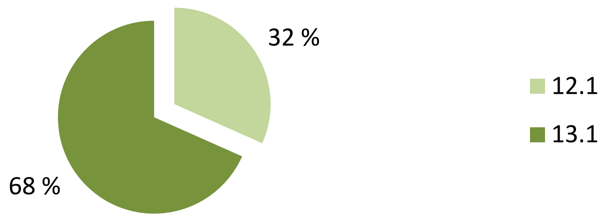

Figure 6.8 Split in Condensate Stabilizer Case C

The component splits in the condensate stabilizer is dependent of the temperature in the reboiler. This affect the models because of the composition in the stabilizer feed. In case A 28 % of the flow follows overhead while 72 % follows stream 13.1. Case B contains more of the lighter heavy hydrocarbons in the stabilizer feed and 37 % will therefore follow the overhead stream 12.1 while 63 % follows as bottom product. The condensate stabilizer split in Case C result in 32 % of the flow follows overhead and 68 % follows as bottom product.

To achieve the separation in the condensate stabilizer the non-refluxed column need energy supply. The stabilizer utilizes hot oil to provide the correct temperature in the reboiler and the energy supply is presented for the different feed gases in Table 6.6.

Table 6.6 Energy Supply to the Reboiler

Condensate Stabilizer		Case A	Case B	Case C
Reboiler	kW	11 160.0	7 119.0	11 850.0

The theoretical approach to the energy supply is given in chapter 4.4. In general one can state that the relative volatility, feed rate and the feed conditions affect the need for energy (Campbell 2004). Here it is worth noticing that the feed rate for Case B is quite low in comparison to the other cases and therefore has a lower energy demand. This is due to the composition of the feed gas and thereby the split in the slug catcher. Case A need 11.1 MW of reboiler duty, Case B needs 7.1 MW and Case C needs 11.8 MW.

7 Modification of Existing Stabilizer I

The simulation is based on the existing plant with some modification to the non-refluxed stabilizer. The temperature in the column is in this case lower than the stabilizer in the existing plant. The simulation model is similar to the model presented in chapter 6, and are shown in Figure 7.1. The cloud represent where the modification is done. Same picture can also be found in appendix B1 without the cloud.

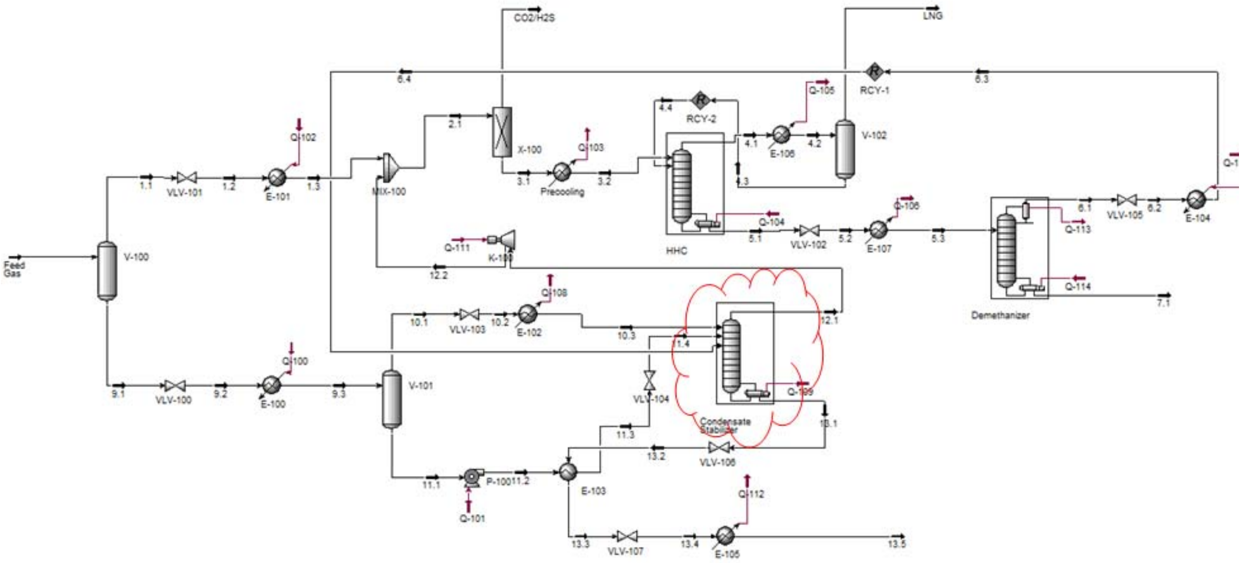

Figure 7.1 Simulation Model of the Modification of Existing Stabilizer I

In order to avoid water in the condensate product all water has to follow the overhead product from the condensate stabilizer. This means that at a column pressure of 15.2 bar the temperature in the stabilizer has to be above 197.6^oC, which is the boiling temperature to water at this pressure. To have some safety limitations the temperature in the reboiler is set to 205 ^oC. In addition the specification in the heavy hydrocarbon scrub column, demethanizer and TVP has to be met. Achieved specifications are presented in Table 7.1.

Table 7.1 Achieved Specifications

		Case A	Case B	Case C
HHC	HHV (MJ/m^3)	40.16	39.92	40.22
Demethanizer	T_{top} (^oC)	- 49.18	- 48.98	- 48.75
Condensate Stabilizer	T_{bottom} (^oC)	205	205	205
TVP at 37.8 ^oC	psia	11.71	10.72	11.10

7.1 Mass Balance

In the same way as the previous chapter, a mass balance can be established from the condensate treatment back to the inlet facilities and up to the heavy hydrocarbon scrub column. The loop is presented in Figure 7.2 and the tags refer to material streams in the simulation model. A complete heat and mass balance for the model is given in appendix B.2-B.10 for Case A, Case B and Case C.

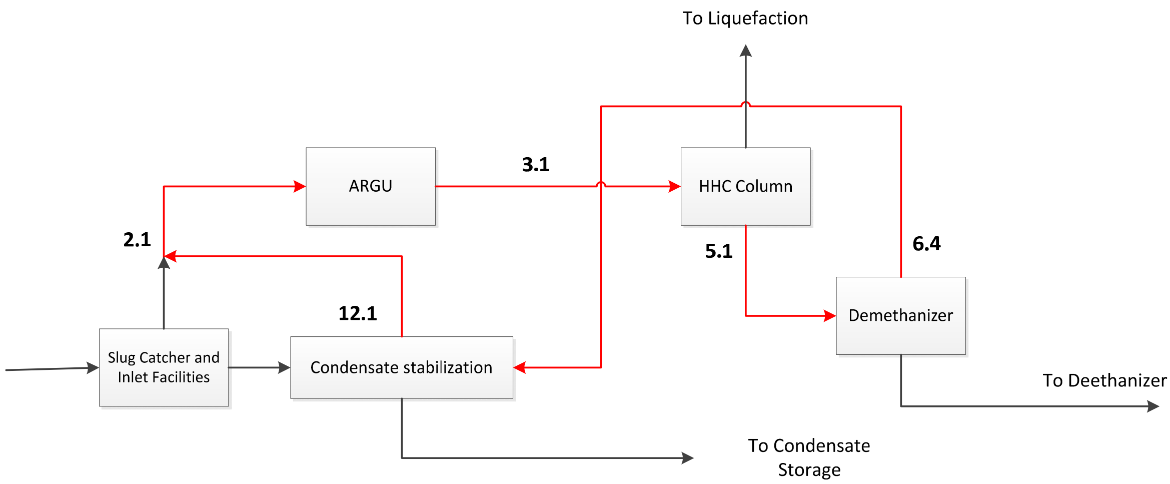

Figure 7.2 Flow Loop with the Modified Stabilizer I

The total flow in the loop is presented in Table 7.2 and illustrated in Figure 7.3.

Table 7.2 Total Mass Flow in the Loop

	Case A kg/h	Case B kg/h	Case C kg/h
12.1	48 415.99	42 219.33	53 352.44
2.1	682 605.16	741 455.68	680 914.72
3.1	601 925.27	644 701,51	600 738.03
5.1	28 736.20	39 250.59	31 685.92
6.4	1 059.17	3 244.42	104.56

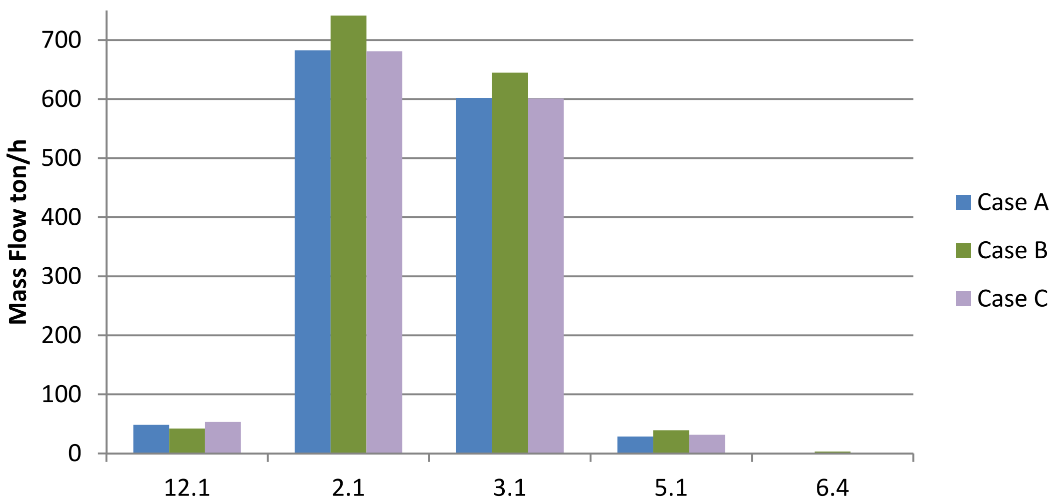

Figure 7.3 Total Mass Flow in the Loop

As stated over, 48.4 ton/h for Case A, 42.2 ton7h for Case B and 53.3 ton/h follows the overhead stream from the condensate stabilizer, stream 12.1. This contributes to respectively 7 %, 5.6 % and 7.8 % of the flow in stream 2.1 where the stream from overhead of the slug catcher meets the overhead from the stabilizer. Stream 3.1 represents the mass flow after the AGRU where 80 ton/h of acid gas has been removed.

After the HHC column most of the gas follows overhead as a LNG product, whereas 4.6 % for Case A, 6 % for Case B and 5.1 % for Case C of the gas follows as bottom product and are sent to the demethanizer. In the demethanizer the outlet temperature in the top is - 49 ^{0}C which leads to a small amount of gas that flows overhead. This gas mainly consists of methane and ethane.

7.1.1 Heavy hydrocarbons

A mass balance of heavy hydrocarbons (C_5 to n-C20) can be established using the same loop as over. A detailed mass balance regarding components can be found in appendix B.4, B.7 and B.10. The C_5+ mass flow is presented in Table 7.3 and in Figure 7.4.

Table 7.3 C_5+ Mass Flow in the Loop

	Case A kg/h	Case B kg/h	Case C kg/h
12.1	6 941.77	7 194.93	7 746.46
2.1	14 399.33	16 772.39	15 891.68
3.1	14 399.33	16 772.39	15 891.68
5.1	11 885.09	14 263.99	13 145.05
6.4	0.00	0.00	0.00

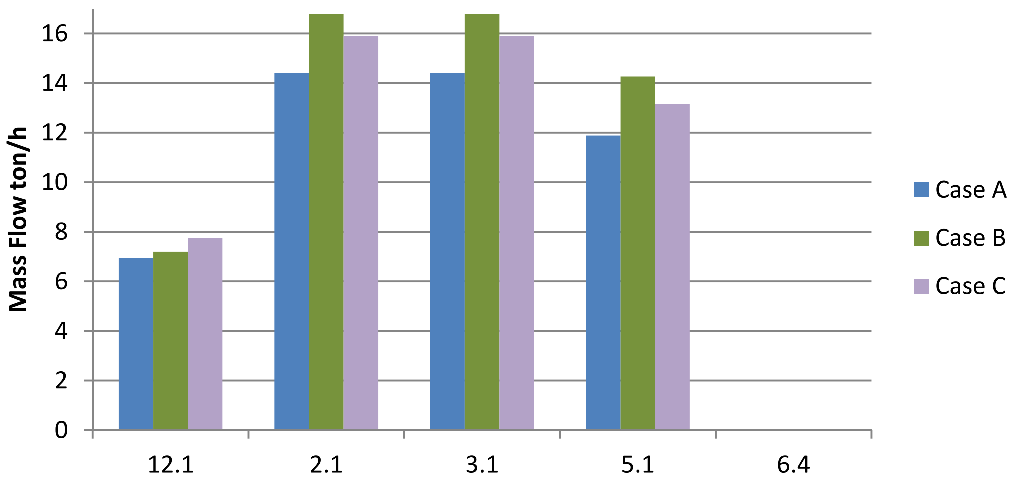

Figure 7.4 C_5+ Mass Flow in the Loop

A mass flow of 6.9 ton/h of heavy hydrocarbons for Case A, 7.1 ton/h for Case B and 7.7 ton/h of heavy hydrocarbons for Case C flows overhead of the condensate stabilizer in stream 12.1. In relation to the heavy hydrocarbons in stream 2.1 this flow from 12.1 will accommodate 49 % of the heavy hydrocarbon flow in Case A, 42 % in Case B and 48 % in Case C. This will contribute to respectively 1.06 %, 0.97 % and 1.13 % of the total mass flow in stream 2.1 before it enters the AGRU.

In the AGRU no heavy hydrocarbons are removed, and the gas is sent to the heavy hydrocarbon scrub column. Most of the C_5+ components will follow the bottom product out of the HHC column, as they contribute to a high HHV and the bottom product are therefore sent to further fractionation. None of the heavy hydrocarbons will follow the overhead product from the demethanizer, stream 6.4, as it consists of only methane and ethane.

7.2 Condensate Stabilizer Performance

The non-refluxed condensate stabilizer operates at 15.2 bar and has a reboiler temperature of 205 ^{0}C. The stabilizer is presented in Figure 7.5.

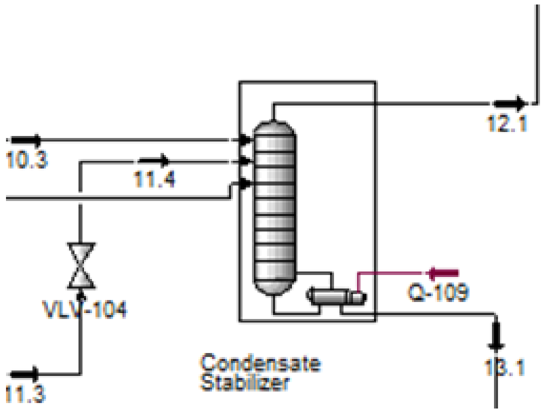

Figure 7.5 Modified Condensate Stabilizer I

The column has, also in this model, three inlet feed locations where two streams are from the slug catcher and one is the overhead from the demethanizer. An overview of the total mass flow of the inlet streams are presented in Table 7.4.

Table 7.4 Total Mass Flow of the Inlet Streams

	Case A kg/h	Case B kg/h	Case C kg/h
10.3	24 090.59	18 430.93	27 521.76
11.4	155 102.48	95 714.95	158 298.19
6.4	1 059.17	3 244.42	104.56
Total	180 252.24	117 390.3	185 924.51

The overhead product stream 12.1 goes back to the main process stream and 13.1 goes to condensate storage. The total mass flow is shown in Table 7.5 and the split in the condensate stabilizer is illustrated in Figure 7.6, Figure 7.7 and Figure 7.8.

Table 7.5 Mass Flow of the Outlet Streams

	Case A kg/h	Case B kg/h	Case C kg/h
12.1	48 415.99	42 219.33	53 352.44
13.1	131 836.25	75 170.97	132 572.07

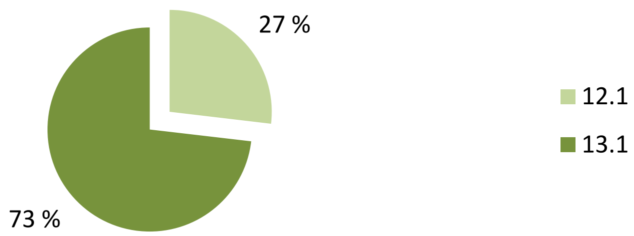

Figure 7.6 Split in Condensate Stabilizer Case A

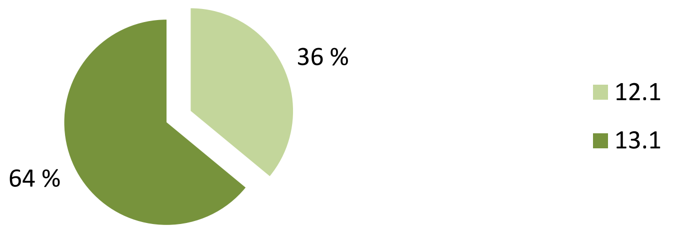

Figure 7.7 Split in Condensate Stabilizer Case B

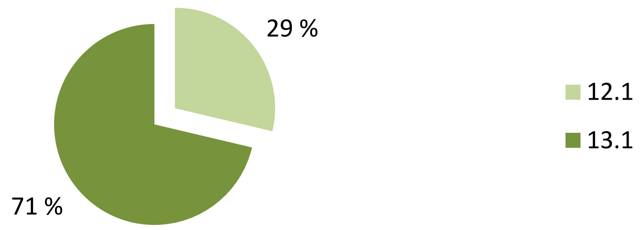

Figure 7.8 Split in Condensate Stabilizer Case C

A temperature decrease in the reboiler will in some extent contribute to a lower amount of heavy hydrocarbons that flows overhead. According to the mass balances given in appendix B.4, B7 and B.10 the overhead stream 12.1 contains more of the lighter hydrocarbons than in the previous chapter. The split in Case A contributes to 27 % of the total feed flows overhead while 73 % follows as bottoms. In Case B 36 % flows overhead and 64 % follows as bottom product. In Case C 29 % of the total feed flows overhead and 71 % follows as bottoms.

Even though the cases has different composition the result of these simulation in this chapter give a reduction in the overhead product by approximately 1 % in comparison to chapter 6 with the existing plant. Consequently, there will be an increase of 1 % of the bottom product from the stabilizer. Case C has some larger variations and result in 3 % reduction in the overhead and 3 % increase in the bottom product.

To achieve the separation in the condensate stabilizer the non-refluxed column need energy supply. The stabilizer utilizes hot oil to provide the correct temperature in the reboiler and the energy supply is presented for the different feed gases in Table 7.6.

Table 7.6 Energy Supply to the Reboiler

Condensate Stabilizer		Case A	Case B	Case C
Reboiler	kW	10 100.0	6 492.0	10 620.0

A lower temperature in the reboiler will directly affect the energy demand. One can also notice here that a lower feed rate contributes to a lower need for energy. Case A and Case C has an energy demand of 10.1 and 10.6 MW respectively, while Case B with a lower feed rate needs 6.5 MW. The need for energy is lower in comparison to the performance of the reboiler in chapter 6.

8 Modification of Existing Stabilizer II

The simulation is based on the existing plant with modifications in regards to the overhead process stream from the demethanizer to the non-refluxed condensate stabilizer. In the existing plant the stream overhead from the demethanizer is directly attached to the condensate stabilizer. Because this stream consists of mostly methane and ethane and its components will basically be transferred through the top of the stabilizer it may be advantageous to bypass the stabilizer and send enter directly the compressors. This will lead to some modifications and reconstruction of the process pipes.

The simulation model is presented in Figure 8.1 where the modification is presented in the cloud. A larger picture of the model without the cloud is given in appendix C.1.

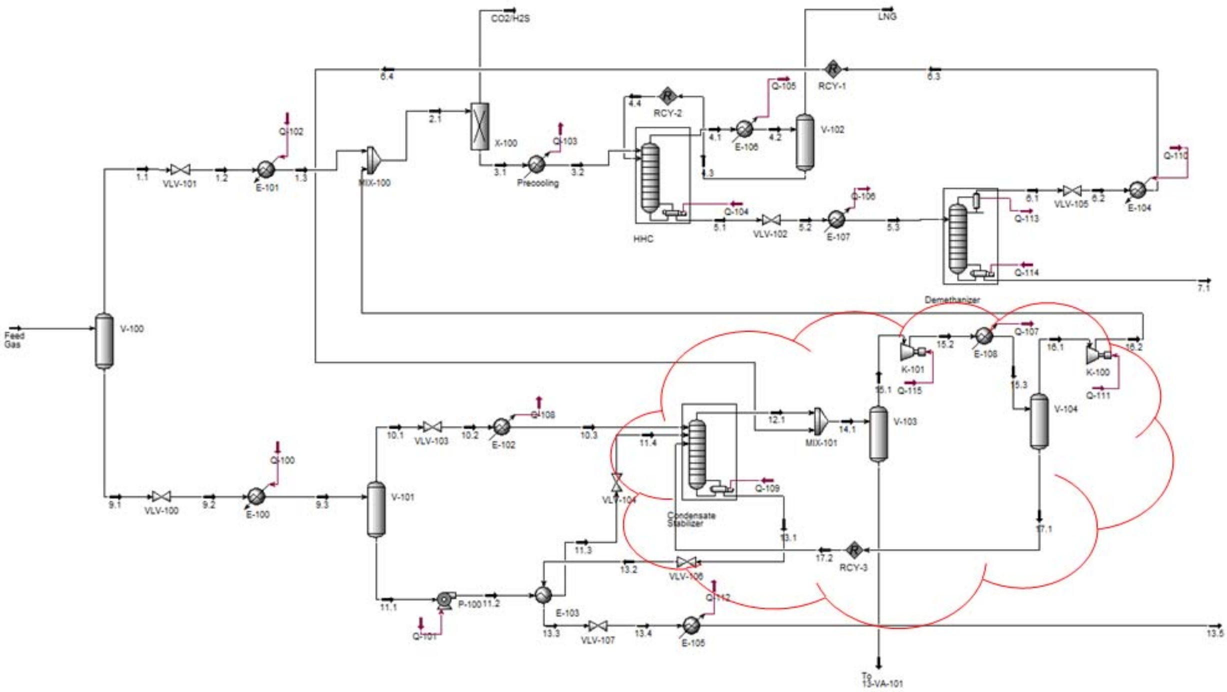

Figure 8.1 Simulation Model of the Modification of Existing Stabilizer II

To accomplish this modification it requires implementation of some more process equipment from the existing plant. In previous simulations the separation and compressor unit has only been simulated as one single compressor. For this modification it has been necessary to implement these units.

The overhead stream from the condensate stabilizer meets the overhead from the demethanizer in the first separator. A Small amount of the flow follows as bottom product and is sent to another part of the plant. The top product is compressed and heated with tempered cooling water before it enters the second separator. The bottom product is sent back to the condensate stabilizer and the overhead is sent back to the main process stream. The loop will work as a reflux system.

The achieved specifications in the model are presented in Table 8.1.

Table 8.1 Achieved Specifications

		Case A	Case B	Case C
HHC	HHV (MJ/m^3)	39.92	39.72	39.97
Demethanizer	T_{top} (^oC)	- 49.21	- 49.05	- 49.10
Condensate Stabilizer	T_{bottom} (^oC)	215	215	215
TVP at 37.8 ^oC	psia	7.889	7.035	7.759

8.1 Mass Balance

Based on the simulation of this modification a mass balance can be established. A complete heat and mass balance for the model is given in appendix C2-C10 for Case A, Case B and Case C.

The mass balance is established from the condensate stabilizer back to the inlet facilities and up to the heavy hydrocarbon scrub column. The loop is presented in Figure 8.2 and the tags refer to material streams in the simulation model.

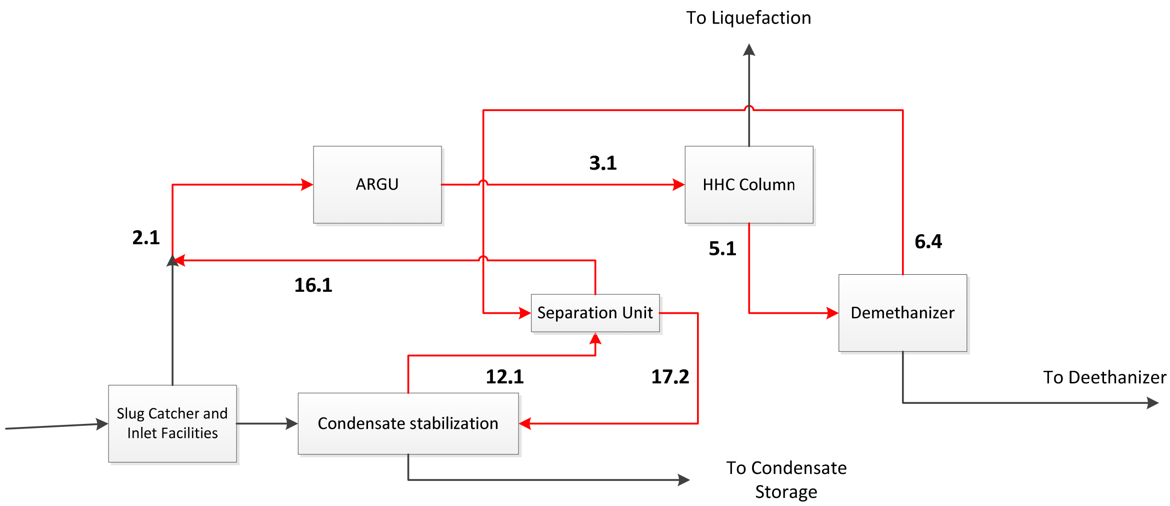

Figure 8.2 Flow Loop with the Modified Stabilizer II

The total mass flow in the loop is presented in Table 8.2 and illustrated in Figure 8.3.

Table 8.2 Total Mass Flow in the Loop

	Case A kg/h	Case B kg/h	Case C kg/h
12.1	52 213.60	44 339.04	60 098.15
17.2	6 007.11	7 069.09	7 224.31
16.1	47 156.82	41 253.88	56 083.17
2.1	681 345.99	740 490.23	683 645.45
3.1	600 666.97	643 737.07	603 469.64
5.1	33 561.57	43 546.70	39 812.46
6.4	1 046.69	4 244.92	3 419.51

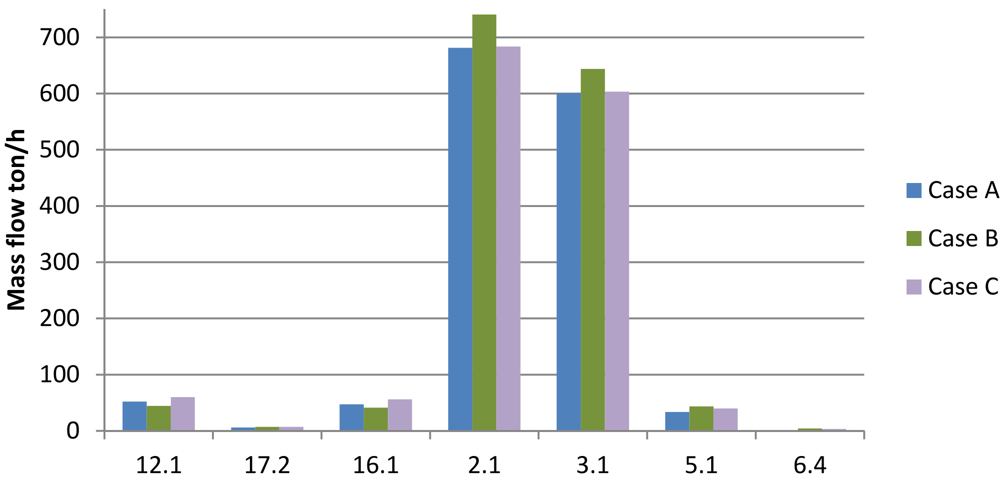

Figure 8.3 Total Mass Flow in the Loop

Relative to the feed gas 52.2 ton/h, 44.3 ton/h and 60 ton/h for Case A, Case B and Case C flows from the overhead of the condensate stabilizer. The stream will meet the overhead from the demethanizer in the separation unit and the total mass flow is stream 12.1 and stream 6.4. Stream 17.2 is the bottom product in the separator and this flow is sent back to the stabilizer. 6 ton/h is sent back in Case A, 7 ton/h in Case B and 7.2 ton/h in Case C.

The overhead product from the separator, stream 16.1, is sent to the main process stream, stream 2.1. The mass flow in 16.1 accommodates 6.4 %, 5.5 % and 8.1 % in relation to the feed gas of the total mass flow in stream 2.1.

Most of the mass flow from the AGRU into the HHC column is removed as LNG product. About 5.5-6.6 % of the total mass flow is removed in the HHC as a bottom product. The bottom product is then sent to the demethanizer where 2.9 % of the gas entering the demethanizer in Case A is removed overhead, 9.6 % in Case B case and 8.5 % in Case C and meets the top product from the condensate stabilizer before the separation unit.

8.1.1 Heavy hydrocarbons

A mass balance of heavy hydrocarbons (C_5 to n-C20) can be established using the same loop as presented in Figure 8.2. A detailed mass balance regarding components can be found in appendix B.4, B.7 and B.10. The C_5+ mass flow is presented in Table 8.3 and illustrated in Figure 8.4.

Table 8.3 C_5+ Mass Flow in the Loop

	Case A kg/h	Case B kg/h	Case C kg/h
12.1	7 932.06	7 965.80	9 678.94
17.2	3 703.96	3 932.00	4 351.06
16.1	4 158.51	3 809.51	5 145.53
2.1	11 616.07	13 386.96	13 290.75
3.1	11 616.07	13 386.96	13 290.75
5.1	10 017.44	11 743.84	11 532.14
6.4	0.00	0.00	0.00

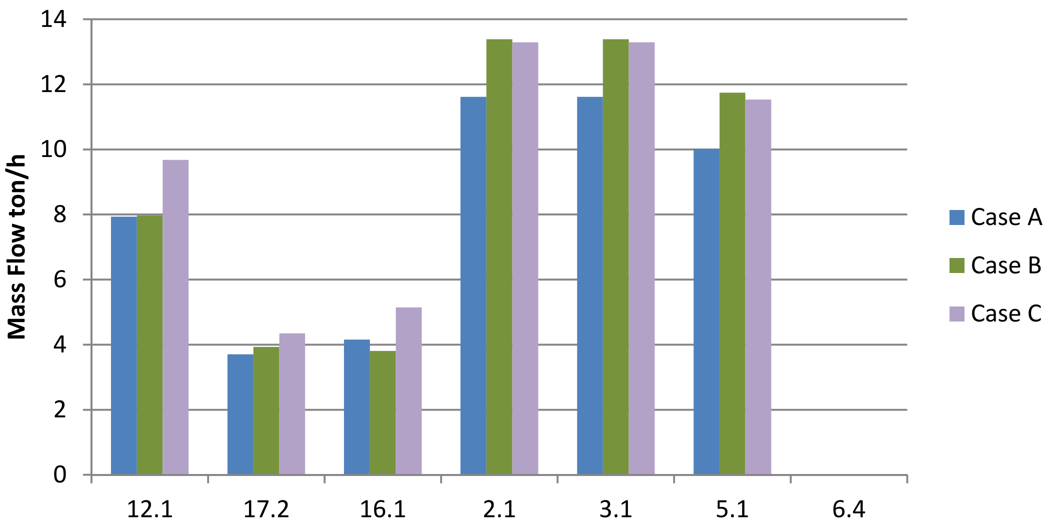

Figure 8.4 C_5+ Mass Flow in the Loop

The top product from the condensate stabilizer consists of 7.9 ton/h of heavy hydrocarbons for Case A, 7.9 ton/h for Case B and 9.6 ton/h for Case C. The flow will meet the overhead stream from the demethanizer and enter the separation unit. 3.7 ton/h will flow back to the condensate stabilizer in the Case A, 3.9 ton/h in Case B and 4.3 ton/h in Case C. The flow that is sent to the main process stream, stream 16.1, contains 4.1 ton/h, 3.8 ton /h and 5.1 ton/h of heavy hydrocarbons.

If the heavy hydrocarbon is seen isolated the flow of C_5+ components from 16.1 contributes in stream 2.1 to 37 % for Case A, 28 % for Case B and 38 % for Case C. In relation to the total mass flow, stream 16.1 with heavy hydrocarbons accommodate 0.61 % total mass flow in the main process stream 2.1 for Case A, 0.51 % for Case B and 0.75 % for Case C.

In the heavy hydrocarbon scrub column the amount of C5+ components extracted is for Case A 10 ton/h, 11.7 ton/h for Case B and 11.5 ton/h for Case C. There is no flow of heavy hydrocarbons back from the demethanizer and the bottom product from the heavy hydrocarbon scrub column is sent to fractionation.

By doing this modification of the flow stream a part of the heavy hydrocarbons are sent back to the stabilizer working as a reflux system. By regulating the temperature over the heat exchanger, E-108, the amount of heavy hydrocarbons that flow back in stream 17.1 can be regulated. There is still a part that is sent back to the main process stream, but the amount is significantly reduced compared to the existing pretreatment facilities in chapter 6.

8.2 Condensate Stabilizer Performance

The non-refluxed condensate stabilizer operates at 15.2 bar and has a reboiler temperature of 215 ^{o}C. The stabilizer is presented in Figure 8.5.

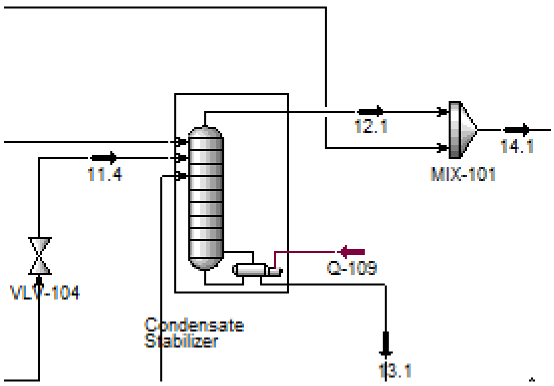

Figure 8.5 Modified Condensate Stabilizer II

The column has three inlet feeds where two of the streams are from the slug catcher, stream 10.3 and 11.4, and stream 17.2 is from the bottom product of the separator. An overview of the total mass flow of the inlet streams are presented in Table 8.4.

Table 8.4 Total Mass Flow of the Inlet Streams

	Case A kg/h	Case B kg/h	Case C kg/h
10.3	24 090.59	18 430.93	27 521.76
11.4	155 102.48	95 714.95	158 298.19
17.2	6 007.11	7 069.09	7 224.31
Total	185 200.18	121 214.97	193 044.26

The overhead product, stream 12.1, is routed back to the main process stream and 13.1 goes to condensate storage. The total mass flow is shown Table 8.5 in and the split in the condensate stabilizer is illustrated in Figure 8.6, Figure 8.7 and Figure 8.8.

Table 8.5 Mass Flow of the Outlet Streams

	Case A kg/h	Case B kg/h	Case C kg/h
12.1	52 213.60	44 339.04	60 098.15
13.1	132 986.58	76 875.94	132 946.11

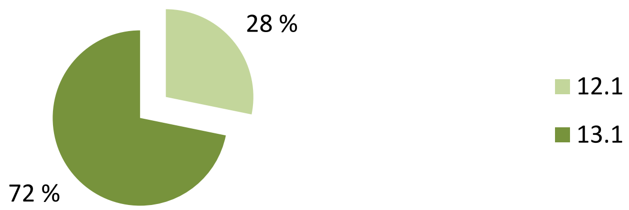

Figure 8.6 Split in Condensate Stabilizer Case A

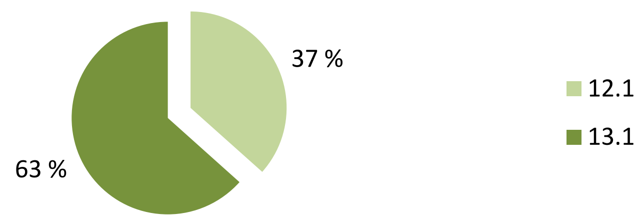

Figure 8.7 Split in Condensate Stabilizer Case B

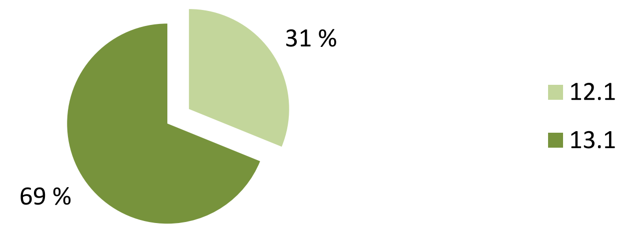

Figure 8.8 Split in Condensate Stabilizer Case C

The performance of this condensate stabilizer is quite similar to the performance of the stabilizer for the existing plant presented in chapter 6. Both stabilizers have three feed streams but stream 6.4 is here replaced with stream 17.2. The split in Case A result in 28% of the feed flows overhead while 72 % follows as bottoms. In Case B 37 % follows overhead while 63 % flows as bottom product. 31 % of the total feed to the stabilizer flows overhead in Case C while 69 % is sent to the condensate storage unit.

Mass balances presented in appendix C.4, C7 and C.10 shows that stream 17.2 consists of mainly heavier hydrocarbons and the stabilizer also needs to handle a somewhat larger flow rate. This affects the amount energy needed.

To achieve the separation in the condensate stabilizer the non-refluxed column need energy supply. The stabilizer utilizes hot oil to provide the correct temperature in the reboiler and the energy supply is presented for the different feed gases in Table 8.6.

Table 8.6 Energy Supply to the Reboiler

Condensate Stabilizer		Case A	Case B	Case C
Reboiler	kW	11 740.0	7 776.0	12 540.0

A larger flow rate contributes to some increase in the energy demand in comparison to the existing plant in chapter 6. The reboiler demands in Case A 11.7 MW, Case B 7.7 MW and in Case C 12.5 MW. This is an increase in comparison to the existing plant with 0.6 MW. A theoretical approach to the energy supply is given in chapter 4.4.

9 New Stabilizer with Reflux

The model is based on the existing plant where the non-refluxed condensate stabilizer is replaced with a refluxed stabilizer. The simulation model is presented in Figure 9.1. The cloud represents the modification that is done in comparison to the existing plant. The picture can also be found in appendix D.1 without the cloud.

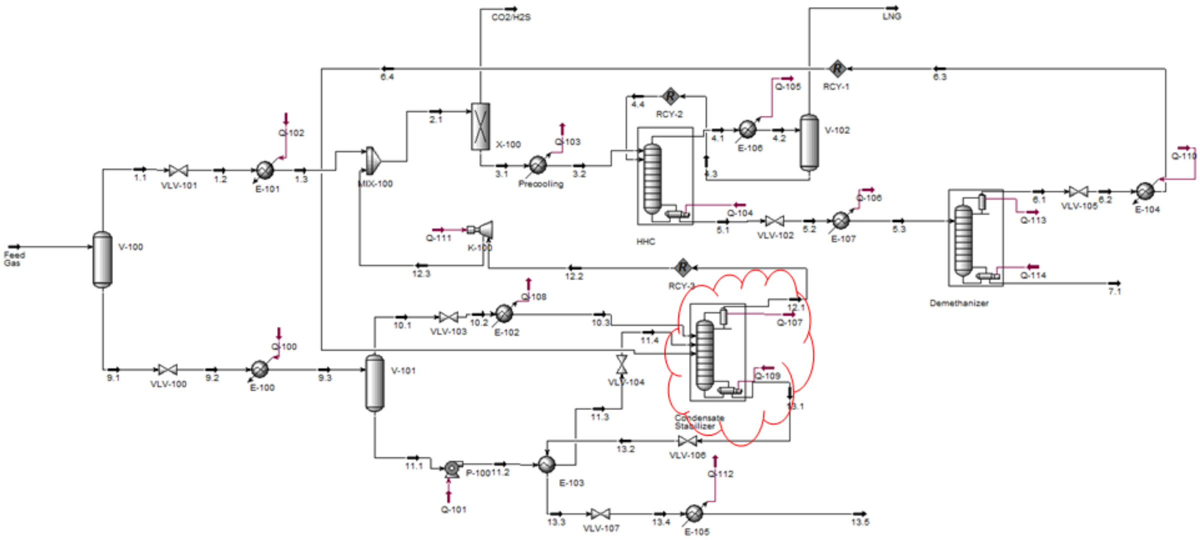

Figure 9.1 Simulation Model of the New Stabilizer with Reflux

The main goal of this distillation column is to optimize the overhead product in the condensate stabilizer such that as much as possible of the lighter hydrocarbons follows as overhead and the heavier hydrocarbons follows as bottom product.

The reboiler temperature must not fall below 205 ^{o}C in order to to avoid among water in the condensate product. The refluxed stabilizer needs in comparison to the non-refluxed stabilizer a condenser and a reflux accumulator. In addition the specification in the heavy hydrocarbon scrub column, demethanizer and TVP has to be met. Achieved specifications in the simulation are presented Table 9.1.

Table 9.1 Achieved Specifications

		Case A	Case B	Case C
HHC	HHV (MJ/m^3)	39.95	39.76	40.04
Demethanizer	T_{top} (^{o}C)	- 49.04	- 49.20	- 49.18
Condensate Stabilizer	T_{top} (^{o}C)	2.41	15.49	9.72
	T_{bottom} (^{o}C)	209.8	220.2	216.4
TVP at 37.8 ^{o}C	psia	8.136	5.153	6.621

9.1 Mass Balance

A mass balance can be established based on the simulation of the new stabilizer with reflux. For a complete heat and mass balance for the model see appendix D.2-D.10 for Case A, Case B and Case C.

The mass balance is established from the condensate stabilizer back to the inlet facilities and up to the heavy hydrocarbon scrub column. The loop is presented in Figure 9.2 and the tags refer to material streams in the simulation model.

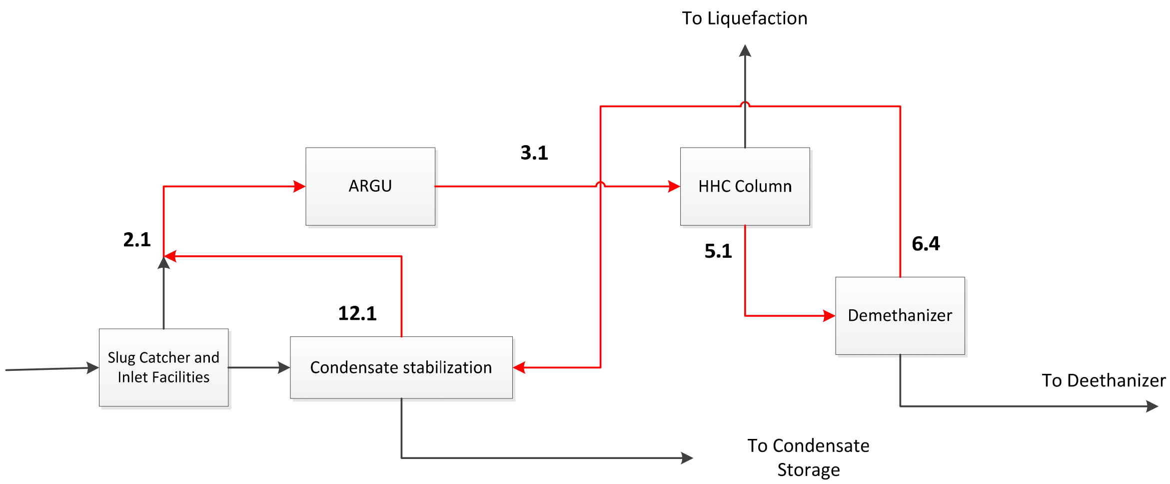

Figure 9.2 Mass Flow Loop of the Model with New Refluxed Stabilizer

The total flow in the loop is presented in Table 9.2 and Figure 9.3.

Table 9.2 Total Mass Flow in the Loop

	Case A kg/h	Case B kg/h	Case C kg/h
12.1	42 516.50	38 851.78	52 148.74
2.1	676 621.30	738 079.00	679 789.19
3.1	595 941.40	641 324.18	599 612.48
5.1	28 328.66	40 120.23	34 325.16
6.4	1 639.86	3 661.02	3 125.51

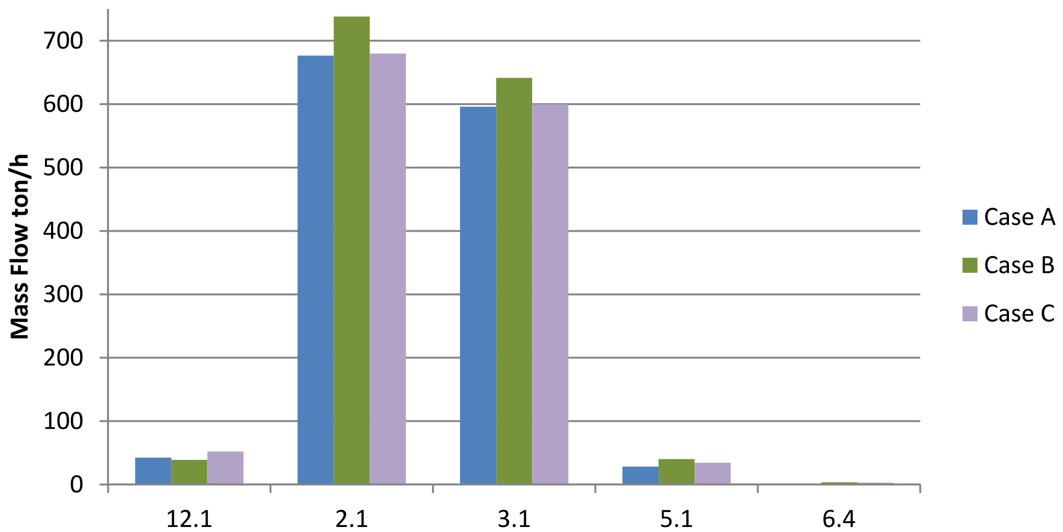

Figure 9.3 Total Mass Flow in the Loop

The overhead mass flow from the condensate stabilizer is for Case A 42.5 ton/h, for Case B 38.8 ton/h and for Case C 52.1 ton/h. This accommodates respectively to 6.2 %, 5.2 % and 7.6 % of the total mass flow in stream 2.1. The rest of the mass flow in 2.1 is overhead product from the slug catcher. Stream 3.1 is after the AGRU where approximately 80 ton/h of acid gas has been removed.

In the heavy hydrocarbon scrub column 5.2-6.2 % of the total stream 3.1 follows as bottom product in stream 5.1. This flow is sent to the demethanizer which sends 1.6 ton/h, 3.6 ton/h and 3.1 ton/h respectively for Case A, Case B and Case C to the condensate stabilizer.

9.1.1 Heavy hydrocarbons

A mass balance of heavy hydrocarbons (C_5 to n-C20) can be established using the same loop as presented in Figure 9.2. A detailed mass balance regarding components can be found in appendix D.4, D.7 and D.10. The C_5+ mass flow is presented in Table 9.3 and illustrated in Figure 9.4.

Table 9.3 C_5+ Mass Flow in the Loop

	Case A kg/h	Case B kg/h	Case C kg/h
12.1	2.44	11.86	7.49
2.1	7 460.01	9 589.06	8 152.74
3.1	7 460.01	9 589.06	8 152.74
5.1	6 213.75	8 300.28	6 894.94
6.4	0.00	0.00	0.00

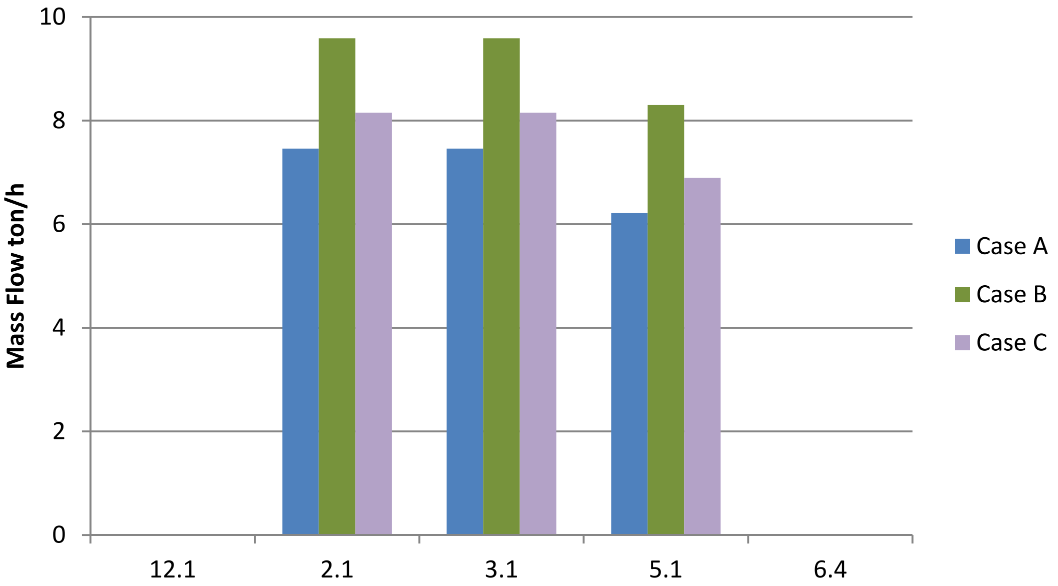

Figure 9.4 C_5+ Mass Flow in the Loop

From the condensate stabilizer it flows respectively 2.4 kg/h, 11.8 kg/h and 7.49 kg/h for Case A, Case B and Case C of heavy hydrocarbons. For Case A this contributes to 0,03 % of the total amount of heavy hydrocarbons in the main process stream 2.1, 0.12 % for Case B and 0.09 % for Case C. In relative to the total flow in stream 2.1 the flow of heavy hydrocarbons from 12.1 accommodates 0.00036 % of the total mass flow for Case A, 0.0016 % for Case B, and 0.0011 % for Case C.

It can also be noted that no heavy hydrocarbons are removed in the AGRU and the flow overhead in the demethanizer consists of only lighter hydrocarbons. The heavy hydrocarbons extracted in the HHC column will be further fractionated.

9.2 Condensate Stabilizer Performance

The refluxed condensate stabilizer operates at 15.2 bar and is presented in Figure 9.5. It has been chosen a reflux ratio of 1.05 based on rules of thumb for optimum reflux ratio of distillation columns that lies between 1.05 and 1.25 (Johnson 2004).

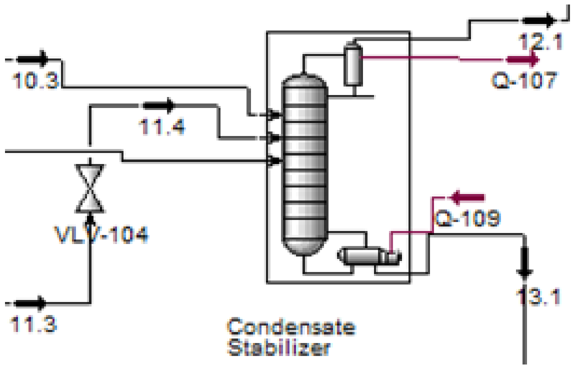

Figure 9.5 New Condensate Stabilizer

The column has three feed locations where two streams are from the slug catcher, stream 10.3 and 11.4, and stream 6.4 is from the overhead demethanizer. Stream 10.3 and 6.4 are in vapor phase while 11.3 consist of 90 % liquid. An overview of the total mass flow of the inlet streams are presented in Table 9.4.

Table 9.4 Total Mass Flow of the Inlet Streams

	Case A kg/h	Case B kg/h	Case C kg/h
10.3	24 090.59	18 430.93	27 521.76
11.4	155 102.48	95 714.95	158 298.19
6.4	1 639.86	3 661.02	3 125.51
Total	180 832.93	117 806.90	188 945.46

The overhead product, stream 12.1, goes back to the main process stream and 13.1 goes to condensate storage. The total mass flow is shown Table 9.5 in and the split in the condensate stabilizer is illustrated in Figure 9.6, Figure 9.7 and Figure 9.8.

Table 9.5 Mass Flow of the Outlet Streams

	Case A kg/h	Case B kg/h	Case C kg/h
12.1	42 516.50	38 851.78	52 148.74
13.1	138 316.43	78 955.12	136 796.71

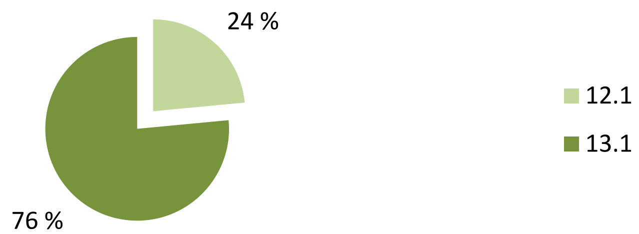

Figure 9.6 Split in Condensate Stabilizer Case A

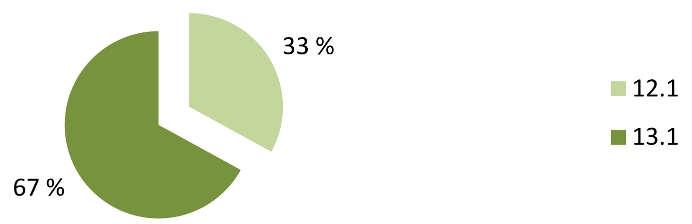

Figure 9.7 Split in Condensate Stabilizer Case B

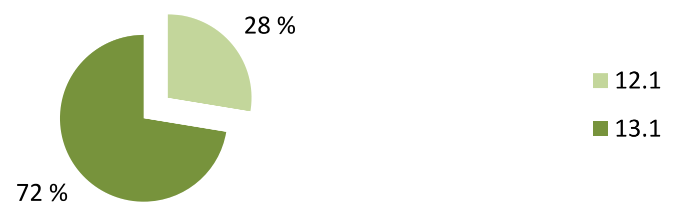

Figure 9.8 Split in Condensate Stabilizer Case C

By evaluating the mass balances presented in appendix D.4, D7 and D.10 and the amount of heavy hydrocarbons that flows overhead the stabilizer it can be stated that the refluxed stabilizer provides a sharp split. The components in 12.1 are mainly methane, ethane, propane and butanes. C_5+ components follow the bottom product and are sent to storage. This contributes to a considerably reduction of the amount of heavy hydrocarbons that flows back in the main process stream. The component split in Case A result in 26 % of the total feed flows overhead and 74 % follows as bottom product. In Case B 34 % flows overhead and 66 % as bottoms while in Case C 30 % flows overhead and 70 % follows as bottom product.

The condensate stabilizer utilizes energy both in the condenser and the reboiler. In the condenser the energy source is cooling water and the reboiler utilizes hot oil achieve the split in the column. The energy supply is presented in Table 9.6.

Table 9.6 Energy Supply to the Reboiler and the Condenser

Condensate Stabilizer		Case A	Case B	Case C
Reboiler	kW	18 660	15 090	22 350
Condenser	kW	9 599	8 814	12 020

Distillation columns are in comparison to non-refluxed columns more energy demanding because of the condenser. Case A will in total demand 28.2 MW, Case B 23.9 MW and Case C will in total demand 34.37 MW. In these simulation it is achieved a sharp split between the light and heavy hydrocarbons which demands energy. The theoretical approach to the energy supply is given in chapter 4.4.

10 Typical Plant Performance

Typical plant performance data is provided by supervisor and are *live* data from the plant discussed in this theses. It has not been possible to obtain mass fractions at desirable areas of the pretreatment facility only overhead of the demethanizer. An analyze of the heavy hydrocarbon flow is therefore mainly based on temperatures and mass flow where it can be obtained. The data is collected during a stable operation of the plant during a 24-hour period presented in Table 10.1.

Table 10.1 Time of data collected

Time	
Start	31.07.2011 16:00:00
End	01.08.2011 16:00:00

The values presented in the further subchapters are the average values during this period. There are three main columns that are analyzed, the heavy hydrocarbon scrub column, demethanizer and the condensate stabilizer. A simplified chart of the pretreatment facilities at the plant discussed is presented in Figure 10.1 where the columns of relevance are marked in red.

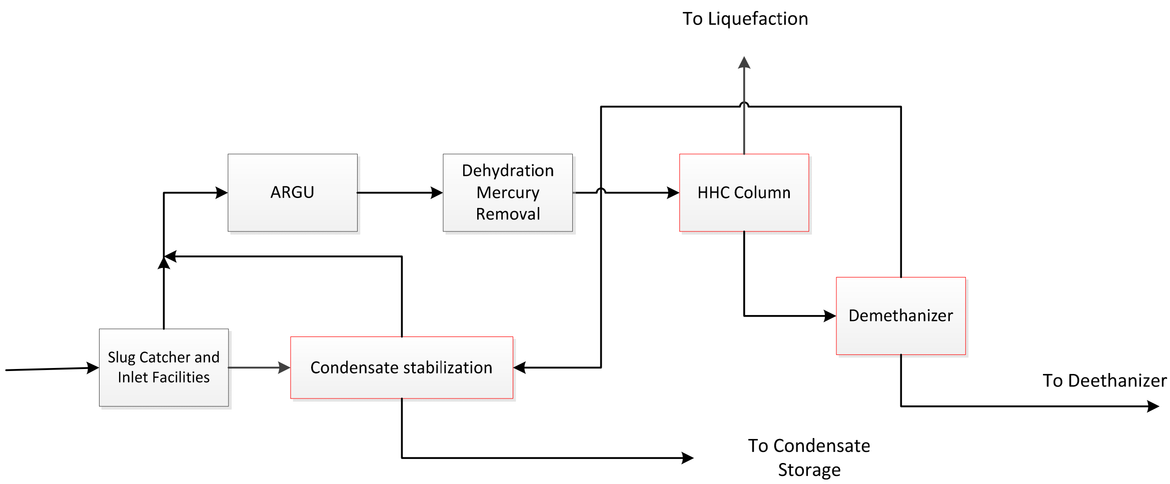

Figure 10.1 Flow Chart of the Pretreatment Processes at the Plant

To verify the simulation model developed in chapter 6 *Existing Pretreatment Facilities* it is favorable to compare the simulation result with the plant data provided by supervisor.

10.1 Heavy Hydrocarbon scrub Column

The heavy hydrocarbon scrub column at the plant is operating at 60 bar. The top product is sent to further liquefaction while the bottom product, NGL, is sent to fractionating. The performance regarding mass flow in the heavy hydrocarbon scrub column is presented in Table 10.2.

Table 10.2 Performance of the Heavy Hydrocarbon Scrub Column

	Mass Flow ton/h
Feed	619.20
Overhead	517.63
Bottom	101.57

Each hour the heavy hydrocarbon scrub column receives 619.2 tons of gas. From this, 517.63 ton/h are further liquefied and sent to LNG storage and 101.57 ton/h are bottom product and sent to fraction to produce products like refrigeration products, LPG and condensate. The typical plant performance data is in Table 10.3 shown together with the data for the HHC column in the simulation model for the *Existing Pretreatment Facilities*. The mass flow data from Case A, Case B and Case C can also be found in appendix A4, A7 and A10.

Table 10.3 HHC at the Plant Compared to the Simulation Model of the Existing Plant

	Plant Data	Case A	Case B	Case C
Feed ton/h	619.20	604.16	646.32	607.07
Overhead ton/h	517.63	574.14	605.9	571.74
Bottom ton/h	101.57	30.03	40.35	35.3

As stated in the Table 10.3 the feed flow from the plant data is quite similar to the cases simulated. The feed in Case A and Case C are lower than in the actual plant while the feed in Case B has a higher mass flow compared to the actual plant. The feed is highly dependent on the composition of the gas and thereby the separation in the slug catcher.

The overhead stream from the HHC column in the actual plant is lower than simulated and thereby the bottom stream is greater than any of the simulation cases. It is assumed that the LNG plant provides a higher heating value of the LNG product of 40 MJ/m^3. In order to meet this specification more of the heavier hydrocarbons need to be extracted. This indicates that the feed to the plant consists of more heavy hydrocarbons than in the feed gas cases simulated.

10.2 Demethanizer

The demethanizer at the LNG plant discussed is from design basis operating with a pressure of 34.2 bar. The overhead product is sent to the condensate stabilizer while the bottom product is sent to the deethanizer. The possible data that could be obtained from the demethanizer is presented in Table 10.4.

Table 10.4 Performance of the Demethanizer

	Mass Flow ton/h	Temperature ^oC	Composition
Feed	101.57		
Overhead		- 48.9	C_1= 81.8 mole% C_2= 18.15 mole% C_3= 35.19 mole ppm CO_2= 3.43 mole ppm

The feed to the demethanizer is the bottom product from the heavy hydrocarbon scrub column and contains of 101.57 ton/h gas. The temperature on the overhead stream is -48.9 ^oC and thus defines the composition of the stream. The typical plant data is compared with the demethanizer from chapter 6 *Existing Pretreatment Facilities*. The data from the simulation model can be found in appendix A2-A.10 for the three different feed gas cases.

Table 10.5 Demethanizer at the Plant Compared to the Simulation Model of the Existing Plant

		Plant Data	Case A	Case B	Case C
Mass Flow ton/h		101.57	30.03	40.35	35.3
Temperature Top ^oC		- 48.90	- 49.17	- 49.08	- 49.84
Composition Top	C_1 mole%	81.80	80.30	86.51	87.14
	C_2 mole%	18.15	19.60	11.90	11.27
	C_3 mole ppm	35.19	25.00	15.76	15.75
	CO_2 mole ppm	3.43	0	0	0

From process flow diagrams the temperature in the overhead stream is set to -49 ^oC. If small variation can be tolerated, both the plant performance and the simulation models have achieved this. In the simulation models this temperature has been used as specification and thereby defined the composition overhead of the demethanizer.

As stated in the table Case A is somewhat closer to the actual performance than the other two feed gas cases. In Case B and Case C more methane and thereby less ethane flows overhead. From appendix A.4, A.7 and A.10 can it be found that the simulation models for Case B and Case C consists of around 2 ton/h pure methane and provides a large mole fraction. Case A consists of 0.5 ton/h of methane. The data provided for the actual LNG plant does not say anything of the amount of flow in the overhead stream back to the condensate stabilizer.

10.3 Condensate Stabilizer

The condensate stabilizer at the plant operates from design basis at 15.2 bar. The plant performance data provided gives information on the two flows from the slug catcher, respectively a liquid stream and a vapor stream. The temperatures for the liquid stream and the overhead of the stabilizer is also given. The performance of the condensate stabilizer is presented in Table 10.6.

Table 10.6 Performance of the Condensate Stabilizer

		Mass Flow ton/h	Temperature ^oC
Feed	Vapor Stream	93.33	
	Liquid Stream	66.67	127.4
Overhead		53.65	38.8

The feed is upstream the stabilizer separated and the vapor stream enters the column in a tray over the liquid stream. The plant data state that 93.33 ton/h enters as vapor and 66.67 ton/h enters as vapor. This gives a total of 160 ton/h of gas that are entering the column from the slug catcher. It has not been possible to obtain the mass flow from the demethanizer. The overhead stream flows back to the inlet facilities and contains of 53.65 ton/h of gas.

The provided temperature in the liquid stream is 127.4 ^oC and the overhead stream is 38.8 ^oC. The reboiler temperature or the temperature of the bottom product has not been possible to obtain.

The provided plant data is in Table 10.7 given together with results from the simulations from chapter 6 *Existing Pretreatment Facilities*. The data from the simulation model can be found in appendix A2-A.10 for the three different feed gas cases.

Table 10.7 The Condensate Stabilizer at the Plant Compared to the Simulation Model of the Existing Plant

		Plant Data	Case A	Case B	Case C
Mass Flow ton/h	Feed Vapor Stream	93.33	24.09	18.43	27.52
	Feed Liquid Stream	66.67	155.10	95.71	158.29
	Overhead	53.65	50.65	43.84	59.68
Temperature ^{0}C	Liquid Stream	127.4	113.0	113.4	113.4
	Overhead	38.8	77.11	78.73	77.36

The first to notice is the difference in the feed flow. Where in the plant data the vapor feed is largest and liquid stream is lowest it is the opposite for the simulation models. Still the total amount of feed from the slug catcher is about the same. In the actual plant the liquid stream and the vapor stream are contributing to 160 ton/h of gas that enters the stabilizer. In Case A this is 179.19 ton/h, for Case B this is 114.14 ton/h and for Case C the total feed from the slug catcher is 185.81 ton/h.

The bottom stream from the stabilizer heat exchange with the liquid feed and the liquid stream are heated. The temperature of the liquid stream in the received plant data is higher than the liquid stream simulated. This means that either the gas flow upstream has a higher temperature than simulated or the bottom product from the stabilizer is actually higher than design basis from the process flow diagrams.

From the plant performance the overhead flow in the condensate stabilizer is quite similar to the simulations. Where the mass flow of the actual plant is 53.65 ton/h the result from the simulations shows 50.65 ton/h for Case A, 43.84 ton/h for Case B and 59.68 ton/h for Case C. Still, to get an idea of which components that are present in this stream the overhead temperature need to be taken into account.

As presented in Table 10.7 the temperature in the overhead stream is much lower in the plant data compared to the simulation models. The flow is pure vapor and the temperature therefor indicates the occurrence of heavy hydrocarbons. Vapor pressures against temperature of different components are presented in Figure 10.2.

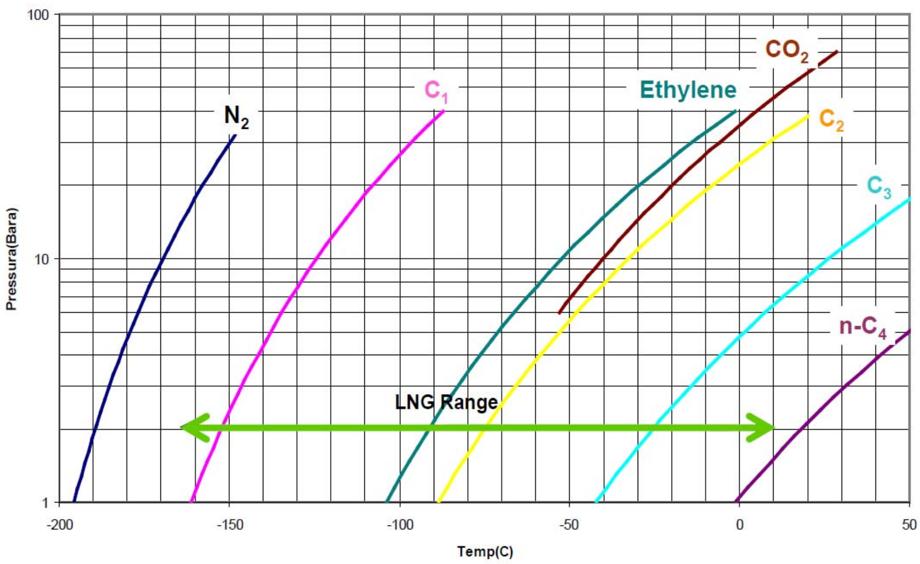

Figure 10.2 Vapor Pressure of Pure Fluids against Temperature (Fredheim, Solbaa et al. 2011)

The diagram indicates the boiling point of the pure fluids at vapor pressure. The *LNG Range* indicates the different components presence in the LNG product and is of no importance in this context. As the diagram shows, at 15.2 bar and 38.8 ^oC the components that are present is those with boiling point beneath this value. In the overhead stream nitrogen, methane, CO_2, ethane and propane are definitively present. In addition, small amounts of heavier hydrocarbons are also assumed to be found in the overhead stream.

In comparison to the plant data the simulation models has a higher temperature in the overhead stream. This indicates the presence of a greater amount of heavier hydrocarbons presence in the simulation models than in the actual plant. It is uncertain how much the heavier hydrocarbons in the actual plant constitute as there is no metering of the composition of the overhead stream. But based on the temperature it is believed by author not to pose as large share as achieved in the simulation model.

11 Preliminary Design of a New Condensate Stabilizer

The design of a new condensate stabilizer is based on simulations and results from chapter 9. This chapter provides preliminary sizing of a column that can be implemented in the existing plant. Design and sizing of the associated reboiler and reflux system is given in chapter 12.

11.1 Design Basis

The design of the condensate stabilizer is based on the performance and component splits achieved in the simulations and presented in chapter 9. The stabilizer is illustrated in Figure 9.5.

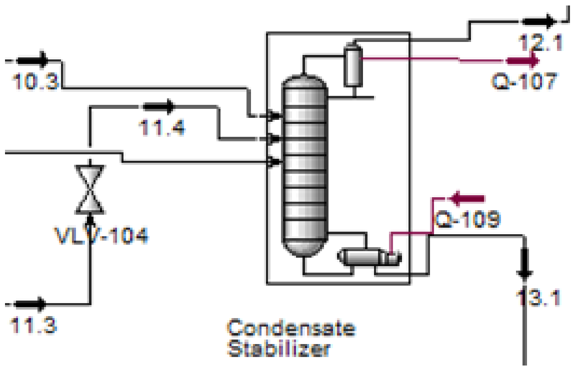

Figure 11.1 Condensate Stabilizer with Reboiler and Reflux

In comparison to the existing stabilizer a new stabilizer with reflux system will increase the recovery of heavy hydrocarbon and send it back to the stabilizer. The main goal of the reflux system is to decrease the amount of heavy hydrocarbons that flows back to the main process stream.

The new condensate stabilizer has a gas inflow between 49 139 Std m^3/ h and 73 294 Std m^3/h in relative to the feed gas composition. This is presented in Table 11.1 which gives the feed to the column.

Table 11.1 Inlet Gas Flow

	Case A Std m^3/h	Case B Std m^3/h	Case C Std m^3/h
10.3	23 854.26	17 920.12	27 337.49
11.4	40 915.08	26 497.04	41 941.54
6.4	2 108.69	4 722.42	4 015.77
Total	66 878.37	49 139.58	73 294.80

It is desirable that the column can handle every feed gas presented over. The design is therefore based on the case which provides the largest flow rate, Case C.

The temperature distribution in the column will in this design meet temperatures achieved in Case C. The bottom product should therefore be at 216.4 ^oC and the top product after the condenser should be 9.72 ^oC

11.1.1 Design Software

As for the simulations, HYSYS is used in the design of the condensate stabilizer. The built in utility tools provides sufficient methods to do preliminary sizing of the stabilizer. In addition the software program *SULCOL* from SULZER Ltd is used for estimate and check the calculations of the final result.

11.2 Operating Pressure

A tower operating pressure needs to be defined in order to make any design calculations. For a refluxed stabilizer the primary consideration for operating pressure is the cooling available in the reflux condenser. The top product will be at bubble point for a liquid product or at dew point for a vapor product. These points are fixed by a satisfying component separation and the temperature in the condenser (GPSA 2004).

In order to maximize the relative volatility between the key components in the separation it is desirable to operate the pressure as low as possible. However, if the overhead product is required with a low temperature for storage or further processing the low pressure in the column will lead to need for extended cooling, either in the condenser or by an external heat exchanger. On the other hand, if the overhead product is to be compressed it may be desirable to operate the column at a higher pressure in order to reduce compression power and the volume flow of gas. If the operating pressure is too high it can exceed the critical temperature in the bottom product, and an undesired separation can occur. (GPSA 2004)

Owing the fact that the overhead product from the condensate stabilizer needs to be compressed in order to return to the main process stream, the operating pressure is set to existing operating pressure of 15.2 bar.

Table 11.2 Operating Pressure of the Column

Operating Pressure	
Pressure	15.2 bar

11.3 Reflux Ratio and Number of Stages

The primary parameter for a refluxed distillation column, in relation to capital cost versus energy cost, is the reflux ratio and number of stages. Reflux ratio can be defined as the ratio of the molar rate of reflux liquid divided by the molar rate net overheat product (GPSA 2004).

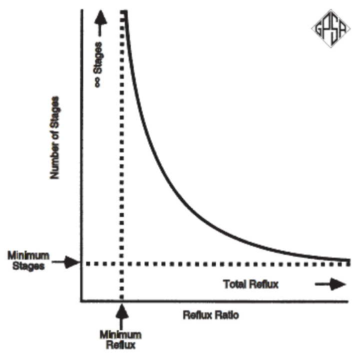

Figure 11.2 Relationship Between Reflux Ratio and Number of Stages (GPSA 2004)

The curve in Figure 11.2, which is a hyperbola, approaches minimum reflux rate at one side and minimum number of trays on the other side. The minimum reflux rate occurs where the number of stages or trays in the column is infinite and the desired product can be produced. At an infinite reflux rate the minimum number of trays occurs, often referred to as total reflux, when the separation per stage in the tower is maximum. (Campbell 2004)

These two limits do not have a practical value itself, but are useful as correlation tools. They can be used to predict the relation between the operating reflux ratio and the actual number of theoretical plates (Campbell 2004). The operation of a column is typically near the minimum reflux rate in order to minimize energy demand to heating and cooling. The criteria are therefore based on an economical consideration. If there is an increase in the condenser heat load the reboiler also has to increase to maintain the energy balance in the column. Therefore, the condenser heat load is a direct function of the reflux rate (Campbell 2004).

11.3.1 Minimum stages

For calculation of minimum number of theoretical stages needed the Frenke Equation is useful for most of multicomponent separation processes (GPSA 2004). The equation can be written in several forms, but a convenient form is shown below (Campbell 2004):

$$S_m = log\left[\frac{\left(\frac{X_L}{X_H}\right)_T \left(\frac{X_H}{X_L}\right)_B}{log\alpha_{avg}}\right] \tag{11.1}$$

Where:

S_m	Minimum number of theoretical plates
X_L	Mole fraction of light key components
X_H	Mole fraction of heavy key components
α_{avg}	Relative volatility at average tower temperature
T, B	Top or the distillated product, bottom product

As stated in the equation it is applied between the top and bottom product. If the fraction column has a total condenser the equation is applied between the top stage and reboiler. With a partial condenser the equation is applied between the distillated product and the reboiler. When the equation is properly used it can give an accurate estimate of the minimum number of stages. (Campbell 2004).

By using K-values and mole fractions calculated by HYSYS for the component split in the stabilizer, and utilize equation (4.1), (4.10) and (11.1) it can be found that the minimum number of stages is 11.

With the respect to experienced parameters provided in GPSA (ch.19 p. 15) which state that the number of actual trays for at condensate stabilizer should be between 16 and 24. Based on this it is decided to have 19 trays in the column.

Table 11.3 Stages in the Condensate Stabilizer

Stages	
Minimum	11
Actual	19

11.3.2 Minimum Reflux Ratio

It is evident that from Figure 11.2 that an infinite number of theoretical stages is necessary to obtain an optimal value for minimum reflux ratio. An infinite number indicates that there are some stages that are performing negligible. The separation between vapor and liquid in these stages will therefore result in no significant change in composition and no change in temperature from stage to stage (Campbell 2004).

A widely used method for calculating minimum reflux ratio is the Underwood method (GPSA 2004). The method involves use of two equations (Campbell 2004):

$$\sum_{i=1}^{i=n} \frac{\alpha_i f_i}{\alpha_i - \varphi} = F(1-q) \qquad (11.2)$$

$$\sum_{i=1}^{i=n} \frac{\alpha_i d_i}{\alpha_i - \varphi} = R_m + D \qquad (11.3)$$

Where:

α_i	Relative volatility of component at average tower temperature (relative to heavy component)
φ	Constant
f_i	Moles of component in feed
d_i	Moles of component in distillate
q	Total heat needed to convert one mole of feed into saturated vapor divided by molar latent heat of the feed. For bubble point feed: q = 1.0 For dew point feed: q = 0 For two phase feed: 0 < q < 1.0
R_m	Minimum reflux rate, mole
D	Distillate rate, mole

Once the theoretical minimum reflux ratio is determent the actual reflux ratio can be established based on economic criteria.

For this thesis it has been chosen a reflux ratio of 1.05 based on rules of thumbs for distillation columns (Johnson 2004).

11.4 Flooding

Flooding is a design limit and flooding capacity refers to the condition where surplus liquid holdup occurs in the column. If it occurs during operation process efficiency will decrease rapidly. In general a column is designed not to exceed 75-80 % of flood, but if the feed consists of foaming fluids it may not be advantageous to exceed 50 %. (Campbell 2004)

For this design it is chosen to have a maximum flooding of 80 %.

11.5 Mechanical Design

In order to make the column work as wanted, consequently as a fractionator, the mechanical internals is essential. Structures and packing promote mass transfer of vapor and liquid. For the choice of the vapor-liquid contactors there are five basic configurations (Campbell 2004):

- Bubble cap
- Sieve trays
- Valve trays
- Structured packing
- Random packing

The first three configurations are for typical trayed columns and the other two is for packed columns. The choice between the two columns is in most cases economical since there are no absolute criteria and their performance is getting more similar (Branan 1998). Though, there are some guidelines and a packed tower is suitable when (Campbell 2004):

- The tower diameter is small
- Corrosive fluids require special materials
- A low pressure drop is needed
- The liquid rate is high enough to minimize distribution problems

In a trayed column the pressure drop is higher than in packed columns. This is a factor to consider especially in low pressure towers. Also, if there are corrosive fluids in the feed it is more expensive to manufacture trays from alloys and packed column has an advantage (GPSA 2004).

According to GPSA random packing is advantageous in liquid loading above 49 $m^3/h/m^2$ and structured packing has been tried on fractionators with little success. A numerous of failures is experienced with structured packing when operating with high pressure or high liquid rate (GPSA 2004). Trayed columns on the other hand, provide good performance over a wide range of vapor and liquid loadings. It is selected to use a packed column for the condensate stabilizer.

11.5.1 Packed Column

A majority of distillation columns in the industry has traditionally been design as trayed columns. If the column is designed properly a packed column can have 20-40 % more capacity compared to a trayed column with the same amount of stages (Branan 1998). In general there are two types of packed columns that are suited for a condensate stabilizer (GPSA 2004):

- Structured packing
- Random packing

A packed column with various internals is presented in Figure 11.3.

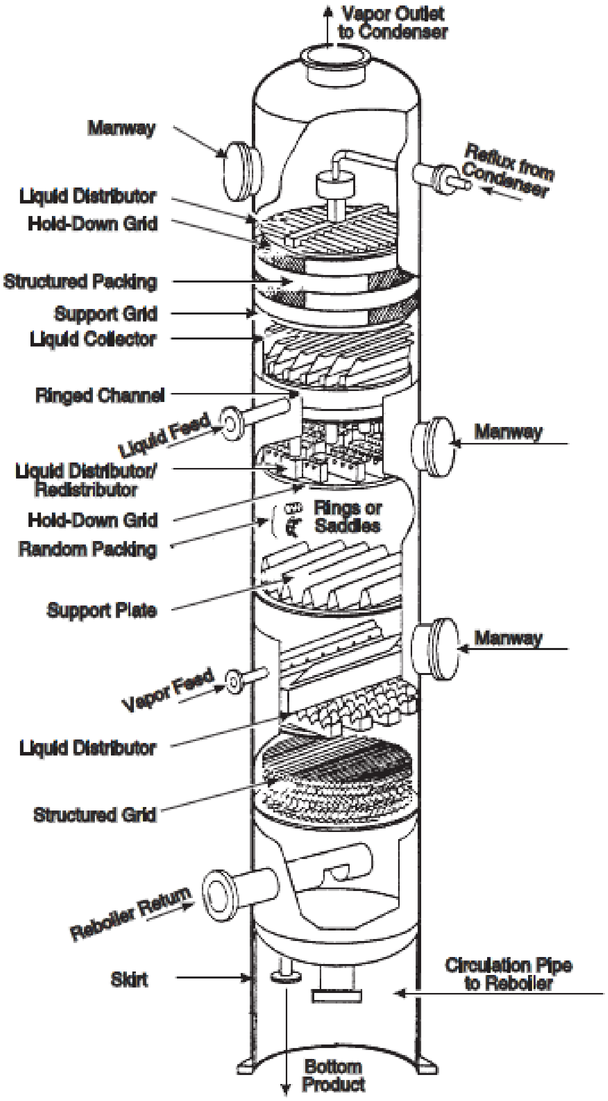

Figure 11.3 Packed Column Internals (GPSA 2004)

Structured packing has a specific geometry. The design can vary in relation to the angle, surface grooves and perforations (GPSA 2004). Structured packing has been applied in fractionators but with little success. Several failures have been detected especially in services with high pressure and/or high liquid rate.

Random packing is discrete pieces of packing that are randomly dumped into the column to promote separation. They have different design in relative to surface area, efficiency and pressure drop (GPSA 2004). Some of these configurations are shown in Figure 11.4. For this design random packing with 1.5 inched *Pall Rings* in metal is selected.

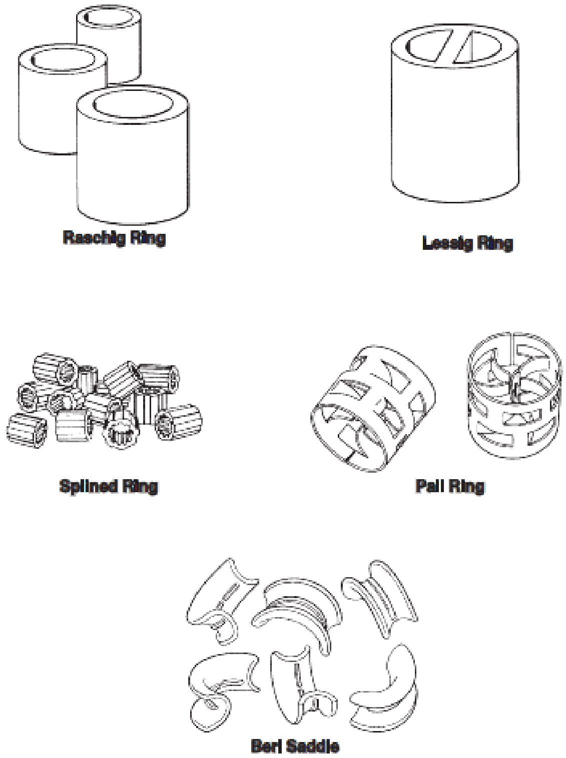

Figure 11.4 Various Types of Random Packing (GPSA 2004)

Pall Rings provide low pressure drops, high flooding limitations, good liquid distribution and have high capacity (Branan 1998). The column will also consist of various internals to support each section of packing and to promote a good distribution of the vapor and liquid phases (GPSA 2004).

11.6 Sizing of the Column

The determination of the diameter and the height of the column are based on parameters presented over and implemented in HYSYS and SULCOL. In addition it will be given a theoretical approach in how to meet the same values without the software program. One cannot use the same calculations for packed columns as for trayed columns. Packed columns require special correlations when determining these values.

11.6.1 Column Diameter

Historical one calculated the column diameter by estimating the gas velocity at the flood point and then sized the column so that the actual velocity was 50-80 % of the flooding velocity. The flood point is where there is a suddenly increase of the measured liquid hold-up and is a function of liquid viscosity, liquid rate, packing characteristics and gas and liquid densities. (Campbell 2004)

Today Generalized Pressure Drop Correlations (GPDC) is widely used for sizing packed columns. It has been extended to include several pressure drops trough the column. The GPDC method follows:

First determine the flow parameter *X (Campbell 2004)*:

$$X = \left(\frac{L}{G}\right)\left(\frac{\rho_V}{\rho_L}\right)^{0.5} \tag{11.4}$$

Where:

L	Liquid mass velocity
G	Gas mass velocity
ρ_V	Gas density
ρ_L	Liquid density

When a pressure drop in the column is decided a value for Y can be determine from the y-axis in Figure 11.5.

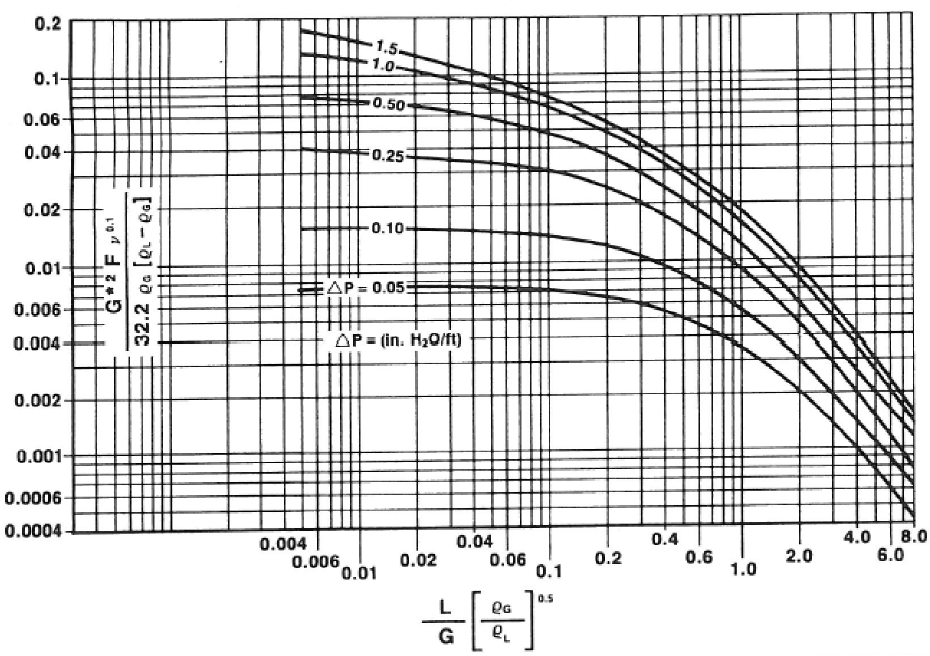

Figure 11.5 Generalized Pressure Drop Correlation (Branan 1998)

The equation for Y is as follows (Branan 1998):

$$Y = \frac{G^2 F v^{0.1}}{32.2\rho_V(\rho_L - \rho_V)} \tag{11.5}$$

Where:

F	Packing factor
v	Liquid viscosity

The packing factor is determine from experimental data and can be given by the manufacturer (Campbell 2004). Table 11.4 provides different packing factors for different packings.

Table 11.4 Packing Factors F for Random Dumped Packings (Branan 1998)

	Nominal Packing Size (in.)							
	½	⅝	¾	1	1¼	1½	2	3 or 3½
IMTP® Packing (Metal)		51		41		24	18	12
Hy-Pak® Packing (Metal)				45		32	26	16
Super Intalox® Saddles (Ceramic)				60			30	
Super Intalox® Saddles (Plastic)				40			28	18
Intalox Snowflake® (Plastic)							13	
Pall Rings (Plastic)		95		55		40	26	17
Pall Rings (Metal)		81		56		40	27	18
Intalox® Saddles (Ceramic)	200		145	92		52	40	22
Raschig Rings (Ceramic)	580	380	255	179	125	93	65	37
Raschig Rings (1/32" Metal)	300	170	155	115				
Raschig Rings (1/16" Metal)	410	300	220	144	110	83	57	32
Berl Saddles (Ceramic)	240		170	110		65	45	
Tellerettes (Plastic)				35			24	17

In this design case it is decided to use 1.5 in. metal Pall Rings and the packing factor is therefore 40.

From the equation (11.5) the gas mass velocity G can then be found and the column diameter can be established from equation (11.6).

$$d = \left(\frac{4m}{\pi G}\right)^{0.5} \tag{11.6}$$

Where:

m Mass flow rate

By utilizing the software program it has been calculated a column diameter of 3 353 mm.

Table 11.5 Condensate Column Diameter

Column Diameter	
d	3 353 mm

11.6.2 Column Height

In order to achieve the desired product enough contact between vapor and liquid are essential. This requires that the packing height is sufficient. For a packed column this calculation requires the height equivalent to a theoretical plate, HETP, or the height of a transfer unit, HTU (GPSA 2004).

The use of the HETP is more used in the industry compared to the HTU because of relations to equilibrium stage calculations discussed earlier in chapter 4 (Campbell 2004). The value of HETP is provided by the manufacture and is determined experimentally. It is a function of properties of the system, flow rates, geometric, packing size, and mechanical factors (GPSA 2004).

The actual packing high, h, is calculated as followed (Campbell 2004):

$$h = (HETP)(N) \tag{11.7}$$

or

$$h = (HTU)(NTU) \tag{11.8}$$

Where:

N Number of theoretical stages

NTU Number of transfer units

From HYSYS the height is given based on the specifications given in the previous subchapters, and it is calculates to be 13.66 m.

Table 11.6 Packing Height

Height	
h	13.66 m

11.7 Result of the Preliminary Column Design

A summary of the specifications that was established in the previous subchapters are presented in Table 11.7.

Table 11.7 Summary of the Specification in the Column

Packed Column			
Design Basis	Inlet Gas Flow	73 294.80	Stm m^3/h
	Operating Pressure	1 520	kPa
Packed column	Pall Rings, metal	1.5	inches
	Max Flooding	80	%
	Packing Correlation[1]	SLVv73	
	HETP Correlations[2]	0.7188	m

In addition there are temperature specifications that need to be met and the achieved temperature profile for the column is presented in Figure 11.6. The x-axis shows each stage from bottom to top of the column and the y-axis shows the temperature (°C). The temperature range from 60 °C in the top of the column, to 216 °C in the bottom for the vapor phase. For the liquid phase the range is from 53 °C to 95 °C.

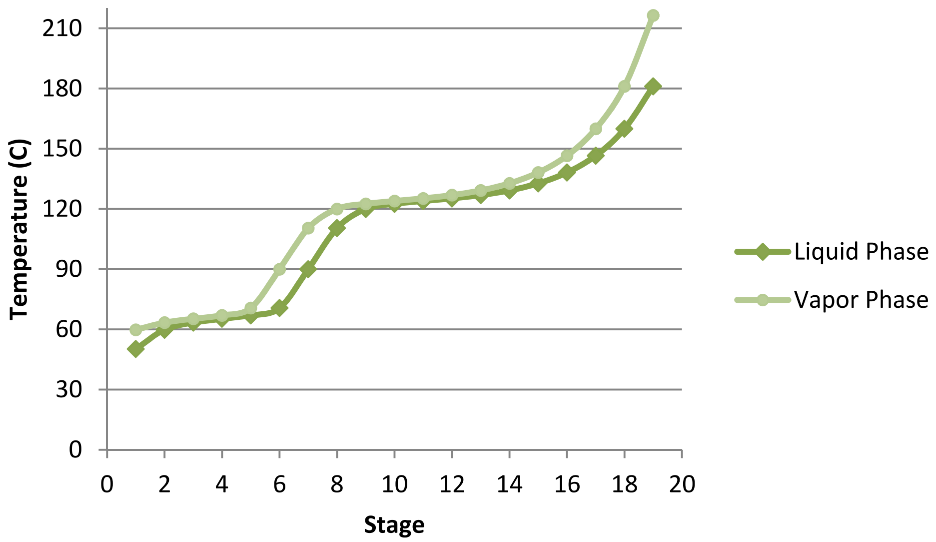

Figure 11.6 Temperature Profile for the Column

[1] Provided by HYSYS
[2] Provided by HYSYS

A preliminary sizing of the column has on this basis been performed and the result is presented in Table 11.8 with both geometric and hydraulic design.

Table 11.8 Final Design of the Column

Column Design			
Column Geometry	Diameter	3.353	m
	Area (X)	8.829	m^2
	Height	13.660	m
Hydraulic Results	Max Flooding	70.50	%
	ΔP	3.948	kPa
	ΔP per Length	0.2891	kPa/m
	Flood Gas Velocity	802.50	$m^3/h\ m^2$
	Flood Gas Velocity	0.2229	m/s

As stated the column is dimensioned with a height of 13.6 m and a diameter of 3.3 m. Max flooding detected is 70.5 % and the pressure drop in the column is 3.95 kPa. The flood gas velocity in the column is 0.22 m/s.

12 Preliminary Design of Reboiler and Reflux System

To accomplish an efficient separation in the distillation column designed in chapter 11, energy is required for the reboiler and the condenser. The reboiler needs high temperature heat to evaporate the distillated product, and low temperature heat is withdrawn at the condenser. Hot oil serves as middle and a high heat source for the whole plant and is utilized in the reboiler, while sea water is available for the condenser. The demand for energy is dependent on several factors like (Campbell 2004):

- How difficult it is to separate the components with the respect of the product specifications, relative volatility.
- Feed rate.
- Feed conditions.

A theoretical energy balance for the column is given in subchapter 4.4 considering the effect of the energy supply to the reboiler and condenser. The reboiler and reflux system discussed in this chapter is based on simulations from chapter 9. The stabilizer is presented in Figure 12.1.

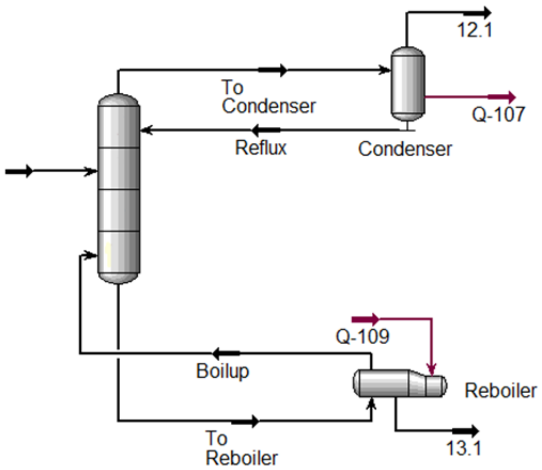

Figure 12.1 Condensate Stabilizer with Condenser and Reboiler

In order to make calculations on sizing of the reboiler and the condenser a short introduction to some basic heat transfer in heat exchangers are given in appendix E1.

12.1 Design Software

For preliminary design of the reboiler and condenser there has not been necessary to use a software program. The design is based on relations presented over. For the design of the reflux accumulator HYSYS is used. The built in utility tools provides sufficient methods to do preliminary sizing of the accumulator.

12.2 Reboiler

When designing a reboiler for the new condensate stabilizer there are several factors that needs to be taken in consideration. In the selection of reboiler type it is important to consider following (Bell and Mueller 2001):

- If there is a risk of fouling in the fluid, the fluid should be on tube side because it is easier to clean than the shell side.
- If corrosive fluids are present they must be placed inside the tubes in order to save costs of a shell made of alloy.
- High pressure fluids should be placed on tube side to avoid thick walled shells and expenses related.
- High temperature fluids should be placed inside tubes to reduce cost on shell design.
- The requirements of the heating medium may be more important than the requirements of the boiling liquid.
- Foaming is easier to handle inside of tubes.

Based on this the hot oil provided for the reboiler should be placed on tube side and one must consider the possibility of moderate fouling. There are several reboilers that are suited to be applied to the designed column. The selection of reboiler type generally follows the selection guidelines provided in Figure 12.2.

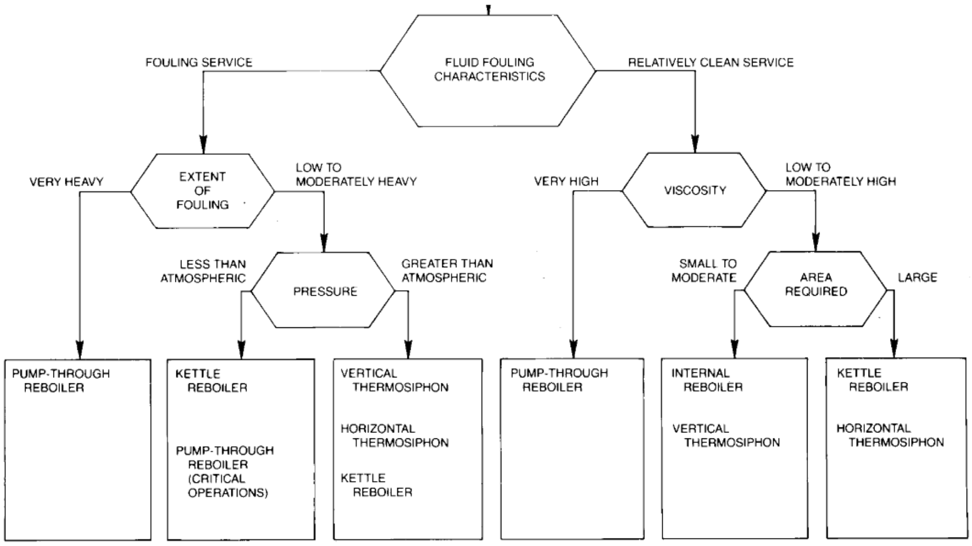

Figure 12.2 Reboiler Selection Chart (GPSA 2004)

Since the reboiler operates above atmospheric pressure the alternative for a reboiler is therefore a *Kettle reboiler* or a vertical or horizontal *Thermosyphon reboiler.* The existing plant analyzed in this thesis has a Kettle reboiler installed and the Kettle is therefore selected for further study.

12.2.1 Preliminary Sizing of the Kettle Reboiler

The Kettle reboiler is commonly used in the gas processing industry. It is preferred because it provides high vapor quality, good turndown capability and the Kettle reboiler have a large heat exchange surface area (GPSA 2004). A general drawing of the reboiler is shown in Figure 12.3.

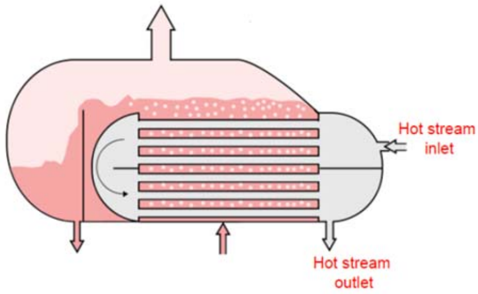

Figure 12.3 Kettle Reboiler (Fredheim, Solbaa et al. 2011)

The Kettle reboiler is a pool type reboiler and the vapor leaves the top at saturate temperature (Bell and Mueller 2001). They are typically more costly than other reboiler due to the shell size and surge volume. The picture below shows a typical kettle installation (GPSA 2004).

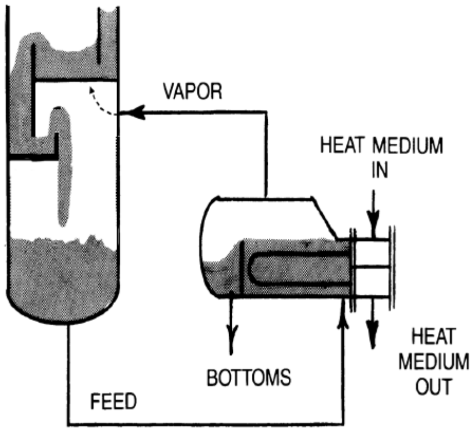

Figure 12.4 Kettle Reboiler on Column Bottom (GPSA 2004)

The preliminary sizing of the reboiler given in this thesis will not go in detail. The main focus is to calculate the surface heat exchange area of the reboiler.

For calculation the overall heat transfer coefficient is necessary. According to GPSA the u-value for hot oil in reboilers is between 510-680 W/m^2 ^{o}C. It is therefore selected a value of 600 W/m^2 ^{o}C.

Table 12.1 Overall Heat transfer Coefficient Hot Oil

U-value	
U	600 W/m^2 ^{o}C

As for the design of the condensate column the design of the reboiler utilizes the simulation that provides the largest flow rate. This means that the heat duty presented in Case C chapter 9.2 is used for calculation. The heat duty is given in Table 12.2.

Table 12.2 Heat Duty Reboiler

Heat	
Q_B	23 340 kW

The bottom liquid from the condensate column flows on shell side and the hot oil will flow on tube side. Hot oil can create fouling and it is therefore convenient to have it on tube side because of easier access for cleaning. In addition it has a high temperature when it enters the reboiler. The temperatures on the shell and tube side are presented in Table 12.3. The data for the shell side is from HYSYS, while the temperatures on tube side are an approximation by author.

Table 12.3 Temperatures in and out of the Reboiler

Temperatures			
Shell side	To reboiler	181.1	^{o}C
	Boilup	216.4	^{o}C
	Bottom stream 13.1	216.4	^{o}C
Tube side	In	250.0	^{o}C
	Out	220.0	^{o}C

Based on these values the area can be established with the log mean temperature difference given in appendix E1, where ΔT_1=33.6 ^{o}C and ΔT_2=38.9 ^{o}C are calculated from Table 12.3. Calculated effective heat exchange area is 1 075.18 m^2.

Table 12.4 Calculated Heat Exchange Area

Area	
A	1 075.18 m^2

In order to handle any fouling that may occur, it is chosen to increase the area for heat exchange by 20 %. In addition it is selected a tube length of 4.8 meters with an outside diameter of 20 mm. The final preliminary design of the Kettle reboiler is given in Table 12.5.

Table 12.5 Final Design of the Reboiler

Kettle Reboiler	
Orientation	Horizontal
Tube Length	4.8 m
Tube Outside Diameter	20 mm
Actual Heat Exchange Area	1 290.2 m^2

It is stated from Table 12.5 that the actual heat exchange area is 1 290.2 m^2. Further sizing and design should reveal if there is possible to use the existing Kettle reboiler to make it operate under these design conditions. If not it need to be replaced or modified and both operating and investment cost need to be calculated. The installation must happen at the same time as for the designed column and man hours need to be identified.

12.3 Reflux system

The reflux system contains of a condenser and a reflux accumulator or drum. The accumulator is basically a separator where the bottom product is sent back to the stabilizer, a brief description was presented in chapter 4.2 and Figure 4.3. The overhead from the accumulator is in this design sent back to the main process stream, upstream the AGRU.

Both the condenser and the reflux accumulator for the distillation column will be designed in this chapter.

12.3.1 Preliminary Sizing of the Shell and Tube Heat Exchanger

A condenser changes the fluid stream completely or partial from vapor to liquid by removing the vaporization heat (GPSA 2004). For the plant discussed in this report sea water is available as cooling medium and different configurations and challenges for such a heat exchanger is described in Figure 12.5.

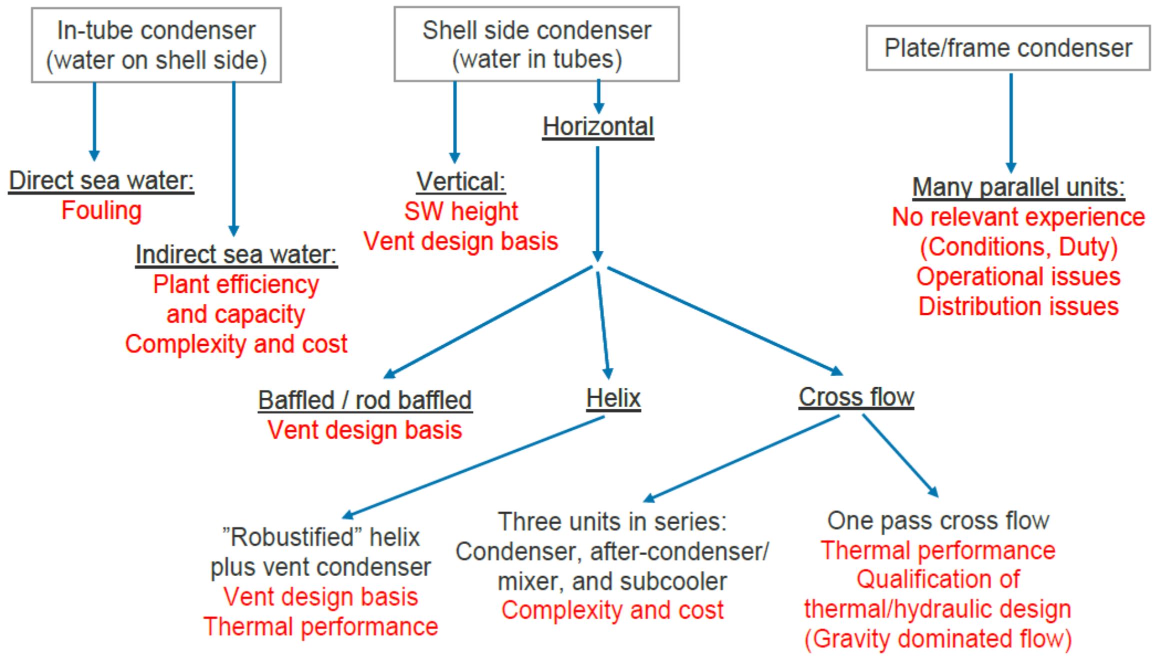

Figure 12.5 Design Issues for Sea water Condensers (Fredheim 2011)

As it appears from the figure over both shell and tube heat exchanger and plate and frame heat exchangers can be used in the design. Shell and tube heat exchangers are widely used in the industry, and are therefore selected for this design.

Shell and tube heat exchangers provide in a relative compact area a large surface heat exchange area. The heat exchanger offer a large number of design opportunities to meet most requirements (Bell and Mueller 2001). Still, the exchangers is generally more space demanding compared to plate and frame (Fredheim, Solbaa et al. 2011). In this design it is assumed that the space needed the exchanger is provided and available in the plant. A typical shell and tube heat exchanger is presented in Figure 12.6.

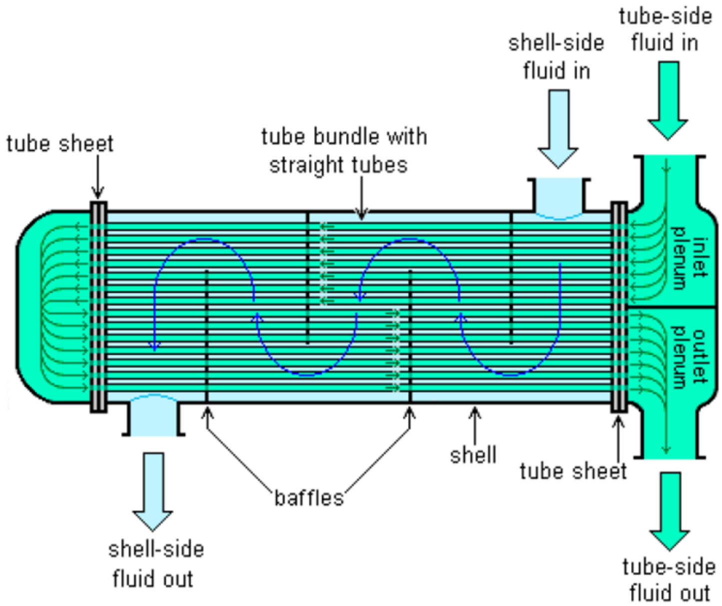

Figure 12.6 Shell and Tube Heat Exchanger (Fredheim 2011)

For this design it is decided to have the sea water on shell side and the condensing fluid on tube side with partial condensation of the condensing fluid. It is assumed that the plant has direct feed of sea water available and in respect to Figure 12.5 one must take fouling into account when designing. The preliminary sizing of the condenser given in this thesis will not go in detail. The main focus is to calculate the surface heat exchange area for the shell and tube.

For calculation the overall heat transfer coefficient is necessary. According to GPSA the u-value for water in condensers is between 200-225 W/m^2 ºC. It is therefore selected a value of 220 W/m^2 ºC.

Table 12.6 Overall Heat transfer Coefficient Hot Oil

U-value	
U	220 W/m^2 ºC

When designing the heat duty from Case C in chapter 9.2 is used for calculation. The heat duty is given in Table 12.7.

Table 12.7 Heat Duty Condenser

Heat	
Q_C	12 020 kW

The sea water flows on shell side and the condensing fluid on tube side. The temperatures are presented in Table 12.8. Data for the tube side is from HYSYS and temperatures from the shell side are an approximation by author.

Table 12.8 Temperatures in and out of the Condenser

Temperatures			
Shell side	In	6	^{o}C
	Out	30	^{o}C
Tube side	To Condenser	50.19	^{o}C
	Reflux	9.712	^{o}C

Based on these values the area can be established with the log mean temperature difference given in appendix E1, where ΔT_1=3.712 ^{o}C and ΔT_2=20.19 ^{o}C are calculated from Table 12.8. Calculated effective heat exchange area therefore is 5 615.24 m^2.

Table 12.9 Calculated Heat Exchange Area

Area	
A	5 615.24 m^2

In order to handle any fouling that may occur, it is chosen in this design to increase the area for heat exchange by 20 %. In addition it is also here selected a tube length of 6 meters, with an outside diameter of 20 mm. The final preliminary design of the shell and tube heat exchanger is given in Table 12.10.

Table 12.10 Final Design of the Condenser

Shell and Tube	
Orientation	Horizontal
Tube Length	6.0 m
Tube Outside Diameter	20 mm
Actual Heat Exchange Area	6 738.3 m^2

As stated from Table 12.10 the actual heat exchange area is calculated to be 6 738.3 m^2. Further design is necessary to establish a good solution for the condenser. Because of the large heat exchange area it may be favorable to have two or three shell and tubes in series.

Since the existing facility do not have a reflux system both operational and investment cost need to be determined. The installation must happen at the same time as installation of the column during a plant turn down. In addition, man hours for installation need to be identified.

12.3.2 Preliminary Sizing of the Reflux Accumulator

A reflux accumulator or a drum is basically a separator where in this design the overhead flows back to the main process stream, while the bottoms is sent back to the column. They are characterized by orientation, either horizontal or vertical (GPSA 2004). The two configurations for a gas-liquid separator are presented in Figure 12.7.

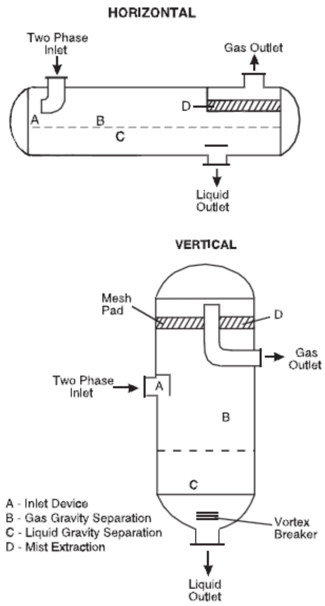

Figure 12.7 Gas-Liquid Separators (GPSA 2004)

Horizontal separators are usually selected when large volumes of liquid are involved and are preferred if there is a three phase separation (Branan 1998). Gas and liquid will occupy their proportionate part of the shell and the separator have an advantage that the droplets and bubbles are moving angular to the bulk phase velocity (GPSA 2004). In a vertical separator the droplets and bubbles flows against it making the separation more difficult.

When the gas-liquid ratio is high or the total gas volume is low vertical separators are preferred (GPSA 2004). The feed enters the separator in the middle of the vessel and vapor flows upwards while the liquid flows downwards. Vertical columns are usually implemented as a compressor knock out drum (Branan 1998). For this design a horizontal separator is selected.

It is important that the horizontal separator is properly designed in order to avoid damage or problems to process equipment. If the vapor that flows overhead consists of any droplets it can damage process equipment such as compressors and turbo expanders. Three factors should be considered when designing a separator (GPSA 2004):

- Vapor capacity to provide necessary area for separation.
- Liquid capacity to provide enough time to *de-gas* the liquid.
- The separators operability to deal with unsteady flows, turndown etc.

The theoretical approach of the sizing is provided by GPSA and can be calculated with first determine the velocity:

$$V_t = \sqrt{\frac{4gD_p(\rho_l - \rho_g)}{3\rho_g C`}} \tag{12.1}$$

Where:

V_t Terminal velocity

g Gravity

D_p Particle diameter of the smallest sized particle that should be removed

ρ Density

$C^{`}$ Drag coefficient

The length L of the accumulator can thereby be determined by assuming a diameter of the vessel:

$$L = \frac{4\dot{q}}{\pi V_t D_V} \tag{12.2}$$

Where:

$\dot{q}$ Gas flow

D_V Assumed diameter

If the length/diameter ratio is lower than 3 or higher than 5 a new vessel diameter should be assumed (Branan 1998). Iteration is thereby necessary and determination of the sizing can have more than one solution.

To perform a preliminary sizing of the accumulator the utility tools in HYSYS is used. It is decided a length/diameter ratio of 3 according to *Vapor/Liquid Calculation Method* for horizontal drum provided in *Rules of Thumb for Chemical Engineers* (Branan 1998). The liquid residue time is set to 5 minutes. The specifications are summarized in Table 12.11.

Table 12.11 Summary of the Specification in the Accumulator

Horizontal Separator		
Pressure	15.20	bar
Temperature	9.712	^oC
Inlet flow	3 865	kgmol/h
L/D ratio	3.00	
Liquid residue time	5.00	min

With the specification given over the final preliminary sizing can be performed. The result for the reflux accumulator is presented in Table 12.12.

Table 12.12 Final Design of the Accumulator

Horizontal Separator		
Diameter	2.438	m
Total length	8.534	m
Maximum vapor velocity	0.284	m/s
Liquid surge height	1.012	m
Vapor space height	1.426	m

As stated the accumulator has a diameter of 2.5 m and a length of 8.5 m. Further sizing and design is necessary and in addition define operating and investment costs. The implementation on the accumulator must happen in coherence with installation of the column, reboiler and the condenser during a plant turndown. In addition man hour for installation need to be detected.

13 Discussion

13.1 Simulation Models

In this thesis it has been established four simulation models with three different feed gas cases each. The *Existing Pretreatment Facilities* is based on existing process flow diagrams provided by supervisor. Some of the process equipment is left out in order to convert the diagrams into HYSYS. They are replaced with valves and heat exchangers to tune in the process as closed to reality as possible. The most important process equipment that affects the results is implemented in the HYSYS model.

An overview of the models is presented in Table 5.2. The *Modification of Existing Stabilizer I*, *Modification of Existing Stabilizer II* and *New Stabilizer with Reflux* are based on the *Existing Pretreatment Facilities* model. The same static values are kept and variables are tuned in such that specifications are met. This has led to some variation both in the models and the cases.

Table 13.1 Simulation Models

Model	Modification
Existing Pretreatment Facilities	None
Modification of Existing Stabilizer I	Temperature reduction in condensate stabilizer reboiler
Modification of Existing Stabilizer II	Change of pipe alignment of the overhead demethanizer
New Stabilizer with Reflux	Installation of new refluxed condensate stabilizer

In the model *Modification of Existing Stabilizer I* the temperature in the condensate stabilizer reboiler is reduced. By achieving this reduction less HHC are evaporated and thereby one can reduce the overhead flow of these components. Another approach to this optimization problem is to reroute the stream line from the demethanizer in such a way that it avoids the stabilizer. The stream consists of only methane and ethane and is therefore favorable to send directly to the compressor and separation unit. Overhead from the stabilizer meet this stream before it is compressed and heavy hydrocarbons are separated in the separation unit and routed back to the stabilizer. The last model is based on replacing the existing non-refluxed condensate stabilizer with a conventional distillation column for a sharp component split.

The variables that need to be tuned in each simulation is the higher heating value in the heavy hydrocarbon scrub column, the overhead temperature in the demethanizer, the temperature in the condensate stabilizer and the true vapor pressure. In order to obtain converge columns some lurching in the specifications is necessary. This will in some way affect the result and thereby the mass balance. The affect is seen upon by author as small and negligible. Some variations in the models need to be tolerated.

For a more realistic approach in the models there would have been favorable to add a pressure drop over the columns. This matter will not however affect the composition or mass balance and are therefore not taken into account.

From the process flow diagrams it is identified a process stream form the depropernizer and back to the heavy hydrocarbon scrub column. This has not been taken in consideration since the flow is very small and the tray out is in the middle of the column which makes it difficult to simulate. The total amount of condensate to storage is therefore not analyzed in this thesis and the fraction trains are not implemented.

If the fraction trains, deethanizer, debutanizer and depropanizer, had been implemented in the simulation model it may have influenced the readers understanding of the importance of this optimization. It is often easier to encourage a modification of a plant if one can detect and show the increased economical incomes. This has to be seen in coherence with operating and investment costs and is not obvious from this thesis.

13.2 Results from the Simulations

In the *Existing Pretreatment Facilities* the heavy hydrocarbon flow from the overhead of the condensate stabilizer contributes to approximately 1 % of the flow in the main process stream. It is thereby stated that to reduce this flow the condensate stabilizer needs to be modified and optimized. Figure 13.1 shows the total mass flow from the condensate stabilizer and to the main process stream. This means in *Existing Pretreatment Facilities*, *Modification of Existing Stabilizer I* and *New Stabilizer with Reflux* stream 12.1, while *Modification of Existing Stabilizer II* stream 16.1. The typical plant performance data is from overhead the condensate stabilizer at the actual plant.

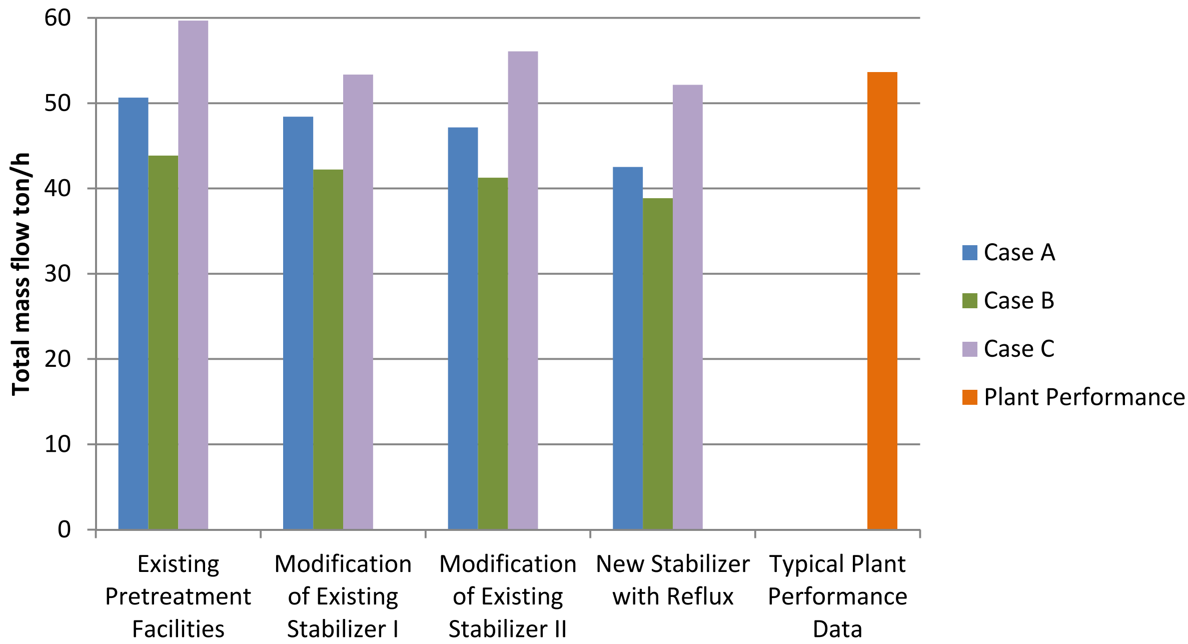

Figure 13.1 Total Mass Flow from the Condensate Stabilizer to the Main Process Stream

The mass flow in *Modification of Existing StabilizerI* is reduced compered to the overhead from the existing condensate stabilizer. The temperature in the modified column is reduced and less heavy hydrocarbons will follow as overhead. The temperature has to meet specification regarding of containments in the feed and especially if there is water following from the slug catcher. The result shows a small and moderate reduction of the heavy hydrocarbons in the main process stream, illustrated in Figure 13.2. Still, this solution is expected to be the cheapest since no equipment needs to be replaced and in addition energy is saved in the reboiler.

Modification of Existing Stabilizer II is proposed to change the routing of the overhead stream from the demethanizer. From the simulations it is evident that the heavier hydrocarbons in the condensate stabilizer are from the bottom product in the slug catcher. The overhead product from the demethanizer consists of methane and ethane and thereby does not contribute to the heavy hydrocarbon flow. This is simultan for all of the simulations models. This means that the flow from the demethanizer is not logical to route to the condensate stabilizer as it is a lean stream and should be sent straight back to the main process stream. It is unnecessary to be routed via the stabilizer and a solution to avoid this is favorable.

The overhead flow from the demethanizer in *Modification of Existing Stabilizer II* is routed directly to the compressor and separator units and thereby avoids the stabilizer. Since the stream does not contain any other components that must be removed before liquefaction it would have been favorable to also avoid the AGRU, dehydration unit and mercury removal unit. But since the stream from the demethanizer must be compressed to 60 bar before entering the heavy hydrocarbon scrub column it is favorable not to invest in any new equipment. But it has been detected, from the typical plant data, a small amount of CO_2 in the overhead from the demethanizer and thereby including the AGRU is necessary.

The result from this modification shows almost a reduction of 50 % of the heavy hydrocarbons in the main process stream as was the case in the *Existing Pretreatment Facilities*, presented in Figure 13.2. The main advantage in this model is the separation units which work as a reflux were the bottom product is sent back to the stabilizer. In this thesis it has not been checked if the piping from the separation unit can handle such a flow but this can easily be detected in the P&IDs. In worst case the piping can be replaced. Even though some cost to modification of the routing from the demethanizer must be expected.

A solution that provides the lowest portion of heavy hydrocarbons in the main process stream is the New *Stabilizer with Reflux*. The existing non-refluxed stabilizer is replaced with a conventional distillation column. The column is provided with a sharp split between n-butane and pentane which contributes to a very low C_5+ flow in the main process stream. This also affects the TVP and would have been higher with some lighter hydrocarbon present in the bottom stream. This will contribute to a too stable condensate product and thereby a larger energy demand than necessary. Based on this simulation model sizing and design of the refluxed condensate column is performed and discussed in subchapter 13.3.

Typical Plant Performance is provided to verify the simulation model for the *Existing Pretreatment Facilities* against normal operation of the plant. As stated from Figure 13.1 the flow from the condensate stabilizer with typical plant data is about the same amount of flow simulated in the *Existing Pretreatment Facilities*. Because it is detected a lower temperature on the overhead it is reasnoable to belive that the composition vary some in relation to the simulation model. The temperature detected in the overhead stream of the condensate stabilizer in the plant is 38.8 ^oC while in the simulation models this varies between 77 and 78 ^oC. This indicates that the stream in the actual plant consists of more ligther hydrocarbons and less heavy hydrocarbons than simulated. The heavy hydrocarbon flow from the condensate stabilizer may not be such a large problem in the plant as first expected.

The flow of heavy hydrocarbons from the stabilizer to the main process stream is presented in Figure 13.2. As for Figure 13.1, this is represented with stream 12.1 for the *Existing Pretreatment Facilities*, *Modification of Existing Stabilizer I* and *New Stabilizer with Reflux* and stream 16.1 for *Modification of Existing Stabilizer II*. The heavy hydrocarbon flow with typical plant performance data has not been possible to obtain.

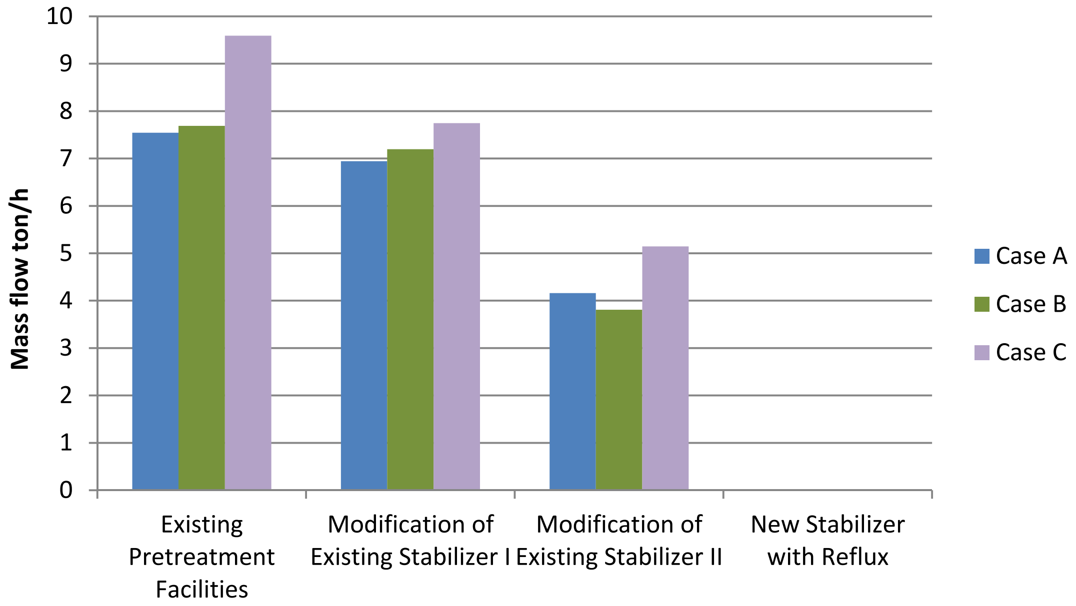

Figure 13.2 C_5+ Mass Flow from the Condensate Stabilizer to the Main Process Stream

It is evident from Figure 13.2 that a reduction of the heavy hydrocarbons in the main process stream is achieved. The case of *New Stabilizer with Reflux* definitively provides the larges reduction. If this is seen in coherence with energy demand for the condensate columns the refluxed column demands significantly more energy than the other modifications. The total energy demand is provided in Figure 13.3.

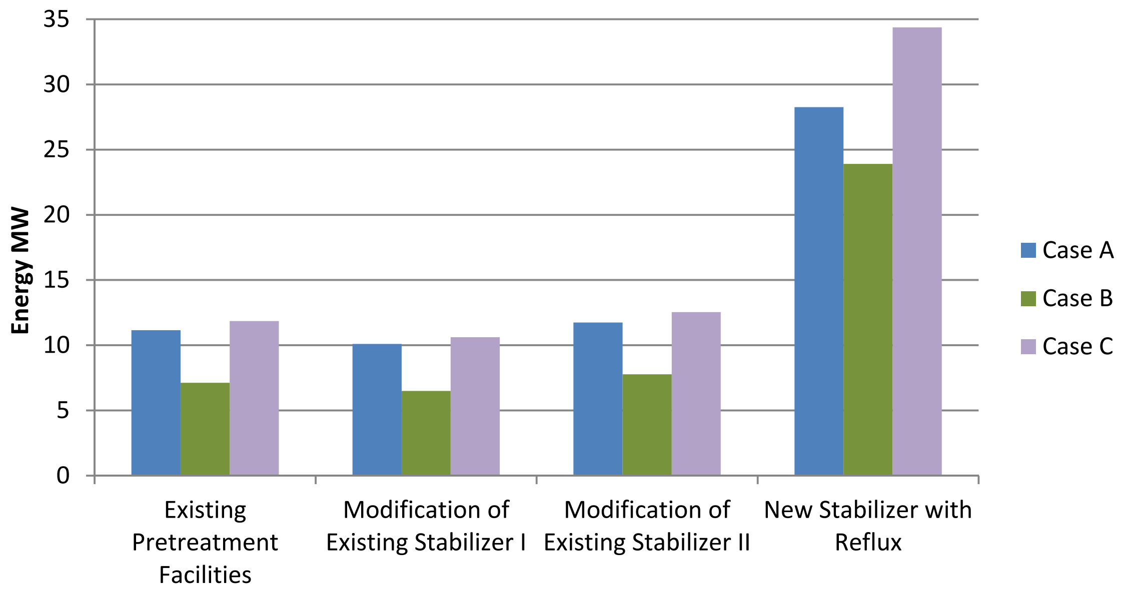

Figure 13.3 Total Energy Supply for the Condensate Stabilizer

The *New Stabilizer with Reflux* has both a reboiler and a condenser which is energy demanding. The *Existing Pretreatment Facilities*, *Modification of Existing Stabilizer I* and *Modification of Existing Stabilizer II* have only a reboiler. The simulations with the refluxed column shows an increased reboiler duty with about 7 MW compared to the other cases. In addition energy is needed in the condenser and the total energy demand is therefore twice as large as the two other modifications and the simulation of the existing plant.

A reduction of the heavy hydrocarbon flow in the main process stream does not only provide free volume but also free load in the heavy hydrocarbon scrub column and columns downstream. C_5+ components will follow as bottom product both in the HHC, demethanizer, deethanizer and depropanizer before it is sent to condensate storage. Most of the components that eventually will end up as condensate should be extracted in the condensate stabilizer for an optimal operation of the plant. This has to be seen in relation to an overall mass and energy balance of the plant.

13.3 Preliminary Sizing of the New Refluxed Condensate Stabilizer

The sizing and design performed in this thesis is a generally approach. It provides a foundation and a more detailed sizing should be performed. Still, there are some choices made in the preliminary sizing that affects the additional design of the refluxed condensate stabilizer.

The choice between a trayed and a packed column is essential for calculations of the column size. The two choices have different approaches and provide various internal design of the column. There exists no specific rule for which column to use in different operations. This makes the decision depended on the economic, based on operating cost and investment costs, and if there is enough space in the plant. A packed column can handle 20-40 % more capacity than a trayed column. This means that for a given feed the trayed column need more space in order to perform as the packed column. A packed column is therefore chosen for further analyzes.

If the existing LNG plants have space limitations this will not only affect the size of the column but also the design of the condenser and reflux accumulator. These are both space demanding process equipment that handles a large amount of flow. The shell and tube condenser has tubes that are 6 meters and some additional length must be added for the inlet nozzles and the shell. The reflux accumulator has length of 8 meters and a diameter of 2.4 meters. This contributes to a large area on the batch that needs to be available. In addition escape routes and routes such that the operators of the plant can access the process equipment for maintenance must be taken into consideration.

The distillation column with additional reboiler and reflux system are space demanding process equipment. In order to save space and in addition save money in investment cost it is favorable that as much equipment as possible from the non-refluxed stabilizer is used in the new stabilizer. This especially concerns the reboiler and the column shell. If there is possible to use the existing reboiler without the need to increase the capacity or the size this will contributes a good solution for the plant. However, both the design of the column and the reboiler capacity has to be seen in relation to the hot oil supply for the whole plant.

Hot oil is provided in the reboiler and sea water for cooling is provided in the condenser. The sea water is seen upon by author as an unlimited heat source while hot oil is restricted by the total amount available in the plant. A modification must therefore be seen upon restriction of hot oil. The optimum solution for a modification is when a sufficient component split is provided as energy efficient as possible. It is possible to reduce the amount of energy in the refluxed column by reducing the strict split between the components, but still this column is more energy demanding than a non-refluxed column, as presented in Figure 13.3.

The supply of hot oil is a bottleneck when designing a new condensate stabilizer. An increase in the flow rate of hot oil providing more heat will decrease the flow rate in other systems and thereby providing an insufficient supply of heat. In this thesis there has only been given a theoretical approach to the energy demand of a distillation column and a further calculation and determination of the design of the stabilizer must reveal the effect this will have in the LNG plant.

The reflux ratio will directly affect the energy demand. In this thesis it is set to be 1.05. This is a value that needs to be further optimized. In order to minimize the energy requirements to heating and cooling the reflux ratio should be near minimum. The ratio is therefore an important economic criterion. As stated, the distillation column requires about twice the amount of energy than a non-refluxed column. To reduce this, the reflux ratio is an essential factor. The amount of energy required is also depended on the relative volatility, feed rate and feed conditions. Since the distillation column provides a sharp split between n-butane and pentane this contributes to increased energy demand. A more lenient split would have provided a somewhat lower energy need. The optimum design of the column is where the energy demand is at its lowest and the component split is sufficient.

14 Conclusion

Pretreatment of gas in LNG plants is essential in order to prevent damage of process equipment and produce a sufficient product. In this thesis the pretreatment facilities are analyzed. The main purpose is to reduce the flow of heavy hydrocarbons from the condensate stabilizer and to the main process stream. By achieving a reduced flow of heavy hydrocarbons free volume is gained and increased regularity in the plant can be achieved.

- An optimization of the heavy hydrocarbon flow from the condensate stabilizer back to the inlet facilities and up to the heavy hydrocarbon scrub column is dependent of the condensate stabilizer performance. A refluxed stabilizer can provide a sharp component split with low overhead C_5+ flow while one degree of freedom is lost in the non-refluxed stabilizer and a less sharp component split is provided.

- The *Existing Pretreatment Facilities* is based on process flow diagrams. The heavy hydrocarbon flow from overhead the condensate stabilizer contributes to 1.1 %, 1.03 % and 1.39 % respectively for Case A, Case B and Case B, of the total mass flow in the main process stream in the inlet facilities, upstream the slug catcher.

- In *Modification of Existing Stabilizer I* the temperature in the reboiler is lowered and the heavy hydrocarbon flow from overhead of the stabilizer contributes to 1.06 %, 0.97% and 1.13 % respectively for Case A, Case B and Case C, of the total mass flow in the main process stream. This modification provides a moderate reduction of the heavy hydrocarbons. In addition, it contributes to a lower energy demand in the column than in the *Existing Pretreatment Facilities*.

- In *Modification of Existing Stabilizer II* the overhead from the demethanizer is routed directly to the compressor and separate unit upstream the condensate stabilizer. The heavy hydrocarbon flow from overhead the separation unit contributes to 0.51 % for Case A and Case B and 0.75 % for Case C of the total mass flow in the main process stream. The performance of the stabilizer is quite the same as in the *Existing Pretreatment Facilities* but the separation unit works as a reflux and sends heavy hydrocarbons as a bottom product back to the stabilizer. This will increase the energy demand of the column.

- In the model *New Stabilizer with Reflux* the non-refluxed condensate column is replaced with a conventional distillation column. This provides a sharp components split and the flow of heavy hydrocarbons from overhead contributes to 0.00036 %, 0.00016 % and 0.0011 % respectively for Case A, Case B and Case C, of the total mass flow in the main process stream. A distillation column is in far more energy demanding than a non-refluxed stabilizer. The energy demand required to obtain the component split provided in this thesis is about the twice as for the condensate stabilizer in the *Existing Pretreatment Facilities*. It is therefore stated that the price to reduce the heavy hydrocarbon flow with a distillation column, compared to the *Existing Pretreatment Facilities,* is payed off by increased energy demand.

- *Typical Plant Performance* data states that the model for the *Existing Pretreatment Facilities* is a robust model close to normal operation of the plant. The data indicates however a lower temperature of the overhead flow from the condensate stabilizer. This concludes that a lower amount of heavy hydrocarbons flows from the stabilizer and back to the main process stream than indicated from the result of the simulation models for the *Existing Pretreatment Facilities*.

- Optimal operation of the plant and thereby optimal choice of modification; none, temperature reduction in the reboiler, change of pipe alignment or installation of new stabilizer, involve a total understanding of energy costs with increased revenues based on increased production of the products that provides most income.

- A preliminary sizing of a column with associated reboiler a reflux system is performed. It is selected a packed column with random pall rings as internals. This gives a column packed height of 13.66 m with a diameter of 3.353 m. It is chosen a Kettle reboiler and the heat exchange area, when fouling is taken into account, is found to be 1 240.2 m^2. The heat exchanger utilizes hot oil as energy source. The shell and tube heat exchanger with sea water works as a condenser and provides an actual heat exchange area of 6 738.3 m^3. It is selected a horizontal reflux accumulator with a length of 8.534 m and a diameter of 2.438 m.

- The reflux ratio is an important parameter when designing refluxed columns. An increase in the ratio will directly affect the energy demand in the condenser. Thereby, there will be an increase in the reboiler duty accordingly to produce a satisfying bottom product. It is therefore evident that for a given feed rate and product specification there is a unique duty for the condenser and reboiler.

- The energy supply to a column must be seen in coherence with the supply to the whole plant. The hot oil utilized at the plant is provided as energy source in several process facilities. It is limited by its volume and an increase in the reboiler duty may affect other systems. Sea water on the other hand is seen upon as an unlimited heat source and can be provided in large quantum if the LNG plant is located in a remote location by the sea.

15 Further work

While working with this thesis ideas for further study have come up concerning the pretreatment facilities analyzed in this report. It is beneficial that the paragraphs below are further analyzed and study in order to make a good decision regarding an optimization of the existing plant.

The main concept for further work is to establish a good foundation to make a decision of a possible modification of the pretreatment facilities. Several aspects need to be further looked into and evaluated, and they are as follows:

- A simulation of the pretreatment facilities with operating conditions needs to be established. The simulation estabilished in this thesis is based on design conditions and it would therefore be favourable to analyze and evaluate the loop of heavy hydrocarbons in order to compare the conditions against the originally design.

- By including all fractionators, also deethanizer, depropanizer and debutanizer in the simulation, the total amount of condensate to storage can be established. An economical analyze can then be performed in order to optimize the amount of LNG, LPG and condensate. The component split in the condensate stabilizer has to be seen in relation to the possibility of increased revenue. It is a rule of thumb that one wants more volume of the product that gives the highest revenues.

- The modification according to chapter 8, where the overhead from the demethanizer avoids the stabilizer and are sent to the separation unit with re-compression, need to be further studied. Some modification of the pipeline has to be done in order to connect the overhead to the separator. In addition it has to be detected if the pipe capacity in the bottom of the separator is capable to handle the increased flow back to the stabilizer. P&IDs (piping and instrument diagrams) of the plant will provide for this. In case of insufficient capacity a further study has to be done in order to detect if the pipeline can be replaced with a pipe of larger diameter. This modification has to be done during a turn down and a cost estimate and man hour need to be established.

- The new refluxed condensate stabilizer needs further analysis. An optimal component split need to be established, both in relation to TVP, volume and to reduce the flow of heavy hydrocarbons back from the overhead to the main process stream. Energy demand in the reboiler and condenser has to be further optimized and determine. It should be detected how the component split affect the energy demand. This has to be seen in relation to the energy demand for the whole plant. Especially is the available hot oil limited and must not exceed actual capacity so it influences other systems in the plant.

- For the new refluxed condensate stabilizer it has to be looked into if there is possible to use the existing shell in the non-refluxed stabilizer with new packing. If this is possible some modification has to be done in order to include a feed location for the refluxed flow from the reflux accumulator. In addition, it has to be looked into possibility of keeping the existing reboiler. This to avoid unnecessary investment costs.

- The new refluxed condensate stabilizer need to be cost estimated, both in relation to investment and operation costs. An economical analyze should include a payback time of 5 and 7 years, with a sensitivity analyze regarding different interest rates. If a decision is made on implementing the new column a replacement should occur during a planned turn down and man hours must be estimated.

- A decision of which alternative for the condensate stabilizer that is most beneficial regarding optimization of the recycled heavy hydrocarbons has to be seen in relation to investments costs, operating costs and revenue. A good foundation and knowledge of all of the alternatives is critical in order to make the best decision.

- A modification of the condensate treatment facilities may affect the compressors upstream. If there is a decrease of the volume flow from overhead of the stabilizer it may cause a modification of the compressor in order to handle the changed flow. A further study should detect this.

- Further design and sizing of the condensate stabilizer with reflux is necessary for a detailed design of the column, reboiler, condenser and reflux accumulator. It should reveal if there is possible to reuse the shell in the column by changing the internals, and use the same reboiler as is already installed at the existing plant. The investment cost and operation cost should be defined and man hour for installation should be determined.

- A decision of a modification of the stabilizer that involves re-building of the facility requires new or modified PFDs and P&IDs. Control valves and safety valves with connections to the flair system should be implemented in the new design for safety reasons.

- An alternative for optimization of the pretreatment facilities not discussed in this thesis is the opportunity to lower the temperature of the liquid stream in to the stabilizer. By doing this more of the heavy hydrocarbons are liquefied before the stabilizer and will follow as bottom product. This is seen upon as a realistic alternative and competitive in relation to the alternatives presented in this report.

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Appendix

Appendix A.1: Simulation Model Existing Pretreatment Facilities

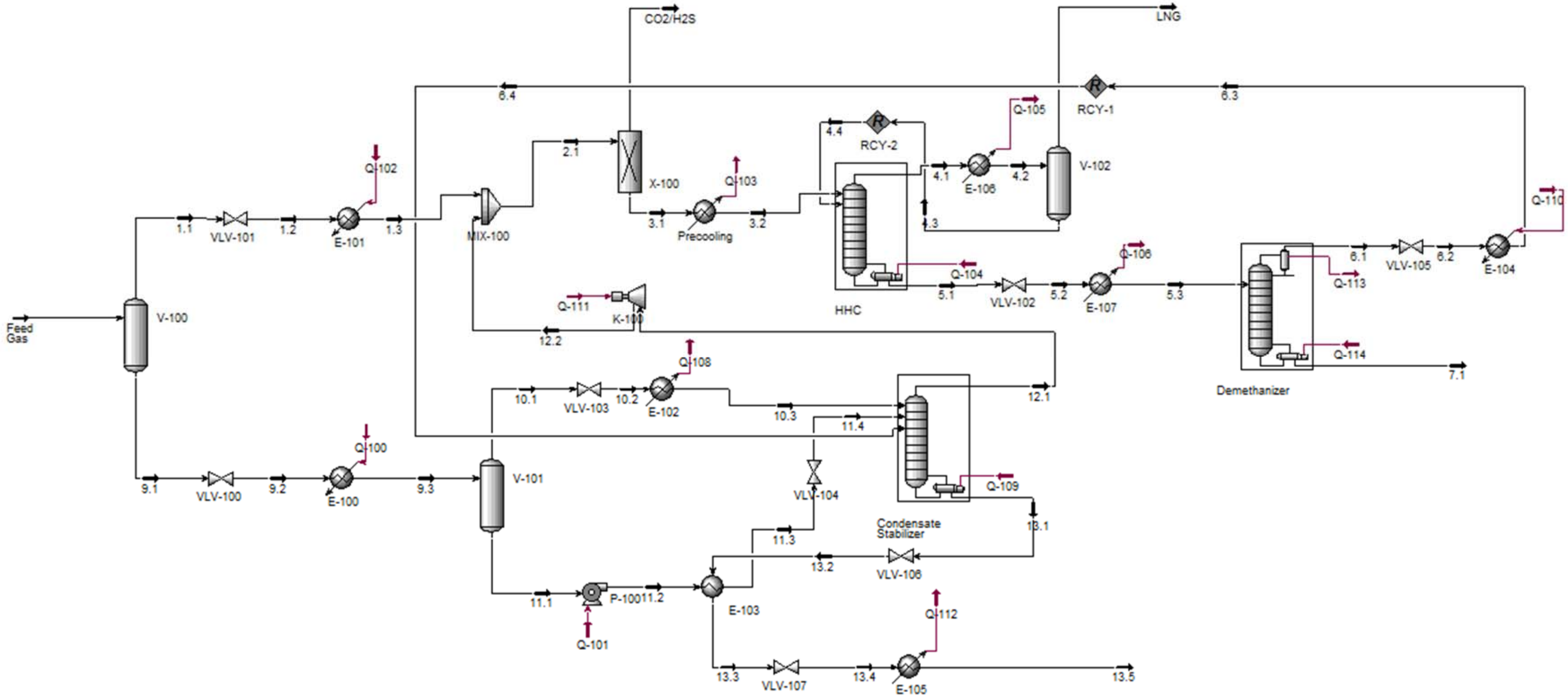

Figure 1 Simulation Model

Appendix A.2: Heat Balance Existing Pretreatment Facilities Case A

	Feed Gas	1.1	1.2	1.3	2.1	CO2/H2S	3.1	3.2	4.1	4.2	4.3	4.4	LNG	5.1	5.2	5.3
Vapor	0,9223	1,00	1,00	1,00	1,00	1,00	1,00	0,9896	1,00	0,9815	0,00	0,00	1,00	0,00	0,4357	0,00
Temperature C	-1,00	-1,00	-6,62	9,98	21,46	21,98	23,70	-10,96	-10,96	-30,96	-30,96	-30,98	-30,96	128,00	111,34	42,44
Pressure kPa	7 000,00	7 000,00	6 000,00	6 000,00	6 000,00	6 000,00	6 000,00	6 000,00	6 000,00	6 000,00	6 000,00	6 000,00	6 000,00	6 000,00	3 420,00	3 420,00
Molar Flow kgmol/h	35 243,33	32 504,02	32 504,02	32 504,02	34 142,03	1 833,27	32 308,76	32 308,76	32 342,18	32 342,18	598,67	599,26	31 743,51	565,84	565,84	565,84
Mass Flow kg/h	813 382,24	634 189,17	634 189,17	634 189,17	684 842,52	80 679,89	604 162,63	604 162,63	594 741,66	594 741,66	20 598,34	20 613,05	574 143,32	30 034,02	30 034,02	30 034,02
Std Ideal Liq Vol Flow m3/h	2 095,85	1 810,59	1 810,59	1 810,59	1 924,11	97,75	1 826,36	1 826,36	1 817,64	1 817,64	45,47	45,51	1 772,17	54,23	54,23	54,23
Molar enthalpy KJ/kgmol	-98 460,63	-94 034,25	-94 034,25	-93 190,99	-93 710,94	-398 093,73	-76 439,60	-78 306,41	-77 915,88	-79 173,64	-110 164,07	-110 152,81	-78 589,18	-109 901,05	-109 901,05	-123 697,07
Molar Entropy KJ/kgmoleC	140,35	143,60	144,58	147,65	149,56	127,08	149,05	142,35	142,96	137,96	100,04	100,05	138,68	138,90	140,42	101,31
Heat Flow KJ/h *10^5	-34 700,80	-30 564,92	-30 564,92	-30 290,82	-31 994,82	-7 298,13	-24 696,69	-25 299,83	-25 199,70	-25 606,49	-659,52	-660,10	-24 946,97	-621,86	-621,86	-699,93
HHV MJ/m3	44,69	38,19	38,19	38,19	39,22		41,44	41,44	40,83	40,83	74,76	74,75	40,20	113,81	113,81	113,81
Mass Density kg/m3	0,9801	0,8273	0,8273	0,8273	0,8507	1,8717	0,7930	0,7930	0,7797	0,7797	1,4717	1,4713	0,7668	2,3144	2,3144	2,3144

	6.1	6.2	6.3	6.4	7.1	9.1	9.2	9.3	10.1	10.2	10.3	11.1	11.2	11.3	11.4
Vapor	1,00	0,9828	1,00	1	0,00	0,00	0,2803	0,3683	1,00	1,00	1,00	0,00	0,00	0,11	0,1168
Temperature C	-49,17	-68,06	-7,06	-7,0497485	108,879824	-1,00	-10,71	29,49	29,49	26,51	37,72	29,49	29,56	113,63	113,40
Pressure kPa	3 420,00	1 520,00	1 520,00	1520	3 420,00	7 000,00	2 000,00	1 950,00	1 950,00	1 520,00	1 520,00	1 950,00	2 100,00	2 100,00	2 043,00
Molar Flow kgmol/h	59,14	59,14	59,14	59,1987839	506,70	2 739,31	2 739,31	2 739,31	1 008,87	1 008,87	1 008,87	1 730,43	1 730,43	1 730,43	1 730,43
Mass Flow kg/h	1 112,13	1 112,13	1 112,13	1113,26318	28 921,89	179 193,07	179 193,07	179 193,07	24 090,59	24 090,59	24 090,59	155 102,48	155 102,48	155 102,48	155 102,48
Std Ideal Liq Vol Flow m3/h	3,53	3,53	3,53	3,53263099	50,70	285,25	285,25	285,25	61,47	61,47	61,47	223,79	223,79	223,79	223,79
Molar enthalpy KJ/kgmol	-81 190,43	-81 190,43	-78 522,87	-78523,14	-118 145,55	-150 983,05	-150 983,05	-144 870,00	-109 304,01	-109 304,01	-108 787,62	-165 605,65	-165 580,06	-147 433,27	-147 433,27
Molar Entropy KJ/kgmoleC	145,18	150,44	161,95	161,950015	124,88	101,81	105,08	126,81	164,36	166,29	167,98	104,91	104,93	157,55	157,59
Heat Flow KJ/h *10^5	-48,02	-48,02	-46,44	-46,484744	-598,64	-4 135,89	-4 135,89	-3 968,43	-1 102,74	-1 102,74	-1 097,53	-2 865,69	-2 865,25	-2 551,23	-2 551,23
HHV MJ/m3	43,42	43,42	43,42	43,4186073	122,52	126,79	126,79	126,79	44,31	44,31	44,31	183,15	183,15	183,15	183,15
Mass Density kg/m3	0,7976	0,7976	0,7976	0,79765877	2,5018	2,9101	2,9101	2,9101	1,0141	1,0141	1,0141	4,2055	4,2055	4,2055	4,2055

	12.1	12.2	13.1	13.2	13.3	13.4	13.5
Vapor	1,00	1,00	0,00	0,0493	0,00	0,00	0,00
Temperature C	77,11	175,59	215,01	212,46	125,99	126,01	17,01
Pressure kPa	1 520,00	6 000,00	1 520,00	1 400,00	1 400,00	1 300,00	1 300,00
Molar Flow kgmol/h	1 638,01	1 638,01	1 160,50	1 160,50	1 160,50	1 160,50	1 160,50
Mass Flow kg/h	50 653,36	50 653,36	129 652,98	129 652,98	129 652,98	129 652,98	129 652,98
Std Ideal Liq Vol Flow m3/h	113,52	113,52	175,27	175,27	175,27	175,27	175,27
Molar enthalpy KJ/kgmol	-109 417,13	-104 028,66	-129 355,03	-129 355,03	-156 413,91	-156 413,91	-183 250,46
Molar Entropy KJ/kgmoleC	172,71	175,77	228,23	228,30	167,29	167,34	89,31
Heat Flow KJ/h *10^5	-1 792,26	-1 704,00	-1 501,16	-1 501,16	-1 815,18	-1 815,18	-2 126,62
HHV MJ/m3	59,77	59,77	241,82	241,82	241,82	241,82	241,82
Mass Density kg/m3	1,3184	1,3184	5,6276	5,6276	5,6276	5,6276	5,6276
TVP @37,8°C							8,297

Appendix A.3: Mole Fraction Existing Pretreatment Facilities Case A

	Feed Gas	1.1	1.2	1.3	2.1	CO2/H2S	3.1	3.2	4.1	4.2	4.3	4.4	LNG	5.1	5.2	5.3	6.1	6.2	6.3	6.4	7.1
Nitrogen	0,02496	0,02679	0,02679	0,02679	0,02576	0	0,02723	0,02723	0,027288	0,03	0,00	0,00	0	0	0	0	0	0,00001	0	0,00001	0
CO2	0,05201	0,05232	0,05232	0,05232	0,05369	0,99990	0,00000	0,00000	0,000000	0,00	0,00	0,00	0	0	0	0	0	0	0	0	0
Methane	0,80070	0,84365	0,84365	0,84365	0,82793	0	0,87491	0,87491	0,880924	0,88092	0,45409	0,45399	0,88898	0,08480	0,08480	0,08480	0,80331	0,80331	0,80331	0,80331	0
Ethane	0,04969	0,04775	0,04775	0,04775	0,05163	0	0,05456	0,05456	0,054095	0,05409	0,13185	0,13183	0,05263	0,16316	0,16316	0,16316	0,19644	0,19644	0,19644	0,19643	0,15927
Propane	0,02505	0,01984	0,01984	0,01984	0,02569	0	0,02715	0,02715	0,025897	0,02590	0,18102	0,18101	0,02297	0,26201	0,26201	0,26201	0,00025	0,00025	0,00025	0,00025	0,29254
i-Butane	0,00395	0,00237	0,00237	0,00237	0,00342	0	0,00361	0,00361	0,003210	0,00321	0,04296	0,04300	0,00246	0,06819	0,06819	0,06819	0	0	0	0	0,07614
n-Butane	0,00820	0,00421	0,00421	0,00421	0,00632	0	0,00667	0,00667	0,005658	0,00566	0,09643	0,09646	0,00394	0,16001	0,16001	0,16001	0	0	0	0	0,17867
i-Pentane	0,00278	0,00091	0,00091	0,00091	0,00147	0	0,00155	0,00155	0,001108	0,00111	0,02987	0,02989	0,00056	0,05706	0,05706	0,05706	0	0	0	0	0,06371
n-Pentane	0,00304	0,00082	0,00082	0,00082	0,00139	0	0,00147	0,00147	0	0,00096	0,02954	0,02956	0,00042	0,06088	0,06088	0,06088	0	0	0	0	0,06798
n-Hexane	0,00348	0,00042	0,00042	0,00042	0,00082	0	0,00086	0,00086	0	0,00034	0,01451	0,01453	0,00007	0,04515	0,04515	0,04515	0	0	0	0	0,05041
n-Heptane	0,00387	0,00020	0,00020	0,00020	0,00044	0	0,00047	0,00047	0	0,00009	0,00457	0,00458	0,00001	0,02628	0,02628	0,02628	0	0	0	0	0,02935
n-Octane	0,00313	0,00007	0,00007	0,00007	0,00017	0	0,00018	0,00018	0	0,00002	0,00082	0,00082	0,00000	0,01031	0,01031	0,01031	0	0	0	0	0,01151
n-Nonane	0,00140	0,00001	0,00001	0,00001	0,00004	0	0,00004	0,00004	0	0	0,00007	0,00007	0	0,00218	0,00218	0,00218	0	0	0	0	0,00243
Benzene	0,00077	0,00007	0,00007	0,00007	0,00016	0	0,00017	0,00017	0	0,00006	0,00248	0,00248	0,00001	0,00876	0,00876	0,00876	0	0	0	0	0,00978
Toluene	0,00889	0,00033	0,00033	0,00033	0,00081	0	0,00086	0,00086	0	0,00014	0,00677	0,00677	0,00001	0,04842	0,04842	0,04842	0	0	0	0	0,05407
m-Xylene	0,00060	0,00001	0,00001	0,00001	0,00002	0	0,00002	0,00002	0	0	0,00007	0,00007	0	0,00140	0,00140	0,00140	0	0	0	0	0,00157
n-Decane	0,00139	0,00001	0,00001	0,00001	0,00002	0	0,00002	0,00002	0	0	0,00002	0,00002	0	0,00107	0,00107	0,00107	0	0	0	0	0,00119
n-C11	0,00062	0	0	0	0	0	0	0	0	0	0,00000	0,00000	0	0,00021	0,00021	0,00021	0	0	0	0	0,00024
n-C12	0,00061	0	0	0	0	0	0	0	0	0	0,00000	0,00000	0	0,00009	0,00009	0,00009	0	0	0	0	0,00010
n-C13	0,00048	0	0	0	0	0	0	0	0	0	0,00000	0	0	0	0,00001	0,00001	0	0	0	0	0,00001
n-C14	0,00326	0	0	0	0	0	0	0	0	0	0,00000	0	0	0	0,00002	0,00002	0	0	0	0	0,00002
n-C15	0,00025	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
n-C16	0,00015	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
n-C17	0,00015	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
n-C18	0,00010	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
n-C19	0,00007	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
n-C20	0,00017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
H2S	0	0	0	0	0,00001	0,00010	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Phenol	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Helium	0,00020	0,00021	0,00021	0,00021	0,00020	0	0,00022	0,00022	0,000216	0	0	0	0	0	0	0	0	0	0	0	0

	9.1	9.2	9.3	10.1	10.2	10.3	11.1	11.2	11.3	11.4	12.1	12.2	13.1	13.2	13.3	13.4	13.5
Nitrogen	0,00327	0,00327	0,00327	0,00845	0,00845	0,00845	0,00025	0,00025	0,00025	0,00025	0,00547	0,00547	0	0	0	0	0
CO2	0,04836	0,04836	0,04836	0,09323	0,09323	0,09323	0,02221	0,02221	0,02221	0,02221	0,08091	0,08091	0	0	0	0	0
Methane	0,29114	0,29114	0,29114	0,68455	0,68455	0,68455	0,06177	0,06177	0,06177	0,06177	0,51600	0,51600	0	0	0	0	0
Ethane	0,07264	0,07264	0,07264	0,11148	0,11148	0,11148	0,05000	0,05000	0,05000	0,05000	0,12860	0,12860	0	0	0	0	0
Propane	0,08679	0,08679	0,08679	0,06762	0,06762	0,06762	0,09796	0,09796	0,09796	0,09796	0,14182	0,14182	0,00477	0,00477	0,00477	0,00477	0,00477
i-Butane	0,02277	0,02277	0,02277	0,00871	0,00871	0,00871	0,03097	0,03097	0,03097	0,03097	0,02420	0,02420	0,01960	0,01960	0,01960	0,01960	0,01960
n-Butane	0,05564	0,05564	0,05564	0,01597	0,01597	0,01597	0,07877	0,07877	0,07877	0,07877	0,04819	0,04819	0,06332	0,06332	0,06332	0,06332	0,06332
i-Pentane	0,02494	0,02494	0,02494	0,00326	0,00326	0,00326	0,03758	0,03758	0,03758	0,03758	0,01259	0,01259	0,04109	0,04109	0,04109	0,04109	0,04109
n-Pentane	0,02946	0,02946	0,02946	0,00297	0,00297	0,00297	0,04491	0,04491	0,04491	0,04491	0,01284	0,01284	0,05141	0,05141	0,05141	0,05141	0,05141
n-Hexane	0,03976	0,03976	0,03976	0,00140	0,00140	0,00140	0,06214	0,06214	0,06214	0,06214	0,00865	0,00865	0,08164	0,08164	0,08164	0,08164	0,08164
n-Heptane	0,04733	0,04733	0,04733	0,00060	0,00060	0,00060	0,07457	0,07457	0,07457	0,07457	0,00522	0,00522	0,10431	0,10431	0,10431	0,10431	0,10431
n-Octane	0,03950	0,03950	0,03950	0,00018	0,00018	0,00018	0,06242	0,06242	0,06242	0,06242	0,00221	0,00221	0,09009	0,09009	0,09009	0,09009	0,09009
n-Nonane	0,01791	0,01791	0,01791	0,00003	0,00003	0,00003	0,02833	0,02833	0,02833	0,02833	0,00050	0,00050	0,04155	0,04155	0,04155	0,04155	0,04155
Benzene	0,00904	0,00904	0,00904	0,00028	0,00028	0,00028	0,01415	0,01415	0,01415	0,01415	0,00179	0,00179	0,01882	0,01882	0,01882	0,01882	0,01882
Toluene	0,11042	0,11042	0,11042	0,00115	0,00115	0,00115	0,17413	0,17413	0,17413	0,17413	0,01031	0,01031	0,24602	0,24602	0,24602	0,24602	0,24602
m-Xylene	0,00767	0,00767	0,00767	0,00002	0,00002	0,00002	0,01212	0,01212	0,01212	0,01212	0,00032	0,00032	0,01763	0,01763	0,01763	0,01763	0,01763
n-Decane	0,01786	0,01786	0,01786	0,00001	0,00001	0,00001	0,02827	0,02827	0,02827	0,02827	0,00025	0,00025	0,04179	0,04179	0,04179	0,04179	0,04179
n-C11	0,00800	0,00800	0,00800	0	0	0	0,01267	0,01267	0,01267	0,01267	0,00005	0,00005	0,01881	0,01881	0,01881	0,01881	0,01881
n-C12	0,00788	0,00788	0,00788	0	0	0	0,01248	0,01248	0,01248	0,01248	0,00002	0,00002	0,01857	0,01857	0,01857	0,01857	0,01857
n-C13	0,00623	0,00623	0,00623	0	0	0	0,00987	0,00987	0,00987	0,00987	0	0	0,01471	0,01471	0,01471	0,01471	0,01471
n-C14	0,04199	0,04199	0,04199	0	0	0	0,06647	0,06647	0,06647	0,06647	0	0	0,09908	0,09908	0,09908	0,09908	0,09908
n-C15	0,00318	0,00318	0,00318	0	0	0	0,00504	0,00504	0,00504	0,00504	0	0	0,00751	0,00751	0,00751	0,00751	0,00751
n-C16	0,00191	0,00191	0,00191	0	0	0	0,00302	0,00302	0,00302	0,00302	0	0	0,00450	0,00450	0,00450	0,00450	0,00450
n-C17	0,00191	0,00191	0,00191	0	0	0	0,00302	0,00302	0,00302	0,00302	0	0	0,00450	0,00450	0,00450	0,00450	0,00450
n-C18	0,00127	0,00127	0,00127	0	0	0	0,00201	0,00201	0,00201	0,00201	0	0	0,00300	0,00300	0,00300	0,00300	0,00300
n-C19	0,00089	0,00089	0,00089	0	0	0	0,00141	0,00141	0,00141	0,00141	0	0	0,00210	0,00210	0,00210	0,00210	0,00210
n-C20	0,00216	0,00216	0,00216	0	0	0	0,00342	0,00342	0,00342	0,00342	0	0	0,00510	0,00510	0,00510	0,00510	0,00510
H2S	0,00001	0,00001	0,00001	0,00001	0,00001	0,00001	0,00001	0,00001	0,00001	0,00001	0,00002	0,00002	0	0	0	0	0
Phenol	0,00003	0,00003	0,00003	0	0	0,00000	0,00004	0,00004	0,00004	0,00004	0	0	0,00006	0,00006	0,00006	0,00006	0,00006
Helium	0,00003	0,00003	0,00003	0,00007	0,00007	0,00007	0	0	0	0,00000	0,00004	0,00004	0	0	0	0	0

Appendix A.4: Mass Balance (kg/h) Existing pretreatment Facilities Case A

	Feed Gas	1.1	1.2	1.3	2.1	CO_2/H_2S	3.1	3.2	4.1	4.2	4.3	4.4	LNG	5.1	5.2	5.3	6.1	6.2	6.3	6.4	7.1
Nitrogen	24 640,19	24 389,15	24 389,15	24 389,15	24 640,20	0,00	24 640,20	24 640,20	24 722,49	24 722,49	82,18	82,30	24 640,31	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,00
CO_2	80 673,96	74 843,48	74 843,48	74 843,48	80 673,96	80 673,96	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Methane	452 721,11	439 926,66	439 926,66	439 926,66	453 484,02	0,00	453 484,02	453 484,02	457 079,39	457 079,39	4 360,11	4 365,72	452 719,28	770,35	770,35	770,35	762,20	762,20	762,20	762,91	8,15
Ethane	52 658,84	46 675,28	46 675,28	46 675,28	53 008,20	0,00	53 008,20	53 008,20	52 608,10	52 608,10	2 373,19	2 375,48	50 234,91	2 775,58	2 775,58	2 775,58	349,26	349,26	349,26	349,69	2 426,32
Propane	38 925,99	28 442,62	28 442,62	28 442,62	38 675,71	0,00	38 675,71	38 675,71	36 923,49	36 923,49	4 777,30	4 783,23	32 146,19	6 535,45	6 535,45	6 535,45	0,65	0,65	0,65	0,65	6 534,80
i-Butane	8 100,22	4 474,66	4 474,66	4 474,66	6 778,99	0,00	6 778,99	6 778,99	6 034,52	6 034,52	1 494,84	1 496,41	4 539,68	2 240,88	2 240,88	2 240,88	0,00	0,00	0,00	0,00	2 240,88
n-Butane	16 806,23	7 947,16	7 947,16	7 947,16	12 544,72	0,00	12 544,72	12 544,72	10 641,82	10 641,82	3 358,06	3 360,01	7 283,75	5 262,91	5 262,91	5 262,91	0,00	0,00	0,00	0,00	5 262,91
i-Pentane	7 062,16	2 133,05	2 133,05	2 133,05	3 625,68	0,00	3 625,68	3 625,68	2 587,66	2 587,66	1 292,08	1 291,74	1 295,58	2 329,75	2 329,75	2 329,75	0,00	0,00	0,00	0,00	2 329,75
n-Pentane	7 741,22	1 918,12	1 918,12	1 918,12	3 441,17	0,00	3 441,17	3 441,17	2 232,46	2 232,46	1 277,71	1 277,10	954,75	2 485,81	2 485,81	2 485,81	0,00	0,00	0,00	0,00	2 485,81
n-Hexane	10 567,93	1 180,73	1 180,73	1 180,73	2 405,18	0,00	2 405,18	2 405,18	952,37	952,37	749,82	749,08	202,55	2 201,88	2 201,88	2 201,88	0,00	0,00	0,00	0,00	2 201,88
n-Heptane	13 650,30	659,68	659,68	659,68	1 519,33	0,00	1 519,33	1 519,33	302,85	302,85	274,77	274,43	28,08	1 490,92	1 490,92	1 490,92	0,00	0,00	0,00	0,00	1 490,92
n-Octane	12 614,54	254,98	254,98	254,98	669,01	0,00	669,01	669,01	58,56	58,56	56,36	56,29	2,20	666,73	666,73	666,73	0,00	0,00	0,00	0,00	666,73
n-Nonane	6 344,08	53,26	53,26	53,26	158,46	0,00	158,46	158,46	5,78	5,78	5,69	5,68	0,09	158,37	158,37	158,37	0,00	0,00	0,00	0,00	158,37
Benzene	2 123,73	188,40	188,40	188,40	418,03	0,00	418,03	418,03	146,55	146,55	115,96	115,82	30,60	387,30	387,30	387,30	0,00	0,00	0,00	0,00	387,30
Toluene	28 874,20	1 003,21	1 003,21	1 003,21	2 564,20	0,00	2 564,20	2 564,20	411,23	411,23	373,95	373,44	37,28	2 526,41	2 526,41	2 526,41	0,00	0,00	0,00	0,00	2 526,41
m-Xylene	2 257,43	27,87	27,87	27,87	84,50	0,00	84,50	84,50	4,91	4,91	4,76	4,75	0,15	84,34	84,34	84,34	0,00	0,00	0,00	0,00	84,34
n-Decane	6 988,25	26,49	26,49	26,49	86,08	0,00	86,08	86,08	1,38	1,38	1,37	1,36	0,01	86,06	86,06	86,06	0,00	0,00	0,00	0,00	86,06
n-C11	3 432,68	5,34	5,34	5,34	18,88	0,00	18,88	18,88	0,12	0,12	0,12	0,12	0,00	18,88	18,88	18,88	0,00	0,00	0,00	0,00	18,88
n-C12	3 681,32	2,85	2,85	2,85	8,39	0,00	8,39	8,39	0,03	0,03	0,03	0,03	0,00	8,39	8,39	8,39	0,00	0,00	0,00	0,00	8,39
n-C13	3 149,04	0,92	0,92	0,92	1,18	0,00	1,18	1,18	0,00	0,00	0,00	0,00	0,00	1,18	1,18	1,18	0,00	0,00	0,00	0,00	1,18
n-C14	22 819,71	2,46	2,46	2,46	2,48	0,00	2,48	2,48	0,00	0,00	0,00	0,00	0,00	2,48	2,48	2,48	0,00	0,00	0,00	0,00	2,48
n-C15	1 851,03	0,11	0,11	0,11	0,11	0,00	0,11	0,11	0,00	0,00	0,00	0,00	0,00	0,11	0,11	0,11	0,00	0,00	0,00	0,00	0,11
n-C16	1 183,92	0,03	0,03	0,03	0,03	0,00	0,03	0,03	0,00	0,00	0,00	0,00	0,00	0,03	0,03	0,03	0,00	0,00	0,00	0,00	0,03
n-C17	1 257,27	0,02	0,02	0,02	0,02	0,00	0,02	0,02	0,00	0,00	0,00	0,00	0,00	0,02	0,02	0,02	0,00	0,00	0,00	0,00	0,02
n-C18	887,05	0,01	0,01	0,01	0,01	0,00	0,01	0,01	0,00	0,00	0,00	0,00	0,00	0,01	0,01	0,01	0,00	0,00	0,00	0,00	0,01
n-C19	655,17	0,01	0,01	0,01	0,01	0,00	0,01	0,01	0,00	0,00	0,00	0,00	0,00	0,01	0,01	0,01	0,00	0,00	0,00	0,00	0,01
n-C20	1 674,28	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
H_2S	5,94	4,95	4,95	4,95	5,94	5,94	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Phenol	6,56	0,03	0,03	0,03	0,13	0,00	0,13	0,13	0,00	0,00	0,00	0,00	0,00	0,13	0,13	0,13	0,00	0,00	0,00	0,00	0,13
Helium	27,91	27,62	27,62	27,62	27,91	0,00	27,91	27,91	27,95	27,95	0,05	0,05	27,91	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Total kg/h	813 382,24	634 189,17	634 189,17	634 189,17	684 842,52	80 679,89	604 162,63	604 162,63	594 741,66	594 741,66	20 598,34	20 613,05	574 143,32	30 034,02	30 034,02	30 034,02	1 112,13	1 112,13	1 112,13	1 113,26	28 921,89

	9.1	9.2	9.3	10.1	10.2	10.3	11.1	11.2	11.3	11.4	12.1	12.2	13.1	13.2	13.3	13.4	13.5
Nitrogen	251,03	251,03	251,03	238,80	238,80	238,80	12,23	12,23	12,23	12,23	251,04	251,04	0,00	0,00	0,00	0,00	0,00
CO_2	5 830,48	5 830,48	5 830,48	4 139,21	4 139,21	4 139,21	1 691,27	1 691,27	1 691,27	1 691,27	5 830,48	5 830,48	0,00	0,00	0,00	0,00	0,00
Methane	12 794,45	12 794,45	12 794,45	11 079,65	11 079,65	11 079,65	1 714,79	1 714,79	1 714,79	1 714,79	13 557,36	13 557,36	0,00	0,00	0,00	0,00	0,00
Ethane	5 983,56	5 983,56	5 983,56	3 381,89	3 381,89	3 381,89	2 601,67	2 601,67	2 601,67	2 601,67	6 332,92	6 332,92	0,32	0,32	0,32	0,32	0,32
Propane	10 483,37	10 483,37	10 483,37	3 008,28	3 008,28	3 008,28	7 475,09	7 475,09	7 475,09	7 475,09	10 233,10	10 233,10	250,93	250,93	250,93	250,93	250,93
i-Butane	3 625,55	3 625,55	3 625,55	510,54	510,54	510,54	3 115,01	3 115,01	3 115,01	3 115,01	2 304,33	2 304,33	1 321,23	1 321,23	1 321,23	1 321,23	1 321,23
n-Butane	8 859,07	8 859,07	8 859,07	936,46	936,46	936,46	7 922,61	7 922,61	7 922,61	7 922,61	4 597,56	4 597,56	4 261,51	4 261,51	4 261,51	4 261,51	4 261,51
i-Pentane	4 929,11	4 929,11	4 929,11	237,48	237,48	237,48	4 691,62	4 691,62	4 691,62	4 691,62	1 492,62	1 492,62	3 436,49	3 436,49	3 436,49	3 436,49	3 436,49
n-Pentane	5 823,10	5 823,10	5 823,10	216,53	216,53	216,53	5 606,57	5 606,57	5 606,57	5 606,57	1 523,05	1 523,05	4 300,05	4 300,05	4 300,05	4 300,05	4 300,05
n-Hexane	9 387,20	9 387,20	9 387,20	121,31	121,31	121,31	9 265,89	9 265,89	9 265,89	9 265,89	1 224,44	1 224,44	8 162,76	8 162,76	8 162,76	8 162,76	8 162,76
n-Heptane	12 990,62	12 990,62	12 990,62	60,63	60,63	60,63	12 929,99	12 929,99	12 929,99	12 929,99	859,65	859,65	12 130,97	12 130,97	12 130,97	12 130,97	12 130,97
n-Octane	12 359,55	12 359,55	12 359,55	20,87	20,87	20,87	12 338,69	12 338,69	12 338,69	12 338,69	414,03	414,03	11 945,53	11 945,53	11 945,53	11 945,53	11 945,53
n-Nonane	6 290,82	6 290,82	6 290,82	3,87	3,87	3,87	6 286,95	6 286,95	6 286,95	6 286,95	105,20	105,20	6 185,62	6 185,62	6 185,62	6 185,62	6 185,62
Benzene	1 935,33	1 935,33	1 935,33	22,42	22,42	22,42	1 912,91	1 912,91	1 912,91	1 912,91	229,63	229,63	1 705,70	1 705,70	1 705,70	1 705,70	1 705,70
Toluene	27 870,99	27 870,99	27 870,99	107,01	107,01	107,01	27 763,98	27 763,98	27 763,98	27 763,98	1 560,99	1 560,99	26 310,00	26 310,00	26 310,00	26 310,00	26 310,00
m-Xylene	2 229,56	2 229,56	2 229,56	2,62	2,62	2,62	2 226,94	2 226,94	2 226,94	2 226,94	56,63	56,63	2 172,92	2 172,92	2 172,92	2 172,92	2 172,92
n-Decane	6 961,76	6 961,76	6 961,76	1,69	1,69	1,69	6 960,08	6 960,08	6 960,08	6 960,08	59,59	59,59	6 902,17	6 902,17	6 902,17	6 902,17	6 902,17
n-C11	3 427,35	3 427,35	3 427,35	0,30	0,30	0,30	3 427,04	3 427,04	3 427,04	3 427,04	13,54	13,54	3 413,81	3 413,81	3 413,81	3 413,81	3 413,81
n-C12	3 678,48	3 678,48	3 678,48	0,14	0,14	0,14	3 678,33	3 678,33	3 678,33	3 678,33	5,54	5,54	3 672,94	3 672,94	3 672,94	3 672,94	3 672,94
n-C13	3 148,11	3 148,11	3 148,11	0,04	0,04	0,04	3 148,07	3 148,07	3 148,07	3 148,07	0,26	0,26	3 147,85	3 147,85	3 147,85	3 147,85	3 147,85
n-C14	22 817,25	22 817,25	22 817,25	0,10	0,10	0,10	22 817,16	22 817,16	22 817,16	22 817,16	0,02	0,02	22 817,23	22 817,23	22 817,23	22 817,23	22 817,23
n-C15	1 850,91	1 850,91	1 850,91	0,00	0,00	0,00	1 850,91	1 850,91	1 850,91	1 850,91	0,00	0,00	1 850,91	1 850,91	1 850,91	1 850,91	1 850,91
n-C16	1 183,89	1 183,89	1 183,89	0,00	0,00	0,00	1 183,88	1 183,88	1 183,88	1 183,88	0,00	0,00	1 183,89	1 183,89	1 183,89	1 183,89	1 183,89
n-C17	1 257,24	1 257,24	1 257,24	0,00	0,00	0,00	1 257,24	1 257,24	1 257,24	1 257,24	0,00	0,00	1 257,24	1 257,24	1 257,24	1 257,24	1 257,24
n-C18	887,04	887,04	887,04	0,00	0,00	0,00	887,04	887,04	887,04	887,04	0,00	0,00	887,04	887,04	887,04	887,04	887,04
n-C19	655,17	655,17	655,17	0,00	0,00	0,00	655,17	655,17	655,17	655,17	0,00	0,00	655,17	655,17	655,17	655,17	655,17
n-C20	1 674,27	1 674,27	1 674,27	0,00	0,00	0,00	1 674,27	1 674,27	1 674,27	1 674,27	0,00	0,00	1 674,27	1 674,27	1 674,27	1 674,27	1 674,27
H_2S	0,99	0,99	0,99	0,46	0,46	0,46	0,52	0,52	0,52	0,52	0,99	0,99	0,00	0,00	0,00	0,00	0,00
Phenol	6,53	6,53	6,53	0,00	0,00	0,00	6,53	6,53	6,53	6,53	0,10	0,10	6,43	6,43	6,43	6,43	6,43
Helium	0,29	0,29	0,29	0,27	0,27	0,27	0,01	0,01	0,01	0,01	0,29	0,29	0,00	0,00	0,00	0,00	0,00
Total	179 193,07	179 193,07	179 193,07	24 090,59	24 090,59	24 090,59	155 102,48	155 102,48	155 102,48	155 102,48	50 653,36	50 653,36	129 652,98	129 652,98	129 652,98	129 652,98	129 652,98

Appendix A.5: Heat Balance Exisiting Pretreatment Facilities Case B

	Feed Gas	1.1	1.2	1.3	2.1	CO2/H2S	3.1	3.2	4.1	4.2	4.3	4.4	LNG	5.1	5.2	5.3
Vapor	0,9494	1,00	1,00	1,00	1,00	1,00	1,00	0,99	1,00	0,9767	0,00	0,00	1,00	0,00	0,2448	0,00
Temperature C	-1,00	-1,00	-6,66	9,94	19,25	21,98	21,58	-13,08	-13,08	-33,08	-33,08	-33,17	-33,08	67,96	57,97	-10,93
Pressure kPa	7 000,00	7 000,00	6 000,00	6 000,00	6 000,00	6 000,00	6 000,00	6 000,00	6 000,00	6 000,00	6 000,00	6 000,00	6 000,00	6 000,00	3 420,00	3 420,00
Molar Flow kgmol/h	37 090,76	35 212,22	35 212,22	35 212,22	36 612,81	2 198,52	34 414,29	34 414,29	34 369,44	34 369,44	801,76	800,90	33 567,69	845,75	845,75	845,75
Mass Flow kg/h	813 382,24	699 236,35	699 236,35	699 236,35	743 080,87	96 754,18	646 326,69	646 326,69	632 774,07	632 774,07	26 860,28	26 801,60	605 913,79	40 354,22	40 354,22	40 354,22
Std Ideal Liq Vol Flow m3/h	2 156,11	1 965,32	1 965,32	1 965,32	2 063,36	117,23	1 946,12	1 946,12	1 929,20	1 929,20	60,25	60,16	1 868,95	77,08	77,08	77,08
Molar enthalpy KJ/kgmol	-99 841,87	-96 394,24	-96 394,24	-95 539,85	-95 867,09	-398 097,75	-76 559,44	-78 465,31	-77 824,19	-79 121,32	-110 044,86	-109 982,58	-78 382,71	-120 847,04	-120 847,04	-130 829,57
Molar Entropy KJ/kgmoleC	142,20	143,64	144,62	147,73	149,31	127,08	148,78	141,89	142,54	137,34	101,34	101,37	138,20	124,10	125,30	91,79
Heat Flow KJ/h *10^5	-37 032,11	-33 942,55	-33 942,55	-33 641,70	-35 099,63	-8 752,24	-26 347,39	-27 003,28	-26 747,74	-27 193,56	-882,29	-880,85	-26 311,26	-1 022,07	-1 022,07	-1 106,49
HHV MJ/m3	42,05	38,08	38,08	38,08	38,97		41,45	41,45	40,70	40,70	72,98	72,90	39,94	103,09	103,09	103,09
Mass Density kg/m3	0,9307	0,8421	0,8421	0,8421	0,8608	1,8717	0,7964	0,7964	0,7806	0,7806	1,4320	1,4304	0,7653	2,0667	2,0667	2,0667

	6.1	6.2	6.3	6.4	7.1	9.1	9.2	9.3	10.1	10.2	10.3	11.1	11.2	11.3	11.4
Vapor	1,00	0,9866	1,00	1,00	0,00	0,00	0,3041	0,4035	1,00	1,00	1,00	0,00	0,00	0,1411	0,1470
Temperature C	-49,08	-66,29	-5,29	-5,29	106,44	-1,00	-12,41	27,79	27,79	24,73	35,94	27,79	27,86	113,69	113,40
Pressure kPa	3 420,00	1 520,00	1 520,00	1 520,00	3 420,00	7 000,00	2 000,00	1 950,00	1 950,00	1 520,00	1 520,00	1 950,00	2 100,00	2 100,00	2 043,00
Molar Flow kgmol/h	179,67	179,67	179,67	179,67	661,48	1 878,55	1 878,55	1 878,55	757,90	757,90	757,90	1 120,65	1 120,65	1 120,65	1 120,65
Mass Flow kg/h	3 262,13	3 262,13	3 262,13	3 262,13	36 844,23	114 145,88	114 145,88	114 145,88	18 430,93	18 430,93	18 430,93	95 714,95	95 714,95	95 714,95	95 714,95
Std Ideal Liq Vol Flow m3/h	10,38	10,38	10,38	10,38	66,25	190,79	190,79	190,79	46,39	46,39	46,39	144,40	144,40	144,40	144,40
Molar enthalpy KJ/kgmol	-80 684,69	-80 684,69	-78 089,75	-78 089,75	-126 252,95	-164 465,54	-164 465,54	-158 416,46	-111 823,84	-111 823,84	-111 302,72	-189 927,37	-189 901,87	-171 158,03	-171 158,03
Molar Entropy KJ/kgmoleC	144,15	149,57	160,67	160,67	132,53	115,13	118,46	140,09	164,19	166,11	167,83	123,80	123,82	178,26	178,31
Heat Flow KJ/h *10^5	-144,97	-144,97	-140,31	-140,31	-835,14	-3 089,56	-3 089,56	-2 975,93	-847,51	-847,51	-843,56	-2 128,41	-2 128,13	-1 918,08	-1 918,08
HHV MJ/m3	42,08	42,08	42,08	42,08	120,47	120,66	120,66	120,66	44,57	44,57	44,57	180,02	180,02	180,02	180,02
Mass Density kg/m3	0,7699	0,7699	0,7699	0,7699	2,4355	2,6841	2,6841	2,6841	1,0329	1,0329	1,0329	3,9739	3,9739	3,9739	3,9739

	12.1	12.2	13.1	13.2	13.3	13.4	13.5
Vapor	1,00	1,00	0,00	0,0549	0,00	0,00	0,00
Temperature C	78,73	175,15	215,00	212,33	113,17	113,20	4,20
Pressure kPa	1 520,00	6 000,00	1 520,00	1 400,00	1 400,00	1 300,00	1 300,00
Molar Flow kgmol/h	1 400,59	1 400,59	657,63	657,63	657,63	657,63	657,63
Mass Flow kg/h	43 844,52	43 844,52	73 563,50	73 563,50	73 563,50	73 563,50	73 563,50
Std Ideal Liq Vol Flow m3/h	98,04	98,04	103,14	103,14	103,14	103,14	103,14
Molar enthalpy KJ/kgmol	-109 477,88	-104 094,03	-169 134,02	-169 134,02	-201 074,93	-201 074,93	-228 333,22
Molar Entropy KJ/kgmoleC	174,05	177,11	266,51	266,58	193,51	193,55	111,21
Heat Flow KJ/h *10^5	-1 533,34	-1 457,93	-1 112,27	-1 112,27	-1 322,32	-1 322,32	-1 501,58
HHV MJ/m3	61,46	61,46	254,11	254,11	254,11	254,11	254,11
Mass Density kg/m3	1,3351	1,3351	5,6794	5,6794	5,6794	5,6794	5,6794
TVP @ 37,8^{0}C							7,63

Appendix A.6: Mole Fraction Existing Pretreatment Facilities Case B

	Feed Gas	1.1	1.2	1.3	2.1	CO2/H2S	3.1	3.2	4.1	4.2	4.3	4.4	LNG	5.1	5.2	5.3	6.1	6.2	6.3	6.4	7.1
Nitrogen	0,02781	0,02908	0,02908	0,02908	0,02817	0	0,02997	0,02997	0,03015	0	0	0	0	0	0,00000	0	0	0	0	0	0
CO2	0,05927	0,05952	0,05952	0,05952	0,06004	0,99992	0	0	0	0	0	0	0	0	0,00000	0	0	0	0	0	0
Methane	0,80427	0,83063	0,83063	0,83063	0,81901	0	0,87134	0,87134	0,87885	0,87885	0,46923	0,46984	0,88864	0,18558	0,18558	0,18558	0,86513	0,86513	0,86513	0,86513	0,00100
Ethane	0,05012	0,04870	0,04870	0,04870	0,05136	0	0,05464	0,05464	0,05395	0,05395	0,13451	0,13472	0,05203	0,15831	0,15831	0,15831	0,11909	0,11909	0,11909	0,11909	0,16939
Propane	0,02448	0,02083	0,02083	0,02083	0,02484	0	0,02643	0,02643	0,02474	0,02474	0,17264	0,17288	0,02121	0,23391	0,23391	0,23391	0,01576	0,01576	0,01576	0,01576	0,29378
i-Butane	0,00380	0,00266	0,00266	0,00266	0,00359	0	0,00381	0,00381	0,00326	0,00326	0,04202	0,04169	0,00234	0,06204	0,06204	0,06204	0,00001	0,00001	0,00001	0,00001	0,07876
n-Butane	0,00790	0,00495	0,00495	0,00495	0,00695	0	0,00739	0,00739	0,00596	0,00596	0,09581	0,09517	0,00381	0,14882	0,14882	0,14882	0	0	0	0	0,18893
i-Pentane	0,00262	0,00115	0,00115	0,00115	0,00175	0	0,00186	0,00186	0,00121	0,00121	0,02935	0,02930	0,00054	0,05431	0,05431	0,05431	0	0	0	0	0,06901
n-Pentane	0,00289	0,00108	0,00108	0,00108	0,00173	0	0,00185	0,00185	0,00107	0,00107	0,02925	0,02920	0,00040	0,05911	0,05911	0,05911	0	0	0	0	0,07507
n-Hexane	0,00321	0,00060	0,00060	0,00060	0,00108	0	0,00115	0,00115	0,00038	0,00038	0,01358	0,01358	0,00007	0,04414	0,04414	0,04414	0	0	0	0	0,05599
n-Heptane	0,00351	0,00029	0,00029	0,00029	0,00060	0	0,00064	0,00064	0,00010	0,00010	0,00400	0,00399	0,00001	0,02555	0,02555	0,02555	0	0	0	0	0,03235
n-Octane	0,00281	0,00010	0,00010	0,00010	0,00023	0	0,00024	0,00024	0,00002	0,00002	0,00068	0,00068	0	0,00989	0,00989	0,00989	0	0	0	0	0,01249
n-Nonane	0,00125	0,00002	0,00002	0,00002	0,00005	0	0,00005	0,00005	0,00000	0	0,00006	0,00006	0	0,00207	0,00207	0,00207	0	0	0	0	0,00261
Benzene	0,00069	0,00011	0,00011	0,00011	0,00021	0	0,00022	0,00022	0,00007	0,00007	0,00244	0,00244	0,00001	0,00863	0,00863	0,00863	0	0	0	0	0,01093
Toluene	0,00080	0,00005	0,00005	0,00005	0,00012	0	0,00012	0,00012	0,00002	0,00002	0,00068	0,00068	0	0,00501	0,00501	0,00501	0	0	0	0	0,00634
m-Xylene	0,00055	0,00001	0,00001	0,00001	0,00003	0	0,00004	0,00004	0	0	0,00007	0,00007	0	0,00145	0,00145	0,00145	0	0	0	0	0,00183
n-Decane	0,00123	0,00001	0,00001	0,00001	0,00002	0	0,00002	0,00002	0	0	0,00001	0,00001	0	0,00095	0,00095	0,00095	0	0	0	0	0,00120
n-C11	0,00055	0	0	0,0	0	0	0	0	0	0	0	0	0	0	0,00017	0,00017	0	0	0	0	0,00021
n-C12	0,00054	0	0	0,0	0	0	0	0	0	0	0	0	0	0	0,00005	0,00005	0	0	0	0	0,00006
n-C13	0,00043	0	0	0,0	0	0	0	0	0	0	0	0	0	0	0,00001	0,00001	0	0	0	0	0,00001
n-C14	0,00029	0	0	0,0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
n-C15	0,00022	0	0	0,0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
n-C16	0,00013	0	0	0,0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
n-C17	0,00013	0	0	0,0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
n-C18	0,00009	0	0	0,0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
n-C19	0,00006	0	0	0,0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
n-C20	0,00015	0	0	0,0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
H2S	0	0	0	0,0	0	0,00008	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Phenol	0	0	0	0,0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Helium	0,00020	0,00021	0,00021	0,00021	0,00020	0	0,00022	0,00022	0,00022	0	0	0	0	0	0	0	0	0	0	0	0

	9.1	9.2	9.3	10.1	10.2	10.3	11.1	11.2	11.3	11.4	12.1	12.2	13.1	13.2	13.3	13.4	13.5
Nitrogen	0,00399	0,00399	0,00399	0,00944	0,00031	0,00031	0,00031	0,00031	0,00031	0,00031	0,00536	0,00536	0,0	0	0	0	0
CO2	0,05456	0,05456	0,05456	0,09946	0,02420	0,02420	0,02420	0,02420	0,02420	0,02420	0,07318	0,07318	0,0	0	0	0	0
Methane	0,31020	0,31020	0,31020	0,67128	0,06600	0,06600	0,06600	0,06600	0,06600	0,06600	0,52703	0,52703	0,0	0	0	0	0
Ethane	0,07674	0,07674	0,07674	0,11112	0,05349	0,05349	0,05349	0,05349	0,05349	0,05349	0,11820	0,11820	0,0	0	0	0	0
Propane	0,09301	0,09301	0,09301	0,06960	0,10884	0,10884	0,10884	0,10884	0,10884	0,10884	0,12586	0,12586	0,00193	0,0019	0,00193	0,00193	0,00193
i-Butane	0,02506	0,02506	0,02506	0,00953	0,03557	0,03557	0,03557	0,03557	0,03557	0,03557	0,02675	0,02675	0,01462	0,0146	0,01462	0,01462	0,01462
n-Butane	0,06319	0,06319	0,06319	0,01821	0,09361	0,09361	0,09361	0,09361	0,09361	0,09361	0,05727	0,05727	0,05854	0,0585	0,05854	0,05854	0,05854
i-Pentane	0,03013	0,03013	0,03013	0,00397	0,04783	0,04783	0,04783	0,04783	0,04783	0,04783	0,01691	0,01691	0,05007	0,0501	0,05007	0,05007	0,05007
n-Pentane	0,03685	0,03685	0,03685	0,00377	0,05923	0,05923	0,05923	0,05923	0,05923	0,05923	0,01815	0,01815	0,06661	0,0666	0,06661	0,06661	0,06661
n-Hexane	0,05224	0,05224	0,05224	0,00186	0,08632	0,08632	0,08632	0,08632	0,08632	0,08632	0,01332	0,01332	0,12087	0,1209	0,12087	0,12087	0,12087
n-Heptane	0,06372	0,06372	0,06372	0,00081	0,10627	0,10627	0,10627	0,10627	0,10627	0,10627	0,00823	0,00823	0,16449	0,1645	0,16449	0,16449	0,16449
n-Octane	0,05365	0,05365	0,05365	0,00024	0,08977	0,08977	0,08977	0,08977	0,08977	0,08977	0,00345	0,00345	0,14591	0,1459	0,14591	0,14591	0,14591
n-Nonane	0,02426	0,02426	0,02426	0,00004	0,04064	0,04064	0,04064	0,04064	0,04064	0,04064	0,00076	0,00076	0,06767	0,0677	0,06767	0,06767	0,06767
Benzene	0,01154	0,01154	0,01154	0,00039	0,01908	0,01908	0,01908	0,01908	0,01908	0,01908	0,00278	0,00278	0,02704	0,0270	0,02704	0,02704	0,02704
Toluene	0,01490	0,01490	0,01490	0,00017	0,02486	0,02486	0,02486	0,02486	0,02486	0,02486	0,00172	0,00172	0,03889	0,0389	0,03889	0,03889	0,03889
m-Xylene	0,01061	0,01061	0,01061	0,00004	0,01776	0,01776	0,01776	0,01776	0,01776	0,01776	0,00054	0,00054	0,02915	0,0292	0,02915	0,02915	0,02915
n-Decane	0,02420	0,02420	0,02420	0,00002	0,04056	0,04056	0,04056	0,04056	0,04056	0,04056	0,00036	0,00036	0,06837	0,0684	0,06837	0,06837	0,06837
n-C11	0,01085	0,01085	0,01085	0	0,01818	0,01818	0,01818	0,01818	0,01818	0,01818	0,00006	0,00006	0,03086	0,0309	0,03086	0,03086	0,03086
n-C12	0,01069	0,01069	0,01069	0	0,01791	0,01791	0,01791	0,01791	0,01791	0,01791	0,00001	0,00001	0,03050	0,0305	0,03050	0,03050	0,03050
n-C13	0,00847	0,00847	0,00847	0	0,01419	0,01419	0,01419	0,01419	0,01419	0,01419	0	0	0,02418	0,0242	0,02418	0,02418	0,02418
n-C14	0,00570	0,00570	0,00570	0	0,00956	0,00956	0,00956	0,00956	0,00956	0,00956	0	0	0,01630	0,0163	0,01630	0,01630	0,01630
n-C15	0,00432	0,00432	0,00432	0	0,00725	0,00725	0,00725	0,00725	0,00725	0,00725	0	0	0,01235	0,0124	0,01235	0,01235	0,01235
n-C16	0,00259	0,00259	0,00259	0	0,00434	0,00434	0,00434	0,00434	0,00434	0,00434	0	0	0,00739	0,0074	0,00739	0,00739	0,00739
n-C17	0,00259	0,00259	0,00259	0	0,00434	0,00434	0,00434	0,00434	0,00434	0,00434	0	0	0,00739	0,0074	0,00739	0,00739	0,00739
n-C18	0,00172	0,00172	0,00172	0	0,00288	0,00288	0,00288	0,00288	0,00288	0,00288	0	0	0,00491	0,0049	0,00491	0,00491	0,00491
n-C19	0,00120	0,00120	0,00120	0	0,00202	0,00202	0,00202	0,00202	0,00202	0,00202	0	0	0,00344	0,0034	0,00344	0,00344	0,00344
n-C20	0,00294	0,00294	0,00294	0	0,00493	0,00493	0,00493	0,00493	0,00493	0,00493	0	0	0,00840	0,0084	0,00840	0,00840	0,00840
H2S	0,00001	0,00001	0,00001	0,00001	0,00001	0,00001	0,00001	0,00001	0,00001	0,00001	0,00001	0,00001	0	0	0	0	0
Phenol	0,00004	0,00004	0,00004	0	0,00007	0,00007	0,00007	0,00007	0,00007	0,00007	0	0	0,00011	0,0001	0,00011	0,00011	0,00011
Helium	0,00003	0,00003	0,00003	0,00006	0	0	0	0	0	0	0,00004	0,00004	0	0	0	0	0

Appendix A.7: Mass Balance (kg/h) Existing Pretreatment Facilities Case B

	Feed Gas	1.1	1.2	1.3	2.1	CO2/H2S	3.1	3.2	4.1	4.2
Nitrogen	28 896,26	28 686,06	28 686,06	28 686,06	28 896,33	0	28 896,33	28 896,33	29 023,43	29 023,43
CO2	96 747,86	92 237,07	92 237,07	92 237,07	96 747,86	96 747,86	0,00	0,00	0,00	0,00
Methane	478 575,09	469 226,59	469 226,59	469 226,59	481 068,79	0	481 068,79	481 068,79	484 587,78	484 587,78
Ethane	55 896,21	51 561,40	51 561,40	51 561,40	56 539,53	0	56 539,53	56 539,53	55 758,07	55 758,07
Propane	40 042,51	32 338,01	32 338,01	32 338,01	40 111,45	0	40 111,45	40 111,45	37 493,37	37 493,37
i-Butane	8 187,96	5 451,56	5 451,56	5 451,56	7 629,30	0	7 629,30	7 629,30	6 519,91	6 519,91
n-Butane	17 022,68	10 123,01	10 123,01	10 123,01	14 784,91	0	14 784,91	14 784,91	11 899,71	11 899,71
i-Pentane	7 000,76	2 916,53	2 916,53	2 916,53	4 625,20	0	4 625,20	4 625,20	3 004,23	3 004,23
n-Pentane	7 742,05	2 746,90	2 746,90	2 746,90	4 581,40	0	4 581,40	4 581,40	2 662,14	2 662,14
n-Hexane	10 263,64	1 805,98	1 805,98	1 805,98	3 413,39	0	3 413,39	3 413,39	1 133,14	1 133,14
n-Heptane	13 030,67	1 035,85	1 035,85	1 035,85	2 191,03	0	2 191,03	2 191,03	346,12	346,12
n-Octane	11 918,53	405,95	405,95	405,95	957,21	0	957,21	957,21	64,29	64,29
n-Nonane	5 932,25	87,39	87,39	87,39	224,75	0	224,75	224,75	6,34	6,34
Benzene	1 990,35	297,36	297,36	297,36	601,57	0	601,57	601,57	184,06	184,06
Toluene	2 751,14	172,67	172,67	172,67	394,60	0	394,60	394,60	53,87	53,87
m-Xylene	2 165,78	49,67	49,67	49,67	130,55	0	130,55	130,55	6,36	6,36
n-Decane	6 512,38	43,14	43,14	43,14	114,79	0	114,79	114,79	1,39	1,39
n-C11	3 194,57	8,93	8,93	8,93	22,24	0	22,24	22,24	0,11	0,11
n-C12	3 424,35	4,77	4,77	4,77	7,37	0	7,37	7,37	0,02	0,02
n-C13	2 933,63	1,58	1,58	1,58	1,63	0	1,63	1,63	0	0
n-C14	2 126,48	0,42	0,42	0,42	0,43	0	0,43	0,43	0	0
n-C15	1 725,38	0,20	0,20	0,20	0,20	0	0,20	0,20	0	0
n-C16	1 100,19	0,06	0,06	0,06	0,06	0	0,06	0,06	0	0
n-C17	1 168,35	0,04	0,04	0,04	0,04	0	0,04	0,04	0	0
n-C18	821,18	0,02	0,02	0,02	0,02	0	0,02	0,02	0	0
n-C19	607,51	0,01	0,01	0,01	0,01	0	0,01	0,01	0	0
n-C20	1 561,46	0	0	0	0	0	0	0	0	0
H2S	6,32	5,65	5,65	5,65	6,32	6	0	0	0	0
Phenol	6,98	0,06	0,06	0,06	0,22	0	0,22	0,22	0	0
Helium	29,69	29,49	29,49	29,49	29,69	0	29,69	29,69	29,76	29,76
Total	813 382,24	699 236,35	699 236,35	699 236,35	743 080,87	96 754,18	646 326,69	646 326,69	632 774,07	632 774,07

	4.3	4.4	LNG	5.1	5.2	5.3	6.1	6.2	6.3	6.4	7.1
Nitrogen	127,13	127,18	28 896,31	0,07	0,07	0,07	0,07	0,07	0,07	0,07	0,00
CO2	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Methane	6 035,43	6 036,93	478 552,35	2 517,95	2 517,95	2 517,95	2 493,70	2 493,70	2 493,70	2 493,70	10,64
Ethane	3 242,89	3 244,51	52 515,18	4 025,97	4 025,97	4 025,97	643,43	643,43	643,43	643,43	3 369,34
Propane	6 103,57	6 105,59	31 389,80	8 723,67	8 723,67	8 723,67	124,86	124,86	124,86	124,86	8 569,25
i-Butane	1 958,25	1 940,59	4 561,66	3 049,98	3 049,98	3 049,98	0,06	0,06	0,06	0,06	3 028,26
n-Butane	4 464,76	4 430,54	7 434,94	7 315,74	7 315,74	7 315,74	0,01	0,01	0,01	0,01	7 264,06
i-Pentane	1 697,67	1 693,01	1 306,55	3 313,99	3 313,99	3 313,99	0	0	0	0	3 293,36
n-Pentane	1 691,81	1 687,46	970,32	3 606,72	3 606,72	3 606,72	0	0	0	0	3 582,91
n-Hexane	938,63	937,06	194,51	3 217,31	3 217,31	3 217,31	0	0	0	0	3 191,68
n-Heptane	321,01	320,37	25,10	2 165,28	2 165,28	2 165,28	0	0	0	0	2 144,47
n-Octane	62,42	62,21	1,86	955,13	955,13	955,13	0	0	0	0	944,09
n-Nonane	6,26	6,23	0,08	224,64	224,64	224,64	0	0	0	0	221,56
Benzene	152,67	152,33	31,38	569,84	569,84	569,84	0	0	0	0	564,98
Toluene	49,97	49,84	3,90	390,57	390,57	390,57	0	0	0	0	386,56
m-Xylene	6,21	6,18	0,15	130,37	130,37	130,37	0	0	0	0	128,71
n-Decane	1,38	1,37	0,01	114,77	114,77	114,77	0	0	0	0	112,89
n-C11	0,11	0,11	0	22,24	22,24	22,24	0	0	0	0	21,72
n-C12	0,02	0,02	0	7,37	7,37	7,37	0	0	0	0	7,15
n-C13	0	0	0	1,63	1,63	1,63	0	0	0	0	1,62
n-C14	0	0	0	0,43	0,43	0,43	0	0	0	0	0,43
n-C15	0	0	0	0,20	0,20	0,20	0	0	0	0	0,20
n-C16	0	0	0	0,06	0,06	0,06	0	0	0	0	0,06
n-C17	0	0	0	0,04	0,04	0,04	0	0	0	0	0,04
n-C18	0	0	0	0,02	0,02	0,02	0	0	0	0	0,02
n-C19	0	0	0	0,01	0,01	0,01	0	0	0	0	0,01
n-C20	0	0	0	0	0	0	0	0	0	0	0
H2S	0	0	0	0	0	0	0	0	0	0	0
Phenol	0	0	0	0,22	0,22	0,22	0	0	0	0	0,22
Helium	0,06	0,06	29,69	0	0	0	0	0	0	0	0
Total	26 860,28	26 801,60	605 913,79	40 354,22	40 354,22	40 354,22	3 262,13	3 262,13	3 262,13	3 262,13	36 844,23

	9.1	9.2	9.3	10.1	10.2	10.3	11.1	11.2	11.3	11.4
Nitrogen	210,20	210,20	210,20	200,39	200,39	200,39	9,81	9,81	9,81	9,81
CO2	4 510,79	4 510,79	4 510,79	3 317,35	3 317,35	3 317,35	1 193,44	1 193,44	1 193,44	1 193,44
Methane	9 348,50	9 348,50	9 348,50	8 162,00	8 162,00	8 162,00	1 186,49	1 186,49	1 186,49	1 186,49
Ethane	4 334,81	4 334,81	4 334,81	2 532,45	2 532,45	2 532,45	1 802,36	1 802,36	1 802,36	1 802,36
Propane	7 704,50	7 704,50	7 704,50	2 325,99	2 325,99	2 325,99	5 378,51	5 378,51	5 378,51	5 378,51
i-Butane	2 736,41	2 736,41	2 736,41	419,82	419,82	419,82	2 316,59	2 316,59	2 316,59	2 316,59
n-Butane	6 899,67	6 899,67	6 899,67	802,21	802,21	802,21	6 097,46	6 097,46	6 097,46	6 097,46
i-Pentane	4 084,24	4 084,24	4 084,24	216,98	216,98	216,98	3 867,26	3 867,26	3 867,26	3 867,26
n-Pentane	4 995,15	4 995,15	4 995,15	206,06	206,06	206,06	4 789,09	4 789,09	4 789,09	4 789,09
n-Hexane	8 457,66	8 457,66	8 457,66	121,33	121,33	121,33	8 336,33	8 336,33	8 336,33	8 336,33
n-Heptane	11 994,81	11 994,81	11 994,81	61,17	61,17	61,17	11 933,65	11 933,65	11 933,65	11 933,65
n-Octane	11 512,59	11 512,59	11 512,59	20,95	20,95	20,95	11 491,64	11 491,64	11 491,64	11 491,64
n-Nonane	5 844,86	5 844,86	5 844,86	3,94	3,94	3,94	5 840,92	5 840,92	5 840,92	5 840,92
Benzene	1 692,99	1 692,99	1 692,99	22,97	22,97	22,97	1 670,03	1 670,03	1 670,03	1 670,03
Toluene	2 578,47	2 578,47	2 578,47	11,70	11,70	11,70	2 566,77	2 566,77	2 566,77	2 566,77
m-Xylene	2 116,11	2 116,11	2 116,11	2,91	2,91	2,91	2 113,20	2 113,20	2 113,20	2 113,20
n-Decane	6 469,24	6 469,24	6 469,24	1,67	1,67	1,67	6 467,57	6 467,57	6 467,57	6 467,57
n-C11	3 185,64	3 185,64	3 185,64	0,30	0,30	0,30	3 185,34	3 185,34	3 185,34	3 185,34
n-C12	3 419,58	3 419,58	3 419,58	0,14	0,14	0,14	3 419,44	3 419,44	3 419,44	3 419,44
n-C13	2 932,06	2 932,06	2 932,06	0,04	0,04	0,04	2 932,02	2 932,02	2 932,02	2 932,02
n-C14	2 126,05	2 126,05	2 126,05	0,01	0,01	0,01	2 126,04	2 126,04	2 126,04	2 126,04
n-C15	1 725,18	1 725,18	1 725,18	0	0	0	1 725,18	1 725,18	1 725,18	1 725,18
n-C16	1 100,14	1 100,14	1 100,14	0	0	0	1 100,14	1 100,14	1 100,14	1 100,14
n-C17	1 168,31	1 168,31	1 168,31	0	0	0	1 168,31	1 168,31	1 168,31	1 168,31
n-C18	821,16	821,16	821,16	0	0	0	821,16	821,16	821,16	821,16
n-C19	607,50	607,50	607,50	0	0	0	607,50	607,50	607,50	607,50
n-C20	1 561,46	1 561,46	1 561,46	0	0	0	1 561,46	1 561,46	1 561,46	1 561,46
H2S	0,67	0,67	0,67	0,34	0,34	0,34	0,32	0,32	0,32	0,32
Phenol	6,92	6,92	6,92	0	0	0	6,92	6,92	6,92	6,92
Helium	0,20	0,20	0,20	0,19	0,19	0,19	0,01	0,01	0,01	0,01
Total	114 145,88	114 145,88	114 145,88	18 430,93	18 430,93	18 430,93	95 714,95	95 714,95	95 714,95	95 714,95

	12.1	12.2	13.1	13.2	13.3	13.4	13.5
Nitrogen	210,27	210,27	0	0	0	0	0
CO2	4 510,79	4 510,79	0	0	0	0	0
Methane	11 842,20	11 842,20	0	0	0	0	0
Ethane	4 978,13	4 978,13	0,12	0,12	0,12	0,12	0,12
Propane	7 773,44	7 773,44	55,92	55,92	55,92	55,92	55,92
i-Butane	2 177,74	2 177,74	558,73	558,73	558,73	558,73	558,73
n-Butane	4 661,90	4 661,90	2 237,78	2 237,78	2 237,78	2 237,78	2 237,78
i-Pentane	1 708,68	1 708,68	2 375,56	2 375,56	2 375,56	2 375,56	2 375,56
n-Pentane	1 834,50	1 834,50	3 160,65	3 160,65	3 160,65	3 160,65	3 160,65
n-Hexane	1 607,41	1 607,41	6 850,25	6 850,25	6 850,25	6 850,25	6 850,25
n-Heptane	1 155,18	1 155,18	10 839,63	10 839,63	10 839,63	10 839,63	10 839,63
n-Octane	551,26	551,26	10 961,33	10 961,33	10 961,33	10 961,33	10 961,33
n-Nonane	137,36	137,36	5 707,50	5 707,50	5 707,50	5 707,50	5 707,50
Benzene	304,21	304,21	1 388,78	1 388,78	1 388,78	1 388,78	1 388,78
Toluene	221,93	221,93	2 356,55	2 356,55	2 356,55	2 356,55	2 356,55
m-Xylene	80,88	80,88	2 035,23	2 035,23	2 035,23	2 035,23	2 035,23
n-Decane	71,65	71,65	6 397,59	6 397,59	6 397,59	6 397,59	6 397,59
n-C11	13,31	13,31	3 172,33	3 172,33	3 172,33	3 172,33	3 172,33
n-C12	2,59	2,59	3 416,99	3 416,99	3 416,99	3 416,99	3 416,99
n-C13	0,05	0,05	2 932,01	2 932,01	2 932,01	2 932,01	2 932,01
n-C14	0	0	2 126,05	2 126,05	2 126,05	2 126,05	2 126,05
n-C15	0	0	1 725,18	1 725,18	1 725,18	1 725,18	1 725,18
n-C16	0	0	1 100,14	1 100,14	1 100,14	1 100,14	1 100,14
n-C17	0	0	1 168,31	1 168,31	1 168,31	1 168,31	1 168,31
n-C18	0	0	821,16	821,16	821,16	821,16	821,16
n-C19	0	0	607,50	607,50	607,50	607,50	607,50
n-C20	0	0	1 561,46	1 561,46	1 561,46	1 561,46	1 561,46
H2S	0,67	0,67	0	0	0	0	0
Phenol	0,17	0,17	6,76	6,76	6,76	6,76	6,76
Helium	0,20	0,20	0,00	0,00	0,00	0,00	0,00
Total	43 844,52	43 844,52	73 563,50	73 563,50	73 563,50	73 563,50	73 563,50

Appendix A.8: Heat Balance Existing Pretreatment Facilities Case C

	Feed Gas	1.1	1.2	1.3	2.1	CO2/H2S	3.1	3.2	4.1	4.2	4.3	4.4	LNG	5.1	5.2	5.3
Vapor	0,9164	1,00	1,00	1,00	1,00	1,00	1,00	0,9875	1,00	0,9807	0,00	0,00	1,00	0,00	0,2357	0,00
Temperature C	-1,00	-1,00	-6,62	9,98	23,65	21,98	26,00	-8,66	-8,66	-28,66	-28,66	-28,65	-28,66	71,66	62,34	-6,56
Pressure kPa	7 000,00	7 000,00	6 000,00	6 000,00	6 000,00	6 000,00	6 000,00	6 000,00	6 000,00	6 000,00	6 000,00	6 000,00	6 000,00	6 000,00	3 420,00	3 420,00
Molar Flow kgmol/h	35 038,71	32 108,67	32 108,67	32 108,67	34 057,53	1 821,84	32 235,69	32 235,69	32 144,80	32 144,80	619,81	619,32	31 524,99	710,22	710,22	710,22
Mass Flow kg/h	813 382,24	627 562,29	627 562,29	627 562,29	687 251,21	80 176,70	607 074,51	607 074,51	593 620,59	593 620,59	21 878,52	21 865,40	571 742,07	35 319,32	35 319,32	35 319,32
Std Ideal Liq Vol Flow m3/h	2 097,88	1 790,00	1 790,00	1 790,00	1 925,22	97,14	1 828,07	1 828,07	1 809,66	1 809,66	47,76	47,72	1 761,91	66,13	66,13	66,13
Molar enthalpy KJ/kgmol	-100 507,43	-94 162,18	-94 162,18	-93 315,83	-93 891,61	-398 093,32	-76 699,32	-78 587,77	-77 945,86	-79 200,45	-112 923,14	-112 933,69	-78 537,43	-124 151,46	-124 151,46	-134 377,43
Molar Entropy KJ/kgmoleC	141,56	143,63	144,61	147,69	150,03	127,08	149,55	142,83	143,40	138,46	100,60	100,60	139,21	125,62	126,82	92,96
Heat Flow KJ/h *10^5	-35 216,50	-30 234,22	-30 234,22	-29 962,47	-31 977,16	-7 252,61	-24 724,56	-25 333,31	-25 055,54	-25 458,82	-699,91	-699,42	-24 758,91	-881,75	-881,75	-954,37
HHV MJ/m3	45,19	38,27	38,27	38,27	39,51		41,74	41,74	41,00	41,00	76,75	76,76	40,30	107,50	107,50	107,50
Mass Density kg/m3	0,9859	0,8288	0,8288	0,8288	0,8559	1,8717	0,7986	0,7986	0,7830	0,7830	1,5109	1,5112	0,7689	2,1597	2,1597	2,1597

	6.1	6.2	6.3	6.4	7.1	9.1	9.2	9.3	10.1	10.2	10.3	11.1	11.2	11.3	11.4
Vapor	1,00	0,9865	1,00	1,00	0,00	0,00	0,30	0,3946	1,00	1,00	1,00	0,00	0,00	0,1236	0,1292
Temperature C	-49,84	-66,99	-5,99	-6,04	113,31	-1,00	-11,53	28,67	28,67	25,69	36,90	28,67	28,74	113,64	113,40
Pressure kPa	3 420,00	1 520,00	1 520,00	1 520,00	3 420,00	7 000,00	2 000,00	1 950,00	1 950,00	1 520,00	1 520,00	1 950,00	2 100,00	2 100,00	2 043,00
Molar Flow kgmol/h	148,20	148,20	148,20	148,57	562,02	2 930,04	2 930,04	2 930,04	1 156,19	1 156,19	1 156,19	1 773,84	1 773,84	1 773,84	1 773,84
Mass Flow kg/h	2 678,23	2 678,23	2 678,23	2 684,28	32 641,10	185 819,95	185 819,95	185 819,95	27 521,76	27 521,76	27 521,76	158 298,19	158 298,19	158 298,19	158 298,19
Std Ideal Liq Vol Flow m3/h	8,54	8,54	8,54	8,56	57,60	307,88	307,88	307,88	70,49	70,49	70,49	237,39	237,39	237,39	237,39
Molar enthalpy KJ/kgmol	-80 641,26	-80 641,26	-78 051,55	-78 049,64	-129 430,00	-170 041,62	-170 041,62	-163 827,29	-108 217,72	-108 217,72	-107 700,48	-200 073,59	-200 047,04	-180 910,57	-180 910,57
Molar Entropy KJ/kgmoleC	143,88	149,31	160,41	160,40	136,47	118,87	122,26	144,42	164,33	166,26	167,96	131,44	131,46	187,01	187,05
Heat Flow KJ/h *10^5	-119,51	-119,51	-115,67	-115,96	-727,42	-4 982,28	-4 982,28	-4 800,20	-1 251,20	-1 251,20	-1 245,22	-3 548,99	-3 548,52	-3 209,07	-3 209,07
HHV MJ/m3	41,91	41,91	41,91	41,90	125,86	125,67	125,67	125,67	44,57	44,57	44,57	187,47	187,47	187,47	187,47
Mass Density kg/m3	0,7663	0,7663	0,766336059	0,7661	2,5491	2,8124	2,8124	2,8124	1,0109	1,0109	1,0109	4,1856	4,1856	4,1856	4,1856

	12.1	12.2	13.1	13.2	13.3	13.4	13.5
Vapor	1,00	1,00	0,00	0,0532	0,00	0,00	0,00
Temperature C	77,36	175,17	214,99	212,49	122,22	122,25	13,25
Pressure kPa	1 520,00	6 000,00	1 520,00	1 400,00	1 400,00	1 300,00	1 300,00
Molar Flow kgmol/h	1 948,86	1 948,86	1 129,75	1 129,75	1 129,75	1 129,75	1 129,75
Mass Flow kg/h	59 688,93	59 688,93	128 815,31	128 815,31	128 815,31	128 815,31	128 815,31
Std Ideal Liq Vol Flow m3/h	135,22	135,22	181,22	181,22	181,22	181,22	181,22
Molar enthalpy KJ/kgmol	-108 772,34	-103 378,02	-179 121,50	-179 121,50	-209 168,11	-209 168,11	-237 683,57
Molar Entropy KJ/kgmoleC	174,32	177,39	277,15	277,22	209,19	209,23	125,40
Heat Flow KJ/h *10^5	-2 119,82	-2 014,69	-2 023,62	-2 023,62	-2 363,07	-2 363,07	-2 685,23
HHV MJ/m3	60,18	60,18	256,69	256,69	256,69	256,69	256,69
Mass Density kg/m3	1,3057	1,3057	5,8022	5,8022	5,8022	5,8022	5,8022

Appendix A.9: Mole fraction Existing Pretreatment Facilities Case C

	Feed Gas	1.1	1.2	1.3	2.1	CO2/H2S	3.1	3.2	4.1	4.2	4.3	4.4	LNG	5.1	5.2	5.3	6.1	6.2	6.3	6.4	7.1
Nitrogen	0,02486	0,02679	0,02679	0,02679	0,02557	0	0,02702	0,02702	0,02719	0	0	0	0	0	0,00000	0	0	0	0	0	0
CO2	0,05199	0,05235	0,05235	0,05235	0,05349	0,99990	0	0	0	0	0	0	0	0	0,00000	0	0	0	0	0	0
Methane	0,79869	0,84303	0,84303	0,84303	0,82550	0	0,87216	0,87216	0,87911	0,87911	0,44245	0,44238	0,88770	0,18257	0,18257	0,18257	0,87112	0,87112	0,87112	0,87144	0,00100
Ethane	0,04995	0,04768	0,04768	0,04768	0,05188	0	0,05481	0,05481	0,05427	0,05427	0,12812	0,12806	0,05282	0,14284	0,14284	0,14284	0,11308	0,11308	0,11308	0,11279	0,15069
Propane	0,02565	0,01988	0,01988	0,01988	0,02630	0	0,02778	0,02778	0,02631	0,02631	0,17750	0,17748	0,02334	0,22501	0,22501	0,22501	0,01577	0,01577	0,01577	0,01575	0,28019
i-Butane	0,00418	0,00245	0,00245	0,00245	0,00369	0	0,00390	0,00390	0,00342	0,00342	0,04402	0,04402	0,00263	0,06030	0,06030	0,06030	0,00001	0,00001	0,00001	0,00001	0,07620
n-Butane	0,00885	0,00445	0,00445	0,00445	0,00705	0	0,00745	0,00745	0,00622	0,00622	0,10174	0,10177	0,00434	0,14509	0,14509	0,14509	0	0	0	0	0,18335
i-Pentane	0,00322	0,00103	0,00103	0,00103	0,00179	0	0,00189	0,00189	0	0,00132	0,03410	0,03412	0,00067	0,05611	0,05611	0,05611	0	0	0	0	0,07090
n-Pentane	0,00362	0,00095	0,00095	0,00095	0,00176	0	0,00186	0,00186	0	0,00118	0,03490	0,03493	0,00052	0,06177	0,06177	0,06177	0	0	0	0	0,07806
n-Hexane	0,00457	0,00055	0,00055	0,00055	0,00116	0	0,00123	0,00123	0	0,00047	0,01919	0,01922	0,00010	0,05129	0,05129	0,05129	0	0	0	0	0
n-Heptane	0,00655	0,00034	0,00034	0,00034	0,00082	0	0,00087	0,00087	0	0,00017	0,00777	0,00778	0,00002	0,03857	0,03857	0,03857	0	0	0	0	0
n-Octane	0,00606	0,00013	0,00013	0,00013	0,00036	0	0,00038	0,00038	0	0,00003	0,00159	0,00159	0,00000	0,01717	0,01717	0,01717	0	0	0	0	0
n-Nonane	0,00313	0,00003	0,00003	0,00003	0,00009	0	0,00009	0,00009	0	0,00000	0,00017	0,00017	0,00000	0,00420	0,00420	0,00420	0	0	0	0	0
Benzene	0,00078	0,00008	0,00008	0,00008	0,00018	0	0,00019	0,00019	0	0,00007	0,00277	0,00277	0,00001	0,00805	0,00805	0,00805	0	0	0	0	0
Toluene	0,00090	0,00004	0,00004	0,00004	0,00010	0	0,00010	0,00010	0	0,00002	0,00080	0,00080	0	0,00459	0,00459	0,00459	0	0	0	0	0
m-Xylene	0,00061	0,00001	0,00001	0,00001	0,00003	0	0,00003	0,00003	0	0	0,00009	0,00009	0	0,00132	0,00132	0,00132	0	0	0	0	0
n-Decane	0,00129	0,00001	0,00001	0,00001	0,00002	0	0,00002	0,00002	0	0	0,00001	0,00001	0	0,00080	0,00080	0,00080	0	0	0	0	0
n-C11	0,00102	0	0	0	0	0	0,00001	0,00001	0	0	0	0	0	0	0,00024	0,00024	0	0	0	0	0
n-C12	0,00081	0	0	0	0	0	0	0	0	0	0	0	0	0	0,00005	0,00005	0	0	0	0	0
n-C13	0,00064	0	0	0	0	0	0	0	0	0	0	0	0	0	0,00001	0,00001	0	0	0	0	0
n-C14	0,00051	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
n-C15	0,00045	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
n-C16	0,00027	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
n-C17	0,00027	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
n-C18	0,00018	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
n-C19	0,00013	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
n-C20	0,00063	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
H2S	0	0	0	0	0,00001	0,00010	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Phenol	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Helium	0,00020	0,00022	0,00022	0,00022	0,00021	0	0,00022	0,00022	0,00022	0	0	0	0	0	0	0	0	0	0	0	0

	9.1	9.2	9.3	10.1	10.2	10.3	11.1	11.2	11.3	11.4	12.1	12.2	13.1	13.2	13.3	13.4	13.5
Nitrogen	0,00368	0,00368	0,00368	0,00888	0,00888	0,00888	0,00030	0,00030	0,00030	0,00030	0,00554	0,00554	0,0	0	0	0	0
CO2	0,04808	0,04808	0,04808	0,08884	0,08884	0,08884	0,02150	0,02150	0,02150	0,02150	0,07228	0,07228	0,0	0	0	0	0
Methane	0,31276	0,31276	0,31276	0,68908	0,68908	0,68908	0,06748	0,06748	0,06748	0,06748	0,53666	0,53666	0,0	0	0	0	0
Ethane	0,07480	0,07480	0,07480	0,10976	0,10976	0,10976	0,05201	0,05201	0,05201	0,05201	0,12105	0,12105	0,0	0	0	0	0
Propane	0,08888	0,08888	0,08888	0,06717	0,06717	0,06717	0,10302	0,10302	0,10302	0,10302	0,13206	0,13206	0,00477	0,0048	0,00477	0,00477	0,00477
i-Butane	0,02313	0,02313	0,02313	0,00890	0,00890	0,00890	0,03240	0,03240	0,03240	0,03240	0,02408	0,02408	0,01843	0,0184	0,01843	0,01843	0,01843
n-Butane	0,05703	0,05703	0,05703	0,01667	0,01667	0,01667	0,08333	0,08333	0,08333	0,08333	0,04982	0,04982	0,06196	0,0620	0,06196	0,06196	0,06196
i-Pentane	0,02725	0,02725	0,02725	0,00364	0,00364	0,00364	0,04264	0,04264	0,04264	0,04264	0,01439	0,01439	0,04586	0,0459	0,04586	0,04586	0,04586
n-Pentane	0,03285	0,03285	0,03285	0,00341	0,00341	0,00341	0,05203	0,05203	0,05203	0,05203	0,01512	0,01512	0,05910	0,0591	0,05910	0,05910	0,05910
n-Hexane	0,04867	0,04867	0,04867	0,00176	0,00176	0,00176	0,07924	0,07924	0,07924	0,07924	0,01137	0,01137	0,10660	0,1066	0,10660	0,10660	0,10660
n-Heptane	0,07470	0,07470	0,07470	0,00096	0,00096	0,00096	0,12276	0,12276	0,12276	0,12276	0,00878	0,00878	0,17858	0,1786	0,17858	0,17858	0,17858
n-Octane	0,07111	0,07111	0,07111	0,00033	0,00033	0,00033	0,11725	0,11725	0,11725	0,11725	0,00415	0,00415	0,17727	0,1773	0,17727	0,17727	0,17727
n-Nonane	0,03714	0,03714	0,03714	0,00006	0,00006	0,00006	0,06131	0,06131	0,06131	0,06131	0,00107	0,00107	0,09449	0,0945	0,09449	0,09449	0,09449
Benzene	0,00845	0,00845	0,00845	0,00029	0,00029	0,00029	0,01376	0,01376	0,01376	0,01376	0,00188	0,00188	0,01867	0,0187	0,01867	0,01867	0,01867
Toluene	0,01034	0,01034	0,01034	0,00012	0,00012	0,00012	0,01700	0,01700	0,01700	0,01700	0,00110	0,00110	0,02492	0,0249	0,02492	0,02492	0,02492
m-Xylene	0,00719	0,00719	0,00719	0,00003	0,00003	0,00003	0,01185	0,01185	0,01185	0,01185	0,00034	0,00034	0,01805	0,0181	0,01805	0,01805	0,01805
n-Decane	0,01533	0,01533	0,01533	0,00001	0,00001	0,00001	0,02532	0,02532	0,02532	0,02532	0,00021	0,00021	0,03941	0,0394	0,03941	0,03941	0,03941
n-C11	0,01215	0,01215	0,01215	0	0	0	0,02008	0,02008	0,02008	0,02008	0,00006	0,00006	0,03142	0,0314	0,03142	0,03142	0,03142
n-C12	0,00966	0,00966	0,00966	0	0	0	0,01595	0,01595	0,01595	0,01595	0,00001	0,00001	0,02503	0,0250	0,02503	0,02503	0,02503
n-C13	0,00764	0,00764	0,00764	0	0	0	0,01262	0,01262	0,01262	0,01262	0	0	0,01981	0,0198	0,01981	0,01981	0,01981
n-C14	0,00609	0,00609	0,00609	0	0	0	0,01005	0,01005	0,01005	0,01005	0	0	0,01578	0,0158	0,01578	0,01578	0,01578
n-C15	0,00537	0,00537	0,00537	0	0	0	0,00887	0,00887	0,00887	0,00887	0	0	0,01392	0,0139	0,01392	0,01392	0,01392
n-C16	0,00322	0,00322	0,00322	0	0	0	0,00531	0,00531	0,00531	0,00531	0	0	0,00834	0,0083	0,00834	0,00834	0,00834
n-C17	0,00322	0,00322	0,00322	0	0	0	0,00531	0,00531	0,00531	0,00531	0	0	0,00834	0,0083	0,00834	0,00834	0,00834
n-C18	0,00215	0,00215	0,00215	0	0	0	0,00356	0,00356	0,00356	0,00356	0	0	0,00558	0,0056	0,00558	0,00558	0,00558
n-C19	0,00155	0,00155	0,00155	0	0	0	0,00257	0,00257	0,00257	0,00257	0	0	0,00403	0,0040	0,00403	0,00403	0,00403
n-C20	0,00752	0,00752	0,00752	0	0	0	0,01242	0,01242	0,01242	0,01242	0	0	0,01951	0,0195	0,01951	0,01951	0,01951
H2S	0,00001	0,00001	0,00001	0,00001	0,00001	0,00001	0,00001	0,00001	0,00001	0,00001	0,00002	0,00002	0	0	0	0	0
Phenol	0,00002	0,00002	0,00002	0	0	0	0,00004	0,00004	0,00004	0,00004	0	0	0,00006	0,0001	0,00006	0,00006	0,00006
Helium	0,00003	0,00003	0,00003	0,00007	0	0	0	0	0	0	0,00004	0,00004	0	0	0	0	0

Appendix A.10: Mass Balance (kg/h) Existing Pretreatment Facilities Case C

	Feed Gas	1.1	1.2	1.3	2.1	CO2/H2S	3.1	3.2	4.1	4.2
Nitrogen	24 399,08	24 096,79	24 096,79	24 096,79	24 399,15	0,00	24 399,15	24 399,15	24 481,97	24 481,97
CO2	80 170,73	73 971,40	73 971,40	73 971,40	80 170,73	80 170,73	0,00	0,00	0,00	0,00
Methane	448 962,26	434 260,49	434 260,49	434 260,49	451 039,35	0,00	451 039,35	451 039,35	453 354,56	453 354,56
Ethane	52 623,57	46 033,50	46 033,50	46 033,50	53 127,10	0,00	53 127,10	53 127,10	52 461,45	52 461,45
Propane	39 625,64	28 142,19	28 142,19	28 142,19	39 491,09	0,00	39 491,09	39 491,09	37 291,05	37 291,05
i-Butane	8 510,90	4 572,33	4 572,33	4 572,33	7 300,56	0,00	7 300,56	7 300,56	6 396,08	6 396,08
n-Butane	18 019,73	8 307,64	8 307,64	8 307,64	13 950,88	0,00	13 950,88	13 950,88	11 624,88	11 624,88
i-Pentane	8 145,46	2 384,08	2 384,08	2 384,08	4 406,91	0,00	4 406,91	4 406,91	3 056,48	3 056,48
n-Pentane	9 154,16	2 209,97	2 209,97	2 209,97	4 336,55	0,00	4 336,55	4 336,55	2 732,17	2 732,17
n-Hexane	13 796,37	1 508,24	1 508,24	1 508,24	3 417,53	0,00	3 417,53	3 417,53	1 304,13	1 304,13
n-Heptane	23 011,42	1 080,05	1 080,05	1 080,05	2 794,47	0,00	2 794,47	2 794,47	532,30	532,30
n-Octane	24 275,39	474,01	474,01	474,01	1 397,54	0,00	1 397,54	1 397,54	116,68	116,68
n-Nonane	14 075,29	116,99	116,99	116,99	383,20	0,00	383,20	383,20	13,67	13,67
Benzene	2 129,29	196,51	196,51	196,51	482,13	0,00	482,13	482,13	169,47	169,47
Toluene	2 899,19	107,68	107,68	107,68	304,84	0,00	304,84	304,84	50,11	50,11
m-Xylene	2 265,43	29,95	29,95	29,95	100,05	0,00	100,05	100,05	6,05	6,05
n-Decane	6 416,31	23,61	23,61	23,61	80,75	0,00	80,75	80,75	1,25	1,25
n-C11	5 575,59	8,57	8,57	8,57	26,39	0,00	26,39	26,39	0,17	0,17
n-C12	4 822,51	3,66	3,66	3,66	5,87	0,00	5,87	5,87	0,02	0,02
n-C13	4 127,92	1,19	1,19	1,19	1,23	0,00	1,23	1,23	0,00	0,00
n-C14	3 538,04	0,38	0,38	0,38	0,38	0,00	0,38	0,38	0,00	0,00
n-C15	3 341,71	0,20	0,20	0,20	0,20	0,00	0,20	0,20	0,00	0,00
n-C16	2 134,18	0,06	0,06	0,06	0,06	0,00	0,06	0,06	0,00	0,00
n-C17	2 266,40	0,04	0,04	0,04	0,04	0,00	0,04	0,04	0,00	0,00
n-C18	1 604,99	0,02	0,02	0,02	0,02	0,00	0,02	0,02	0,00	0,00
n-C19	1 223,07	0,01	0,01	0,01	0,01	0,00	0,01	0,01	0,00	0,00
n-C20	6 226,99	0,01	0,01	0,01	0,01	0,00	0,01	0,01	0,00	0,00
H2S	5,97	4,97	4,97	4,97	5,97	5,97	0,00	0,00	0,00	0,00
Phenol	6,60	0,03	0,03	0,03	0,16	0,00	0,16	0,16	0,00	0,00
Helium	28,05	27,72	27,72	27,72	28,05	0,00	28,05	28,05	28,10	28,10
Total	813 382,24	627 562,29	627 562,29	627 562,29	687 251,21	80 176,70	607 074,51	607 074,51	593 620,59	593 620,59

	4.3	4.4	LNG	5.1	5.2	5.3	6.1	6.2	6.3	6.4	7.1
Nitrogen	82,98	82,89	24 399,00	0,07	0,07	0,07	0,07	0,07	0,07	0,07	0,00
CO2	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Methane	4 399,48	4 395,36	448 955,08	2 080,15	2 080,15	2 080,15	2 071,12	2 071,12	2 071,12	2 077,09	9,03
Ethane	2 387,80	2 384,95	50 073,65	3 050,60	3 050,60	3 050,60	503,93	503,93	503,93	503,89	2 546,67
Propane	4 851,29	4 847,01	32 439,76	7 047,05	7 047,05	7 047,05	103,05	103,05	103,05	103,19	6 943,99
i-Butane	1 585,74	1 584,64	4 810,33	2 489,12	2 489,12	2 489,12	0,05	0,05	0,05	0,05	2 489,07
n-Butane	3 665,25	3 663,58	7 959,62	5 989,57	5 989,57	5 989,57	0,00	0,00	0,00	0,00	5 989,57
i-Pentane	1 524,76	1 524,77	1 531,72	2 875,21	2 875,21	2 875,21	0,00	0,00	0,00	0,00	2 875,21
n-Pentane	1 560,72	1 560,92	1 171,45	3 165,30	3 165,30	3 165,30	0,00	0,00	0,00	0,00	3 165,30
n-Hexane	1 025,27	1 025,65	278,86	3 139,05	3 139,05	3 139,05	0,00	0,00	0,00	0,00	3 139,05
n-Heptane	482,62	482,84	49,68	2 745,01	2 745,01	2 745,01	0,00	0,00	0,00	0,00	2 745,01
n-Octane	112,25	112,31	4,42	1 393,17	1 393,17	1 393,17	0,00	0,00	0,00	0,00	1 393,17
n-Nonane	13,46	13,47	0,21	382,99	382,99	382,99	0,00	0,00	0,00	0,00	382,99
Benzene	133,97	134,05	35,50	446,71	446,71	446,71	0,00	0,00	0,00	0,00	446,71
Toluene	45,58	45,62	4,53	300,34	300,34	300,34	0,00	0,00	0,00	0,00	300,34
m-Xylene	5,87	5,87	0,19	99,87	99,87	99,87	0,00	0,00	0,00	0,00	99,87
n-Decane	1,24	1,24	0,01	80,74	80,74	80,74	0,00	0,00	0,00	0,00	80,74
n-C11	0,17	0,17	0,00	26,39	26,39	26,39	0,00	0,00	0,00	0,00	26,39
n-C12	0,02	0,02	0,00	5,87	5,87	5,87	0,00	0,00	0,00	0,00	5,87
n-C13	0,00	0,00	0,00	1,23	1,23	1,23	0,00	0,00	0,00	0,00	1,23
n-C14	0,00	0,00	0,00	0,38	0,38	0,38	0,00	0,00	0,00	0,00	0,38
n-C15	0,00	0,00	0,00	0,20	0,20	0,20	0,00	0,00	0,00	0,00	0,20
n-C16	0,00	0,00	0,00	0,06	0,06	0,06	0,00	0,00	0,00	0,00	0,06
n-C17	0,00	0,00	0,00	0,04	0,04	0,04	0,00	0,00	0,00	0,00	0,04
n-C18	0,00	0,00	0,00	0,02	0,02	0,02	0,00	0,00	0,00	0,00	0,02
n-C19	0,00	0,00	0,00	0,01	0,01	0,01	0,00	0,00	0,00	0,00	0,01
n-C20	0,00	0,00	0,00	0,01	0,01	0,01	0,00	0,00	0,00	0,00	0,01
H2S	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Phenol	0,00	0,00	0,00	0,16	0,16	0,16	0,00	0,00	0,00	0,00	0,16
Helium	0,05	0,05	28,05	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Total	21 878,52	21 865,40	571 742,07	35 319,32	35 319,32	35 319,32	2 678,23	2 678,23	2 678,23	2 684,28	32 641,10

	9.1	9.2	9.3	10.1	10.2	10.3	11.1	11.2	11.3	11.4
Nitrogen	302,29	302,29	302,29	287,47	287,47	287,47	14,82	14,82	14,82	14,82
CO2	6 199,33	6 199,33	6 199,33	4 520,58	4 520,58	4 520,58	1 678,75	1 678,75	1 678,75	1 678,75
Methane	14 701,77	14 701,77	14 701,77	12 781,58	12 781,58	12 781,58	1 920,19	1 920,19	1 920,19	1 920,19
Ethane	6 590,07	6 590,07	6 590,07	3 815,97	3 815,97	3 815,97	2 774,10	2 774,10	2 774,10	2 774,10
Propane	11 483,45	11 483,45	11 483,45	3 424,83	3 424,83	3 424,83	8 058,62	8 058,62	8 058,62	8 058,62
i-Butane	3 938,57	3 938,57	3 938,57	597,95	597,95	597,95	3 340,62	3 340,62	3 340,62	3 340,62
n-Butane	9 712,09	9 712,09	9 712,09	1 120,50	1 120,50	1 120,50	8 591,59	8 591,59	8 591,59	8 591,59
i-Pentane	5 761,37	5 761,37	5 761,37	303,60	303,60	303,60	5 457,78	5 457,78	5 457,78	5 457,78
n-Pentane	6 944,19	6 944,19	6 944,19	284,54	284,54	284,54	6 659,65	6 659,65	6 659,65	6 659,65
n-Hexane	12 288,13	12 288,13	12 288,13	175,40	175,40	175,40	12 112,72	12 112,72	12 112,72	12 112,72
n-Heptane	21 931,37	21 931,37	21 931,37	111,34	111,34	111,34	21 820,04	21 820,04	21 820,04	21 820,04
n-Octane	23 801,38	23 801,38	23 801,38	43,07	43,07	43,07	23 758,31	23 758,31	23 758,31	23 758,31
n-Nonane	13 958,30	13 958,30	13 958,30	9,36	9,36	9,36	13 948,94	13 948,94	13 948,94	13 948,94
Benzene	1 932,78	1 932,78	1 932,78	26,37	26,37	26,37	1 906,41	1 906,41	1 906,41	1 906,41
Toluene	2 791,51	2 791,51	2 791,51	12,82	12,82	12,82	2 778,69	2 778,69	2 778,69	2 778,69
m-Xylene	2 235,48	2 235,48	2 235,48	3,11	3,11	3,11	2 232,37	2 232,37	2 232,37	2 232,37
n-Decane	6 392,70	6 392,70	6 392,70	1,64	1,64	1,64	6 391,06	6 391,06	6 391,06	6 391,06
n-C11	5 567,02	5 567,02	5 567,02	0,52	0,52	0,52	5 566,49	5 566,49	5 566,49	5 566,49
n-C12	4 818,85	4 818,85	4 818,85	0,19	0,19	0,19	4 818,66	4 818,66	4 818,66	4 818,66
n-C13	4 126,73	4 126,73	4 126,73	0,06	0,06	0,06	4 126,68	4 126,68	4 126,68	4 126,68
n-C14	3 537,67	3 537,67	3 537,67	0,02	0,02	0,02	3 537,65	3 537,65	3 537,65	3 537,65
n-C15	3 341,51	3 341,51	3 341,51	0,01	0,01	0,01	3 341,50	3 341,50	3 341,50	3 341,50
n-C16	2 134,13	2 134,13	2 134,13	0,00	0,00	0,00	2 134,13	2 134,13	2 134,13	2 134,13
n-C17	2 266,36	2 266,36	2 266,36	0,00	0,00	0,00	2 266,36	2 266,36	2 266,36	2 266,36
n-C18	1 604,97	1 604,97	1 604,97	0,00	0,00	0,00	1 604,97	1 604,97	1 604,97	1 604,97
n-C19	1 223,06	1 223,06	1 223,06	0,00	0,00	0,00	1 223,06	1 223,06	1 223,06	1 223,06
n-C20	6 226,98	6 226,98	6 226,98	0,00	0,00	0,00	6 226,98	6 226,98	6 226,98	6 226,98
H2S	1,00	1,00	1,00	0,51	0,51	0,51	0,49	0,49	0,49	0,49
Phenol	6,56	6,56	6,56	0,00	0,00	0,00	6,56	6,56	6,56	6,56
Helium	0,33	0,33	0,33	0,32	0,32	0,32	0,02	0,02	0,02	0,02
Total	185 819,95	185 819,95	185 819,95	27 521,76	27 521,76	27 521,76	158 298,19	158 298,19	158 298,19	158 298,19

	12.1	12.2	13.1	13.2	13.3	13.4	13.5
Nitrogen	302,37	302,37	0,00	0,00	0,00	0,00	0,00
CO2	6 199,33	6 199,33	0,00	0,00	0,00	0,00	0,00
Methane	16 778,85	16 778,85	0,00	0,00	0,00	0,00	0,00
Ethane	7 093,60	7 093,60	0,35	0,35	0,35	0,35	0,35
Propane	11 348,90	11 348,90	237,74	237,74	237,74	237,74	237,74
i-Butane	2 728,23	2 728,23	1 210,39	1 210,39	1 210,39	1 210,39	1 210,39
n-Butane	5 643,24	5 643,24	4 068,86	4 068,86	4 068,86	4 068,86	4 068,86
i-Pentane	2 022,83	2 022,83	3 738,55	3 738,55	3 738,55	3 738,55	3 738,55
n-Pentane	2 126,57	2 126,57	4 817,61	4 817,61	4 817,61	4 817,61	4 817,61
n-Hexane	1 909,30	1 909,30	10 378,83	10 378,83	10 378,83	10 378,83	10 378,83
n-Heptane	1 714,42	1 714,42	20 216,95	20 216,95	20 216,95	20 216,95	20 216,95
n-Octane	923,53	923,53	22 877,85	22 877,85	22 877,85	22 877,85	22 877,85
n-Nonane	266,21	266,21	13 692,09	13 692,09	13 692,09	13 692,09	13 692,09
Benzene	285,62	285,62	1 647,15	1 647,15	1 647,15	1 647,15	1 647,15
Toluene	197,16	197,16	2 594,35	2 594,35	2 594,35	2 594,35	2 594,35
m-Xylene	70,10	70,10	2 165,38	2 165,38	2 165,38	2 165,38	2 165,38
n-Decane	57,13	57,13	6 335,56	6 335,56	6 335,56	6 335,56	6 335,56
n-C11	17,82	17,82	5 549,20	5 549,20	5 549,20	5 549,20	5 549,20
n-C12	2,22	2,22	4 816,64	4 816,64	4 816,64	4 816,64	4 816,64
n-C13	0,04	0,04	4 126,69	4 126,69	4 126,69	4 126,69	4 126,69
n-C14	0,00	0,00	3 537,67	3 537,67	3 537,67	3 537,67	3 537,67
n-C15	0,00	0,00	3 341,51	3 341,51	3 341,51	3 341,51	3 341,51
n-C16	0,00	0,00	2 134,13	2 134,13	2 134,13	2 134,13	2 134,13
n-C17	0,00	0,00	2 266,36	2 266,36	2 266,36	2 266,36	2 266,36
n-C18	0,00	0,00	1 604,97	1 604,97	1 604,97	1 604,97	1 604,97
n-C19	0,00	0,00	1 223,06	1 223,06	1 223,06	1 223,06	1 223,06
n-C20	0,00	0,00	6 226,98	6 226,98	6 226,98	6 226,98	6 226,98
H2S	1,00	1,00	0,00	0,00	0,00	0,00	0,00
Phenol	0,13	0,13	6,43	6,43	6,43	6,43	6,43
Helium	0,33	0,33	0,00	0,00	0,00	0,00	0,00
Total	59 688,93	59 688,93	128 815,31	128 815,31	128 815,31	128 815,31	128 815,31

Appendix B.1: Simulation Model Modification of Existing Stabilizer I

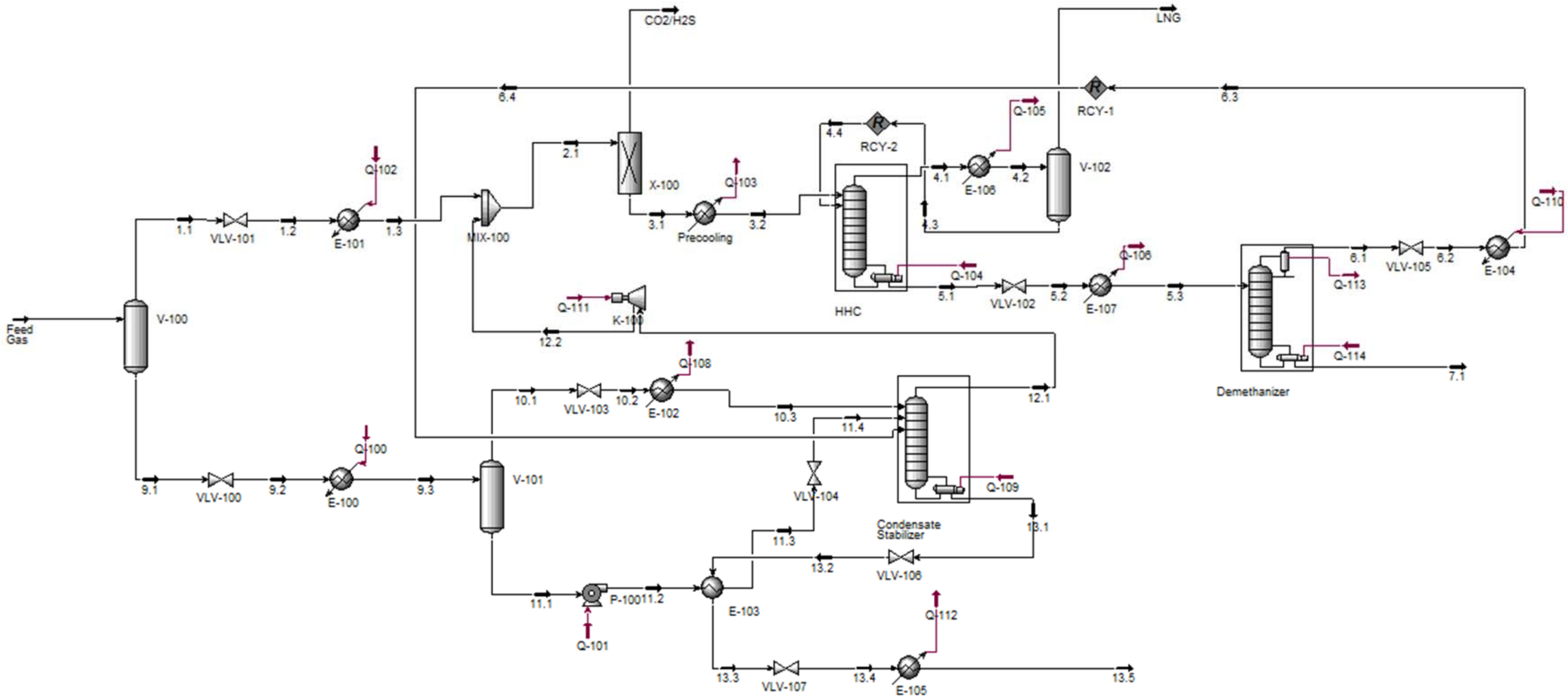

Figure 2 Simulation Model

Appendix B.2: Heat Balance Modification of Existing Stabilizer I Case A

	Feed Gas	1.1	1.2	1.3	2.1	CO2/H2S	3.1	3.2	4.1	4.2	4.3	4.4	LNG	5.1	5.2	5.3
Vapor	0,9223	1,00	1,00	1,00	1,00	1,00	1,00	0,9903	1,00	0,9818	0,00	0,00	1,00	0,00	0,4390	0,00
Temperature C	-1,00	-1,00	-6,62	9,98	20,93	21,98	23,14	-11,52	-11,52	-31,52	-31,52	-31,54	-31,52	128,00	111,23	42,33
Pressure kPa	7 000,00	7 000,00	6 000,00	6 000,00	6 000,00	6 000,00	6 000,00	6 000,00	6 000,00	6 000,00	6 000,00	6 000,00	6 000,00	6 000,00	3 420,00	3 420,00
Molar Flow kgmol/h	35 243,33	32 504,02	32 504,02	32 504,02	34 100,21	1 833,27	32 266,94	32 266,94	32 313,89	32 313,89	589,02	589,31	31 724,88	542,36	542,36	542,36
Mass Flow kg/h	813 382,24	634 189,17	634 189,17	634 189,17	682 605,16	80 679,89	601 925,27	601 925,27	593 377,03	593 377,03	20 181,11	20 187,96	573 195,92	28 736,20	28 736,20	28 736,20
Std Ideal Liq Vol Flow m3/h	2 095,85	1 810,59	1 810,59	1 810,59	1 920,13	97,75	1 822,37	1 822,37	1 815,09	1 815,09	44,65	44,67	1 770,43	51,96	51,96	51,96
Molar enthalpy KJ/kgmol	-98 460,63	-94 034,25	-94 034,25	-93 190,99	-93 706,81	-398 093,73	-76 412,85	-78 271,09	-77 906,38	-79 163,97	-109 955,41	-109 947,80	-78 592,28	-109 831,77	-109 831,77	-123 646,09
Molar Entropy KJ/kgmoleC	140,35	143,60	144,58	147,65	149,49	127,08	148,98	142,29	142,87	137,86	100,11	100,11	138,56	139,10	140,63	101,46
Heat Flow KJ/h *10^5	-34 700,80	-30 564,92	-30 564,92	-30 290,82	-3 195 421 607,30	-7 298,13	-2 465 608 751,47	-2 525 568 381,06	-2 517 458 455,71	-2 558 096 017,74	-64 765 584,64	-64 793 810,01	-2 493 330 433,10	-59 568 263,12	-59 568 263,12	-67 060 584,87
HHV MJ/m3	44,69	38,19	38,19	38,19	39,13		41,35	41,35	40,78	40,78	74,46	74,45	40,16	113,62	113,62	113,62
Mass Density kg/m3	0,9801	0,8273	0,8273	0,8273	0,8490	1,8717	0,7911	0,7911	0,7786	0,7786	1,4654	1,4651	0,7660	2,3100	2,3100	2,3100

	6.1	6.2	6.3	6.4	7.1	9.1	9.2	9.3	10.1	10.2	10.3	11.1	11.2	11.3	11.4	12.1
Vapor	1,00	0,98	1,00	1,00	0,00	0,00	0,2803	0,3683	1,00	1,00	1,00	0,00	0,00	0,1117	0,1168	1,00
Temperature C	-49,18	-68,07	-7,07	-7,06	107,99	-1,00	-10,71	29,49	29,49	26,51	37,72	29,49	29,56	113,63	113,40	74,88
Pressure kPa	3 420,00	1 520,00	1 520,00	1 520,00	3 420,00	7 000,00	2 000,00	1 950,00	1 950,00	1 520,00	1 520,00	1 950,00	2 100,00	2 100,00	2 043,00	1 520,00
Molar Flow kgmol/h	55,77	55,77	55,77	56,33	486,59	2 739,31	2 739,31	2 739,31	1 008,87	1 008,87	1 008,87	1 730,43	1 730,43	1 730,43	1 730,43	1 596,18
Mass Flow kg/h	1 048,73	1 048,73	1 048,73	1 059,17	27 687,48	179 193,07	179 193,07	179 193,07	24 090,59	24 090,59	24 090,59	155 102,48	155 102,48	155 102,48	155 102,48	48 415,99
Std Ideal Liq Vol Flow m3/h	3,33	3,33	3,33	3,36	48,63	285,25	285,25	285,25	61,47	61,47	61,47	223,79	223,79	223,79	223,79	109,53
Molar enthalpy KJ/kgmol	-81 190,47	-81 190,47	-78 522,87	-78 522,89	-118 154,06	-150 983,05	-150 983,05	-144 870,00	-109 304,01	-109 304,01	-108 787,62	-165 605,65	-165 580,06	-147 433,27	-147 433,27	-109 593,59
Molar Entropy KJ/kgmoleC	145,18	150,44	161,95	161,95	124,76	101,81	105,08	126,81	164,36	166,29	167,98	104,91	104,93	157,55	157,59	172,59
Heat Flow KJ/h *10^5	-4 527 983,50	-4 527 983,50	-4 379 211,70	-4 422 814,33	-57 492 495,52	-4 135,89	-4 135,89	-3 968,43	-1 102,74	-1 102,74	-1 097,53	-2 865,69	-2 865,25	-2 551,23	-2 551,23	-174 931 333,89
HHV MJ/m3	43,42	43,42	43,42	43,42	122,14	126,79	126,79	126,79	44,31	44,31	44,31	183,15	183,15	183,15	183,15	58,37
Mass Density kg/m3	0,7976	0,7976	0,7976	0,7976	2,4934	2,9101	2,9101	2,9101	1,0141	1,0141	1,0141	4,2055	4,2055	4,2055	4,2055	1,2927

	12.1	12.2	13.1	13.2	13.3	13.4	13.5
Vapor	1,00	1,00	0,00	0,0435	0,00	0,00	0,00
Temperature C	74,88	174,79	204,99	202,76	115,93	115,95	6,95
Pressure kPa	1 520,00	6 000,00	1 520,00	1 400,00	1 400,00	1 300,00	1 300,00
Molar Flow kgmol/h	1 596,18	1 596,18	1 199,45	1 199,45	1 199,45	1 199,45	1 199,45
Mass Flow kg/h	48 415,99	48 415,99	131 836,25	131 836,25	131 836,25	131 836,25	131 836,25
Std Ideal Liq Vol Flow m3/h	109,53	109,53	179,08	179,08	179,08	179,08	179,08
Molar enthalpy KJ/kgmol	-109 593,59	-104 210,82	-131 742,70	-131 742,70	-157 922,87	-157 922,87	-183 818,63
Molar Entropy KJ/kgmoleC	172,59	175,65	219,91	219,97	159,57	159,62	82,05
Heat Flow KJ/h *10^5	-174 931 333,89	-166 339 451,45	-158 018 602,04	-158 018 602,04	-189 420 376,66	-189 420 376,66	-220 481 007,41
HHV MJ/m3	58,37	58,37	236,88	236,88	236,88	236,88	236,88
Mass Density kg/m3	1,2927	1,2927	5,4993	5,4993	5,4993	5,4993	5,499345366
TVP @ 37,8^{0}C psia							11,7100

Appendix B.3 Mole fraction Modification of Existing Stabiliser I Case A

	Feed Gas	1.1	1.2	1.3	2.1	CO2/H2S	3.1	3.2	4.1	4.2
Nitrogen	0,02496	0,02679	0,02679	0,02679	0,02579	0	0,02726	0,02726	0,027310	0,03
CO2	0,05201	0,05232	0,05232	0,05232	0,05376	0,99990	0,00000	0,00000	0,000000	0,00
Methane	0,80070	0,84365	0,84365	0,84365	0,82887	0	0,87596	0,87596	0,881625	0,88162
Ethane	0,04969	0,04775	0,04775	0,04775	0,05168	0	0,05461	0,05461	0,054163	0,05416
Propane	0,02505	0,01984	0,01984	0,01984	0,02516	0	0,02659	0,02659	0,025413	0,02541
i-Butane	0,00395	0,00237	0,00237	0,00237	0,00328	0	0,00346	0,00346	0,003095	0,00310
n-Butane	0,00820	0,00421	0,00421	0,00421	0,00610	0	0,00645	0,00645	0,005506	0,00551
i-Pentane	0,00278	0,00091	0,00091	0,00091	0,00143	0	0,00151	0,00151	0,001091	0,00109
n-Pentane	0,00304	0,00082	0,00082	0,00082	0,00135	0	0,00143	0,00143	0	0,00094
n-Hexane	0,00348	0,00042	0,00042	0,00042	0,00079	0	0,00083	0,00083	0	0,00034
n-Heptane	0,00387	0,00020	0,00020	0,00020	0,00042	0	0,00045	0,00045	0	0,00009
n-Octane	0,00313	0,00007	0,00007	0,00007	0,00016	0	0,00017	0,00017	0	0,00002
n-Nonane	0,00140	0,00001	0,00001	0,00001	0,00003	0	0,00004	0,00004	0	0
Benzene	0,00077	0,00007	0,00007	0,00007	0,00015	0	0,00016	0,00016	0	0,00006
Toluene	0,00889	0,00033	0,00033	0,00033	0,00077	0	0,00082	0,00082	0	0,00014
m-Xylene	0,00060	0,00001	0,00001	0,00001	0,00002	0	0,00002	0,00002	0	0
n-Decane	0,00139	0,00001	0,00001	0,00001	0,00002	0	0,00002	0,00002	0	0
n-C11	0,00062	0	0	0	0	0	0	0	0	0
n-C12	0,00061	0	0	0	0	0	0	0	0	0
n-C13	0,00048	0	0	0	0	0	0	0	0	0
n-C14	0,00326	0	0	0	0	0	0	0	0	0
n-C15	0,00025	0	0	0	0	0	0	0	0	0
n-C16	0,00015	0	0	0	0	0	0	0	0	0
n-C17	0,00015	0	0	0	0	0	0	0	0	0
n-C18	0,00010	0	0	0	0	0	0	0	0	0
n-C19	0,00007	0	0	0	0	0	0	0	0	0
n-C20	0,00017	0	0	0	0	0	0	0	0	0
H2S	0	0	0	0	0,00001	0,00010	0	0	0	0
Phenol	0	0	0	0	0	0	0	0	0	0
Helium	0,00020	0,00021	0,00021	0,00021	0,00020	0	0,00022	0,00022	0,000216	0

	4.3	4.4	LNG	5.1	5.2	5.3	6.1	6.2	6.3	6.4	7.1
Nitrogen	0,00	0,00	0	0	0	0	0	0,00001	0	0	0
CO2	0,00	0,00	0	0	0	0	0	0	0	0	0
Methane	0,45699	0,45707	0,88951	0,08350	0,08350	0,08350	0,80335	0,80335	0,80335	0,80335	0
Ethane	0,13308	0,13310	0,05270	0,16673	0,16673	0,16673	0,19641	0,19641	0,19641	0,19641	0,16333
Propane	0,17942	0,17942	0,02255	0,26259	0,26259	0,26259	0,00023	0,00023	0,00023	0,00024	0,29266
i-Butane	0,04189	0,04188	0,00237	0,06708	0,06708	0,06708	0	0	0	0	0,07477
n-Butane	0,09500	0,09498	0,00384	0,15894	0,15894	0,15894	0	0	0	0	0,17716
i-Pentane	0,02981	0,02979	0,00056	0,05721	0,05721	0,05721	0	0	0	0	0,06376
n-Pentane	0,02950	0,02948	0,00041	0,06099	0,06099	0,06099	0	0	0	0	0,06798
n-Hexane	0,01456	0,01454	0,00007	0,04513	0,04513	0,04513	0	0	0	0	0,05031
n-Heptane	0,00458	0,00458	0,00001	0,02613	0,02613	0,02613	0	0	0	0	0,02913
n-Octane	0,00082	0,00082	0,00000	0,01017	0,01017	0,01017	0	0	0	0	0,01133
n-Nonane	0,00007	0,00007	0	0,00213	0,00213	0,00213	0	0	0	0	0,00237
Benzene	0,00248	0,00248	0,00001	0,00873	0,00873	0,00873	0	0	0	0	0,00973
Toluene	0,00676	0,00675	0,00001	0,04795	0,04795	0,04795	0	0	0	0	0,05345
m-Xylene	0,00007	0,00007	0	0,00137	0,00137	0,00137	0	0	0	0	0,00153
n-Decane	0,00002	0,00002	0	0,00103	0,00103	0,00103	0	0	0	0	0,00115
n-C11	0,00000	0,00000	0	0,00020	0,00020	0,00020	0	0	0	0	0,00022
n-C12	0,00000	0,00000	0	0,00007	0,00007	0,00007	0	0	0	0	0,00008
n-C13	0,00000	0	0	0	0,00001	0,00001	0	0	0	0	0,00001
n-C14	0,00000	0	0	0	0,00002	0,00002	0	0	0	0	0,00003
n-C15	0	0	0	0	0	0	0	0	0	0	0
n-C16	0	0	0	0	0	0	0	0	0	0	0
n-C17	0	0	0	0	0	0	0	0	0	0	0
n-C18	0	0	0	0	0	0	0	0	0	0	0
n-C19	0	0	0	0	0	0	0	0	0	0	0
n-C20	0	0	0	0	0	0	0	0	0	0	0
H2S	0	0	0	0	0	0	0	0	0	0	0
Phenol	0	0	0	0	0	0	0	0	0	0	0
Helium	0	0	0	0	0	0	0	0	0	0	0

	9.1	9.2	9.3	10.1	10.2	10.3	11.1	11.2	11.3	11.4	12.1	12.2	13.1	13.2	13.3	13.4	13.5
Nitrogen	0,00327	0,00327	0,00327	0,00845	0,00845	0,00845	0,00025	0,00025	0,00025	0,00025	0,00561	0,00561	0	0	0	0	0
CO2	0,04836	0,04836	0,04836	0,09323	0,09323	0,09323	0,02221	0,02221	0,02221	0,02221	0,08300	0,08300	0	0	0	0	0
Methane	0,29114	0,29114	0,29114	0,68455	0,68455	0,68455	0,06177	0,06177	0,06177	0,06177	0,52799	0,52799	0	0	0	0	0
Ethane	0,07264	0,07264	0,07264	0,11148	0,11148	0,11148	0,05000	0,05000	0,05000	0,05000	0,13155	0,13155	0	0	0	0	0
Propane	0,08679	0,08679	0,08679	0,06762	0,06762	0,06762	0,09796	0,09796	0,09796	0,09796	0,13336	0,13336	0,02075	0,02075	0,02075	0,02075	0,02075
i-Butane	0,02277	0,02277	0,02277	0,00871	0,00871	0,00871	0,03097	0,03097	0,03097	0,03097	0,02176	0,02176	0,02305	0,02305	0,02305	0,02305	0,02305
n-Butane	0,05564	0,05564	0,05564	0,01597	0,01597	0,01597	0,07877	0,07877	0,07877	0,07877	0,04475	0,04475	0,06752	0,06752	0,06752	0,06752	0,06752
i-Pentane	0,02494	0,02494	0,02494	0,00326	0,00326	0,00326	0,03758	0,03758	0,03758	0,03758	0,01200	0,01200	0,04099	0,04099	0,04099	0,04099	0,04099
n-Pentane	0,02946	0,02946	0,02946	0,00297	0,00297	0,00297	0,04491	0,04491	0,04491	0,04491	0,01223	0,01223	0,05101	0,05101	0,05101	0,05101	0,05101
n-Hexane	0,03976	0,03976	0,03976	0,00140	0,00140	0,00140	0,06214	0,06214	0,06214	0,06214	0,00821	0,00821	0,07989	0,07989	0,07989	0,07989	0,07989
n-Heptane	0,04733	0,04733	0,04733	0,00060	0,00060	0,00060	0,07457	0,07457	0,07457	0,07457	0,00493	0,00493	0,10152	0,10152	0,10152	0,10152	0,10152
n-Octane	0,03950	0,03950	0,03950	0,00018	0,00018	0,00018	0,06242	0,06242	0,06242	0,06242	0,00207	0,00207	0,08745	0,08745	0,08745	0,08745	0,08745
n-Nonane	0,01791	0,01791	0,01791	0,00003	0,00003	0,00003	0,02833	0,02833	0,02833	0,02833	0,00046	0,00046	0,04027	0,04027	0,04027	0,04027	0,04027
Benzene	0,00904	0,00904	0,00904	0,00028	0,00028	0,00028	0,01415	0,01415	0,01415	0,01415	0,00170	0,00170	0,01840	0,01840	0,01840	0,01840	0,01840
Toluene	0,11042	0,11042	0,11042	0,00115	0,00115	0,00115	0,17413	0,17413	0,17413	0,17413	0,00972	0,00972	0,23925	0,23925	0,23925	0,23925	0,23925
m-Xylene	0,00767	0,00767	0,00767	0,00002	0,00002	0,00002	0,01212	0,01212	0,01212	0,01212	0,00030	0,00030	0,01710	0,01710	0,01710	0,01710	0,01710
n-Decane	0,01786	0,01786	0,01786	0,00001	0,00001	0,00001	0,02827	0,02827	0,02827	0,02827	0,00023	0,00023	0,04048	0,04048	0,04048	0,04048	0,04048
n-C11	0,00800	0,00800	0,00800	0	0	0	0,01267	0,01267	0,01267	0,01267	0,00005	0,00005	0,01822	0,01822	0,01822	0,01822	0,01822
n-C12	0,00788	0,00788	0,00788	0	0	0	0,01248	0,01248	0,01248	0,01248	0,00001	0,00001	0,01799	0,01799	0,01799	0,01799	0,01799
n-C13	0,00623	0,00623	0,00623	0	0	0	0,00987	0,00987	0,00987	0,00987	0	0	0,01424	0,01424	0,01424	0,01424	0,01424
n-C14	0,04199	0,04199	0,04199	0	0	0	0,06647	0,06647	0,06647	0,06647	0	0	0,09589	0,09589	0,09589	0,09589	0,09589
n-C15	0,00318	0,00318	0,00318	0	0	0	0,00504	0,00504	0,00504	0,00504	0	0	0,00726	0,00726	0,00726	0,00726	0,00726
n-C16	0,00191	0,00191	0,00191	0	0	0	0,00302	0,00302	0,00302	0,00302	0	0	0,00436	0,00436	0,00436	0,00436	0,00436
n-C17	0,00191	0,00191	0,00191	0	0	0	0,00302	0,00302	0,00302	0,00302	0	0	0,00436	0,00436	0,00436	0,00436	0,00436
n-C18	0,00127	0,00127	0,00127	0	0	0	0,00201	0,00201	0,00201	0,00201	0	0	0,00291	0,00291	0,00291	0,00291	0,00291
n-C19	0,00089	0,00089	0,00089	0	0	0	0,00141	0,00141	0,00141	0,00141	0	0	0,00203	0,00203	0,00203	0,00203	0,00203
n-C20	0,00216	0,00216	0,00216	0	0	0	0,00342	0,00342	0,00342	0,00342	0	0	0,00494	0,00494	0,00494	0,00494	0,00494
H2S	0,00001	0,00001	0,00001	0,00001	0,00001	0,00001	0,00001	0,00001	0,00001	0,00001	0,00002	0,00002	0	0	0	0	0
Phenol	0,00003	0,00003	0,00003	0	0	0	0,00004	0,00004	0,00004	0,00004	0	0	0,00006	0,00006	0,00006	0,00006	0,00006
Helium	0,00003	0,00003	0,00003	0,00007	0,00007	0,00007	0	0	0	0	0,00005	0,00005	0	0	0	0	0

Appendix B.4 Mass Balance (kg/h) Modification of Existing Stabilizer I Case A

	Feed Gas	1.1	1.2	1.3	2.1	CO2/H2S	3.1	3.2	4.1	4.2
Nitrogen	24 640,19	24 389,15	24 389,15	24 389,15	24 640,20	0,00	24 640,20	24 640,20	24 721,57	24 721,57
CO2	80 673,96	74 843,48	74 843,48	74 843,48	80 673,95	80 673,96	0,00	0,00	0,00	0,00
Methane	452 721,11	439 926,66	439 926,66	439 926,66	453 447,03	0,00	453 447,03	453 447,03	457 041,78	457 041,78
Ethane	52 658,84	46 675,28	46 675,28	46 675,28	52 989,46	0,00	52 989,46	52 989,46	52 628,99	52 628,99
Propane	38 925,99	28 442,62	28 442,62	28 442,62	37 829,27	0,00	37 829,27	37 829,27	36 211,50	36 211,50
i-Butane	8 100,22	4 474,66	4 474,66	4 474,66	6 493,13	0,00	6 493,13	6 493,13	5 813,17	5 813,17
n-Butane	16 806,23	7 947,16	7 947,16	7 947,16	12 098,83	0,00	12 098,83	12 098,83	10 341,72	10 341,72
i-Pentane	7 062,16	2 133,05	2 133,05	2 133,05	3 514,52	0,00	3 514,52	3 514,52	2 542,70	2 542,70
n-Pentane	7 741,22	1 918,12	1 918,12	1 918,12	3 326,98	0,00	3 326,98	3 326,98	2 193,70	2 193,70
n-Hexane	10 567,93	1 180,73	1 180,73	1 180,73	2 310,10	0,00	2 310,10	2 310,10	939,02	939,02
n-Heptane	13 650,30	659,68	659,68	659,68	1 448,13	0,00	1 448,13	1 448,13	298,28	298,28
n-Octane	12 614,54	254,98	254,98	254,98	632,02	0,00	632,02	632,02	57,31	57,31
n-Nonane	6 344,08	53,26	53,26	53,26	148,19	0,00	148,19	148,19	5,60	5,60
Benzene	2 123,73	188,40	188,40	188,40	400,13	0,00	400,13	400,13	144,15	144,15
Toluene	28 874,20	1 003,21	1 003,21	1 003,21	2 433,24	0,00	2 433,24	2 433,24	403,38	403,38
m-Xylene	2 257,43	27,87	27,87	27,87	79,27	0,00	79,27	79,27	4,76	4,76
n-Decane	6 988,25	26,49	26,49	26,49	79,54	0,00	79,54	79,54	1,31	1,31
n-C11	3 432,68	5,34	5,34	5,34	16,89	0,00	16,89	16,89	0,11	0,11
n-C12	3 681,32	2,85	2,85	2,85	6,62	0,00	6,62	6,62	0,02	0,02
n-C13	3 149,04	0,92	0,92	0,92	1,03	0,00	1,03	1,03	0,00	0,00
n-C14	22 819,71	2,46	2,46	2,46	2,47	0,00	2,47	2,47	0,00	0,00
n-C15	1 851,03	0,11	0,11	0,11	0,11	0,00	0,11	0,11	0,00	0,00
n-C16	1 183,92	0,03	0,03	0,03	0,03	0,00	0,03	0,03	0,00	0,00
n-C17	1 257,27	0,02	0,02	0,02	0,02	0,00	0,02	0,02	0,00	0,00
n-C18	887,05	0,01	0,01	0,01	0,01	0,00	0,01	0,01	0,00	0,00
n-C19	655,17	0,01	0,01	0,01	0,01	0,00	0,01	0,01	0,00	0,00
n-C20	1 674,28	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
H2S	5,94	4,95	4,95	4,95	5,94	5,94	0,00	0,00	0,00	0,00
Phenol	6,56	0,03	0,03	0,03	0,12	0,00	0,12	0,12	0,00	0,00
Helium	27,91	27,62	27,62	27,62	27,91	0,00	27,91	27,91	27,95	27,95
Total kg/h	813 382,24	634 189,17	634 189,17	634 189,17	682 605,16	80 679,89	601 925,27	601 925,27	593 377,03	593 377,03

	4.3	4.4	LNG	5.1	5.2	5.3	6.1	6.2	6.3	6.4	7.1
Nitrogen	81,32	81,38	24 640,25	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,00
CO2	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Methane	4 318,34	4 321,31	452 723,44	726,56	726,56	726,56	718,77	718,77	718,77	725,92	7,80
Ethane	2 357,15	2 358,65	50 271,83	2 719,12	2 719,12	2 719,12	329,37	329,37	329,37	332,65	2 389,74
Propane	4 660,14	4 662,52	31 551,37	6 280,28	6 280,28	6 280,28	0,58	0,58	0,58	0,59	6 279,71
i-Butane	1 434,17	1 434,64	4 379,00	2 114,61	2 114,61	2 114,61	0,00	0,00	0,00	0,00	2 114,61
n-Butane	3 252,54	3 253,30	7 089,18	5 010,42	5 010,42	5 010,42	0,00	0,00	0,00	0,00	5 010,42
i-Pentane	1 266,92	1 266,82	1 275,78	2 238,64	2 238,64	2 238,64	0,00	0,00	0,00	0,00	2 238,64
n-Pentane	1 253,59	1 253,35	940,11	2 386,63	2 386,63	2 386,63	0,00	0,00	0,00	0,00	2 386,63
n-Hexane	738,92	738,46	200,10	2 109,54	2 109,54	2 109,54	0,00	0,00	0,00	0,00	2 109,54
n-Heptane	270,60	270,35	27,69	1 420,19	1 420,19	1 420,19	0,00	0,00	0,00	0,00	1 420,19
n-Octane	55,15	55,09	2,15	629,81	629,81	629,81	0,00	0,00	0,00	0,00	629,81
n-Nonane	5,51	5,51	0,09	148,09	148,09	148,09	0,00	0,00	0,00	0,00	148,09
Benzene	113,97	113,93	30,18	369,91	369,91	369,91	0,00	0,00	0,00	0,00	369,91
Toluene	366,70	366,54	36,68	2 396,41	2 396,41	2 396,41	0,00	0,00	0,00	0,00	2 396,41
m-Xylene	4,62	4,61	0,15	79,12	79,12	79,12	0,00	0,00	0,00	0,00	79,12
n-Decane	1,31	1,30	0,01	79,53	79,53	79,53	0,00	0,00	0,00	0,00	79,53
n-C11	0,11	0,11	0,00	16,89	16,89	16,89	0,00	0,00	0,00	0,00	16,89
n-C12	0,02	0,02	0,00	6,62	6,62	6,62	0,00	0,00	0,00	0,00	6,62
n-C13	0,00	0,00	0,00	1,03	1,03	1,03	0,00	0,00	0,00	0,00	1,03
n-C14	0,00	0,00	0,00	2,47	2,47	2,47	0,00	0,00	0,00	0,00	2,47
n-C15	0,00	0,00	0,00	0,11	0,11	0,11	0,00	0,00	0,00	0,00	0,11
n-C16	0,00	0,00	0,00	0,03	0,03	0,03	0,00	0,00	0,00	0,00	0,03
n-C17	0,00	0,00	0,00	0,02	0,02	0,02	0,00	0,00	0,00	0,00	0,02
n-C18	0,00	0,00	0,00	0,01	0,01	0,01	0,00	0,00	0,00	0,00	0,01
n-C19	0,00	0,00	0,00	0,01	0,01	0,01	0,00	0,00	0,00	0,00	0,01
n-C20	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
H2S	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Phenol	0,00	0,00	0,00	0,12	0,12	0,12	0,00	0,00	0,00	0,00	0,12
Helium	0,05	0,05	27,91	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Total kg/h	20 181,11	20 187,96	573 195,92	28 736,20	28 736,20	28 736,20	1 048,73	1 048,73	1 048,73	1 059,17	27 687,48

	9.1	9.2	9.3	10.1	10.2	10.3	11.1	11.2	11.3
Nitrogen	251,03	251,03	251,03	238,80	238,80	238,80	12,23	12,23	12,23
CO2	5 830,48	5 830,48	5 830,48	4 139,21	4 139,21	4 139,21	1 691,27	1 691,27	1 691,27
Methane	12 794,45	12 794,45	12 794,45	11 079,65	11 079,65	11 079,65	1 714,79	1 714,79	1 714,79
Ethane	5 983,56	5 983,56	5 983,56	3 381,89	3 381,89	3 381,89	2 601,67	2 601,67	2 601,67
Propane	10 483,37	10 483,37	10 483,37	3 008,28	3 008,28	3 008,28	7 475,09	7 475,09	7 475,09
i-Butane	3 625,55	3 625,55	3 625,55	510,54	510,54	510,54	3 115,01	3 115,01	3 115,01
n-Butane	8 859,07	8 859,07	8 859,07	936,46	936,46	936,46	7 922,61	7 922,61	7 922,61
i-Pentane	4 929,11	4 929,11	4 929,11	237,48	237,48	237,48	4 691,62	4 691,62	4 691,62
n-Pentane	5 823,10	5 823,10	5 823,10	216,53	216,53	216,53	5 606,57	5 606,57	5 606,57
n-Hexane	9 387,20	9 387,20	9 387,20	121,31	121,31	121,31	9 265,89	9 265,89	9 265,89
n-Heptane	12 990,62	12 990,62	12 990,62	60,63	60,63	60,63	12 929,99	12 929,99	12 929,99
n-Octane	12 359,55	12 359,55	12 359,55	20,87	20,87	20,87	12 338,69	12 338,69	12 338,69
n-Nonane	6 290,82	6 290,82	6 290,82	3,87	3,87	3,87	6 286,95	6 286,95	6 286,95
Benzene	1 935,33	1 935,33	1 935,33	22,42	22,42	22,42	1 912,91	1 912,91	1 912,91
Toluene	27 870,99	27 870,99	27 870,99	107,01	107,01	107,01	27 763,98	27 763,98	27 763,98
m-Xylene	2 229,56	2 229,56	2 229,56	2,62	2,62	2,62	2 226,94	2 226,94	2 226,94
n-Decane	6 961,76	6 961,76	6 961,76	1,69	1,69	1,69	6 960,08	6 960,08	6 960,08
n-C11	3 427,35	3 427,35	3 427,35	0,30	0,30	0,30	3 427,04	3 427,04	3 427,04
n-C12	3 678,48	3 678,48	3 678,48	0,14	0,14	0,14	3 678,33	3 678,33	3 678,33
n-C13	3 148,11	3 148,11	3 148,11	0,04	0,04	0,04	3 148,07	3 148,07	3 148,07
n-C14	22 817,25	22 817,25	22 817,25	0,10	0,10	0,10	22 817,16	22 817,16	22 817,16
n-C15	1 850,91	1 850,91	1 850,91	0,00	0,00	0,00	1 850,91	1 850,91	1 850,91
n-C16	1 183,89	1 183,89	1 183,89	0,00	0,00	0,00	1 183,88	1 183,88	1 183,88
n-C17	1 257,24	1 257,24	1 257,24	0,00	0,00	0,00	1 257,24	1 257,24	1 257,24
n-C18	887,04	887,04	887,04	0,00	0,00	0,00	887,04	887,04	887,04
n-C19	655,17	655,17	655,17	0,00	0,00	0,00	655,17	655,17	655,17
n-C20	1 674,27	1 674,27	1 674,27	0,00	0,00	0,00	1 674,27	1 674,27	1 674,27
H2S	0,99	0,99	0,99	0,46	0,46	0,46	0,52	0,52	0,52
Phenol	6,53	6,53	6,53	0,00	0,00	0,00	6,53	6,53	6,53
Helium	0,29	0,29	0,29	0,27	0,27	0,27	0,01	0,01	0,01
Total	179 193,07	179 193,07	179 193,07	24 090,59	24 090,59	24 090,59	155 102,48	155 102,48	155 102,48

	11.4	12.1	12.2	13.1	13.2	13.3	13.4	13.5
Nitrogen	12,23	251,04	251,04	0,00	0,00	0,00	0,00	0,00
CO2	1 691,27	5 830,47	5 830,47	0,01	0,01	0,01	0,01	0,01
Methane	1 714,79	13 520,37	13 520,37	0,00	0,00	0,00	0,00	0,00
Ethane	2 601,67	6 314,18	6 314,18	2,03	2,03	2,03	2,03	2,03
Propane	7 475,09	9 386,65	9 386,65	1 097,31	1 097,31	1 097,31	1 097,31	1 097,31
i-Butane	3 115,01	2 018,47	2 018,47	1 607,08	1 607,08	1 607,08	1 607,08	1 607,08
n-Butane	7 922,61	4 151,68	4 151,68	4 707,39	4 707,39	4 707,39	4 707,39	4 707,39
i-Pentane	4 691,62	1 381,46	1 381,46	3 547,65	3 547,65	3 547,65	3 547,65	3 547,65
n-Pentane	5 606,57	1 408,86	1 408,86	4 414,24	4 414,24	4 414,24	4 414,24	4 414,24
n-Hexane	9 265,89	1 129,37	1 129,37	8 257,83	8 257,83	8 257,83	8 257,83	8 257,83
n-Heptane	12 929,99	788,45	788,45	12 202,17	12 202,17	12 202,17	12 202,17	12 202,17
n-Octane	12 338,69	377,04	377,04	11 982,51	11 982,51	11 982,51	11 982,51	11 982,51
n-Nonane	6 286,95	94,93	94,93	6 195,89	6 195,89	6 195,89	6 195,89	6 195,89
Benzene	1 912,91	211,73	211,73	1 723,60	1 723,60	1 723,60	1 723,60	1 723,60
Toluene	27 763,98	1 430,03	1 430,03	26 440,96	26 440,96	26 440,96	26 440,96	26 440,96
m-Xylene	2 226,94	51,40	51,40	2 178,15	2 178,15	2 178,15	2 178,15	2 178,15
n-Decane	6 960,08	53,06	53,06	6 908,71	6 908,71	6 908,71	6 908,71	6 908,71
n-C11	3 427,04	11,55	11,55	3 415,79	3 415,79	3 415,79	3 415,79	3 415,79
n-C12	3 678,33	3,78	3,78	3 674,70	3 674,70	3 674,70	3 674,70	3 674,70
n-C13	3 148,07	0,10	0,10	3 148,01	3 148,01	3 148,01	3 148,01	3 148,01
n-C14	22 817,16	0,01	0,01	22 817,24	22 817,24	22 817,24	22 817,24	22 817,24
n-C15	1 850,91	0,00	0,00	1 850,91	1 850,91	1 850,91	1 850,91	1 850,91
n-C16	1 183,88	0,00	0,00	1 183,89	1 183,89	1 183,89	1 183,89	1 183,89
n-C17	1 257,24	0,00	0,00	1 257,24	1 257,24	1 257,24	1 257,24	1 257,24
n-C18	887,04	0,00	0,00	887,04	887,04	887,04	887,04	887,04
n-C19	655,17	0,00	0,00	655,17	655,17	655,17	655,17	655,17
n-C20	1 674,27	0,00	0,00	1 674,27	1 674,27	1 674,27	1 674,27	1 674,27
H2S	0,52	0,99	0,99	0,00	0,00	0,00	0,00	0,00
Phenol	6,53	0,09	0,09	6,44	6,44	6,44	6,44	6,44
Helium	0,01	0,29	0,29	0,00	0,00	0,00	0,00	0,00
Total	155 102,48	48 415,99	48 415,99	131 836,25	131 836,25	131 836,25	131 836,25	131 836,25

Appendix B.5 Heat Balance Modification of Existing Stabilizer I Case B

	Feed Gas	1.1	1.2	1.3	2.1	CO2/H2S	3.1	3.2	4.1	4.2	4.3	4.4	LNG	5.1	5.2	5.3
Vapor	0,95	1,00	1,00	1,00	1,00	1,00	1,00	0,99	1,00	0,98	0,00	0,00	1,00	0,00	0,25	0,00
Temperature C	-1,00	-1,00	-6,66	9,94	18,89	21,98	21,20	-13,46	-13,46	-33,46	-33,46	-33,47	-33,46	67,76	57,71	-11,19
Pressure kPa	7 000,00	7 000,00	6 000,00	6 000,00	6 000,00	6 000,00	6 000,00	6 000,00	6 000,00	6 000,00	6 000,00	6 000,00	6 000,00	6 000,00	3 420,00	3 420,00
Molar Flow kgmol/h	37 090,76	35 212,22	35 212,22	35 212,22	36 584,65	2 198,52	34 386,13	34 386,13	34 358,61	34 358,61	796,90	797,06	33 561,71	824,58	824,58	824,58
Mass Flow kg/h	813 382,24	699 236,35	699 236,35	699 236,35	741 455,68	96 754,18	644 701,51	644 701,51	632 049,77	632 049,77	26 595,75	26 598,85	605 454,03	39 250,59	39 250,59	39 250,59
Std Ideal Liq Vol Flow m3/h	2 156,11	1 965,32	1 965,32	1 965,32	2 060,53	117,23	1 943,30	1 943,30	1 928,02	1 928,02	59,78	59,79	1 868,23	75,08	75,08	75,08
Molar enthalpy KJ/kgmol	-99 841,87	-96 394,24	-96 394,24	-95 539,85	-95 857,43	-398 097,75	-76 533,36	-78 432,04	-77 820,89	-79 118,59	-109 841,01	-109 836,85	-78 389,10	-120 696,61	-120 696,61	-130 669,92
Molar Entropy KJ/kgmoleC	142,20	143,64	144,62	147,73	149,25	127,08	148,73	141,85	142,47	137,26	101,44	101,44	138,11	124,15	125,35	91,84
Heat Flow KJ/h *10^5	-37 032,11	-33 942,55	-33 942,55	-33 641,70	-35 069,10	-8 752,24	-26 316,86	-26 969,74	-26 738,18	-27 184,05	-875,33	-875,47	-26 308,72	-995,24	-995,24	-1 077,48
HHV MJ/m3	42,05	38,08	38,08	38,08	38,90		41,38	41,38	40,67	40,67	72,71	72,71	39,92	102,85	102,85	102,85
Mass Density kg/m3	0,9307	0,8421	0,8421	0,8421	0,8596	1,8717	0,7951	0,7951	0,7800	0,7800	1,4264	1,4263	0,7648	2,0615	2,0615	2,0615

	6.1	6.2	6.3	6.4	7.1	9.1	9.2	9.3	10.1	10.2	10.3	11.1	11.2	11.3	11.4
Vapor	1,00	0,99	1,00	1,00	0,00	0,00	0,30	0,40	1,00	1,00	1,00	0,00	0,00	0,14	0,15
Temperature C	-48,98	-66,21	-5,21	-5,23	106,14	-1,00	-12,41	27,79	27,79	24,73	35,94	27,79	27,86	113,69	113,40
Pressure kPa	3 420,00	1 520,00	1 520,00	1 520,00	3 420,00	7 000,00	2 000,00	1 950,00	1 950,00	1 520,00	1 520,00	1 950,00	2 100,00	2 100,00	2 043,00
Molar Flow kgmol/h	177,62	177,62	177,62	178,61	653,79	1 878,55	1 878,55	1 878,55	757,90	757,90	757,90	1 120,65	1 120,65	1 120,65	1 120,65
Mass Flow kg/h	3 226,81	3 226,81	3 226,81	3 244,42	36 372,73	114 145,88	114 145,88	114 145,88	18 430,93	18 430,93	18 430,93	95 714,95	95 714,95	95 714,95	95 714,95
Std Ideal Liq Vol Flow m3/h	10,27	10,27	10,27	10,33	65,45	190,79	190,79	190,79	46,39	46,39	46,39	144,40	144,40	144,40	144,40
Molar enthalpy KJ/kgmol	-80 690,43	-80 690,43	-78 094,81	-78 093,63	-126 199,74	-164 465,54	-164 465,54	-158 416,46	-111 823,84	-111 823,84	-111 302,72	-189 927,37	-189 901,87	-171 158,03	-171 158,03
Molar Entropy KJ/kgmoleC	144,18	149,61	160,70	160,69	132,46	115,13	118,46	140,09	164,19	166,11	167,83	123,80	123,82	178,26	178,31
Heat Flow KJ/h *10^5	-143,32	-143,32	-138,71	-139,49	-825,09	-3 089,56	-3 089,56	-2 975,93	-847,51	-847,51	-843,56	-2 128,41	-2 128,13	-1 918,08	-1 918,08
HHV MJ/m3	42,11	42,11	42,11	42,10	120,33	120,66	120,66	120,66	44,57	44,57	44,57	180,02	180,02	180,02	180,02
Mass Density kg/m3	0,7704	0,7704	0,7704	0,7703	2,4324	2,6841	2,6841	2,6841	1,0329	1,0329	1,0329	3,9739	3,9739	3,9739	3,9739

	12.1	12.2	13.1	13.2	13.3	13.4	13.5
Vapor	1,00	1,00	0,00	0,05	0,00	0,00	0,00
Temperature C	76,84	174,52	205,00	202,62	103,67	103,70	-5,30
Pressure kPa	1 520,00	6 000,00	1 520,00	1 400,00	1 400,00	1 300,00	1 300,00
Molar Flow kgmol/h	1 372,43	1 372,43	684,73	684,73	684,73	684,73	684,73
Mass Flow kg/h	42 219,33	42 219,33	75 170,97	75 170,97	75 170,97	75 170,97	75 170,97
Std Ideal Liq Vol Flow m3/h	95,21	95,21	105,91	105,91	105,91	105,91	105,91
Molar enthalpy KJ/kgmol	-109 386,39	-104 005,54	-170 316,66	-170 316,66	-200 993,19	-200 993,19	-227 248,98
Molar Entropy KJ/kgmoleC	173,88	176,95	256,22	256,29	184,50	184,55	102,88
Heat Flow KJ/h *10^5	-1 501,25	-1 427,40	-1 166,21	-1 166,21	-1 376,26	-1 376,26	-1 556,05
HHV MJ/m3	60,20	60,20	247,86	247,86	247,86	247,86	247,86
Mass Density kg/m3	1,3115	1,3115	5,5278	5,5278	5,5278	5,5278	5,5278
TVP @ 37,8⁰C psia							10,72

Appendix B.6 Mole Fraction Modification of Existing Stabilizer I Case B

	Feed Gas	1.1	1.2	1.3	2.1	CO2/H2S	3.1	3.2	4.1	4.2	4.3	4.4	LNG	5.1	5.2	5.3	6.1	6.2	6.3	6.4	7.1
Nitrogen	0,02781	0,02908	0,02908	0,02908	0,02820	0	0,03000	0,03000	0,03015	0	0	0	0	0	0	0	0	0	0	0	0
CO2	0,05927	0,05952	0,05952	0,05952	0,06009	0,99992	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Methane	0,80427	0,83063	0,83063	0,83063	0,81962	0	0,87202	0,87202	0,87921	0,87921	0,47158	0,47162	0,88889	0,18540	0,18540	0,18540	0,86434	0,86434	0,86434	0,86452	0,00100
Ethane	0,05012	0,04870	0,04870	0,04870	0,05139	0	0,05468	0,05468	0,05401	0,05401	0,13538	0,13538	0,05208	0,16040	0,16040	0,16040	0,11989	0,11989	0,11989	0,11970	0,17050
Propane	0,02448	0,02083	0,02083	0,02083	0,02463	0	0,02621	0,02621	0,02458	0,02458	0,17251	0,17251	0,02107	0,23528	0,23528	0,23528	0,01575	0,01575	0,01575	0,01576	0,29498
i-Butane	0,00380	0,00266	0,00266	0,00266	0,00346	0	0,00368	0,00368	0,00316	0,00316	0,04096	0,04095	0,00227	0,06117	0,06117	0,06117	0,00001	0,00001	0,00001	0,00001	0,07802
n-Butane	0,00790	0,00495	0,00495	0,00495	0,00674	0	0,00717	0,00717	0,00581	0,00581	0,09407	0,09405	0,00372	0,14751	0,14751	0,14751	0	0	0	0	0,18784
i-Pentane	0,00262	0,00115	0,00115	0,00115	0,00171	0	0,00182	0,00182	0	0,00120	0,02922	0,02921	0,00053	0,05425	0,05425	0,05425	0	0	0	0	0,06898
n-Pentane	0,00289	0,00108	0,00108	0,00108	0,00169	0	0,00180	0,00180	0	0,00106	0,02913	0,02912	0,00040	0,05899	0,05899	0,05899	0	0	0	0	0,07502
n-Hexane	0,00321	0,00060	0,00060	0,00060	0,00105	0	0,00112	0,00112	0	0,00038	0,01356	0,01355	0,00007	0,04391	0,04391	0,04391	0	0	0	0	0,05591
n-Heptane	0,00351	0,00029	0,00029	0,00029	0,00058	0	0,00061	0,00061	0	0,00010	0,00398	0,00398	0,00001	0,02528	0,02528	0,02528	0	0	0	0	0,03224
n-Octane	0,00281	0,00010	0,00010	0,00010	0,00022	0	0,00023	0,00023	0	0,00002	0,00068	0,00067	0	0,00971	0,00971	0,00971	0	0	0	0	0,01241
n-Nonane	0,00125	0,00002	0,00002	0,00002	0,00005	0	0,00005	0,00005	0	0	0,00006	0,00006	0	0,00202	0,00202	0,00202	0	0	0	0	0,00259
Benzene	0,00069	0,00011	0,00011	0,00011	0,00020	0	0,00022	0,00022	0	0,00007	0,00243	0,00243	0,00001	0,00856	0,00856	0,00856	0	0	0	0	0,01091
Toluene	0,00080	0,00005	0,00005	0,00005	0,00011	0	0,00012	0,00012	0	0,00002	0,00067	0,00067	0	0,00495	0,00495	0,00495	0	0	0	0	0,00631
m-Xylene	0,00055	0,00001	0,00001	0,00001	0,00003	0	0,00003	0,00003	0	0	0,00007	0,00007	0	0,00142	0,00142	0,00142	0	0	0	0	0,00182
n-Decane	0,00123	0,00001	0,00001	0,00001	0,00002	0	0,00002	0,00002	0	0	0,00001	0,00001	0	0,00092	0,00092	0,00092	0	0	0	0	0,00118
n-C11	0,00055	0	0	0,0	0	0	0	0	0	0	0	0	0	0	0,00016	0,00016	0	0	0	0	0,00020
n-C12	0,00054	0	0	0,0	0	0	0	0	0	0	0	0	0	0	0,00005	0,00005	0	0	0	0	0,00006
n-C13	0,00043	0	0	0,0	0	0	0	0	0	0	0	0	0	0	0,00001	0,00001	0	0	0	0	0,00001
n-C14	0,00029	0	0	0,0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
n-C15	0,00022	0	0	0,0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
n-C16	0,00013	0	0	0,0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
n-C17	0,00013	0	0	0,0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
n-C18	0,00009	0	0	0,0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
n-C19	0,00006	0	0	0,0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
n-C20	0,00015	0	0	0,0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
H2S	0	0	0	0,0	0	0,00008	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Phenol	0	0	0	0,0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Helium	0,00020	0,00021	0,00021	0,00021	0,00020	0	0,00022	0,00022	0,00022	0	0	0	0	0	0	0	0	0	0	0	0

	9.1	9.2	9.3	10.1	10.2	10.3	11.1	11.2	11.3	11.4	12.1	12.2	13.1	13.2	13.3	13.4	13.5
Nitrogen	0,00399	0,00399	0,00399	0,00944	0,00031	0,00031	0,00031	0,00031	0,00031	0,00031	0,00547	0,00547	0,0	0	0	0	0
CO2	0,05456	0,05456	0,05456	0,09946	0,02420	0,02420	0,02420	0,02420	0,02420	0,02420	0,07468	0,07468	0,0	0	0	0	0
Methane	0,31020	0,31020	0,31020	0,67128	0,06600	0,06600	0,06600	0,06600	0,06600	0,06600	0,53710	0,53710	0,0	0	0	0	0
Ethane	0,07674	0,07674	0,07674	0,11112	0,05349	0,05349	0,05349	0,05349	0,05349	0,05349	0,12059	0,12059	0,0	0	0	0	0
Propane	0,09301	0,09301	0,09301	0,06960	0,10884	0,10884	0,10884	0,10884	0,10884	0,10884	0,12225	0,12225	0,01423	0,0142	0,01423	0,01423	0,01423
i-Butane	0,02506	0,02506	0,02506	0,00953	0,03557	0,03557	0,03557	0,03557	0,03557	0,03557	0,02381	0,02381	0,02103	0,0210	0,02103	0,02103	0,02103
n-Butane	0,06319	0,06319	0,06319	0,01821	0,09361	0,09361	0,09361	0,09361	0,09361	0,09361	0,05267	0,05267	0,06779	0,0678	0,06779	0,06779	0,06779
i-Pentane	0,03013	0,03013	0,03013	0,00397	0,04783	0,04783	0,04783	0,04783	0,04783	0,04783	0,01620	0,01620	0,05020	0,0502	0,05020	0,05020	0,05020
n-Pentane	0,03685	0,03685	0,03685	0,00377	0,05923	0,05923	0,05923	0,05923	0,05923	0,05923	0,01740	0,01740	0,06623	0,0662	0,06623	0,06623	0,06623
n-Hexane	0,05224	0,05224	0,05224	0,00186	0,08632	0,08632	0,08632	0,08632	0,08632	0,08632	0,01275	0,01275	0,11778	0,1178	0,11778	0,11778	0,11778
n-Heptane	0,06372	0,06372	0,06372	0,00081	0,10627	0,10627	0,10627	0,10627	0,10627	0,10627	0,00784	0,00784	0,15910	0,1591	0,15910	0,15910	0,15910
n-Octane	0,05365	0,05365	0,05365	0,00024	0,08977	0,08977	0,08977	0,08977	0,08977	0,08977	0,00326	0,00326	0,14065	0,1407	0,14065	0,14065	0,14065
n-Nonane	0,02426	0,02426	0,02426	0,00004	0,04064	0,04064	0,04064	0,04064	0,04064	0,04064	0,00072	0,00072	0,06512	0,0651	0,06512	0,06512	0,06512
Benzene	0,01154	0,01154	0,01154	0,00039	0,01908	0,01908	0,01908	0,01908	0,01908	0,01908	0,00266	0,00266	0,02632	0,0263	0,02632	0,02632	0,02632
Toluene	0,01490	0,01490	0,01490	0,00017	0,02486	0,02486	0,02486	0,02486	0,02486	0,02486	0,00164	0,00164	0,03759	0,0376	0,03759	0,03759	0,03759
m-Xylene	0,01061	0,01061	0,01061	0,00004	0,01776	0,01776	0,01776	0,01776	0,01776	0,01776	0,00051	0,00051	0,02808	0,0281	0,02808	0,02808	0,02808
n-Decane	0,02420	0,02420	0,02420	0,00002	0,04056	0,04056	0,04056	0,04056	0,04056	0,04056	0,00033	0,00033	0,06574	0,0657	0,06574	0,06574	0,06574
n-C11	0,01085	0,01085	0,01085	0	0,01818	0,01818	0,01818	0,01818	0,01818	0,01818	0,00005	0,00005	0,02966	0,0297	0,02966	0,02966	0,02966
n-C12	0,01069	0,01069	0,01069	0	0,01791	0,01791	0,01791	0,01791	0,01791	0,01791	0,00001	0,00001	0,02930	0,0293	0,02930	0,02930	0,02930
n-C13	0,00847	0,00847	0,00847	0	0,01419	0,01419	0,01419	0,01419	0,01419	0,01419	0	0	0,02323	0,0232	0,02323	0,02323	0,02323
n-C14	0,00570	0,00570	0,00570	0	0,00956	0,00956	0,00956	0,00956	0,00956	0,00956	0	0	0,01565	0,0157	0,01565	0,01565	0,01565
n-C15	0,00432	0,00432	0,00432	0	0,00725	0,00725	0,00725	0,00725	0,00725	0,00725	0	0	0,01186	0,0119	0,01186	0,01186	0,01186
n-C16	0,00259	0,00259	0,00259	0	0,00434	0,00434	0,00434	0,00434	0,00434	0,00434	0	0	0,00710	0,0071	0,00710	0,00710	0,00710
n-C17	0,00259	0,00259	0,00259	0	0,00434	0,00434	0,00434	0,00434	0,00434	0,00434	0	0	0,00710	0,0071	0,00710	0,00710	0,00710
n-C18	0,00172	0,00172	0,00172	0	0,00288	0,00288	0,00288	0,00288	0,00288	0,00288	0	0	0,00471	0,0047	0,00471	0,00471	0,00471
n-C19	0,00120	0,00120	0,00120	0	0,00202	0,00202	0,00202	0,00202	0,00202	0,00202	0	0	0,00330	0,0033	0,00330	0,00330	0,00330
n-C20	0,00294	0,00294	0,00294	0	0,00493	0,00493	0,00493	0,00493	0,00493	0,00493	0	0	0,00807	0,0081	0,00807	0,00807	0,00807
H2S	0,00001	0,00001	0,00001	0,00001	0,00001	0,00001	0,00001	0,00001	0,00001	0,00001	0,00001	0,00001	0	0	0	0	0
Phenol	0,00004	0,00004	0,00004	0	0,00007	0,00007	0,00007	0,00007	0,00007	0,00007	0	0	0,00011	0,0001	0,00011	0,00011	0,00011
Helium	0,00003	0,00003	0,00003	0,00006	0	0	0	0	0	0	0,00004	0,00004	0	0	0	0	0

Appendix B.7 Mass Balance (kg/h) Modification of Existing Stabilizer I Case B

	Feed Gas	1.1	1.2	1.3	2.1	CO2/H2S	3.1	3.2	4.1	4.2
Nitrogen	28 896,26	28 686,06	28 686,06	28 686,06	28 896,33	0	28 896,33	28 896,33	29 023,29	29 023,29
CO2	96 747,86	92 237,07	92 237,07	92 237,07	96 747,86	96 747,86	0,00	0,00	0,00	0,00
Methane	478 575,09	469 226,59	469 226,59	469 226,59	481 052,35	0	481 052,35	481 052,35	484 630,49	484 630,49
Ethane	55 896,21	51 561,40	51 561,40	51 561,40	56 538,08	0	56 538,08	56 538,08	55 805,87	55 805,87
Propane	40 042,51	32 338,01	32 338,01	32 338,01	39 736,83	0	39 736,83	39 736,83	37 244,95	37 244,95
i-Butane	8 187,96	5 451,56	5 451,56	5 451,56	7 350,86	0	7 350,86	7 350,86	6 316,62	6 316,62
n-Butane	17 022,68	10 123,01	10 123,01	10 123,01	14 324,77	0	14 324,77	14 324,77	11 612,00	11 612,00
i-Pentane	7 000,76	2 916,53	2 916,53	2 916,53	4 520,63	0	4 520,63	4 520,63	2 972,48	2 972,48
n-Pentane	7 742,05	2 746,90	2 746,90	2 746,90	4 469,84	0	4 469,84	4 469,84	2 634,73	2 634,73
n-Hexane	10 263,64	1 805,98	1 805,98	1 805,98	3 313,70	0	3 313,70	3 313,70	1 124,10	1 124,10
n-Heptane	13 030,67	1 035,85	1 035,85	1 035,85	2 113,94	0	2 113,94	2 113,94	342,72	342,72
n-Octane	11 918,53	405,95	405,95	405,95	916,82	0	916,82	916,82	63,28	63,28
n-Nonane	5 932,25	87,39	87,39	87,39	213,48	0	213,48	213,48	6,18	6,18
Benzene	1 990,35	297,36	297,36	297,36	582,76	0	582,76	582,76	182,35	182,35
Toluene	2 751,14	172,67	172,67	172,67	379,77	0	379,77	379,77	53,26	53,26
m-Xylene	2 165,78	49,67	49,67	49,67	124,47	0	124,47	124,47	6,23	6,23
n-Decane	6 512,38	43,14	43,14	43,14	107,83	0	107,83	107,83	1,34	1,34
n-C11	3 194,57	8,93	8,93	8,93	20,24	0	20,24	20,24	0,10	0,10
n-C12	3 424,35	4,77	4,77	4,77	6,56	0	6,56	6,56	0,02	0,02
n-C13	2 933,63	1,58	1,58	1,58	1,61	0	1,61	1,61	0	0
n-C14	2 126,48	0,42	0,42	0,42	0,43	0	0,43	0,43	0	0
n-C15	1 725,38	0,20	0,20	0,20	0,20	0	0,20	0,20	0	0
n-C16	1 100,19	0,06	0,06	0,06	0,06	0	0,06	0,06	0	0
n-C17	1 168,35	0,04	0,04	0,04	0,04	0	0,04	0,04	0	0
n-C18	821,18	0,02	0,02	0,02	0,02	0	0,02	0,02	0	0
n-C19	607,51	0,01	0,01	0,01	0,01	0	0,01	0,01	0	0
n-C20	1 561,46	0	0	0	0	0	0	0	0	0
H2S	6,32	5,65	5,65	5,65	6,32	6	0	0	0	0
Phenol	6,98	0,06	0,06	0,06	0,21	0	0,21	0,21	0	0
Helium	29,69	29,49	29,49	29,49	29,69	0	29,69	29,69	29,76	29,76
Total	813 382,24	699 236,35	699 236,35	699 236,35	741 455,68	96 754,18	644 701,51	644 701,51	632 049,77	632 049,77

	4.3	4.4	LNG	5.1	5.2	5.3	6.1	6.2	6.3	6.4	7.1
Nitrogen	126,99	127,03	28 896,30	0,07	0,07	0,07	0,07	0,07	0,07	0,07	0,00
CO2	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Methane	6 028,96	6 030,69	478 601,53	2 452,55	2 452,55	2 452,55	2 462,96	2 462,96	2 462,96	2 477,26	10,46
Ethane	3 243,97	3 244,81	52 561,89	3 977,02	3 977,02	3 977,02	640,32	640,32	640,32	642,91	3 351,95
Propane	6 062,15	6 063,29	31 182,80	8 555,16	8 555,16	8 555,16	123,40	123,40	123,40	124,10	8 504,31
i-Butane	1 897,11	1 897,28	4 419,52	2 931,51	2 931,51	2 931,51	0,06	0,06	0,06	0,06	2 964,97
n-Butane	4 357,12	4 357,29	7 254,88	7 070,06	7 070,06	7 070,06	0,01	0,01	0,01	0,01	7 138,18
i-Pentane	1 679,85	1 679,66	1 292,63	3 227,81	3 227,81	3 227,81	0	0	0	0	3 253,86
n-Pentane	1 674,66	1 674,38	960,07	3 509,50	3 509,50	3 509,50	0	0	0	0	3 538,96
n-Hexane	931,25	930,94	192,84	3 120,54	3 120,54	3 120,54	0	0	0	0	3 149,90
n-Heptane	317,88	317,75	24,84	2 088,97	2 088,97	2 088,97	0	0	0	0	2 112,16
n-Octane	61,45	61,42	1,83	914,96	914,96	914,96	0	0	0	0	927,17
n-Nonane	6,11	6,11	0,07	213,41	213,41	213,41	0	0	0	0	216,82
Benzene	151,24	151,21	31,11	551,61	551,61	551,61	0	0	0	0	557,20
Toluene	49,40	49,39	3,86	375,90	375,90	375,90	0	0	0	0	380,41
m-Xylene	6,08	6,08	0,15	124,32	124,32	124,32	0	0	0	0	126,17
n-Decane	1,33	1,33	0,01	107,82	107,82	107,82	0	0	0	0	109,95
n-C11	0,10	0,10	0	20,24	20,24	20,24	0	0	0	0	20,88
n-C12	0,02	0,02	0	6,56	6,56	6,56	0	0	0	0	6,80
n-C13	0	0	0	1,61	1,61	1,61	0	0	0	0	1,61
n-C14	0	0	0	0,43	0,43	0,43	0	0	0	0	0,43
n-C15	0	0	0	0,20	0,20	0,20	0	0	0	0	0,20
n-C16	0	0	0	0,06	0,06	0,06	0	0	0	0	0,06
n-C17	0	0	0	0,04	0,04	0,04	0	0	0	0	0,04
n-C18	0	0	0	0,02	0,02	0,02	0	0	0	0	0,02
n-C19	0	0	0	0,01	0,01	0,01	0	0	0	0	0,01
n-C20	0	0	0	0	0	0	0	0	0	0	0
H2S	0	0	0	0	0	0	0	0	0	0	0
Phenol	0	0	0	0,21	0,21	0,21	0	0	0	0	0,21
Helium	0,06	0,06	29,69	0	0	0	0	0	0	0	0
Total	26 595,75	26 598,85	605 454,03	39 250,59	39 250,59	39 250,59	3 226,81	3 226,81	3 226,81	3 244,42	36 372,73

	9.1	9.2	9.3	10.1	10.2	10.3	11.1	11.2	11.3	11.4	12.1	12.2	13.1	13.2	13.3	13.4	13.5
Nitrogen	210,20	210,20	210,20	200,39	200,39	200,39	9,81	9,81	9,81	9,81	210,27	210,27	0	0	0	0	0
CO2	4 510,79	4 510,79	4 510,79	3 317,35	3 317,35	3 317,35	1 193,44	1 193,44	1 193,44	1 193,44	4 510,79	4 510,79	0	0	0	0	0
Methane	9 348,50	9 348,50	9 348,50	8 162,00	8 162,00	8 162,00	1 186,49	1 186,49	1 186,49	1 186,49	11 825,76	11 825,76	0	0	0	0	0
Ethane	4 334,81	4 334,81	4 334,81	2 532,45	2 532,45	2 532,45	1 802,36	1 802,36	1 802,36	1 802,36	4 976,68	4 976,68	1,04	1,04	1,04	1,04	1,04
Propane	7 704,50	7 704,50	7 704,50	2 325,99	2 325,99	2 325,99	5 378,51	5 378,51	5 378,51	5 378,51	7 398,82	7 398,82	429,78	429,78	429,78	429,78	429,78
i-Butane	2 736,41	2 736,41	2 736,41	419,82	419,82	419,82	2 316,59	2 316,59	2 316,59	2 316,59	1 899,30	1 899,30	837,17	837,17	837,17	837,17	837,17
n-Butane	6 899,67	6 899,67	6 899,67	802,21	802,21	802,21	6 097,46	6 097,46	6 097,46	6 097,46	4 201,76	4 201,76	2 697,92	2 697,92	2 697,92	2 697,92	2 697,92
i-Pentane	4 084,24	4 084,24	4 084,24	216,98	216,98	216,98	3 867,26	3 867,26	3 867,26	3 867,26	1 604,10	1 604,10	2 480,13	2 480,13	2 480,13	2 480,13	2 480,13
n-Pentane	4 995,15	4 995,15	4 995,15	206,06	206,06	206,06	4 789,09	4 789,09	4 789,09	4 789,09	1 722,94	1 722,94	3 272,21	3 272,21	3 272,21	3 272,21	3 272,21
n-Hexane	8 457,66	8 457,66	8 457,66	121,33	121,33	121,33	8 336,33	8 336,33	8 336,33	8 336,33	1 507,71	1 507,71	6 949,94	6 949,94	6 949,94	6 949,94	6 949,94
n-Heptane	11 994,81	11 994,81	11 994,81	61,17	61,17	61,17	11 933,65	11 933,65	11 933,65	11 933,65	1 078,08	1 078,08	10 916,73	10 916,73	10 916,73	10 916,73	10 916,73
n-Octane	11 512,59	11 512,59	11 512,59	20,95	20,95	20,95	11 491,64	11 491,64	11 491,64	11 491,64	510,88	510,88	11 001,71	11 001,71	11 001,71	11 001,71	11 001,71
n-Nonane	5 844,86	5 844,86	5 844,86	3,94	3,94	3,94	5 840,92	5 840,92	5 840,92	5 840,92	126,09	126,09	5 718,77	5 718,77	5 718,77	5 718,77	5 718,77
Benzene	1 692,99	1 692,99	1 692,99	22,97	22,97	22,97	1 670,03	1 670,03	1 670,03	1 670,03	285,40	285,40	1 407,59	1 407,59	1 407,59	1 407,59	1 407,59
Toluene	2 578,47	2 578,47	2 578,47	11,70	11,70	11,70	2 566,77	2 566,77	2 566,77	2 566,77	207,10	207,10	2 371,38	2 371,38	2 371,38	2 371,38	2 371,38
m-Xylene	2 116,11	2 116,11	2 116,11	2,91	2,91	2,91	2 113,20	2 113,20	2 113,20	2 113,20	74,80	74,80	2 041,31	2 041,31	2 041,31	2 041,31	2 041,31
n-Decane	6 469,24	6 469,24	6 469,24	1,67	1,67	1,67	6 467,57	6 467,57	6 467,57	6 467,57	64,69	64,69	6 404,55	6 404,55	6 404,55	6 404,55	6 404,55
n-C11	3 185,64	3 185,64	3 185,64	0,30	0,30	0,30	3 185,34	3 185,34	3 185,34	3 185,34	11,31	11,31	3 174,33	3 174,33	3 174,33	3 174,33	3 174,33
n-C12	3 419,58	3 419,58	3 419,58	0,14	0,14	0,14	3 419,44	3 419,44	3 419,44	3 419,44	1,79	1,79	3 417,80	3 417,80	3 417,80	3 417,80	3 417,80
n-C13	2 932,06	2 932,06	2 932,06	0,04	0,04	0,04	2 932,02	2 932,02	2 932,02	2 932,02	0,03	0,03	2 932,03	2 932,03	2 932,03	2 932,03	2 932,03
n-C14	2 126,05	2 126,05	2 126,05	0,01	0,01	0,01	2 126,04	2 126,04	2 126,04	2 126,04	0	0	2 126,05	2 126,05	2 126,05	2 126,05	2 126,05
n-C15	1 725,18	1 725,18	1 725,18	0	0	0	1 725,18	1 725,18	1 725,18	1 725,18	0	0	1 725,18	1 725,18	1 725,18	1 725,18	1 725,18
n-C16	1 100,14	1 100,14	1 100,14	0	0	0	1 100,14	1 100,14	1 100,14	1 100,14	0	0	1 100,14	1 100,14	1 100,14	1 100,14	1 100,14
n-C17	1 168,31	1 168,31	1 168,31	0	0	0	1 168,31	1 168,31	1 168,31	1 168,31	0	0	1 168,31	1 168,31	1 168,31	1 168,31	1 168,31
n-C18	821,16	821,16	821,16	0	0	0	821,16	821,16	821,16	821,16	0	0	821,16	821,16	821,16	821,16	821,16
n-C19	607,50	607,50	607,50	0	0	0	607,50	607,50	607,50	607,50	0	0	607,50	607,50	607,50	607,50	607,50
n-C20	1 561,46	1 561,46	1 561,46	0	0	0	1 561,46	1 561,46	1 561,46	1 561,46	0	0	1 561,46	1 561,46	1 561,46	1 561,46	1 561,46
H2S	0,67	0,67	0,67	0,34	0,34	0,34	0,32	0,32	0,32	0,32	0,66	0,66	0	0	0	0	0
Phenol	6,92	6,92	6,92	0	0	0	6,92	6,92	6,92	6,92	0,15	0,15	6,77	6,77	6,77	6,77	6,77
Helium	0,20	0,20	0,20	0,19	0,19	0,19	0,01	0,01	0,01	0,01	0,20	0,20	0,00	0,00	0,00	0,00	0,00
Total	114 145,88	114 145,88	114 145,88	18 430,93	18 430,93	18 430,93	95 714,95	95 714,95	95 714,95	95 714,95	42 219,33	42 219,33	75 170,97	75 170,97	75 170,97	75 170,97	

Appendix B.8 Heat Balance Modification of Existing Stabilizer I Case C

	Feed Gas	1.1	1.2	1.3	2.1	CO2/H2S	3.1	3.2	4.1	4.2	4.3	4.4	LNG	5.1	5.2	5.3
Vapor	0,9164	1,00	1,00	1,00	1,00	1,00	1,00	0,9886	1,00	0,98	0,00	0,00	1,00	0,00	0,6207	0,00
Temperature C	-1,00	-1,00	-6,62	9,98	22,02	21,98	24,29	-10,37	-10,37	-30,37	-30,37	-30,29	-30,37	147,77	128,54	59,64
Pressure kPa	7 000,00	7 000,00	6 000,00	6 000,00	6 000,00	6 000,00	6 000,00	6 000,00	6 000,00	6 000,00	6 000,00	6 000,00	6 000,00	6 000,00	3 420,00	3 420,00
Molar Flow kgmol/h	35 038,71	32 108,67	32 108,67	32 108,67	33 856,82	1 821,84	32 034,99	32 034,99	32 087,83	32 087,83	643,38	641,55	31 444,46	588,70	588,70	588,70
Mass Flow kg/h	813 382,24	627 562,29	627 562,29	627 562,29	680 914,72	80 176,70	600 738,03	600 738,03	591 243,80	591 243,80	22 231,73	22 191,69	569 012,08	31 685,92	31 685,92	31 685,92
Std Ideal Liq Vol Flow m3/h	2 097,88	1 790,00	1 790,00	1 790,00	1 910,78	97,14	1 813,63	1 813,63	1 804,85	1 804,85	49,08	48,96	1 755,77	57,75	57,75	57,75
Molar enthalpy KJ/kgmol	-100 507,43	-94 162,18	-94 162,18	-93 315,83	-93 958,59	-398 093,32	-76 662,40	-78 537,99	-77 971,50	-79 237,64	-111 779,45	-111 833,34	-78 571,81	-115 919,97	-115 919,97	-132 167,71
Molar Entropy KJ/kgmoleC	141,56	143,63	144,61	147,69	149,77	127,08	149,28	142,56	143,08	138,06	101,08	101,07	138,82	158,21	160,12	116,20
Heat Flow KJ/h *10^5	-35 216,50	-30 234,22	-30 234,22	-29 962,47	-31 811,39	-7 252,61	-24 558,79	-25 159,64	-25 019,37	-25 425,64	-719,16	-717,46	-24 706,48	-682,42	-682,42	-778,07
HHV MJ/m3	45,19	38,27	38,27	38,27	39,34		41,57	41,57	40,91	40,91	75,21	75,28	40,22	116,45	116,45	116,45
Mass Density kg/m3	0,9859	0,8288	0,8288	0,8288	0,8530	1,8717	0,7952	0,7952	0,7813	0,7813	1,4782	1,4798	0,7672	2,3488	2,3488	2,3488

	6.1	6.2	6.3	6.4	7.1	9.1	9.2	9.3	10.1	10.2	10.3	11.1	11.2	11.3	11.4
Vapor	1,00	0,9829	1,00	1,00	0,00	0,00	0,3014	0,3946	1,00	1,00	1,00	0,00	0,00	0,12	0,13
Temperature C	-48,75	-67,69	-6,69	-6,69	73,24	-1,00	-11,53	28,67	28,67	25,69	36,90	28,67	28,74	113,64	113,40
Pressure kPa	3 420,00	1 520,00	1 520,00	1 520,00	3 420,00	7 000,00	2 000,00	1 950,00	1 950,00	1 520,00	1 520,00	1 950,00	2 100,00	2 100,00	2 043,00
Molar Flow kgmol/h	5,55	5,55	5,55	5,55	583,35	2 930,04	2 930,04	2 930,04	1 156,19	1 156,19	1 156,19	1 773,84	1 773,84	1 773,84	1 773,84
Mass Flow kg/h	104,56	104,56	104,56	104,56	31 594,82	185 819,95	185 819,95	185 819,95	27 521,76	27 521,76	27 521,76	158 298,19	158 298,19	158 298,19	158 298,19
Std Ideal Liq Vol Flow m3/h	0,33	0,33	0,33	0,33	57,44	307,88	307,88	307,88	70,49	70,49	70,49	237,39	237,39	237,39	237,39
Molar enthalpy KJ/kgmol	-81 210,45	-81 210,45	-78 540,81	-78 540,81	-130 587,93	-170 041,62	-170 041,62	-163 827,29	-108 217,72	-108 217,72	-107 700,48	-200 073,59	-200 047,04	-180 910,57	-180 910,57
Molar Entropy KJ/kgmoleC	145,32	150,58	162,08	162,08	121,94	118,87	122,26	144,42	164,33	166,26	167,96	131,44	131,46	187,01	187,05
Heat Flow KJ/h *10^5	-4,50	-4,50	-4,36	-4,36	-761,78	-4 982,28	-4 982,28	-4 800,20	-1 251,20	-1 251,20	-1 245,22	-3 548,99	-3 548,52	-3 209,07	-3 209,07
HHV MJ/m3	43,51	43,51	43,51	43,51	117,19	125,67	125,67	125,67	44,57	44,57	44,57	187,47	187,47	187,47	187,47
Mass Density kg/m3	0,7997	0,7997	0,799704278	0,7997	2,3645	2,8124	2,8124	2,8124	1,0109	1,0109	1,0109	4,1856	4,1856	4,1856	4,1856

	12.1	12.2	13.1	13.2	13.3	13.4	13.5
Vapor	1,00	1,00	0,00	0,0484	0,00	0,00	0,00
Temperature C	74,15	172,68	205,00	202,71	113,47	113,50	4,50
Pressure kPa	1 520,00	6 000,00	1 520,00	1 400,00	1 400,00	1 300,00	1 300,00
Molar Flow kgmol/h	1 748,15	1 748,15	1 187,43	1 187,43	1 187,43	1 187,43	1 187,43
Mass Flow kg/h	53 352,44	53 352,44	132 572,07	132 572,07	132 572,07	132 572,07	132 572,07
Std Ideal Liq Vol Flow m3/h	120,78	120,78	187,43	187,43	187,43	187,43	187,43
Molar enthalpy KJ/kgmol	-111 114,91	-105 764,43	-179 718,51	-179 718,51	-208 305,57	-208 305,57	-235 769,62
Molar Entropy KJ/kgmoleC	173,88	176,94	265,46	265,53	199,39	199,43	116,55
Heat Flow KJ/h *10^5	-1 942,46	-1 848,92	-2 134,03	-2 134,03	-2 473,48	-2 473,48	-2 799,60
HHV MJ/m3	59,14	59,14	249,81	249,81	249,81	249,81	249,81
Mass Density kg/m3	1,3008	1,3008	5,6293	5,6293	5,6293	5,6293	5,6293
TVP @ 37,8 ^{0}C psia							11,1

Appendix B.9 Mole Fraction Modification of Existing Stabilizer I Case C

	Feed Gas	1.1	1.2	1.3	2.1	CO2/H2S	3.1	3.2	4.1	4.2	4.3	4.4	LNG	5.1	5.2	5.3	6.1	6.2	6.3	6.4	7.1
Nitrogen	0,02486	0,02679	0,02679	0,02679	0,02573	0	0,02719	0,02719	0,02724	0	0	0	0	0	0,00000	0	0	0	0	0	0
CO2	0,05199	0,05235	0,05235	0,05235	0,05380	0,99990	0	0	0	0	0	0	0	0	0,00000	0	0	0	0	0	0
Methane	0,79869	0,84303	0,84303	0,84303	0,82670	0	0,87372	0,87372	0,88011	0,88011	0,45332	0,45274	0,88884	0,06645	0,06645	0,06645	0,79976	0,79976	0,79976	0,79976	0,05947
Ethane	0,04995	0,04768	0,04768	0,04768	0,05172	0	0,05466	0,05466	0,05414	0,05414	0,13062	0,13076	0,05257	0,16631	0,16631	0,16631	0,20006	0,20006	0,20006	0,20006	0,16598
Propane	0,02565	0,01988	0,01988	0,01988	0,02601	0	0,02749	0,02749	0,02611	0,02611	0,17915	0,17886	0,02297	0,26799	0,26799	0,26799	0,00013	0,00013	0,00013	0,00013	0,27048
i-Butane	0,00418	0,00245	0,00245	0,00245	0,00349	0	0,00369	0,00369	0,00326	0,00326	0,04229	0,04231	0,00246	0,06901	0,06901	0,06901	0	0	0	0	0,06966
n-Butane	0,00885	0,00445	0,00445	0,00445	0,00662	0	0,00700	0,00700	0,00590	0,00590	0,09695	0,09713	0,00404	0,16514	0,16514	0,16514	0	0	0	0	0,16670
i-Pentane	0,00322	0,00103	0,00103	0,00103	0,00165	0	0,00175	0,00175	0	0,00124	0,03173	0,03187	0,00061	0,06255	0,06255	0,06255	0	0	0	0	0,06315
n-Pentane	0,00362	0,00095	0,00095	0,00095	0,00161	0	0,00171	0,00171	0	0,00110	0,03214	0,03230	0,00046	0,06820	0,06820	0,06820	0	0	0	0	0,06886
n-Hexane	0,00457	0,00055	0,00055	0,00055	0,00104	0	0,00110	0,00110	0	0,00043	0,01723	0,01735	0,00009	0,05520	0,05520	0,05520	0	0	0	0	0
n-Heptane	0,00655	0,00034	0,00034	0,00034	0,00072	0	0,00076	0,00076	0	0,00015	0,00686	0,00691	0,00001	0,04086	0,04086	0,04086	0	0	0	0	0
n-Octane	0,00606	0,00013	0,00013	0,00013	0,00031	0	0,00033	0,00033	0	0,00003	0,00138	0,00139	0,00000	0,01799	0,01799	0,01799	0	0	0	0	0
n-Nonane	0,00313	0,00003	0,00003	0,00003	0,00008	0	0,00008	0,00008	0	0,00000	0,00015	0,00015	0,00000	0,00437	0,00437	0,00437	0	0	0	0	0
Benzene	0,00078	0,00008	0,00008	0,00008	0,00016	0	0,00017	0,00017	0	0,00006	0,00247	0,00249	0,00001	0,00859	0,00859	0,00859	0	0	0	0	0
Toluene	0,00090	0,00004	0,00004	0,00004	0,00009	0	0,00009	0,00009	0	0,00002	0,00070	0,00071	0	0,00482	0,00482	0,00482	0	0	0	0	0
m-Xylene	0,00061	0,00001	0,00001	0,00001	0,00002	0	0,00003	0,00003	0	0	0,00008	0,00008	0	0,00138	0,00138	0,00138	0	0	0	0	0
n-Decane	0,00129	0,00001	0,00001	0,00001	0,00001	0	0,00002	0,00002	0	0	0,00001	0,00001	0	0,00082	0,00082	0,00082	0	0	0	0	0
n-C11	0,00102	0	0	0	0	0	0	0	0	0	0	0	0	0	0,00024	0,00024	0	0	0	0	0
n-C12	0,00081	0	0	0	0	0	0	0	0	0	0	0	0	0	0,00005	0,00005	0	0	0	0	0
n-C13	0,00064	0	0	0	0	0	0	0	0	0	0	0	0	0	0,00001	0,00001	0	0	0	0	0
n-C14	0,00051	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
n-C15	0,00045	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
n-C16	0,00027	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
n-C17	0,00027	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
n-C18	0,00018	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
n-C19	0,00013	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
n-C20	0,00063	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
H2S	0	0	0	0	0,00001	0,00010	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Phenol	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Helium	0,00020	0,00022	0,00022	0,00022	0,00021	0	0,00022	0,00022	0,00022	0	0	0	0	0	0	0	0	0	0	0	0

	9.1	9.2	9.3	10.1	10.2	10.3	11.1	11.2	11.3	11.4	12.1	12.2	13.1	13.2	13.3	13.4	13.5
Nitrogen	0,00368	0,00368	0,00368	0,00888	0,00888	0,00888	0,00030	0,00030	0,00030	0,00030	0,00617	0,00617	0,0	0	0	0	0
CO2	0,04808	0,04808	0,04808	0,08884	0,08884	0,08884	0,02150	0,02150	0,02150	0,02150	0,08058	0,08058	0,0	0	0	0	0
Methane	0,31276	0,31276	0,31276	0,68908	0,68908	0,68908	0,06748	0,06748	0,06748	0,06748	0,52675	0,52675	0,0	0	0	0	0
Ethane	0,07480	0,07480	0,07480	0,10976	0,10976	0,10976	0,05201	0,05201	0,05201	0,05201	0,12598	0,12598	0,0	0	0	0	0
Propane	0,08888	0,08888	0,08888	0,06717	0,06717	0,06717	0,10302	0,10302	0,10302	0,10302	0,13871	0,13871	0,01510	0,0151	0,01510	0,01510	0,01510
i-Butane	0,02313	0,02313	0,02313	0,00890	0,00890	0,00890	0,03240	0,03240	0,03240	0,03240	0,02254	0,02254	0,02389	0,0239	0,02389	0,02389	0,02389
n-Butane	0,05703	0,05703	0,05703	0,01667	0,01667	0,01667	0,08333	0,08333	0,08333	0,08333	0,04650	0,04650	0,07226	0,0723	0,07226	0,07226	0,07226
i-Pentane	0,02725	0,02725	0,02725	0,00364	0,00364	0,00364	0,04264	0,04264	0,04264	0,04264	0,01314	0,01314	0,04790	0,0479	0,04790	0,04790	0,04790
n-Pentane	0,03285	0,03285	0,03285	0,00341	0,00341	0,00341	0,05203	0,05203	0,05203	0,05203	0,01373	0,01373	0,06084	0,0608	0,06084	0,06084	0,06084
n-Hexane	0,04867	0,04867	0,04867	0,00176	0,00176	0,00176	0,07924	0,07924	0,07924	0,07924	0,01017	0,01017	0,10512	0,1051	0,10512	0,10512	0,10512
n-Heptane	0,07470	0,07470	0,07470	0,00096	0,00096	0,00096	0,12276	0,12276	0,12276	0,12276	0,00782	0,00782	0,17280	0,1728	0,17280	0,17280	0,17280
n-Octane	0,07111	0,07111	0,07111	0,00033	0,00033	0,00033	0,11725	0,11725	0,11725	0,11725	0,00370	0,00370	0,17002	0,1700	0,17002	0,17002	0,17002
n-Nonane	0,03714	0,03714	0,03714	0,00006	0,00006	0,00006	0,06131	0,06131	0,06131	0,06131	0,00095	0,00095	0,09025	0,0903	0,09025	0,09025	0,09025
Benzene	0,00845	0,00845	0,00845	0,00029	0,00029	0,00029	0,01376	0,01376	0,01376	0,01376	0,00168	0,00168	0,01837	0,0184	0,01837	0,01837	0,01837
Toluene	0,01034	0,01034	0,01034	0,00012	0,00012	0,00012	0,01700	0,01700	0,01700	0,01700	0,00098	0,00098	0,02407	0,0241	0,02407	0,02407	0,02407
m-Xylene	0,00719	0,00719	0,00719	0,00003	0,00003	0,00003	0,01185	0,01185	0,01185	0,01185	0,00030	0,00030	0,01729	0,0173	0,01729	0,01729	0,01729
n-Decane	0,01533	0,01533	0,01533	0,00001	0,00001	0,00001	0,02532	0,02532	0,02532	0,02532	0,00018	0,00018	0,03757	0,0376	0,03757	0,03757	0,03757
n-C11	0,01215	0,01215	0,01215	0	0	0	0,02008	0,02008	0,02008	0,02008	0,00005	0,00005	0,02992	0,0299	0,02992	0,02992	0,02992
n-C12	0,00966	0,00966	0,00966	0	0	0	0,01595	0,01595	0,01595	0,01595	0	0	0,02382	0,0238	0,02382	0,02382	0,02382
n-C13	0,00764	0,00764	0,00764	0	0	0	0,01262	0,01262	0,01262	0,01262	0	0	0,01885	0,0189	0,01885	0,01885	0,01885
n-C14	0,00609	0,00609	0,00609	0	0	0	0,01005	0,01005	0,01005	0,01005	0	0	0,01502	0,0150	0,01502	0,01502	0,01502
n-C15	0,00537	0,00537	0,00537	0	0	0	0,00887	0,00887	0,00887	0,00887	0	0	0,01325	0,0132	0,01325	0,01325	0,01325
n-C16	0,00322	0,00322	0,00322	0	0	0	0,00531	0,00531	0,00531	0,00531	0	0	0,00794	0,0079	0,00794	0,00794	0,00794
n-C17	0,00322	0,00322	0,00322	0	0	0	0,00531	0,00531	0,00531	0,00531	0	0	0,00794	0,0079	0,00794	0,00794	0,00794
n-C18	0,00215	0,00215	0,00215	0	0	0	0,00356	0,00356	0,00356	0,00356	0	0	0,00531	0,0053	0,00531	0,00531	0,00531
n-C19	0,00155	0,00155	0,00155	0	0	0	0,00257	0,00257	0,00257	0,00257	0	0	0,00384	0,0038	0,00384	0,00384	0,00384
n-C20	0,00752	0,00752	0,00752	0	0	0	0,01242	0,01242	0,01242	0,01242	0	0	0,01856	0,0186	0,01856	0,01856	0,01856
H2S	0,00001	0,00001	0,00001	0,00001	0,00001	0,00001	0,00001	0,00001	0,00001	0,00001	0,00002	0,00002	0	0	0	0	0
Phenol	0,00002	0,00002	0,00002	0	0	0	0,00004	0,00004	0,00004	0,00004	0	0	0,00006	0,0001	0,00006	0,00006	0,00006
Helium	0,00003	0,00003	0,00003	0,00007	0	0	0	0	0	0	0,00005	0,00005	0	0	0	0	0

Appendix B.10 Mass Balance (kg/h) Modification of Existing Stabilizer I Case C

	Feed Gas	1.1	1.2	1.3	2.1	CO2/H2S	3.1	3.2	4.1	4.2
Nitrogen	24 399,08	24 096,79	24 096,79	24 096,79	24 399,09	0	24 399,09	24 399,09	24 487,27	24 487,27
CO2	80 170,73	73 971,40	73 971,40	73 971,40	80 170,73	80 170,73	0	0	0	0
Methane	448 962,26	434 260,49	434 260,49	434 260,49	449 033,42	0	449 033,42	449 033,42	453 065,59	453 065,59
Ethane	52 623,57	46 033,50	46 033,50	46 033,50	52 655,98	0	52 655,98	52 655,98	52 234,47	52 234,47
Propane	39 625,64	28 142,19	28 142,19	28 142,19	38 835,17	0	38 835,17	38 835,17	36 938,16	36 938,16
i-Butane	8 510,90	4 572,33	4 572,33	4 572,33	6 862,29	0	6 862,29	6 862,29	6 078,75	6 078,75
n-Butane	18 019,73	8 307,64	8 307,64	8 307,64	13 032,21	0	13 032,21	13 032,21	11 003,32	11 003,32
i-Pentane	8 145,46	2 384,08	2 384,08	2 384,08	4 041,52	0	4 041,52	4 041,52	2 860,07	2 860,07
n-Pentane	9 154,16	2 209,97	2 209,97	2 209,97	3 941,87	0	3 941,87	3 941,87	2 540,46	2 540,46
n-Hexane	13 796,37	1 508,24	1 508,24	1 508,24	3 039,67	0	3 039,67	3 039,67	1 198,27	1 198,27
n-Heptane	23 011,42	1 080,05	1 080,05	1 080,05	2 450,57	0	2 450,57	2 450,57	484,71	484,71
n-Octane	24 275,39	474,01	474,01	474,01	1 213,22	0	1 213,22	1 213,22	105,18	105,18
n-Nonane	14 075,29	116,99	116,99	116,99	330,19	0	330,19	330,19	12,21	12,21
Benzene	2 129,29	196,51	196,51	196,51	425,51	0	425,51	425,51	155,00	155,00
Toluene	2 899,19	107,68	107,68	107,68	265,33	0	265,33	265,33	45,53	45,53
m-Xylene	2 265,43	29,95	29,95	29,95	86,08	0	86,08	86,08	5,43	5,43
n-Decane	6 416,31	23,61	23,61	23,61	68,95	0	68,95	68,95	1,10	1,10
n-C11	5 575,59	8,57	8,57	8,57	21,80	0	21,80	21,80	0,14	0,14
n-C12	4 822,51	3,66	3,66	3,66	5,04	0	5,04	5,04	0,02	0,02
n-C13	4 127,92	1,19	1,19	1,19	1,22	0	1,22	1,22	0	0
n-C14	3 538,04	0,38	0,38	0,38	0,38	0	0,38	0,38	0	0
n-C15	3 341,71	0,20	0,20	0,20	0,20	0	0,20	0,20	0	0
n-C16	2 134,18	0,06	0,06	0,06	0,06	0	0,06	0,06	0	0
n-C17	2 266,40	0,04	0,04	0,04	0,04	0	0,04	0,04	0	0
n-C18	1 604,99	0,02	0,02	0,02	0,02	0	0,02	0,02	0	0
n-C19	1 223,07	0,01	0,01	0,01	0,01	0	0,01	0,01	0	0
n-C20	6 226,99	0,01	0,01	0,01	0,01	0	0,01	0,01	0	0
H2S	5,97	4,97	4,97	4,97	5,97	6	0	0	0	0
Phenol	6,60	0,03	0,03	0,03	0,14	0	0,14	0,14	0	0
Helium	28,05	27,72	27,72	27,72	28,05	0	28,05	28,05	28,10	28,10
Total	813 382,24	627 562,29	627 562,29	627 562,29	680 914,72	80 176,70	600 738,03	600 738,03	591 243,80	591 243,80

	4.3	4.4	LNG	5.1	5.2	5.3	6.1	6.2	6.3	6.4	7.1
Nitrogen	88,60	88,21	24 398,67	0,03	0,03	0,03	0,01	0,01	0,01	0,01	0
CO2	0	0	0	0	0	0	0	0	0	0	0
Methane	4 679,00	4 659,75	448 386,58	627,58	627,58	627,58	71,16	71,16	71,16	71,16	556,57
Ethane	2 527,03	2 522,60	49 707,44	2 944,11	2 944,11	2 944,11	33,36	33,36	33,36	33,36	2 911,49
Propane	5 082,52	5 059,98	31 855,64	6 956,98	6 956,98	6 956,98	0,03	0,03	0,03	0,03	6 957,79
i-Butane	1 581,54	1 577,81	4 497,21	2 361,36	2 361,36	2 361,36	0,00	0,00	0,00	0,00	2 361,84
n-Butane	3 625,35	3 621,79	7 377,98	5 650,68	5 650,68	5 650,68	0	0	0	0	5 652,18
i-Pentane	1 473,06	1 475,40	1 387,02	2 656,85	2 656,85	2 656,85	0	0	0	0	2 657,98
n-Pentane	1 491,81	1 495,32	1 048,65	2 896,72	2 896,72	2 896,72	0	0	0	0	2 898,13
n-Hexane	955,06	959,13	243,21	2 800,53	2 800,53	2 800,53	0	0	0	0	2 802,60
n-Heptane	442,12	444,49	42,60	2 410,35	2 410,35	2 410,35	0	0	0	0	2 412,72
n-Octane	101,45	102,06	3,74	1 210,10	1 210,10	1 210,10	0	0	0	0	1 211,54
n-Nonane	12,03	12,11	0,18	330,08	330,08	330,08	0	0	0	0	330,53
Benzene	123,99	124,58	31,02	395,09	395,09	395,09	0	0	0	0	395,41
Toluene	41,60	41,84	3,93	261,64	261,64	261,64	0	0	0	0	261,93
m-Xylene	5,27	5,31	0,16	85,95	85,95	85,95	0	0	0	0	86,06
n-Decane	1,09	1,10	0,01	68,95	68,95	68,95	0	0	0	0	69,06
n-C11	0,14	0,14	0,00	21,80	21,80	21,80	0	0	0	0	21,85
n-C12	0,02	0,02	0,00	5,04	5,04	5,04	0	0	0	0	5,05
n-C13	0	0	0	1,22	1,22	1,22	0	0	0	0	1,22
n-C14	0	0	0	0,38	0,38	0,38	0	0	0	0	0,38
n-C15	0	0	0	0,20	0,20	0,20	0	0	0	0	0,20
n-C16	0	0	0	0,06	0,06	0,06	0	0	0	0	0,06
n-C17	0	0	0	0,04	0,04	0,04	0	0	0	0	0,04
n-C18	0	0	0	0,02	0,02	0,02	0	0	0	0	0,02
n-C19	0	0	0	0,01	0,01	0,01	0	0	0	0	0,01
n-C20	0	0	0	0,01	0,01	0,01	0	0	0	0	0,01
H2S	0	0	0	0	0	0	0	0	0	0	0,00
Phenol	0	0	0	0,14	0,14	0,14	0	0	0	0	0,14
Helium	0,05	0,05	28,05	0,00	0,00	0,00	0	0	0	0	0,00
Total	22 231,73	22 191,69	569 012,08	31 685,92	31 685,92	31 685,92	104,56	104,56	104,56	104,56	31 594,82

	9.1	9.2	9.3	10.1	10.2	10.3	11.1	11.2	11.3	11.4	12.1	12.2	13.1	13.2	13.3	13.4	13.5
Nitrogen	302,29	302,29	302,29	287,47	287,47	287,47	14,82	14,82	14,82	14,82	302,30	302,30	0	0	0	0	0
CO2	6 199,33	6 199,33	6 199,33	4 520,58	4 520,58	4 520,58	1 678,75	1 678,75	1 678,75	1 678,75	6 199,33	6 199,33	0	0	0	0	0
Methane	14 701,77	14 701,77	14 701,77	12 781,58	12 781,58	12 781,58	1 920,19	1 920,19	1 920,19	1 920,19	14 772,92	14 772,92	0	0	0	0	0
Ethane	6 590,07	6 590,07	6 590,07	3 815,97	3 815,97	3 815,97	2 774,10	2 774,10	2 774,10	2 774,10	6 622,47	6 622,47	0,96	0,96	0,96	0,96	0,96
Propane	11 483,45	11 483,45	11 483,45	3 424,83	3 424,83	3 424,83	8 058,62	8 058,62	8 058,62	8 058,62	10 692,98	10 692,98	790,51	790,51	790,51	790,51	790,51
i-Butane	3 938,57	3 938,57	3 938,57	597,95	597,95	597,95	3 340,62	3 340,62	3 340,62	3 340,62	2 289,96	2 289,96	1 648,61	1 648,61	1 648,61	1 648,61	1 648,61
n-Butane	9 712,09	9 712,09	9 712,09	1 120,50	1 120,50	1 120,50	8 591,59	8 591,59	8 591,59	8 591,59	4 724,57	4 724,57	4 987,52	4 987,52	4 987,52	4 987,52	4 987,52
i-Pentane	5 761,37	5 761,37	5 761,37	303,60	303,60	303,60	5 457,78	5 457,78	5 457,78	5 457,78	1 657,44	1 657,44	4 103,94	4 103,94	4 103,94	4 103,94	4 103,94
n-Pentane	6 944,19	6 944,19	6 944,19	284,54	284,54	284,54	6 659,65	6 659,65	6 659,65	6 659,65	1 731,89	1 731,89	5 212,29	5 212,29	5 212,29	5 212,29	5 212,29
n-Hexane	12 288,13	12 288,13	12 288,13	175,40	175,40	175,40	12 112,72	12 112,72	12 112,72	12 112,72	1 531,43	1 531,43	10 756,70	10 756,70	10 756,70	10 756,70	10 756,70
n-Heptane	21 931,37	21 931,37	21 931,37	111,34	111,34	111,34	21 820,04	21 820,04	21 820,04	21 820,04	1 370,52	1 370,52	20 560,85	20 560,85	20 560,85	20 560,85	20 560,85
n-Octane	23 801,38	23 801,38	23 801,38	43,07	43,07	43,07	23 758,31	23 758,31	23 758,31	23 758,31	739,21	739,21	23 062,17	23 062,17	23 062,17	23 062,17	23 062,17
n-Nonane	13 958,30	13 958,30	13 958,30	9,36	9,36	9,36	13 948,94	13 948,94	13 948,94	13 948,94	213,20	213,20	13 745,10	13 745,10	13 745,10	13 745,10	13 745,10
Benzene	1 932,78	1 932,78	1 932,78	26,37	26,37	26,37	1 906,41	1 906,41	1 906,41	1 906,41	229,00	229,00	1 703,77	1 703,77	1 703,77	1 703,77	1 703,77
Toluene	2 791,51	2 791,51	2 791,51	12,82	12,82	12,82	2 778,69	2 778,69	2 778,69	2 778,69	157,66	157,66	2 633,85	2 633,85	2 633,85	2 633,85	2 633,85
m-Xylene	2 235,48	2 235,48	2 235,48	3,11	3,11	3,11	2 232,37	2 232,37	2 232,37	2 232,37	56,13	56,13	2 179,35	2 179,35	2 179,35	2 179,35	2 179,35
n-Decane	6 392,70	6 392,70	6 392,70	1,64	1,64	1,64	6 391,06	6 391,06	6 391,06	6 391,06	45,34	45,34	6 347,36	6 347,36	6 347,36	6 347,36	6 347,36
n-C11	5 567,02	5 567,02	5 567,02	0,52	0,52	0,52	5 566,49	5 566,49	5 566,49	5 566,49	13,23	13,23	5 553,78	5 553,78	5 553,78	5 553,78	5 553,78
n-C12	4 818,85	4 818,85	4 818,85	0,19	0,19	0,19	4 818,66	4 818,66	4 818,66	4 818,66	1,39	1,39	4 817,47	4 817,47	4 817,47	4 817,47	4 817,47
n-C13	4 126,73	4 126,73	4 126,73	0,06	0,06	0,06	4 126,68	4 126,68	4 126,68	4 126,68	0,03	0,03	4 126,71	4 126,71	4 126,71	4 126,71	4 126,71
n-C14	3 537,67	3 537,67	3 537,67	0,02	0,02	0,02	3 537,65	3 537,65	3 537,65	3 537,65	0	0	3 537,67	3 537,67	3 537,67	3 537,67	3 537,67
n-C15	3 341,51	3 341,51	3 341,51	0,01	0,01	0,01	3 341,50	3 341,50	3 341,50	3 341,50	0	0	3 341,51	3 341,51	3 341,51	3 341,51	3 341,51
n-C16	2 134,13	2 134,13	2 134,13	0	0	0	2 134,13	2 134,13	2 134,13	2 134,13	0	0	2 134,13	2 134,13	2 134,13	2 134,13	2 134,13
n-C17	2 266,36	2 266,36	2 266,36	0	0	0	2 266,36	2 266,36	2 266,36	2 266,36	0	0	2 266,36	2 266,36	2 266,36	2 266,36	2 266,36
n-C18	1 604,97	1 604,97	1 604,97	0	0	0	1 604,97	1 604,97	1 604,97	1 604,97	0	0	1 604,97	1 604,97	1 604,97	1 604,97	1 604,97
n-C19	1 223,06	1 223,06	1 223,06	0	0	0	1 223,06	1 223,06	1 223,06	1 223,06	0	0	1 223,06	1 223,06	1 223,06	1 223,06	1 223,06
n-C20	6 226,98	6 226,98	6 226,98	0	0	0	6 226,98	6 226,98	6 226,98	6 226,98	0	0	6 226,98	6 226,98	6 226,98	6 226,98	6 226,98
H2S	1,00	1,00	1,00	0,51	0,51	0,51	0,49	0,49	0,49	0,49	1,00	1,00	0	0	0	0	0
Phenol	6,56	6,56	6,56	0	0	0	6,56	6,56	6,56	6,56	0,10	0,10	6,46	6,46	6,46	6,46	6,46
Helium	0,33	0,33	0,33	0,32	0,32	0,32	0,02	0,02	0,02	0,02	0,33	0,33	0,00	0,00	0,00	0,00	0,00
Total	185 819,95	185 819,95	185 819,95	27 521,76	27 521,76	27 521,76	158 298,19	158 298,19	158 298,19	158 298,19	53 352,44	53 352,44	132 572,07	132 572,07	132 572,07	132 572,07	132 572,07

Appendix C.1 Simulation Model Modification of Existing Stabilizer II

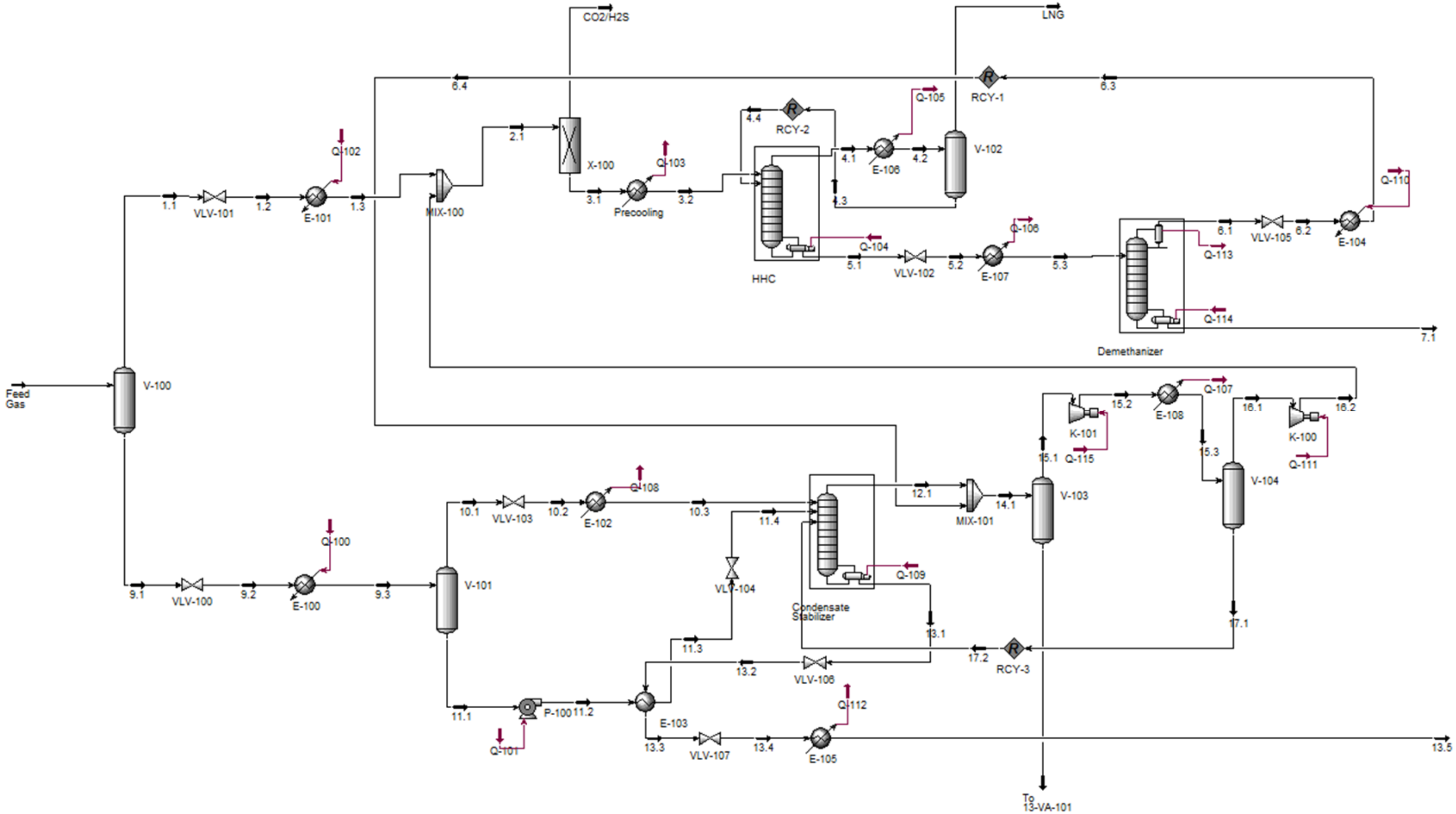

Figure 3 Simulation Model

Appendix C.2 Heat Balance Modification of Existing Stabilizer II Case A

	Feed Gas	1.1	1.2	1.3	2.1	CO2/H2S	3.1	3.2	4.1	4.2	4.3	4.4	LNG	5.1	5.2	5.3
Vapor	0,9223	1,00	1,00	1,00	1,00	1,00	1,00	0,9890	1,00	0,9715	0,00	0,00	1,00	1,00	0,5897	0,00
Temperature C	-1,00	-1,00	-6,62	9,98	15,86	21,98	17,72	-16,94	-16,98	-36,98	-36,98	-36,98	-36,98	128,00	107,67	38,77
Pressure kPa	7 000,00	7 000,00	6 000,00	6 000,00	6 000,00	6 000,00	6 000,00	6 000,00	6 000,00	6 000,00	6 000,00	6 000,00	6 000,00	6 000,00	3 420,00	3 420,00
Molar Flow kgmol/h	35 243,33	32 504,02	32 504,02	32 504,02	34 100,62	1 833,26	32 267,37	32 267,37	32 516,88	32 516,88	928,29	927,98	31 588,60	678,47	678,47	678,47
Mass Flow kg/h	813 382,24	634 189,17	634 189,17	634 189,17	681 345,99	80 679,64	600 666,97	600 666,97	596 212,84	596 212,84	29 114,80	29 107,45	567 098,04	33 561,57	33 561,57	33 561,57
Std Ideal Liq Vol Flow m3/h	2 095,85	1 810,59	1 810,59	1 810,59	1 919,19	97,75	1 821,44	1 821,44	1 825,61	1 825,61	67,65	67,63	1 757,96	63,46	63,46	63,46
Molar enthalpy KJ/kgmol	-98 460,63	-94 034,25	-94 034,25	-93 190,99	-93 971,06	-398 093,73	-76 692,53	-78 580,64	-78 185,58	-79 539,50	-106 300,47	-106 304,02	-78 753,08	-108 876,89	-108 876,89	-123 694,29
Molar Entropy KJ/kgmoleC	140,35	143,60	144,58	147,65	148,66	127,08	148,11	141,18	141,74	136,22	102,93	102,93	137,20	145,79	147,59	105,32
Heat Flow KJ/h *10^5	-34 700,80	-30 564,92	-30 564,92	-30 290,82	-32 044,72	-7 298,11	-24 746,67	-25 355,91	-25 423,51	-25 863,77	-986,77	-986,49	-24 876,99	-738,70	-738,70	-839,23
HHV MJ/m3	44,69	38,19	38,19	38,19	39,06		41,28	41,28	40,73	40,73	68,56	68,57	39,92	106,52	106,52	106,52
Mass Density kg/m3	0,9801	0,8273	0,8273	0,8273	0,8474	1,8717	0,7894	0,7894	0,7774	0,7774	1,3386	1,3387	0,7611	2,1459	2,1459	2,1459

	6.1	6.2	6.3	6.4	7.1	9.1	9.2	9.3	10.1	10.2	10.3	11.1	11.2	11.3	11.4
Vapor	1,00	0,9828	1,00	1,00	0,00	0,00	0,2803	0,3683	1,00	1,00	1,00	0,00	0,00	0,11	0,1168
Temperature C	-49,21	-68,10	-7,10	-7,11	94,42	-1,00	-10,71	29,49	29,49	26,51	37,72	29,49	29,56	113,63	113,40
Pressure kPa	3 420,00	1 520,00	1 520,00	1 520,00	3 420,00	7 000,00	2 000,00	1 950,00	1 950,00	1 520,00	1 520,00	1 950,00	2 100,00	2 100,00	2 043,00
Molar Flow kgmol/h	55,82	55,82	55,82	55,67	622,66	2 739,31	2 739,31	2 739,31	1 008,87	1 008,87	1 008,87	1 730,43	1 730,43	1 730,43	1 730,43
Mass Flow kg/h	1 049,62	1 049,62	1 049,62	1 046,69	32 511,96	179 193,07	179 193,07	179 193,07	24 090,59	24 090,59	24 090,59	155 102,48	155 102,48	155 102,48	155 102,48
Std Ideal Liq Vol Flow m3/h	3,33	3,33	3,33	3,32	60,13	285,25	285,25	285,25	61,47	61,47	61,47	223,79	223,79	223,79	223,79
Molar enthalpy KJ/kgmol	-81 189,82	-81 189,82	-78 522,07	-78 521,72	-119 090,02	-150 983,05	-150 983,05	-144 870,00	-109 304,01	-109 304,01	-108 787,62	-165 605,65	-165 580,06	-147 433,27	-147 433,27
Molar Entropy KJ/kgmoleC	145,17	150,43	161,94	161,94	125,25	101,81	105,08	126,81	164,36	166,29	167,98	104,91	104,93	157,55	157,59
Heat Flow KJ/h *10^5	-45,32	-45,32	-43,83	-43,71	-741,52	-4 135,89	-4 135,89	-3 968,43	-1 102,74	-1 102,74	-1 097,53	-2 865,69	-2 865,25	-2 551,23	-2 551,23
HHV MJ/m3	43,41	43,41	43,41	43,41	112,44	126,79	126,79	126,79	44,31	44,31	44,31	183,15	183,15	183,15	183,15
Mass Density kg/m3	0,7976	0,7976	0,7976	0,7976	2,2722	2,9101	2,9101	2,9101	1,0141	1,0141	1,0141	4,2055	4,2055	4,2055	4,2055

	12.1	13.1	13.2	13.3	13.4	13.5	14.1	15.1	15.2	15.3	To VE-13-101	16.1	16.2	17.1	17.2
Vapor	1,00	0,00	0,0506	0,00	0,00	0,00	1,00	1,00	1,00	0,9433	0,00	1,00	1,00	0,00	0,00
Temperature C	79,44	214,99	212,35	128,48	128,50	19,50	77,66	77,66	141,61	68,81	77,66	68,81	103,27	68,81	68,77
Pressure kPa	1 520,00	1 520,00	1 400,00	1 400,00	1 300,00	1 300,00	1 520,00	1 520,00	3 800,00	3 800,00	1 520,00	3 800,00	6 000,00	3 800,00	3 800,00
Molar Flow kgmol/h	1 637,52	1 197,06	1 197,06	1 197,06	1 197,06	1 197,06	1 693,18	1 692,54	1 692,54	1 692,54	0,64	1 596,60	1 596,60	95,94	95,28
Mass Flow kg/h	52 213,60	132 986,58	132 986,58	132 986,58	132 986,58	132 986,58	53 260,30	53 203,91	53 203,91	53 203,91	56,39	47 156,82	47 156,82	6 047,09	6 007,11
Std Ideal Liq Vol Flow m3/h	115,11	179,83	179,83	179,83	179,83	179,83	118,43	118,35	118,35	118,35	0,08	108,60	108,60	9,75	9,68
Molar enthalpy KJ/kgmol	-110 701,36	-128 080,42	-128 080,42	-154 312,79	-154 312,79	-181 137,96	-109 643,42	-109 634,55	-106 141,42	-112 168,02	-133 067,36	-111 344,34	-109 851,89	-125 874,77	-125 861,74
Molar Entropy KJ/kgmoleC	172,79	225,34	225,41	166,43	166,48	89,05	172,61	172,64	174,78	158,66	95,49	162,38	163,37	96,86	96,81
Heat Flow KJ/h *10^5	-1 812,76	-1 533,20	-1 533,20	-1 847,22	-1 847,22	-2 168,33	-1 856,46	-1 855,61	-1 796,49	-1 898,49	-0,85	-1 777,72	-1 753,89	-120,77	-119,92
HHV MJ/m3	61,59	240,48	240,48	240,48	240,48	240,48	60,98	60,94	60,94	60,94	192,95	56,90	56,90	131,85	131,90
Mass Density kg/m3	1,3602	5,5846	5,5846	5,5846	5,5846	5,5846	1,3415	1,3406	1,3406	1,3406	4,1625	1,2580	1,2580	2,7926	2,7938
TVP @ 37,8°C psia						7,889									

Appendix C.3 Mole Fraction Modification of Existing Stabilizer II Case A

	Feed Gas	1.1	1.2	1.3	2.1	CO2/H2S	3.1	3.2	4.1	4.2	4.3	4.4	LNG	5.1	5.2	5.3	6.1	6.2	6.3	6.4	7.1
Nitrogen	0,02496	0,02679	0,02679	0,02679	0,02579	0	0,02726	0,02726	0,027210	0,03	0,01	0,01	0	0	0,00000	0	0	0,00002	0	0	0
CO2	0,05201	0,05232	0,05232	0,05232	0,05375	0,99990	0,00000	0,00000	0,000000	0,00	0,00	0,00	0	0	0,00000	0	0	0	0	0	0
Methane	0,80070	0,84365	0,84365	0,84365	0,82884	0	0,87593	0,87593	0,882152	0,88215	0,50248	0,50243	0,89331	0,06701	0,06701	0,06701	0,80331	0,80331	0,80331	0,80337	0
Ethane	0,04969	0,04775	0,04775	0,04775	0,05167	0	0,05461	0,05461	0,053917	0,05392	0,13920	0,13919	0,05141	0,20343	0,20343	0,20343	0,19650	0,19650	0,19650	0,19644	0,20406
Propane	0,02505	0,01984	0,01984	0,01984	0,02579	0	0,02726	0,02726	0,025718	0,02572	0,17872	0,17873	0,02122	0,30824	0,30824	0,30824	0,00017	0,00017	0,00017	0,00017	0,33585
i-Butane	0,00395	0,00237	0,00237	0,00237	0,00345	0	0,00365	0,00365	0,003177	0,00318	0,03912	0,03913	0,00212	0,07476	0,07476	0,07476	0	0	0	0	0,08146
n-Butane	0,00820	0,00421	0,00421	0,00421	0,00622	0	0,00657	0,00657	0,005420	0,00542	0,08170	0,08171	0,00318	0,16468	0,16468	0,16468	0	0	0	0	0,17944
i-Pentane	0,00278	0,00091	0,00091	0,00091	0,00135	0	0,00143	0,00143	0,000967	0,00097	0,02093	0,02094	0,00038	0,05011	0,05011	0,05011	0	0	0	0	0,05460
n-Pentane	0,00304	0,00082	0,00082	0,00082	0,00125	0	0,00132	0,00132	0	0,00080	0,01927	0,01927	0,00026	0,05053	0,05053	0,05053	0	0	0	0	0,05506
n-Hexane	0,00348	0,00042	0,00042	0,00042	0,00064	0	0,00068	0,00068	0	0,00024	0,00723	0,00724	0,00004	0,03048	0,03048	0,03048	0	0	0	0	0,03321
n-Heptane	0,00387	0,00020	0,00020	0,00020	0,00029	0	0,00031	0,00031	0	0,00005	0,00176	0,00176	0	0,01449	0,01449	0,01449	0	0	0	0	0,01578
n-Octane	0,00313	0,00007	0,00007	0,00007	0,00009	0	0,00010	0,00010	0	0,00001	0,00024	0,00024	0	0,00456	0,00456	0,00456	0	0	0	0	0,00497
n-Nonane	0,00140	0,00001	0,00001	0,00001	0,00002	0	0,00002	0,00002	0	0	0,00002	0,00002	0	0,00078	0,00078	0,00078	0	0	0	0	0,00084
Benzene	0,00077	0,00007	0,00007	0,00007	0,00012	0	0,00012	0,00012	0	0,00004	0,00120	0,00121	0,00001	0,00560	0,00560	0,00560	0	0	0	0	0,00610
Toluene	0,00889	0,00033	0,00033	0,00033	0,00049	0	0,00052	0,00052	0	0,00008	0,00250	0,00250	0	0,02438	0,02438	0,02438	0	0	0	0	0,02657
m-Xylene	0,00060	0,00001	0,00001	0,00001	0,00001	0	0,00001	0,00001	0	0	0,00002	0,00002	0	0,00053	0,00053	0,00053	0	0	0	0	0,00058
n-Decane	0,00139	0,00001	0,00001	0,00001	0,00001	0	0,00001	0,00001	0	0	0	0	0	0,00032	0,00032	0,00032	0	0	0	0	0,00035
n-C11	0,00062	0	0	0	0	0	0	0	0	0	0	0	0	0,00006	0,00006	0,00006	0	0	0	0	0,00006
n-C12	0,00061	0	0	0	0	0	0	0	0	0	0	0	0	0,00003	0,00003	0,00003	0	0	0	0	0,00003
n-C13	0,00048	0	0	0	0	0	0	0	0	0	0	0	0	0	0,00001	0,00001	0	0	0	0	0,00001
n-C14	0,00326	0	0	0	0	0	0	0	0	0	0	0	0	0	0,00002	0,00002	0	0	0	0	0,00002
n-C15	0,00025	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
n-C16	0,00015	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
n-C17	0,00015	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
n-C18	0,00010	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
n-C19	0,00007	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
n-C20	0,00017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
H2S	0	0	0	0	0,00001	0,00010	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Phenol	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Helium	0,00020	0,00021	0,00021	0,00021	0,00020	0	0,00022	0,00022	0,000215	0	0	0	0	0	0	0	0	0	0	0	0

	9.1	9.2	9.3	10.1	10.2	10.3	11.1	11.2	11.3	11.4	12.1	13.1	13.2	13.3	13.4	13.5	14.1	15.1	15.2	15.3	To VE-13-101	16.1	16.2	17.1	17.2
Nitrogen	0,00327	0,00327	0,00327	0,00845	0,00845	0,00845	0,00025	0,00025	0,00025	0,00025	0,00550	0	0	0	0	0	0,00532	0,00532	0,00532	0,00532	0,00012	0,00561	0,00561	0,00041	0,00041
CO2	0,04836	0,04836	0,04836	0,09323	0,09323	0,09323	0,02221	0,02221	0,02221	0,02221	0,08238	0	0	0	0	0	0,07968	0,07970	0,07970	0,07970	0,00938	0,08296	0,08296	0,02540	0,02543
Methane	0,29114	0,29114	0,29114	0,68455	0,68455	0,68455	0,06177	0,06177	0,06177	0,06177	0,49222	0	0	0	0	0	0,50245	0,50263	0,50263	0,50263	0,02915	0,52747	0,52747	0,08935	0,08935
Ethane	0,07264	0,07264	0,07264	0,11148	0,11148	0,11148	0,05000	0,05000	0,05000	0,05000	0,12561	0	0	0	0	0	0,12794	0,12798	0,12798	0,12798	0,02681	0,13144	0,13144	0,07040	0,07041
Propane	0,08679	0,08679	0,08679	0,06762	0,06762	0,06762	0,09796	0,09796	0,09796	0,09796	0,15388	0,00253	0,00253	0,00253	0,00253	0,00253	0,14883	0,14885	0,14885	0,14885	0,07933	0,14690	0,14690	0,18126	0,18128
i-Butane	0,02277	0,02277	0,02277	0,00871	0,00871	0,00871	0,03097	0,03097	0,03097	0,03097	0,02838	0,01800	0,01800	0,01800	0,01800	0,01800	0,02744	0,02744	0,02744	0,02744	0,03044	0,02552	0,02552	0,05943	0,05917
n-Butane	0,05564	0,05564	0,05564	0,01597	0,01597	0,01597	0,07877	0,07877	0,07877	0,07877	0,05424	0,06416	0,06416	0,06416	0,06416	0,06416	0,05245	0,05245	0,05245	0,05245	0,07537	0,04724	0,04724	0,13902	0,13863
i-Pentane	0,02494	0,02494	0,02494	0,00326	0,00326	0,00326	0,03758	0,03758	0,03758	0,03758	0,01329	0,04329	0,04329	0,04329	0,04329	0,04329	0,01285	0,01284	0,01284	0,01284	0,03666	0,01029	0,01029	0,05532	0,05531
n-Pentane	0,02946	0,02946	0,02946	0,00297	0,00297	0,00297	0,04491	0,04491	0,04491	0,04491	0,01352	0,05404	0,05404	0,05404	0,05404	0,05404	0,01307	0,01306	0,01306	0,01306	0,04546	0,00999	0,00999	0,06421	0,06423
n-Hexane	0,03976	0,03976	0,03976	0,00140	0,00140	0,00140	0,06214	0,06214	0,06214	0,06214	0,00905	0,08415	0,08415	0,08415	0,08415	0,08415	0,00875	0,00873	0,00873	0,00873	0,07151	0,00508	0,00508	0,06948	0,06956
n-Heptane	0,04733	0,04733	0,04733	0,00060	0,00060	0,00060	0,07457	0,07457	0,07457	0,07457	0,00550	0,10543	0,10543	0,10543	0,10543	0,10543	0,00532	0,00529	0,00529	0,00529	0,09657	0,00210	0,00210	0,05833	0,05844
n-Octane	0,03950	0,03950	0,03950	0,00018	0,00018	0,00018	0,06242	0,06242	0,06242	0,06242	0,00235	0,08960	0,08960	0,08960	0,08960	0,08960	0,00227	0,00224	0,00224	0,00224	0,09034	0,00055	0,00055	0,03045	0,03052
n-Nonane	0,01791	0,01791	0,01791	0,00003	0,00003	0,00003	0,02833	0,02833	0,02833	0,02833	0,00054	0,04085	0,04085	0,04085	0,04085	0,04085	0,00052	0,00051	0,00051	0,00051	0,04531	0,00007	0,00007	0,00776	0,00778
Benzene	0,00904	0,00904	0,00904	0,00028	0,00028	0,00028	0,01415	0,01415	0,01415	0,01415	0,00187	0,01936	0,01936	0,01936	0,01936	0,01936	0,00181	0,00181	0,00181	0,00181	0,01725	0,00099	0,00099	0,01540	0,01542
Toluene	0,11042	0,11042	0,11042	0,00115	0,00115	0,00115	0,17413	0,17413	0,17413	0,17413	0,01088	0,24765	0,24765	0,24765	0,24765	0,24765	0,01053	0,01044	0,01044	0,01044	0,24012	0,00364	0,00364	0,12358	0,12384
m-Xylene	0,00767	0,00767	0,00767	0,00002	0,00002	0,00002	0,01212	0,01212	0,01212	0,01212	0,00035	0,01745	0,01745	0,01745	0,01745	0,01745	0,00034	0,00033	0,00033	0,00033	0,01921	0,00006	0,00006	0,00477	0,00478
n-Decane	0,01786	0,01786	0,01786	0,00001	0,00001	0,00001	0,02827	0,02827	0,02827	0,02827	0,00028	0,04082	0,04082	0,04082	0,04082	0,04082	0,00027	0,00025	0,00025	0,00025	0,04697	0,00002	0,00002	0,00416	0,00417
n-C11	0,00800	0,00800	0,00800	0	0	0	0,01267	0,01267	0,01267	0,01267	0,00006	0,01830	0,01830	0,01830	0,01830	0,01830	0,00006	0,00005	0,00005	0,00005	0,02056	0	0	0,00086	0,00087
n-C12	0,00788	0,00788	0,00788	0	0	0	0,01248	0,01248	0,01248	0,01248	0,00003	0,01803	0,01803	0,01803	0,01803	0,01803	0,00003	0,00002	0,00002	0,00002	0,01595	0	0	0,00035	0,00035
n-C13	0,00623	0,00623	0,00623	0	0	0	0,00987	0,00987	0,00987	0,00987	0	0,01426	0,01426	0,01426	0,01426	0,01426	0	0	0	0	0	0	0	0,00003	0,00003
n-C14	0,04199	0,04199	0,04199	0	0	0	0,06647	0,06647	0,06647	0,06647	0	0,09608	0,09608	0,09608	0,09608	0,09608	0	0	0	0	0	0	0	0	0
n-C15	0,00318	0,00318	0,00318	0	0	0	0,00504	0,00504	0,00504	0,00504	0	0,00728	0,00728	0,00728	0,00728	0,00728	0	0	0	0	0	0	0	0	0
n-C16	0,00191	0,00191	0,00191	0	0	0	0,00302	0,00302	0,00302	0,00302	0	0,00437	0,00437	0,00437	0,00437	0,00437	0	0	0	0	0	0	0	0	0
n-C17	0,00191	0,00191	0,00191	0	0	0	0,00302	0,00302	0,00302	0,00302	0	0,00437	0,00437	0,00437	0,00437	0,00437	0	0	0	0	0	0	0	0	0
n-C18	0,00127	0,00127	0,00127	0	0	0	0,00201	0,00201	0,00201	0,00201	0	0,00291	0,00291	0,00291	0,00291	0,00291	0	0	0	0	0	0	0	0	0
n-C19	0,00089	0,00089	0,00089	0	0	0	0,00141	0,00141	0,00141	0,00141	0	0,00204	0,00204	0,00204	0,00204	0,00204	0	0	0	0	0	0	0	0	0
n-C20	0,00216	0,00216	0,00216	0	0	0	0,00342	0,00342	0,00342	0,00342	0	0,00495	0,00495	0,00495	0,00495	0,00495	0	0	0	0	0	0	0	0	0
H2S	0,00001	0,00001	0,00001	0,00001	0,00001	0,00001	0,00001	0,00001	0,00001	0,00001	0,00002	0	0	0	0	0	0,00002	0,00002	0,00002	0,00002	0,00001	0,00002	0,00002	0,00001	0,00001
Phenol	0,00003	0,00003	0,00003	0	0	0	0,00004	0,00004	0,00004	0,00004	0	0,00006	0,00006	0,00006	0,00006	0,00006	0	0	0	0	0	0	0,00000	0,00001	0,00001
Helium	0,00003	0,00003	0,00003	0,00007	0,00007	0,00007	0	0	0	0	0,00004	0	0	0	0	0	0,00004	0,00004	0,00004	0,00004	0,00000	0,00005	0	0	0

Appendix C.4 Mass Balance (kg/h) Modification of Existing Stabilizer II Case A

	Feed Gas	1.1	1.2	1.3	2.1	CO_2/H_2S	3.1	3.2	4.1	4.2
Nitrogen	24 640,19	24 389,15	24 389,15	24 389,15	24 640,21	0,00	24 640,21	24 640,21	24 785,40	24 785,40
CO_2	80 673,96	74 843,48	74 843,48	74 843,48	80 673,08	80 673,96	0,00	0,00	0,00	0,00
Methane	452 721,11	439 926,66	439 926,66	439 926,66	453 437,29	0,00	453 437,29	453 437,29	460 187,98	460 187,98
Ethane	52 658,84	46 675,28	46 675,28	46 675,28	52 985,60	0,00	52 985,60	52 985,60	52 719,19	52 719,19
Propane	38 925,99	28 442,62	28 442,62	28 442,62	38 785,50	0,00	38 785,50	38 785,50	36 877,33	36 877,33
i-Butane	8 100,22	4 474,66	4 474,66	4 474,66	6 842,91	0,00	6 842,91	6 842,91	6 005,43	6 005,43
n-Butane	16 806,23	7 947,16	7 947,16	7 947,16	12 331,44	0,00	12 331,44	12 331,44	10 244,58	10 244,58
i-Pentane	7 062,16	2 133,05	2 133,05	2 133,05	3 318,57	0,00	3 318,57	3 318,57	2 267,69	2 267,69
n-Pentane	7 741,22	1 918,12	1 918,12	1 918,12	3 068,53	0,00	3 068,53	3 068,53	1 885,27	1 885,27
n-Hexane	10 567,93	1 180,73	1 180,73	1 180,73	1 679,51	0,00	1 679,51	1 679,51	676,17	676,17
n-Heptane	13 650,30	659,68	659,68	659,68	995,28	0,00	995,28	995,28	173,77	173,77
n-Octane	12 614,54	254,98	254,98	254,98	354,42	0,00	354,42	354,42	26,52	26,52
n-Nonane	6 344,08	53,26	53,26	53,26	67,47	0,00	67,47	67,47	2,09	2,09
Benzene	2 123,73	188,40	188,40	188,40	311,69	0,00	311,69	311,69	102,38	102,38
Toluene	28 874,20	1 003,21	1 003,21	1 003,21	1 538,78	0,00	1 538,78	1 538,78	228,58	228,58
m-Xylene	2 257,43	27,87	27,87	27,87	38,44	0,00	38,44	38,44	2,04	2,04
n-Decane	6 988,25	26,49	26,49	26,49	30,96	0,00	30,96	30,96	0,42	0,42
n-C11	3 432,68	5,34	5,34	5,34	5,86	0,00	5,86	5,86	0,03	0,03
n-C12	3 681,32	2,85	2,85	2,85	2,98	0,00	2,98	2,98	0,01	0,01
n-C13	3 149,04	0,92	0,92	0,92	0,93	0,00	0,93	0,93	0,00	0,00
n-C14	22 819,71	2,46	2,46	2,46	2,46	0,00	2,46	2,46	0,00	0,00
n-C15	1 851,03	0,11	0,11	0,11	0,11	0,00	0,11	0,11	0,00	0,00
n-C16	1 183,92	0,03	0,03	0,03	0,03	0,00	0,03	0,03	0,00	0,00
n-C17	1 257,27	0,02	0,02	0,02	0,02	0,00	0,02	0,02	0,00	0,00
n-C18	887,05	0,01	0,01	0,01	0,01	0,00	0,01	0,01	0,00	0,00
n-C19	655,17	0,01	0,01	0,01	0,01	0,00	0,01	0,01	0,00	0,00
n-C20	1 674,28	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
H_2S	5,94	4,95	4,95	4,95	5,94	5,94	0,00	0,00	0,00	0,00
Phenol	6,56	0,03	0,03	0,03	0,04	0,00	0,04	0,04	0,00	0,00
Helium	27,91	27,62	27,62	27,62	27,91	0,00	27,91	27,91	27,98	27,98
Total kg/h	813 382,24	634 189,17	634 189,17	634 189,17	681 345,99	80 679,89	600 666,97	600 666,97	596 212,84	596 212,84

	4.3	4.4	LNG	5.1	5.2	5.3	6.1	6.2	6.3	6.4	7.1
Nitrogen	145,27	145,22	24 640,13	0,03	0,03	0,03	0,03	0,03	0,03	0,03	0,00
CO_2	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Methane	7 483,09	7 480,03	452 704,89	729,35	729,35	729,35	719,36	719,36	719,36	717,44	9,99
Ethane	3 885,64	3 883,98	48 833,55	4 150,38	4 150,38	4 150,38	329,82	329,82	329,82	328,81	3 820,57
Propane	7 315,72	7 313,88	29 561,61	9 222,05	9 222,05	9 222,05	0,41	0,41	0,41	0,41	9 221,64
i-Butane	2 110,94	2 110,57	3 894,49	2 948,05	2 948,05	2 948,05	0,00	0,00	0,00	0,00	2 948,05
n-Butane	4 407,95	4 407,36	5 836,63	6 494,23	6 494,23	6 494,23	0,00	0,00	0,00	0,00	6 494,23
i-Pentane	1 402,00	1 401,99	865,69	2 452,87	2 452,87	2 452,87	0,00	0,00	0,00	0,00	2 452,87
n-Pentane	1 290,33	1 290,37	594,94	2 473,63	2 473,63	2 473,63	0,00	0,00	0,00	0,00	2 473,63
n-Hexane	578,63	578,74	97,54	1 782,08	1 782,08	1 782,08	0,00	0,00	0,00	0,00	1 782,08
n-Heptane	163,27	163,31	10,50	984,82	984,82	984,82	0,00	0,00	0,00	0,00	984,82
n-Octane	25,88	25,89	0,64	353,79	353,79	353,79	0,00	0,00	0,00	0,00	353,79
n-Nonane	2,07	2,07	0,02	67,45	67,45	67,45	0,00	0,00	0,00	0,00	67,45
Benzene	87,36	87,36	15,02	296,68	296,68	296,68	0,00	0,00	0,00	0,00	296,68
Toluene	214,14	214,15	14,44	1 524,35	1 524,35	1 524,35	0,00	0,00	0,00	0,00	1 524,35
m-Xylene	1,99	1,99	0,04	38,40	38,40	38,40	0,00	0,00	0,00	0,00	38,40
n-Decane	0,41	0,41	0,00	30,96	30,96	30,96	0,00	0,00	0,00	0,00	30,96
n-C11	0,03	0,03	0,00	5,86	5,86	5,86	0,00	0,00	0,00	0,00	5,86
n-C12	0,01	0,01	0,00	2,98	2,98	2,98	0,00	0,00	0,00	0,00	2,98
n-C13	0,00	0,00	0,00	0,93	0,93	0,93	0,00	0,00	0,00	0,00	0,93
n-C14	0,00	0,00	0,00	2,46	2,46	2,46	0,00	0,00	0,00	0,00	2,46
n-C15	0,00	0,00	0,00	0,11	0,11	0,11	0,00	0,00	0,00	0,00	0,11
n-C16	0,00	0,00	0,00	0,03	0,03	0,03	0,00	0,00	0,00	0,00	0,03
n-C17	0,00	0,00	0,00	0,02	0,02	0,02	0,00	0,00	0,00	0,00	0,02
n-C18	0,00	0,00	0,00	0,01	0,01	0,01	0,00	0,00	0,00	0,00	0,01
n-C19	0,00	0,00	0,00	0,01	0,01	0,01	0,00	0,00	0,00	0,00	0,01
n-C20	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
H_2S	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Phenol	0,00	0,00	0,00	0,04	0,04	0,04	0,00	0,00	0,00	0,00	0,04
Helium	0,07	0,07	27,91	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Total kg/h	29 114,80	29 107,45	567 098,04	33 561,57	33 561,57	33 561,57	1 049,62	1 049,62	1 049,62	1 046,69	32 511,96

	9.1	9.2	9.3	10.1	10.2	10.3	11.1	11.2	11.3	11.4	12.1
Nitrogen	251,03	251,03	251,03	238,80	238,80	238,80	12,23	12,23	12,23	12,23	252,13
CO_2	5 830,48	5 830,48	5 830,48	4 139,21	4 139,21	4 139,21	1 691,27	1 691,27	1 691,27	1 691,27	5 937,12
Methane	12 794,45	12 794,45	12 794,45	11 079,65	11 079,65	11 079,65	1 714,79	1 714,79	1 714,79	1 714,79	12 931,02
Ethane	5 983,56	5 983,56	5 983,56	3 381,89	3 381,89	3 381,89	2 601,67	2 601,67	2 601,67	2 601,67	6 185,14
Propane	10 483,37	10 483,37	10 483,37	3 008,28	3 008,28	3 008,28	7 475,09	7 475,09	7 475,09	7 475,09	11 111,58
i-Butane	3 625,55	3 625,55	3 625,55	510,54	510,54	510,54	3 115,01	3 115,01	3 115,01	3 115,01	2 700,80
n-Butane	8 859,07	8 859,07	8 859,07	936,46	936,46	936,46	7 922,61	7 922,61	7 922,61	7 922,61	5 162,33
i-Pentane	4 929,11	4 929,11	4 929,11	237,48	237,48	237,48	4 691,62	4 691,62	4 691,62	4 691,62	1 570,14
n-Pentane	5 823,10	5 823,10	5 823,10	216,53	216,53	216,53	5 606,57	5 606,57	5 606,57	5 606,57	1 597,04
n-Hexane	9 387,20	9 387,20	9 387,20	121,31	121,31	121,31	9 265,89	9 265,89	9 265,89	9 265,89	1 277,17
n-Heptane	12 990,62	12 990,62	12 990,62	60,63	60,63	60,63	12 929,99	12 929,99	12 929,99	12 929,99	902,58
n-Octane	12 359,55	12 359,55	12 359,55	20,87	20,87	20,87	12 338,69	12 338,69	12 338,69	12 338,69	439,80
n-Nonane	6 290,82	6 290,82	6 290,82	3,87	3,87	3,87	6 286,95	6 286,95	6 286,95	6 286,95	113,47
Benzene	1 935,33	1 935,33	1 935,33	22,42	22,42	22,42	1 912,91	1 912,91	1 912,91	1 912,91	239,57
Toluene	27 870,99	27 870,99	27 870,99	107,01	107,01	107,01	27 763,98	27 763,98	27 763,98	27 763,98	1 642,23
m-Xylene	2 229,56	2 229,56	2 229,56	2,62	2,62	2,62	2 226,94	2 226,94	2 226,94	2 226,94	60,50
n-Decane	6 961,76	6 961,76	6 961,76	1,69	1,69	1,69	6 960,08	6 960,08	6 960,08	6 960,08	65,48
n-C11	3 427,35	3 427,35	3 427,35	0,30	0,30	0,30	3 427,04	3 427,04	3 427,04	3 427,04	15,52
n-C12	3 678,48	3 678,48	3 678,48	0,14	0,14	0,14	3 678,33	3 678,33	3 678,33	3 678,33	7,61
n-C13	3 148,11	3 148,11	3 148,11	0,04	0,04	0,04	3 148,07	3 148,07	3 148,07	3 148,07	0,87
n-C14	22 817,25	22 817,25	22 817,25	0,10	0,10	0,10	22 817,16	22 817,16	22 817,16	22 817,16	0,09
n-C15	1 850,91	1 850,91	1 850,91	0,00	0,00	0,00	1 850,91	1 850,91	1 850,91	1 850,91	0,00
n-C16	1 183,89	1 183,89	1 183,89	0,00	0,00	0,00	1 183,88	1 183,88	1 183,88	1 183,88	0,00
n-C17	1 257,24	1 257,24	1 257,24	0,00	0,00	0,00	1 257,24	1 257,24	1 257,24	1 257,24	0,00
n-C18	887,04	887,04	887,04	0,00	0,00	0,00	887,04	887,04	887,04	887,04	0,00
n-C19	655,17	655,17	655,17	0,00	0,00	0,00	655,17	655,17	655,17	655,17	0,00
n-C20	1 674,27	1 674,27	1 674,27	0,00	0,00	0,00	1 674,27	1 674,27	1 674,27	1 674,27	0,00
H_2S	0,99	0,99	0,99	0,46	0,46	0,46	0,52	0,52	0,52	0,52	1,03
Phenol	6,53	6,53	6,53	0,00	0,00	0,00	6,53	6,53	6,53	6,53	0,11
Helium	0,29	0,29	0,29	0,27	0,27	0,27	0,01	0,01	0,01	0,01	0,29
Total	179 193,07	179 193,07	179 193,07	24 090,59	24 090,59	24 090,59	155 102,48	155 102,48	155 102,48	155 102,48	52 213,60

	13.1	13.2	13.3	13.4	13.5	14.1	15.1	15.2	15.3	To VE-13-101	16.1	16.2	17.1	17.2
Nitrogen	0,00	0,00	0,00	0,00	0,00	252,16	252,16	252,16	252,16	0,00	251,06	251,06	1,10	1,10
CO_2	0,00	0,00	0,00	0,00	0,00	5 937,12	5 936,86	5 936,86	5 936,86	0,26	5 829,60	5 829,60	107,25	106,64
Methane	0,00	0,00	0,00	0,00	0,00	13 648,45	13 648,16	13 648,16	13 648,16	0,30	13 510,62	13 510,62	137,53	136,57
Ethane	0,13	0,13	0,13	0,13	0,13	6 513,95	6 513,43	6 513,43	6 513,43	0,52	6 310,32	6 310,32	203,12	201,71
Propane	133,40	133,40	133,40	133,40	133,40	11 111,99	11 109,75	11 109,75	11 109,75	2,24	10 342,88	10 342,88	766,87	761,61
i-Butane	1 252,45	1 252,45	1 252,45	1 252,45	1 252,45	2 700,80	2 699,66	2 699,66	2 699,66	1,13	2 368,25	2 368,25	331,42	327,69
n-Butane	4 464,42	4 464,42	4 464,42	4 464,42	4 464,42	5 162,33	5 159,53	5 159,53	5 159,53	2,81	4 384,28	4 384,28	775,24	767,69
i-Pentane	3 739,19	3 739,19	3 739,19	3 739,19	3 739,19	1 570,14	1 568,44	1 568,44	1 568,44	1,69	1 185,52	1 185,52	382,93	380,22
n-Pentane	4 667,57	4 667,57	4 667,57	4 667,57	4 667,57	1 597,04	1 594,93	1 594,93	1 594,93	2,10	1 150,41	1 150,41	444,52	441,50
n-Hexane	8 681,13	8 681,13	8 681,13	8 681,13	8 681,13	1 277,17	1 273,22	1 273,22	1 273,22	3,95	698,78	698,78	574,44	571,10
n-Heptane	12 645,94	12 645,94	12 645,94	12 645,94	12 645,94	902,58	896,38	896,38	896,38	6,20	335,60	335,60	560,78	557,89
n-Octane	12 251,94	12 251,94	12 251,94	12 251,94	12 251,94	439,80	433,18	433,18	433,18	6,61	99,44	99,44	333,74	332,18
n-Nonane	6 272,47	6 272,47	6 272,47	6 272,47	6 272,47	113,47	109,75	109,75	109,75	3,72	14,21	14,21	95,54	95,13
Benzene	1 810,53	1 810,53	1 810,53	1 810,53	1 810,53	239,57	238,71	238,71	238,71	0,86	123,29	123,29	115,41	114,77
Toluene	27 315,90	27 315,90	27 315,90	27 315,90	27 315,90	1 642,23	1 628,05	1 628,05	1 628,05	14,18	535,57	535,57	1 092,48	1 087,13
m-Xylene	2 217,46	2 217,46	2 217,46	2 217,46	2 217,46	60,50	59,19	59,19	59,19	1,31	10,58	10,58	48,61	48,40
n-Decane	6 952,78	6 952,78	6 952,78	6 952,78	6 952,78	65,48	61,20	61,20	61,20	4,28	4,47	4,47	56,73	56,50
n-C11	3 424,72	3 424,72	3 424,72	3 424,72	3 424,72	15,52	13,46	13,46	13,46	2,06	0,52	0,52	12,94	12,89
n-C12	3 676,57	3 676,57	3 676,57	3 676,57	3 676,57	7,61	5,87	5,87	5,87	1,74	0,13	0,13	5,74	5,71
n-C13	3 147,74	3 147,74	3 147,74	3 147,74	3 147,74	0,87	0,52	0,52	0,52	0,35	0,01	0,01	0,52	0,50
n-C14	22 817,20	22 817,20	22 817,20	22 817,20	22 817,20	0,09	0,03	0,03	0,03	0,05	0,00	0,00	0,03	0,03
n-C15	1 850,91	1 850,91	1 850,91	1 850,91	1 850,91	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
n-C16	1 183,89	1 183,89	1 183,89	1 183,89	1 183,89	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
n-C17	1 257,24	1 257,24	1 257,24	1 257,24	1 257,24	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
n-C18	887,04	887,04	887,04	887,04	887,04	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
n-C19	655,17	655,17	655,17	655,17	655,17	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
n-C20	1 674,27	1 674,27	1 674,27	1 674,27	1 674,27	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
H_2S	0,00	0,00	0,00	0,00	0,00	1,03	1,03	1,03	1,03	0,00	0,99	0,99	0,04	0,04
Phenol	6,52	6,52	6,52	6,52	6,52	0,11	0,11	0,11	0,11	0,00	0,01	0,01	0,09	0,09
Helium	0,00	0,00	0,00	0,00	0,00	0,29	0,29	0,29	0,29	0,00	0,29	0,29	0,00	0,00
Total	132 986,58	132 986,58	132 986,58	132 986,58	132 986,58	53 260,30	53 203,91	53 203,91	53 203,91	56,39	47 156,82	47 156,82	6 047,09	6 007,11

Appendix C.5 Heat Balance Modification of Existing Stabilizer II Case B

	Feed Gas	1.1	1.2	1.3	2.1	CO2/H2S	3.1	3.2	4.1	4.2	4.3	4.4	LNG	5.1	5.2	5.3
Vapor	0,95	1,00	1,00	1,00	1,00	1,00	1,00	0,9855	1,00	0,9678	0,00	0,00	1,00	0,00	0,2720	0,00
Temperature C	-1,00	-1,00	-6,66	9,94	14,59	21,98	16,56	-18,10	-18,12	-38,12	-38,12	-38,08	-38,12	65,62	54,08	-14,82
Pressure kPa	7 000,00	7 000,00	6 000,00	6 000,00	6 000,00	6 000,00	6 000,00	6 000,00	6 000,00	6 000,00	6 000,00	6 000,00	6 000,00	6 000,00	3 420,00	3 420,00
Molar Flow kgmol/h	37 090,76	35 212,22	35 212,22	35 212,22	36 619,98	1 833,26	34 421,49	34 421,49	34 562,58	34 562,58	1 113,61	1 113,82	33 448,97	972,73	972,73	972,73
Mass Flow kg/h	813 382,24	699 236,35	699 236,35	699 236,35	740 490,23	80 679,64	643 737,07	643 737,07	634 768,39	634 768,39	34 564,50	34 578,02	600 203,88	43 546,70	43 546,70	43 546,70
Std Ideal Liq Vol Flow m3/h	2 156,11	1 965,32	1 965,32	1 965,32	2 061,29	97,75	1 944,06	1 944,06	1 938,69	1 938,69	80,82	80,84	1 857,87	86,21	86,21	86,21
Molar enthalpy KJ/kgmol	-99 841,87	-96 394,24	-96 394,24	-95 539,85	-96 008,00	-398 093,73	-76 713,59	-78 637,42	-78 042,22	-79 421,89	-106 265,24	-106 270,13	-78 528,20	-117 231,93	-117 231,93	-127 106,14
Molar Entropy KJ/kgmoleC	142,20	143,64	144,62	147,73	148,53	127,08	147,97	140,87	141,51	135,86	103,30	103,31	136,95	125,27	126,49	92,97
Heat Flow KJ/h *10^5	-37 032,11	-33 942,55	-33 942,55	-33 641,70	-3 515 810 677,60	-7 298,11	-2 640 595 641,97	-2 706 816 638,37	-2 697 340 316,21	-2 745 025 230,91	-118 338 322,15	-118 366 191,99	-2 626 686 908,75	-114 035 053,06	-114 035 053,06	-123 639 996,94
HHV MJ/m3	42,05	38,08	38,08	38,08	38,82		41,29	41,29	40,62	40,62	67,90	67,91	39,72	96,90	96,90	96,90
Mass Density kg/m3	0,9307	0,8421	0,8421	0,8421	0,8576	1,8717	0,7930	0,7930	0,7787	0,7787	1,3244	1,3247	0,7607	1,9322	1,9322	1,9322

	6.1	6.2	6.3	6.4	7.1	9.1	9.2	9.3	10.1	10.2	10.3	11.1	11.2	11.3	11.4
Vapor	1,00	0,9828	1,00	1,00	0,00	0,00	0,3041	0,40	1,00	1,00	1,00	0,00	0,00	0,1411	0,1470
Temperature C	-49,05	-67,97	-6,97	-6,97	99,07	-1,00	-12,41	27,79	27,79	24,73	35,94	27,79	27,79	113,69	113,40
Pressure kPa	3 420,00	1 520,00	1 520,00	1 520,00	3 420,00	7 000,00	2 000,00	1 950,00	1 950,00	1 520,00	1 520,00	1 950,00	1 950,00	2 100,00	2 043,00
Molar Flow kgmol/h	225,47	225,47	225,47	225,47	748,37	1 878,55	1 878,55	1 878,55	757,90	757,90	757,90	1 120,65	1 120,65	1 120,65	1 120,65
Mass Flow kg/h	4 244,92	4 244,92	4 244,92	4 244,92	39 356,48	114 145,89	114 145,89	114 145,89	18 430,93	18 430,93	18 430,93	95 714,95	95 714,95	95 714,95	95 714,95
Std Ideal Liq Vol Flow m3/h	13,47	13,47	13,47	13,47	72,84	190,79	190,79	190,79	46,39	46,39	46,39	144,40	144,40	144,40	144,40
Molar enthalpy KJ/kgmol	-81 203,31	-81 203,31	-78 534,12	-78 534,12	-123 751,22	-164 465,54	-164 465,54	-158 416,47	-111 823,84	-111 823,84	-111 302,72	-189 927,37	-189 927,37	-171 158,03	-171 158,03
Molar Entropy KJ/kgmoleC	145,22	150,49	161,99	161,99	129,96	115,13	118,46	140,09	164,19	166,11	167,83	123,80	123,80	178,26	178,31
Heat Flow KJ/h *10^5	-18 308 757,86	-18 308 757,86	-17 706 942,03	-17 706 942,03	-92 612 157,23	-3 089,56	-3 089,56	-2 975,93	-847,51	-847,51	-843,56	-2 128,41	-2 128,41	-1 918,08	-1 918,08
HHV MJ/m3	43,46	43,46	43,46	43,46	113,73	120,66	120,66	120,66	44,57	44,57	44,57	180,02	180,02	180,02	180,02
Mass Density kg/m3	0,7986	0,7986	0,7986	0,7986	2,2890	2,6841	2,6841	2,6841	1,0329	1,0329	1,0329	3,9739	3,9739	3,9739	3,9739

	12.1	13.1	13.2	13.3	13.4	13.5	14.1	15.1	15.2	15.3	To VE-13-101	16.1	16.2	17.1	17.2
Vapor	1,00	0,00	0,0573	0,00	0,00	0,00	1,00	1,00	1,00	0,9231	0,00	1,00	1,00	0,00	0,00
Temperature C	84,07	215,00	212,18	118,25	118,28	9,28	75,92	75,92	138,50	65,70	75,92	65,70	99,94	65,70	65,71
Pressure kPa	1 520,00	1 520,00	1 400,00	1 400,00	1 300,00	1 300,00	1 520,00	1 520,00	3 800,00	3 800,00	1 520,00	3 800,00	6 000,00	3 800,00	3 800,00
Molar Flow kgmol/h	1 302,64	693,29	693,29	693,29	693,29	693,29	1 528,10	1 525,05	1 525,05	1 525,05	3,05	1 407,76	1 407,76	117,29	117,38
Mass Flow kg/h	44 339,04	76 875,94	76 875,94	76 875,94	76 875,94	76 875,94	48 583,96	48 317,29	48 317,29	48 317,29	266,67	41 253,88	41 253,88	7 063,41	7 069,09
Std Ideal Liq Vol Flow m3/h	94,86	107,90	107,90	107,90	107,90	107,90	108,32	107,93	107,93	107,93	0,40	95,97	95,97	11,96	11,97
Molar enthalpy KJ/kgmol	-114 396,88	-167 460,22	-167 460,22	-197 757,90	-197 757,90	-225 092,66	-109 105,41	-108 974,41	-105 520,44	-111 892,63	-174 571,03	-109 187,26	-107 717,62	-144 363,09	-144 367,93
Molar Entropy KJ/kgmoleC	174,41	262,36	262,43	193,52	193,57	112,25	173,40	173,48	175,61	158,40	130,82	162,09	163,09	114,09	114,08
Heat Flow KJ/h *10^5	-149 017 442,37	-116 099 212,02	-116 099 212,02	-137 104 412,93	-137 104 412,93	-156 055 445,29	-166 724 384,40	-166 191 629,07	-160 924 146,14	-170 642 068,77	-532 755,33	-153 709 474,98	-151 640 570,15	-16 932 593,79	-16 946 452,99
HHV MJ/m3	66,31	251,71	251,71	251,71	251,71	251,71	62,90	62,67	62,67	62,67	197,11	57,48	57,48	127,97	127,97
Mass Density kg/m3	1,4541	5,6088	5,6088	5,6088	5,6088	5,6088	1,3564	1,3516	1,3516	1,3516	4,1261	1,2482	1,2482	2,6534	2,6535
TVP @ 37,8°C						7,0350									

Appendix C.6 Mole Fraction Modification of Existing Stabilizer II Case B

	Feed Gas	1.1	1.2	1.3	2.1	CO2/H2S	3.1	3.2	4.1	4.2	4.3	4.4	LNG	5.1	5.2	5.3	6.1	6.2	6.3	6.4	7.1
Nitrogen	0,02781	0,02908	0,02908	0,02908	0,02817	0	0,02997	0,02997	0,03005	0,03	0,01	0,01	0	0	0	0	0,00001	0,00001	0,00001	0	0
CO2	0,05927	0,05952	0,05952	0,05952	0,06003	0,99990	0,00000	0,00000	0,00000	0,00	0,00	0,00	0	0	0	0	0	0	0	0	0
Methane	0,80427	0,83063	0,83063	0,83063	0,81954	0	0,87189	0,87189	0,87951	0,87951	0,50942	0,50918	0,89184	0,18551	0,18551	0,18551	0,80151	0,80151	0,80151	0,80151	0
Ethane	0,05012	0,04870	0,04870	0,04870	0,05198	0	0,05530	0,05530	0,05441	0,05441	0,14180	0,14171	0,05150	0,18574	0,18574	0,18574	0,19848	0,19848	0,19848	0,19848	0,18177
Propane	0,02448	0,02083	0,02083	0,02083	0,02478	0	0,02636	0,02636	0,02442	0,02442	0,16835	0,16887	0,01962	0,25866	0,25866	0,25866	0	0	0	0	0,33671
i-Butane	0,00380	0,00266	0,00266	0,00266	0,00367	0	0,00390	0,00390	0,00327	0,00327	0,03902	0,03896	0,00208	0,06650	0,06650	0,06650	0	0	0	0	0,08646
n-Butane	0,00790	0,00495	0,00495	0,00495	0,00700	0	0,00744	0,00744	0,00584	0,00584	0,08433	0,08417	0,00322	0,15247	0,15247	0,15247	0	0	0	0	0,19821
i-Pentane	0,00262	0,00115	0,00115	0,00115	0,00157	0	0,00167	0,00167	0,00103	0,00103	0,02089	0,02088	0,00087	0,04618	0,04618	0,04618	0	0	0	0	0,06008
n-Pentane	0,00289	0,00108	0,00108	0,00108	0,00150	0	0,00160	0,00160	0,00088	0,00088	0,01943	0,01943	0,00026	0,04759	0,04759	0,04759	0	0	0	0	0,06193
n-Hexane	0,00321	0,00060	0,00060	0,00060	0,00080	0	0,00086	0,00086	0,00026	0,00026	0,00703	0,00705	0,00003	0,02910	0,02910	0,02910	0	0	0	0	0,03794
n-Heptane	0,00351	0,00029	0,00029	0,00029	0,00037	0	0,00040	0,00040	0,00006	0,00006	0,00165	0,00165	0	0,01395	0,01395	0,01395	0	0	0	0	0,01822
n-Octane	0,00281	0,00010	0,00010	0,00010	0,00012	0	0,00013	0,00013	0,00001	0,00001	0,00023	0,00023	0	0,00447	0,00447	0,00447	0	0	0	0	0,00585
n-Nonane	0,00125	0,00002	0,00002	0,00002	0,00002	0	0,00002	0,00002	0	0	0,00002	0,00002	0	0,00080	0,00080	0,00080	0	0	0	0	0,00104
Benzene	0,00069	0,00011	0,00011	0,00011	0,00015	0	0,00016	0,00016	0,00005	0,00005	0,00123	0,00123	0,00001	0,00545	0,00545	0,00545	0	0	0	0	0,00711
Toluene	0,00080	0,00005	0,00005	0,00005	0,00007	0	0,00007	0,00007	0,00001	0,00001	0,00027	0,00027	0	0,00256	0,00256	0,00256	0	0	0	0	0,00334
m-Xylene	0,00055	0,00001	0,00001	0,00001	0,00002	0	0,00002	0,00002	0	0	0,00002	0,00002	0	0,00059	0,00059	0,00059	0	0	0	0	0,00077
n-Decane	0,00123	0,00001	0,00001	0,00001	0,00001	0	0,00001	0,00001	0	0	0	0	0	0,00033	0,00033	0,00033	0	0	0	0	0,00044
n-C11	0,00055	0	0	0	0	0	0	0	0	0	0	0	0	0,00006	0,00006	0,00006	0	0	0	0	0,00008
n-C12	0,00054	0	0	0	0	0	0	0	0	0	0	0	0	0,00003	0,00003	0,00003	0	0	0	0	0,00004
n-C13	0,00043	0	0	0	0	0	0	0	0	0	0	0	0	0	0,00001	0,00001	0	0	0	0	0,00001
n-C14	0,00029	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
n-C15	0,00022	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
n-C16	0,00013	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
n-C17	0,00013	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
n-C18	0,00009	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
n-C19	0,00006	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
n-C20	0,00015	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
H2S	0	0	0	0	0,00001	0,00010	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Phenol	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Helium	0,00020	0,00021	0,00021	0,00021	0,00020	0	0,00022	0,00022	0,00022	0,00022	0	0	0	0	0	0	0	0	0	0	0

	9.1	9.2	9.3	10.1	10.2	10.3	11.1	11.2	11.3	11.4	12.1	13.1	13.2	13.3	13.4	13.5	14.1	15.1	15.2	15.3	To VE-13-101	16.1	16.2	17.1	17.2
Nitrogen	0,00399	0,00399	0,00399	0,00944	0,00944	0,00944	0,00031	0,00031	0,00031	0,00031	0,00580	0	0	0	0	0	0,00495	0,00496	0,00496	0,00496	0,00013	0,00533	0,00533	0,00045	0,00045
CO2	0,05456	0,05456	0,05456	0,09946	0,09946	0,09946	0,02420	0,02420	0,02420	0,02420	0,08080	0	0	0	0	0	0,06887	0,06900	0,06900	0,06900	0,00846	0,07279	0,07279	0,02343	0,02344
Methane	0,31020	0,31020	0,31020	0,67128	0,67128	0,67128	0,06600	0,06600	0,06600	0,06600	0,45651	0	0	0	0	0	0,50742	0,50837	0,50837	0,50837	0,03273	0,54224	0,54224	0,10180	0,10183
Ethane	0,07674	0,07674	0,07674	0,11112	0,11112	0,11112	0,05349	0,05349	0,05349	0,05349	0,11764	0	0	0	0	0	0,12957	0,12977	0,12977	0,12977	0,02940	0,13411	0,13411	0,07764	0,07743
Propane	0,09301	0,09301	0,09301	0,06960	0,06960	0,06960	0,10884	0,10884	0,10884	0,10884	0,14860	0,00065	0,00065	0,00065	0,00065	0,00065	0,12668	0,12678	0,12678	0,12678	0,07322	0,12365	0,12365	0,16443	0,16449
i-Butane	0,02506	0,02506	0,02506	0,00953	0,00953	0,00953	0,03557	0,03557	0,03557	0,03557	0,03747	0,00939	0,00939	0,00939	0,00939	0,00939	0,03194	0,03193	0,03193	0,03193	0,03712	0,02874	0,02874	0,07022	0,07026
n-Butane	0,06319	0,06319	0,06319	0,01821	0,01821	0,01821	0,09361	0,09361	0,09361	0,09361	0,07934	0,05239	0,05239	0,05239	0,05239	0,05239	0,06763	0,06756	0,06756	0,06756	0,10074	0,05832	0,05832	0,17848	0,17858
i-Pentane	0,03013	0,03013	0,03013	0,00397	0,00397	0,00397	0,04783	0,04783	0,04783	0,04783	0,01917	0,05702	0,05702	0,05702	0,05702	0,05702	0,01634	0,01627	0,01627	0,01627	0,04836	0,01203	0,01203	0,06722	0,06723
n-Pentane	0,03685	0,03685	0,03685	0,00377	0,00377	0,00377	0,05923	0,05923	0,05923	0,05923	0,02023	0,07531	0,07531	0,07531	0,07531	0,07531	0,01725	0,01716	0,01716	0,01716	0,06178	0,01196	0,01196	0,07952	0,07953
n-Hexane	0,05224	0,05224	0,05224	0,00186	0,00186	0,00186	0,08632	0,08632	0,08632	0,08632	0,01439	0,12889	0,12889	0,12889	0,12889	0,12889	0,01226	0,01208	0,01208	0,01208	0,10250	0,00602	0,00602	0,08486	0,08486
n-Heptane	0,06372	0,06372	0,06372	0,00081	0,00081	0,00081	0,10627	0,10627	0,10627	0,10627	0,00905	0,16723	0,16723	0,16723	0,16723	0,16723	0,00771	0,00744	0,00744	0,00744	0,14341	0,00236	0,00236	0,06840	0,06838
n-Octane	0,05365	0,05365	0,05365	0,00024	0,00024	0,00024	0,08977	0,08977	0,08977	0,08977	0,00393	0,14363	0,14363	0,14363	0,14363	0,14363	0,00335	0,00309	0,00309	0,00309	0,13343	0,00057	0,00057	0,03333	0,03332
n-Nonane	0,02426	0,02426	0,02426	0,00004	0,00004	0,00004	0,04064	0,04064	0,04064	0,04064	0,00091	0,06532	0,06532	0,06532	0,06532	0,06532	0,00078	0,00066	0,00066	0,00066	0,06198	0,00007	0,00007	0,00773	0,00773
Benzene	0,01154	0,01154	0,01154	0,00039	0,00039	0,00039	0,01908	0,01908	0,01908	0,01908	0,00300	0,02872	0,02872	0,02872	0,02872	0,02872	0,00256	0,00252	0,00252	0,00252	0,02324	0,00121	0,00121	0,01824	0,01823
Toluene	0,01490	0,01490	0,01490	0,00017	0,00017	0,00017	0,02486	0,02486	0,02486	0,02486	0,00189	0,03930	0,03930	0,03930	0,03930	0,03930	0,00161	0,00155	0,00155	0,00155	0,03418	0,00045	0,00045	0,01475	0,01474
m-Xylene	0,01061	0,01061	0,01061	0,00004	0,00004	0,00004	0,01776	0,01776	0,01776	0,01776	0,00063	0,02848	0,02848	0,02848	0,02848	0,02848	0,00053	0,00048	0,00048	0,00048	0,02719	0,00007	0,00007	0,00539	0,00538
n-Decane	0,02420	0,02420	0,02420	0,00002	0,00002	0,00002	0,04056	0,04056	0,04056	0,04056	0,00046	0,06530	0,06530	0,06530	0,06530	0,06530	0,00039	0,00028	0,00028	0,00028	0,05600	0,00002	0,00002	0,00344	0,00344
n-C11	0,01085	0,01085	0,01085	0	0	0	0,01818	0,01818	0,01818	0,01818	0,00009	0,02931	0,02931	0,02931	0,02931	0,02931	0,00008	0,00004	0,00004	0,00004	0,01800	0	0	0,00052	0,00052
n-C12	0,01069	0,01069	0,01069	0	0	0	0,01791	0,01791	0,01791	0,01791	0,00003	0,02892	0,02892	0,02892	0,02892	0,02892	0,00002	0	0	0	0,00759	0	0	0,00011	0,00011
n-C13	0,00847	0,00847	0,00847	0	0	0	0,01419	0,01419	0,01419	0,01419	0	0,02294	0,02294	0,02294	0,02294	0,02294	0	0	0	0	0	0	0	0	0
n-C14	0,00570	0,00570	0,00570	0	0	0	0,00956	0,00956	0,00956	0,00956	0	0,01546	0,01546	0,01546	0,01546	0,01546	0	0	0	0	0	0	0	0	0
n-C15	0,00432	0,00432	0,00432	0	0	0	0,00725	0,00725	0,00725	0,00725	0	0,01171	0,01171	0,01171	0,01171	0,01171	0	0	0	0	0	0	0	0	0
n-C16	0,00259	0,00259	0,00259	0	0	0	0,00434	0,00434	0,00434	0,00434	0	0,00701	0,00701	0,00701	0,00701	0,00701	0	0	0	0	0	0	0	0	0
n-C17	0,00259	0,00259	0,00259	0	0	0	0,00434	0,00434	0,00434	0,00434	0	0,00701	0,00701	0,00701	0,00701	0,00701	0	0	0	0	0	0	0	0	0
n-C18	0,00172	0,00172	0,00172	0	0	0	0,00288	0,00288	0,00288	0,00288	0	0,00465	0,00465	0,00465	0,00465	0,00465	0	0	0	0	0	0	0	0	0
n-C19	0,00120	0,00120	0,00120	0	0	0	0,00202	0,00202	0,00202	0,00202	0	0,00326	0,00326	0,00326	0,00326	0,00326	0	0	0	0	0	0	0	0	0
n-C20	0,00294	0,00294	0,00294	0	0	0	0,00493	0,00493	0,00493	0,00493	0	0,00797	0,00797	0,00797	0,00797	0,00797	0	0	0	0	0	0	0	0	0
H2S	0,00001	0,00001	0,00001	0,00001	0,00001	0,00001	0,00001	0,00001	0,00001	0,00001	0,00002	0	0	0	0	0	0,00001	0,00001	0,00001	0,00001	0	0,00001	0,00001	0,00001	0,00001
Phenol	0,00004	0,00004	0,00004	0	0	0	0,00007	0,00007	0,00007	0,00007	0	0,00011	0,00011	0,00011	0,00011	0,00011	0	0	0	0	0	0	0	0,00001	0,00001
Helium	0,00003	0,00003	0,00003	0,00006	0,00006	0,00006	0	0	0	0	0,00004	0	0	0	0	0	0,00003	0,00003	0,00003	0,00003	0	0,00004	0	0	0

Appendix C.7 Mass Balance (kg/h) Modification of Existing Stabilizer II Case B

	Feed Gas	1.1	1.2	1.3	2.1	CO2/H2S	3.1	3.2	4.1	4.2	4.3	4.4	LNG	5.1	5.2	5.3	6.1	6.2	6.3	6.4	7.1
Nitrogen	28 896,26	28 686,06	28 686,06	28 686,06	28 896,31	0,00	28 896,31	28 896,31	29 092,56	29 092,56	196,34	196,31	28 896,22	0,07	0,07	0,07	0,07	0,07	0,07	0,07	0,00
CO2	96 747,86	92 237,07	92 237,07	92 237,07	96 746,85	80 673,96	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Methane	478 575,09	469 226,59	469 226,59	469 226,59	481 472,88	0,00	481 472,88	481 472,88	487 676,53	487 676,53	9 101,04	9 098,59	478 575,49	2 894,94	2 894,94	2 894,94	2 899,18	2 899,18	2 899,18	2 899,18	0,00
Ethane	55 896,21	51 561,40	51 561,40	51 561,40	57 238,64	0,00	57 238,64	57 238,64	56 551,83	56 551,83	4 748,44	4 746,07	51 803,38	5 432,89	5 432,89	5 432,89	1 345,66	1 345,66	1 345,66	1 345,66	4 090,38
Propane	40 042,51	32 338,01	32 338,01	32 338,01	40 013,80	0,00	40 013,80	40 013,80	37 213,24	37 213,24	8 267,02	8 294,39	28 946,22	11 094,95	11 094,95	11 094,95	0,01	0,01	0,01	0,01	11 111,85
i-Butane	8 187,96	5 451,56	5 451,56	5 451,56	7 803,45	0,00	7 803,45	7 803,45	6 565,76	6 565,76	2 525,77	2 522,03	4 039,99	3 759,71	3 759,71	3 759,71	0,00	0,00	0,00	0,00	3 760,74
n-Butane	17 022,68	10 123,01	10 123,01	10 123,01	14 895,25	0,00	14 895,25	14 895,25	11 724,36	11 724,36	5 458,73	5 449,35	6 265,64	8 620,24	8 620,24	8 620,24	0,00	0,00	0,00	0,00	8 621,67
i-Pentane	7 000,76	2 916,53	2 916,53	2 916,53	4 138,42	0,00	4 138,42	4 138,42	2 575,64	2 575,64	1 678,17	1 678,32	897,46	3 241,10	3 241,10	3 241,10	0,00	0,00	0,00	0,00	3 244,17
n-Pentane	7 742,05	2 746,90	2 746,90	2 746,90	3 962,06	0,00	3 962,06	3 962,06	2 183,90	2 183,90	1 560,91	1 561,76	622,99	3 339,93	3 339,93	3 339,93	0,00	0,00	0,00	0,00	3 344,06
n-Hexane	10 263,64	1 805,98	1 805,98	1 805,98	2 536,31	0,00	2 536,31	2 536,31	773,06	773,06	674,76	676,45	98,30	2 439,70	2 439,70	2 439,70	0,00	0,00	0,00	0,00	2 446,71
n-Heptane	13 030,67	1 035,85	1 035,85	1 035,85	1 369,42	0,00	1 369,42	1 369,42	194,12	194,12	183,91	184,70	10,21	1 360,00	1 360,00	1 360,00	0,00	0,00	0,00	0,00	1 366,50
n-Octane	11 918,53	405,95	405,95	405,95	497,49	0,00	497,49	497,49	29,59	29,59	28,97	29,13	0,62	497,03	497,03	497,03	0,00	0,00	0,00	0,00	500,18
n-Nonane	5 932,25	87,39	87,39	87,39	99,47	0,00	99,47	99,47	2,47	2,47	2,45	2,47	0,02	99,47	99,47	99,47	0,00	0,00	0,00	0,00	100,16
Benzene	1 990,35	297,36	297,36	297,36	429,89	0,00	429,89	429,89	123,07	123,07	107,09	107,40	15,98	414,21	414,21	414,21	0,00	0,00	0,00	0,00	415,56
Toluene	2 751,14	172,67	172,67	172,67	230,80	0,00	230,80	230,80	29,22	29,22	27,61	27,75	1,61	229,32	229,32	229,32	0,00	0,00	0,00	0,00	230,58
m-Xylene	2 165,78	49,67	49,67	49,67	60,54	0,00	60,54	60,54	2,71	2,71	2,66	2,67	0,05	60,50	60,50	60,50	0,00	0,00	0,00	0,00	60,95
n-Decane	6 512,38	43,14	43,14	43,14	46,24	0,00	46,24	46,24	0,49	0,49	0,49	0,49	0,00	46,24	46,24	46,24	0,00	0,00	0,00	0,00	46,53
n-C11	3 194,57	8,93	8,93	8,93	9,19	0,00	9,19	9,19	0,04	0,04	0,04	0,04	0,00	9,19	9,19	9,19	0,00	0,00	0,00	0,00	9,23
n-C12	3 424,35	4,77	4,77	4,77	4,81	0,00	4,81	4,81	0,01	0,01	0,01	0,01	0,00	4,81	4,81	4,81	0,00	0,00	0,00	0,00	4,81
n-C13	2 933,63	1,58	1,58	1,58	1,58	0,00	1,58	1,58	0,00	0,00	0,00	0,00	0,00	1,58	1,58	1,58	0,00	0,00	0,00	0,00	1,58
n-C14	2 126,48	0,42	0,42	0,42	0,42	0,00	0,42	0,42	0,00	0,00	0,00	0,00	0,00	0,42	0,42	0,42	0,00	0,00	0,00	0,00	0,42
n-C15	1 725,38	0,20	0,20	0,20	0,20	0,00	0,20	0,20	0,00	0,00	0,00	0,00	0,00	0,20	0,20	0,20	0,00	0,00	0,00	0,00	0,20
n-C16	1 100,19	0,06	0,06	0,06	0,06	0,00	0,06	0,06	0,00	0,00	0,00	0,00	0,00	0,06	0,06	0,06	0,00	0,00	0,00	0,00	0,06
n-C17	1 168,35	0,04	0,04	0,04	0,04	0,00	0,04	0,04	0,00	0,00	0,00	0,00	0,00	0,04	0,04	0,04	0,00	0,00	0,00	0,00	0,04
n-C18	821,18	0,02	0,02	0,02	0,02	0,00	0,02	0,02	0,00	0,00	0,00	0,00	0,00	0,02	0,02	0,02	0,00	0,00	0,00	0,00	0,02
n-C19	607,51	0,01	0,01	0,01	0,01	0,00	0,01	0,01	0,00	0,00	0,00	0,00	0,00	0,01	0,01	0,01	0,00	0,00	0,00	0,00	0,01
n-C20	1 561,46	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
H2S	6,32	5,65	5,65	5,65	6,32	5,94	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Phenol	6,98	0,06	0,06	0,06	0,07	0,00	0,07	0,07	0,00	0,00	0,00	0,00	0,00	0,07	0,07	0,07	0,00	0,00	0,00	0,00	0,07
Helium	29,69	29,49	29,49	29,49	29,69	0,00	29,69	29,69	29,78	29,78	0,09	0,09	29,69	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Total kg/h	813 382,24	699 236,35	699 236,35	699 236,35	740 490,23	80 679,89	643 737,07	643 737,07	634 768,39	634 768,39	34 564,50	34 578,02	600 203,88	43 546,70	43 546,70	43 546,70	4 244,92	4 244,92	4 244,92	4 244,92	39 356,48

	9.1	9.2	9.3	10.1	10.2	10.3	11.1	11.2	11.3	11.4	12.1	13.1	13.2	13.3	13.4	13.5	14.1	15.1	15.2	15.3	To VE-13-101	16.1	16.2	17.1	17.2
Nitrogen	210,20	210,20	210,20	200,39	200,39	200,39	9,81	9,81	9,81	9,81	211,67	0,00	0,00	0,00	0,00	0,00	211,74	211,73	211,73	211,73	0,01	210,26	210,26	1,47	1,47
CO2	4 510,79	4 510,79	4 510,79	3 317,35	3 317,35	3 317,35	1 193,44	1 193,44	1 193,44	1 193,44	4 631,89	0,00	0,00	0,00	0,00	0,00	4 631,89	4 630,75	4 630,75	4 630,75	1,14	4 509,78	4 509,78	120,97	121,09
Methane	9 348,50	9 348,50	9 348,50	8 162,00	8 162,00	8 162,00	1 186,49	1 186,49	1 186,49	1 186,49	9 540,26	0,00	0,00	0,00	0,00	0,00	12 439,44	12 437,84	12 437,84	12 437,84	1,60	12 246,29	12 246,29	191,55	191,77
Ethane	4 334,81	4 334,81	4 334,81	2 532,45	2 532,45	2 532,45	1 802,36	1 802,36	1 802,36	1 802,36	4 608,10	0,02	0,02	0,02	0,02	0,02	5 953,76	5 951,06	5 951,06	5 951,06	2,70	5 677,24	5 677,24	273,82	273,31
Propane	7 704,50	7 704,50	7 704,50	2 325,99	2 325,99	2 325,99	5 378,51	5 378,51	5 378,51	5 378,51	8 536,11	19,84	19,84	19,84	19,84	19,84	8 536,12	8 526,27	8 526,27	8 526,27	9,85	7 675,79	7 675,79	850,48	851,45
i-Butane	2 736,40	2 736,40	2 736,40	419,82	419,82	419,82	2 316,59	2 316,59	2 316,59	2 316,59	2 837,22	378,57	378,57	378,57	378,57	378,57	2 837,22	2 830,63	2 830,63	2 830,63	6,58	2 351,89	2 351,89	478,74	479,38
n-Butane	6 899,67	6 899,67	6 899,67	802,21	802,21	802,21	6 097,46	6 097,46	6 097,46	6 097,46	6 006,89	2 111,21	2 111,21	2 111,21	2 111,21	2 111,21	6 006,89	5 989,02	5 989,02	5 989,02	17,87	4 772,24	4 772,24	1 216,78	1 218,44
i-Pentane	4 084,24	4 084,24	4 084,24	216,98	216,98	216,98	3 867,26	3 867,26	3 867,26	3 867,26	1 801,40	2 852,26	2 852,26	2 852,26	2 852,26	2 852,26	1 801,40	1 790,75	1 790,75	1 790,75	10,65	1 221,89	1 221,89	568,86	569,42
n-Pentane	4 995,15	4 995,15	4 995,15	206,06	206,06	206,06	4 789,09	4 789,09	4 789,09	4 789,09	1 901,71	3 767,01	3 767,01	3 767,01	3 767,01	3 767,01	1 901,71	1 888,10	1 888,10	1 888,10	13,60	1 215,17	1 215,17	672,94	673,56
n-Hexane	8 457,66	8 457,66	8 457,66	121,33	121,33	121,33	8 336,33	8 336,33	8 336,33	8 336,33	1 615,10	7 700,95	7 700,95	7 700,95	7 700,95	7 700,95	1 615,10	1 588,14	1 588,14	1 588,14	26,96	730,33	730,33	857,81	858,39
n-Heptane	11 994,81	11 994,81	11 994,81	61,17	61,17	61,17	11 933,65	11 933,65	11 933,65	11 933,65	1 181,34	11 617,80	11 617,80	11 617,80	11 617,80	11 617,80	1 181,34	1 137,49	1 137,49	1 137,49	43,85	333,56	333,56	803,93	804,33
n-Octane	11 512,59	11 512,59	11 512,59	20,95	20,95	20,95	11 491,64	11 491,64	11 491,64	11 491,64	584,67	11 374,70	11 374,70	11 374,70	11 374,70	11 374,70	584,67	538,15	538,15	538,15	46,52	91,54	91,54	446,61	446,78
n-Nonane	5 844,86	5 844,86	5 844,86	3,94	3,94	3,94	5 840,92	5 840,92	5 840,92	5 840,92	152,69	5 808,55	5 808,55	5 808,55	5 808,55	5 808,55	152,69	128,42	128,42	128,42	24,26	12,08	12,08	116,34	116,37
Benzene	1 692,99	1 692,99	1 692,99	22,97	22,97	22,97	1 670,03	1 670,03	1 670,03	1 670,03	305,15	1 555,03	1 555,03	1 555,03	1 555,03	1 555,03	305,15	299,61	299,61	299,61	5,54	132,53	132,53	167,08	167,19
Toluene	2 578,47	2 578,47	2 578,47	11,70	11,70	11,70	2 566,77	2 566,77	2 566,77	2 566,77	227,12	2 510,81	2 510,81	2 510,81	2 510,81	2 510,81	227,12	217,51	217,51	217,51	9,61	58,13	58,13	159,38	159,48
m-Xylene	2 116,11	2 116,11	2 116,11	2,91	2,91	2,91	2 113,20	2 113,20	2 113,20	2 113,20	86,74	2 096,45	2 096,45	2 096,45	2 096,45	2 096,45	86,74	77,93	77,93	77,93	8,81	10,87	10,87	67,06	67,08
n-Decane	6 469,24	6 469,24	6 469,24	1,67	1,67	1,67	6 467,57	6 467,57	6 467,57	6 467,57	84,92	6 441,83	6 441,83	6 441,83	6 441,83	6 441,83	84,92	60,60	60,60	60,60	24,32	3,11	3,11	57,49	57,50
n-C11	3 185,64	3 185,64	3 185,64	0,30	0,30	0,30	3 185,34	3 185,34	3 185,34	3 185,34	18,44	3 176,79	3 176,79	3 176,79	3 176,79	3 176,79	18,44	9,86	9,86	9,86	8,59	0,26	0,26	9,59	9,59
n-C12	3 419,58	3 419,58	3 419,58	0,14	0,14	0,14	3 419,44	3 419,44	3 419,44	3 419,44	6,24	3 415,61	3 415,61	3 415,61	3 415,61	3 415,61	6,24	2,30	2,30	2,30	3,94	0,03	0,03	2,26	2,27
n-C13	2 932,06	2 932,06	2 932,06	0,04	0,04	0,04	2 932,02	2 932,02	2 932,02	2 932,02	0,28	2 931,83	2 931,83	2 931,83	2 931,83	2 931,83	0,28	0,06	0,06	0,06	0,23	0,00	0,00	0,06	0,06
n-C14	2 126,05	2 126,05	2 126,05	0,01	0,01	0,01	2 126,04	2 126,04	2 126,04	2 126,04	0,00	2 126,05	2 126,05	2 126,05	2 126,05	2 126,05	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
n-C15	1 725,18	1 725,18	1 725,18	0,00	0,00	0,00	1 725,18	1 725,18	1 725,18	1 725,18	0,00	1 725,18	1 725,18	1 725,18	1 725,18	1 725,18	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
n-C16	1 100,14	1 100,14	1 100,14	0,00	0,00	0,00	1 100,14	1 100,14	1 100,14	1 100,14	0,00	1 100,14	1 100,14	1 100,14	1 100,14	1 100,14	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
n-C17	1 168,31	1 168,31	1 168,31	0,00	0,00	0,00	1 168,31	1 168,31	1 168,31	1 168,31	0,00	1 168,31	1 168,31	1 168,31	1 168,31	1 168,31	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
n-C18	821,16	821,16	821,16	0,00	0,00	0,00	821,16	821,16	821,16	821,16	0,00	821,16	821,16	821,16	821,16	821,16	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
n-C19	607,50	607,50	607,50	0,00	0,00	0,00	607,50	607,50	607,50	607,50	0,00	607,50	607,50	607,50	607,50	607,50	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
n-C20	1 561,46	1 561,46	1 561,46	0,00	0,00	0,00	1 561,46	1 561,46	1 561,46	1 561,46	0,00	1 561,46	1 561,46	1 561,46	1 561,46	1 561,46	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
H2S	0,67	0,67	0,67	0,34	0,34	0,34	0,32	0,32	0,32	0,32	0,70	0,00	0,00	0,00	0,00	0,00	0,70	0,70	0,70	0,70	0,00	0,66	0,66	0,04	0,04
Phenol	6,92	6,92	6,92	0,00	0,00	0,00	6,92	6,92	6,92	6,92	0,19	6,88	6,88	6,88	6,88	6,88	0,19	0,16	0,16	0,16	0,03	0,01	0,01	0,14	0,14
Helium	0,20	0,20	0,20	0,19	0,19	0,19	0,01	0,01	0,01	0,01	0,20	0,00	0,00	0,00	0,00	0,00	0,20	0,20	0,20	0,20	0,00	0,20	0,20	0,00	0,00
Total	114 145,89	114 145,89	114 145,89	18 430,93	18 430,93	18 430,93	95 714,95	95 714,95	95 714,95	95 714,95	44 339,04	76 875,94	76 875,94	76 875,94	76 875,94	76 875,94	48 583,96	48 317,29	48 317,29	48 317,29	266,67	41 253,88	41 253,88	7 063,41	7 069,09

Appendix C.8 Heat Balance Modification of Existing Stabilizer II Case C

	Feed Gas	1.1	1.2	1.3	2.1	CO2/H2S	3.1	3.2	4.1	4.2	4.3	4.4	LNG	5.1	5.2	5.3
Vapor	0,92	1,00	1,00	1,00	1,00	1,00	1,00	0,9862	1,00	0,97	0,00	0,00	1,00	0,00	0,2705	0,00
Temperature C	-1,00	-1,00	-6,62	9,98	16,87	21,98	18,77	-15,89	-15,90	-35,90	-35,90	-35,93	-35,90	67,93	56,54	-12,36
Pressure kPa	7 000,00	7 000,00	6 000,00	6 000,00	6 000,00	6 000,00	6 000,00	6 000,00	6 000,00	6 000,00	6 000,00	6 000,00	6 000,00	6 000,00	3 420,00	3 420,00
Molar Flow kgmol/h	35 038,71	32 108,67	32 108,67	32 108,67	34 049,37	1 821,84	32 227,55	32 227,55	32 324,58	32 324,58	971,99	971,42	31 352,59	874,39	874,39	874,39
Mass Flow kg/h	813 382,24	627 562,29	627 562,29	627 562,29	683 645,45	80 176,70	603 469,64	603 469,64	594 504,00	594 504,00	30 872,04	30 846,82	563 631,96	39 812,46	39 812,46	39 812,46
Std Ideal Liq Vol Flow m3/h	2 097,88	1 790,00	1 790,00	1 790,00	1 921,24	97,14	1 824,10	1 824,10	1 817,22	1 817,22	71,31	71,26	1 745,91	78,14	78,14	78,14
Molar enthalpy KJ/kgmol	-100 507,43	-94 162,18	-94 162,18	-93 315,83	-94 101,99	-398 093,32	-76 917,43	-78 833,07	-78 234,60	-79 593,32	-107 475,15	-107 466,70	-78 728,93	-118 544,61	-118 544,61	-128 551,24
Molar Entropy KJ/kgmoleC	141,56	143,63	144,61	147,69	148,89	127,08	148,35	141,35	141,95	136,44	103,02	103,01	137,48	126,18	127,41	93,71
Heat Flow KJ/h *10^5	-35 216,50	-30 234,22	-30 234,22	-29 962,47	-32 041,13	-7 252,61	-24 788,61	-25 405,97	-25 289,01	-25 728,21	-1 044,65	-1 043,95	-24 683,56	-1 036,54	-1 036,54	-1 124,04
HHV MJ/m3	45,19	38,27	38,27	38,27	39,31		41,52	41,52	40,85	40,85	69,44	69,42	39,97	98,56	98,56	98,56
Mass Density kg/m3	0,9859	0,8288	0,8288	0,8288	0,8515	1,8717	0,7941	0,7941	0,7798	0,7798	1,3559	1,3556	0,7621	1,9669	1,9669	1,9669

	6.1	6.2	6.3	6.4	7.1	9.1	9.2	9.3	10.1	10.2	10.3	11.1	11.2	11.3	11.4
Vapor	1,00	0,9859	1,00	1,00	0,00	0,00	0,30	0,39	1,00	1,00	1,00	0,00	0,00	0,12	0,1292
Temperature C	-49,10	-66,69	-5,69	-5,69	98,46	-1,00	-11,53	28,67	28,67	25,69	36,90	28,67	28,74	113,64	113,40
Pressure kPa	3 420,00	1 520,00	1 520,00	1 520,00	3 420,00	7 000,00	2 000,00	1 950,00	1 950,00	1 520,00	1 520,00	1 950,00	2 100,00	2 100,00	2 043,00
Molar Flow kgmol/h	186,84	186,84	186,84	186,84	686,37	2 930,04	2 930,04	2 930,04	1 156,19	1 156,19	1 156,19	1 773,84	1 773,84	1 773,84	1 773,84
Mass Flow kg/h	3 419,51	3 419,51	3 419,51	3 419,51	36 331,41	185 819,95	185 819,95	185 819,95	27 521,76	27 521,76	27 521,76	158 298,19	158 298,19	158 298,19	158 298,19
Std Ideal Liq Vol Flow m3/h	10,88	10,88	10,88	10,88	67,15	307,88	307,88	307,88	70,49	70,49	70,49	237,39	237,39	237,39	237,39
Molar enthalpy KJ/kgmol	-80 798,62	-80 798,62	-78 188,82	-78 188,82	-124 896,08	-170 041,62	-170 041,62	-163 827,29	-108 217,72	-108 217,72	-107 700,48	-200 073,39	-200 047,04	-180 910,57	-180 910,57
Molar Entropy KJ/kgmoleC	144,43	149,83	161,00	161,00	130,87	118,87	122,26	144,42	164,33	166,26	167,96	131,44	131,46	187,01	187,05
Heat Flow KJ/h *10^5	-150,96	-150,96	-146,09	-146,09	-857,25	-4 982,28	-4 982,28	-4 800,20	-1 251,20	-1 251,20	-1 245,22	-3 548,99	-3 548,52	-3 209,07	-3 209,07
HHV MJ/m3	42,38	42,38	42,38	42,38	114,54	125,67	125,67	125,67	44,57	44,57	44,57	187,47	187,47	187,47	187,47
Mass Density kg/m3	0,7761	0,7761	0,7761	0,7761	2,3053	2,8124	2,8124	2,8124	1,0109	1,0109	1,0109	4,1856	4,1856	4,1856	4,1856

	12.1	13.1	13.2	13.3	13.4	13.5	14.1	15.1	15.2	15.3	To VE-13-101	16.1	16.2	17.1	17.2
Vapor	1,00	0,00	0,0551	0,00	0,00	0,00	1,00	1,00	1,00	0,94	0,00	1,00	1,00	0,00	0,00
Temperature C	80,04	215,00	212,38	125,56	125,59	16,59	75,28	75,28	139,17	66,37	75,28	66,37	100,89	66,37	66,37
Pressure kPa	1 520,00	1 520,00	1 400,00	1 400,00	1 300,00	1 300,00	1 520,00	1 520,00	3 800,00	3 800,00	1 520,00	3 800,00	6 000,00	3 800,00	3 800,00
Molar Flow kgmol/h	1 871,89	1 173,83	1 173,83	1 173,83	1 173,83	1 173,83	2 058,74	2 056,38	2 056,38	2 056,38	2,36	1 940,70	1 940,70	115,68	115,69
Mass Flow kg/h	60 098,15	132 946,11	132 946,11	132 946,11	132 946,11	132 946,11	63 517,66	63 306,76	63 306,76	63 306,76	210,90	56 083,17	56 083,17	7 223,60	7 224,31
Std Ideal Liq Vol Flow m3/h	132,78	187,20	187,20	187,20	187,20	187,20	143,65	143,34	143,34	143,34	0,31	131,24	131,24	12,10	12,10
Molar enthalpy KJ/kgmol	-111 531,80	-177 895,00	-177 895,00	-206 813,23	-206 813,23	-235 355,91	-108 505,76	-108 419,04	-104 944,54	-110 896,31	-184 067,31	-108 595,06	-107 108,96	-149 503,63	-149 502,88
Molar Entropy KJ/kgmoleC	174,57	274,02	274,09	208,86	208,91	125,81	173,77	173,81	175,95	159,93	135,65	162,44	163,44	117,80	117,80
Heat Flow KJ/h *10^5	-2 087,76	-2 088,19	-2 088,19	-2 427,64	-2 427,64	-2 762,68	-2 233,85	-2 229,50	-2 158,05	-2 280,44	-4,34	-2 107,50	-2 078,66	-172,94	-172,96
HHV MJ/m3	62,78	254,99	254,99	254,99	254,99	254,99	60,91	60,77	60,77	60,77	203,55	56,66	56,66	133,35	133,35
Mass Density kg/m3	1,3699	5,7481	5,7481	5,7481	5,7481	5,7481	1,3155	1,3126	1,3126	1,3126	4,2495	1,2306	1,2306	2,7636	2,7636
TVP @ 37,8°C psia						7,7590									

Appendix C.9 Mole Fraction Modification of Existing Stabilizer II Case C

	Feed Gas	1.1	1.2	1.3	2.1	CO2/H2S	3.1	3.2	4.1
Nitrogen	0,02486	0,02679	0,02679	0,02679	0,02558	0	0,02703	0,02703	0,02711
CO2	0,05199	0,05235	0,05235	0,05235	0,05350	0,99990	0	0	0
Methane	0,79869	0,84303	0,84303	0,84303	0,82657	0	0,87329	0,87329	0,88062
Ethane	0,04995	0,04768	0,04768	0,04768	0,05214	0	0,05509	0,05509	0,05431
Propane	0,02565	0,01988	0,01988	0,01988	0,02639	0	0,02788	0,02788	0,02601
i-Butane	0,00418	0,00245	0,00245	0,00245	0,00377	0	0,00398	0,00398	0,00339
n-Butane	0,00885	0,00445	0,00445	0,00445	0,00696	0	0,00735	0,00735	0,00589
i-Pentane	0,00322	0,00103	0,00103	0,00103	0,00160	0	0,00169	0,00169	0
n-Pentane	0,00362	0,00095	0,00095	0,00095	0,00152	0	0,00161	0,00161	0
n-Hexane	0,00457	0,00055	0,00055	0,00055	0,00086	0	0,00091	0,00091	0
n-Heptane	0,00655	0,00034	0,00034	0,00034	0,00050	0	0,00052	0,00052	0
n-Octane	0,00606	0,00013	0,00013	0,00013	0,00017	0	0,00018	0,00018	0
n-Nonane	0,00313	0,00003	0,00003	0,00003	0,00003	0	0,00004	0,00004	0
Benzene	0,00078	0,00008	0,00008	0,00008	0,00013	0	0,00014	0,00014	0
Toluene	0,00090	0,00004	0,00004	0,00004	0,00005	0	0,00006	0,00006	0
m-Xylene	0,00061	0,00001	0,00001	0,00001	0,00001	0	0,00001	0,00001	0
n-Decane	0,00129	0,00001	0,00001	0,00001	0,00001	0	0,00001	0,00001	0
n-C11	0,00102	0	0	0	0	0	0	0	0
n-C12	0,00081	0	0	0	0	0	0	0	0
n-C13	0,00064	0	0	0	0	0	0	0	0
n-C14	0,00051	0	0	0	0	0	0	0	0
n-C15	0,00045	0	0	0	0	0	0	0	0
n-C16	0,00027	0	0	0	0	0	0	0	0
n-C17	0,00027	0	0	0	0	0	0	0	0
n-C18	0,00018	0	0	0	0	0	0	0	0
n-C19	0,00013	0	0	0	0	0	0	0	0
n-C20	0,00063	0	0	0	0	0	0	0	0
H2S	0	0	0	0	0,00001	0,00010	0	0	0
Phenol	0	0	0	0	0	0	0	0	0
Helium	0,00020	0,00022	0,00022	0,00022	0,00021	0	0,00022	0,00022	0,00022

	4.2	4.3	4.4	LNG	5.1	5.2	5.3	6.1	6.2	6.3	6.4	7.1
Nitrogen	0	0	0	0	0	0	0	0	0	0,00001	0	0
CO2	0	0	0	0	0	0	0	0	0	0,00000	0	0
Methane	0,88062	0,49567	0,49589	0,89256	0,18300	0,18300	0,18300	0,85146	0,85146	0,85146	0,85146	0,00099
Ethane	0,05431	0,13808	0,13813	0,05171	0,17617	0,17617	0,17617	0,13603	0,13603	0,13603	0,13603	0,18725
Propane	0,02601	0,17713	0,17685	0,02132	0,26260	0,26260	0,26260	0,01249	0,01249	0,01249	0,01249	0,33070
i-Butane	0,00339	0,04059	0,04060	0,00223	0,06656	0,06656	0,06656	0	0	0	0	0,08471
n-Butane	0,00589	0,08610	0,08612	0,00340	0,14902	0,14902	0,14902	0	0	0	0	0,18963
i-Pentane	0,00109	0,02265	0,02265	0,00042	0,04715	0,04715	0,04715	0	0	0	0	0,05999
n-Pentane	0,00092	0,02129	0,02129	0,00029	0,04871	0,04871	0,04871	0	0	0	0	0,06195
n-Hexane	0,00030	0,00852	0,00851	0,00004	0,03195	0,03195	0,03195	0	0	0	0	0,04059
n-Heptane	0,00008	0,00256	0,00255	0	0,01913	0,01913	0,01913	0	0	0	0	0,02426
n-Octane	0,00001	0,00039	0,00039	0	0,00671	0,00671	0,00671	0	0	0	0	0,00850
n-Nonane	0	0,00003	0,00003	0	0,00132	0,00132	0,00132	0	0	0	0	0,00167
Benzene	0,00004	0,00120	0,00119	0,00001	0,00480	0,00480	0,00480	0	0	0	0	0,00610
Toluene	0,00001	0,00025	0,00025	0	0,00212	0,00212	0,00212	0	0	0	0	0,00269
m-Xylene	0	0,00002	0,00002	0	0,00045	0,00045	0,00045	0	0	0	0	0,00058
n-Decane	0	0	0	0	0,00022	0,00022	0,00022	0	0	0	0	0,00028
n-C11	0	0	0	0	0	0,00007	0,00007	0	0	0	0	0,00008
n-C12	0	0	0	0	0	0,00002	0,00002	0	0	0	0	0,00003
n-C13	0	0	0	0	0	0,00001	0,00001	0	0	0	0	0,00001
n-C14	0	0	0	0	0	0	0	0	0	0	0	0
n-C15	0	0	0	0	0	0	0	0	0	0	0	0
n-C16	0	0	0	0	0	0	0	0	0	0	0	0
n-C17	0	0	0	0	0	0	0	0	0	0	0	0
n-C18	0	0	0	0	0	0	0	0	0	0	0	0
n-C19	0	0	0	0	0	0	0	0	0	0	0	0
n-C20	0	0	0	0	0	0	0	0	0	0	0	0
H2S	0	0	0	0	0	0	0	0	0	0	0	0
Phenol	0	0	0	0	0	0	0	0	0	0	0	0
Helium	0	0	0	0	0	0	0	0	0	0	0	0

	9.1	9.2	9.3	10.1	10.2	10.3	11.1	11.2	11.3	11.4
Nitrogen	0,00368	0,00368	0,00368	0,00888	0,00888	0,00888	0,00030	0,00030	0,00030	0,00030
CO2	0,04808	0,04808	0,04808	0,08884	0,08884	0,08884	0,02150	0,02150	0,02150	0,02150
Methane	0,31276	0,31276	0,31276	0,68908	0,68908	0,68908	0,06748	0,06748	0,06748	0,06748
Ethane	0,07480	0,07480	0,07480	0,10976	0,10976	0,10976	0,05201	0,05201	0,05201	0,05201
Propane	0,08888	0,08888	0,08888	0,06717	0,06717	0,06717	0,10302	0,10302	0,10302	0,10302
i-Butane	0,02313	0,02313	0,02313	0,00890	0,00890	0,00890	0,03240	0,03240	0,03240	0,03240
n-Butane	0,05703	0,05703	0,05703	0,01667	0,01667	0,01667	0,08333	0,08333	0,08333	0,08333
i-Pentane	0,02725	0,02725	0,02725	0,00364	0,00364	0,00364	0,04264	0,04264	0,04264	0,04264
n-Pentane	0,03285	0,03285	0,03285	0,00341	0,00341	0,00341	0,05203	0,05203	0,05203	0,05203
n-Hexane	0,04867	0,04867	0,04867	0,00176	0,00176	0,00176	0,07924	0,07924	0,07924	0,07924
n-Heptane	0,07470	0,07470	0,07470	0,00096	0,00096	0,00096	0,12276	0,12276	0,12276	0,12276
n-Octane	0,07111	0,07111	0,07111	0,00033	0,00033	0,00033	0,11725	0,11725	0,11725	0,11725
n-Nonane	0,03714	0,03714	0,03714	0,00006	0,00006	0,00006	0,06131	0,06131	0,06131	0,06131
Benzene	0,00845	0,00845	0,00845	0,00029	0,00029	0,00029	0,01376	0,01376	0,01376	0,01376
Toluene	0,01034	0,01034	0,01034	0,00012	0,00012	0,00012	0,01700	0,01700	0,01700	0,01700
m-Xylene	0,00719	0,00719	0,00719	0,00003	0,00003	0,00003	0,01185	0,01185	0,01185	0,01185
n-Decane	0,01533	0,01533	0,01533	0,00001	0,00001	0,00001	0,02532	0,02532	0,02532	0,02532
n-C11	0,01215	0,01215	0,01215	0	0	0	0,02008	0,02008	0,02008	0,02008
n-C12	0,00966	0,00966	0,00966	0	0	0	0,01595	0,01595	0,01595	0,01595
n-C13	0,00764	0,00764	0,00764	0	0	0	0,01262	0,01262	0,01262	0,01262
n-C14	0,00609	0,00609	0,00609	0	0	0	0,01005	0,01005	0,01005	0,01005
n-C15	0,00537	0,00537	0,00537	0	0	0	0,00887	0,00887	0,00887	0,00887
n-C16	0,00322	0,00322	0,00322	0	0	0	0,00531	0,00531	0,00531	0,00531
n-C17	0,00322	0,00322	0,00322	0	0	0	0,00531	0,00531	0,00531	0,00531
n-C18	0,00215	0,00215	0,00215	0	0	0	0,00356	0,00356	0,00356	0,00356
n-C19	0,00155	0,00155	0,00155	0	0	0	0,00257	0,00257	0,00257	0,00257
n-C20	0,00752	0,00752	0,00752	0	0	0	0,01242	0,01242	0,01242	0,01242
H2S	0,00001	0,00001	0,00001	0,00001	0,00001	0,00001	0,00001	0,00001	0,00001	0,00001
Phenol	0,00002	0,00002	0,00002	0	0	0	0,00004	0,00004	0,00004	0,00004
Helium	0,00003	0,00003	0,00003	0,00007	0	0	0	0	0	0

	12.1	13.1	13.2	13.3	13.4	13.5	14.1	15.1	15.2	15.3
Nitrogen	0,00579	0,0	0	0	0	0	0,00527	0,00527	0,00527	0,00527
CO2	0,07668	0,0	0	0	0	0	0,06972	0,06979	0,06979	0,06979
Methane	0,49587	0,0	0	0	0	0	0,52814	0,52871	0,52871	0,52871
Ethane	0,12152	0,0	0	0	0	0	0,12284	0,12295	0,12295	0,12295
Propane	0,14889	0,00187	0,0019	0,00187	0,00187	0,00187	0,13651	0,13658	0,13658	0,13658
i-Butane	0,03036	0,01543	0,0154	0,01543	0,01543	0,01543	0,02761	0,02760	0,02760	0,02760
n-Butane	0,05948	0,06205	0,0621	0,06205	0,06205	0,06205	0,05408	0,05405	0,05405	0,05405
i-Pentane	0,01520	0,04982	0,0498	0,04982	0,04982	0,04982	0,01382	0,01379	0,01379	0,01379
n-Pentane	0,01586	0,06386	0,0639	0,06386	0,06386	0,06386	0,01442	0,01437	0,01437	0,01437
n-Hexane	0,01175	0,11125	0,1112	0,11125	0,11125	0,11125	0,01068	0,01059	0,01059	0,01059
n-Heptane	0,00917	0,18093	0,1809	0,18093	0,18093	0,18093	0,00833	0,00816	0,00816	0,00816
n-Octane	0,00442	0,17569	0,1757	0,17569	0,17569	0,17569	0,00402	0,00383	0,00383	0,00383
n-Nonane	0,00117	0,09232	0,0923	0,09232	0,09232	0,09232	0,00106	0,00096	0,00096	0,00096
Benzene	0,00194	0,01945	0,0194	0,01945	0,01945	0,01945	0,00176	0,00174	0,00174	0,00174
Toluene	0,00115	0,02517	0,0252	0,02517	0,02517	0,02517	0,00104	0,00102	0,00102	0,00102
m-Xylene	0,00036	0,01780	0,0178	0,01780	0,01780	0,01780	0,00033	0,00031	0,00031	0,00031
n-Decane	0,00024	0,03818	0,0382	0,03818	0,03818	0,03818	0,00021	0,00017	0,00017	0,00017
n-C11	0,00008	0,03030	0,0303	0,03030	0,03030	0,03030	0,00007	0,00005	0,00005	0,00005
n-C12	0,00001	0,02409	0,0241	0,02409	0,02409	0,02409	0,00001	0	0	0
n-C13	0	0,01907	0,0191	0,01907	0,01907	0,01907	0	0	0	0
n-C14	0	0,01519	0,0152	0,01519	0,01519	0,01519	0	0	0	0
n-C15	0	0,01340	0,0134	0,01340	0,01340	0,01340	0	0	0	0
n-C16	0	0,00803	0,0080	0,00803	0,00803	0,00803	0	0	0	0
n-C17	0	0,00803	0,0080	0,00803	0,00803	0,00803	0	0	0	0
n-C18	0	0,00537	0,0054	0,00537	0,00537	0,00537	0	0	0	0
n-C19	0	0,00388	0,0039	0,00388	0,00388	0,00388	0	0	0	0
n-C20	0	0,01878	0,0188	0,01878	0,01878	0,01878	0	0	0	0
H2S	0,00002	0	0	0	0	0	0,00001	0,00001	0,00001	0,00001
Phenol	0	0,00006	0,0001	0,00006	0,00006	0,00006	0	0	0	0
Helium	0,00004	0	0	0	0	0	0,00004	0,00004	0,00004	0,00004

	To VE-13-101	16.1	16.2	17.1	17.2
Nitrogen	0,00014	0,00556	0,00556	0,00046	0,00046
CO2	0,00861	0,07257	0,07257	0,02308	0,02308
Methane	0,03415	0,55414	0,55414	0,10205	0,10205
Ethane	0,02806	0,12599	0,12599	0,07196	0,07196
Propane	0,07991	0,13416	0,13416	0,17703	0,17704
i-Butane	0,03251	0,02555	0,02555	0,06211	0,06211
n-Butane	0,08167	0,04847	0,04847	0,14775	0,14775
i-Pentane	0,04172	0,01096	0,01096	0,06129	0,06129
n-Pentane	0,05277	0,01090	0,01090	0,07263	0,07263
n-Hexane	0,09201	0,00607	0,00607	0,08629	0,08629
n-Heptane	0,16199	0,00315	0,00315	0,09222	0,09222
n-Octane	0,17175	0,00089	0,00089	0,05316	0,05316
n-Nonane	0,09417	0,00013	0,00013	0,01489	0,01489
Benzene	0,01642	0,00097	0,00097	0,01478	0,01478
Toluene	0,02286	0,00036	0,00036	0,01201	0,01201
m-Xylene	0,01801	0,00006	0,00006	0,00451	0,00451
n-Decane	0,03650	0,00001	0,00001	0,00287	0,00287
n-C11	0,02096	0	0	0,00078	0,00078
n-C12	0,00554	0	0	0,00011	0,00011
n-C13	0,00018	0	0	0	0
n-C14	0	0	0	0	0
n-C15	0	0	0	0	0
n-C16	0	0	0	0	0
n-C17	0	0	0	0	0
n-C18	0	0	0	0	0
n-C19	0	0	0	0	0
n-C20	0	0	0	0	0
H2S	0	0,00002	0,00002	0,00001	0,00001
Phenol	0,00007	0	0	0,00001	0,00001
Helium	0	0,00004	0,00004	0	0

Appendix C.10 Mass Balance (kg/h) Modification of Existing Stabilizer II Case C

	Feed Gas	1.1	1.2	1.3	2.1	CO2/H2S	3.1	3.2	4.1	4.2	4.3	4.4	LNG	5.1	5.2	5.3	6.1	6.2	6.3	6.4	7.1
Nitrogen	24 399,08	24 096,79	24 096,79	24 096,79	24 399,13	0	24 399,13	24 399,13	24 548,76	24 548,76	149,70	149,69	24 399,06	0,06	0,06	0,06	0,06	0,06	0,06	0,06	0
CO2	80 170,73	73 971,40	73 971,40	73 971,40	80 169,85	80 170,73	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Methane	448 962,26	434 260,49	434 260,49	434 260,49	451 513,21	0	451 513,21	451 513,21	456 674,28	456 674,28	7 729,18	7 728,10	448 945,10	2 567,03	2 567,03	2 567,03	2 552,22	2 552,22	2 552,22	2 552,22	10,85
Ethane	52 623,57	46 033,50	46 033,50	46 033,50	53 385,78	0	53 385,78	53 385,78	52 788,67	52 788,67	4 035,79	4 034,77	48 752,88	4 631,88	4 631,88	4 631,88	764,28	764,28	764,28	764,28	3 864,61
Propane	39 625,64	28 142,19	28 142,19	28 142,19	39 623,83	0	39 623,83	39 623,83	37 074,05	37 074,05	7 592,23	7 575,52	29 481,82	10 125,29	10 125,29	10 125,29	102,91	102,91	102,91	102,91	10 009,22
i-Butane	8 510,90	4 572,33	4 572,33	4 572,33	7 453,95	0	7 453,95	7 453,95	6 363,96	6 363,96	2 298,30	2 292,61	4 070,66	3 382,59	3 382,59	3 382,59	0,04	0,04	0,04	0,04	3 379,26
n-Butane	18 019,73	8 307,64	8 307,64	8 307,64	13 774,89	0	13 774,89	13 774,89	11 064,14	11 064,14	4 864,33	4 862,66	6 199,81	7 573,42	7 573,42	7 573,42	0	0	0	0	7 565,33
i-Pentane	8 145,46	2 384,08	2 384,08	2 384,08	3 918,97	0	3 918,97	3 918,97	2 531,68	2 531,68	1 588,32	1 587,56	943,36	2 974,85	2 974,85	2 974,85	0	0	0	0	2 970,68
n-Pentane	9 154,16	2 209,97	2 209,97	2 209,97	3 736,53	0	3 736,53	3 736,53	2 155,40	2 155,40	1 492,88	1 491,91	662,52	3 073,04	3 073,04	3 073,04	0	0	0	0	3 068,12
n-Hexane	13 796,37	1 508,24	1 508,24	1 508,24	2 524,13	0	2 524,13	2 524,13	829,35	829,35	713,60	712,50	115,75	2 407,27	2 407,27	2 407,27	0	0	0	0	2 400,69
n-Heptane	23 011,42	1 080,05	1 080,05	1 080,05	1 691,99	0	1 691,99	1 691,99	264,49	264,49	249,08	248,38	15,41	1 675,88	1 675,88	1 675,88	0	0	0	0	1 668,71
n-Octane	24 275,39	474,01	474,01	474,01	671,42	0	671,42	671,42	44,65	44,65	43,61	43,43	1,04	670,20	670,20	670,20	0	0	0	0	666,31
n-Nonane	14 075,29	116,99	116,99	116,99	148,27	0	148,27	148,27	4,15	4,15	4,11	4,09	0,04	148,21	148,21	148,21	0	0	0	0	147,21
Benzene	2 129,29	196,51	196,51	196,51	343,00	0	343,00	343,00	105,74	105,74	90,77	90,59	14,97	327,85	327,85	327,85	0	0	0	0	326,85
Toluene	2 899,19	107,68	107,68	107,68	172,40	0	172,40	172,40	24,04	24,04	22,59	22,50	1,45	170,86	170,86	170,86	0	0	0	0	170,04
m-Xylene	2 265,43	29,95	29,95	29,95	42,27	0	42,27	42,27	2,11	2,11	2,07	2,06	0,04	42,21	42,21	42,21	0	0	0	0	41,93
n-Decane	6 416,31	23,61	23,61	23,61	27,07	0	27,07	27,07	0,33	0,33	0,32	0,32	0	27,07	27,07	27,07	0	0	0	0	26,89
n-C11	5 575,59	8,57	8,57	8,57	9,09	0	9,09	9,09	0,04	0,04	0,04	0,04	0	9,09	9,09	9,09	0	0	0	0	9,05
n-C12	4 822,51	3,66	3,66	3,66	3,70	0	3,70	3,70	0,01	0,01	0,01	0,01	0	3,70	3,70	3,70	0	0	0	0	3,69
n-C13	4 127,92	1,19	1,19	1,19	1,19	0	1,19	1,19	0	0	0	0	0	1,19	1,19	1,19	0	0	0	0	1,19
n-C14	3 538,04	0,38	0,38	0,38	0,38	0	0,38	0,38	0	0	0	0	0	0,38	0,38	0,38	0	0	0	0	0,38
n-C15	3 341,71	0,20	0,20	0,20	0,20	0	0,20	0,20	0	0	0	0	0	0,20	0,20	0,20	0	0	0	0	0,20
n-C16	2 134,18	0,06	0,06	0,06	0,06	0	0,06	0,06	0	0	0	0	0	0,06	0,06	0,06	0	0	0	0	0,06
n-C17	2 266,40	0,04	0,04	0,04	0,04	0	0,04	0,04	0	0	0	0	0	0,04	0,04	0,04	0	0	0	0	0,04
n-C18	1 604,99	0,02	0,02	0,02	0,02	0	0,02	0,02	0	0	0	0	0	0,02	0,02	0,02	0	0	0	0	0,02
n-C19	1 223,07	0,01	0,01	0,01	0,01	0	0,01	0,01	0	0	0	0	0	0,01	0,01	0,01	0	0	0	0	0,01
n-C20	6 226,99	0,01	0,01	0,01	0,01	0	0,01	0,01	0	0	0	0	0	0,01	0,01	0,01	0	0	0	0	0,01
H2S	5,97	4,97	4,97	4,97	5,97	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0,00
Phenol	6,60	0,03	0,03	0,03	0,05	0	0,05	0,05	0	0	0	0	0	0,05	0,05	0,05	0	0	0	0	0,05
Helium	28,05	27,72	27,72	27,72	28,05	0	28,05	28,05	28,13	28,13	0,08	0,08	28,05	0	0	0	0	0	0	0	0
Total	813 382,24	627 562,29	627 562,29	627 562,29	683 645,45	80 176,70	603 469,64	603 469,64	594 504,00	594 504,00	30 872,04	30 846,82	563 631,96	39 812,46	39 812,46	39 812,46	3 419,51	3 419,51	3 419,51	3 419,51	36 331,41

	9.1	9.2	9.3	10.1	10.2	10.3	11.1	11.2	11.3	11.4	12.1	13.1	13.2	13.3	13.4	13.5	14.1	15.1	15.2	15.3	To VE-13-101	16.1	16.2	17.1	17.2
Nitrogen	302,29	302,29	302,29	287,47	287,47	287,47	14,82	14,82	14,82	14,82	303,77	0	0,00	0,00	0,00	0,00	303,83	303,82	303,82	303,82	0,01	302,34	302,34	1,48	1,48
CO2	6 199,33	6 199,33	6 199,33	4 520,58	4 520,58	4 520,58	1 678,75	1 678,75	1 678,75	1 678,75	6 316,87	0	0,00	0,00	0,00	0,00	6 316,87	6 315,97	6 315,97	6 315,97	0,89	6 198,45	6 198,45	117,52	117,53
Methane	14 701,77	14 701,77	14 701,77	12 781,58	12 781,58	12 781,58	1 920,19	1 920,19	1 920,19	1 920,19	14 891,18	0	0,00	0,00	0,00	0,00	17 443,40	17 442,11	17 442,11	17 442,11	1,29	17 252,72	17 252,72	189,39	189,41
Ethane	6 590,07	6 590,07	6 590,07	3 815,97	3 815,97	3 815,97	2 774,10	2 774,10	2 774,10	2 774,10	6 840,30	0,10	0,10	0,10	0,10	0,10	7 604,58	7 602,59	7 602,59	7 602,59	1,99	7 352,27	7 352,27	250,32	250,34
Propane	11 483,45	11 483,45	11 483,45	3 424,83	3 424,83	3 424,83	8 058,62	8 058,62	8 058,62	8 058,62	12 290,07	96,55	96,55	96,55	96,55	96,55	12 392,98	12 384,66	12 384,66	12 384,66	8,32	11 481,64	11 481,64	903,02	903,17
i-Butane	3 938,57	3 938,57	3 938,57	597,95	597,95	597,95	3 340,62	3 340,62	3 340,62	3 340,62	3 303,62	1 052,57	1 052,57	1 052,57	1 052,57	1 052,57	3 303,66	3 299,20	3 299,20	3 299,20	4,46	2 881,62	2 881,62	417,58	417,63
n-Butane	9 712,09	9 712,09	9 712,09	1 120,50	1 120,50	1 120,50	8 591,59	8 591,59	8 591,59	8 591,59	6 471,89	4 233,75	4 233,75	4 233,75	4 233,75	4 233,75	6 471,90	6 460,69	6 460,69	6 460,69	11,20	5 467,26	5 467,26	993,44	993,55
i-Pentane	5 761,37	5 761,37	5 761,37	303,60	303,60	303,60	5 457,78	5 457,78	5 457,78	5 457,78	2 053,55	4 219,44	4 219,44	4 219,44	4 219,44	4 219,44	2 053,55	2 046,44	2 046,44	2 046,44	7,10	1 534,88	1 534,88	511,56	511,61
n-Pentane	6 944,19	6 944,19	6 944,19	284,54	284,54	284,54	6 659,65	6 659,65	6 659,65	6 659,65	2 141,77	5 408,70	5 408,70	5 408,70	5 408,70	5 408,70	2 141,77	2 132,79	2 132,79	2 132,79	8,98	1 526,56	1 526,56	606,22	606,28
n-Hexane	12 288,13	12 288,13	12 288,13	175,40	175,40	175,40	12 112,72	12 112,72	12 112,72	12 112,72	1 894,81	11 253,60	11 253,60	11 253,60	11 253,60	11 253,60	1 894,81	1 876,09	1 876,09	1 876,09	18,71	1 015,89	1 015,89	860,20	860,28
n-Heptane	21 931,37	21 931,37	21 931,37	111,34	111,34	111,34	21 820,04	21 820,04	21 820,04	21 820,04	1 719,20	21 281,21	21 281,21	21 281,21	21 281,21	21 281,21	1 719,20	1 680,89	1 680,89	1 680,89	38,31	611,94	611,94	1 068,95	1 069,03
n-Octane	23 801,38	23 801,38	23 801,38	43,07	43,07	43,07	23 758,31	23 758,31	23 758,31	23 758,31	946,15	23 557,72	23 557,72	23 557,72	23 557,72	23 557,72	946,15	899,84	899,84	899,84	46,30	197,41	197,41	702,43	702,48
n-Nonane	13 958,30	13 958,30	13 958,30	9,36	9,36	9,36	13 948,94	13 948,94	13 948,94	13 948,94	280,66	13 898,53	13 898,53	13 898,53	13 898,53	13 898,53	280,66	252,15	252,15	252,15	28,50	31,28	31,28	220,87	220,89
Benzene	1 932,78	1 932,78	1 932,78	26,37	26,37	26,37	1 906,41	1 906,41	1 906,41	1 906,41	283,10	1 783,27	1 783,27	1 783,27	1 783,27	1 783,27	283,10	280,07	280,07	280,07	3,08	146,49	146,49	133,59	133,60
Toluene	2 791,51	2 791,51	2 791,51	12,82	12,82	12,82	2 778,69	2 778,69	2 778,69	2 778,69	197,73	2 721,83	2 721,83	2 721,83	2 721,83	2 721,83	197,73	192,76	192,76	192,76	4,97	64,72	64,72	128,04	128,05
m-Xylene	2 235,48	2 235,48	2 235,48	3,11	3,11	3,11	2 232,37	2 232,37	2 232,37	2 232,37	72,25	2 218,65	2 218,65	2 218,65	2 218,65	2 218,65	72,25	67,74	67,74	67,74	4,51	12,32	12,32	55,42	55,42
n-Decane	6 392,70	6 392,70	6 392,70	1,64	1,64	1,64	6 391,06	6 391,06	6 391,06	6 391,06	62,90	6 376,99	6 376,99	6 376,99	6 376,99	6 376,99	62,90	50,65	50,65	50,65	12,26	3,46	3,46	47,19	47,19
n-C11	5 567,02	5 567,02	5 567,02	0,52	0,52	0,52	5 566,49	5 566,49	5 566,49	5 566,49	22,37	5 558,76	5 558,76	5 558,76	5 558,76	5 558,76	22,37	14,63	14,63	14,63	7,73	0,52	0,52	14,11	14,11
n-C12	4 818,85	4 818,85	4 818,85	0,19	0,19	0,19	4 818,66	4 818,66	4 818,66	4 818,66	4,35	4 816,58	4 816,58	4 816,58	4 816,58	4 816,58	4,35	2,13	2,13	2,13	2,23	0,04	0,04	2,08	2,08
n-C13	4 126,73	4 126,73	4 126,73	0,06	0,06	0,06	4 126,68	4 126,68	4 126,68	4 126,68	0,11	4 126,65	4 126,65	4 126,65	4 126,65	4 126,65	0,11	0,03	0,03	0,03	0,08	0,0	0,0	0,03	0,03
n-C14	3 537,67	3 537,67	3 537,67	0,02	0,02	0,02	3 537,65	3 537,65	3 537,65	3 537,65	0	3 537,67	3 537,67	3 537,67	3 537,67	3 537,67	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
n-C15	3 341,51	3 341,51	3 341,51	0,01	0,01	0,01	3 341,50	3 341,50	3 341,50	3 341,50	0	3 341,51	3 341,51	3 341,51	3 341,51	3 341,51	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
n-C16	2 134,13	2 134,13	2 134,13	0	0	0	2 134,13	2 134,13	2 134,13	2 134,13	0	2 134,13	2 134,13	2 134,13	2 134,13	2 134,13	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
n-C17	2 266,36	2 266,36	2 266,36	0	0	0	2 266,36	2 266,36	2 266,36	2 266,36	0	2 266,36	2 266,36	2 266,36	2 266,36	2 266,36	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
n-C18	1 604,97	1 604,97	1 604,97	0	0	0	1 604,97	1 604,97	1 604,97	1 604,97	0	1 604,97	1 604,97	1 604,97	1 604,97	1 604,97	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
n-C19	1 223,06	1 223,06	1 223,06	0	0	0	1 223,06	1 223,06	1 223,06	1 223,06	0	1 223,06	1 223,06	1 223,06	1 223,06	1 223,06	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
n-C20	6 226,98	6 226,98	6 226,98	0	0	0	6 226,98	6 226,98	6 226,98	6 226,98	0	6 226,98	6 226,98	6 226,98	6 226,98	6 226,98	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
H2S	1,00	1,00	1,00	0,51	0,51	0,51	0,49	0,49	0,49	0,49	1,04	0	0,00	0,00	0,00	0,00	1,04	1,04	1,04	1,04	0,0	1,00	1,00	0,04	0,04
Phenol	6,56	6,56	6,56	0	0	0	6,56	6,56	6,56	6,56	0,14	6,54	6,54	6,54	6,54	6,54	0,14	0,12	0,12	0,12	0,01	0,01	0,01	0,11	0,11
Helium	0,33	0,33	0,33	0,32	0,32	0,32	0,02	0,02	0,02	0,02	0,33	0,0	0,0	0,0	0,0	0,0	0,33	0,33	0,33	0,33	0,00	0,33	0,33	0,0	0,0
Total	185 819,95	185 819,95	185 819,95	27 521,76	27 521,76	27 521,76	158 298,19	158 298,19	158 298,19	158 298,19	60 098,15	132 946,11	132 946,11	132 946,11	132 946,11	132 946,11	63 517,66	63 306,76	63 306,76	63 306,76	210,90	56 083,17	56 083,17	7 223,60	7 224,31

Appendix D.1 Simulation Model New Stabilizer with Reflux

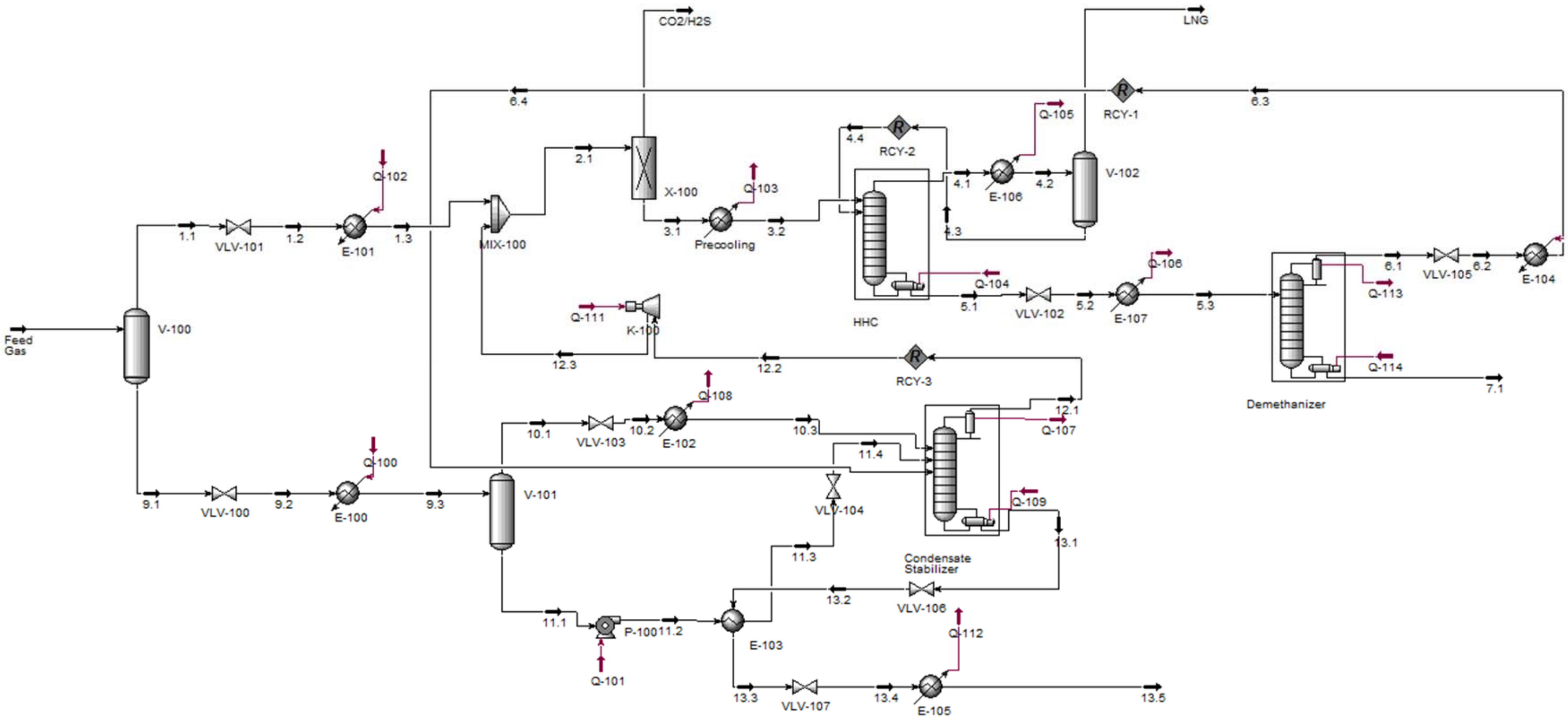

Figure 4 Simulation Model

Appendix D.2 Heat Balance New Stablizer with Reflux Case A

	Feed Gas	1.1	1.2	1.3	2.1	CO2/H2S	3.1	3.2	4.1	4.2	4.3	4.4	LNG	5.1	5.2	5.3
Vapor	0,9223	1,00	1,00	1,00	1,00	1,00	1,00	0,9946	1,00	0,9706	0,00	0,00	1,00	0,0003	0,3305	0,00
Temperature C	-1,00	-1,00	-6,62	9,98	15,40	21,98	17,25	-17,41	-17,51	-37,51	-37,51	-37,51	-37,51	77,73	63,38	-5,52
Pressure kPa	7 000,00	7 000,00	6 000,00	6 000,00	6 000,00	6 000,00	6 000,00	6 000,00	6 000,00	6 000,00	6 000,00	6 000,00	6 000,00	6 000,00	3 420,00	3 420,00
Molar Flow kgmol/h	35 243,33	32 504,02	32 504,02	32 504,02	34 060,77	1 833,26	32 227,50	32 227,50	32 548,98	32 548,98	958,49	958,73	31 590,49	637,24	637,24	637,24
Mass Flow kg/h	813 382,24	634 189,17	634 189,17	634 189,17	676 621,30	80 679,64	595 941,40	595 941,40	597 184,63	597 184,63	29 566,00	29 571,89	567 618,63	28 328,66	28 328,66	28 328,66
Std Ideal Liq Vol Flow m3/h	2 095,85	1 810,59	1 810,59	1 810,59	1 912,90	97,75	1 815,14	1 815,14	1 828,17	1 828,17	69,35	69,37	1 758,82	56,34	56,34	56,34
Molar enthalpy KJ/kgmol	-98 460,63	-94 034,25	-94 034,25	-93 190,99	-93 888,91	-398 093,73	-76 584,14	-78 413,17	-78 227,96	-79 591,79	-105 361,70	-105 359,71	-78 809,90	-111 852,88	-111 852,88	-122 486,39
Molar Entropy KJ/kgmoleC	140,35	143,60	144,58	147,65	148,66	127,08	148,11	141,39	141,65	136,08	103,81	103,81	137,06	128,93	130,24	95,36
Heat Flow KJ/h *10^5	-34 700,80	-30 564,92	-30 564,92	-30 290,82	-31 979,28	-7 298,11	-24 681,15	-25 270,60	-25 462,40	-25 906,32	-1 009,88	-1 010,11	-24 896,43	-712,77	-712,77	-780,53
HHV MJ/m3	44,69	38,19	38,19	38,19	38,83		41,03	41,03	40,75	40,75	67,49	67,48	39,95	95,96	95,96	95,96
Mass Density kg/m3	0,9801	0,8273	0,8273	0,8273	0,8424	1,8717	0,7841	0,7841	0,7779	0,7779	1,3160	1,3160	0,7618	1,9179	1,9179	1,9179

	6.1	6.2	6.3	6.4	7.1	9.1	9.2	9.3	10.1	10.2	10.3	11.1	11.2	11.3	11.4
Vapor	1,00	0,9856	1,00	1,00	0,00	0,00	0,2803	0,3683	1,00	1,00	1,00	0,00	0,00	0,1117	0,1168
Temperature C	-49,04	-66,85	-5,85	-5,85	69,87	-1,00	-10,71	29,49	29,49	26,51	37,72	29,49	29,56	113,63	113,40
Pressure kPa	3 420,00	1 520,00	1 520,00	1 520,00	3 420,00	7 000,00	2 000,00	1 950,00	1 950,00	1 520,00	1 520,00	1 950,00	2 100,00	2 100,00	2 043,00
Molar Flow kgmol/h	89,18	89,18	89,18	89,18	548,06	2 739,31	2 739,31	2 739,31	1 008,87	1 008,87	1 008,87	1 730,43	1 730,43	1 730,43	1 730,43
Mass Flow kg/h	1 639,86	1 639,86	1 639,86	1 639,86	26 688,80	179 193,07	179 193,07	179 193,07	24 090,59	24 090,59	24 090,59	155 102,48	155 102,48	155 102,48	155 102,48
Std Ideal Liq Vol Flow m3/h	5,21	5,21	5,21	5,21	51,13	285,25	285,25	285,25	61,47	61,47	61,47	223,79	223,79	223,79	223,79
Molar enthalpy KJ/kgmol	-80 863,26	-80 863,26	-78 244,83	-78 244,83	-119 077,44	-150 983,05	-150 983,05	-144 870,00	-109 304,01	-109 304,01	-108 787,62	-165 605,65	-165 580,06	-147 433,27	-147 433,27
Molar Entropy KJ/kgmoleC	144,60	149,97	161,19	161,19	119,88	101,81	105,08	126,81	164,36	166,29	167,98	104,91	104,93	157,55	157,59
Heat Flow KJ/h *10^5	-72,12	-72,12	-69,78	-69,78	-652,61	-4 135,89	-4 135,89	-3 968,43	-1 102,74	-1 102,74	-1 097,53	-2 865,69	-2 865,25	-2 551,23	-2 551,23
HHV MJ/m3	42,56	42,56	42,56	42,56	104,98	126,79	126,79	126,79	44,31	44,31	44,31	183,15	183,15	183,15	183,15
Mass Density kg/m3	0,7798	0,7798	0,7798	0,7798	2,1100	2,9101	2,9101	2,9101	1,0141	1,0141	1,0141	4,2055	4,2055	4,2055	4,2055

	12.1	12.2	12.3	13.1	13.2	13.3	13.4	13.5
Vapor	1,00	1,00	1,00	0,00	0,0513	0,00	0,00	0,00
Temperature C	2,41	2,45	103,49	209,75	207,02	126,38	126,40	17,40
Pressure kPa	1 520,00	1 520,00	6 000,00	1 520,00	1 400,00	1 400,00	1 300,00	1 300,00
Molar Flow kgmol/h	1 560,14	1 556,74	1 556,74	1 268,35	1 268,35	1 268,35	1 268,35	1 268,35
Mass Flow kg/h	42 516,50	42 432,13	42 432,13	138 316,43	138 316,43	138 316,43	138 316,43	138 316,43
Std Ideal Liq Vol Flow m3/h	102,53	102,30	102,30	187,93	187,93	187,93	187,93	187,93
Molar enthalpy KJ/kgmol	-112 540,85	-112 600,08	-108 461,14	-129 021,59	-129 021,59	-153 779,52	-153 779,52	-180 081,88
Molar Entropy KJ/kgmoleC	161,54	161,55	164,35	217,44	217,51	161,38	161,42	85,04
Heat Flow KJ/h *10^5	-1 755,79	-1 752,89	-1 688,46	-1 636,45	-1 636,45	-1 950,47	-1 950,47	-2 284,07
HHV MJ/m3	52,16	52,15	52,15	235,38	235,38	235,38	235,38	235,38
Mass Density kg/m3	1,1592	1,1594	1,1594	5,4411	5,4411	5,4411	5,4411	5,4411
TVP @ 37,8°C psia								8,136

Appendix D.3 Mole Fraction New Stablizer with Reflux Case A

	Feed Gas	1.1	1.2	1.3	2.1	CO2/H2S	3.1	3.2	4.1	4.2	4.3	4.4	LNG	5.1	5.2	5.3	6.1	6.2	6.3	6.4	7.1
Nitrogen	0,02496	0,02679	0,02679	0,02679	0,02582	0	0,02729	0,02729	0,02719	0,02719	0,00572	0,00572	0,02784	0	0	0	0,00001	0,00001	0,00001	0,00001	0
CO2	0,05201	0,05232	0,05232	0,05232	0,05382	0,99990	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Methane	0,80070	0,84365	0,84365	0,84365	0,83065	0	0,87791	0,87791	0,88125	0,88125	0,50911	0,50914	0,89254	0,15253	0,15253	0,15253	0,84354	0,84354	0,84354	0,84354	0,04008
Ethane	0,04969	0,04775	0,04775	0,04775	0,05177	0	0,05472	0,05472	0,05426	0,05426	0,14028	0,14028	0,05165	0,20679	0,20679	0,20679	0,14577	0,14577	0,14577	0,14577	0,21672
Propane	0,02505	0,01984	0,01984	0,01984	0,02592	0	0,02739	0,02739	0,02655	0,02655	0,18285	0,18284	0,02181	0,30442	0,30442	0,30442	0,01067	0,01067	0,01067	0,01067	0,35222
i-Butane	0,00395	0,00237	0,00237	0,00237	0,00388	0	0,00410	0,00410	0,00381	0,00381	0,04612	0,04612	0,00252	0,08214	0,08214	0,08214	0	0	0	0	0,09551
n-Butane	0,00820	0,00421	0,00421	0,00421	0,00520	0	0,00549	0,00549	0,00495	0,00495	0,07319	0,07318	0,00288	0,13489	0,13489	0,13489	0	0	0	0	0,15684
i-Pentane	0,00278	0,00091	0,00091	0,00091	0,00087	0	0,00092	0,00092	0,00074	0,00074	0,01563	0,01563	0,00029	0,03215	0,03215	0,03215	0	0	0	0	0,03738
n-Pentane	0,00304	0,00082	0,00082	0,00082	0,00078	0	0,00083	0,00083	0,00062	0,00062	0,01454	0,01454	0,00020	0,03178	0,03178	0,03178	0	0	0	0	0,03696
n-Hexane	0,00348	0,00042	0,00042	0,00042	0,00040	0	0,00043	0,00043	0,00022	0,00022	0,00647	0,00647	0,00003	0,01987	0,01987	0,01987	0	0	0	0	0,02311
n-Heptane	0,00387	0,00020	0,00020	0,00020	0,00019	0	0,00020	0,00020	0,00006	0,00006	0,00191	0,00191	0	0,01015	0,01015	0,01015	0	0	0	0	0,01180
n-Octane	0,00313	0,00007	0,00007	0,00007	0,00007	0	0,00007	0,00007	0,00001	0,00001	0,00031	0,00031	0	0,00349	0,00349	0,00349	0	0	0	0	0,00406
n-Nonane	0,00140	0,00001	0,00001	0,00001	0,00001	0	0,00001	0,00001	0	0	0,00003	0,00003	0	0,00065	0,00065	0,00065	0	0	0	0	0,00076
Benzene	0,00077	0,00007	0,00007	0,00007	0,00007	0	0,00007	0,00007	0,00004	0,00004	0,00105	0,00105	0,00001	0,00351	0,00351	0,00351	0	0	0	0	0,00408
Toluene	0,00889	0,00033	0,00033	0,00033	0,00032	0	0,00034	0,00034	0,00009	0,00009	0,00273	0,00273	0	0,01680	0,01680	0,01680	0	0	0	0	0,01954
m-Xylene	0,00060	0,00001	0,00001	0,00001	0,00001	0	0,00001	0,00001	0	0	0,00003	0,00003	0	0,00041	0,00041	0,00041	0	0	0	0	0,00048
n-Decane	0,00139	0,00001	0,00001	0,00001	0,00001	0	0,00001	0,00001	0	0	0	0	0	0,00029	0,00029	0,00029	0	0	0	0	0,00034
n-C11	0,00062	0	0	0	0	0	0	0	0	0	0	0	0	0,00005	0,00005	0,00005	0	0	0	0	0,00006
n-C12	0,00061	0	0	0	0	0	0	0	0	0	0	0	0	0,00003	0,00003	0,00003	0	0	0	0	0,00003
n-C13	0,00048	0	0	0	0	0	0	0	0	0	0	0	0	0,00001	0,00001	0,00001	0	0	0	0	0,00001
n-C14	0,00326	0	0	0	0	0	0	0	0	0	0	0	0	0,00002	0,00002	0,00002	0	0	0	0	0,00002
n-C15	0,00025	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
n-C16	0,00015	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
n-C17	0,00015	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
n-C18	0,00010	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
n-C19	0,00007	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
n-C20	0,00017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
H2S	0	0	0	0	0,00001	0,00010	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Phenol	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Helium	0,00020	0,00021	0,00021	0,00021	0,00020	0	0,00022	0,00022	0,00021	0,00021	0,00002	0,00002	0,00022	0	0	0	0	0	0	0	0

	9.1	9.2	9.3	10.1	10.2	10.3	11.1	11.2	11.3	11.4	12.1	12.2	12.3	13.1	13.2	13.3	13.4	13.5
Nitrogen	0,00327	0,00327	0,00327	0,00845	0,00845	0,00845	0,00025	0,00025	0,00025	0,00025	0,00574	0,00576	0,00576	0	0	0	0	0
CO2	0,04836	0,04836	0,04836	0,09323	0,09323	0,09323	0,02221	0,02221	0,02221	0,02221	0,08492	0,08510	0,08510	0	0	0	0	0
Methane	0,29114	0,29114	0,29114	0,68455	0,68455	0,68455	0,06177	0,06177	0,06177	0,06177	0,55940	0,55940	0,55940	0	0	0	0	0
Ethane	0,07264	0,07264	0,07264	0,11148	0,11148	0,11148	0,05000	0,05000	0,05000	0,05000	0,13588	0,13569	0,13569	0	0	0	0	0
Propane	0,08679	0,08679	0,08679	0,06762	0,06762	0,06762	0,09796	0,09796	0,09796	0,09796	0,15298	0,15276	0,15276	0,00001	0,00001	0,00001	0,00001	0,00001
i-Butane	0,02277	0,02277	0,02277	0,00871	0,00871	0,00871	0,03097	0,03097	0,03097	0,03097	0,03527	0,03536	0,03536	0,00579	0,00579	0,00579	0,00579	0,00579
n-Butane	0,05564	0,05564	0,05564	0,01597	0,01597	0,01597	0,07877	0,07877	0,07877	0,07877	0,02572	0,02584	0,02584	0,08853	0,08853	0,08853	0,08853	0,08853
i-Pentane	0,02494	0,02494	0,02494	0,00326	0,00326	0,00326	0,03758	0,03758	0,03758	0,03758	0,00002	0,00002	0,00002	0,05384	0,05384	0,05384	0,05384	0,05384
n-Pentane	0,02946	0,02946	0,02946	0,00297	0,00297	0,00297	0,04491	0,04491	0,04491	0,04491	0	0	0	0,06363	0,06363	0,06363	0,06363	0,06363
n-Hexane	0,03976	0,03976	0,03976	0,00140	0,00140	0,00140	0,06214	0,06214	0,06214	0,06214	0	0	0	0,08588	0,08588	0,08588	0,08588	0,08588
n-Heptane	0,04733	0,04733	0,04733	0,00060	0,00060	0,00060	0,07457	0,07457	0,07457	0,07457	0	0	0	0,10221	0,10221	0,10221	0,10221	0,10221
n-Octane	0,03950	0,03950	0,03950	0,00018	0,00018	0,00018	0,06242	0,06242	0,06242	0,06242	0	0	0	0,08531	0,08531	0,08531	0,08531	0,08531
n-Nonane	0,01791	0,01791	0,01791	0,00003	0,00003	0,00003	0,02833	0,02833	0,02833	0,02833	0	0	0	0,03867	0,03867	0,03867	0,03867	0,03867
Benzene	0,00904	0,00904	0,00904	0,00028	0,00028	0,00028	0,01415	0,01415	0,01415	0,01415	0	0	0	0,01953	0,01953	0,01953	0,01953	0,01953
Toluene	0,11042	0,11042	0,11042	0,00115	0,00115	0,00115	0,17413	0,17413	0,17413	0,17413	0	0	0	0,23848	0,23848	0,23848	0,23848	0,23848
m-Xylene	0,00767	0,00767	0,00767	0,00002	0,00002	0,00002	0,01212	0,01212	0,01212	0,01212	0	0	0	0,01656	0,01656	0,01656	0,01656	0,01656
n-Decane	0,01786	0,01786	0,01786	0,00001	0,00001	0,00001	0,02827	0,02827	0,02827	0,02827	0	0	0	0,03858	0,03858	0,03858	0,03858	0,03858
n-C11	0,00800	0,00800	0,00800	0	0	0	0,01267	0,01267	0,01267	0,01267	0	0	0	0,01729	0,01729	0,01729	0,01729	0,01729
n-C12	0,00788	0,00788	0,00788	0	0	0	0,01248	0,01248	0,01248	0,01248	0	0	0	0,01703	0,01703	0,01703	0,01703	0,01703
n-C13	0,00623	0,00623	0,00623	0	0	0	0,00987	0,00987	0,00987	0,00987	0	0	0	0,01346	0,01346	0,01346	0,01346	0,01346
n-C14	0,04199	0,04199	0,04199	0	0	0	0,06647	0,06647	0,06647	0,06647	0	0	0	0,09068	0,09068	0,09068	0,09068	0,09068
n-C15	0,00318	0,00318	0,00318	0	0	0	0,00504	0,00504	0,00504	0,00504	0	0	0	0,00687	0,00687	0,00687	0,00687	0,00687
n-C16	0,00191	0,00191	0,00191	0	0	0	0,00302	0,00302	0,00302	0,00302	0	0	0	0,00412	0,00412	0,00412	0,00412	0,00412
n-C17	0,00191	0,00191	0,00191	0	0	0	0,00302	0,00302	0,00302	0,00302	0	0	0	0,00412	0,00412	0,00412	0,00412	0,00412
n-C18	0,00127	0,00127	0,00127	0	0	0	0,00201	0,00201	0,00201	0,00201	0	0	0	0,00275	0,00275	0,00275	0,00275	0,00275
n-C19	0,00089	0,00089	0,00089	0	0	0	0,00141	0,00141	0,00141	0,00141	0	0	0	0,00192	0,00192	0,00192	0,00192	0,00192
n-C20	0,00216	0,00216	0,00216	0	0	0	0,00342	0,00342	0,00342	0,00342	0	0	0	0,00467	0,00467	0,00467	0,00467	0,00467
H2S	0,00001	0,00001	0,00001	0,00001	0,00001	0,00001	0,00001	0,00001	0,00001	0,00001	0,00002	0,00002	0,00002	0	0	0	0	0
Phenol	0,00003	0,00003	0,00003	0	0	0	0,00004	0,00004	0,00004	0,00004	0,0	0,0	0,0	0,00005	0,00005	0,00005	0,00005	0,00005
Helium	0,00003	0,00003	0,00003	0,00007	0,00007	0,00007	0	0	0	0	0,00005	0,00005	0,00005	0	0	0	0	0

Appendix D.4 Mass Balance (kg/h) New Stablizer with Reflux Case A

	Feed Gas	1.1	1.2	1.3	2.1	CO2/H2S	3.1	3.2	4.1	4.2	4.3	4.4	LNG	5.1	5.2	5.3	6.1	6.2	6.3	6.4	7.1
Nitrogen	24 640,19	24 389,15	24 389,15	24 389,15	24 640,22	0,00	24 640,22	24 640,22	24 793,81	24 793,81	153,59	153,62	24 640,22	0,03	0,03	0,03	0,03	0,03	0,03	0,03	0,00
CO2	80 673,96	74 843,48	74 843,48	74 843,48	80 673,96	80 673,96	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Methane	452 721,11	439 926,66	439 926,66	439 926,66	453 897,56	0,00	453 897,56	453 897,56	460 169,21	460 169,21	7 828,58	7 830,97	452 340,64	1 559,31	1 559,31	1 559,31	1 206,90	1 206,90	1 206,90	1 206,90	352,41
Ethane	52 658,84	46 675,28	46 675,28	46 675,28	53 027,24	0,00	53 027,24	53 027,24	53 108,86	53 108,86	4 043,15	4 044,16	49 065,72	3 962,53	3 962,53	3 962,53	390,92	390,92	390,92	390,92	3 571,61
Propane	38 925,99	28 442,62	28 442,62	28 442,62	38 929,44	0,00	38 929,44	38 929,44	38 105,22	38 105,22	7 728,48	7 730,06	30 376,74	8 554,28	8 554,28	8 554,28	41,97	41,97	41,97	41,97	8 512,31
i-Butane	8 100,22	4 474,66	4 474,66	4 474,66	7 673,74	0,00	7 673,74	7 673,74	7 201,19	7 201,19	2 569,57	2 569,97	4 631,62	3 042,53	3 042,53	3 042,53	0,03	0,03	0,03	0,03	3 042,50
n-Butane	16 806,23	7 947,16	7 947,16	7 947,16	10 285,26	0,00	10 285,26	10 285,26	9 367,21	9 367,21	4 077,63	4 078,15	5 289,58	4 996,20	4 996,20	4 996,20	0,00	0,00	0,00	0,00	4 996,20
i-Pentane	7 062,16	2 133,05	2 133,05	2 133,05	2 135,08	0,00	2 135,08	2 135,08	1 737,94	1 737,94	1 081,11	1 081,17	656,83	1 478,30	1 478,30	1 478,30	0,00	0,00	0,00	0,00	1 478,30
n-Pentane	7 741,22	1 918,12	1 918,12	1 918,12	1 918,55	0,00	1 918,55	1 918,55	1 462,74	1 462,74	1 005,54	1 005,56	457,20	1 461,37	1 461,37	1 461,37	0,00	0,00	0,00	0,00	1 461,37
n-Hexane	10 567,93	1 180,73	1 180,73	1 180,73	1 180,73	0,00	1 180,73	1 180,73	623,63	623,63	534,26	534,21	89,37	1 091,31	1 091,31	1 091,31	0,00	0,00	0,00	0,00	1 091,31
n-Heptane	13 650,30	659,68	659,68	659,68	659,68	0,00	659,68	659,68	195,03	195,03	183,26	183,22	11,77	647,87	647,87	647,87	0,00	0,00	0,00	0,00	647,87
n-Octane	12 614,54	254,98	254,98	254,98	254,98	0,00	254,98	254,98	35,17	35,17	34,32	34,31	0,85	254,12	254,12	254,12	0,00	0,00	0,00	0,00	254,12
n-Nonane	6 344,08	53,26	53,26	53,26	53,26	0,00	53,26	53,26	3,16	3,16	3,13	3,13	0,03	53,23	53,23	53,23	0,00	0,00	0,00	0,00	53,23
Benzene	2 123,73	188,40	188,40	188,40	188,40	0,00	188,40	188,40	92,52	92,52	78,93	78,92	13,60	174,80	174,80	174,80	0,00	0,00	0,00	0,00	174,80
Toluene	28 874,20	1 003,21	1 003,21	1 003,21	1 003,21	0,00	1 003,21	1 003,21	257,41	257,41	240,91	240,90	16,50	986,69	986,69	986,69	0,00	0,00	0,00	0,00	986,69
m-Xylene	2 257,43	27,87	27,87	27,87	27,87	0,00	27,87	27,87	2,76	2,76	2,70	2,70	0,06	27,81	27,81	27,81	0,00	0,00	0,00	0,00	27,81
n-Decane	6 988,25	26,49	26,49	26,49	26,49	0,00	26,49	26,49	0,69	0,69	0,69	0,69	0,00	26,48	26,48	26,48	0,00	0,00	0,00	0,00	26,48
n-C11	3 432,68	5,34	5,34	5,34	5,34	0,00	5,34	5,34	0,06	0,06	0,06	0,06	0,00	5,34	5,34	5,34	0,00	0,00	0,00	0,00	5,34
n-C12	3 681,32	2,85	2,85	2,85	2,85	0,00	2,85	2,85	0,01	0,01	0,01	0,01	0,00	2,85	2,85	2,85	0,00	0,00	0,00	0,00	2,85
n-C13	3 149,04	0,92	0,92	0,92	0,92	0,00	0,92	0,92	0,00	0,00	0,00	0,00	0,00	0,92	0,92	0,92	0,00	0,00	0,00	0,00	0,92
n-C14	22 819,71	2,46	2,46	2,46	2,46	0,00	2,46	2,46	0,00	0,00	0,00	0,00	0,00	2,46	2,46	2,46	0,00	0,00	0,00	0,00	2,46
n-C15	1 851,03	0,11	0,11	0,11	0,11	0,00	0,11	0,11	0,00	0,00	0,00	0,00	0,00	0,11	0,11	0,11	0,00	0,00	0,00	0,00	0,11
n-C16	1 183,92	0,03	0,03	0,03	0,03	0,00	0,03	0,03	0,00	0,00	0,00	0,00	0,00	0,03	0,03	0,03	0,00	0,00	0,00	0,00	0,03
n-C17	1 257,27	0,02	0,02	0,02	0,02	0,00	0,02	0,02	0,00	0,00	0,00	0,00	0,00	0,02	0,02	0,02	0,00	0,00	0,00	0,00	0,02
n-C18	887,05	0,01	0,01	0,01	0,01	0,00	0,01	0,01	0,00	0,00	0,00	0,00	0,00	0,01	0,01	0,01	0,00	0,00	0,00	0,00	0,01
n-C19	655,17	0,01	0,01	0,01	0,01	0,00	0,01	0,01	0,00	0,00	0,00	0,00	0,00	0,01	0,01	0,01	0,00	0,00	0,00	0,00	0,01
n-C20	1 674,28	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
H2S	5,94	4,95	4,95	4,95	5,94	5,94	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Phenol	6,56	0,03	0,03	0,03	0,03	0,00	0,03	0,03	0,00	0,00	0,00	0,00	0,00	0,03	0,03	0,03	0,00	0,00	0,00	0,00	0,03
Helium	27,91	27,62	27,62	27,62	27,91	0,00	27,91	27,91	27,98	27,98	0,08	0,08	27,91	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Total kg/h	813 382,24	634 189,17	634 189,17	634 189,17	676 621,30	80 679,89	595 941,40	595 941,40	597 184,63	597 184,63	29 566,00	29 571,89	567 618,63	28 328,66	28 328,66	28 328,66	1 639,86	1 639,86	1 639,86	1 639,86	26 688,80

	9.1	9.2	9.3	10.1	10.2	10.3	11.1	11.2	11.3	11.4	12.1	12.2	12.3	13.1	13.2	13.3	13.4	13.5
Nitrogen	251,03	251,03	251,03	238,80	238,80	238,80	12,23	12,23	12,23	12,23	251,07	251,06	251,06	0,00	0,00	0,00	0,00	0,00
CO2	5 830,48	5 830,48	5 830,48	4 139,21	4 139,21	4 139,21	1 691,27	1 691,27	1 691,27	1 691,27	5 830,48	5 830,48	5 830,48	0,00	0,00	0,00	0,00	0,00
Methane	12 794,45	12 794,45	12 794,45	11 079,65	11 079,65	11 079,65	1 714,79	1 714,79	1 714,79	1 714,79	14 001,35	13 970,89	13 970,89	0,00	0,00	0,00	0,00	0,00
Ethane	5 983,56	5 983,56	5 983,56	3 381,89	3 381,89	3 381,89	2 601,67	2 601,67	2 601,67	2 601,67	6 374,48	6 351,95	6 351,95	0,00	0,00	0,00	0,00	0,00
Propane	10 483,37	10 483,37	10 483,37	3 008,28	3 008,28	3 008,28	7 475,09	7 475,09	7 475,09	7 475,09	10 524,78	10 486,82	10 486,82	0,56	0,56	0,56	0,56	0,56
i-Butane	3 625,55	3 625,55	3 625,55	510,54	510,54	510,54	3 115,01	3 115,01	3 115,01	3 115,01	3 198,38	3 199,08	3 199,08	427,20	427,20	427,20	427,20	427,20
n-Butane	8 859,07	8 859,07	8 859,07	936,46	936,46	936,46	7 922,61	7 922,61	7 922,61	7 922,61	2 332,25	2 338,10	2 338,10	6 526,82	6 526,82	6 526,82	6 526,82	6 526,82
i-Pentane	4 929,11	4 929,11	4 929,11	237,48	237,48	237,48	4 691,62	4 691,62	4 691,62	4 691,62	2,01	2,02	2,02	4 927,10	4 927,10	4 927,10	4 927,10	4 927,10
n-Pentane	5 823,10	5 823,10	5 823,10	216,53	216,53	216,53	5 606,57	5 606,57	5 606,57	5 606,57	0,43	0,43	0,43	5 822,67	5 822,67	5 822,67	5 822,67	5 822,67
n-Hexane	9 387,20	9 387,20	9 387,20	121,31	121,31	121,31	9 265,89	9 265,89	9 265,89	9 265,89	0,00	0,00	0,00	9 387,20	9 387,20	9 387,20	9 387,20	9 387,20
n-Heptane	12 990,62	12 990,62	12 990,62	60,63	60,63	60,63	12 929,99	12 929,99	12 929,99	12 929,99	0,00	0,00	0,00	12 990,62	12 990,62	12 990,62	12 990,62	12 990,62
n-Octane	12 359,55	12 359,55	12 359,55	20,87	20,87	20,87	12 338,69	12 338,69	12 338,69	12 338,69	0,00	0,00	0,00	12 359,55	12 359,55	12 359,55	12 359,55	12 359,55
n-Nonane	6 290,82	6 290,82	6 290,82	3,87	3,87	3,87	6 286,95	6 286,95	6 286,95	6 286,95	0,00	0,00	0,00	6 290,82	6 290,82	6 290,82	6 290,82	6 290,82
Benzene	1 935,33	1 935,33	1 935,33	22,42	22,42	22,42	1 912,91	1 912,91	1 912,91	1 912,91	0,00	0,00	0,00	1 935,33	1 935,33	1 935,33	1 935,33	1 935,33
Toluene	27 870,99	27 870,99	27 870,99	107,01	107,01	107,01	27 763,98	27 763,98	27 763,98	27 763,98	0,00	0,00	0,00	27 870,99	27 870,99	27 870,99	27 870,99	27 870,99
m-Xylene	2 229,56	2 229,56	2 229,56	2,62	2,62	2,62	2 226,94	2 226,94	2 226,94	2 226,94	0,00	0,00	0,00	2 229,56	2 229,56	2 229,56	2 229,56	2 229,56
n-Decane	6 961,76	6 961,76	6 961,76	1,69	1,69	1,69	6 960,08	6 960,08	6 960,08	6 960,08	0,00	0,00	0,00	6 961,76	6 961,76	6 961,76	6 961,76	6 961,76
n-C11	3 427,35	3 427,35	3 427,35	0,30	0,30	0,30	3 427,04	3 427,04	3 427,04	3 427,04	0,00	0,00	0,00	3 427,35	3 427,35	3 427,35	3 427,35	3 427,35
n-C12	3 678,48	3 678,48	3 678,48	0,14	0,14	0,14	3 678,33	3 678,33	3 678,33	3 678,33	0,00	0,00	0,00	3 678,48	3 678,48	3 678,48	3 678,48	3 678,48
n-C13	3 148,11	3 148,11	3 148,11	0,04	0,04	0,04	3 148,07	3 148,07	3 148,07	3 148,07	0,00	0,00	0,00	3 148,11	3 148,11	3 148,11	3 148,11	3 148,11
n-C14	22 817,25	22 817,25	22 817,25	0,10	0,10	0,10	22 817,16	22 817,16	22 817,16	22 817,16	0,00	0,00	0,00	22 817,25	22 817,25	22 817,25	22 817,25	22 817,25
n-C15	1 850,91	1 850,91	1 850,91	0,00	0,00	0,00	1 850,91	1 850,91	1 850,91	1 850,91	0,00	0,00	0,00	1 850,91	1 850,91	1 850,91	1 850,91	1 850,91
n-C16	1 183,89	1 183,89	1 183,89	0,00	0,00	0,00	1 183,88	1 183,88	1 183,88	1 183,88	0,00	0,00	0,00	1 183,89	1 183,89	1 183,89	1 183,89	1 183,89
n-C17	1 257,24	1 257,24	1 257,24	0,00	0,00	0,00	1 257,24	1 257,24	1 257,24	1 257,24	0,00	0,00	0,00	1 257,24	1 257,24	1 257,24	1 257,24	1 257,24
n-C18	887,04	887,04	887,04	0,00	0,00	0,00	887,04	887,04	887,04	887,04	0,00	0,00	0,00	887,04	887,04	887,04	887,04	887,04
n-C19	655,17	655,17	655,17	0,00	0,00	0,00	655,17	655,17	655,17	655,17	0,00	0,00	0,00	655,17	655,17	655,17	655,17	655,17
n-C20	1 674,27	1 674,27	1 674,27	0,00	0,00	0,00	1 674,27	1 674,27	1 674,27	1 674,27	0,00	0,00	0,00	1 674,27	1 674,27	1 674,27	1 674,27	1 674,27
H2S	0,99	0,99	0,99	0,46	0,46	0,46	0,52	0,52	0,52	0,52	0,99	0,99	0,99	0,00	0,00	0,00	0,00	0,00
Phenol	6,53	6,53	6,53	0,00	0,00	0,00	6,53	6,53	6,53	6,53	0,00	0,00	0,00	6,53	6,53	6,53	6,53	6,53
Helium	0,29	0,29	0,29	0,27	0,27	0,27	0,01	0,01	0,01	0,01	0,29	0,29	0,29	0,00	0,00	0,00	0,00	0,00
Total	179 193,07	179 193,07	179 193,07	24 090,59	24 090,59	24 090,59	155 102,48	155 102,48	155 102,48	155 102,48	42 516,50	42 432,13	42 432,13	138 316,43	138 316,43	138 316,43	138 316,43	138 316,43

Appendix D.5 Heat Balance New Stablizer with Reflux Case B

	Feed Gas	1.1	1.2	1.3	2.1	CO2/H2S	3.1	3.2	4.1	4.2	4.3	4.4	LNG	5.1	5.2	5.3
Vapor	0,9494	1,00	1,00	1,00	1,00	1,00	1,00	0,99	1,00	0,9653	0,00	0,00	1,00	0,00	0,2845	0,00
Temperature C	-1,00	-1,00	-6,66	9,94	15,10	21,98	17,12	-17,54	-17,59	-37,59	-37,59	-37,59	-37,59	65,33	53,15	-15,75
Pressure kPa	7 000,00	7 000,00	6 000,00	6 000,00	6 000,00	6 000,00	6 000,00	6 000,00	6 000,00	6 000,00	6 000,00	6 000,00	6 000,00	6 000,00	3 420,00	3 420,00
Molar Flow kgmol/h	37 090,76	35 212,22	35 212,22	35 212,22	36 579,79	2 198,52	34 381,27	34 381,27	34 666,01	34 666,01	1 203,50	1 202,68	33 462,51	917,94	917,94	917,94
Mass Flow kg/h	813 382,24	699 236,35	699 236,35	699 236,35	738 079,00	96 754,18	641 324,82	641 324,82	638 492,32	638 492,32	37 316,11	37 287,72	601 176,20	40 120,23	40 120,23	40 120,23
Std Ideal Liq Vol Flow m3/h	2 156,11	1 965,32	1 965,32	1 965,32	2 057,05	117,23	1 939,82	1 939,82	1 946,57	1 946,57	87,28	87,22	1 859,28	80,47	80,47	80,47
Molar enthalpy KJ/kgmol	-99 841,87	-96 394,24	-96 394,24	-95 539,85	-95 947,00	-398 097,75	-76 625,93	-78 504,70	-78 098,94	-79 492,18	-106 181,20	-106 176,25	-78 532,30	-115 749,64	-115 749,64	-125 632,19
Molar Entropy KJ/kgmoleC	142,20	143,64	144,62	147,73	148,60	127,08	148,04	141,13	141,56	135,87	103,14	103,15	137,05	125,57	126,82	93,19
Heat Flow KJ/h *10^5	-37 032,11	-33 942,55	-33 942,55	-33 641,70	-35 097,21	-8 752,24	-26 344,97	-26 990,91	-27 073,78	-27 556,76	-1 277,89	-1 276,96	-26 278,88	-1 062,52	-1 062,52	-1 153,23
HHV MJ/m3	42,05	38,08	38,08	38,08	38,73		41,20	41,20	40,73	40,73	67,84	67,83	39,76	94,68	94,68	94,68
Mass Density kg/m3	0,9307	0,8421	0,8421	0,8421	0,8557	1,8717	0,7910	0,7910	0,7810	0,7810	1,3230	1,3229	0,7616	1,8842	1,8842	1,8842

	6.1	6.2	6.3	6.4	7.1	9.1	9.2	9.3	10.1	10.2	10.3	11.1	11.2	11.3	11.4
Vapor	1,00	0,9857	1,00	1,00	0,00	0,00	0,3041	0,4035	1,00	1,00	1,00	0,00	0,00	0,1411	0,1470
Temperature C	-49,20	-66,89	-5,89	-5,89	92,53	-1,00	-12,41	27,79	27,79	24,73	35,94	27,79	27,86	113,69	113,40
Pressure kPa	3 420,00	1 520,00	1 520,00	1 520,00	3 420,00	7 000,00	2 000,00	1 950,00	1 950,00	1 520,00	1 520,00	1 950,00	2 100,00	2 100,00	2 043,00
Molar Flow kgmol/h	199,73	199,73	199,73	199,73	717,88	1 878,55	1 878,55	1 878,55	757,90	757,90	757,90	1 120,65	1 120,65	1 120,65	1 120,65
Mass Flow kg/h	3 661,02	3 661,02	3 661,02	3 661,02	36 441,17	114 145,88	114 145,88	114 145,88	18 430,93	18 430,93	18 430,93	95 714,95	95 714,95	95 714,95	95 714,95
Std Ideal Liq Vol Flow m3/h	11,64	11,64	11,64	11,64	68,80	190,79	190,79	190,79	46,39	46,39	46,39	144,40	144,40	144,40	144,40
Molar enthalpy KJ/kgmol	-80 823,52	-80 823,52	-78 210,28	-78 210,28	-122 229,17	-164 465,54	-164 465,54	-158 416,46	-111 823,84	-111 823,84	-111 302,72	-189 927,37	-189 901,87	-171 158,03	-171 158,03
Molar Entropy KJ/kgmoleC	144,47	149,86	161,06	161,06	128,17	115,13	118,46	140,09	164,19	166,11	167,83	123,80	123,82	178,26	178,31
Heat Flow KJ/h *10^5	-161,43	-161,43	-156,21	-156,21	-877,45	-3 089,56	-3 089,56	-2 975,93	-847,51	-847,51	-843,56	-2 128,41	-2 128,13	-1 918,08	-1 918,08
HHV MJ/m3	42,44	42,44	42,44	42,44	109,81	120,66	120,66	120,66	44,57	44,57	44,57	180,02	180,02	180,02	180,02
Mass Density kg/m3	0,7774	0,7774	0,7774	0,7774	2,2044	2,6841	2,6841	2,6841	1,0329	1,0329	1,0329	3,9739	3,9739	3,9739	3,9739

	12.1	12.2	12.3	13.1	13.2	13.3	13.4	13.5
Vapor	1,00	1,00	1,00	0,00	0,0643	0,00	0,00	0,00
Temperature C	15,49	15,42	114,22	220,18	216,98	127,41	127,44	18,44
Pressure kPa	1 520,00	1 520,00	6 000,00	1 520,00	1 400,00	1 400,00	1 300,00	1 300,00
Molar Flow kgmol/h	1 367,59	1 367,57	1 367,57	710,69	710,69	710,69	710,69	710,69
Mass Flow kg/h	38 851,78	38 842,65	38 842,65	78 955,12	78 955,12	78 955,12	78 955,12	78 955,12
Std Ideal Liq Vol Flow m3/h	91,74	91,73	91,73	110,70	110,70	110,70	110,70	110,70
Molar enthalpy KJ/kgmol	-110 744,90	-110 738,55	-106 430,28	-165 704,45	-165 704,45	-195 260,67	-195 260,67	-223 176,75
Molar Entropy KJ/kgmoleC	161,71	161,71	164,55	264,32	264,39	198,25	198,30	117,47
Heat Flow KJ/h *10^5	-1 514,53	-1 514,43	-1 455,51	-1 177,64	-1 177,64	-1 387,69	-1 387,69	-1 586,09
HHV MJ/m3	55,47	55,46	55,46	252,77	252,77	252,77	252,77	252,77
Mass Density kg/m3	1,2093	1,2090	1,2090	5,6235	5,6235	5,6235	5,6235	5,6235
TVP @ 37,8⁰C psia								5,153

Appendix D.6 Mole Fraction New Stablizer with Reflux Case B

	Feed Gas	1.1	1.2	1.3	2.1	CO2/H2S	3.1	3.2	4.1	4.2	4.3	4.4	LNG	5.1	5.2	5.3	6.1	6.2	6.3	6.4	7.1
Nitrogen	0,02781	0,02908	0,02908	0,02908	0,02820	0	0,03000	0,03000	0,02997	0,02997	0,00629	0,00629	0,03083	0	0	0	0,00001	0,00001	0,00001	0,00001	0,00000
CO2	0,05927	0,05952	0,05952	0,05952	0,06010	0,99992	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Methane	0,80427	0,83063	0,83063	0,83063	0,82014	0	0,87258	0,87258	0,87811	0,87811	0,50744	0,50747	0,89144	0,18555	0,18555	0,18555	0,84854	0,84854	0,84854	0,84854	0,00115
Ethane	0,05012	0,04870	0,04870	0,04870	0,05158	0	0,05488	0,05488	0,05419	0,05419	0,13966	0,13968	0,05112	0,19197	0,19197	0,19197	0,13984	0,13984	0,13984	0,13984	0,20652
Propane	0,02448	0,02083	0,02083	0,02083	0,02490	0	0,02649	0,02649	0,02509	0,02509	0,16905	0,16917	0,01991	0,26636	0,26636	0,26636	0,01160	0,01160	0,01160	0,01160	0,33730
i-Butane	0,00380	0,00266	0,00266	0,00266	0,00384	0	0,00409	0,00409	0,00361	0,00361	0,04160	0,04162	0,00224	0,07147	0,07147	0,07147	0	0	0	0	0,09136
n-Butane	0,00790	0,00495	0,00495	0,00495	0,00773	0	0,00823	0,00823	0,00691	0,00691	0,09589	0,09565	0,00371	0,17231	0,17231	0,17231	0	0	0	0	0,22006
i-Pentane	0,00262	0,00115	0,00115	0,00115	0,00111	0	0,00118	0,00118	0,00083	0,00083	0,01593	0,01595	0,00029	0,03370	0,03370	0,03370	0	0	0	0	0,04307
n-Pentane	0,00289	0,00108	0,00108	0,00108	0,00104	0	0,00111	0,00111	0,00071	0,00071	0,01487	0,01489	0,00020	0,03420	0,03420	0,03420	0	0	0	0	0,04372
n-Hexane	0,00321	0,00060	0,00060	0,00060	0,00057	0	0,00061	0,00061	0,00024	0,00024	0,00604	0,00605	0,00003	0,02175	0,02175	0,02175	0	0	0	0	0,02781
n-Heptane	0,00351	0,00029	0,00029	0,00029	0,00028	0	0,00030	0,00030	0,00006	0,00006	0,00161	0,00162	0	0,01115	0,01115	0,01115	0	0	0	0	0,01426
n-Octane	0,00281	0,00010	0,00010	0,00010	0,00010	0	0,00010	0,00010	0,00001	0,00001	0,00025	0,00025	0	0,00387	0,00387	0,00387	0	0	0	0	0,00494
n-Nonane	0,00125	0,00002	0,00002	0,00002	0,00002	0	0,00002	0,00002	0	0	0,00002	0,00002	0	0,00074	0,00074	0,00074	0	0	0	0	0,00095
Benzene	0,00069	0,00011	0,00011	0,00011	0,00010	0	0,00011	0,00011	0,00004	0,00004	0,00103	0,00104	0,00001	0,00396	0,00396	0,00396	0	0	0	0	0,00506
Toluene	0,00080	0,00005	0,00005	0,00005	0,00005	0	0,00005	0,00005	0,00001	0,00001	0,00026	0,00026	0	0,00202	0,00202	0,00202	0	0	0	0	0,00259
m-Xylene	0,00055	0,00001	0,00001	0,00001	0,00001	0	0,00001	0,00001	0	0	0,00003	0,00003	0	0,00051	0,00051	0,00051	0	0	0	0	0,00065
n-Decane	0,00123	0,00001	0,00001	0,00001	0,00001	0	0,00001	0,00001	0	0	0	0	0	0,00033	0,00033	0,00033	0	0	0	0	0,00042
n-C11	0,00055	0	0	0	0	0	0	0	0	0	0	0	0	0,00006	0,00006	0,00006	0	0	0	0	0,00008
n-C12	0,00054	0	0	0	0	0	0	0	0	0	0	0	0	0,00003	0,00003	0,00003	0	0	0	0	0,00004
n-C13	0,00043	0	0	0	0	0	0	0	0	0	0	0	0	0,00001	0,00001	0,00001	0	0	0	0	0,00001
n-C14	0,00029	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
n-C15	0,00022	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
n-C16	0,00013	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
n-C17	0,00013	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
n-C18	0,00009	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
n-C19	0,00006	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
n-C20	0,00015	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
H2S	0	0	0	0	0,00001	0,00008	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Phenol	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Helium	0,00020	0,00021	0,00021	0,00021	0,00020	0	0,00022	0,00022	0,00021	0,00021	0,00002	0,00002	0,00022	0	0	0	0	0	0	0	0

	9.1	9.2	9.3	10.1	10.2	10.3	11.1	11.2	11.3	11.4	12.1	12.2	12.3	13.1	13.2	13.3	13.4	13.5
Nitrogen	0,00399	0,00399	0,00399	0,00944	0,00031	0,00031	0,00031	0,00031	0,00031	0,00031	0,00549	0,00549	0,00549	0	0	0	0	0
CO2	0,05456	0,05456	0,05456	0,09946	0,02420	0,02420	0,02420	0,02420	0,02420	0,02420	0,07495	0,07495	0,07495	0	0	0	0	0
Methane	0,31020	0,31020	0,31020	0,67128	0,06600	0,06600	0,06600	0,06600	0,06600	0,06600	0,55002	0,55002	0,55002	0	0	0	0	0
Ethane	0,07674	0,07674	0,07674	0,11112	0,05349	0,05349	0,05349	0,05349	0,05349	0,05349	0,12583	0,12589	0,12589	0	0	0	0	0
Propane	0,09301	0,09301	0,09301	0,06960	0,10884	0,10884	0,10884	0,10884	0,10884	0,10884	0,12945	0,12979	0,12979	0	0	0	0	0
i-Butane	0,02506	0,02506	0,02506	0,00953	0,03557	0,03557	0,03557	0,03557	0,03557	0,03557	0,03427	0,03426	0,03426	0,00030	0,00030	0,00030	0,00030	0,00030
n-Butane	0,06319	0,06319	0,06319	0,01821	0,09361	0,09361	0,09361	0,09361	0,09361	0,09361	0,07982	0,07944	0,07944	0,01342	0,01342	0,01342	0,01342	0,01342
i-Pentane	0,03013	0,03013	0,03013	0,00397	0,04783	0,04783	0,04783	0,04783	0,04783	0,04783	0,00010	0,00010	0,00010	0,07946	0,07946	0,07946	0,07946	0,07946
n-Pentane	0,03685	0,03685	0,03685	0,00377	0,05923	0,05923	0,05923	0,05923	0,05923	0,05923	0,00002	0,00002	0,00002	0,09737	0,09737	0,09737	0,09737	0,09737
n-Hexane	0,05224	0,05224	0,05224	0,00186	0,08632	0,08632	0,08632	0,08632	0,08632	0,08632	0	0	0	0,13809	0,13809	0,13809	0,13809	0,13809
n-Heptane	0,06372	0,06372	0,06372	0,00081	0,10627	0,10627	0,10627	0,10627	0,10627	0,10627	0	0	0	0,16843	0,16843	0,16843	0,16843	0,16843
n-Octane	0,05365	0,05365	0,05365	0,00024	0,08977	0,08977	0,08977	0,08977	0,08977	0,08977	0	0	0	0,14181	0,14181	0,14181	0,14181	0,14181
n-Nonane	0,02426	0,02426	0,02426	0,00004	0,04064	0,04064	0,04064	0,04064	0,04064	0,04064	0	0	0	0,06412	0,06412	0,06412	0,06412	0,06412
Benzene	0,01154	0,01154	0,01154	0,00039	0,01908	0,01908	0,01908	0,01908	0,01908	0,01908	0	0	0	0,03050	0,03050	0,03050	0,03050	0,03050
Toluene	0,01490	0,01490	0,01490	0,00017	0,02486	0,02486	0,02486	0,02486	0,02486	0,02486	0	0	0	0,03938	0,03938	0,03938	0,03938	0,03938
m-Xylene	0,01061	0,01061	0,01061	0,00004	0,01776	0,01776	0,01776	0,01776	0,01776	0,01776	0	0	0	0,02805	0,02805	0,02805	0,02805	0,02805
n-Decane	0,02420	0,02420	0,02420	0,00002	0,04056	0,04056	0,04056	0,04056	0,04056	0,04056	0	0	0	0,06398	0,06398	0,06398	0,06398	0,06398
n-C11	0,01085	0,01085	0,01085	0,00000	0,01818	0,01818	0,01818	0,01818	0,01818	0,01818	0	0	0	0,02868	0,02868	0,02868	0,02868	0,02868
n-C12	0,01069	0,01069	0,01069	0,00000	0,01791	0,01791	0,01791	0,01791	0,01791	0,01791	0	0	0	0,02825	0,02825	0,02825	0,02825	0,02825
n-C13	0,00847	0,00847	0,00847	0,00000	0,01419	0,01419	0,01419	0,01419	0,01419	0,01419	0	0	0	0,02238	0,02238	0,02238	0,02238	0,02238
n-C14	0,00570	0,00570	0,00570	0,00000	0,00956	0,00956	0,00956	0,00956	0,00956	0,00956	0	0	0	0,01508	0,01508	0,01508	0,01508	0,01508
n-C15	0,00432	0,00432	0,00432	0,00000	0,00725	0,00725	0,00725	0,00725	0,00725	0,00725	0	0	0	0,01143	0,01143	0,01143	0,01143	0,01143
n-C16	0,00259	0,00259	0,00259	0,00000	0,00434	0,00434	0,00434	0,00434	0,00434	0,00434	0	0	0	0,00684	0,00684	0,00684	0,00684	0,00684
n-C17	0,00259	0,00259	0,00259	0,00000	0,00434	0,00434	0,00434	0,00434	0,00434	0,00434	0	0	0	0,00684	0,00684	0,00684	0,00684	0,00684
n-C18	0,00172	0,00172	0,00172	0,00000	0,00288	0,00288	0,00288	0,00288	0,00288	0,00288	0	0	0	0,00454	0,00454	0,00454	0,00454	0,00454
n-C19	0,00120	0,00120	0,00120	0,00000	0,00202	0,00202	0,00202	0,00202	0,00202	0,00202	0	0	0	0,00318	0,00318	0,00318	0,00318	0,00318
n-C20	0,00294	0,00294	0,00294	0,00000	0,00493	0,00493	0,00493	0,00493	0,00493	0,00493	0	0	0	0,00778	0,00778	0,00778	0,00778	0,00778
H2S	0,00001	0,00001	0,00001	0,00001	0,00001	0,00001	0,00001	0,00001	0,00001	0,00001	0,00001	0,00001	0,00001	0	0	0	0	0
Phenol	0,00004	0,00004	0,00004	0,00000	0,00007	0,00007	0,00007	0,00007	0,00007	0,00007	0	0	0	0,00010	0,00010	0,00010	0,00010	0,00010
Helium	0,00003	0,00003	0,00003	0,00006	0	0	0	0	0	0	0,00004	0,00004	0,00004	0	0	0	0	0

Appendix D.7 Mass Balance (kg/h) New Stablizer with Reflux Case B

	Feed Gas	1.1	1.2	1.3	2.1	CO2/H2S	3.1	3.2	4.1	4.2
Nitrogen	28 896,26	28 686,06	28 686,06	28 686,06	28 896,33	0,00	28 896,33	28 896,33	29 108,15	29 108,15
CO2	96 747,86	92 237,07	92 237,07	92 237,07	96 747,86	96 747,86	0,00	0,00	0,00	0,00
Methane	478 575,09	469 226,59	469 226,59	469 226,59	481 293,82	0,00	481 293,82	481 293,82	488 352,81	488 352,81
Ethane	55 896,21	51 561,40	51 561,40	51 561,40	56 738,29	0,00	56 738,29	56 738,29	56 490,71	56 490,71
Propane	40 042,51	32 338,01	32 338,01	32 338,01	40 165,14	0,00	40 165,14	40 165,14	38 355,48	38 355,48
i-Butane	8 187,96	5 451,56	5 451,56	5 451,56	8 175,07	0,00	8 175,07	8 175,07	7 270,94	7 270,94
n-Butane	17 022,68	10 123,01	10 123,01	10 123,01	16 437,38	0,00	16 437,38	16 437,38	13 930,07	13 930,07
i-Pentane	7 000,76	2 916,53	2 916,53	2 916,53	2 926,06	0,00	2 926,06	2 926,06	2 078,06	2 078,06
n-Pentane	7 742,05	2 746,90	2 746,90	2 746,90	2 748,96	0,00	2 748,96	2 748,96	1 775,51	1 775,51
n-Hexane	10 263,64	1 805,98	1 805,98	1 805,98	1 805,99	0,00	1 805,99	1 805,99	712,17	712,17
n-Heptane	13 030,67	1 035,85	1 035,85	1 035,85	1 035,85	0,00	1 035,85	1 035,85	204,57	204,57
n-Octane	11 918,53	405,95	405,95	405,95	405,95	0,00	405,95	405,95	35,08	35,08
n-Nonane	5 932,25	87,39	87,39	87,39	87,39	0,00	87,39	87,39	3,22	3,22
Benzene	1 990,35	297,36	297,36	297,36	297,36	0,00	297,36	297,36	110,93	110,93
Toluene	2 751,14	172,67	172,67	172,67	172,67	0,00	172,67	172,67	30,80	30,80
m-Xylene	2 165,78	49,67	49,67	49,67	49,67	0,00	49,67	49,67	3,27	3,27
n-Decane	6 512,38	43,14	43,14	43,14	43,14	0,00	43,14	43,14	0,69	0,69
n-C11	3 194,57	8,93	8,93	8,93	8,93	0,00	8,93	8,93	0,06	0,06
n-C12	3 424,35	4,77	4,77	4,77	4,77	0,00	4,77	4,77	0,01	0,01
n-C13	2 933,63	1,58	1,58	1,58	1,58	0,00	1,58	1,58	0,00	0,00
n-C14	2 126,48	0,42	0,42	0,42	0,42	0,00	0,42	0,42	0,00	0,00
n-C15	1 725,38	0,20	0,20	0,20	0,20	0,00	0,20	0,20	0,00	0,00
n-C16	1 100,19	0,06	0,06	0,06	0,06	0,00	0,06	0,06	0,00	0,00
n-C17	1 168,35	0,04	0,04	0,04	0,04	0,00	0,04	0,04	0,00	0,00
n-C18	821,18	0,02	0,02	0,02	0,02	0,00	0,02	0,02	0,00	0,00
n-C19	607,51	0,01	0,01	0,01	0,01	0,00	0,01	0,01	0,00	0,00
n-C20	1 561,46	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
H2S	6,32	5,65	5,65	5,65	6,32	6,32	0,00	0,00	0,00	0,00
Phenol	6,98	0,06	0,06	0,06	0,06	0,00	0,06	0,06	0,00	0,00
Helium	29,69	29,49	29,49	29,49	29,69	0,00	29,69	29,69	29,79	29,79
Total	813 382,24	699 236,35	699 236,35	699 236,35	738 079,00	96 754,18	641 324,82	641 324,82	638 492,32	638 492,32

	4.3	4.4	LNG	5.1	5.2	5.3	6.1	6.2	6.3	6.4	7.1
Nitrogen	212,01	211,89	28 896,14	0,07	0,07	0,07	0,07	0,07	0,07	0,07	0,00
CO2	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Methane	9 797,38	9 791,43	478 555,43	2 732,43	2 732,43	2 732,43	2 718,90	2 718,90	2 718,90	2 718,90	13,23
Ethane	5 054,29	5 051,30	51 436,43	5 298,87	5 298,87	5 298,87	839,86	839,86	839,86	839,86	4 458,04
Propane	8 971,77	8 972,05	29 383,71	10 781,71	10 781,71	10 781,71	102,14	102,14	102,14	102,14	10 677,60
i-Butane	2 909,92	2 909,22	4 361,02	3 813,34	3 813,34	3 813,34	0,04	0,04	0,04	0,04	3 812,08
n-Butane	6 707,88	6 686,15	7 222,19	9 193,46	9 193,46	9 193,46	0,00	0,00	0,00	0,00	9 182,39
i-Pentane	1 383,22	1 383,79	694,84	2 231,79	2 231,79	2 231,79	0,00	0,00	0,00	0,00	2 230,94
n-Pentane	1 290,98	1 291,86	484,52	2 265,32	2 265,32	2 265,32	0,00	0,00	0,00	0,00	2 264,52
n-Hexane	626,18	627,01	86,00	1 720,82	1 720,82	1 720,82	0,00	0,00	0,00	0,00	1 720,32
n-Heptane	194,37	194,71	10,19	1 025,99	1 025,99	1 025,99	0,00	0,00	0,00	0,00	1 025,81
n-Octane	34,39	34,45	0,70	405,31	405,31	405,31	0,00	0,00	0,00	0,00	405,28
n-Nonane	3,19	3,20	0,03	87,37	87,37	87,37	0,00	0,00	0,00	0,00	87,37
Benzene	97,27	97,38	13,66	283,80	283,80	283,80	0,00	0,00	0,00	0,00	283,71
Toluene	29,19	29,23	1,61	171,09	171,09	171,09	0,00	0,00	0,00	0,00	171,06
m-Xylene	3,21	3,21	0,06	49,62	49,62	49,62	0,00	0,00	0,00	0,00	49,61
n-Decane	0,68	0,68	0,00	43,13	43,13	43,13	0,00	0,00	0,00	0,00	43,13
n-C11	0,06	0,06	0,00	8,93	8,93	8,93	0,00	0,00	0,00	0,00	8,93
n-C12	0,01	0,01	0,00	4,77	4,77	4,77	0,00	0,00	0,00	0,00	4,77
n-C13	0,00	0,00	0,00	1,58	1,58	1,58	0,00	0,00	0,00	0,00	1,58
n-C14	0,00	0,00	0,00	0,42	0,42	0,42	0,00	0,00	0,00	0,00	0,42
n-C15	0,00	0,00	0,00	0,20	0,20	0,20	0,00	0,00	0,00	0,00	0,20
n-C16	0,00	0,00	0,00	0,06	0,06	0,06	0,00	0,00	0,00	0,00	0,06
n-C17	0,00	0,00	0,00	0,04	0,04	0,04	0,00	0,00	0,00	0,00	0,04
n-C18	0,00	0,00	0,00	0,02	0,02	0,02	0,00	0,00	0,00	0,00	0,02
n-C19	0,00	0,00	0,00	0,01	0,01	0,01	0,00	0,00	0,00	0,00	0,01
n-C20	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
H2S	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Phenol	0,00	0,00	0,00	0,06	0,06	0,06	0,00	0,00	0,00	0,00	0,06
Helium	0,10	0,10	29,69	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Total	37 316,11	37 287,72	601 176,20	40 120,23	40 120,23	40 120,23	3 661,02	3 661,02	3 661,02	3 661,02	36 441,17

	9.1	9.2	9.3	10.1	10.2	10.3	11.1	11.2	11.3	11.4
Nitrogen	210,20	210,20	210,20	200,39	200,39	200,39	9,81	9,81	9,81	9,81
CO2	4 510,79	4 510,79	4 510,79	3 317,35	3 317,35	3 317,35	1 193,44	1 193,44	1 193,44	1 193,44
Methane	9 348,50	9 348,50	9 348,50	8 162,00	8 162,00	8 162,00	1 186,49	1 186,49	1 186,49	1 186,49
Ethane	4 334,81	4 334,81	4 334,81	2 532,45	2 532,45	2 532,45	1 802,36	1 802,36	1 802,36	1 802,36
Propane	7 704,50	7 704,50	7 704,50	2 325,99	2 325,99	2 325,99	5 378,51	5 378,51	5 378,51	5 378,51
i-Butane	2 736,41	2 736,41	2 736,41	419,82	419,82	419,82	2 316,59	2 316,59	2 316,59	2 316,59
n-Butane	6 899,67	6 899,67	6 899,67	802,21	802,21	802,21	6 097,46	6 097,46	6 097,46	6 097,46
i-Pentane	4 084,24	4 084,24	4 084,24	216,98	216,98	216,98	3 867,26	3 867,26	3 867,26	3 867,26
n-Pentane	4 995,15	4 995,15	4 995,15	206,06	206,06	206,06	4 789,09	4 789,09	4 789,09	4 789,09
n-Hexane	8 457,66	8 457,66	8 457,66	121,33	121,33	121,33	8 336,33	8 336,33	8 336,33	8 336,33
n-Heptane	11 994,81	11 994,81	11 994,81	61,17	61,17	61,17	11 933,65	11 933,65	11 933,65	11 933,65
n-Octane	11 512,59	11 512,59	11 512,59	20,95	20,95	20,95	11 491,64	11 491,64	11 491,64	11 491,64
n-Nonane	5 844,86	5 844,86	5 844,86	3,94	3,94	3,94	5 840,92	5 840,92	5 840,92	5 840,92
Benzene	1 692,99	1 692,99	1 692,99	22,97	22,97	22,97	1 670,03	1 670,03	1 670,03	1 670,03
Toluene	2 578,47	2 578,47	2 578,47	11,70	11,70	11,70	2 566,77	2 566,77	2 566,77	2 566,77
m-Xylene	2 116,11	2 116,11	2 116,11	2,91	2,91	2,91	2 113,20	2 113,20	2 113,20	2 113,20
n-Decane	6 469,24	6 469,24	6 469,24	1,67	1,67	1,67	6 467,57	6 467,57	6 467,57	6 467,57
n-C11	3 185,64	3 185,64	3 185,64	0,30	0,30	0,30	3 185,34	3 185,34	3 185,34	3 185,34
n-C12	3 419,58	3 419,58	3 419,58	0,14	0,14	0,14	3 419,44	3 419,44	3 419,44	3 419,44
n-C13	2 932,06	2 932,06	2 932,06	0,04	0,04	0,04	2 932,02	2 932,02	2 932,02	2 932,02
n-C14	2 126,05	2 126,05	2 126,05	0,01	0,01	0,01	2 126,04	2 126,04	2 126,04	2 126,04
n-C15	1 725,18	1 725,18	1 725,18	0,00	0,00	0,00	1 725,18	1 725,18	1 725,18	1 725,18
n-C16	1 100,14	1 100,14	1 100,14	0,00	0,00	0,00	1 100,14	1 100,14	1 100,14	1 100,14
n-C17	1 168,31	1 168,31	1 168,31	0,00	0,00	0,00	1 168,31	1 168,31	1 168,31	1 168,31
n-C18	821,16	821,16	821,16	0,00	0,00	0,00	821,16	821,16	821,16	821,16
n-C19	607,50	607,50	607,50	0,00	0,00	0,00	607,50	607,50	607,50	607,50
n-C20	1 561,46	1 561,46	1 561,46	0,00	0,00	0,00	1 561,46	1 561,46	1 561,46	1 561,46
H2S	0,67	0,67	0,67	0,34	0,34	0,34	0,32	0,32	0,32	0,32
Phenol	6,92	6,92	6,92	0,00	0,00	0,00	6,92	6,92	6,92	6,92
Helium	0,20	0,20	0,20	0,19	0,19	0,19	0,01	0,01	0,01	0,01
Total	114 145,88	114 145,88	114 145,88	18 430,93	18 430,93	18 430,93	95 714,95	95 714,95	95 714,95	95 714,95

	12.1	12.2	12.3	13.1	13.2	13.3	13.4	13.5
Nitrogen	210,27	210,27	210,27	0,00	0,00	0,00	0,00	0,00
CO2	4 510,79	4 510,79	4 510,79	0,00	0,00	0,00	0,00	0,00
Methane	12 067,40	12 067,22	12 067,22	0,00	0,00	0,00	0,00	0,00
Ethane	5 174,67	5 176,88	5 176,88	0,00	0,00	0,00	0,00	0,00
Propane	7 806,62	7 827,13	7 827,13	0,03	0,03	0,03	0,03	0,03
i-Butane	2 724,17	2 723,51	2 723,51	12,27	12,27	12,27	12,27	12,27
n-Butane	6 345,13	6 314,37	6 314,37	554,55	554,55	554,55	554,55	554,55
i-Pentane	9,76	9,54	9,54	4 074,48	4 074,48	4 074,48	4 074,48	4 074,48
n-Pentane	2,10	2,06	2,06	4 993,06	4 993,06	4 993,06	4 993,06	4 993,06
n-Hexane	0,00	0,00	0,00	8 457,66	8 457,66	8 457,66	8 457,66	8 457,66
n-Heptane	0,00	0,00	0,00	11 994,81	11 994,81	11 994,81	11 994,81	11 994,81
n-Octane	0,00	0,00	0,00	11 512,59	11 512,59	11 512,59	11 512,59	11 512,59
n-Nonane	0,00	0,00	0,00	5 844,86	5 844,86	5 844,86	5 844,86	5 844,86
Benzene	0,00	0,00	0,00	1 692,99	1 692,99	1 692,99	1 692,99	1 692,99
Toluene	0,00	0,00	0,00	2 578,47	2 578,47	2 578,47	2 578,47	2 578,47
m-Xylene	0,00	0,00	0,00	2 116,11	2 116,11	2 116,11	2 116,11	2 116,11
n-Decane	0,00	0,00	0,00	6 469,24	6 469,24	6 469,24	6 469,24	6 469,24
n-C11	0,00	0,00	0,00	3 185,64	3 185,64	3 185,64	3 185,64	3 185,64
n-C12	0,00	0,00	0,00	3 419,58	3 419,58	3 419,58	3 419,58	3 419,58
n-C13	0,00	0,00	0,00	2 932,06	2 932,06	2 932,06	2 932,06	2 932,06
n-C14	0,00	0,00	0,00	2 126,05	2 126,05	2 126,05	2 126,05	2 126,05
n-C15	0,00	0,00	0,00	1 725,18	1 725,18	1 725,18	1 725,18	1 725,18
n-C16	0,00	0,00	0,00	1 100,14	1 100,14	1 100,14	1 100,14	1 100,14
n-C17	0,00	0,00	0,00	1 168,31	1 168,31	1 168,31	1 168,31	1 168,31
n-C18	0,00	0,00	0,00	821,16	821,16	821,16	821,16	821,16
n-C19	0,00	0,00	0,00	607,50	607,50	607,50	607,50	607,50
n-C20	0,00	0,00	0,00	1 561,46	1 561,46	1 561,46	1 561,46	1 561,46
H2S	0,67	0,67	0,67	0,00	0,00	0,00	0,00	0,00
Phenol	0,00	0,00	0,00	6,92	6,92	6,92	6,92	6,92
Helium	0,20	0,20	0,20	0,00	0,00	0,00	0,00	0,00
Total	38 851,78	38 842,65	38 842,65	78 955,12	78 955,12	78 955,12	78 955,12	78 955,12

Appendix D.8 Heat Balance New Stablizer with Reflux Case C

	Feed Gas	1.1	1.2	1.3	2.1	CO2/H2S	3.1	3.2
Vapor	0,92	1,00	1,00	1,00	1,00	1,00	1,00	0,9926
Temperature C	-1,00	-1,00	-6,62	9,98	17,14	21,98	19,08	-15,58
Pressure kPa	7 000,00	7 000,00	6 000,00	6 000,00	6 000,00	6 000,00	6 000,00	6 000,00
Molar Flow kgmol/h	35 038,71	32 108,67	32 108,67	32 108,67	33 996,39	1 821,84	32 174,55	32 174,55
Mass Flow kg/h	813 382,24	627 562,29	627 562,29	627 562,29	679 789,19	80 176,70	599 612,48	599 612,48
Std Ideal Liq Vol Flow m3/h	2 097,88	1 790,00	1 790,00	1 790,00	1 915,26	97,14	1 818,12	1 818,12
Molar enthalpy KJ/kgmol	-100 507,43	-94 162,18	-94 162,18	-93 315,83	-94 001,29	-398 093,32	-76 782,54	-78 632,28
Molar Entropy KJ/kgmoleC	141,56	143,63	144,61	147,69	148,95	127,08	148,42	141,66
Heat Flow KJ/h *10^5	-35 216,50	-30 234,22	-30 234,22	-29 962,47	-31 957,04	-7 252,61	-24 704,44	-25 299,58
HHV MJ/m3	45,19	38,27	38,27	38,27	39,13		41,34	41,34
Mass Density kg/m3	0,9859	0,8288	0,8288	0,8288	0,8480	1,8717	0,7903	0,7903

	4.1	4.2	4.3	4.4	LNG	5.1	5.2	5.3
Vapor	1,00	0,9668	0,00	0,00	1,00	0,00	0,2915	0,00
Temperature C	-15,65	-35,65	-35,65	-35,67	-35,65	66,74	54,25	-14,65
Pressure kPa	6 000,00	6 000,00	6 000,00	6 000,00	6 000,00	6 000,00	3 420,00	3 420,00
Molar Flow kgmol/h	32 466,69	32 466,69	1 076,40	1 077,11	31 390,29	784,96	784,96	784,96
Mass Flow kg/h	599 158,64	599 158,64	33 855,51	33 871,31	565 303,12	34 325,16	34 325,16	34 325,16
Std Ideal Liq Vol Flow m3/h	1 827,89	1 827,89	78,63	78,68	1 749,26	68,90	68,90	68,90
Molar enthalpy KJ/kgmol	-78 321,33	-79 700,17	-106 919,35	-106 910,11	-78 766,80	-115 935,64	-115 935,64	-125 925,89
Molar Entropy KJ/kgmoleC	141,97	136,38	103,35	103,35	137,51	126,93	128,19	94,34
Heat Flow KJ/h *10^5	-25 428,35	-25 876,01	-1 150,88	-1 151,54	-24 725,13	-910,05	-910,05	-988,47
HHV MJ/m3	40,98	40,98	68,80	68,79	40,04	94,76	94,76	94,76
Mass Density kg/m3	0,7825	0,7825	1,3424	1,3422	0,7635	1,8852	1,8852	1,8852

	6.1	6.2	6.3	6.4	7.1	9.1	9.2	9.3
Vapor	1,00	0,9854	1,00	1,00	0,00	0,00	0,3014	0,3946
Temperature C	-49,18	-67,05	-6,05	-6,05	92,31	-1,00	-11,53	28,67
Pressure kPa	3 420,00	1 520,00	1 520,00	1 520,00	3 420,00	7 000,00	2 000,00	1 950,00
Molar Flow kgmol/h	169,84	169,84	169,84	169,84	615,12	2 930,04	2 930,04	2 930,04
Mass Flow kg/h	3 125,51	3 125,51	3 125,51	3 125,51	31 199,65	185 819,95	185 819,95	185 819,95
Std Ideal Liq Vol Flow m3/h	9,94	9,94	9,94	9,94	58,97	307,88	307,88	307,88
Molar enthalpy KJ/kgmol	-80 879,20	-80 879,20	-78 258,39	-78 258,39	-122 667,91	-170 041,62	-170 041,62	-163 827,29
Molar Entropy KJ/kgmoleC	144,61	149,97	161,22	161,22	129,06	118,87	122,26	144,42
Heat Flow KJ/h *10^5	-137,37	-137,37	-132,91	-132,91	-754,56	-4 982,28	-4 982,28	-4 800,20
HHV MJ/m3	42,59	42,59	42,59	42,59	109,76	125,67	125,67	125,67
Mass Density kg/m3	0,7805	0,7805	0,7805	0,7805	2,2025	2,8124	2,8124	2,8124

	10.1	10.2	10.3	11.1	11.2	11.3	11.4
Vapor	1,00	1,00	1,00	0,00	0,00	0,1236	0,1292
Temperature C	28,67	25,69	36,90	28,67	28,74	113,64	113,40
Pressure kPa	1 950,00	1 520,00	1 520,00	1 950,00	2 100,00	2 100,00	2 043,00
Molar Flow kgmol/h	1 156,19	1 156,19	1 156,19	1 773,84	1 773,84	1 773,84	1 773,84
Mass Flow kg/h	27 521,76	27 521,76	27 521,76	158 298,19	158 298,19	158 298,19	158 298,19
Std Ideal Liq Vol Flow m3/h	70,49	70,49	70,49	237,39	237,39	237,39	237,39
Molar enthalpy KJ/kgmol	-108 217,72	-108 217,72	-107 700,48	-200 073,59	-200 047,04	-180 910,57	-180 910,57
Molar Entropy KJ/kgmoleC	164,33	166,26	167,96	131,44	131,46	187,01	187,05
Heat Flow KJ/h *10^5	-1 251,20	-1 251,20	-1 245,22	-3 548,99	-3 548,52	-3 209,07	-3 209,07
HHV MJ/m3	44,57	44,57	44,57	187,47	187,47	187,47	187,47
Mass Density kg/m3	1,0109	1,0109	1,0109	4,1856	4,1856	4,1856	4,1856

	12.1	12.2	12.3	13.1	13.2	13.3	13.4	13.5
Vapor	1,00	1,00	1,00	0,00	0,0591	0,00	0,00	0,00
Temperature C	9,71	9,75	109,78	216,44	213,58	130,21	130,23	21,23
Pressure kPa	1 520,00	1 520,00	6 000,00	1 520,00	1 400,00	1 400,00	1 300,00	1 300,00
Molar Flow kgmol/h	1 885,21	1 887,72	1 887,72	1 214,66	1 214,66	1 214,66	1 214,66	1 214,66
Mass Flow kg/h	52 148,74	52 226,90	52 226,90	136 796,72	136 796,72	136 796,72	136 796,72	136 796,72
Std Ideal Liq Vol Flow m3/h	125,08	125,26	125,26	192,74	192,74	192,74	192,74	192,74
Molar enthalpy KJ/kgmol	-109 928,70	-109 904,37	-105 660,61	-176 448,23	-176 448,23	-204 394,38	-204 394,38	-233 072,88
Molar Entropy KJ/kgmoleC	161,75	161,75	164,58	271,81	271,89	209,28	209,33	126,96
Heat Flow KJ/h *10^5	-2 072,39	-2 074,68	-1 994,57	-2 143,25	-2 143,25	-2 482,70	-2 482,70	-2 831,05
HHV MJ/m3	53,96	53,98	53,98	253,56	253,56	253,56	253,56	253,56
Mass Density kg/m3	1,1770	1,1772	1,1772	5,7021	5,7021	5,7021	5,7021	5,7021
TVP @ 37,8 °C psia								6,621

Appendix D.9 Mole fraction New Stablizer with Reflux Case C

	Feed Gas	1.1	1.2	1.3	2.1	CO2/H2S	3.1	3.2	4.1	4.2	4.3	4.4	LNG	5.1	5.2	5.3	6.1	6.2	6.3	6.4	7.1
Nitrogen	0,02486	0,02679	0,02679	0,02679	0,02562	0	0,02707	0,02707	0,02701	0	0	0	0	0	0	0	0	0	0	0	0
CO2	0,05199	0,05235	0,05235	0,05235	0,05358	0,99990	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Methane	0,79869	0,84303	0,84303	0,84303	0,82742	0	0,87427	0,87427	0,87848	0,87848	0,49717	0,49728	0,89155	0,18291	0,18291	0,18291	0,84176	0,84176	0,84176	0,84176	0,00100
Ethane	0,04995	0,04768	0,04768	0,04768	0,05223	0	0,05519	0,05519	0,05465	0,05465	0,13753	0,13754	0,05181	0,19028	0,19028	0,19028	0,14824	0,14824	0,14824	0,14824	0,20189
Propane	0,02565	0,01988	0,01988	0,01988	0,02650	0	0,02800	0,02800	0,02692	0,02692	0,17828	0,17826	0,02173	0,27863	0,27863	0,27863	0,00999	0,00999	0,00999	0,00999	0,35281
i-Butane	0,00418	0,00245	0,00245	0,00245	0,00425	0	0,00449	0,00449	0,00410	0,00410	0,04700	0,04699	0,00263	0,07879	0,07879	0,07879	0	0	0	0	0,10054
n-Butane	0,00885	0,00445	0,00445	0,00445	0,00721	0	0,00762	0,00762	0,00672	0,00672	0,09325	0,09320	0,00376	0,16210	0,16210	0,16210	0	0	0	0	0,20686
i-Pentane	0,00322	0,00103	0,00103	0,00103	0,00097	0	0,00103	0,00103	0,00080	0,00080	0,01550	0,01548	0,00029	0,03052	0,03052	0,03052	0	0	0	0	0,03895
n-Pentane	0,00362	0,00095	0,00095	0,00095	0,00090	0	0,00095	0,00095	0,00068	0,00068	0,01463	0,01462	0,00021	0,03078	0,03078	0,03078	0	0	0	0	0,03928
n-Hexane	0,00457	0,00055	0,00055	0,00055	0,00051	0	0,00054	0,00054	0,00026	0,00026	0,00686	0,00685	0,00004	0,02086	0,02086	0,02086	0	0	0	0	0
n-Heptane	0,00655	0,00034	0,00034	0,00034	0,00032	0	0,00033	0,00033	0,00009	0,00009	0,00249	0,00249	0	0,01353	0,01353	0,01353	0	0	0	0	0
n-Octane	0,00606	0,00013	0,00013	0,00013	0,00012	0	0,00013	0,00013	0,00002	0,00002	0,00046	0,00046	0	0,00527	0,00527	0,00527	0	0	0	0	0
n-Nonane	0,00313	0,00003	0,00003	0,00003	0,00003	0	0,00003	0,00003	0,00000	0,00000	0,00004	0,00004	0	0,00116	0,00116	0,00116	0	0	0	0	0
Benzene	0,00078	0,00008	0,00008	0,00008	0,00007	0	0,00008	0,00008	0,00004	0,00004	0,00094	0,00093	0	0,00301	0,00301	0,00301	0	0	0	0	0
Toluene	0,00090	0,00004	0,00004	0,00004	0,00003	0	0,00004	0,00004	0,00001	0,00001	0,00025	0,00025	0	0,00147	0,00147	0,00147	0	0	0	0	0
m-Xylene	0,00061	0,00001	0,00001	0,00001	0,00001	0	0,00001	0,00001	0	0	0,00002	0,00002	0	0,00036	0,00036	0,00036	0	0	0	0	0
n-Decane	0,00129	0,00001	0,00001	0,00001	0,00000	0	0,00001	0,00001	0	0	0	0	0	0,00021	0,00021	0,00021	0	0	0	0	0
n-C11	0,00102	0	0	0	0	0	0	0	0	0	0	0	0	0	0,00007	0,00007	0	0	0	0	0
n-C12	0,00081	0	0	0	0	0	0	0	0	0	0	0	0	0	0,00003	0,00003	0	0	0	0	0
n-C13	0,00064	0	0	0	0	0	0	0	0	0	0	0	0	0	0,00001	0,00001	0	0	0	0	0
n-C14	0,00051	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
n-C15	0,00045	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
n-C16	0,00027	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
n-C17	0,00027	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
n-C18	0,00018	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
n-C19	0,00013	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
n-C20	0,00063	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
H2S	0	0	0	0	0,00001	0,00010	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Phenol	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Helium	0,00020	0,00022	0,00022	0,00022	0,00021	0	0,00022	0,00022	0,00022	0	0	0	0	0	0	0	0	0	0	0	0

	9.1	9.2	9.3	10.1	10.2	10.3	11.1	11.2	11.3	11.4	12.1	12.2	12.3	13.1	13.2	13.3	13.4	13.5
Nitrogen	0,00368	0,00368	0,00368	0,00888	0,00888	0,00888	0,00030	0,00030	0,00030	0,00030	0,00573	0,00572	0,00572	0	0	0	0	0
CO2	0,04808	0,04808	0,04808	0,08884	0,08884	0,08884	0,02150	0,02150	0,02150	0,02150	0,07472	0,07462	0,07462	0	0	0	0	0
Methane	0,31276	0,31276	0,31276	0,68908	0,68908	0,68908	0,06748	0,06748	0,06748	0,06748	0,56194	0,56179	0,56179	0	0	0	0	0
Ethane	0,07480	0,07480	0,07480	0,10976	0,10976	0,10976	0,05201	0,05201	0,05201	0,05201	0,12961	0,12966	0,12966	0	0	0	0	0
Propane	0,08888	0,08888	0,08888	0,06717	0,06717	0,06717	0,10302	0,10302	0,10302	0,10302	0,13903	0,13913	0,13913	0	0	0	0	0
i-Butane	0,02313	0,02313	0,02313	0,00890	0,00890	0,00890	0,03240	0,03240	0,03240	0,03240	0,03485	0,03482	0,03482	0,0017	0,00169	0,00169	0,00169	0,00169
n-Butane	0,05703	0,05703	0,05703	0,01667	0,01667	0,01667	0,08333	0,08333	0,08333	0,08333	0,05401	0,05414	0,05414	0,0537	0,05373	0,05373	0,05373	0,05373
i-Pentane	0,02725	0,02725	0,02725	0,00364	0,00364	0,00364	0,04264	0,04264	0,04264	0,04264	0,00004	0,00004	0,00004	0,0657	0,06567	0,06567	0,06567	0,06567
n-Pentane	0,03285	0,03285	0,03285	0,00341	0,00341	0,00341	0,05203	0,05203	0,05203	0,05203	0,00001	0,00001	0,00001	0,0792	0,07922	0,07922	0,07922	0,07922
n-Hexane	0,04867	0,04867	0,04867	0,00176	0,00176	0,00176	0,07924	0,07924	0,07924	0,07924	0	0	0	0,1174	0,11739	0,11739	0,11739	0,11739
n-Heptane	0,07470	0,07470	0,07470	0,00096	0,00096	0,00096	0,12276	0,12276	0,12276	0,12276	0	0	0	0,1802	0,18019	0,18019	0,18019	0,18019
n-Octane	0,07111	0,07111	0,07111	0,00033	0,00033	0,00033	0,11725	0,11725	0,11725	0,11725	0	0	0	0,1715	0,17154	0,17154	0,17154	0,17154
n-Nonane	0,03714	0,03714	0,03714	0,00006	0,00006	0,00006	0,06131	0,06131	0,06131	0,06131	0	0	0	0,0896	0,08960	0,08960	0,08960	0,08960
Benzene	0,00845	0,00845	0,00845	0,00029	0,00029	0,00029	0,01376	0,01376	0,01376	0,01376	0	0	0	0,0204	0,02037	0,02037	0,02037	0,02037
Toluene	0,01034	0,01034	0,01034	0,00012	0,00012	0,00012	0,01700	0,01700	0,01700	0,01700	0	0	0	0,0249	0,02494	0,02494	0,02494	0,02494
m-Xylene	0,00719	0,00719	0,00719	0,00003	0,00003	0,00003	0,01185	0,01185	0,01185	0,01185	0	0	0	0,0173	0,01734	0,01734	0,01734	0,01734
n-Decane	0,01533	0,01533	0,01533	0,00001	0,00001	0,00001	0,02532	0,02532	0,02532	0,02532	0	0	0	0,0370	0,03699	0,03699	0,03699	0,03699
n-C11	0,01215	0,01215	0,01215	0	0	0	0,02008	0,02008	0,02008	0,02008	0	0	0	0,0293	0,02932	0,02932	0,02932	0,02932
n-C12	0,00966	0,00966	0,00966	0	0	0	0,01595	0,01595	0,01595	0,01595	0	0	0	0,0233	0,02329	0,02329	0,02329	0,02329
n-C13	0,00764	0,00764	0,00764	0	0	0	0,01262	0,01262	0,01262	0,01262	0	0	0	0,0184	0,01843	0,01843	0,01843	0,01843
n-C14	0,00609	0,00609	0,00609	0	0	0	0,01005	0,01005	0,01005	0,01005	0	0	0	0,0147	0,01468	0,01468	0,01468	0,01468
n-C15	0,00537	0,00537	0,00537	0	0	0	0,00887	0,00887	0,00887	0,00887	0	0	0	0,0130	0,01295	0,01295	0,01295	0,01295
n-C16	0,00322	0,00322	0,00322	0	0	0	0,00531	0,00531	0,00531	0,00531	0	0	0	0,0078	0,00776	0,00776	0,00776	0,00776
n-C17	0,00322	0,00322	0,00322	0	0	0	0,00531	0,00531	0,00531	0,00531	0	0	0	0,0078	0,00776	0,00776	0,00776	0,00776
n-C18	0,00215	0,00215	0,00215	0	0	0	0,00356	0,00356	0,00356	0,00356	0	0	0	0,0052	0,00519	0,00519	0,00519	0,00519
n-C19	0,00155	0,00155	0,00155	0	0	0	0,00257	0,00257	0,00257	0,00257	0	0	0	0,0038	0,00375	0,00375	0,00375	0,00375
n-C20	0,00752	0,00752	0,00752	0	0	0	0,01242	0,01242	0,01242	0,01242	0	0	0	0,0181	0,01814	0,01814	0,01814	0,01814
H2S	0,00001	0,00001	0,00001	0,00001	0,00001	0,00001	0,00001	0,00001	0,00001	0,00001	0,00002	0,00002	0,00002	0	0	0	0	0
Phenol	0,00002	0,00002	0,00002	0	0	0	0,00004	0,00004	0,00004	0,00004	0	0	0	0,0001	0,00006	0,00006	0,00006	0,00006
Helium	0,00003	0,00003	0,00003	0,00007	0	0	0	0	0	0	0,00004	0,00004	0,00004	0	0	0	0	0

Appendix D.10 Mass Balance (kg/h) New Stablizer with Reflux Case C

	Feed Gas	1.1	1.2	1.3	2.1	CO2/H2S	3.1	3.2	4.1	4.2
Nitrogen	24 399,08	24 096,79	24 096,79	24 096,79	24 399,14	0,00	24 399,14	24 399,14	24 566,91	24 566,91
CO2	80 170,73	73 971,40	73 971,40	73 971,40	80 170,73	80 170,73	0,00	0,00	0,00	0,00
Methane	448 962,26	434 260,49	434 260,49	434 260,49	451 274,02	0,00	451 274,02	451 274,02	457 563,57	457 563,57
Ethane	52 623,57	46 033,50	46 033,50	46 033,50	53 393,48	0,00	53 393,48	53 393,48	53 356,78	53 356,78
Propane	39 625,64	28 142,19	28 142,19	28 142,19	39 723,90	0,00	39 723,90	39 723,90	38 546,05	38 546,05
i-Butane	8 510,90	4 572,33	4 572,33	4 572,33	8 392,63	0,00	8 392,63	8 392,63	7 739,47	7 739,47
n-Butane	18 019,73	8 307,64	8 307,64	8 307,64	14 248,50	0,00	14 248,50	14 248,50	12 687,58	12 687,58
i-Pentane	8 145,46	2 384,08	2 384,08	2 384,08	2 390,21	0,00	2 390,21	2 390,21	1 865,09	1 865,09
n-Pentane	9 154,16	2 209,97	2 209,97	2 209,97	2 211,36	0,00	2 211,36	2 211,36	1 604,29	1 604,29
n-Hexane	13 796,37	1 508,24	1 508,24	1 508,24	1 508,24	0,00	1 508,24	1 508,24	732,39	732,39
n-Heptane	23 011,42	1 080,05	1 080,05	1 080,05	1 080,05	0,00	1 080,05	1 080,05	284,64	284,64
n-Octane	24 275,39	474,01	474,01	474,01	474,01	0,00	474,01	474,01	57,47	57,47
n-Nonane	14 075,29	116,99	116,99	116,99	116,99	0,00	116,99	116,99	6,20	6,20
Benzene	2 129,29	196,51	196,51	196,51	196,51	0,00	196,51	196,51	90,78	90,78
Toluene	2 899,19	107,68	107,68	107,68	107,68	0,00	107,68	107,68	25,83	25,83
m-Xylene	2 265,43	29,95	29,95	29,95	29,95	0,00	29,95	29,95	2,79	2,79
n-Decane	6 416,31	23,61	23,61	23,61	23,61	0,00	23,61	23,61	0,55	0,55
n-C11	5 575,59	8,57	8,57	8,57	8,57	0,00	8,57	8,57	0,08	0,08
n-C12	4 822,51	3,66	3,66	3,66	3,66	0,00	3,66	3,66	0,02	0,02
n-C13	4 127,92	1,19	1,19	1,19	1,19	0,00	1,19	1,19	0,00	0,00
n-C14	3 538,04	0,38	0,38	0,38	0,38	0,00	0,38	0,38	0,00	0,00
n-C15	3 341,71	0,20	0,20	0,20	0,20	0,00	0,20	0,20	0,00	0,00
n-C16	2 134,18	0,06	0,06	0,06	0,06	0,00	0,06	0,06	0,00	0,00
n-C17	2 266,40	0,04	0,04	0,04	0,04	0,00	0,04	0,04	0,00	0,00
n-C18	1 604,99	0,02	0,02	0,02	0,02	0,00	0,02	0,02	0,00	0,00
n-C19	1 223,07	0,01	0,01	0,01	0,01	0,00	0,01	0,01	0,00	0,00
n-C20	6 226,99	0,01	0,01	0,01	0,01	0,00	0,01	0,01	0,00	0,00
H2S	5,97	4,97	4,97	4,97	5,97	5,97	0,00	0,00	0,00	0,00
Phenol	6,60	0,03	0,03	0,03	0,03	0,00	0,03	0,03	0,00	0,00
Helium	28,05	27,72	27,72	27,72	28,05	0,00	28,05	28,05	28,14	28,14
Total	813 382,24	627 562,29	627 562,29	627 562,29	679 789,19	80 176,70	599 612,48	599 612,48	599 158,64	599 158,64

	4.3	4.4	LNG	5.1	5.2	5.3	6.1	6.2	6.3	6.4	7.1
Nitrogen	167,68	167,83	24 399,23	0,06	0,06	0,06	0,06	0,06	0,06	0,06	0,00
CO2	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Methane	8 585,49	8 592,99	448 978,08	2 303,44	2 303,44	2 303,44	2 293,57	2 293,57	2 293,57	2 293,57	9,87
Ethane	4 451,35	4 454,73	48 905,42	4 491,43	4 491,43	4 491,43	757,06	757,06	757,06	757,06	3 734,37
Propane	8 462,13	8 466,83	30 083,92	9 644,68	9 644,68	9 644,68	74,80	74,80	74,80	74,80	9 569,89
i-Butane	2 940,68	2 941,56	4 798,79	3 594,72	3 594,72	3 594,72	0,02	0,02	0,02	0,02	3 594,69
n-Butane	5 833,94	5 834,92	6 853,64	7 395,83	7 395,83	7 395,83	0,00	0,00	0,00	0,00	7 395,83
i-Pentane	1 203,67	1 203,40	661,42	1 728,52	1 728,52	1 728,52	0,00	0,00	0,00	0,00	1 728,52
n-Pentane	1 136,57	1 136,15	467,72	1 743,21	1 743,21	1 743,21	0,00	0,00	0,00	0,00	1 743,21
n-Hexane	636,14	635,56	96,24	1 411,41	1 411,41	1 411,41	0,00	0,00	0,00	0,00	1 411,41
n-Heptane	269,04	268,69	15,61	1 064,09	1 064,09	1 064,09	0,00	0,00	0,00	0,00	1 064,09
n-Octane	56,21	56,13	1,26	472,66	472,66	472,66	0,00	0,00	0,00	0,00	472,66
n-Nonane	6,15	6,14	0,06	116,92	116,92	116,92	0,00	0,00	0,00	0,00	116,92
Benzene	78,64	78,60	12,14	184,33	184,33	184,33	0,00	0,00	0,00	0,00	184,33
Toluene	24,35	24,33	1,48	106,18	106,18	106,18	0,00	0,00	0,00	0,00	106,18
m-Xylene	2,74	2,73	0,05	29,89	29,89	29,89	0,00	0,00	0,00	0,00	29,89
n-Decane	0,54	0,54	0,00	23,61	23,61	23,61	0,00	0,00	0,00	0,00	23,61
n-C11	0,08	0,08	0,00	8,57	8,57	8,57	0,00	0,00	0,00	0,00	8,57
n-C12	0,02	0,02	0,00	3,66	3,66	3,66	0,00	0,00	0,00	0,00	3,66
n-C13	0,00	0,00	0,00	1,19	1,19	1,19	0,00	0,00	0,00	0,00	1,19
n-C14	0,00	0,00	0,00	0,38	0,38	0,38	0,00	0,00	0,00	0,00	0,38
n-C15	0,00	0,00	0,00	0,20	0,20	0,20	0,00	0,00	0,00	0,00	0,20
n-C16	0,00	0,00	0,00	0,06	0,06	0,06	0,00	0,00	0,00	0,00	0,06
n-C17	0,00	0,00	0,00	0,04	0,04	0,04	0,00	0,00	0,00	0,00	0,04
n-C18	0,00	0,00	0,00	0,02	0,02	0,02	0,00	0,00	0,00	0,00	0,02
n-C19	0,00	0,00	0,00	0,01	0,01	0,01	0,00	0,00	0,00	0,00	0,01
n-C20	0,00	0,00	0,00	0,01	0,01	0,01	0,00	0,00	0,00	0,00	0,01
H2S	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Phenol	0,00	0,00	0,00	0,03	0,03	0,03	0,00	0,00	0,00	0,00	0,03
Helium	0,09	0,09	28,05	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Total	33 855,51	33 871,31	565 303,12	34 325,16	34 325,16	34 325,16	3 125,51	3 125,51	3 125,51	3 125,51	31 199,65

	9.1	9.2	9.3	10.1	10.2	10.3	11.1	11.2	11.3	11.4
Nitrogen	302,29	302,29	302,29	287,47	287,47	287,47	14,82	14,82	14,82	14,82
CO2	6 199,33	6 199,33	6 199,33	4 520,58	4 520,58	4 520,58	1 678,75	1 678,75	1 678,75	1 678,75
Methane	14 701,77	14 701,77	14 701,77	12 781,58	12 781,58	12 781,58	1 920,19	1 920,19	1 920,19	1 920,19
Ethane	6 590,07	6 590,07	6 590,07	3 815,97	3 815,97	3 815,97	2 774,10	2 774,10	2 774,10	2 774,10
Propane	11 483,45	11 483,45	11 483,45	3 424,83	3 424,83	3 424,83	8 058,62	8 058,62	8 058,62	8 058,62
i-Butane	3 938,57	3 938,57	3 938,57	597,95	597,95	597,95	3 340,62	3 340,62	3 340,62	3 340,62
n-Butane	9 712,09	9 712,09	9 712,09	1 120,50	1 120,50	1 120,50	8 591,59	8 591,59	8 591,59	8 591,59
i-Pentane	5 761,37	5 761,37	5 761,37	303,60	303,60	303,60	5 457,78	5 457,78	5 457,78	5 457,78
n-Pentane	6 944,19	6 944,19	6 944,19	284,54	284,54	284,54	6 659,65	6 659,65	6 659,65	6 659,65
n-Hexane	12 288,13	12 288,13	12 288,13	175,40	175,40	175,40	12 112,72	12 112,72	12 112,72	12 112,72
n-Heptane	21 931,37	21 931,37	21 931,37	111,34	111,34	111,34	21 820,04	21 820,04	21 820,04	21 820,04
n-Octane	23 801,38	23 801,38	23 801,38	43,07	43,07	43,07	23 758,31	23 758,31	23 758,31	23 758,31
n-Nonane	13 958,30	13 958,30	13 958,30	9,36	9,36	9,36	13 948,94	13 948,94	13 948,94	13 948,94
Benzene	1 932,78	1 932,78	1 932,78	26,37	26,37	26,37	1 906,41	1 906,41	1 906,41	1 906,41
Toluene	2 791,51	2 791,51	2 791,51	12,82	12,82	12,82	2 778,69	2 778,69	2 778,69	2 778,69
m-Xylene	2 235,48	2 235,48	2 235,48	3,11	3,11	3,11	2 232,37	2 232,37	2 232,37	2 232,37
n-Decane	6 392,70	6 392,70	6 392,70	1,64	1,64	1,64	6 391,06	6 391,06	6 391,06	6 391,06
n-C11	5 567,02	5 567,02	5 567,02	0,52	0,52	0,52	5 566,49	5 566,49	5 566,49	5 566,49
n-C12	4 818,85	4 818,85	4 818,85	0,19	0,19	0,19	4 818,66	4 818,66	4 818,66	4 818,66
n-C13	4 126,73	4 126,73	4 126,73	0,06	0,06	0,06	4 126,68	4 126,68	4 126,68	4 126,68
n-C14	3 537,67	3 537,67	3 537,67	0,02	0,02	0,02	3 537,65	3 537,65	3 537,65	3 537,65
n-C15	3 341,51	3 341,51	3 341,51	0,01	0,01	0,01	3 341,50	3 341,50	3 341,50	3 341,50
n-C16	2 134,13	2 134,13	2 134,13	0,00	0,00	0,00	2 134,13	2 134,13	2 134,13	2 134,13
n-C17	2 266,36	2 266,36	2 266,36	0,00	0,00	0,00	2 266,36	2 266,36	2 266,36	2 266,36
n-C18	1 604,97	1 604,97	1 604,97	0,00	0,00	0,00	1 604,97	1 604,97	1 604,97	1 604,97
n-C19	1 223,06	1 223,06	1 223,06	0,00	0,00	0,00	1 223,06	1 223,06	1 223,06	1 223,06
n-C20	6 226,98	6 226,98	6 226,98	0,00	0,00	0,00	6 226,98	6 226,98	6 226,98	6 226,98
H2S	1,00	1,00	1,00	0,51	0,51	0,51	0,49	0,49	0,49	0,49
Phenol	6,56	6,56	6,56	0,00	0,00	0,00	6,56	6,56	6,56	6,56
Helium	0,33	0,33	0,33	0,32	0,32	0,32	0,02	0,02	0,02	0,02
Total	185 819,95	185 819,95	185 819,95	27 521,76	27 521,76	27 521,76	158 298,19	158 298,19	158 298,19	158 298,19

	12.1	12.2	12.3	13.1	13.2	13.3	13.4	13.5
Nitrogen	302,35	302,35	302,35	0,00	0,00	0,00	0,00	0
CO2	6 199,33	6 199,33	6 199,33	0,00	0,00	0,00	0,00	0
Methane	16 995,34	17 013,53	17 013,53	0,00	0,00	0,00	0,00	0
Ethane	7 347,13	7 359,97	7 359,97	0,00	0,00	0,00	0,00	0,00
Propane	11 558,02	11 581,71	11 581,71	0,22	0,22	0,22	0,22	0,22
i-Butane	3 819,09	3 820,30	3 820,30	119,50	119,50	119,50	119,50	119,50
n-Butane	5 918,65	5 940,86	5 940,86	3 793,44	3 793,44	3 793,44	3 793,44	3 793,44
i-Pentane	6,11	6,13	6,13	5 755,27	5 755,27	5 755,27	5 755,27	5 755,27
n-Pentane	1,38	1,39	1,39	6 942,80	6 942,80	6 942,80	6 942,80	6 942,80
n-Hexane	0,00	0,00	0,00	12 288,12	12 288,12	12 288,12	12 288,12	12 288,12
n-Heptane	0,00	0,00	0,00	21 931,37	21 931,37	21 931,37	21 931,37	21 931,37
n-Octane	0,00	0,00	0,00	23 801,38	23 801,38	23 801,38	23 801,38	23 801,38
n-Nonane	0,00	0,00	0,00	13 958,30	13 958,30	13 958,30	13 958,30	13 958,30
Benzene	0,00	0,00	0,00	1 932,78	1 932,78	1 932,78	1 932,78	1 932,78
Toluene	0,00	0,00	0,00	2 791,51	2 791,51	2 791,51	2 791,51	2 791,51
m-Xylene	0,00	0,00	0,00	2 235,48	2 235,48	2 235,48	2 235,48	2 235,48
n-Decane	0,00	0,00	0,00	6 392,70	6 392,70	6 392,70	6 392,70	6 392,70
n-C11	0,00	0,00	0,00	5 567,02	5 567,02	5 567,02	5 567,02	5 567,02
n-C12	0,00	0,00	0,00	4 818,85	4 818,85	4 818,85	4 818,85	4 818,85
n-C13	0,00	0,00	0,00	4 126,73	4 126,73	4 126,73	4 126,73	4 126,73
n-C14	0,00	0,00	0,00	3 537,67	3 537,67	3 537,67	3 537,67	3 537,67
n-C15	0,00	0,00	0,00	3 341,51	3 341,51	3 341,51	3 341,51	3 341,51
n-C16	0,00	0,00	0,00	2 134,13	2 134,13	2 134,13	2 134,13	2 134,13
n-C17	0,00	0,00	0,00	2 266,36	2 266,36	2 266,36	2 266,36	2 266,36
n-C18	0,00	0,00	0,00	1 604,97	1 604,97	1 604,97	1 604,97	1 604,97
n-C19	0,00	0,00	0,00	1 223,06	1 223,06	1 223,06	1 223,06	1 223,06
n-C20	0,00	0,00	0,00	6 226,98	6 226,98	6 226,98	6 226,98	6 226,98
H2S	1,00	1,00	1,00	0,00	0,00	0,00	0,00	0
Phenol	0,00	0,00	0,00	6,56	6,56	6,56	6,56	6,56
Helium	0,33	0,33	0,33	0,00	0,00	0,00	0,00	0
Total	52 148,74	52 226,90	52 226,90	136 796,72	136 796,72	136 796,72	136 796,72	136 796,72

Appendix E1 Basic Heat Transfer Relations

Heat transfer in exchangers like reboiler and condenser type typically involves two fluids. In the plant discussed in this thesis the bottom product from the column exchange with hot oil in the reboiler, while the overhead will exchange with water in the condenser. The heat is transferred from the hot fluid to the wall by convection, through the wall by conduction and to the cold fluid by convection (Incropera, DeWitt et al. 2006).

When the heat is transferred one must consider the thermal resistance in the fluid, wall and in addition include the fouling factor. The fouling factor represents deposits from the fluid that will decrease the overall heat transfer rate and the total thermal resistance can be written as (Bell and Mueller 2001):

$$\sum R_{total} = R_{hot\ side} + R_{wall} + R_{cold\ side} + R_{fouling} \tag{1}$$

By combining the thermal resistance from the cold and the hot side the overall heat transfer coefficient can be defined:

$$\dot{Q} = \frac{\Delta T}{R} = UA\Delta T = U_h A_h \Delta T = U_c A_c \Delta T \tag{2}$$

Where:

Q	Heat transferred
ΔT	Temperature difference
U	Overall heat transfer coefficient, W/m^2 °C
A	Area

For heat exchangers with two fluids that exchange heat the temperature difference between the hot and the cold fluid will vary along the exchanger. A convenient temperature difference is the mean temperature difference T_m shown is equation (3).

$$\dot{Q} = UA\Delta T_m \tag{3}$$

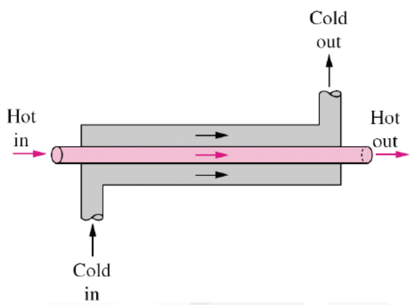

Figure 1 Concentric Heat Exchanger Parallel Flow (Incropera, DeWitt et al. 2006)

Figure 1 shows a concentric heat exchanger with parallel flow. An energy balance one each fluid is performed respectively for the hot and the cold fluid:

$$\delta\dot{Q} = -\dot{m}_h c_{ph} dT_h \quad (4)$$

$$\delta\dot{Q} = -\dot{m}_c c_{pc} dT_c \quad (5)$$

Where:

$\dot{m}$ Mass flow

c_p Heat transfer capacity of the fluid

By reorganizing the equations and take their difference one can obtain:

$$dT_h - dT_c = d(T_h - T_c) = -\delta\dot{Q}(\frac{1}{\dot{m}_h c_{ph}} + \frac{1}{\dot{m}_c c_{pc}}) \quad (6)$$

In the differential section of the heat exchanger the rate of heat transferred can also be written as in equation (7).

$$\delta\dot{Q} = U(T_h - T_c)dA \quad (7)$$

By substituting equation (7) into equation (6) and rearrange this gives:

$$\frac{d(T_h - T_c)}{T_h - T_c} = -UdA(\frac{1}{\dot{m}_h c_{ph}} + \frac{1}{\dot{m}_c c_{pc}}) \quad (8)$$

By using C_h and C_c as the heat capacity rates for $\dot{m}_h c_{ph}$ and $\dot{m}_c c_{pc}$ respectively, substituting this into equation (8). This gives equation (9):

$$Q = UA\Delta T_{lm} \quad (9)$$

Where ΔT_{lm} is the *log mean temperature difference*, LMTD:

$$\Delta T_{lm} = \frac{\Delta T_2 - \Delta T_1}{\ln(\frac{\Delta T_2}{\Delta T_1})} \quad (10)$$

From these equations it is stated that if the need for heat increases, this will require a larger heat exchange area or bigger temperature differences in the fluids. If the need decreases a smaller surface area or temperature difference is required. It is important not to oversize the heat exchangers in order to have an energy efficient design.