Evaluación Técnica de la Modernización de la Planta de Gas del Campo Payoa a través del Reemplazo del Intercambiador de Calor Gas-Gas

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Monografía para optar al título de Especialista en Ingeniería de Gas

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A mi esposa e hija, por la paciencia, amor y apoyo incondicional para lograr el objetivo de cursar una Especialización. A mis padres por su motivación, ayuda económica y consentimiento que fueron factores fundamentales en mi motivación para lograr el objetivo de llegar a ser Especialista en Ingeniería de Gas.

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Resumen

Título: Evaluación Técnica de la Modernización de la Planta de Gas del Campo Payoa a través del Reemplazo del Intercambiador de Calor Gas-Gas.[*]

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Palabras clave:

Descripción
La Planta del Gas del campo Payoa comenzó a operar en el año 1965 bajo el contrato de Asociación "Carare Las Monas" suscrito entre Ecopetrol S.A. y PetroSantander GMBH. Con el paso de los años el volumen de extracción de las fracciones pesadas de hidrocarburos presentes en el Gas Rico, que alimenta el proceso de la Planta de Gas del campo Payoa, ha venido disminuyendo y la calidad de los productos tales como Gas Residual, Propano, Butano y Gasolina se han visto afectadas. La razón de esta disminución de volumen y afectación en la calidad es que varios de los equipos principales de la planta presentan baja eficiencia, fugas o deterioro por tantos años de uso.

Durante el desarrollo de la presente Monografía se realizó una descripción del proceso actual de la Planta de Gas del campo Payoa. Se utilizó el software de proceso Aspen Hysys para simular el desempeño actual de la Planta ajustándolo con los datos reales de campo y también se simuló el impacto que tendría el reemplazo de uno de los equipos principales del proceso, conocido como Intercambiador de Calor Gas – Gas, en los volúmenes de extracción de las fracciones pesadas del Gas Rico y en la calidad del Gas Residual. Finalmente, se realizó un dimensionamiento del Intercambiador de Calor nuevo que mejor se adaptaría al proceso de la Planta de Gas del campo Payoa.

Las conclusiones principales de la evaluación después de instalar y poner en operación un nuevo Intercambiador de Calor en la Planta de Gas del campo Payoa son:

- La extracción de las fracciones pesadas tendría un incremento de 37% en volumen.
- La relación entre los líquidos recuperados y el gas procesado (GPM) incrementaría de 2.07 a 2.85.
- El porcentaje molar de las fracciones pesadas presentes en la corriente de gas residual disminuiría de 4.89% a 3.85%.
- La instalación de un nuevo Intercambiador Gas-Gas es altamente benéfica para el proceso de la Planta de Gas.

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Abstract

Title: Technical Evaluation of the Payoa Gas Plant upgrade by the Replacement of the Gas-Gas Heater.[*]

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Keywords:

Description
The Payoa Gas Planta started operation in 1965 under the Association Contract "Carare-Las Monas" executed between Ecopetrol S.A. y PetroSantander GMBH. Through the years, the extraction of the heavy fraction of Hydrocarbons presents in the Rich Gas that goes into the Gas Plant process has decreased. Also, the quality of the products such as Dry Gas, Propane, Butane and Gasoline has been affected. The decrease in extraction and quality affection is because some of the main equipment in the Gas Plant have leaks, low efficiency and wear due to several years of operation.

During the development of the present study a general description of the current Gas Plant process was done. By using Hysys the actual performance of the Payoa Gas Plant was simulated and compared against field data for adjustment. Then, a simulation installing a new Gas-Gas Heater was performed to evaluate the impact of it, in the recovered volume of the heavy hydrocarbons fraction and the Dry Gas quality. Finally, a design of the new Gas-Gas Heater that better fits the needs of the Gas Plan was done.

The main conclusions of the evaluation after installing and putting in operation a new Gas-Gas Heater in the Payoa Gas Plant are:

- The extraction of the heavy hydrocarbons fraction would increase by 37% in volume.
- The relationship between extracted liquids and the gas that is processed in the gas plant (GPM) will increase from 2.07 to 2.85.
- The molar percentage of the heavy fraction present in the Residual Gas Stream will decrease from 4.89% to 3.85%.
- The installation of a new Gas-Gas Heater is highly recommended to improve the Payoa Gas Plant Process.

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Introducción

La primera tecnología implementada en Colombia para el tratamiento y procesamiento del gas natural, enfocada a la remoción de fracciones pesadas (C_3^+), fueron las plantas de Tratamiento de Gas que utilizan como principio de operación la absorción de fracciones pesadas en el gas a través de aceite pobre. Este principio de extracción se encuentra descrito en (Santillana Jaime y Salinas Julia, 2019). Algunas de estas plantas de tratamiento de gas que aun operan en Colombia, cuentan también con un sistema de refrigeración del gas de entrada lo suficientemente robusto para disminuir la temperatura por debajo de la temperatura ambiente, teniendo la opción de bypassear la torre absorvedora. Este es el caso específico de la Planta de Gas del Campo Payoa, operada por PetroSantander Colombia Inc, que ya no utiliza el principio de absorción de fracciones pesadas a través de aceite pobre, pero si la refrigeración mecánica.

Los campos en Colombia, que fueron grandes productores de gas entre los años 1970 y 1980 han experimentado la declinación natural de su producción de gas, caída de la presión de yacimiento y por esta razón varias de éstas grandes Plantas de Gas construidas en Colombia han sido desmanteladas o se han hecho grandes inversiones para implementar otras tecnologías para el tratamiento del gas tales como remoción de fracciones pesadas en el gas por efecto Joule – Thomson, Sistemas turbo-expander o la tecnología Twister.

La planta de gas del campo Payoa cuyo principio es la refrigeración mecánica aún se encuentra en operación y cualquier mejora en su eficiencia tiene beneficios económicos significativos e incrementa la vida útil del activo y en General del Campo Payoa.

El gas natural es el combustible fósil de mayor eficiencia energética, con ventajas en comparación a otros combustibles tales como el petróleo crudo o el carbón. Aunque el uso primario

del gas natural es como combustible, éste es también puede ser utilizado como una fuente de materia prima para la industria petroquímica. Tal como se cita en (Mokhatab, 2012) el gas natural es la fuente de energía con mayor crecimiento durante las dos últimas décadas en todo el mundo debido a su bajo nivel de emisiones, menor impacto en el efecto invernadero y a su alta eficiencia en la generación de energía. Por ejemplo, en el campo Payoa, la demanda energética se satisface a partir del gas seco o gas residual que resulta después del proceso de la Planta de Gas. PetroSantander es autogenerador y no depende de la red nacional de energía eléctrica lo que le da una alta confiabilidad en su operación.

Por las razones expuestas anteriormente cualquier mejora en el proceso de tratamiento de gas de la Planta del campo Payoa contribuye no solo trae un beneficio económico a Ecopetrol y Petrosantander por el aumento en la extracción de las fracciones pesadas, sino también a la conservación ambiental porque se obtiene un gas residual de mejor calidad que será utilizado como combustible.

En la presente monografía se desarrolla una evaluación sobre el efecto que tendría la instalación de un nuevo Intercambiador de Calor Gas-Gas en el proceso de la Planta de Gas del campo Payoa específicamente en:

- Los porcentajes de remoción y/o recuperación de las fracciones pesadas C_3^+, presentes en el gas de entrada.
- Calidad del gas residual que se utiliza para generación y/o se vende a través del Gasoducto Payoa – Galán – Refinería Barrancabermeja.
- Volúmenes recuperados de Propano, Butano y Gasolina.

1. Planteamiento del Problema

Para el planteamiento del problema y en general para el desarrollo de la Monografía se utilizó como referencia el documento guía de la clase "Taller de Monografía" (González, Germán, 2021) de la Especialización de Ingeniería de Gas de la UIS años 2021-2022.

La Planta de Gas del Campo Payoa comenzó su operación entre los años 1965 y 1967 bajo el contrato de Asociación Carare Las Monas (Ecopetrol S.A. & PetroSantander Colombia Inc, 2003). Debido a su antigüedad, varios de los equipos principales de la Planta de Gas han perdido eficiencia y hoy en día se considera que requieren ser modernizados o reemplazados debido a compromisos en su integridad mecánica. Ese es el caso específico del equipo conocido como "Intercambiador de Calor Gas-Gas". Debido a su largo tiempo de uso, el Intercambiador de Calor Gas-Gas ha venido perdiendo eficiencia y a pesar de que se le hacen los mantenimientos periódicos el equipo no alcanza a operar a las condiciones ideales para lograr la calidad deseada de los productos que se obtienen del proceso de la Planta de Gas, los cuáles son: Gas Seco, Propano, Butano y Gasolina.

Por lo tanto, las preguntas a resolver con la presente monografía son:

¿De qué manera la baja eficiencia del Intercambiador de Calor Gas-Gas afecta la calidad y composición de los productos que se obtienen en el proceso de la Planta de gas del campo Payoa?

¿Cuál sería el impacto de instalar y poner en marcha un nuevo Intercambiador de Calor Gas-Gas en la Planta de gas del campo Payoa?

El presente trabajo de Monografía presenta un análisis y descripción del proceso actual de la Planta de Gas del campo Payoa. Además, se desarrolló una simulación en software de proceso para verificar el impacto que tendría el reemplazo del Intercambiador de Calor Gas-Gas en la

calidad de los productos y en la eficiencia del proceso. De esta forma se podrá evaluar técnica y económicamente la Modernización de la Planta de Gas del Campo Payoa. El Intercambiador de Calor Gas-Gas instalado en la Planta de Gas de Payoa es un intercambiador de Calor de tubos y carcaza de un paso. Por el lado tubos ingresa el gas rico a alta temperatura y por el lado carcaza circula el gas residual o gas ventas ya frío como resultado del proceso de la Planta de Gas. Con base en el comportamiento del Intercambiador durante la operación normal de la Planta y con base en las inspecciones realizadas bajo estándares de la norma API 510 (API 510 Ninth Edition, 2006) se ha evidenciado que la eficiencia del equipo está por debajo del 50% debido a que varios de sus tubos internos están presentando fugas lo que ha disminuido el área disponible para intercambio de calor entre el gas de entrada (que circula por los tubos internos) y el gas residual que circula por el lado carcaza de los tubos. Para evitar las fugas de gas rico se han aislado más del 35% de los tubos internos y por lo que se ha recomendado su reemplazo puesto que con la disminución del área de transferencia de calor mínima no se alcanzan las temperaturas y especificaciones requeridas en las corrientes de gas a la salida de este intercambiador.

Actualmente el gas seco procesado y tratado en la Planta de Gas del campo Payoa contiene fracciones de C_3, C_4 y C_5 por encima de los niveles deseados debido a que se está presentando arrastre de estos componentes al gas seco durante el proceso. Las razones de este arrastre es que algunos de los equipos principales de la Planta, llevan operando continuamente por más de 50 años, han disminuido su eficiencia y a pesar de que se le hacen sus mantenimientos preventivos no se logra operarlos a las condiciones deseadas. Este arrastre de fracciones pesadas se traduce en una disminución en la extracción de Propano, Butano y Gasolina presentes en el gas rico. Durante los mantenimientos realizados al Intercambiador de Calor Gas-Gas se ha observado que los tubos internos están presentando fugas siendo necesario “condenar” algunos tubos para disminuir fugas

y mejorar la extracción de C_3^+. Sin embargo, entre más tubos se condenen más se afecta la eficiencia del Intercambiador de Carlor Gas-Gas. En las siguientes imágenes se puede apreciar el intercambiador objeto de la evaluación y la forma como se han aislado o "condenado" los tubos internos del Intercambiador Gas-Gas que presentan fugas o deterioro.

Figura 1.

Vista lateral Intercambiador de Calor Planta de Gas Payoa

Figura 2.

Vista Interna del Intercambiador de Calor

2. Objetivos

2.1 Objetivo General

Definir los aspectos técnicos en la modernización de la planta de gas y como la baja eficiencia del Intercambiador de Calor Gas-Gas, afecta la calidad y composición de los productos que se obtienen en el Proceso de la Planta de Gas (Gas Seco, Propano, Butano y Gasolina) del Campo Payoa mediante la revisión de datos históricos y simulación usando Hysys.

2.2 Objetivos Específicos

- Describir el proceso actual de la Planta de Gas del Campo Payoa mostrando las propiedades principales y volúmenes de los productos que se obtienen en el proceso (Gas Seco, Propano, Butano y Gasolina).
- Desarrollar la simulación de la Planta de Gas del campo Payoa para el caso de incorporación de un nuevo Intercambiador Gas-Gas mostrando su efecto en las propiedades y volúmenes de los productos que se obtienen en el proceso (Gas Seco, Propano, Butano y Gasolina).
- Comparar y evaluar los resultados de las condiciones actuales de la Planta de Gas del campo Payoa contra la simulación para el caso de incorporación de un nuevo Intercambiador de Calor Gas-Gas.
- Realizar el dimensionamiento del intercambiador de calor que permita cubrir la necesidad actual de la Planta de Gas del Campo Payoa para garantizar la calidad de los productos, referencia: (Profesora Dosinda González-Mendizabal, 2002) y (Nicolás Santos Santos, 2021).

3. Descripción del Proceso Actual de la Planta de Gas del Campo Payoa

Tomando como referencia el (Manual de operación Planta de procesamiento de Gas), el proceso general de la planta de tratamiento de Gas del campo Payoa es el siguiente:

Como se muestra en la Figura 3 el gas rico producido en los campos Payoa, Payoa West, Salina, Corazón y Corazón West es succionado por compresores y descargado a la planta de gas para pasar a su primera etapa de enfriamiento en una torre de tiro forzado con sistema de reciclo de agua de enfriamiento, que ayuda al enfriamiento del aire que es succionado por ventiladores. El gas entra a una temperatura de 110 F aproximadamente y a una presión de 450 psig y sale a 85 F aproximadamente.

Como segundo paso el gas rico pasa al intercambiador de calor gas-gas (carcaza-tubo) en donde se logra disminuir la temperatura a 66 F aproximadamente. En este equipo ocurre un intercambio de calor entre el gas rico y el gas residual al cual se le han removido los hidrocarburos C_3^+ que se han generado por efecto del enfriamiento en el Intercambiador Chiller y que se han condensado en el separador de Gas de entrada.

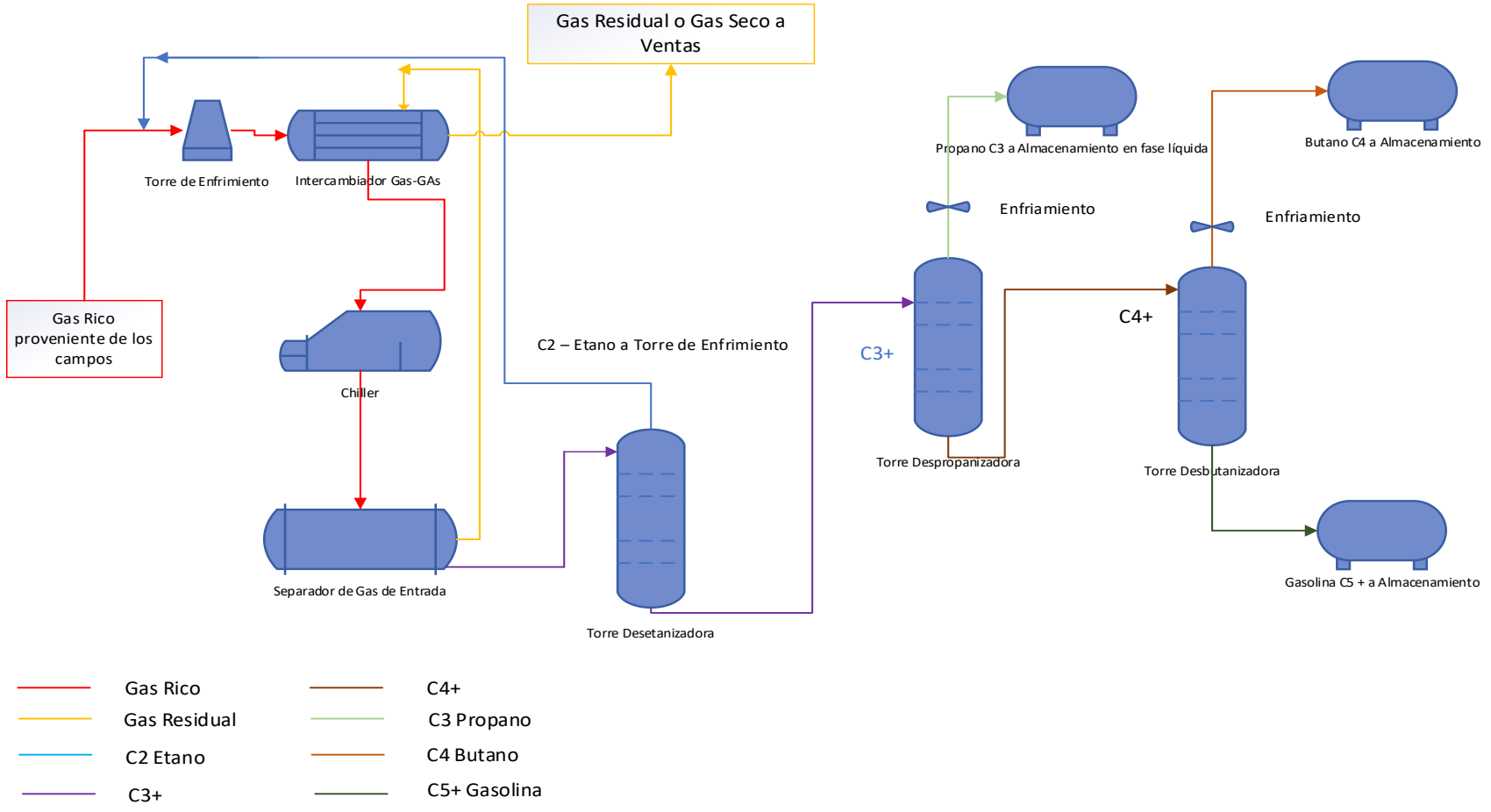
Continuando con el proceso del Gas Rico, este es direccionado hacia el Intercambiador Chiller, equipo en el cual la corriente de gas alcanza temperaturas de hasta -10 °F, haciendo uso del ciclo del propano de refrigeración mecánica. Posteriormente, el gas rico pasa al separador de Gas de entrada donde la fase gaseosa (Gas Residual) es enviada al intercambiador Gas-Gas para ser aprovechado en el proceso de enfriamiento del gas de entrada y posteriormente es enviado a ventas a través del Gasoducto de 10” de diámetro Payoa – Barrancabermeja. Los hidrocarburos C_3^+ recuperados, que se encuentran en fase líquida están en condiciones para ingresar a la torre desetanizadora.

En la torre desetanizadora la corriente C_3^+ ingresa por el tope, para ser calentada y remover las trazas de etano (C_2), las cuáles son recuperadas, comprimidas y reinyectadas en el proceso inicial de la Planta (Torre de Enfriamiento).

El siguiente paso es la torre despropanizadora donde la corriente C_3^+ es calentada recuperando por tope el Propano en fase gaseosa y por fondos C_4^+. El Propano es enviado a torre de enfriamiento para condensación y posterior almacenamiento para venta y comercialización. La corriente de C_4^+ es direccionada a la torre desbutanizadora donde ocurre otro calentamiento recuperando por tope Butano en fase gaseosa y por fondos C_5^+ o gasolina natural. El Butano es enviado a torre de enfriamiento para condensación y después a almacenamiento para posterior venta. La corriente C_5^+ es almacenada para ser mezclada con el crudo que se produce en el campo Payoa y se comercializa a través del Oleoducto de 8” de diámetro Payoa-Galán-Refinería Barrancabermeja. El diagrama de Bloques (Figura 3) ilustra el proceso descrito anteriormente:

Figura 3.

Proceso Planta de Gas Payoa



4. Simulación en Software de Proceso Actual de la Planta Vs. Proceso después de Cambio del Intercambiador Gas-Gas

Para realizar el proceso de simulación del proceso actual se tomaron parámetros operacionales y datos más representativos del mes de noviembre de 2021, los cuáles se describen a continuación:

Tabla 1.

Parámetros Operacionales y Datos Representativos del Gas de Entrada (gas rico)

Parámetro de Entrada	Valor
Volumen de gas de entrada, KPC	8000
Presión gas de entrada, psig	450
Temperatura gas de entrada, F	110
Poder Calorífico gas de entrada, BTU/SCF	1436

Con los parámetros mencionados anteriormente y con la ayuda del Ing. de Procesos de la Planta de Gas del campo Payoa se realizó la simulación en el Software Hysys. Para lograr el ajuste con los volúmenes obtenidos en el proceso real debido al deterioro del Intercambiador de Calor Gas-Gas se asumió en el software una fuga de gas rico en el Intercambiador Gas-Gas. Esta fuga provoca que parte del gas rico se vaya en la corriente de gas residual en lugar de que entre al proceso de la planta para extraerle los Hidrocarburos presentes en la fracción C_3^+. Los resultados más importantes de esta simulación se muestran en la siguiente tabla:

Tabla 2.

Resultados de la Simulación Inicial (Intercambiador Averiado)

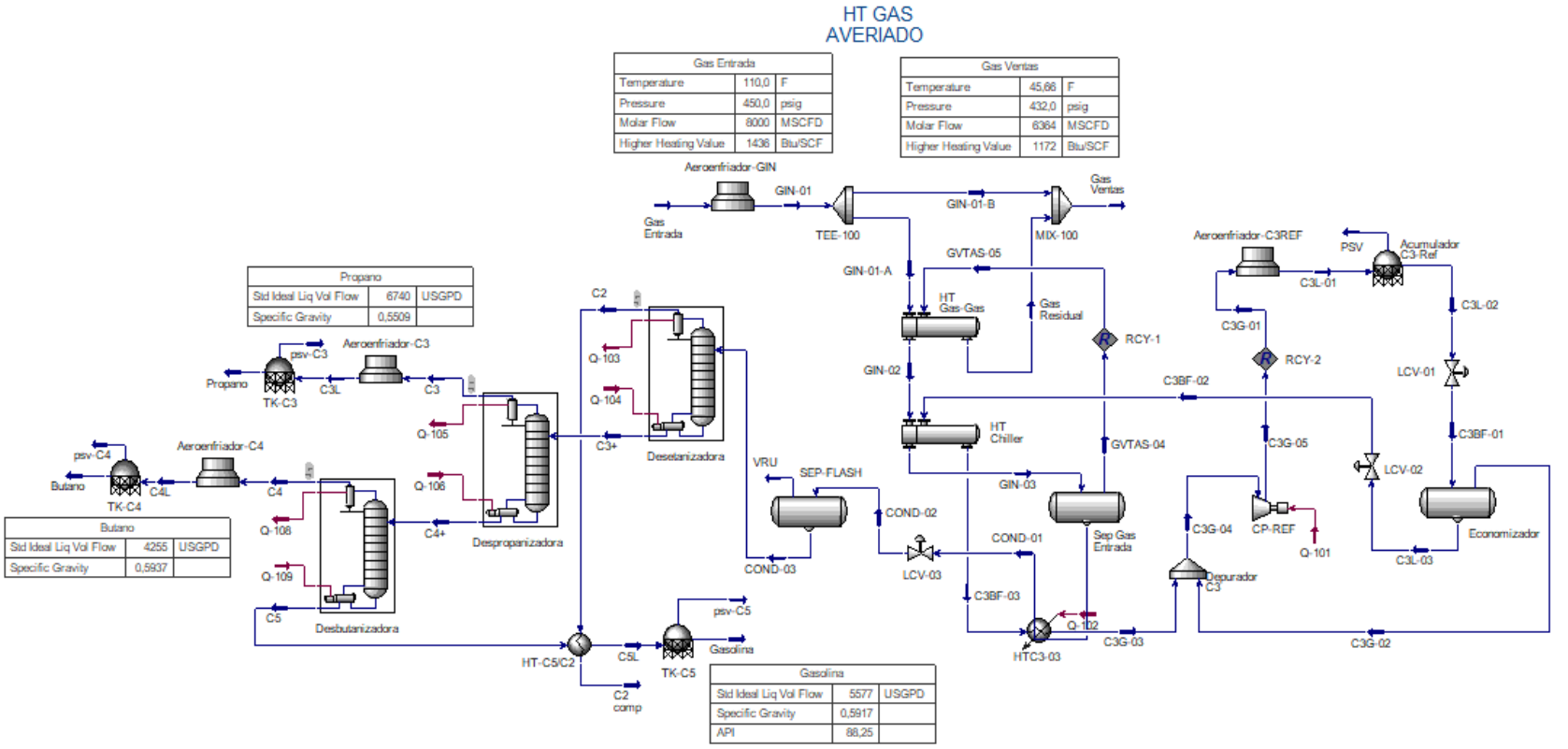
Parámetro	Valor
Gas residual a ventas, KPC	6364
Volumen de Propano extraído, gal	6740
Volumen de Butano extraído, gal	4255
Volumen de Gasolina extraído, gal	5577
Poder Calorífico Gas residual, BTU/SCF	1172
Fracción Molar C3+	0.0489
GPM	2.07

Los detalles de la simulación se presentan en los Apéndices A y B y la Figura 4.

Los volúmenes de cada uno de los productos obtenidos que se muestran en la Tabla 2. fueron comparados contra los valores reales de campo en un periodo de 15 días logrando un ajuste entre Simulación y datos reales del 87% para el Gas Residual, 85% para el volumen de Propano extraído, 89% para el volumen de Butano extraído y 92% para el volumen de Gasolina extraído.

Figura 4.

Simulación Hysys Proceso actual Planta de Gas Campo Payoa – Intercambiador de Calor averiado



Posteriormente se realizó una simulación manteniendo los mismos parámetros de entrada para el gas rico, asumiendo que el intercambiador de calor gas-gas había sido cambiado como parte de la modernización de la Planta de Gas por lo tanto no existe la fuga de gas rico en el intercambiador. Las mediciones de campo muestran que por las fugas que presentan los tubos del intercambiador Gas-Gas se están perdiendo entre 200 a 250 KPCD de gas rico, el cual no está ingresando al proceso de la Planta de Gas sino que se están yendo en la corriente de Gas Residual.

La siguiente tabla muestra los resultados más relevantes de la simulación:

Tabla 3.

Resultados de la Simulación (Intercambiador Nuevo – Manteniendo los Mismos Parámetros de Entrada de Gas Rico)

Parámetro	Valor
Gas residual a ventas, KPCD	6134
Volumen de Propano extraído, gal/d	6851
Volumen de Butano extraído, gal/d	4674
Volumen de Gasolina extraído, gal/d	11260
Poder Calorífico Gas residual, BTU/ft^3	1146
Fracción Molar C3+ en la corriente de gas residual	0.0382
GPM	2.85

Los detalles de la simulación se presentan los Apéndice C y D y en la Figura 5 El diagrama de fases entre el gas de entrada y el gas agua abajo del intercambiador nuevo obtenido para el proceso se presenta en la Figura 6. En este diagrama de fases se puede apreciar que aguas abajo del intercambiador el gas rico sale con una temperatura de 65F mientras que para el caso del intercambiador averiado o con fugas el gas rico sale del intercambiador a 69F.

4.1 Análisis de Resultados

Comparando los resultados de las dos simulaciones se puede evidenciar lo siguiente con respecto al gas residual o gas ventas:

- El volumen de gas residual para el caso del Intercambiador nuevo disminuye en 230 KPCD con respecto al caso del Intercambiador Averiado.
- El poder calorífico del gas residual para el caso del Intercambiador averiado supera lo establecido en el Reglamento Único de Transporte mientras que para el caso del Intercambiador nuevo el poder calorífico no supera el límite máximo permitido de 1150 BTU/ft^3.
- Se puede también observar que la fracción molar de C_3^+ es menor en el caso del Intercambiador nuevo con respecto al caso de Intercambiador averiado, pasando de 0.0489 a 0.0382.

Con respecto a la extracción de productos pesados se evidencia que el volumen extraído o recuperado después del procesamiento del Gas rico es sustancialmente mayor para el caso del Intercambiador nuevo en comparación con el intercambiador averiado. En la Tabla 4 se muestra la comparación:

Tabla 4.

Comparación Extracción Intercambiador Nuevo vs. Averiado

Parámetro	Intercambiador Nuevo	Intercambiador Averiado
Volumen de Propano extraído, gal/d	6851	6740
Volumen de Butano extraído, gal/d	4674	4255
Volumen de Gasolina extraído, gal/d	11260	5577
GPM	2.85	2.07

Figura 5.

Simulación Hysys Proceso Planta de Gas Campo Payoa – Intercambiador de Calor Nuevo

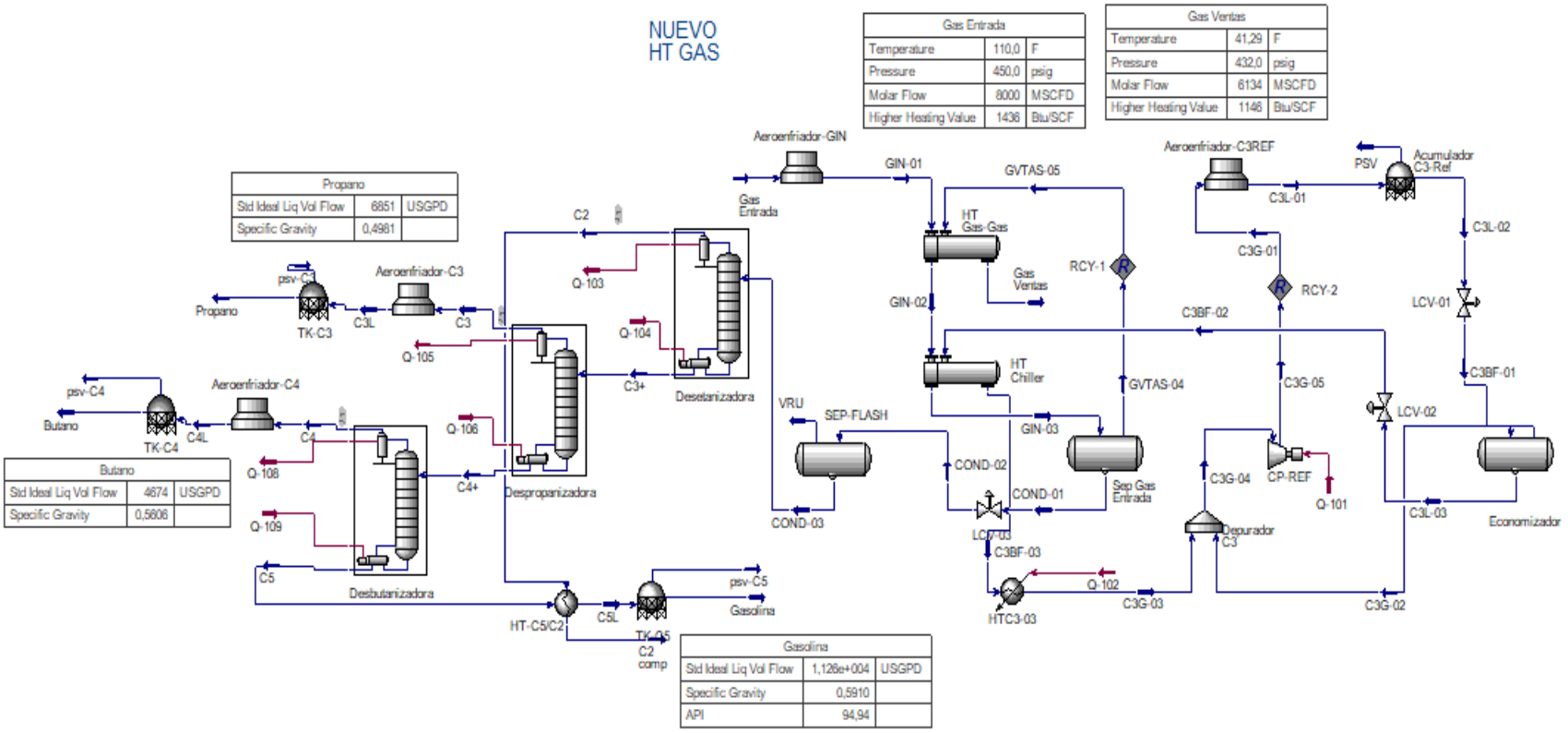
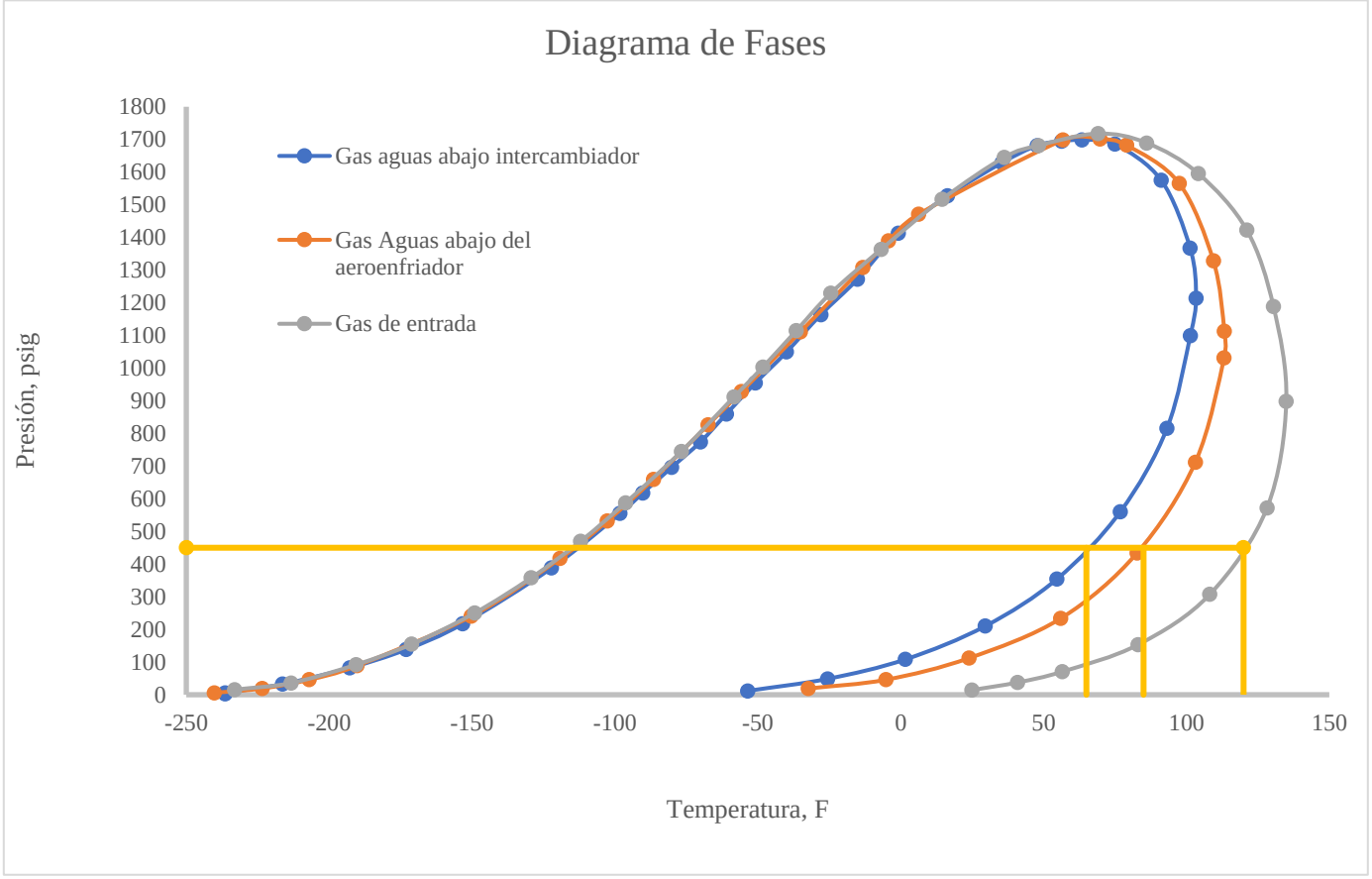


Figura 6.

Diagrama de Fases – Intercambiador de Calor Nuevo



¿Cuál es el análisis de la Figura 6? Se realiza la explicación en la 25 del documento.

5. Dimensionamiento del Nuevo Intercambiador de Calor HT (Gas-Gas)

Para el dimensionamiento del nuevo intercambiador se desarrolló el siguiente paso a paso:

- Definición y cálculo de las propiedades del Gas de Entrada a la planta y del Gas Residual o Gas ventas de acuerdo con su cromatografía.
- Tomando como referencia las propiedades de cada componente presente en la corriente de Gas de Entrada y en la corriente de Gas Residual descritas en la (Gas Processors Suppliers Association, s.f.) se construyeron las Tablas 5 y 6 para determinar la Masa Aparente, la Temperatura Crítica, la Presión Crítica y la Capacidad Calorífica de cada corriente.

Tabla 5.

Propiedades de la Corriente de Gas de Entrada

A Componente	Variables tomadas de las tablas de la GPSA					Variables Calculadas					
	B Fracción Molar, Xi	C Peso Molecular, lb/lbmol (PM)	D Teperatura Crítica, K	E Presión Crítica, psia	F Calor Específico, BTU/(Lb°F)	G Cálculo de la Masa Aparente (Xi*PM), lb	H Temperatura Crítica del gas, K	I Presión Crítica del gas, psia	J Composición en masa del gas, lbmol	K Fracción en masa del gas, lbm/lbm	L Capacidad Calorífica del gas (Cp), BTU/lb°F)
CO2	0.0085	44.0095	546.67	1070	0.1992	0.374	4.647	0.516	37.408	0.015	0.003
Nitrógeno	0.0015	28.0134	60.67	190.7	0.2483	0.042	0.091	0.516	4.202	0.002	0.0005
Metano	0.6905	16.0425	343.67	667	0.5266	11.077	237.304	378.857	1107.735	0.45	0.237
Etano	0.1401	30.069	548.67	706.6	0.4079	4.213	76.869	93.12	421.267	0.171	0.0698
Propano	0.0703	44.0956	664.67	615.5	0.3873	3.100	46.726	51.577	309.992	0.126	0.0488
I-Butano	0.0178	58.1222	733.67	527.9	0.3866	1.035	13.059	13.609	103.458	0.042	0.0162
n-Butano	0.0349	58.1222	764.55	550.9	0.3949	2.028	26.683	28.921	202.846	0.082	0.0324
I-Pentano	0.0157	72.1488	828.67	490.4	0.3828	1.133	13.01	13.261	113.274	0.046	0.0176
n-Pentano	0.0146	72.1488	844.67	488.8	0.3879	1.053	12.332	13.325	105.337	0.043	0.0167
n-Hexano	0.0044	86.1754	912.67	436.9	0.3857	0.379	4.016	4.275	37.917	0.015	0.0058
n-Heptano	0.0013	100.2019	971.67	396.8	0.3841	0.130	1.263	1.331	13.026	0.005	0.0019
n-Octano	0.0004	114.2285	1023.67	360.7	0.3829	0.046	0.409	0.428	4.569	0.002	0.0008
n-Nonano	0.0000	128.2551	1069.67	330.7	0.382	0.000	0	0	0	0	0
n-Decano	0.0000	142.2817	1111.67	304.6	0.3818	0.000	0	0	0	0	0
						24.610	**436.409**	**599.736**	**2461.031**		**0.4505**

Tabla 6.

Propiedades de la Corriente de Gas Residual (Gas Ventas)

A Componente	Variables tomadas de las tablas de la GPSA					Variables Calculadas					
	B Fracción Molar, Xi	C Peso Molecular, lb/lbmol (PM)	D Teperatura Crítica, K	E Presión Crítica, psia	F Calor Específico, BTU/(Lb°F)	G Cálculo de la Masa Aparente (Xi*PM), lb	H Temperatura Crítica del gas, K	I Presión Crítica del gas, psia	J Composición en masa del gas, lbmol	K Fracción en masa del gas, lbm/lbm	L Capacidad Calorífica del gas (Cp), BTU/lb°F)
CO2	0.0091	44.0095	546.67	1070	0.1992	0.400	4.975	0.552	40.049	0.021	0.0042
Nitrógeno	0.002	28.0134	60.67	190.7	0.2483	0.056	0.121	0.687	5.603	0.003	0.0007
Metano	0.8327	16.0425	343.67	667	0.5266	13.359	286.174	456.878	1335.859	0.695	0.366
Etano	0.118	30.069	548.67	706.6	0.4079	3.548	64.743	78.431	354.814	0.185	0.0755
Propano	0.0286	44.0956	664.67	615.5	0.3873	1.261	19.01	20.983	126.113	0.066	0.0256
I-Butano	0.0034	58.1222	733.67	527.9	0.3866	0.198	2.494	2.599	19.762	0.01	0.0039
n-Butano	0.0047	58.1222	764.55	550.9	0.3949	0.273	3.593	3.895	27.317	0.014	0.0055
I-Pentano	0.0009	72.1488	828.67	490.4	0.3828	0.065	0.746	0.76	6.493	0.003	0.0011
n-Pentano	0.0006	72.1488	844.67	488.8	0.3879	0.043	0.507	0.548	4.329	0.002	0.0008
n-Hexano	0.0001	86.1754	912.67	436.9	0.3857	0.009	0.091	0.097	0.862	0	0
n-Heptano	0	100.2019	971.67	396.8	0.3841	0.000	0	0	0	0	0
n-Octano	0	114.2285	1023.67	360.7	0.3829	0.000	0	0	0	0	0
n-Nonano	0	128.2551	1069.67	330.7	0.382	0.000	0	0	0	0	0
n-Decano	0	142.2817	1111.67	304.6	0.3818	0.000	0	0	0	0	0
						19.212	**382.454**	**565.43**	**1921.201**		**0.4833**

Con la Temperatura Crítica (columna H de las Tablas 5 y 6) y Presión Crítica (columna I de las Tablas 5 y 6) se calculan la Temperatura reducida y Presión reducida utilizando la regla de mezclas de Kay para cada una de las corrientes.

Gas de Entrada al Intercambiador de Calor (datos tomados de la simulación hysys y contrastados con datos de campo):

$$Treducida = \frac{Temperatura\ del\ gas\ en\ el\ proceso\ (gas\ ventas\ carcasa\ del\ intercambiador), K}{Temperatura\ Crítica, K}$$

$$Treducida\ gas\ de\ ventas = \frac{451}{436} = 1.03$$

$$Preducida = \frac{Presión\ del\ gas\ en\ el\ proceso, psia}{Presión\ Crítica, psia}$$

$$Preducida\ gas\ de\ entrada = \frac{446.6}{600} = 0.7$$

Con la temperatura reducida y la presión reducida se determina el factor Z para el gas de entrada utilizando la gráfica de factor Z para gases a bajas presiones pseudoreducidas desarrollada por Brown, G.G, Katz Et al. De esta gráfica se lee un factor equivalente a 0.7.

Aplicando la ecuación de gas ideales se determina la densidad del gas de entrada:

$$\rho(\frac{lb}{ft^3}) = \frac{Presión\ (psia) * Masa\ Aparente\ (columna\ I\ de\ la\ tabla\ 6.2)}{Z * R\ constante\ gas\ reales * T\ (K)}$$

$$\rho(\frac{lb}{ft^3}) = \frac{446.6\ psia * 24.61\ lb}{0.7 * 10.732\ \frac{psia\ ft^3}{lbmolR} *\ 451\ K}$$

$$\rho = 3.24 \frac{lb}{ft^3}$$

Teniendo en cuenta que el caudal de gas de ventas es 6.124 MMSCFD el flujo másico en libras por hora se puede determinar de la siguiente forma:

$$Flujo\ Másico\ de\ gas\ en\ \frac{lb}{h} = 6.124\ \frac{MMSCF}{d} * \frac{1d}{24\ h} * 3.24 \frac{lb}{ft^3} * \frac{1000000\ ft^3}{1\ MMSCF}$$

$$= \mathbf{827750\ \frac{lb}{h}}$$

Gas Ventas o Gas Residual (datos tomados de la simulación hysys y contrastados con datos de campo):

$$Treducida = \frac{Temperatura\ del\ gas\ en\ el\ proceso\ (entrada\ el\ intercambiador), K}{Temperatura\ Crítica, K}$$

$$Treducida\ gas\ de\ entrada = \frac{545}{382} = 1.42$$

$$Preducida = \frac{Presión\ del\ gas\ en\ el\ proceso, psia}{Presión\ Crítica, psia}$$

$$Preducida\ gas\ de\ entrada = \frac{464.6}{565.4} = 0.82$$

Con la temperatura reducida y la presión reducida se determina el factor Z para el gas de entrada utilizando la gráfica de factor Z para gases a bajas presiones pseudoreducidas desarrollada por Brown, G.G, Katz Et al. De esta gráfica se lee un factor equivalente a 0.94.

Aplicando la ecuación de gas ideales se determina la densidad del gas de entrada:

$$\rho(\frac{lb}{ft^3}) = \frac{Presión\ (psia) * Masa\ Aparente\ \ (columna\ I\ de\ las\ tablas\ 6.1)}{Z * R\ constante\ gas\ reales * T\ (K)}$$

$$\rho(\frac{lb}{ft^3}) = \frac{464.6\ psia * 19.212\ lb}{0.94 * 10.732\ \frac{psia\ ft^3}{lbmolR} *\ 545\ K}$$

$$\rho = 1.62 \frac{lb}{ft^3}$$

Teniendo en cuenta que el caudal de gas de entrada es 8 MMSCFD el flujo másico en libras por hora se puede determinar de la siguiente forma:

$$Flujo\ Másico\ de\ gas\ en\ \frac{lb}{h} = 8\ \frac{MMSCF}{d} * \frac{1d}{24\ h} * 1.62 \frac{lb}{ft^3} * \frac{1000000\ ft^3}{1\ MMSCF} = \mathbf{540000\ \frac{lb}{h}}$$

Posteriormente se utilizó la hoja de cálculo compartida por (Manuel Cabarcas, 2021b) en la clase de Operaciones Básicas de Procesos de la Especialización de Ingeniería de Gas de la UIS años 2021-2022. Los datos principales de diseño del intercambiador obtenidos con esta hoja de cálculo fueron:

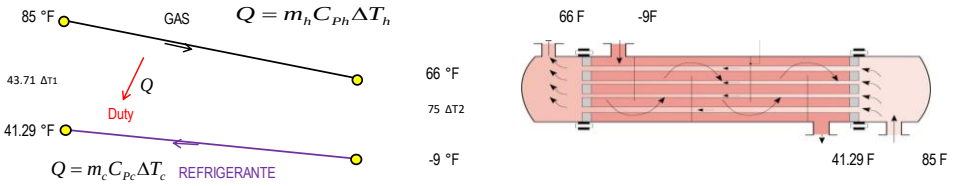
- Área del Intercambiador 2186 ft^2.
- Número de tubos 522.

Figura 7.

Hoja de Cálculo para el Diseño del Intercambiador

Gas de entrada 8 MMSCFD ó 827750 lb/h con base en la densidad del gas de entrada al intercambiador.

Gas ventas o gas residual 6.124 MMSCFD ó 540000 lb/h con base en la densidad del gas residual que fluye a través de la carcaza del intercambiador.



$$Q = m_h C_{Ph} \Delta T_h$$

VARIABLE	SIMBOLO	VALOR	UNIDADES
Capacidad calorífica del gas de entrada	C_{Ph}	0.4833	Btu/lbm-°F
Temperatura de entrada del gas	T_{h1}	85	°F
Temperatura de salida del gas	T_{h2}	66	°F
Flujo másico del gas de entrada	m_h	827750	lbm/hr
Duty del intercambiador de calor (calculado)	Q	7,600,980	Btu/hr

$$Q = m_c C_{Pc} \Delta T_c \longrightarrow \Delta T_c = \frac{Q}{m_c C_{pc}} \longrightarrow T_{c2} = T_{c1} + \Delta T_c$$

VARIABLE	SIMBOLO	VALOR	UNIDADES
Duty del intercambiador de calor	Q	7,600,980	Btu/hr
Flujo másico del refrigenrante	m_c	540000	lbm/hr
Temperatura de entrada del refrigerante	T_{c1}	-9.00	°F
Capacidad calorífica del refrigenerante	C_{Pc}	0.45	Btu/lbm-°F
Temperatura de salida del refrigerante	T_{c2}	41.29	°F

$$\Delta T_m = \frac{\Delta T_1 - \Delta T_2}{\ln\left(\frac{\Delta T_1}{\Delta T_2}\right)} \longrightarrow Q = UA\Delta T_m \longrightarrow A = \frac{Q}{U\Delta T_m}$$

VARIABLE	SIMBOLO	VALOR	UNIDADES
Duty del intercambiador de calor	Q	7,600,980	Btu/hr
Coeficiente global de transferencia de calor	U	60	Btu/hr-ft2-°F
Temperatura de entrada del gas	T_{h1}	85	°F
Temperatura de salida del gas	T_{h2}	66	°F
Temperatura de entrada del refrigerante (gas ventas)	T_{c1}	-9.00	°F
Temperatura de salida del refrigerante (gas ventas)	T_{c2}	41.29	°F
Diferencia de temperatura terminal más grande	ΔT_1	43.71	°F
Diferencia de temperatura terminal más pequeña	ΔT_2	75	°F
Temperatura media logaritmica	ΔT_m	57.95	°F
Area de transferencia de calor calculado	A	2186	ft2
Número de Tubos	n	522	Un

6. Análisis Costo-Beneficio

Teniendo en cuenta los precios de venta de referencia que se manejan para cada uno de los productos que resultan del proceso de la Planta de Gas del campo Payoa es altamente beneficioso realizar la inversión para instalar y poner en Marcha de un nuevo Intercambiador de Calor Gas – Gas. Los siguientes son los precios de venta que tiene estipulados PetroSantander con sus clientes para cada producto obtenido en el proceso de la Planta de Gas.

- Gas Residual 3.5 USD/MMBTU referencia (Ecopetrol S.A. - PetroSatander, 2021).
- Butano 62.85 USD/bbl y Propano 40 USD/bbl Referencia (Alma Gas - PetroSantander, 2020)
- Gasolina: Precio del crudo Brent más marcadores por calidad. La gasolina se vende mezclada con el crudo producido en el campo Payoa referencia. Para el mes de diciembre de 2021 el precio promedio de venta fua 87.78 USD/bbl (Ecopetrol - PetroSantander, 2019).

El ingreso adicional por día por el incremento de cada producto sería:

- Propano: 111 gal/d adicionales * 40 USD/bbl * 1 bbl/42 gal = 106 USD/d
- Butano: 419 gal/d adicionales * 62.85 USD/bbl * 1 bbl/42 gal = 627 USD/d
- Gasolina: 5683 gal/d adicionales * 87.78 USD/bbl * 1 bbl/42 gal = 11877 USD/d
- **Total ingreso adicional: 12610 USD.**

La inversión estimada de acuerdo con un presupuesto realizado conjuntamente con el departamento de producción de PetroSantander se calculó en:

- 335000 USD para la adquisición del Intercambiador, gastos logísticos de importación y transporte al campo Payoa.

- 21000 USD costos de instalación y puesta en marcha del intercambiador en la planta de gas.

- **Total inversión estimada: 356000 USD.**

El tiempo de pago estimado de la inversión teniendo en cuenta los ingresos adicionales por incremento en el recobro de las fracciones pesadas sería de 1 mes aproximadamente.

7. Conclusiones

- De acuerdo con el análisis costo-beneficio la instalación y puesta en marcha de un nuevo Intercambiador de Calor Gas – Gas incrementaría el volumen de Propano, Butano y Gasolina que se extrae del Gas Rico que se procesa en la Planta de Gas del campo Payoa. Para una carga constante de 8 MMCFD el incremento en galones por día de cada producto sería el siguiente: Propano 111 gal/d, Butano 419 gal/d y Gasolina 5683 gal/d, trayendo consigo un beneficio económico diario de 12610 USD que pagaría la inversión de compra e instalación de un nuevo Intercambiador de Calor Gas – Gas en 1 mes aproximadamente.

- El proceso actual de la Planta de Gas del campo Payoa presenta deficiencias en la extracción de Propano, Butano y Gasolina y en la calidad del Gas residual que pueden ser corregidas o mejoradas a través de la instalación de un nuevo Intercambiador de Calor Gas-Gas de tubos y carcaza de 1 paso con un área de transferencia de calor de 2186 ft^2 y 522 tubos internos.

- La instalación y puesta en marcha de un nuevo intercambiador de Calor Gas – Gas tendría el siguiente impacto en la calidad del Gas Residual: disminución del poder calorífico de 1172 a 1146 BTU/ft^3 garantizado cumpliendo con especificaciones del RUT y disminución en el % de molar de la fracción C_3^+ de 4.89 a 3.82%.

8. Recomendaciones

Para continuar con la maduración del proyecto y verificar el dimensionamiento del Intercambiador Gas-Gas se hacen las siguientes recomendaciones:

- Realizar sensibilidades en las simulaciones realizadas en Hysys modificando las siguientes variables:
    - Aumento y disminución del volumen de Gas de entrada.
    - Incremento de la fuga en el intercambiador Gas-Gas actualmente instalado.
- Realizar una revisión de la metalurgia de los equipos actualmente utilizada en la Planta de Gas y determinar las velocidades de corrosión para definir si es necesario implementar diferentes aleaciones a las actualmente utilizadas y así evitar el deterioro de los equipos principales del proceso de la Planta de Gas del Campo Payoa.
- Elaborar un cronograma detallado de la Parada de Planta de Gas que se requiere para instalar un nuevo Intercambiador Gas-Gas estableciendo los controles operacionales y las funciones y tareas de cada grupo que se involucrará en la actividad.

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Apéndices

Apéndice A. Reporte de Operación HT Averiado

	PETROSANTANDER COLOMBIA Bedford, MA USA		Case Name:	Simulación Mario HT Gas-01.hsc				
			Unit Set:	NewUser				
			Date/Time:	Fri Dec 3 09:02:18 2021				

Heat Exchanger: HT Gas-Gas

CONNECTIONS

Tube Side				Shell Side			
Inlet		Outlet		Inlet		Outlet	
Name	GIN-01-A	Name	GIN-02	Name	GVTAS-05	Name	Gas Residual
From Op.	TEE-100	To Op.	HT Chiller	From Op.	RCY-1	To Op.	MIX-100
Op. Type	Tee	Op. Type	Heat Exchanger	Op. Type	Recycle	Op. Type	Mixer
Temp	84.62 F	Temp	68.00 F	Temp	1.87 F *	Temp	45.37 F

PARAMETERS

Heat Exchanger Model:			Simple End Point		
Tube Side DeltaP:	3.000 psi *	Shell Side DeltaP:	10.00 psi *	Passes:	---
UA:	8000 Btu/F-hr *	Tolerance:	1.0000e-04		

Tube Side Data		Shell Side Data	
Heat Transfer Coeff	---	Heat Transfer Coeff	---
Tube Pressure Drop	3.00 psi *	Shell Pressure Drop	10.00 psi *
Fouling	1.0000e-003 F-hr-ft2/Btu *	Fouling	1.0000e-003 F-hr-ft2/Btu *
Tube Length	39.52 ft *	Shell Passes	1
Tube O.D.	0.75 in *	Shell Series	1
Tube Thickness	0.0415 in	Shell Parallel	1
Tube Pitch	0.9375 in *	Baffle Type	Single
Orientation	Horizontal	Baffle Cut(%Area)	25.00 *
Passes Per Shell	1 *	Baffle Orientation	Horizontal
Tubes Per Shell	295 *	Spacing	18.8141 in *
Layout Angle	Triangular Rotated (60 degrees)	Diameter	18.5000 in *
TEMA Type	N E N	Area	2289.17 ft2

SPECS

	Spec Value	Curr Value	Rel Error	Active	Estimate
E-100 Heat Balance	0.0000 Btu/hr	0.0000 Btu/hr	0.0000	On	Off
E-100 UA	8000 Btu/F-hr *	8000 Btu/F-hr	-1.376e-005	On	Off

Detailed Specifications

E-100 Heat Balance

Type: Duty	Pass: Error	Spec Value: 0.0000 Btu/hr

E-100 UA

Type: UA	Pass: Overall	Spec Value: 8000 Btu/F-hr *

User Variables

RATING

Sizing

Overall Data

Configuration

# of Shells in Series	1	Tube Passes per Shell	1 *	Elevation (Base)	0.0000 ft		
# of Shells in Parallel	1	Exchange Orientation	Horizontal	First Tube Pass Flow Direction	Co-Current		
TEMA Type:		N		E		N	

Calculated Information

Shell HT Coeff	---	Tube HT Coeff	---
Overall U	3.495 Btu/hr-ft2-F	Overall UA	8000 Btu/F-hr *
Shell DP	10.00 psi *	Tube DP	3.000 psi *
Shell Vol per Shell	284.3 gal	Tube Vol per Shell	211.6 gal
HT Area per Shell	2289 ft2		

Shell Data

Shell and Tube Bundle

Shell Diameter (in)	18.50 *	Tube Pitch (in)	0.9375 *	Shell Fouling (F-hr-ft2/Btu)	1.000e-003 *

PETROSANTANDER COLOMBIA Bedford, MA USA	Case Name:	Simulación Mario HT Gas-01.hsc	
	Unit Set:	NewUser	
	Date/Time:	Fri Dec 3 09:02:18 2021	

Heat Exchanger: HT Gas-Gas (continued)

# of Tubes per Shell	295 *	Tube Layout Angle	Triangular Rotated (60 degrees)

Shell Baffles

Shell Baffle Type	Single	Shell Baffle Orientation	Horizontal
Baffle Cut (%Area)	25.00 *	Baffle Spacing	18.81 in *

Tube Data

Dimensions

OD (in)	ID (in)	Tube Thickness (in)	Tube Length (ft)
0.7500 *	0.6670 *	4.150e-002	39.52 *

Tube Properties

Tube Fouling (F-hr-ft2/Btu)	Thermal Cond. (Btu/hr-ft-F)	Wall Cp (Btu/lb-F)	Wall Density (lb/ft3)
1.000e-003 *	26.00	---	---

Nozzle Parameters

Base Elevation Relative to Ground Level: 0.0000 ft

		GIN-01-A	GVTAS-05	GIN-02
Diameter	(ft)	0.1640	0.1640	0.1640
Elevation (Base)	(ft)	0.0000	0.0000	0.0000
Elevation (Ground)	(ft)	0.0000 *	0.0000 *	0.0000 *
Elevation (% of Height)	(%)	0.00	0.00	0.00
		Gas Residual		
Diameter	(ft)	0.1640		
Elevation (Base)	(ft)	0.0000		
Elevation (Ground)	(ft)	0.0000 *		
Elevation (% of Height)	(%)	0.00		

Simple Heat Loss Parameters

Overall U (Btu/hr-ft2-F)	Ambient Temperature (F)	Overall Heat Transfer Area (ft2)	Heat Flow (Btu/hr)
2.495	90.00 *	---	---

CONDITIONS

Name		GIN-01-A	GVTAS-05	GIN-02	Gas Residual
Vapour		0.9526	1.0000	0.9244	1.0000
Temperature	(F)	84.6165	1.8703 *	68.0038	45.3653
Pressure	(psig)	447.0000	442.0000 *	444.0000	432.0000
Molar Flow	(MSCFD)	7880.0000	6244.2569 *	7880.0000	6244.2569
Mass Flow	(lb/hr)	21295.3370	13435.1072	21295.3370	13435.1072
Std Ideal Liq Vol Flow	(USGPD)	161995.7023	116701.4392	161995.7023	116701.4392
Molar Enthalpy	(Btu/lbmole)	-3.802e+004	-3.585e+004	-3.841e+004	-3.536e+004
Molar Entropy	(Btu/lbmole-F)	37.24	36.23	36.53	37.28
Heat Flow	(Btu/hr)	-3.2902e+07	-2.4578e+07	-3.3236e+07	-2.4244e+07

PROPERTIES

Name		GIN-01-A	GVTAS-05	GIN-02	Gas Residual	
Molecular Weight		24.61	19.59	24.61	19.59	
Molar Density	(lbmole/ft3)	9.555e-002	0.1107	0.1009	9.371e-002	
Mass Density	(lb/ft3)	2.352	2.170	2.483	1.836	
Act. Volume Flow	(USGPD)	1.626e+006	1.112e+006	1.539e+006	1.314e+006	
Mass Enthalpy	(Btu/lb)	-1545	-1829	-1561	-1805	
Mass Entropy	(Btu/lb-F)	1.513	1.849	1.484	1.902	
Heat Capacity	(Btu/lbmole-F)	13.58	11.17	13.65	10.82	
Mass Heat Capacity	(Btu/lb-F)	0.5519	0.5703	0.5545	0.5524	
LHV Molar Basis (Std)	(Btu/SCF)	1317	1064	1317	1064	
HHV Molar Basis (Std)	(Btu/SCF)	1436	1167	1436	1167	
HHV Mass Basis (Std)	(Btu/lb)	2.214e+004	2.259e+004	2.214e+004	2.259e+004	
CO2 Loading		---	---	---	---	
CO2 Apparent Mole Conc.	(lbmole/ft3)	---	---	---	---	
CO2 Apparent Wt. Conc.	(lbmol/lb)	---	---	---	---	
LHV Mass Basis (Std)	(Btu/lb)	2.030e+004	2.061e+004	2.030e+004	2.061e+004	
Phase Fraction [Vol. Basis]		0.9287	1.000	0.8888	1.000	
Phase Fraction [Mass Basis]		0.8951	1.000	0.8396	1.000	
Phase Fraction [Act. Vol. Basis]		0.9928	1.000	0.9883	1.000	

PETROSANTANDER COLOMBIA
Bedford, MA
USA

Case Name: Simulación Mario HT Gas-01.hsc
Unit Set: NewUser
Date/Time: Fri Dec 3 09:02:18 2021

Heat Exchanger: HT Gas-Gas (continued)

PROPERTIES

Name		GIN-01-A	GVTAS-05	GIN-02	Gas Residual
Mass Exergy	(Btu/lb)	141.9	184.8	141.7	181.0
Partial Pressure of CO2	(psig)	-10.63	-10.50	-10.59	-10.59
Cost Based on Flow	(Cost/s)	0.0000	0.0000	0.0000	0.0000
Act. Gas Flow	(ACFM)	149.8	103.2	141.2	121.9
Avg. Liq. Density	(lbmole/ft3)	0.9589	1.055	0.9589	1.055
Specific Heat	(Btu/lbmole-F)	13.58	11.17	13.65	10.82
Std. Gas Flow	(MSCFD)	7865	6233	7865	6233
Std. Ideal Liq. Mass Density	(lb/ft3)	23.60	20.67	23.60	20.67
Act. Liq. Flow	(USGPD)	1.177e+004	---	1.799e+004	---
Z Factor		---	0.8328	---	0.8795
Watson K		17.09	18.55	17.09	18.55
User Property		---	---	---	---
Partial Pressure of H2S	(psig)	-14.70	-14.70	-14.70	-14.70
Cp/(Cp - R)		1.171	1.216	1.170	1.225
Cp/Cv		1.336	1.536	1.327	1.437
Ideal Gas Cp/Cv		1.210	1.279	1.214	1.268
Ideal Gas Cp	(Btu/lbmole-F)	11.45	9.096	11.26	9.384
Mass Ideal Gas Cp	(Btu/lb-F)	0.4651	0.4642	0.4576	0.4789
Heat of Vap.	(Btu/lbmole)	6461	4034	6469	4067
Kinematic Viscosity	(cSt)	---	0.3050	---	0.3838
Liq. Mass Density (Std. Cond)	(lb/ft3)	6.535e-002	5.193e-002	6.535e-002	5.193e-002
Liq. Vol. Flow (Std. Cond)	(USGPD)	5.850e+007	4.645e+007	5.850e+007	4.645e+007
Liquid Fraction		4.736e-002	0.0000	7.563e-002	0.0000
Molar Volume	(ft3/lbmole)	10.47	9.032	9.910	10.67
Mass Heat of Vap.	(Btu/lb)	262.5	205.9	262.8	207.5
Phase Fraction [Molar Basis]		0.9526	1.0000	0.9244	1.0000
Surface Tension	(dyne/cm)	9.233	---	9.473	---
Thermal Conductivity	(Btu/hr-ft-F)	---	1.660e-002	---	1.810e-002
Bubble Point Pressure	(psig)	---	---	---	---
Viscosity	(cP)	---	1.060e-002	---	1.129e-002
Cv (Semi-Ideal)	(Btu/lbmole-F)	11.60	9.188	11.66	8.838
Mass Cv (Semi-Ideal)	(Btu/lb-F)	0.4712	0.4689	0.4738	0.4511
Cv	(Btu/lbmole-F)	10.17	7.276	10.29	7.533
Mass Cv	(Btu/lb-F)	0.4131	0.3713	0.4180	0.3844
Cv (Ent. Method)	(Btu/lbmole-F)	---	---	---	---
Mass Cv (Ent. Method)	(Btu/lb-F)	---	---	---	---
Cp/Cv (Ent. Method)		---	---	---	---
Reid VP at 37.8 C	(psig)	---	---	---	---
True VP at 37.8 C	(psig)	---	---	---	---
Liq. Vol. Flow - Sum(Std. Cond()	USGPD)	5.578e+007	4.645e+007	5.415e+007	4.645e+007
Viscosity Index		---	---	---	-75.25

DETAILS

Overall/Detailed Performance

Duty:	3.340e+05 Btu/hr	UA Curv. Error:	0.00e-01 Btu/F-hr
Heat Leak:	0.000e-01 Btu/hr	Hot Pinch Temp:	68.00 F
Heat Loss:	0.000e-01 Btu/hr	Cold Pinch Temp:	45.37 F
UA:	8.000e+03 Btu/F-hr	Ft Factor:	---
Min. Approach:	22.64 F	Uncorrected Lmtd:	46.39 F
Lmtd:	41.75 F		

TABLES

PETROSANTANDER COLOMBIA
Bedford, MA
USA

Case Name: Simulación Mario HT Gas-01.hsc
Unit Set: NewUser
Date/Time: Fri Dec 3 09:02:18 2021

Heat Exchanger: HT Gas-Gas (continued)

Shell Side - Overall Phase

Temperature (F)	Pressure (psig)	Heat Flow (Btu/hr)	Enthalpy (Btu/lbmole)
1.87	442.00	0.00	-35846.29
45.37	432.00	333965.26	-35359.21

UA (Btu/F-hr)	Molar Vap Frac	Mass Vap Frac	Heat of Vap. (Btu/lbmole)
0.00	1.0000	1.0000	---
0.00	1.0000	1.0000	---

Shell Side - Vapour Phase

Mass Flow (lb/hr)	Molecular Wt	Density (lb/ft3)	Mass Sp Heat (Btu/lb-F)	Viscosity (cP)	Thermal Cond (Btu/hr-ft-F)
13435.11	19.59	2.17	0.57	0.01	0.02
13435.11	19.59	1.84	0.55	0.01	0.02

Std Gas Flow (MSCFD)	Z Factor	Pseudo Pc (psig)	Pseudo Tc (F)	Pseudo Zc	Pseudo Omega
6232.56	0.83	662.38	-72.62	0.29	0.03
6232.56	0.88	662.38	-72.62	0.29	0.03

Shell Side - Light Liquid Phase

Mass Flow (lb/hr)	Density (lb/ft3)	Mass Sp Heat (Btu/lb-F)	Viscosity (cP)	Thermal Cond (Btu/hr-ft-F)	Surface Tens (dyne/cm)
---	---	---	---	---	---
---	---	---	---	---	---

Molecular Wt	Sp Gravity	Pseudo Pc (psig)	Pseudo Tc (F)	Pseudo Zc	Pseudo Omega
---	---	---	---	---	---
---	---	---	---	---	---

Shell Side - Heavy Liquid Phase

Mass Flow (lb/hr)	Density (lb/ft3)	Mass Sp Heat (Btu/lb-F)	Viscosity (cP)	Thermal Cond (Btu/hr-ft-F)	Surface Tens (dyne/cm)
---	---	---	---	---	---
---	---	---	---	---	---

Molecular Wt	Sp Gravity	Pseudo Pc (psig)	Pseudo Tc (F)	Pseudo Zc	Pseudo Omega
---	---	---	---	---	---
---	---	---	---	---	---

Shell Side - Mixed Liquid

Mass Flow (lb/hr)	Density (lb/ft3)	Mass Sp Heat (Btu/lb-F)	Viscosity (cP)	Thermal Cond (Btu/hr-ft-F)	Surface Tens (dyne/cm)
0.00	---	---	---	---	---
0.00	---	---	---	---	---

Molecular Wt	Sp Gravity	Pseudo Pc (psig)	Pseudo Tc (F)	Pseudo Zc	Pseudo Omega
---	---	---	---	---	---
---	---	---	---	---	---

Tube Side - Overall Phase

Temperature (F)	Pressure (psig)	Heat Flow (Btu/hr)	Enthalpy (Btu/lbmole)
68.00	444.00	0.00	-38410.69
84.62	447.00	333965.26	-38024.72

UA (Btu/F-hr)	Molar Vap Frac	Mass Vap Frac	Heat of Vap. (Btu/lbmole)
0.00	0.9244	0.8396	---
0.00	0.9526	0.8951	---

PETROSANTANDER COLOMBIA
Bedford, MA
USA

Case Name: Simulación Mario HT Gas-01.hsc
Unit Set: NewUser
Date/Time: Fri Dec 3 09:02:18 2021

Heat Exchanger: HT Gas-Gas (continued)

Tube Side - Vapour Phase

Mass Flow (lb/hr)	Molecular Wt	Density (lb/ft3)	Mass Sp Heat (Btu/lb-F)	Viscosity (cP)	Thermal Cond (Btu/hr-ft-F)
17879.79	22.35	2.11	0.55	0.01	0.02
19061.98	23.13	2.12	0.55	0.01	0.02
Std Gas Flow (MSCFD)	**Z Factor**	**Pseudo Pc (psig)**	**Pseudo Tc (F)**	**Pseudo Zc**	**Pseudo Omega**
7270.38	0.86	655.83	-43.70	0.29	0.04
7492.77	0.86	653.44	-36.35	0.29	0.05

Tube Side - Light Liquid Phase

Mass Flow (lb/hr)	Density (lb/ft3)	Mass Sp Heat (Btu/lb-F)	Viscosity (cP)	Thermal Cond (Btu/hr-ft-F)	Surface Tens (dyne/cm)
3415.54	34.08	0.59	0.14	0.05	9.47
2233.35	34.08	0.60	0.14	0.05	9.23
Molecular Wt	**Sp Gravity**	**Pseudo Pc (psig)**	**Pseudo Tc (F)**	**Pseudo Zc**	**Pseudo Omega**
52.19	0.55	559.05	229.98	0.28	0.17
54.50	0.55	549.40	245.47	0.28	0.18

Tube Side - Heavy Liquid Phase

Mass Flow (lb/hr)	Density (lb/ft3)	Mass Sp Heat (Btu/lb-F)	Viscosity (cP)	Thermal Cond (Btu/hr-ft-F)	Surface Tens (dyne/cm)
---	---	---	---	---	---
---	---	---	---	---	---
Molecular Wt	**Sp Gravity**	**Pseudo Pc (psig)**	**Pseudo Tc (F)**	**Pseudo Zc**	**Pseudo Omega**
---	---	---	---	---	---
---	---	---	---	---	---

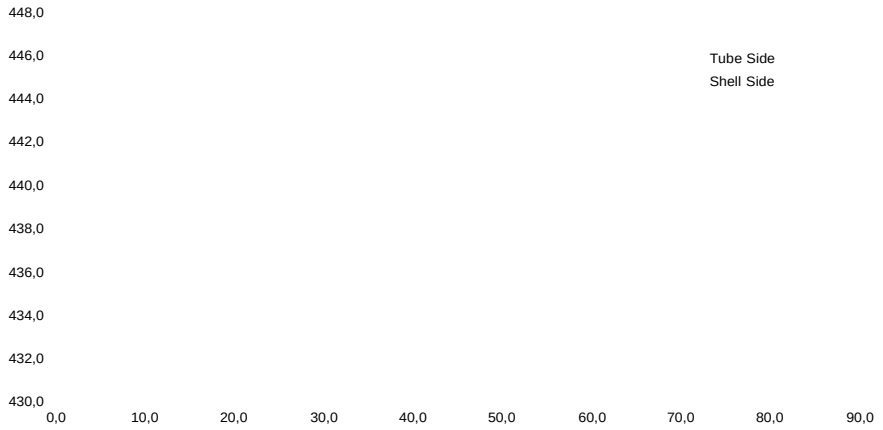
Tube Side - Mixed Liquid

Mass Flow (lb/hr)	Density (lb/ft3)	Mass Sp Heat (Btu/lb-F)	Viscosity (cP)	Thermal Cond (Btu/hr-ft-F)	Surface Tens (dyne/cm)
3415.54	34.08	0.59	0.14	0.05	---
2233.35	34.08	0.60	0.14	0.05	---
Molecular Wt	**Sp Gravity**	**Pseudo Pc (psig)**	**Pseudo Tc (F)**	**Pseudo Zc**	**Pseudo Omega**
52.19	0.55	559.05	229.98	0.28	0.17
54.50	0.55	549.40	245.47	0.28	0.18

PETROSANTANDER COLOMBIA
Bedford, MA
USA

Case Name:	Simulación Mario HT Gas-01.hsc
Unit Set:	NewUser
Date/Time:	Fri Dec 3 09:02:18 2021

Heat Exchanger: HT Gas-Gas (continued)



DYNAMICS

Basic Model

Model Parameters

Tube Volume	(gal)	26.42	Shell UA	(lb/hr)	---
Shell Volume	(gal)	26.42	Tube UA	(lb/hr)	---
Elevation	(ft)	0.0000	Minimum Flow Scale Factor		0.0000 *
Overall UA	(Btu/F-hr)	8000 *			

Summary

Shell Duty: --- Tube Duty: ---

Pressure Flow Specifications

Shell Side Specification

Delta P	(psi)	10.00 *	Active	k	lb/hr/sqrt(psia-lb/ft3)	---	Not Active

Tube Side Specifications

Delta P	(psi)	3.000 *	Active	k	lb/hr/sqrt(psia-lb/ft3)	---	Not Active

Holdup

Shell Holdup

Phase	Accumulation (MSCFD)	Moles (lbmole)	Volume (gal)
Vapour	0.0000	0.0000	0.0000
Liquid	0.0000	0.0000	0.0000
Aqueous	0.0000	0.0000	0.0000
Total	**0.0000**	**0.0000**	**0.0000**

Tube Holdup

Phase	Accumulation (MSCFD)	Moles (lbmole)	Volume (gal)
Vapour	0.0000	0.0000	0.0000
Liquid	0.0000	0.0000	0.0000

PETROSANTANDER COLOMBIA
Bedford, MA
USA

Case Name: Simulación Mario HT Gas-01.hsc
Unit Set: NewUser
Date/Time: Fri Dec 3 09:02:18 2021

Heat Exchanger: HT Gas-Gas (continued)

Phase	Accumulation (MSCFD)	Moles (lbmole)	Volume (gal)
Aqueous	0.0000	0.0000	0.0000
Total	**0.0000**	**0.0000**	**0.0000**

Overall Fouling Details

Delay Time (seconds) ---
Ramp Time (seconds) ---
Overall UA Decrease ---
Active Status Off

Shell Fouling Details

Delay Time (seconds) ---
Ramp Time (seconds) ---
Shell UA Decrease ---
Shell DP Increase ---
Active Status Off

Tube Fouling Details

Delay Time (seconds) ---
Ramp Time (seconds) ---
Tube UA Decrease ---
Tube DP Increase ---
Active Status Off

NOTES

HTFS

Exchanger Design and Rating

Apéndice B. Reporte de Simulación HT Averiado

	PETROSANTANDER COLOMBIA Bedford, MA USA	Case Name:	Simulación Mario HT Gas-01.hsc		
		Unit Set:	NewUser		
		Date/Time:	Fri Dec 3 09:03:31 2021		
	Material Stream: Gas Entrada	Fluid Package:			
		Property Package:			
	CONDITIONS				
		Overall	Vapour Phase	Liquid Phase	
	Vapour / Phase Fraction	0.9893	0.9893	0.0107	
	Temperature: (F)	110.0 *	110.0	110.0	
	Pressure: (psig)	450.0 *	450.0	450.0	
	Molar Flow (MSCFD)	8000 *	7914	85.99	
	Mass Flow (lb/hr)	2.162e+004	2.106e+004	557.9	
	Std Ideal Liq Vol Flow (USGPD)	1.645e+005	1.617e+005	2786	
	Molar Enthalpy (Btu/lbmole)	-3.746e+004	-3.717e+004	-6.416e+004	
	Molar Entropy (Btu/lbmole-F)	38.25	38.39	25.42	
	Heat Flow (Btu/hr)	-3.290e+007	-3.230e+007	-6.058e+005	
	Liq Vol Flow @Std Cond (USGPD)	5.939e+007 *	5.876e+007	2737	
	PROPERTIES				
		Overall	Vapour Phase	Liquid Phase	
	Molecular Weight	24.61	24.24	59.09	
	Molar Density (lbmole/ft3)	8.829e-002	8.749e-002	0.5812	
	Mass Density (lb/ft3)	2.173	2.120	34.34	
	Act. Volume Flow (USGPD)	1.786e+006	1.783e+006	2917	
	Mass Enthalpy (Btu/lb)	-1522	-1534	-1086	
	Mass Entropy (Btu/lb-F)	1.554	1.584	0.4303	
	Heat Capacity (Btu/lbmole-F)	13.50	13.26	35.59	
	Mass Heat Capacity (Btu/lb-F)	0.5484	0.5470	0.6023	
	LHV Molar Basis (Std) (Btu/SCF)	1317	1298	3051	
	HHV Molar Basis (Std) (Btu/SCF)	1436	1416	3286	
	HHV Mass Basis (Std) (Btu/lb)	2.214e+004	2.217e+004	2.110e+004	
	CO2 Loading	---	---	---	
	CO2 Apparent Mole Conc. (lbmole/ft3)	---	---	1.608e-003	
	CO2 Apparent Wt. Conc. (lbmol/lb)	---	---	4.681e-005	
	LHV Mass Basis (Std) (Btu/lb)	2.030e+004	2.032e+004	1.959e+004	
	Phase Fraction [Vol. Basis]	0.9831	0.9831	1.694e-002	
	Phase Fraction [Mass Basis]	0.9742	0.9742	2.580e-002	
	Phase Fraction [Act. Vol. Basis]	0.9984	0.9984	1.633e-003	
	Mass Exergy (Btu/lb)	143.0	---	---	
	Partial Pressure of CO2 (psig)	-10.70	---	---	
	Cost Based on Flow (Cost/s)	0.0000	0.0000	0.0000	
	Act. Gas Flow (ACFM)	165.5	165.5	---	
	Avg. Liq. Density (lbmole/ft3)	0.9589	0.9650	0.6084	
	Specific Heat (Btu/lbmole-F)	13.50	13.26	35.59	
	Std. Gas Flow (MSCFD)	7985	7899	85.83	
	Std. Ideal Liq. Mass Density (lb/ft3)	23.60	23.39	35.95	
	Act. Liq. Flow (USGPD)	2917	---	2917	
	Z Factor	---	0.8688	0.1308	
	Watson K	17.09	17.19	13.62	
	User Property	---	---	---	
	Partial Pressure of H2S (psig)	-14.70	---	---	
	Cp/(Cp - R)	1.173	1.176	1.059	
	Cp/Cv	1.345	1.358	1.059	
	Ideal Gas Cp/Cv	1.204	1.207	1.086	

PETROSANTANDER COLOMBIA
Bedford, MA
USA

Case Name: Simulación Mario HT Gas-01.hsc
Unit Set: NewUser
Date/Time: Fri Dec 3 09:03:31 2021

Material Stream: Gas Entrada (continued)

Fluid Package: Basis-1
Property Package: Peng-Robinson

PROPERTIES

		Overall	Vapour Phase	Liquid Phase		
Surface Tension	(dyne/cm)	9.127	---	9.127		
Thermal Conductivity	(Btu/hr-ft-F)	---	1.928e-002	5.115e-002		
Bubble Point Pressure	(psig)	---	---	---		
Viscosity	(cP)	---	1.243e-002	0.1393		
Cv (Semi-Ideal)	(Btu/lbmole-F)	11.51	11.27	33.60		
Mass Cv (Semi-Ideal)	(Btu/lb-F)	0.4677	0.4651	0.5687		
Cv	(Btu/lbmole-F)	10.04	9.765	33.60		
Mass Cv	(Btu/lb-F)	0.4078	0.4029	0.5687		
Cv (Ent. Method)	(Btu/lbmole-F)	---	---	---		
Mass Cv (Ent. Method)	(Btu/lb-F)	---	---	---		
Cp/Cv (Ent. Method)		---	---	---		
Reid VP at 37.8 C	(psig)	---	---	157.0		
True VP at 37.8 C	(psig)	---	---	430.3		
Liq. Vol. Flow - Sum(Std. Cond)()	USGPD	5.877e+007	5.876e+007	2737		
Viscosity Index		-108.7	---	---		

COMPOSITION

Overall Phase

Vapour Fraction 0.9893

COMPONENTS	MOLAR FLOW (lbmole/hr)	MOLE FRACTION	MASS FLOW (lb/hr)	MASS FRACTION	LIQUID VOLUME FLOW (USGPD)	LIQUID VOLUME FRACTION
CO2	7.5019 *	0.0085 *	330.1579 *	0.0153 *	1150.4167 *	0.0070 *
Nitrogen	1.3440 *	0.0015 *	37.6501 *	0.0017 *	134.2745 *	0.0008 *
Methane	606.5436 *	0.6905 *	9730.8192 *	0.4501 *	93469.5273 *	0.5683 *
Ethane	123.0340 *	0.1401 *	3699.6576 *	0.1711 *	29913.1509 *	0.1819 *
Propane	61.7893 *	0.0703 *	2724.7511 *	0.1260 *	15465.3064 *	0.0940 *
i-Butane	15.5923 *	0.0178 *	906.2944 *	0.0419 *	4637.9172 *	0.0282 *
n-Butane	30.6838 *	0.0349 *	1783.4852 *	0.0825 *	8794.2458 *	0.0535 *
i-Pentane	13.8090 *	0.0157 *	996.3463 *	0.0461 *	4595.9787 *	0.0279 *
n-Pentane	12.7813 *	0.0146 *	922.1908 *	0.0427 *	4211.4421 *	0.0256 *
n-Hexane	3.8651 *	0.0044 *	333.0919 *	0.0154 *	1445.5542 *	0.0088 *
n-Heptane	1.1156 *	0.0013 *	111.7914 *	0.0052 *	468.0934 *	0.0028 *
n-Octane	0.3602 *	0.0004 *	41.1422 *	0.0019 *	167.7372 *	0.0010 *
n-Decane	0.0000 *	0.0000 *	0.0000 *	0.0000 *	0.0000 *	0.0000 *
n-Nonane	0.0176 *	0.0000 *	2.2534 *	0.0001 *	8.9974 *	0.0001 *
Total	878.4375	1.0000	21619.6314	1.0000	164462.6419	1.0000

Vapour Phase

Phase Fraction 0.9893

COMPONENTS	MOLAR FLOW (lbmole/hr)	MOLE FRACTION	MASS FLOW (lb/hr)	MASS FRACTION	LIQUID VOLUME FLOW (USGPD)	LIQUID VOLUME FRACTION
CO2	7.4757	0.0086	329.0085	0.0156	1146.4118	0.0071
Nitrogen	1.3430	0.0015	37.6230	0.0018	134.1777	0.0008
Methane	605.4298	0.6967	9712.9512	0.4612	93297.8956	0.5771
Ethane	122.1825	0.1406	3674.0527	0.1744	29706.1256	0.1837
Propane	60.6549	0.0698	2674.7282	0.1270	15181.3838	0.0939
i-Butane	15.0212	0.0173	873.1018	0.0415	4468.0557	0.0276
n-Butane	29.2321	0.0336	1699.1035	0.0807	8378.1654	0.0518
i-Pentane	12.5447	0.0144	905.1185	0.0430	4175.1603	0.0258
n-Pentane	11.3596	0.0131	819.6167	0.0389	3743.0087	0.0232
n-Hexane	2.9627	0.0034	255.3178	0.0121	1108.0301	0.0069
n-Heptane	0.6505	0.0007	65.1881	0.0031	272.9559	0.0017
n-Octane	0.1353	0.0002	15.4609	0.0007	63.0343	0.0004
n-Decane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
n-Nonane	0.0037	0.0000	0.4773	0.0000	1.9058	0.0000
Total	868.9958	1.0000	21061.7483	1.0000	161676.3106	1.0000

PETROSANTANDER COLOMBIA
Bedford, MA
USA

Case Name: Simulación Mario HT Gas-01.hsc
Unit Set: NewUser
Date/Time: Fri Dec 3 09:03:31 2021

Material Stream: Gas Entrada (continued)

Fluid Package: Basis-1
Property Package: Peng-Robinson

COMPOSITION

Liquid Phase

Phase Fraction 1.075e-002

COMPONENTS	MOLAR FLOW (lbmole/hr)	MOLE FRACTION	MASS FLOW (lb/hr)	MASS FRACTION	LIQUID VOLUME FLOW (USGPD)	LIQUID VOLUME FRACTION
CO2	0.0261	0.0028	1.1494	0.0021	4.0049	0.0014
Nitrogen	0.0010	0.0001	0.0272	0.0000	0.0969	0.0000
Methane	1.1138	0.1180	17.8680	0.0320	171.6317	0.0616
Ethane	0.8515	0.0902	25.6049	0.0459	207.0254	0.0743
Propane	1.1344	0.1201	50.0228	0.0897	283.9226	0.1019
i-Butane	0.5711	0.0605	33.1926	0.0595	169.8615	0.0610
n-Butane	1.4517	0.1538	84.3817	0.1513	416.0804	0.1493
i-Pentane	1.2644	0.1339	91.2278	0.1635	420.8185	0.1510
n-Pentane	1.4216	0.1506	102.5741	0.1839	468.4334	0.1681
n-Hexane	0.9025	0.0956	77.7740	0.1394	337.5242	0.1211
n-Heptane	0.4651	0.0493	46.6033	0.0835	195.1375	0.0700
n-Octane	0.2248	0.0238	25.6813	0.0460	104.7030	0.0376
n-Decane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
n-Nonane	0.0138	0.0015	1.7761	0.0032	7.0915	0.0025
Total	9.4418	1.0000	557.8831	1.0000	2786.3314	1.0000

K VALUE

COMPONENTS	MIXED	LIGHT	HEAVY
CO2	3.110	3.110	---
Nitrogen	15.05	15.05	---
Methane	5.906	5.906	---
Ethane	1.559	1.559	---
Propane	0.5810	0.5810	---
i-Butane	0.2858	0.2858	---
n-Butane	0.2188	0.2188	---
i-Pentane	0.1078	0.1078	---
n-Pentane	8.682e-002	8.682e-002	---
n-Hexane	3.567e-002	3.567e-002	---
n-Heptane	1.520e-002	1.520e-002	---
n-Octane	6.541e-003	6.541e-003	---
n-Decane	---	---	---
n-Nonane	2.920e-003	2.920e-003	---

UNIT OPERATIONS

FEED TO	PRODUCT FROM	LOGICAL CONNECTION
Air cooler: Aeroenfriador-GIN		

UTILITIES

(No utilities reference this stream)

PROCESS UTILITY

DYNAMICS

Pressure Specification (Active): 450.0 psig *

Flow Specification (Active) Molar: 8000 MSCFD * Mass: 2.162e+004 lb/hr Std Ideal Liq Volume: 6.45e+005 USGPD

User Variables

NOTES

Description

PETROSANTANDER COLOMBIA
Bedford, MA
USA

Case Name: Simulación Mario HT Gas-01.hsc
Unit Set: NewUser
Date/Time: Fri Dec 3 09:03:31 2021

Material Stream: Gas Ventas

Fluid Package: Basis-1
Property Package: Peng-Robinson

CONDITIONS

	Overall	Vapour Phase			
Vapour / Phase Fraction	1.0000	1.0000			
Temperature: (F)	45.66	45.66			
Pressure: (psig)	432.0	432.0			
Molar Flow (MSCFD)	6364	6364			
Mass Flow (lb/hr)	1.376e+004	1.376e+004			
Std Ideal Liq Vol Flow (USGPD)	1.192e+005	1.192e+005			
Molar Enthalpy (Btu/lbmole)	-3.541e+004	-3.541e+004			
Molar Entropy (Btu/lbmole-F)	37.28	37.28			
Heat Flow (Btu/hr)	-2.475e+007	-2.475e+007			
Liq Vol Flow @Std Cond (USGPD)	4.734e+007 *	4.734e+007			

PROPERTIES

	Overall	Vapour Phase			
Molecular Weight	19.69	19.69			
Molar Density (lbmole/ft3)	9.376e-002	9.376e-002			
Mass Density (lb/ft3)	1.846	1.846			
Act. Volume Flow (USGPD)	1.338e+006	1.338e+006			
Mass Enthalpy (Btu/lb)	-1798	-1798			
Mass Entropy (Btu/lb-F)	1.894	1.894			
Heat Capacity (Btu/lbmole-F)	10.87	10.87			
Mass Heat Capacity (Btu/lb-F)	0.5521	0.5521			
LHV Molar Basis (Std) (Btu/SCF)	1069	1069			
HHV Molar Basis (Std) (Btu/SCF)	1172	1172			
HHV Mass Basis (Std) (Btu/lb)	2.258e+004	2.258e+004			
CO2 Loading	---	---			
CO2 Apparent Mole Conc. (lbmole/ft3)	---	---			
CO2 Apparent Wt. Conc. (lbmol/lb)	---	---			
LHV Mass Basis (Std) (Btu/lb)	2.060e+004	2.060e+004			
Phase Fraction [Vol. Basis]	1.000	1.000			
Phase Fraction [Mass Basis]	1.000	1.000			
Phase Fraction [Act. Vol. Basis]	1.000	1.000			
Mass Exergy (Btu/lb)	180.1	---			
Partial Pressure of CO2 (psig)	-10.59	---			
Cost Based on Flow (Cost/s)	0.0000	0.0000			
Act. Gas Flow (ACFM)	124.2	124.2			
Avg. Liq. Density (lbmole/ft3)	1.053	1.053			
Specific Heat (Btu/lbmole-F)	10.87	10.87			
Std. Gas Flow (MSCFD)	6352	6352			
Std. Ideal Liq. Mass Density (lb/ft3)	20.73	20.73			
Act. Liq. Flow (USGPD)	---	---			
Z Factor	0.8786	0.8786			
Watson K	18.51	18.51			
User Property	---	---			
Partial Pressure of H2S (psig)	-14.70	---			
Cp/(Cp - R)	1.224	1.224			
Cp/Cv	1.437	1.437			
Ideal Gas Cp/Cv	1.267	1.267			
Ideal Gas Cp (Btu/lbmole-F)	9.417	9.417			
Mass Ideal Gas Cp (Btu/lb-F)	0.4783	0.4783			
Heat of Vap. (Btu/lbmole)	4178	---			
Kinematic Viscosity (cSt)	0.3820	0.3820			
Liq. Mass Density (Std. Cond) (lb/ft3)	5.218e-002	5.218e-002			
Liq. Vol. Flow (Std. Cond) (USGPD)	4.734e+007	4.734e+007			
Liquid Fraction	0.0000	0.0000			
Molar Volume (ft3/lbmole)	10.67	10.67			
Mass Heat of Vap. (Btu/lb)	212.2	---			
Phase Fraction [Molar Basis]	1.0000	1.0000			

PETROSANTANDER COLOMBIA
Bedford, MA
USA

Case Name: Simulación Mario HT Gas-01.hsc
Unit Set: NewUser
Date/Time: Fri Dec 3 09:03:31 2021

Material Stream: Gas Ventas (continued)

Fluid Package: Basis-1
Property Package: Peng-Robinson

PROPERTIES

		Overall	Vapour Phase			
Surface Tension	(dyne/cm)	---	---			
Thermal Conductivity	(Btu/hr-ft-F)	1.808e-002	1.808e-002			
Bubble Point Pressure	(psig)	---	---			
Viscosity	(cP)	1.130e-002	1.130e-002			
Cv (Semi-Ideal)	(Btu/lbmole-F)	8.884	8.884			
Mass Cv (Semi-Ideal)	(Btu/lb-F)	0.4512	0.4512			
Cv	(Btu/lbmole-F)	7.567	7.567			
Mass Cv	(Btu/lb-F)	0.3843	0.3843			
Cv (Ent. Method)	(Btu/lbmole-F)	---	---			
Mass Cv (Ent. Method)	(Btu/lb-F)	---	---			
Cp/Cv (Ent. Method)		---	---			
Reid VP at 37.8 C	(psig)	---	---			
True VP at 37.8 C	(psig)	---	---			
Liq. Vol. Flow - Sum(Std. Cond)()	USGPD)	4.734e+007	4.734e+007			
Viscosity Index		-77.81	---			

COMPOSITION

Overall Phase — Vapour Fraction 1.0000

COMPONENTS	MOLAR FLOW (lbmole/hr)	MOLE FRACTION	MASS FLOW (lb/hr)	MASS FRACTION	LIQUID VOLUME FLOW (USGPD)	LIQUID VOLUME FRACTION
CO2	6.4182	0.0092	282.4682	0.0205	984.2445	0.0083
Nitrogen	1.3188	0.0019	36.9444	0.0027	131.7577	0.0011
Methane	569.5399	0.8150	9137.1668	0.6641	87767.1902	0.7365
Ethane	87.3660	0.1250	2627.1155	0.1909	21241.2365	0.1782
Propane	24.2840	0.0347	1070.8648	0.0778	6078.0789	0.0510
i-Butane	3.2232	0.0046	187.3450	0.0136	958.7291	0.0080
n-Butane	4.7437	0.0068	275.7262	0.0200	1359.5875	0.0114
i-Pentane	1.0386	0.0015	74.9346	0.0054	345.6606	0.0029
n-Pentane	0.7545	0.0011	54.4387	0.0040	248.6095	0.0021
n-Hexane	0.1106	0.0002	9.5304	0.0007	41.3603	0.0003
n-Heptane	0.0215	0.0000	2.1588	0.0002	9.0393	0.0001
n-Octane	0.0059	0.0000	0.6734	0.0000	2.7456	0.0000
n-Decane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
n-Nonane	0.0003	0.0000	0.0348	0.0000	0.1391	0.0000
Total	698.8253	1.0000	13759.4017	1.0000	119168.3788	1.0000

Vapour Phase — Phase Fraction 1.000

COMPONENTS	MOLAR FLOW (lbmole/hr)	MOLE FRACTION	MASS FLOW (lb/hr)	MASS FRACTION	LIQUID VOLUME FLOW (USGPD)	LIQUID VOLUME FRACTION
CO2	6.4182	0.0092	282.4682	0.0205	984.2445	0.0083
Nitrogen	1.3188	0.0019	36.9444	0.0027	131.7577	0.0011
Methane	569.5399	0.8150	9137.1668	0.6641	87767.1902	0.7365
Ethane	87.3660	0.1250	2627.1155	0.1909	21241.2365	0.1782
Propane	24.2840	0.0347	1070.8648	0.0778	6078.0789	0.0510
i-Butane	3.2232	0.0046	187.3450	0.0136	958.7291	0.0080
n-Butane	4.7437	0.0068	275.7262	0.0200	1359.5875	0.0114
i-Pentane	1.0386	0.0015	74.9346	0.0054	345.6606	0.0029
n-Pentane	0.7545	0.0011	54.4387	0.0040	248.6095	0.0021
n-Hexane	0.1106	0.0002	9.5304	0.0007	41.3603	0.0003
n-Heptane	0.0215	0.0000	2.1588	0.0002	9.0393	0.0001
n-Octane	0.0059	0.0000	0.6734	0.0000	2.7456	0.0000
n-Decane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
n-Nonane	0.0003	0.0000	0.0348	0.0000	0.1391	0.0000
Total	698.8253	1.0000	13759.4017	1.0000	119168.3788	1.0000

PETROSANTANDER COLOMBIA
Bedford, MA
USA

Case Name: Simulación Mario HT Gas-01.hsc
Unit Set: NewUser
Date/Time: Fri Dec 3 09:03:31 2021

Material Stream: Gas Ventas (continued)

Fluid Package: Basis-1
Property Package: Peng-Robinson

K VALUE

COMPONENTS	MIXED	LIGHT	HEAVY
CO2	---	---	---
Nitrogen	---	---	---
Methane	---	---	---
Ethane	---	---	---
Propane	---	---	---
i-Butane	---	---	---
n-Butane	---	---	---
i-Pentane	---	---	---
n-Pentane	---	---	---
n-Hexane	---	---	---
n-Heptane	---	---	---
n-Octane	---	---	---
n-Decane	---	---	---
n-Nonane	---	---	---

UNIT OPERATIONS

FEED TO	PRODUCT FROM	LOGICAL CONNECTION
	Mixer: MIX-100	

UTILITIES

(No utilities reference this stream)

PROCESS UTILITY

DYNAMICS

Pressure Specification	(Inactive)	432.0 psig					
Flow Specification	(Inactive)	Molar:	6364 MSCFD	Mass:	1.376e+004 lb/hr	Std Ideal Liq Volume	1.332e+005 USGPD

User Variables

NOTES

Description

Material Stream: Propano

Fluid Package: Basis-1
Property Package: Peng-Robinson

CONDITIONS

		Overall	Vapour Phase	Liquid Phase		
Vapour / Phase Fraction		0.0000	0.0000	1.0000		
Temperature:	(F)	97.11	97.11	97.11		
Pressure:	(psig)	44.00	44.00	44.00		
Molar Flow	(MSCFD)	212.8	0.0000	212.8		
Mass Flow	(lb/hr)	1347	0.0000	1347		
Std Ideal Liq Vol Flow	(USGPD)	6740	0.0000	6740		
Molar Enthalpy	(Btu/lbmole)	-6.327e+004	-5.439e+004	-6.327e+004		
Molar Entropy	(Btu/lbmole-F)	17.07	33.38	17.07		
Heat Flow	(Btu/hr)	-1.478e+006	0.0000	-1.478e+006		
Liq Vol Flow @Std Cond	(USGPD)	6720 *	0.0000	6720		

PROPERTIES

		Overall	Vapour Phase	Liquid Phase		
Molecular Weight		57.65	56.85	57.65		
Molar Density	(lbmole/ft3)	0.5965	1.093e-002	0.5965		

PETROSANTANDER COLOMBIA
Bedford, MA
USA

Case Name: Simulación Mario HT Gas-01.hsc
Unit Set: NewUser
Date/Time: Fri Dec 3 09:03:31 2021

Material Stream: Propano (continued)

Fluid Package: Basis-1
Property Package: Peng-Robinson

PROPERTIES

	Overall	Vapour Phase	Liquid Phase		
Mass Density (lb/ft3)	34.39	0.6212	34.39		
Act. Volume Flow (USGPD)	7033	0.0000	7033		
Mass Enthalpy (Btu/lb)	-1097	-956.8	-1097		
Mass Entropy (Btu/lb-F)	0.2960	0.5872	0.2960		
Heat Capacity (Btu/lbmole-F)	34.67	24.52	34.67		
Mass Heat Capacity (Btu/lb-F)	0.6014	0.4313	0.6014		
LHV Molar Basis (Std) (Btu/SCF)	2988	2948	2988		
HHV Molar Basis (Std) (Btu/SCF)	3218	3176	3218		
HHV Mass Basis (Std) (Btu/lb)	2.118e+004	2.120e+004	2.118e+004		
CO2 Loading	---	---	---		
CO2 Apparent Mole Conc. (lbmole/ft3)	1.130e-009	---	1.130e-009		
CO2 Apparent Wt. Conc. (lbmol/lb)	3.287e-011	---	3.287e-011		
LHV Mass Basis (Std) (Btu/lb)	1.966e+004	1.967e+004	1.966e+004		
Phase Fraction [Vol. Basis]	---	---	1.000		
Phase Fraction [Mass Basis]	0.0000	0.0000	1.000		
Phase Fraction [Act. Vol. Basis]	0.0000	0.0000	1.000		
Mass Exergy (Btu/lb)	18.24	---	---		
Partial Pressure of CO2 (psig)	-14.70	---	---		
Cost Based on Flow (Cost/s)	0.0000	0.0000	0.0000		
Act. Gas Flow (ACFM)	---	---	---		
Avg. Liq. Density (lbmole/ft3)	0.6225	0.6259	0.6225		
Specific Heat (Btu/lbmole-F)	34.67	24.52	34.67		
Std. Gas Flow (MSCFD)	212.4	0.0000	212.4		
Std. Ideal Liq. Mass Density (lb/ft3)	35.89	35.58	35.89		
Act. Liq. Flow (USGPD)	7033	---	7033		
Z Factor	---	0.8991	1.647e-002		
Watson K	13.62	13.69	13.62		
User Property	---	---	---		
Partial Pressure of H2S (psig)	-14.70	---	---		
Cp/(Cp - R)	1.061	1.088	1.061		
Cp/Cv	1.061	1.131	1.061		
Ideal Gas Cp/Cv	1.091	1.092	1.091		
Ideal Gas Cp (Btu/lbmole-F)	23.90	23.57	23.90		
Mass Ideal Gas Cp (Btu/lb-F)	0.4145	0.4145	0.4145		
Heat of Vap. (Btu/lbmole)	8590	---	---		
Kinematic Viscosity (cSt)	0.2666	0.7909	0.2666		
Liq. Mass Density (Std. Cond) (lb/ft3)	35.99	35.71	35.99		
Liq. Vol. Flow (Std. Cond) (USGPD)	6720	0.0000	6720		
Liquid Fraction	1.000	0.0000	1.000		
Molar Volume (ft3/lbmole)	1.676	91.52	1.676		
Mass Heat of Vap. (Btu/lb)	149.0	---	---		
Phase Fraction [Molar Basis]	0.0000	0.0000	1.0000		
Surface Tension (dyne/cm)	9.960	---	9.960		
Thermal Conductivity (Btu/hr-ft-F)	5.060e-002	9.922e-003	5.060e-002		
Bubble Point Pressure (psig)	44.00	---	---		
Viscosity (cP)	0.1469	7.870e-003	0.1469		
Cv (Semi-Ideal) (Btu/lbmole-F)	32.69	22.53	32.69		
Mass Cv (Semi-Ideal) (Btu/lb-F)	0.5670	0.3963	0.5670		
Cv (Btu/lbmole-F)	32.69	21.67	32.69		
Mass Cv (Btu/lb-F)	0.5670	0.3812	0.5670		
Cv (Ent. Method) (Btu/lbmole-F)	---	---	---		
Mass Cv (Ent. Method) (Btu/lb-F)	---	---	---		
Cp/Cv (Ent. Method)	---	---	---		
Reid VP at 37.8 C (psig)	46.12	53.54	46.12		
True VP at 37.8 C (psig)	46.65	54.72	46.65		
Liq. Vol. Flow - Sum(Std. Cond)() (USGPD)	6720	0.0000	6720		
Viscosity Index	-28.87	---	---		

PETROSANTANDER COLOMBIA
Bedford, MA
USA

Case Name: Simulación Mario HT Gas-01.hsc
Unit Set: NewUser
Date/Time: Fri Dec 3 09:03:31 2021

Material Stream: Propano (continued)

Fluid Package: Basis-1
Property Package: Peng-Robinson

COMPOSITION

Overall Phase

Vapour Fraction 0.0000

COMPONENTS	MOLAR FLOW (lbmole/hr)	MOLE FRACTION	MASS FLOW (lb/hr)	MASS FRACTION	LIQUID VOLUME FLOW (USGPD)	LIQUID VOLUME FRACTION
CO2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Nitrogen	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Methane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Ethane	0.0006	0.0000	0.0179	0.0000	0.1450	0.0000
Propane	0.7916	0.0339	34.9097	0.0259	198.1427	0.0294
i-Butane	6.5483	0.2802	380.6201	0.2825	1947.8049	0.2890
n-Butane	16.0240	0.6857	931.3900	0.6914	4592.6217	0.6814
i-Pentane	0.0027	0.0001	0.1954	0.0001	0.9013	0.0001
n-Pentane	0.0002	0.0000	0.0150	0.0000	0.0684	0.0000
n-Hexane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
n-Heptane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
n-Octane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
n-Decane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
n-Nonane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Total	23.3675	1.0000	1347.1481	1.0000	6739.6839	1.0000

Vapour Phase

Phase Fraction 0.0000

COMPONENTS	MOLAR FLOW (lbmole/hr)	MOLE FRACTION	MASS FLOW (lb/hr)	MASS FRACTION	LIQUID VOLUME FLOW (USGPD)	LIQUID VOLUME FRACTION
CO2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Nitrogen	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Methane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Ethane	0.0000	0.0002	0.0000	0.0001	0.0000	0.0002
Propane	0.0000	0.0903	0.0000	0.0700	0.0000	0.0788
i-Butane	0.0000	0.3246	0.0000	0.3319	0.0000	0.3366
n-Butane	0.0000	0.5848	0.0000	0.5979	0.0000	0.5843
i-Pentane	0.0000	0.0000	0.0000	0.0001	0.0000	0.0000
n-Pentane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
n-Hexane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
n-Heptane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
n-Octane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
n-Decane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
n-Nonane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Total	0.0000	1.0000	0.0000	1.0000	0.0000	1.0000

Liquid Phase

Phase Fraction 1.000

COMPONENTS	MOLAR FLOW (lbmole/hr)	MOLE FRACTION	MASS FLOW (lb/hr)	MASS FRACTION	LIQUID VOLUME FLOW (USGPD)	LIQUID VOLUME FRACTION
CO2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Nitrogen	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Methane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Ethane	0.0006	0.0000	0.0179	0.0000	0.1450	0.0000
Propane	0.7916	0.0339	34.9097	0.0259	198.1427	0.0294
i-Butane	6.5483	0.2802	380.6201	0.2825	1947.8049	0.2890
n-Butane	16.0240	0.6857	931.3900	0.6914	4592.6217	0.6814
i-Pentane	0.0027	0.0001	0.1954	0.0001	0.9013	0.0001
n-Pentane	0.0002	0.0000	0.0150	0.0000	0.0684	0.0000
n-Hexane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
n-Heptane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
n-Octane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
n-Decane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
n-Nonane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Total	23.3675	1.0000	1347.1481	1.0000	6739.6839	1.0000

PETROSANTANDER COLOMBIA
Bedford, MA
USA

Case Name: Simulación Mario HT Gas-01.hsc
Unit Set: NewUser
Date/Time: Fri Dec 3 09:03:31 2021

Material Stream: Propano (continued)

Fluid Package: Basis-1
Property Package: Peng-Robinson

K VALUE

COMPONENTS	MIXED	LIGHT	HEAVY
CO2	19.58	19.58	---
Nitrogen	113.8	113.8	---
Methane	39.70	39.70	---
Ethane	8.446	8.446	---
Propane	2.665	2.665	---
i-Butane	1.158	1.158	---
n-Butane	0.8528	0.8528	---
i-Pentane	0.3713	0.3713	---
n-Pentane	0.2892	0.2892	---
n-Hexane	0.1020	0.1020	---
n-Heptane	3.748e-002	3.748e-002	---
n-Octane	1.393e-002	1.393e-002	---
n-Decane	---	---	---
n-Nonane	5.399e-003	5.399e-003	---

UNIT OPERATIONS

FEED TO	PRODUCT FROM	LOGICAL CONNECTION
	Tank: TK-C3	

UTILITIES

(No utilities reference this stream)

PROCESS UTILITY

DYNAMICS

Pressure Specification (Inactive) 44.00 psig

Flow Specification (Inactive) Molar: 212.8 MSCFD Mass: 1347 lb/hr Std Ideal Liq Volume: 6740 USGPD

User Variables

NOTES

Description

Material Stream: Butano

Fluid Package: Basis-1
Property Package: Peng-Robinson

CONDITIONS

	Overall	Vapour Phase	Liquid Phase		
Vapour / Phase Fraction	0.0000	0.0000	1.0000		
Temperature: (F)	108.5 *	108.5	108.5		
Pressure: (psig)	12.00	12.00	12.00		
Molar Flow (MSCFD)	119.3	0.0000	119.3		
Mass Flow (lb/hr)	918.0	0.0000	918.0		
Std Ideal Liq Vol Flow (USGPD)	4255	0.0000	4255		
Molar Enthalpy (Btu/lbmole)	-7.295e+004	-6.111e+004	-7.295e+004		
Molar Entropy (Btu/lbmole-F)	16.98	34.42	16.98		
Heat Flow (Btu/hr)	-9.557e+005	0.0000	-9.557e+005		
Liq Vol Flow @Std Cond (USGPD)	4238 *	0.0000	4238		

PROPERTIES

	Overall	Vapour Phase	Liquid Phase		
Molecular Weight	70.07	67.75	70.07		
Molar Density (lbmole/ft3)	0.5289	4.651e-003	0.5289		

PETROSANTANDER COLOMBIA
Bedford, MA
USA

Case Name: Simulación Mario HT Gas-01.hsc
Unit Set: NewUser
Date/Time: Fri Dec 3 09:03:31 2021

Material Stream: Butano (continued)

Fluid Package: Basis-1
Property Package: Peng-Robinson

PROPERTIES

	Overall	Vapour Phase	Liquid Phase		
Mass Density (lb/ft3)	37.06	0.3151	37.06		
Act. Volume Flow (USGPD)	4447	0.0000	4447		
Mass Enthalpy (Btu/lb)	-1041	-902.0	-1041		
Mass Entropy (Btu/lb-F)	0.2423	0.5081	0.2423		
Heat Capacity (Btu/lbmole-F)	39.74	28.82	39.74		
Mass Heat Capacity (Btu/lb-F)	0.5671	0.4254	0.5671		
LHV Molar Basis (Std) (Btu/SCF)	3601	3487	3601		
HHV Molar Basis (Std) (Btu/SCF)	3873	3751	3873		
HHV Mass Basis (Std) (Btu/lb)	2.098e+004	2.101e+004	2.098e+004		
CO2 Loading	---	---	---		
CO2 Apparent Mole Conc. (lbmole/ft3)	4.353e-018	---	4.353e-018		
CO2 Apparent Wt. Conc. (lbmol/lb)	1.175e-019	---	1.175e-019		
LHV Mass Basis (Std) (Btu/lb)	1.950e+004	1.953e+004	1.950e+004		
Phase Fraction [Vol. Basis]	---	---	1.000		
Phase Fraction [Mass Basis]	0.0000	0.0000	1.000		
Phase Fraction [Act. Vol. Basis]	0.0000	0.0000	1.000		
Mass Exergy (Btu/lb)	0.5909	---	---		
Partial Pressure of CO2 (psig)	-14.70	---	---		
Cost Based on Flow (Cost/s)	0.0000	0.0000	0.0000		
Act. Gas Flow (ACFM)	---	---	---		
Avg. Liq. Density (lbmole/ft3)	0.5527	0.5651	0.5527		
Specific Heat (Btu/lbmole-F)	39.74	28.82	39.74		
Std. Gas Flow (MSCFD)	119.1	0.0000	119.1		
Std. Ideal Liq. Mass Density (lb/ft3)	38.73	38.29	38.73		
Act. Liq. Flow (USGPD)	4447	---	4447		
Z Factor	---	0.9414	8.278e-003		
Watson K	13.10	13.17	13.10		
User Property	---	---	---		
Partial Pressure of H2S (psig)	-14.70	---	---		
Cp/(Cp - R)	1.053	1.074	1.053		
Cp/Cv	1.053	1.092	1.053		
Ideal Gas Cp/Cv	1.073	1.075	1.073		
Ideal Gas Cp (Btu/lbmole-F)	29.25	28.32	29.25		
Mass Ideal Gas Cp (Btu/lb-F)	0.4175	0.4180	0.4175		
Heat of Vap. (Btu/lbmole)	1.053e+004	---	---		
Kinematic Viscosity (cSt)	0.3004	1.440	0.3004		
Liq. Mass Density (Std. Cond) (lb/ft3)	38.89	38.46	38.89		
Liq. Vol. Flow (Std. Cond) (USGPD)	4238	0.0000	4238		
Liquid Fraction	1.000	0.0000	1.000		
Molar Volume (ft3/lbmole)	1.891	215.0	1.891		
Mass Heat of Vap. (Btu/lb)	150.3	---	---		
Phase Fraction [Molar Basis]	0.0000	0.0000	1.0000		
Surface Tension (dyne/cm)	12.37	---	12.37		
Thermal Conductivity (Btu/hr-ft-F)	5.556e-002	9.353e-003	5.556e-002		
Bubble Point Pressure (psig)	12.00	---	---		
Viscosity (cP)	0.1783	7.268e-003	0.1783		
Cv (Semi-Ideal) (Btu/lbmole-F)	37.75	26.83	37.75		
Mass Cv (Semi-Ideal) (Btu/lb-F)	0.5387	0.3961	0.5387		
Cv (Btu/lbmole-F)	37.75	26.39	37.75		
Mass Cv (Btu/lb-F)	0.5387	0.3895	0.5387		
Cv (Ent. Method) (Btu/lbmole-F)	---	---	---		
Mass Cv (Ent. Method) (Btu/lb-F)	---	---	---		
Cp/Cv (Ent. Method)	---	---	---		
Reid VP at 37.8 C (psig)	8.252	13.94	8.252		
True VP at 37.8 C (psig)	8.424	14.23	8.424		
Liq. Vol. Flow - Sum(Std. Cond)() USGPD)	4238	0.0000	4238		
Viscosity Index	-23.14	---	---		

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Bedford, MA
USA

Case Name: Simulación Mario HT Gas-01.hsc
Unit Set: NewUser
Date/Time: Fri Dec 3 09:03:31 2021

Material Stream: Butano (continued)

Fluid Package: Basis-1
Property Package: Peng-Robinson

COMPOSITION

Overall Phase

Vapour Fraction 0.0000

COMPONENTS	MOLAR FLOW (lbmole/hr)	MOLE FRACTION	MASS FLOW (lb/hr)	MASS FRACTION	LIQUID VOLUME FLOW (USGPD)	LIQUID VOLUME FRACTION
CO2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Nitrogen	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Methane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Ethane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Propane	0.0001	0.0000	0.0042	0.0000	0.0240	0.0000
i-Butane	0.0983	0.0075	5.7155	0.0062	29.2488	0.0069
n-Butane	1.8536	0.1415	107.7396	0.1174	531.2565	0.1248
i-Pentane	6.2421	0.4765	450.3784	0.4906	2077.5199	0.4882
n-Pentane	4.8984	0.3739	353.4278	0.3850	1614.0270	0.3793
n-Hexane	0.0084	0.0006	0.7241	0.0008	3.1423	0.0007
n-Heptane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
n-Octane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
n-Decane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
n-Nonane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Total	13.1009	1.0000	917.9896	1.0000	4255.2187	1.0000

Vapour Phase

Phase Fraction 0.0000

COMPONENTS	MOLAR FLOW (lbmole/hr)	MOLE FRACTION	MASS FLOW (lb/hr)	MASS FRACTION	LIQUID VOLUME FLOW (USGPD)	LIQUID VOLUME FRACTION
CO2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Nitrogen	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Methane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Ethane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Propane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
i-Butane	0.0000	0.0211	0.0000	0.0181	0.0000	0.0198
n-Butane	0.0000	0.2929	0.0000	0.2513	0.0000	0.2642
i-Pentane	0.0000	0.4257	0.0000	0.4534	0.0000	0.4460
n-Pentane	0.0000	0.2601	0.0000	0.2770	0.0000	0.2698
n-Hexane	0.0000	0.0002	0.0000	0.0002	0.0000	0.0002
n-Heptane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
n-Octane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
n-Decane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
n-Nonane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Total	0.0000	1.0000	0.0000	1.0000	0.0000	1.0000

Liquid Phase

Phase Fraction 1.000

COMPONENTS	MOLAR FLOW (lbmole/hr)	MOLE FRACTION	MASS FLOW (lb/hr)	MASS FRACTION	LIQUID VOLUME FLOW (USGPD)	LIQUID VOLUME FRACTION
CO2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Nitrogen	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Methane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Ethane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Propane	0.0001	0.0000	0.0042	0.0000	0.0240	0.0000
i-Butane	0.0983	0.0075	5.7155	0.0062	29.2488	0.0069
n-Butane	1.8536	0.1415	107.7396	0.1174	531.2565	0.1248
i-Pentane	6.2421	0.4765	450.3784	0.4906	2077.5199	0.4882
n-Pentane	4.8984	0.3739	353.4278	0.3850	1614.0270	0.3793
n-Hexane	0.0084	0.0006	0.7241	0.0008	3.1423	0.0007
n-Heptane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
n-Octane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
n-Decane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
n-Nonane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Total	13.1009	1.0000	917.9896	1.0000	4255.2187	1.0000

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Case Name: Simulación Mario HT Gas-01.hsc
Unit Set: NewUser
Date/Time: Fri Dec 3 09:03:31 2021

Material Stream: Butano (continued)

Fluid Package: Basis-1
Property Package: Peng-Robinson

K VALUE

COMPONENTS	MIXED	LIGHT	HEAVY
CO2	47.04	47.04	---
Nitrogen	284.9	284.9	---
Methane	98.44	98.44	---
Ethane	20.82	20.82	---
Propane	6.527	6.527	---
i-Butane	2.815	2.815	---
n-Butane	2.070	2.070	---
i-Pentane	0.8935	0.8935	---
n-Pentane	0.6957	0.6957	---
n-Hexane	0.2430	0.2430	---
n-Heptane	8.841e-002	8.841e-002	---
n-Octane	3.252e-002	3.252e-002	---
n-Decane	---	---	---
n-Nonane	1.247e-002	1.247e-002	---

UNIT OPERATIONS

FEED TO	PRODUCT FROM	LOGICAL CONNECTION
	Tank: TK-C4	

UTILITIES

(No utilities reference this stream)

PROCESS UTILITY

DYNAMICS

Pressure Specification (Inactive) 12.00 psig

Flow Specification (Inactive) Molar: 119.3 MSCFD Mass: 918.0 lb/hr Std Ideal Liq Volume: 4255 USGPD

User Variables

NOTES

Description

Material Stream: Gasolina

Fluid Package: Basis-1
Property Package: Peng-Robinson

CONDITIONS

	Overall	Liquid Phase	Vapour Phase		
Vapour / Phase Fraction	0.0000	1.0000	0.0000		
Temperature: (F)	155.2	155.2	155.2		
Pressure: (psig)	20.00	20.00	20.00		
Molar Flow (MSCFD)	145.0	145.0	0.0000		
Mass Flow (lb/hr)	1247	1247	0.0000		
Std Ideal Liq Vol Flow (USGPD)	5577	5577	0.0000		
Molar Enthalpy (Btu/lbmole)	-7.665e+004	-7.665e+004	-6.348e+004		
Molar Entropy (Btu/lbmole-F)	24.00	24.00	38.81		
Heat Flow (Btu/hr)	-1.220e+006	-1.220e+006	0.0000		
Liq Vol Flow @Std Cond (USGPD)	5550 *	5550	0.0000		

PROPERTIES

	Overall	Liquid Phase	Vapour Phase		
Molecular Weight	78.35	78.35	74.06		
Molar Density (lbmole/ft3)	0.4714	0.4714	5.678e-003		

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Case Name: Simulación Mario HT Gas-01.hsc
Unit Set: NewUser
Date/Time: Fri Dec 3 09:03:31 2021

Material Stream: Gasolina (continued)

Fluid Package: Basis-1
Property Package: Peng-Robinson

PROPERTIES

	Overall	Liquid Phase	Vapour Phase		
Mass Density (lb/ft3)	36.93	36.93	0.4205		
Act. Volume Flow (USGPD)	6063	6063	0.0000		
Mass Enthalpy (Btu/lb)	-978.4	-978.4	-857.1		
Mass Entropy (Btu/lb-F)	0.3063	0.3063	0.5240		
Heat Capacity (Btu/lbmole-F)	46.36	46.36	33.69		
Mass Heat Capacity (Btu/lb-F)	0.5917	0.5917	0.4549		
LHV Molar Basis (Std) (Btu/SCF)	4014	4014	3800		
HHV Molar Basis (Std) (Btu/SCF)	4313	4313	4085		
HHV Mass Basis (Std) (Btu/lb)	2.089e+004	2.089e+004	2.093e+004		
CO2 Loading	---	---	---		
CO2 Apparent Mole Conc. (lbmole/ft3)	4.649e-031	4.649e-031	---		
CO2 Apparent Wt. Conc. (lbmol/lb)	1.259e-032	1.259e-032	---		
LHV Mass Basis (Std) (Btu/lb)	1.944e+004	1.944e+004	1.947e+004		
Phase Fraction [Vol. Basis]	---	1.000	---		
Phase Fraction [Mass Basis]	0.0000	1.000	0.0000		
Phase Fraction [Act. Vol. Basis]	0.0000	1.000	0.0000		
Mass Exergy (Btu/lb)	3.052	---	---		
Partial Pressure of CO2 (psig)	-14.70	---	---		
Cost Based on Flow (Cost/s)	0.0000	0.0000	0.0000		
Act. Gas Flow (ACFM)	---	---	---		
Avg. Liq. Density (lbmole/ft3)	0.5126	0.5126	0.5328		
Specific Heat (Btu/lbmole-F)	46.36	46.36	33.69		
Std. Gas Flow (MSCFD)	144.7	144.7	0.0000		
Std. Ideal Liq. Mass Density (lb/ft3)	40.16	40.16	39.46		
Act. Liq. Flow (USGPD)	6063	6063	---		
Z Factor	---	1.115e-002	0.9261		
Watson K	12.93	12.93	13.00		
User Property	---	---	---		
Partial Pressure of H2S (psig)	-14.70	---	---		
Cp/(Cp - R)	1.045	1.045	1.063		
Cp/Cv	1.330	1.330	1.083		
Ideal Gas Cp/Cv	1.060	1.060	1.064		
Ideal Gas Cp (Btu/lbmole-F)	34.87	34.87	33.01		
Mass Ideal Gas Cp (Btu/lb-F)	0.4451	0.4451	0.4457		
Heat of Vap. (Btu/lbmole)	1.220e+004	---	---		
Kinematic Viscosity (cSt)	0.2927	0.2927	1.124		
Liq. Mass Density (Std. Cond) (lb/ft3)	40.35	40.35	39.62		
Liq. Vol. Flow (Std. Cond) (USGPD)	5550	5550	0.0000		
Liquid Fraction	1.000	1.000	0.0000		
Molar Volume (ft3/lbmole)	2.121	2.121	176.1		
Mass Heat of Vap. (Btu/lb)	155.7	---	---		
Phase Fraction [Molar Basis]	0.0000	1.0000	0.0000		
Surface Tension (dyne/cm)	11.53	11.53	---		
Thermal Conductivity (Btu/hr-ft-F)	5.477e-002	5.477e-002	1.035e-002		
Bubble Point Pressure (psig)	18.19	---	---		
Viscosity (cP)	0.1732	0.1732	7.567e-003		
Cv (Semi-Ideal) (Btu/lbmole-F)	44.37	44.37	31.70		
Mass Cv (Semi-Ideal) (Btu/lb-F)	0.5664	0.5664	0.4281		
Cv (Btu/lbmole-F)	34.87	34.87	31.10		
Mass Cv (Btu/lb-F)	0.4450	0.4450	0.4199		
Cv (Ent. Method) (Btu/lbmole-F)	34.31	34.31	---		
Mass Cv (Ent. Method) (Btu/lb-F)	0.4379	0.4379	---		
Cp/Cv (Ent. Method)	1.351	1.351	---		
Reid VP at 37.8 C (psig)	-1.629	-1.629	1.626		
True VP at 37.8 C (psig)	-1.564	-1.564	1.667		
Liq. Vol. Flow - Sum(Std. Cond()USGPD)	5550	5550	0.0000		
Viscosity Index	-24.24	---	---		

PETROSANTANDER COLOMBIA
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Case Name: Simulación Mario HT Gas-01.hsc
Unit Set: NewUser
Date/Time: Fri Dec 3 09:03:31 2021

Material Stream: Gasolina (continued)

Fluid Package: Basis-1
Property Package: Peng-Robinson

COMPOSITION

Overall Phase

Vapour Fraction 0.0000

COMPONENTS	MOLAR FLOW (lbmole/hr)	MOLE FRACTION	MASS FLOW (lb/hr)	MASS FRACTION	LIQUID VOLUME FLOW (USGPD)	LIQUID VOLUME FRACTION
CO2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Nitrogen	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Methane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Ethane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Propane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
i-Butane	0.0001	0.0000	0.0062	0.0000	0.0316	0.0000
n-Butane	0.0309	0.0019	1.7940	0.0014	8.8459	0.0016
i-Pentane	4.6550	0.2924	335.8675	0.2693	1549.3007	0.2778
n-Pentane	6.0246	0.3784	434.6878	0.3485	1985.1235	0.3560
n-Hexane	3.7447	0.2352	322.7156	0.2587	1400.5231	0.2511
n-Heptane	1.0940	0.0687	109.6263	0.0879	459.0275	0.0823
n-Octane	0.3543	0.0223	40.4680	0.0324	164.9889	0.0296
n-Decane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
n-Nonane	0.0173	0.0011	2.2185	0.0018	8.8582	0.0016
Total	15.9209	1.0000	1247.3840	1.0000	5576.6996	1.0000

Liquid Phase

Phase Fraction 1.000

COMPONENTS	MOLAR FLOW (lbmole/hr)	MOLE FRACTION	MASS FLOW (lb/hr)	MASS FRACTION	LIQUID VOLUME FLOW (USGPD)	LIQUID VOLUME FRACTION
CO2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Nitrogen	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Methane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Ethane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Propane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
i-Butane	0.0001	0.0000	0.0062	0.0000	0.0316	0.0000
n-Butane	0.0309	0.0019	1.7940	0.0014	8.8459	0.0016
i-Pentane	4.6550	0.2924	335.8675	0.2693	1549.3007	0.2778
n-Pentane	6.0246	0.3784	434.6878	0.3485	1985.1235	0.3560
n-Hexane	3.7447	0.2352	322.7156	0.2587	1400.5231	0.2511
n-Heptane	1.0940	0.0687	109.6263	0.0879	459.0275	0.0823
n-Octane	0.3543	0.0223	40.4680	0.0324	164.9889	0.0296
n-Decane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
n-Nonane	0.0173	0.0011	2.2185	0.0018	8.8582	0.0016
Total	15.9209	1.0000	1247.3840	1.0000	5576.6996	1.0000

Vapour Phase

Phase Fraction 0.0000

COMPONENTS	MOLAR FLOW (lbmole/hr)	MOLE FRACTION	MASS FLOW (lb/hr)	MASS FRACTION	LIQUID VOLUME FLOW (USGPD)	LIQUID VOLUME FRACTION
CO2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Nitrogen	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Methane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Ethane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Propane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
i-Butane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
n-Butane	0.0000	0.0059	0.0000	0.0046	0.0000	0.0050
i-Pentane	0.0000	0.4239	0.0000	0.4130	0.0000	0.4186
n-Pentane	0.0000	0.4451	0.0000	0.4337	0.0000	0.4352
n-Hexane	0.0000	0.1100	0.0000	0.1280	0.0000	0.1220
n-Heptane	0.0000	0.0132	0.0000	0.0179	0.0000	0.0165
n-Octane	0.0000	0.0018	0.0000	0.0028	0.0000	0.0025
n-Decane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
n-Nonane	0.0000	0.0000	0.0000	0.0001	0.0000	0.0001
Total	0.0000	1.0000	0.0000	1.0000	0.0000	1.0000

PETROSANTANDER COLOMBIA
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Case Name: Simulación Mario HT Gas-01.hsc
Unit Set: NewUser
Date/Time: Fri Dec 3 09:03:31 2021

Material Stream: Gasolina (continued)

Fluid Package: Basis-1
Property Package: Peng-Robinson

K VALUE

COMPONENTS	MIXED	LIGHT	HEAVY
CO2	---	---	---
Nitrogen	---	---	---
Methane	---	---	---
Ethane	23.09	23.09	---
Propane	8.364	8.364	---
i-Butane	3.982	3.982	---
n-Butane	3.055	3.055	---
i-Pentane	1.450	1.450	---
n-Pentane	1.176	1.176	---
n-Hexane	0.4675	0.4675	---
n-Heptane	0.1927	0.1927	---
n-Octane	8.033e-002	8.033e-002	---
n-Decane	---	---	---
n-Nonane	3.462e-002	3.462e-002	---

UNIT OPERATIONS

FEED TO	PRODUCT FROM	LOGICAL CONNECTION
	Tank: TK-C5	

UTILITIES

(No utilities reference this stream)

PROCESS UTILITY

DYNAMICS

Pressure Specification	(Inactive)	20.00 psig				
Flow Specification	(Inactive)	Molar:	145.0 MSCFD	Mass:	1247 lb/hr	Std Ideal Liq Volume: 5577 USGPD

User Variables

NOTES

Description

Apéndice C. Reporte de Operación HT Nuevo

PETROSANTANDER COLOMBIA Bedford, MA USA	Case Name:	Simulación Mario HT Gas.hsc	
	Unit Set:	NewUser	
	Date/Time:	Fri Dec 3 08:56:11 2021	

Heat Exchanger: HT Gas-Gas

CONNECTIONS

Tube Side				Shell Side			
Inlet		Outlet		Inlet		Outlet	
Name	GIN-01	Name	GIN-02	Name	GVTAS-05	Name	Gas Ventas
From Op.	Aeroenfriador-GIN	To Op.	HT Chiller	From Op.	RCY-1	To Op.	
Op. Type	Air cooler	Op. Type	Heat Exchanger	Op. Type	Recycle	Op. Type	
Temp	84.62 F	Temp	66.32 F	Temp	-9.11 F *	Temp	41.29 F

PARAMETERS

Heat Exchanger Model:			Simple End Point		
Tube Side DeltaP:	3.000 psi *	Shell Side DeltaP:	10.00 psi *	Passes:	---
UA:	8000 Btu/F-hr *	Tolerance:	1.0000e-04		

Tube Side Data		Shell Side Data	
Heat Transfer Coeff	---	Heat Transfer Coeff	---
Tube Pressure Drop	3.00 psi *	Shell Pressure Drop	10.00 psi *
Fouling	1.0000e-003 F-hr-ft2/Btu *	Fouling	1.0000e-003 F-hr-ft2/Btu *
Tube Length	39.52 ft *	Shell Passes	1
Tube O.D.	0.75 in *	Shell Series	1
Tube Thickness	0.0415 in	Shell Parallel	1
Tube Pitch	0.9375 in *	Baffle Type	Single
Orientation	Horizontal	Baffle Cut(%Area)	25.00 *
Passes Per Shell	1 *	Baffle Orientation	Horizontal
Tubes Per Shell	295 *	Spacing	18.8141 in *
Layout Angle	Triangular Rotated (60 degrees)	Diameter	18.5000 in *
TEMA Type	N E N	Area	2289.17 ft2

SPECS

	Spec Value	Curr Value	Rel Error	Active	Estimate
E-100 Heat Balance	0.0000 Btu/hr	-2.134e-009 Btu/hr	-5.703e-015	On	Off
E-100 UA	8000 Btu/F-hr *	8000 Btu/F-hr	1.215e-005	On	Off

Detailed Specifications

E-100 Heat Balance

Type: Duty	Pass: Error	Spec Value: 0.0000 Btu/hr

E-100 UA

Type: UA	Pass: Overall	Spec Value: 8000 Btu/F-hr *

User Variables

RATING

Sizing

Overall Data

Configuration

# of Shells in Series	1	Tube Passes per Shell	1 *	Elevation (Base)		0.0000 ft	
# of Shells in Parallel	1	Exchange Orientation	Horizontal	First Tube Pass Flow Direction		Co-Current	
TEMA Type:		N		E		N	

Calculated Information

Shell HT Coeff	---	Tube HT Coeff	---
Overall U	3.495 Btu/hr-ft2-F	Overall UA	8000 Btu/F-hr *
Shell DP	10.00 psi *	Tube DP	3.000 psi *
Shell Vol per Shell	284.3 gal	Tube Vol per Shell	211.6 gal
HT Area per Shell	2289 ft2		

Shell Data

Shell and Tube Bundle

Shell Diameter (in)	18.50 *	Tube Pitch (in)	0.9375 *	Shell Fouling (F-hr-ft2/Btu)	1.000e-003 *

PETROSANTANDER COLOMBIA Bedford, MA USA		Case Name:	Simulación Mario HT Gas.hsc
		Unit Set:	NewUser
		Date/Time:	Fri Dec 3 08:56:11 2021

Heat Exchanger: HT Gas-Gas (continued)

# of Tubes per Shell	295 *	Tube Layout Angle	Triangular Rotated (60 degrees)

Shell Baffles

Shell Baffle Type	Single	Shell Baffle Orientation	Horizontal
Baffle Cut (%Area)	25.00 *	Baffle Spacing	18.81 in *

Tube Data

Dimensions

OD (in)	ID (in)	Tube Thickness (in)	Tube Length (ft)
0.7500 *	0.6670 *	4.150e-002	39.52 *

Tube Properties

Tube Fouling (F-hr-ft2/Btu)	Thermal Cond. (Btu/hr-ft-F)	Wall Cp (Btu/lb-F)	Wall Density (lb/ft3)
1.000e-003 *	26.00	---	---

Nozzle Parameters

Base Elevation Relative to Ground Level: 0.0000 ft

		GIN-01	GVTAS-05	GIN-02
Diameter	(ft)	0.1640	0.1640	0.1640
Elevation (Base)	(ft)	0.0000	0.0000	0.0000
Elevation (Ground)	(ft)	0.0000 *	0.0000 *	0.0000 *
Elevation (% of Height)	(%)	0.00	0.00	0.00
		Gas Ventas		
Diameter	(ft)	0.1640		
Elevation (Base)	(ft)	0.0000		
Elevation (Ground)	(ft)	0.0000 *		
Elevation (% of Height)	(%)	0.00		

Simple Heat Loss Parameters

Overall U (Btu/hr-ft2-F)	Ambient Temperature (F)	Overall Heat Transfer Area (ft2)	Heat Flow (Btu/hr)
2.495	90.00 *	---	---

CONDITIONS

Name		GIN-01	GVTAS-05	GIN-02	Gas Ventas
Vapour		0.9526	1.0000	0.9213	1.0000
Temperature	(F)	84.6165	-9.1052 *	66.3167	41.2868
Pressure	(psig)	447.0000	442.0000 *	444.0000	432.0000
Molar Flow	(MSCFD)	8000.0000	6134.0641 *	8000.0000	6134.0641
Mass Flow	(lb/hr)	21619.6314	12935.2271	21619.6314	12935.2271
Std Ideal Liq Vol Flow	(USGPD)	164462.6419	113576.2318	164462.6419	113576.2318
Molar Enthalpy	(Btu/lbmole)	-3.802e+004	-3.575e+004	-3.845e+004	-3.520e+004
Molar Entropy	(Btu/lbmole-F)	37.24	35.96	36.46	37.17
Heat Flow	(Btu/hr)	-3.3403e+07	-2.4080e+07	-3.3777e+07	-2.3706e+07

PROPERTIES

Name		GIN-01	GVTAS-05	GIN-02	Gas Ventas	
Molecular Weight		24.61	19.20	24.61	19.20	
Molar Density	(lbmole/ft3)	9.555e-002	0.1143	0.1016	9.426e-002	
Mass Density	(lb/ft3)	2.352	2.195	2.500	1.810	
Act. Volume Flow	(USGPD)	1.650e+006	1.058e+006	1.553e+006	1.283e+006	
Mass Enthalpy	(Btu/lb)	-1545	-1862	-1562	-1833	
Mass Entropy	(Btu/lb-F)	1.513	1.872	1.481	1.935	
Heat Capacity	(Btu/lbmole-F)	13.58	11.09	13.66	10.65	
Mass Heat Capacity	(Btu/lb-F)	0.5519	0.5776	0.5548	0.5545	
LHV Molar Basis (Std)	(Btu/SCF)	1317	1045	1317	1045	
HHV Molar Basis (Std)	(Btu/SCF)	1436	1146	1436	1146	
HHV Mass Basis (Std)	(Btu/lb)	2.214e+004	2.264e+004	2.214e+004	2.264e+004	
CO2 Loading		---	---	---	---	
CO2 Apparent Mole Conc.	(lbmole/ft3)	---	---	---	---	
CO2 Apparent Wt. Conc.	(lbmol/lb)	---	---	---	---	
LHV Mass Basis (Std)	(Btu/lb)	2.030e+004	2.064e+004	2.030e+004	2.064e+004	
Phase Fraction [Vol. Basis]		0.9287	1.000	0.8846	1.000	
Phase Fraction [Mass Basis]		0.8951	1.000	0.8339	1.000	
Phase Fraction [Act. Vol. Basis]		0.9928	1.000	0.9878	1.000	

PETROSANTANDER COLOMBIA
Bedford, MA
USA

Case Name: Simulación Mario HT Gas.hsc
Unit Set: NewUser
Date/Time: Fri Dec 3 08:56:11 2021

Heat Exchanger: HT Gas-Gas (continued)

PROPERTIES

Name	GIN-01	GVTAS-05	GIN-02	Gas Ventas
Mass Exergy (Btu/lb)	141.9	189.9	141.8	185.1
Partial Pressure of CO2 (psig)	-10.63	-10.53	-10.59	-10.62
Cost Based on Flow (Cost/s)	0.0000	0.0000	0.0000	0.0000
Act. Gas Flow (ACFM)	152.1	98.22	142.4	119.1
Avg. Liq. Density (lbmole/ft3)	0.9589	1.065	0.9589	1.065
Specific Heat (Btu/lbmole-F)	13.58	11.09	13.66	10.65
Std. Gas Flow (MSCFD)	7985	6123	7985	6123
Std. Ideal Liq. Mass Density (lb/ft3)	23.60	20.45	23.60	20.45
Act. Liq. Flow (USGPD)	1.194e+004	---	1.892e+004	---
Z Factor	---	0.8264	---	0.8815
Watson K	17.09	18.66	17.09	18.66
User Property	---	---	---	---
Partial Pressure of H2S (psig)	-14.70	-14.70	-14.70	-14.70
Cp/(Cp - R)	1.171	1.218	1.170	1.229
Cp/Cv	1.336	1.561	1.326	1.442
Ideal Gas Cp/Cv	1.210	1.286	1.215	1.274
Ideal Gas Cp (Btu/lbmole-F)	11.45	8.926	11.24	9.239
Mass Ideal Gas Cp (Btu/lb-F)	0.4651	0.4648	0.4568	0.4811
Heat of Vap. (Btu/lbmole)	6461	3840	6469	3874
Kinematic Viscosity (cSt)	---	0.2963	---	0.3870
Liq. Mass Density (Std. Cond) (lb/ft3)	6.535e-002	5.088e-002	6.535e-002	5.088e-002
Liq. Vol. Flow (Std. Cond) (USGPD)	5.939e+007	4.564e+007	5.939e+007	4.564e+007
Liquid Fraction	4.736e-002	0.0000	7.866e-002	0.0000
Molar Volume (ft3/lbmole)	10.47	8.750	9.845	10.61
Mass Heat of Vap. (Btu/lb)	262.5	200.0	262.8	201.7
Phase Fraction [Molar Basis]	0.9526	1.0000	0.9213	1.0000
Surface Tension (dyne/cm)	9.233	---	9.498	---
Thermal Conductivity (Btu/hr-ft-F)	---	1.635e-002	---	1.808e-002
Bubble Point Pressure (psig)	---	---	---	---
Viscosity (cP)	---	1.042e-002	---	1.122e-002
Cv (Semi-Ideal) (Btu/lbmole-F)	11.60	9.106	11.67	8.663
Mass Cv (Semi-Ideal) (Btu/lb-F)	0.4712	0.4742	0.4742	0.4511
Cv (Btu/lbmole-F)	10.17	7.107	10.30	7.385
Mass Cv (Btu/lb-F)	0.4131	0.3701	0.4185	0.3845
Cv (Ent. Method) (Btu/lbmole-F)	---	---	---	---
Mass Cv (Ent. Method) (Btu/lb-F)	---	---	---	---
Cp/Cv (Ent. Method)	---	---	---	---
Reid VP at 37.8 C (psig)	---	---	---	---
True VP at 37.8 C (psig)	---	---	---	---
Liq. Vol. Flow - Sum(Std. Cond()USGPD)	5.663e+007	4.564e+007	5.479e+007	4.564e+007
Viscosity Index	---	---	---	-72.16

DETAILS

Overall/Detailed Performance

Duty:	3.741e+05 Btu/hr	UA Curv. Error:	0.00e-01 Btu/F-hr
Heat Leak:	0.000e-01 Btu/hr	Hot Pinch Temp:	66.32 F
Heat Loss:	0.000e-01 Btu/hr	Cold Pinch Temp:	41.29 F
UA:	8.000e+03 Btu/F-hr	Ft Factor:	---
Min. Approach:	25.03 F	Uncorrected Lmtd:	52.04 F
Lmtd:	46.76 F		

TABLES

PETROSANTANDER COLOMBIA Bedford, MA USA	Case Name:	Simulación Mario HT Gas.hsc	
	Unit Set:	NewUser	
	Date/Time:	Fri Dec 3 08:56:11 2021	

Heat Exchanger: HT Gas-Gas (continued)

Shell Side - Overall Phase

Temperature (F)	Pressure (psig)	Heat Flow (Btu/hr)	Enthalpy (Btu/lbmole)
-9.11	442.00	0.00	-35750.74
41.29	432.00	374113.11	-35195.31

UA (Btu/F-hr)	Molar Vap Frac	Mass Vap Frac	Heat of Vap. (Btu/lbmole)
0.00	1.0000	1.0000	---
0.00	1.0000	1.0000	---

Shell Side - Vapour Phase

Mass Flow (lb/hr)	Molecular Wt	Density (lb/ft3)	Mass Sp Heat (Btu/lb-F)	Viscosity (cP)	Thermal Cond (Btu/hr-ft-F)
12935.23	19.20	2.19	0.58	0.01	0.02
12935.23	19.20	1.81	0.55	0.01	0.02

Std Gas Flow (MSCFD)	Z Factor	Pseudo Pc (psig)	Pseudo Tc (F)	Pseudo Zc	Pseudo Omega
6122.57	0.83	662.86	-77.13	0.29	0.03
6122.57	0.88	662.86	-77.13	0.29	0.03

Shell Side - Light Liquid Phase

Mass Flow (lb/hr)	Density (lb/ft3)	Mass Sp Heat (Btu/lb-F)	Viscosity (cP)	Thermal Cond (Btu/hr-ft-F)	Surface Tens (dyne/cm)
---	---	---	---	---	---
---	---	---	---	---	---

Molecular Wt	Sp Gravity	Pseudo Pc (psig)	Pseudo Tc (F)	Pseudo Zc	Pseudo Omega
---	---	---	---	---	---
---	---	---	---	---	---

Shell Side - Heavy Liquid Phase

Mass Flow (lb/hr)	Density (lb/ft3)	Mass Sp Heat (Btu/lb-F)	Viscosity (cP)	Thermal Cond (Btu/hr-ft-F)	Surface Tens (dyne/cm)
---	---	---	---	---	---
---	---	---	---	---	---

Molecular Wt	Sp Gravity	Pseudo Pc (psig)	Pseudo Tc (F)	Pseudo Zc	Pseudo Omega
---	---	---	---	---	---
---	---	---	---	---	---

Shell Side - Mixed Liquid

Mass Flow (lb/hr)	Density (lb/ft3)	Mass Sp Heat (Btu/lb-F)	Viscosity (cP)	Thermal Cond (Btu/hr-ft-F)	Surface Tens (dyne/cm)
0.00	---	---	---	---	---
0.00	---	---	---	---	---

Molecular Wt	Sp Gravity	Pseudo Pc (psig)	Pseudo Tc (F)	Pseudo Zc	Pseudo Omega
---	---	---	---	---	---
---	---	---	---	---	---

Tube Side - Overall Phase

Temperature (F)	Pressure (psig)	Heat Flow (Btu/hr)	Enthalpy (Btu/lbmole)
66.32	444.00	374113.11	-38450.60
84.62	447.00	0.00	-38024.72

UA (Btu/F-hr)	Molar Vap Frac	Mass Vap Frac	Heat of Vap. (Btu/lbmole)
0.00	0.9213	0.8339	---
0.00	0.9526	0.8951	---

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Bedford, MA
USA

Case Name: Simulación Mario HT Gas.hsc
Unit Set: NewUser
Date/Time: Fri Dec 3 08:56:11 2021

Heat Exchanger: HT Gas-Gas (continued)

Tube Side - Vapour Phase

Mass Flow (lb/hr)	Molecular Wt	Density (lb/ft3)	Mass Sp Heat (Btu/lb-F)	Viscosity (cP)	Thermal Cond (Btu/hr-ft-F)
18029.00	22.28	2.11	0.55	0.01	0.02
19352.27	23.13	2.12	0.55	0.01	0.02
Std Gas Flow (MSCFD)	**Z Factor**	**Pseudo Pc (psig)**	**Pseudo Tc (F)**	**Pseudo Zc**	**Pseudo Omega**
7356.87	0.86	656.06	-44.47	0.29	0.04
7606.87	0.86	653.44	-36.35	0.29	0.05

Tube Side - Light Liquid Phase

Mass Flow (lb/hr)	Density (lb/ft3)	Mass Sp Heat (Btu/lb-F)	Viscosity (cP)	Thermal Cond (Btu/hr-ft-F)	Surface Tens (dyne/cm)
3590.63	34.08	0.59	0.14	0.05	9.50
2267.37	34.08	0.60	0.14	0.05	9.23
Molecular Wt	**Sp Gravity**	**Pseudo Pc (psig)**	**Pseudo Tc (F)**	**Pseudo Zc**	**Pseudo Omega**
51.96	0.55	560.03	228.37	0.28	0.17
54.50	0.55	549.40	245.47	0.28	0.18

Tube Side - Heavy Liquid Phase

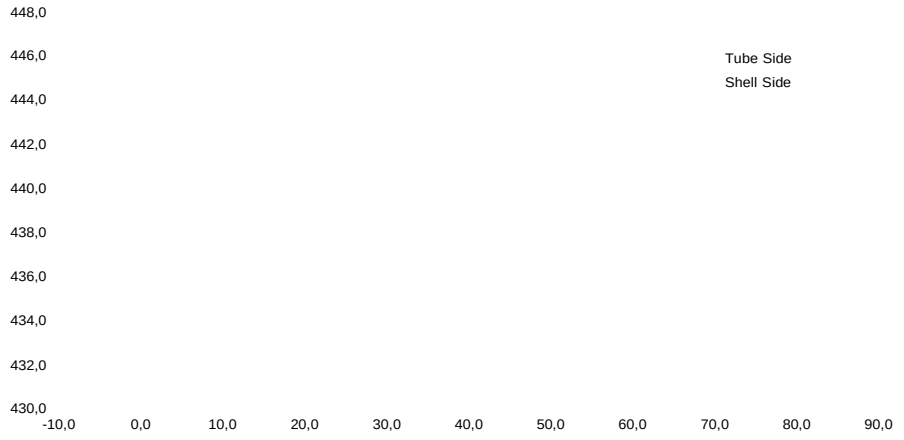
Mass Flow (lb/hr)	Density (lb/ft3)	Mass Sp Heat (Btu/lb-F)	Viscosity (cP)	Thermal Cond (Btu/hr-ft-F)	Surface Tens (dyne/cm)
---	---	---	---	---	---
---	---	---	---	---	---
Molecular Wt	**Sp Gravity**	**Pseudo Pc (psig)**	**Pseudo Tc (F)**	**Pseudo Zc**	**Pseudo Omega**
---	---	---	---	---	---
---	---	---	---	---	---

Tube Side - Mixed Liquid

Mass Flow (lb/hr)	Density (lb/ft3)	Mass Sp Heat (Btu/lb-F)	Viscosity (cP)	Thermal Cond (Btu/hr-ft-F)	Surface Tens (dyne/cm)
3590.63	34.08	0.59	0.14	0.05	---
2267.37	34.08	0.60	0.14	0.05	---
Molecular Wt	**Sp Gravity**	**Pseudo Pc (psig)**	**Pseudo Tc (F)**	**Pseudo Zc**	**Pseudo Omega**
51.96	0.55	560.03	228.37	0.28	0.17
54.50	0.55	549.40	245.47	0.28	0.18

PETROSANTANDER COLOMBIA Bedford, MA USA	Case Name:	Simulación Mario HT Gas.hsc	
	Unit Set:	NewUser	
	Date/Time:	Fri Dec 3 08:56:11 2021	

Heat Exchanger: HT Gas-Gas (continued)



DYNAMICS

Basic Model

Model Parameters

Tube Volume	(gal)	26.42	Shell UA	(lb/hr)	---
Shell Volume	(gal)	26.42	Tube UA	(lb/hr)	---
Elevation	(ft)	0.0000	Minimum Flow Scale Factor		0.0000 *
Overall UA	(Btu/F-hr)	8000 *			

Summary

Shell Duty: ---	Tube Duty: ---

Pressure Flow Specifications

Shell Side Specification

Delta P	(psi)	10.00 *	Active	k	lb/hr/sqrt(psia-lb/ft3)	---	Not Active

Tube Side Specifications

Delta P	(psi)	3.000 *	Active	k	lb/hr/sqrt(psia-lb/ft3)	---	Not Active

Holdup

Shell Holdup

Phase	Accumulation (MSCFD)	Moles (lbmole)	Volume (gal)
Vapour	0.0000	0.0000	0.0000
Liquid	0.0000	0.0000	0.0000
Aqueous	0.0000	0.0000	0.0000
Total	**0.0000**	**0.0000**	**0.0000**

Tube Holdup

Phase	Accumulation (MSCFD)	Moles (lbmole)	Volume (gal)
Vapour	0.0000	0.0000	0.0000
Liquid	0.0000	0.0000	0.0000

PETROSANTANDER COLOMBIA
Bedford, MA
USA

Case Name: Simulación Mario HT Gas.hsc
Unit Set: NewUser
Date/Time: Fri Dec 3 08:56:11 2021

Heat Exchanger: HT Gas-Gas (continued)

Phase	Accumulation (MSCFD)	Moles (lbmole)	Volume (gal)
Aqueous	0.0000	0.0000	0.0000
Total	**0.0000**	**0.0000**	**0.0000**

Overall Fouling Details

Delay Time (seconds) ---
Ramp Time (seconds) ---
Overall UA Decrease ---
Active Status Off

Shell Fouling Details

Delay Time (seconds) ---
Ramp Time (seconds) ---
Shell UA Decrease ---
Shell DP Increase ---
Active Status Off

Tube Fouling Details

Delay Time (seconds) ---
Ramp Time (seconds) ---
Tube UA Decrease ---
Tube DP Increase ---
Active Status Off

NOTES

HTFS

Exchanger Design and Rating

Apéndice D. Reporte de Simulación HT Nuevo

PETROSANTANDER COLOMBIA
Bedford, MA
USA

Case Name: Simulación Mario HT Gas.hsc
Unit Set: NewUser
Date/Time: Fri Dec 3 08:59:03 2021

Material Stream: Gas Entrada

Fluid Package:
Property Package:

CONDITIONS

	Overall	Vapour Phase	Liquid Phase
Vapour / Phase Fraction	0.9893	0.9893	0.0107
Temperature: (F)	110.0 *	110.0	110.0
Pressure: (psig)	450.0 *	450.0	450.0
Molar Flow (MSCFD)	8000 *	7914	85.99
Mass Flow (lb/hr)	2.162e+004	2.106e+004	557.9
Std Ideal Liq Vol Flow (USGPD)	1.645e+005	1.617e+005	2786
Molar Enthalpy (Btu/lbmole)	-3.746e+004	-3.717e+004	-6.416e+004
Molar Entropy (Btu/lbmole-F)	38.25	38.39	25.42
Heat Flow (Btu/hr)	-3.290e+007	-3.230e+007	-6.058e+005
Liq Vol Flow @Std Cond (USGPD)	5.939e+007 *	5.876e+007	2737

PROPERTIES

	Overall	Vapour Phase	Liquid Phase
Molecular Weight	24.61	24.24	59.09
Molar Density (lbmole/ft3)	8.829e-002	8.749e-002	0.5812
Mass Density (lb/ft3)	2.173	2.120	34.34
Act. Volume Flow (USGPD)	1.786e+006	1.783e+006	2917
Mass Enthalpy (Btu/lb)	-1522	-1534	-1086
Mass Entropy (Btu/lb-F)	1.554	1.584	0.4303
Heat Capacity (Btu/lbmole-F)	13.50	13.26	35.59
Mass Heat Capacity (Btu/lb-F)	0.5484	0.5470	0.6023
LHV Molar Basis (Std) (Btu/SCF)	1317	1298	3051
HHV Molar Basis (Std) (Btu/SCF)	1436	1416	3286
HHV Mass Basis (Std) (Btu/lb)	2.214e+004	2.217e+004	2.110e+004
CO2 Loading	---	---	---
CO2 Apparent Mole Conc. (lbmole/ft3)	---	---	1.608e-003
CO2 Apparent Wt. Conc. (lbmol/lb)	---	---	4.681e-005
LHV Mass Basis (Std) (Btu/lb)	2.030e+004	2.032e+004	1.959e+004
Phase Fraction [Vol. Basis]	0.9831	0.9831	1.694e-002
Phase Fraction [Mass Basis]	0.9742	0.9742	2.580e-002
Phase Fraction [Act. Vol. Basis]	0.9984	0.9984	1.633e-003
Mass Exergy (Btu/lb)	143.0	---	---
Partial Pressure of CO2 (psig)	-10.70	---	---
Cost Based on Flow (Cost/s)	0.0000	0.0000	0.0000
Act. Gas Flow (ACFM)	165.5	165.5	---
Avg. Liq. Density (lbmole/ft3)	0.9589	0.9650	0.6084
Specific Heat (Btu/lbmole-F)	13.50	13.26	35.59
Std. Gas Flow (MSCFD)	7985	7899	85.83
Std. Ideal Liq. Mass Density (lb/ft3)	23.60	23.39	35.95
Act. Liq. Flow (USGPD)	2917	---	2917
Z Factor	---	0.8688	0.1308
Watson K	17.09	17.19	13.62
User Property	---	---	---
Partial Pressure of H2S (psig)	-14.70	---	---
Cp/(Cp - R)	1.173	1.176	1.059
Cp/Cv	1.345	1.358	1.059
Ideal Gas Cp/Cv	1.204	1.207	1.086

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Bedford, MA
USA

Case Name: Simulación Mario HT Gas.hsc
Unit Set: NewUser
Date/Time: Fri Dec 3 08:59:03 2021

Material Stream: Gas Entrada (continued)

Fluid Package: Basis-1
Property Package: Peng-Robinson

PROPERTIES

		Overall	Vapour Phase	Liquid Phase		
Surface Tension	(dyne/cm)	9.127	---	9.127		
Thermal Conductivity	(Btu/hr-ft-F)	---	1.928e-002	5.115e-002		
Bubble Point Pressure	(psig)	---	---	---		
Viscosity	(cP)	---	1.243e-002	0.1393		
Cv (Semi-Ideal)	(Btu/lbmole-F)	11.51	11.27	33.60		
Mass Cv (Semi-Ideal)	(Btu/lb-F)	0.4677	0.4651	0.5687		
Cv	(Btu/lbmole-F)	10.04	9.765	33.60		
Mass Cv	(Btu/lb-F)	0.4078	0.4029	0.5687		
Cv (Ent. Method)	(Btu/lbmole-F)	---	---	---		
Mass Cv (Ent. Method)	(Btu/lb-F)	---	---	---		
Cp/Cv (Ent. Method)		---	---	---		
Reid VP at 37.8 C	(psig)	---	---	157.0		
True VP at 37.8 C	(psig)	---	---	430.3		
Liq. Vol. Flow - Sum(Std. Cond)()	USGPD	5.877e+007	5.876e+007	2737		
Viscosity Index		-108.7	---	---		

COMPOSITION

Overall Phase

Vapour Fraction 0.9893

COMPONENTS	MOLAR FLOW (lbmole/hr)	MOLE FRACTION	MASS FLOW (lb/hr)	MASS FRACTION	LIQUID VOLUME FLOW (USGPD)	LIQUID VOLUME FRACTION
CO2	7.5019 *	0.0085 *	330.1579 *	0.0153 *	1150.4167 *	0.0070 *
Nitrogen	1.3440 *	0.0015 *	37.6501 *	0.0017 *	134.2745 *	0.0008 *
Methane	606.5436 *	0.6905 *	9730.8192 *	0.4501 *	93469.5273 *	0.5683 *
Ethane	123.0340 *	0.1401 *	3699.6576 *	0.1711 *	29913.1509 *	0.1819 *
Propane	61.7893 *	0.0703 *	2724.7511 *	0.1260 *	15465.3064 *	0.0940 *
i-Butane	15.5923 *	0.0178 *	906.2944 *	0.0419 *	4637.9172 *	0.0282 *
n-Butane	30.6838 *	0.0349 *	1783.4852 *	0.0825 *	8794.2458 *	0.0535 *
i-Pentane	13.8090 *	0.0157 *	996.3463 *	0.0461 *	4595.9787 *	0.0279 *
n-Pentane	12.7813 *	0.0146 *	922.1908 *	0.0427 *	4211.4421 *	0.0256 *
n-Hexane	3.8651 *	0.0044 *	333.0919 *	0.0154 *	1445.5542 *	0.0088 *
n-Heptane	1.1156 *	0.0013 *	111.7914 *	0.0052 *	468.0934 *	0.0028 *
n-Octane	0.3602 *	0.0004 *	41.1422 *	0.0019 *	167.7372 *	0.0010 *
n-Decane	0.0000 *	0.0000 *	0.0000 *	0.0000 *	0.0000 *	0.0000 *
n-Nonane	0.0176 *	0.0000 *	2.2534 *	0.0001 *	8.9974 *	0.0001 *
Total	878.4375	1.0000	21619.6314	1.0000	164462.6419	1.0000

Vapour Phase

Phase Fraction 0.9893

COMPONENTS	MOLAR FLOW (lbmole/hr)	MOLE FRACTION	MASS FLOW (lb/hr)	MASS FRACTION	LIQUID VOLUME FLOW (USGPD)	LIQUID VOLUME FRACTION
CO2	7.4757	0.0086	329.0085	0.0156	1146.4118	0.0071
Nitrogen	1.3430	0.0015	37.6230	0.0018	134.1777	0.0008
Methane	605.4298	0.6967	9712.9512	0.4612	93297.8956	0.5771
Ethane	122.1825	0.1406	3674.0527	0.1744	29706.1256	0.1837
Propane	60.6549	0.0698	2674.7282	0.1270	15181.3838	0.0939
i-Butane	15.0212	0.0173	873.1018	0.0415	4468.0557	0.0276
n-Butane	29.2321	0.0336	1699.1035	0.0807	8378.1654	0.0518
i-Pentane	12.5447	0.0144	905.1185	0.0430	4175.1603	0.0258
n-Pentane	11.3596	0.0131	819.6167	0.0389	3743.0087	0.0232
n-Hexane	2.9627	0.0034	255.3178	0.0121	1108.0301	0.0069
n-Heptane	0.6505	0.0007	65.1881	0.0031	272.9559	0.0017
n-Octane	0.1353	0.0002	15.4609	0.0007	63.0343	0.0004
n-Decane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
n-Nonane	0.0037	0.0000	0.4773	0.0000	1.9058	0.0000
Total	868.9958	1.0000	21061.7483	1.0000	161676.3106	1.0000

PETROSANTANDER COLOMBIA
Bedford, MA
USA

Case Name: Simulación Mario HT Gas.hsc
Unit Set: NewUser
Date/Time: Fri Dec 3 08:59:03 2021

Material Stream: Gas Entrada (continued)

Fluid Package: Basis-1
Property Package: Peng-Robinson

COMPOSITION

Liquid Phase

Phase Fraction 1.075e-002

COMPONENTS	MOLAR FLOW (lbmole/hr)	MOLE FRACTION	MASS FLOW (lb/hr)	MASS FRACTION	LIQUID VOLUME FLOW (USGPD)	LIQUID VOLUME FRACTION
CO2	0.0261	0.0028	1.1494	0.0021	4.0049	0.0014
Nitrogen	0.0010	0.0001	0.0272	0.0000	0.0969	0.0000
Methane	1.1138	0.1180	17.8680	0.0320	171.6317	0.0616
Ethane	0.8515	0.0902	25.6049	0.0459	207.0254	0.0743
Propane	1.1344	0.1201	50.0228	0.0897	283.9226	0.1019
i-Butane	0.5711	0.0605	33.1926	0.0595	169.8615	0.0610
n-Butane	1.4517	0.1538	84.3817	0.1513	416.0804	0.1493
i-Pentane	1.2644	0.1339	91.2278	0.1635	420.8185	0.1510
n-Pentane	1.4216	0.1506	102.5741	0.1839	468.4334	0.1681
n-Hexane	0.9025	0.0956	77.7740	0.1394	337.5242	0.1211
n-Heptane	0.4651	0.0493	46.6033	0.0835	195.1375	0.0700
n-Octane	0.2248	0.0238	25.6813	0.0460	104.7030	0.0376
n-Decane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
n-Nonane	0.0138	0.0015	1.7761	0.0032	7.0915	0.0025
Total	9.4418	1.0000	557.8831	1.0000	2786.3314	1.0000

K VALUE

COMPONENTS	MIXED	LIGHT	HEAVY
CO2	3.110	3.110	---
Nitrogen	15.05	15.05	---
Methane	5.906	5.906	---
Ethane	1.559	1.559	---
Propane	0.5810	0.5810	---
i-Butane	0.2858	0.2858	---
n-Butane	0.2188	0.2188	---
i-Pentane	0.1078	0.1078	---
n-Pentane	8.682e-002	8.682e-002	---
n-Hexane	3.567e-002	3.567e-002	---
n-Heptane	1.520e-002	1.520e-002	---
n-Octane	6.541e-003	6.541e-003	---
n-Decane	---	---	---
n-Nonane	2.920e-003	2.920e-003	---

UNIT OPERATIONS

FEED TO	PRODUCT FROM	LOGICAL CONNECTION
Air cooler: Aeroenfriador-GIN		

UTILITIES

(No utilities reference this stream)

PROCESS UTILITY

DYNAMICS

Pressure Specification (Active): 450.0 psig *

Flow Specification (Active) Molar: 8000 MSCFD * Mass: 2.162e+004 lb/hr Std Ideal Liq Volume: 2.645e+005 USGPD

User Variables

NOTES

Description

PETROSANTANDER COLOMBIA
Bedford, MA
USA

Case Name: Simulación Mario HT Gas.hsc
Unit Set: NewUser
Date/Time: Fri Dec 3 08:59:03 2021

Material Stream: Gas Ventas

Fluid Package: Basis-1
Property Package: Peng-Robinson

CONDITIONS

	Overall	Vapour Phase			
Vapour / Phase Fraction	1.0000	1.0000			
Temperature: (F)	41.29	41.29			
Pressure: (psig)	432.0	432.0			
Molar Flow (MSCFD)	6134	6134			
Mass Flow (lb/hr)	1.294e+004	1.294e+004			
Std Ideal Liq Vol Flow (USGPD)	1.136e+005	1.136e+005			
Molar Enthalpy (Btu/lbmole)	-3.520e+004	-3.520e+004			
Molar Entropy (Btu/lbmole-F)	37.17	37.17			
Heat Flow (Btu/hr)	-2.371e+007	-2.371e+007			
Liq Vol Flow @Std Cond (USGPD)	4.564e+007 *	4.564e+007			

PROPERTIES

	Overall	Vapour Phase			
Molecular Weight	19.20	19.20			
Molar Density (lbmole/ft3)	9.426e-002	9.426e-002			
Mass Density (lb/ft3)	1.810	1.810			
Act. Volume Flow (USGPD)	1.283e+006	1.283e+006			
Mass Enthalpy (Btu/lb)	-1833	-1833			
Mass Entropy (Btu/lb-F)	1.935	1.935			
Heat Capacity (Btu/lbmole-F)	10.65	10.65			
Mass Heat Capacity (Btu/lb-F)	0.5545	0.5545			
LHV Molar Basis (Std) (Btu/SCF)	1045	1045			
HHV Molar Basis (Std) (Btu/SCF)	1146	1146			
HHV Mass Basis (Std) (Btu/lb)	2.264e+004	2.264e+004			
CO2 Loading	---	---			
CO2 Apparent Mole Conc. (lbmole/ft3)	---	---			
CO2 Apparent Wt. Conc. (lbmol/lb)	---	---			
LHV Mass Basis (Std) (Btu/lb)	2.064e+004	2.064e+004			
Phase Fraction [Vol. Basis]	1.000	1.000			
Phase Fraction [Mass Basis]	1.000	1.000			
Phase Fraction [Act. Vol. Basis]	1.000	1.000			
Mass Exergy (Btu/lb)	185.1	---			
Partial Pressure of CO2 (psig)	-10.62	---			
Cost Based on Flow (Cost/s)	0.0000	0.0000			
Act. Gas Flow (ACFM)	119.1	119.1			
Avg. Liq. Density (lbmole/ft3)	1.065	1.065			
Specific Heat (Btu/lbmole-F)	10.65	10.65			
Std. Gas Flow (MSCFD)	6123	6123			
Std. Ideal Liq. Mass Density (lb/ft3)	20.45	20.45			
Act. Liq. Flow (USGPD)	---	---			
Z Factor	0.8815	0.8815			
Watson K	18.66	18.66			
User Property	---	---			
Partial Pressure of H2S (psig)	-14.70	---			
Cp/(Cp - R)	1.229	1.229			
Cp/Cv	1.442	1.442			
Ideal Gas Cp/Cv	1.274	1.274			
Ideal Gas Cp (Btu/lbmole-F)	9.239	9.239			
Mass Ideal Gas Cp (Btu/lb-F)	0.4811	0.4811			
Heat of Vap. (Btu/lbmole)	3874	---			
Kinematic Viscosity (cSt)	0.3870	0.3870			
Liq. Mass Density (Std. Cond) (lb/ft3)	5.088e-002	5.088e-002			
Liq. Vol. Flow (Std. Cond) (USGPD)	4.564e+007	4.564e+007			
Liquid Fraction	0.0000	0.0000			
Molar Volume (ft3/lbmole)	10.61	10.61			
Mass Heat of Vap. (Btu/lb)	201.7	---			
Phase Fraction [Molar Basis]	1.0000	1.0000			

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Case Name: Simulación Mario HT Gas.hsc
Unit Set: NewUser
Date/Time: Fri Dec 3 08:59:03 2021

Material Stream: Gas Ventas (continued)

Fluid Package: Basis-1
Property Package: Peng-Robinson

PROPERTIES

		Overall	Vapour Phase			
Surface Tension	(dyne/cm)	---	---			
Thermal Conductivity	(Btu/hr-ft-F)	1.808e-002	1.808e-002			
Bubble Point Pressure	(psig)	---	---			
Viscosity	(cP)	1.122e-002	1.122e-002			
Cv (Semi-Ideal)	(Btu/lbmole-F)	8.663	8.663			
Mass Cv (Semi-Ideal)	(Btu/lb-F)	0.4511	0.4511			
Cv	(Btu/lbmole-F)	7.385	7.385			
Mass Cv	(Btu/lb-F)	0.3845	0.3845			
Cv (Ent. Method)	(Btu/lbmole-F)	---	---			
Mass Cv (Ent. Method)	(Btu/lb-F)	---	---			
Cp/Cv (Ent. Method)		---	---			
Reid VP at 37.8 C	(psig)	---	---			
True VP at 37.8 C	(psig)	---	---			
Liq. Vol. Flow - Sum(Std. Cond)()	USGPD	4.564e+007	4.564e+007			
Viscosity Index		-72.16	---			

COMPOSITION

Overall Phase

Vapour Fraction 1.0000

COMPONENTS	MOLAR FLOW (lbmole/hr)	MOLE FRACTION	MASS FLOW (lb/hr)	MASS FRACTION	LIQUID VOLUME FLOW (USGPD)	LIQUID VOLUME FRACTION
CO2	6.1427	0.0091	270.3402	0.0209	941.9852	0.0083
Nitrogen	1.3137	0.0020	36.8001	0.0028	131.2432	0.0012
Methane	560.8837	0.8327	8998.2952	0.6956	86433.2567	0.7610
Ethane	79.4822	0.1180	2390.0471	0.1848	19324.4476	0.1701
Propane	19.2740	0.0286	849.9345	0.0657	4824.1096	0.0425
i-Butane	2.2757	0.0034	132.2730	0.0102	676.9008	0.0060
n-Butane	3.1673	0.0047	184.0990	0.0142	907.7799	0.0080
i-Pentane	0.5842	0.0009	42.1500	0.0033	194.4308	0.0017
n-Pentane	0.3877	0.0006	27.9757	0.0022	127.7591	0.0011
n-Hexane	0.0345	0.0001	2.9742	0.0002	12.9074	0.0001
n-Heptane	0.0030	0.0000	0.3033	0.0000	1.2702	0.0000
n-Octane	0.0003	0.0000	0.0341	0.0000	0.1389	0.0000
n-Decane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
n-Nonane	0.0000	0.0000	0.0006	0.0000	0.0024	0.0000
Total	673.5490	1.0000	12935.2271	1.0000	113576.2318	1.0000

Vapour Phase

Phase Fraction 1.000

COMPONENTS	MOLAR FLOW (lbmole/hr)	MOLE FRACTION	MASS FLOW (lb/hr)	MASS FRACTION	LIQUID VOLUME FLOW (USGPD)	LIQUID VOLUME FRACTION
CO2	6.1427	0.0091	270.3402	0.0209	941.9852	0.0083
Nitrogen	1.3137	0.0020	36.8001	0.0028	131.2432	0.0012
Methane	560.8837	0.8327	8998.2952	0.6956	86433.2567	0.7610
Ethane	79.4822	0.1180	2390.0471	0.1848	19324.4476	0.1701
Propane	19.2740	0.0286	849.9345	0.0657	4824.1096	0.0425
i-Butane	2.2757	0.0034	132.2730	0.0102	676.9008	0.0060
n-Butane	3.1673	0.0047	184.0990	0.0142	907.7799	0.0080
i-Pentane	0.5842	0.0009	42.1500	0.0033	194.4308	0.0017
n-Pentane	0.3877	0.0006	27.9757	0.0022	127.7591	0.0011
n-Hexane	0.0345	0.0001	2.9742	0.0002	12.9074	0.0001
n-Heptane	0.0030	0.0000	0.3033	0.0000	1.2702	0.0000
n-Octane	0.0003	0.0000	0.0341	0.0000	0.1389	0.0000
n-Decane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
n-Nonane	0.0000	0.0000	0.0006	0.0000	0.0024	0.0000
Total	673.5490	1.0000	12935.2271	1.0000	113576.2318	1.0000

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Unit Set: NewUser
Date/Time: Fri Dec 3 08:59:03 2021

Material Stream: Gas Ventas (continued)

Fluid Package: Basis-1
Property Package: Peng-Robinson

K VALUE

COMPONENTS	MIXED	LIGHT	HEAVY
CO2	---	---	---
Nitrogen	---	---	---
Methane	---	---	---
Ethane	---	---	---
Propane	---	---	---
i-Butane	---	---	---
n-Butane	---	---	---
i-Pentane	---	---	---
n-Pentane	---	---	---
n-Hexane	---	---	---
n-Heptane	---	---	---
n-Octane	---	---	---
n-Decane	---	---	---
n-Nonane	---	---	---

UNIT OPERATIONS

FEED TO	PRODUCT FROM	LOGICAL CONNECTION
	Heat Exchanger: HT Gas-Gas	

UTILITIES

(No utilities reference this stream)

PROCESS UTILITY

DYNAMICS

Pressure Specification (Inactive) 432.0 psig

Flow Specification (Inactive) Molar: 6134 MSCFD Mass: 1.294e+004 lb/hr Std Ideal Liq Volume: 1.286e+005 USGPD

User Variables

NOTES

Description

Material Stream: Propano

Fluid Package: Basis-1
Property Package: Peng-Robinson

CONDITIONS

		Overall	Liquid Phase	Vapour Phase		
Vapour / Phase Fraction		0.0000	1.0000	0.0000		
Temperature:	(F)	114.8	114.8	114.8		
Pressure:	(psig)	184.0	184.0	184.0		
Molar Flow	(MSCFD)	230.3	230.3	0.0000		
Mass Flow	(lb/hr)	1282	1282	0.0000		
Std Ideal Liq Vol Flow	(USGPD)	6851	6851	0.0000		
Molar Enthalpy	(Btu/lbmole)	-5.694e+004	-5.694e+004	-4.836e+004		
Molar Entropy	(Btu/lbmole-F)	23.79	23.79	34.72		
Heat Flow	(Btu/hr)	-1.440e+006	-1.440e+006	0.0000		
Liq Vol Flow @Std Cond	(USGPD)	6814 *	6814	0.0000		

PROPERTIES

	Overall	Liquid Phase	Vapour Phase		
Molecular Weight	50.71	50.71	48.20		
Molar Density (lbmole/ft3)	0.6132	0.6132	4.380e-002		

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Case Name: Simulación Mario HT Gas.hsc
Unit Set: NewUser
Date/Time: Fri Dec 3 08:59:03 2021

Material Stream: Propano (continued)

Fluid Package: Basis-1
Property Package: Peng-Robinson

PROPERTIES

	Overall	Liquid Phase	Vapour Phase		
Mass Density (lb/ft3)	31.10	31.10	2.111		
Act. Volume Flow (USGPD)	7404	7404	0.0000		
Mass Enthalpy (Btu/lb)	-1123	-1123	-1003		
Mass Entropy (Btu/lb-F)	0.4691	0.4691	0.7203		
Heat Capacity (Btu/lbmole-F)	34.27	34.27	24.66		
Mass Heat Capacity (Btu/lb-F)	0.6757	0.6757	0.5117		
LHV Molar Basis (Std) (Btu/SCF)	2643	2643	2519		
HHV Molar Basis (Std) (Btu/SCF)	2851	2851	2719		
HHV Mass Basis (Std) (Btu/lb)	2.133e+004	2.133e+004	2.140e+004		
CO2 Loading	---	---	---		
CO2 Apparent Mole Conc. (lbmole/ft3)	1.667e-008	1.667e-008	---		
CO2 Apparent Wt. Conc. (lbmol/lb)	5.359e-010	5.359e-010	---		
LHV Mass Basis (Std) (Btu/lb)	1.978e+004	1.978e+004	1.983e+004		
Phase Fraction [Vol. Basis]	---	1.000	---		
Phase Fraction [Mass Basis]	0.0000	1.000	0.0000		
Phase Fraction [Act. Vol. Basis]	0.0000	1.000	0.0000		
Mass Exergy (Btu/lb)	35.26	---	---		
Partial Pressure of CO2 (psig)	-14.70	---	---		
Cost Based on Flow (Cost/s)	0.0000	0.0000	0.0000		
Act. Gas Flow (ACFM)	---	---	---		
Avg. Liq. Density (lbmole/ft3)	0.6627	0.6627	0.6818		
Specific Heat (Btu/lbmole-F)	34.27	34.27	24.66		
Std. Gas Flow (MSCFD)	229.9	229.9	0.0000		
Std. Ideal Liq. Mass Density (lb/ft3)	33.60	33.60	32.86		
Act. Liq. Flow (USGPD)	7404	7404	---		
Z Factor	---	5.257e-002	0.7360		
Watson K	14.16	14.16	14.35		
User Property	---	---	---		
Partial Pressure of H2S (psig)	-14.70	---	---		
Cp/(Cp - R)	1.062	1.062	1.088		
Cp/Cv	1.520	1.520	1.311		
Ideal Gas Cp/Cv	1.101	1.101	1.107		
Ideal Gas Cp (Btu/lbmole-F)	21.59	21.59	20.54		
Mass Ideal Gas Cp (Btu/lb-F)	0.4257	0.4257	0.4261		
Heat of Vap. (Btu/lbmole)	6604	---	---		
Kinematic Viscosity (cSt)	0.2152	0.2152	0.2790		
Liq. Mass Density (Std. Cond) (lb/ft3)	33.79	33.79	33.03		
Liq. Vol. Flow (Std. Cond) (USGPD)	6814	6814	0.0000		
Liquid Fraction	1.000	1.000	0.0000		
Molar Volume (ft3/lbmole)	1.631	1.631	22.83		
Mass Heat of Vap. (Btu/lb)	130.2	---	---		
Phase Fraction [Molar Basis]	0.0000	1.0000	0.0000		
Surface Tension (dyne/cm)	6.292	6.292	---		
Thermal Conductivity (Btu/hr-ft-F)	4.722e-002	4.722e-002	1.215e-002		
Bubble Point Pressure (psig)	139.4	---	---		
Viscosity (cP)	0.1072	0.1072	9.434e-003		
Cv (Semi-Ideal) (Btu/lbmole-F)	32.28	32.28	22.68		
Mass Cv (Semi-Ideal) (Btu/lb-F)	0.6366	0.6366	0.4705		
Cv (Btu/lbmole-F)	22.55	22.55	18.81		
Mass Cv (Btu/lb-F)	0.4446	0.4446	0.3903		
Cv (Ent. Method) (Btu/lbmole-F)	19.62	19.62	---		
Mass Cv (Ent. Method) (Btu/lb-F)	0.3869	0.3869	---		
Cp/Cv (Ent. Method)	1.747	1.747	---		
Reid VP at 37.8 C (psig)	109.0	109.0	132.6		
True VP at 37.8 C (psig)	112.5	112.5	135.8		
Liq. Vol. Flow - Sum(Std. Cond)() USGPD)	6814	6814	0.0000		
Viscosity Index	-49.94	---	---		

PETROSANTANDER COLOMBIA
Bedford, MA
USA

Case Name: Simulación Mario HT Gas.hsc
Unit Set: NewUser
Date/Time: Fri Dec 3 08:59:03 2021

Material Stream: Propano (continued)

Fluid Package: Basis-1
Property Package: Peng-Robinson

COMPOSITION

Overall Phase

Vapour Fraction 0.0000

COMPONENTS	MOLAR FLOW (lbmole/hr)	MOLE FRACTION	MASS FLOW (lb/hr)	MASS FRACTION	LIQUID VOLUME FLOW (USGPD)	LIQUID VOLUME FRACTION
CO2	0.0000	0.0000	0.0000	0.0000	0.0001	0.0000
Nitrogen	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Methane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Ethane	0.0125	0.0005	0.3770	0.0003	3.0481	0.0004
Propane	13.3397	0.5275	588.2455	0.4587	3338.7993	0.4873
i-Butane	8.1744	0.3233	475.1356	0.3705	2431.4835	0.3549
n-Butane	3.7614	0.1487	218.6315	0.1705	1078.0574	0.1573
i-Pentane	0.0001	0.0000	0.0036	0.0000	0.0168	0.0000
n-Pentane	0.0000	0.0000	0.0003	0.0000	0.0012	0.0000
n-Hexane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
n-Heptane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
n-Octane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
n-Decane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
n-Nonane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Total	25.2881	1.0000	1282.3936	1.0000	6851.4064	1.0000

Liquid Phase

Phase Fraction 1.000

COMPONENTS	MOLAR FLOW (lbmole/hr)	MOLE FRACTION	MASS FLOW (lb/hr)	MASS FRACTION	LIQUID VOLUME FLOW (USGPD)	LIQUID VOLUME FRACTION
CO2	0.0000	0.0000	0.0000	0.0000	0.0001	0.0000
Nitrogen	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Methane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Ethane	0.0125	0.0005	0.3770	0.0003	3.0481	0.0004
Propane	13.3397	0.5275	588.2455	0.4587	3338.7993	0.4873
i-Butane	8.1744	0.3233	475.1356	0.3705	2431.4835	0.3549
n-Butane	3.7614	0.1487	218.6315	0.1705	1078.0574	0.1573
i-Pentane	0.0001	0.0000	0.0036	0.0000	0.0168	0.0000
n-Pentane	0.0000	0.0000	0.0003	0.0000	0.0012	0.0000
n-Hexane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
n-Heptane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
n-Octane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
n-Decane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
n-Nonane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Total	25.2881	1.0000	1282.3936	1.0000	6851.4064	1.0000

Vapour Phase

Phase Fraction 0.0000

COMPONENTS	MOLAR FLOW (lbmole/hr)	MOLE FRACTION	MASS FLOW (lb/hr)	MASS FRACTION	LIQUID VOLUME FLOW (USGPD)	LIQUID VOLUME FRACTION
CO2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Nitrogen	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Methane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Ethane	0.0000	0.0017	0.0000	0.0011	0.0000	0.0016
Propane	0.0000	0.7039	0.0000	0.6440	0.0000	0.6691
i-Butane	0.0000	0.2168	0.0000	0.2615	0.0000	0.2449
n-Butane	0.0000	0.0775	0.0000	0.0935	0.0000	0.0844
i-Pentane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
n-Pentane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
n-Hexane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
n-Heptane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
n-Octane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
n-Decane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
n-Nonane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Total	0.0000	1.0000	0.0000	1.0000	0.0000	1.0000

PETROSANTANDER COLOMBIA
Bedford, MA
USA

Case Name: Simulación Mario HT Gas.hsc
Unit Set: NewUser
Date/Time: Fri Dec 3 08:59:03 2021

Material Stream: Propano (continued)

Fluid Package: Basis-1
Property Package: Peng-Robinson

K VALUE

COMPONENTS	MIXED	LIGHT	HEAVY
CO2	7.113	7.113	---
Nitrogen	29.83	29.83	---
Methane	12.45	12.45	---
Ethane	3.461	3.461	---
Propane	1.334	1.334	---
i-Butane	0.6708	0.6708	---
n-Butane	0.5211	0.5211	---
i-Pentane	0.2619	0.2619	---
n-Pentane	0.2139	0.2139	---
n-Hexane	9.073e-002	9.073e-002	---
n-Heptane	3.984e-002	3.984e-002	---
n-Octane	1.769e-002	1.769e-002	---
n-Decane	---	---	---
n-Nonane	---	---	---

UNIT OPERATIONS

FEED TO	PRODUCT FROM	LOGICAL CONNECTION
	Tank: TK-C3	

UTILITIES

(No utilities reference this stream)

PROCESS UTILITY

DYNAMICS

Pressure Specification	(Inactive)	184.0 psig			
Flow Specification	(Inactive)	Molar: 230.3 MSCFD	Mass: 1282 lb/hr	Std Ideal Liq Volume: 6851 USGPD	

User Variables

NOTES

Description

Material Stream: Butano

Fluid Package: Basis-1
Property Package: Peng-Robinson

CONDITIONS

		Overall	Liquid Phase	Vapour Phase		
Vapour / Phase Fraction		0.0000	1.0000	0.0000		
Temperature:	(F)	108.5 *	108.5	108.5		
Pressure:	(psig)	55.70	55.70	55.70		
Molar Flow	(MSCFD)	143.3	143.3	0.0000		
Mass Flow	(lb/hr)	959.5	959.5	0.0000		
Std Ideal Liq Vol Flow	(USGPD)	4674	4674	0.0000		
Molar Enthalpy	(Btu/lbmole)	-6.537e+004	-6.537e+004	-5.549e+004		
Molar Entropy	(Btu/lbmole-F)	16.57	16.57	31.46		
Heat Flow	(Btu/hr)	-1.029e+006	-1.029e+006	0.0000		
Liq Vol Flow @Std Cond	(USGPD)	4657 *	4657	0.0000		

PROPERTIES

		Overall	Liquid Phase	Vapour Phase		
Molecular Weight		60.97	60.97	59.35		
Molar Density	(lbmole/ft3)	0.5739	0.5739	1.324e-002		

PETROSANTANDER COLOMBIA
Bedford, MA
USA

Case Name: Simulación Mario HT Gas.hsc
Unit Set: NewUser
Date/Time: Fri Dec 3 08:59:03 2021

Material Stream: Butano (continued)

Fluid Package: Basis-1
Property Package: Peng-Robinson

PROPERTIES

	Overall	Liquid Phase	Vapour Phase		
Mass Density (lb/ft3)	35.00	35.00	0.7860		
Act. Volume Flow (USGPD)	4922	4922	0.0000		
Mass Enthalpy (Btu/lb)	-1072	-1072	-935.0		
Mass Entropy (Btu/lb-F)	0.2718	0.2718	0.5300		
Heat Capacity (Btu/lbmole-F)	36.43	36.43	26.29		
Mass Heat Capacity (Btu/lb-F)	0.5975	0.5975	0.4430		
LHV Molar Basis (Std) (Btu/SCF)	3152	3152	3072		
HHV Molar Basis (Std) (Btu/SCF)	3394	3394	3309		
HHV Mass Basis (Std) (Btu/lb)	2.112e+004	2.112e+004	2.115e+004		
CO2 Loading	---	---	---		
CO2 Apparent Mole Conc. (lbmole/ft3)	8.038e-016	8.038e-016	---		
CO2 Apparent Wt. Conc. (lbmol/lb)	2.297e-017	2.297e-017	---		
LHV Mass Basis (Std) (Btu/lb)	1.962e+004	1.962e+004	1.964e+004		
Phase Fraction [Vol. Basis]	---	1.000	---		
Phase Fraction [Mass Basis]	0.0000	1.000	0.0000		
Phase Fraction [Act. Vol. Basis]	0.0000	1.000	0.0000		
Mass Exergy (Btu/lb)	12.37	---	---		
Partial Pressure of CO2 (psig)	-14.70	---	---		
Cost Based on Flow (Cost/s)	0.0000	0.0000	0.0000		
Act. Gas Flow (ACFM)	---	---	---		
Avg. Liq. Density (lbmole/ft3)	0.6043	0.6043	0.6139		
Specific Heat (Btu/lbmole-F)	36.43	36.43	26.29		
Std. Gas Flow (MSCFD)	143.0	143.0	0.0000		
Std. Ideal Liq. Mass Density (lb/ft3)	36.85	36.85	36.43		
Act. Liq. Flow (USGPD)	4922	4922	---		
Z Factor	---	2.012e-002	0.8718		
Watson K	13.42	13.42	13.50		
User Property	---	---	---		
Partial Pressure of H2S (psig)	-14.70	---	---		
Cp/(Cp - R)	1.058	1.058	1.082		
Cp/Cv	1.415	1.415	1.137		
Ideal Gas Cp/Cv	1.084	1.084	1.086		
Ideal Gas Cp (Btu/lbmole-F)	25.64	25.64	24.99		
Mass Ideal Gas Cp (Btu/lb-F)	0.4205	0.4205	0.4211		
Heat of Vap. (Btu/lbmole)	8915	---	---		
Kinematic Viscosity (cSt)	0.2668	0.2668	0.6283		
Liq. Mass Density (Std. Cond) (lb/ft3)	36.99	36.99	36.55		
Liq. Vol. Flow (Std. Cond) (USGPD)	4657	4657	0.0000		
Liquid Fraction	1.000	1.000	0.0000		
Molar Volume (ft3/lbmole)	1.742	1.742	75.51		
Mass Heat of Vap. (Btu/lb)	146.2	---	---		
Phase Fraction [Molar Basis]	0.0000	1.0000	0.0000		
Surface Tension (dyne/cm)	10.29	10.29	---		
Thermal Conductivity (Btu/hr-ft-F)	5.121e-002	5.121e-002	1.015e-002		
Bubble Point Pressure (psig)	38.89	---	---		
Viscosity (cP)	0.1496	0.1496	7.910e-003		
Cv (Semi-Ideal) (Btu/lbmole-F)	34.45	34.45	24.31		
Mass Cv (Semi-Ideal) (Btu/lb-F)	0.5649	0.5649	0.4095		
Cv (Btu/lbmole-F)	25.75	25.75	23.13		
Mass Cv (Btu/lb-F)	0.4223	0.4223	0.3896		
Cv (Ent. Method) (Btu/lbmole-F)	24.66	24.66	---		
Mass Cv (Ent. Method) (Btu/lb-F)	0.4044	0.4044	---		
Cp/Cv (Ent. Method)	1.477	1.477	---		
Reid VP at 37.8 C (psig)	31.98	31.98	37.38		
True VP at 37.8 C (psig)	32.29	32.29	37.64		
Liq. Vol. Flow - Sum(Std. Cond()USGPD)	4657	4657	0.0000		
Viscosity Index	-28.83	---	---		

PETROSANTANDER COLOMBIA
Bedford, MA
USA

Case Name: Simulación Mario HT Gas.hsc
Unit Set: NewUser
Date/Time: Fri Dec 3 08:59:03 2021

Material Stream: Butano (continued)

Fluid Package: Basis-1
Property Package: Peng-Robinson

COMPOSITION

Overall Phase

Vapour Fraction 0.0000

COMPONENTS	MOLAR FLOW (lbmole/hr)	MOLE FRACTION	MASS FLOW (lb/hr)	MASS FRACTION	LIQUID VOLUME FLOW (USGPD)	LIQUID VOLUME FRACTION
CO2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Nitrogen	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Methane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Ethane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Propane	0.0268	0.0017	1.1814	0.0012	6.7052	0.0014
i-Butane	1.8302	0.1163	106.3778	0.1109	544.3834	0.1165
n-Butane	10.6541	0.6771	619.2625	0.6454	3053.5420	0.6532
i-Pentane	2.2466	0.1428	162.0978	0.1689	747.7300	0.1600
n-Pentane	0.9775	0.0621	70.5316	0.0735	322.1021	0.0689
n-Hexane	0.0000	0.0000	0.0013	0.0000	0.0058	0.0000
n-Heptane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
n-Octane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
n-Decane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
n-Nonane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Total	15.7352	1.0000	959.4524	1.0000	4674.4686	1.0000

Liquid Phase

Phase Fraction 1.000

COMPONENTS	MOLAR FLOW (lbmole/hr)	MOLE FRACTION	MASS FLOW (lb/hr)	MASS FRACTION	LIQUID VOLUME FLOW (USGPD)	LIQUID VOLUME FRACTION
CO2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Nitrogen	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Methane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Ethane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Propane	0.0268	0.0017	1.1814	0.0012	6.7052	0.0014
i-Butane	1.8302	0.1163	106.3778	0.1109	544.3834	0.1165
n-Butane	10.6541	0.6771	619.2625	0.6454	3053.5420	0.6532
i-Pentane	2.2466	0.1428	162.0978	0.1689	747.7300	0.1600
n-Pentane	0.9775	0.0621	70.5316	0.0735	322.1021	0.0689
n-Hexane	0.0000	0.0000	0.0013	0.0000	0.0058	0.0000
n-Heptane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
n-Octane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
n-Decane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
n-Nonane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Total	15.7352	1.0000	959.4524	1.0000	4674.4686	1.0000

Vapour Phase

Phase Fraction 0.0000

COMPONENTS	MOLAR FLOW (lbmole/hr)	MOLE FRACTION	MASS FLOW (lb/hr)	MASS FRACTION	LIQUID VOLUME FLOW (USGPD)	LIQUID VOLUME FRACTION
CO2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Nitrogen	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Methane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Ethane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Propane	0.0000	0.0055	0.0000	0.0041	0.0000	0.0047
i-Butane	0.0000	0.1691	0.0000	0.1656	0.0000	0.1720
n-Butane	0.0000	0.7322	0.0000	0.7171	0.0000	0.7176
i-Pentane	0.0000	0.0694	0.0000	0.0843	0.0000	0.0789
n-Pentane	0.0000	0.0238	0.0000	0.0289	0.0000	0.0268
n-Hexane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
n-Heptane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
n-Octane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
n-Decane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
n-Nonane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Total	0.0000	1.0000	0.0000	1.0000	0.0000	1.0000

PETROSANTANDER COLOMBIA
Bedford, MA
USA

Case Name: Simulación Mario HT Gas.hsc
Unit Set: NewUser
Date/Time: Fri Dec 3 08:59:03 2021

Material Stream: Butano (continued)

Fluid Package: Basis-1
Property Package: Peng-Robinson

K VALUE

COMPONENTS	MIXED	LIGHT	HEAVY
CO2	21.99	21.99	---
Nitrogen	121.4	121.4	---
Methane	43.71	43.71	---
Ethane	9.832	9.832	---
Propane	3.239	3.239	---
i-Butane	1.454	1.454	---
n-Butane	1.081	1.081	---
i-Pentane	0.4859	0.4859	---
n-Pentane	0.3823	0.3823	---
n-Hexane	0.1405	0.1405	---
n-Heptane	5.370e-002	5.370e-002	---
n-Octane	2.077e-002	2.077e-002	---
n-Decane	---	---	---
n-Nonane	8.366e-003	8.366e-003	---

UNIT OPERATIONS

FEED TO	PRODUCT FROM	LOGICAL CONNECTION
	Tank: TK-C4	

UTILITIES

(No utilities reference this stream)

PROCESS UTILITY

DYNAMICS

Pressure Specification (Inactive) 55.70 psig

Flow Specification (Inactive) Molar: 143.3 MSCFD Mass: 959.5 lb/hr Std Ideal Liq Volume: 4674 USGPD

User Variables

NOTES

Description

Material Stream: Gasolina

Fluid Package: Basis-1
Property Package: Peng-Robinson

CONDITIONS

	Overall	Vapour Phase	Liquid Phase		
Vapour / Phase Fraction	0.0000	0.0000	1.0000		
Temperature: (F)	121.2	121.2	121.2		
Pressure: (psig)	20.00	20.00	20.00		
Molar Flow (MSCFD)	312.1	0.0000	312.1		
Mass Flow (lb/hr)	2444	0.0000	2444		
Std Ideal Liq Vol Flow (USGPD)	1.126e+004	0.0000	1.126e+004		
Molar Enthalpy (Btu/lbmole)	-7.290e+004	-5.879e+004	-7.290e+004		
Molar Entropy (Btu/lbmole-F)	20.19	35.32	20.19		
Heat Flow (Btu/hr)	-2.498e+006	0.0000	-2.498e+006		
Liq Vol Flow @Std Cond (USGPD)	1.120e+004 *	0.0000	1.120e+004		

PROPERTIES

	Overall	Vapour Phase	Liquid Phase		
Molecular Weight	71.32	65.25	71.32		
Molar Density (lbmole/ft3)	0.5173	5.970e-003	0.5173		

PETROSANTANDER COLOMBIA
Bedford, MA
USA

Case Name: Simulación Mario HT Gas.hsc
Unit Set: NewUser
Date/Time: Fri Dec 3 08:59:03 2021

Material Stream: Gasolina (continued)

Fluid Package: Basis-1
Property Package: Peng-Robinson

PROPERTIES

	Overall	Vapour Phase	Liquid Phase		
Mass Density (lb/ft3)	36.89	0.3895	36.89		
Act. Volume Flow (USGPD)	1.189e+004	0.0000	1.189e+004		
Mass Enthalpy (Btu/lb)	-1022	-901.0	-1022		
Mass Entropy (Btu/lb-F)	0.2831	0.5413	0.2831		
Heat Capacity (Btu/lbmole-F)	41.17	28.46	41.17		
Mass Heat Capacity (Btu/lb-F)	0.5772	0.4362	0.5772		
LHV Molar Basis (Std) (Btu/SCF)	3665	3364	3665		
HHV Molar Basis (Std) (Btu/SCF)	3941	3620	3941		
HHV Mass Basis (Std) (Btu/lb)	2.097e+004	2.105e+004	2.097e+004		
CO2 Loading	---	---	---		
CO2 Apparent Mole Conc. (lbmole/ft3)	7.557e-025	---	7.557e-025		
CO2 Apparent Wt. Conc. (lbmol/lb)	2.048e-026	---	2.048e-026		
LHV Mass Basis (Std) (Btu/lb)	1.950e+004	1.956e+004	1.950e+004		
Phase Fraction [Vol. Basis]	---	---	1.000		
Phase Fraction [Mass Basis]	0.0000	0.0000	1.000		
Phase Fraction [Act. Vol. Basis]	0.0000	0.0000	1.000		
Mass Exergy (Btu/lb)	1.251	---	---		
Partial Pressure of CO2 (psig)	-14.70	---	---		
Cost Based on Flow (Cost/s)	0.0000	0.0000	0.0000		
Act. Gas Flow (ACFM)	---	---	---		
Avg. Liq. Density (lbmole/ft3)	0.5464	0.5792	0.5464		
Specific Heat (Btu/lbmole-F)	41.17	28.46	41.17		
Std. Gas Flow (MSCFD)	311.5	0.0000	311.5		
Std. Ideal Liq. Mass Density (lb/ft3)	38.97	37.79	38.97		
Act. Liq. Flow (USGPD)	1.189e+004	---	1.189e+004		
Z Factor	---	0.9324	1.076e-002		
Watson K	13.08	13.26	13.08		
User Property	---	---	---		
Partial Pressure of H2S (psig)	-14.70	---	---		
Cp/(Cp - R)	1.051	1.075	1.051		
Cp/Cv	1.051	1.097	1.051		
Ideal Gas Cp/Cv	1.070	1.077	1.070		
Ideal Gas Cp (Btu/lbmole-F)	30.35	27.86	30.35		
Mass Ideal Gas Cp (Btu/lb-F)	0.4256	0.4271	0.4256		
Heat of Vap. (Btu/lbmole)	1.172e+004	---	---		
Kinematic Viscosity (cSt)	0.2987	1.218	0.2987		
Liq. Mass Density (Std. Cond) (lb/ft3)	39.18	37.97	39.18		
Liq. Vol. Flow (Std. Cond) (USGPD)	1.120e+004	0.0000	1.120e+004		
Liquid Fraction	1.000	0.0000	1.000		
Molar Volume (ft3/lbmole)	1.933	167.5	1.933		
Mass Heat of Vap. (Btu/lb)	164.3	---	---		
Phase Fraction [Molar Basis]	0.0000	0.0000	1.0000		
Surface Tension (dyne/cm)	11.91	---	11.91		
Thermal Conductivity (Btu/hr-ft-F)	5.477e-002	9.932e-003	5.477e-002		
Bubble Point Pressure (psig)	20.00	---	---		
Viscosity (cP)	0.1765	7.601e-003	0.1765		
Cv (Semi-Ideal) (Btu/lbmole-F)	39.18	26.48	39.18		
Mass Cv (Semi-Ideal) (Btu/lb-F)	0.5494	0.4058	0.5494		
Cv (Btu/lbmole-F)	39.18	25.94	39.18		
Mass Cv (Btu/lb-F)	0.5494	0.3976	0.5494		
Cv (Ent. Method) (Btu/lbmole-F)	---	---	---		
Mass Cv (Ent. Method) (Btu/lb-F)	---	---	---		
Cp/Cv (Ent. Method)	---	---	---		
Reid VP at 37.8 C (psig)	9.645	20.98	9.645		
True VP at 37.8 C (psig)	10.02	21.41	10.02		
Liq. Vol. Flow - Sum(Std. Cond)() USGPD)	1.120e+004	0.0000	1.120e+004		
Viscosity Index	-23.38	---	---		

PETROSANTANDER COLOMBIA
Bedford, MA
USA

Case Name: Simulación Mario HT Gas.hsc
Unit Set: NewUser
Date/Time: Fri Dec 3 08:59:03 2021

Material Stream: Gasolina (continued)

Fluid Package: Basis-1
Property Package: Peng-Robinson

COMPOSITION

Overall Phase

Vapour Fraction 0.0000

COMPONENTS	MOLAR FLOW (lbmole/hr)	MOLE FRACTION	MASS FLOW (lb/hr)	MASS FRACTION	LIQUID VOLUME FLOW (USGPD)	LIQUID VOLUME FRACTION
CO2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Nitrogen	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Methane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Ethane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Propane	0.0029	0.0001	0.1262	0.0001	0.7161	0.0001
i-Butane	0.8798	0.0257	51.1375	0.0209	261.6936	0.0232
n-Butane	8.1795	0.2387	475.4330	0.1945	2344.3281	0.2082
i-Pentane	9.6399	0.2813	695.5351	0.2846	3208.3868	0.2849
n-Pentane	10.3897	0.3032	749.6350	0.3067	3423.4179	0.3040
n-Hexane	3.7026	0.1080	319.0877	0.1306	1384.7787	0.1230
n-Heptane	1.0982	0.0320	110.0494	0.0450	460.7993	0.0409
n-Octane	0.3581	0.0104	40.9035	0.0167	166.7643	0.0148
n-Decane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
n-Nonane	0.0175	0.0005	2.2483	0.0009	8.9771	0.0008
Total	34.2682	1.0000	2444.1556	1.0000	11259.8618	1.0000

Vapour Phase

Phase Fraction 0.0000

COMPONENTS	MOLAR FLOW (lbmole/hr)	MOLE FRACTION	MASS FLOW (lb/hr)	MASS FRACTION	LIQUID VOLUME FLOW (USGPD)	LIQUID VOLUME FRACTION
CO2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Nitrogen	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Methane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Ethane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Propane	0.0000	0.0005	0.0000	0.0003	0.0000	0.0004
i-Butane	0.0000	0.0662	0.0000	0.0590	0.0000	0.0635
n-Butane	0.0000	0.4585	0.0000	0.4084	0.0000	0.4239
i-Pentane	0.0000	0.2405	0.0000	0.2660	0.0000	0.2582
n-Pentane	0.0000	0.2044	0.0000	0.2260	0.0000	0.2173
n-Hexane	0.0000	0.0265	0.0000	0.0350	0.0000	0.0320
n-Heptane	0.0000	0.0030	0.0000	0.0046	0.0000	0.0040
n-Octane	0.0000	0.0004	0.0000	0.0007	0.0000	0.0006
n-Decane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
n-Nonane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Total	0.0000	1.0000	0.0000	1.0000	0.0000	1.0000

Liquid Phase

Phase Fraction 1.000

COMPONENTS	MOLAR FLOW (lbmole/hr)	MOLE FRACTION	MASS FLOW (lb/hr)	MASS FRACTION	LIQUID VOLUME FLOW (USGPD)	LIQUID VOLUME FRACTION
CO2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Nitrogen	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Methane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Ethane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Propane	0.0029	0.0001	0.1262	0.0001	0.7161	0.0001
i-Butane	0.8798	0.0257	51.1375	0.0209	261.6936	0.0232
n-Butane	8.1795	0.2387	475.4330	0.1945	2344.3281	0.2082
i-Pentane	9.6399	0.2813	695.5351	0.2846	3208.3868	0.2849
n-Pentane	10.3897	0.3032	749.6350	0.3067	3423.4179	0.3040
n-Hexane	3.7026	0.1080	319.0877	0.1306	1384.7787	0.1230
n-Heptane	1.0982	0.0320	110.0494	0.0450	460.7993	0.0409
n-Octane	0.3581	0.0104	40.9035	0.0167	166.7643	0.0148
n-Decane	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
n-Nonane	0.0175	0.0005	2.2483	0.0009	8.9771	0.0008
Total	34.2682	1.0000	2444.1556	1.0000	11259.8618	1.0000

PETROSANTANDER COLOMBIA
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Case Name: Simulación Mario HT Gas.hsc
Unit Set: NewUser
Date/Time: Fri Dec 3 08:59:03 2021

Material Stream: Gasolina (continued)

Fluid Package: Basis-1
Property Package: Peng-Robinson

K VALUE

COMPONENTS	MIXED	LIGHT	HEAVY
CO2	38.78	38.78	---
Nitrogen	---	---	---
Methane	78.38	78.38	---
Ethane	17.65	17.65	---
Propane	5.791	5.791	---
i-Butane	2.579	2.579	---
n-Butane	1.921	1.921	---
i-Pentane	0.8550	0.8550	---
n-Pentane	0.6742	0.6742	---
n-Hexane	0.2455	0.2455	---
n-Heptane	9.296e-002	9.296e-002	---
n-Octane	3.560e-002	3.560e-002	---
n-Decane	---	---	---
n-Nonane	1.418e-002	1.418e-002	---

UNIT OPERATIONS

FEED TO	PRODUCT FROM	LOGICAL CONNECTION
	Tank: TK-C5	

UTILITIES

(No utilities reference this stream)

PROCESS UTILITY

DYNAMICS

Pressure Specification	(Inactive)	20.00 psig				
Flow Specification	(Inactive)	Molar:	312.1 MSCFD	Mass:	2444 lb/hr	Std Ideal Liq Volume: 1.26e+004 USGPD

User Variables

NOTES

Description