NETL Life Cycle Inventory Data
Process Documentation File

Process Name:	Natural Gas Liquid Separation
Reference Flow:	1 kg of Natural gas (production) [Valuable substances]
Brief Description:	Natural gas liquids separation from extracted natural gas

Section I: Meta Data

Geographical Coverage: N/A   **Region:** N/A

Year Data Best Represents: 2010

Process Type: Extraction Process (EP)

Process Scope: Gate-to-Gate Process (GG)

Allocation Applied: No

Completeness: All Relevant Flows Captured

Flows Aggregated in Data Set:

☑ Process   ☑ Energy Use   ☐ Energy P&D   ☐ Material P&D

Relevant Output Flows Included in Data Set:

Releases to Air:	☐ Greenhouse Gases	☐ Criteria Air	☐ Other
Releases to Water:	☐ Inorganic	☐ Organic Emissions	☐ Other
Water Usage:	☐ Water Consumption	☐ Water Demand (throughput)	
Releases to Soil:	☐ Inorganic Releases	☐ Organic Releases	☐ Other

Adjustable Process Parameters:

Aux_boiler_NG	*[kg/kg] kg of combusted natural gas for 1 kg processed ng output.*
Elect_in	*[MWh/kg] MWh of electricty for 1 kg processed ng output*
Ext_Benz	*[kg/kg] Weight fraction of extracted natural gas that is benzene.*
Ext_C2H6	*[kg/kg] Weight fraction of extracted natural gas that is ethane.*

Ext_C3H8 *[kg/kg] Weight fraction of extracted natural gas that is propane.*

Ext_CH4 *[kg/kg] Weight fraction of extracted natural gas that is methane.*

Ext_CO2 *[kg/kg] Weight fraction of extracted natural gas that is carbon dioxide.*

Ext_cyclohexane *[kg/kg] Weight fraction of extracted natural gas that is cyclohexane.*

Ext_cyclopent *[kg/kg] Weight fraction of extracted natural gas that is cyclopentane.*

Ext_Ebenz *[kg/kg] Weight fraction of extracted natural gas that is eythlbenzene.*

Ext_H2S *[kg/kg] Weight fraction of extracted natural gas that is hydrogen sulfide.*

Ext_i_heptanes *[kg/kg] Weight fraction of extracted natural gas that are isomers of heptane.*

Ext_i_hexanes *[kg/kg] Weight fraction of extracted natural gas that are isomers of hexane.*

Ext_isobut *[kg/kg] Weight fraction of extracted natural gas that is iso-butane.*

Ext_isopentane *[kg/kg] Weight fraction of extracted natural gas that is iso-pentane.*

Ext_methcychex *[kg/kg] Weight fraction of extracted natural gas that is methyl cyclohexane.*

Ext_N_but *[kg/kg] Weight fraction of extracted natural gas that is n-butane.*

Ext_N_hex *[kg/kg] Weight fraction of extracted natural gas that is n-hexane.*

Ext_N_pentane *[kg/kg] Weight fraction of extracted natural gas that is n-pentane.*

Ext_N2 *[kg/kg] Weight fraction of extracted natural gas that is nitrogen.*

Ext_Tol *[kg/kg] Weight fraction of extracted natural gas that is toluene.*

Ext_trimetpen2 *[kg/kg] Weight fraction of extracted natural gas that is 2,2,4-Trimethylpentane.*

Ext_undef_VOC   *[kg/kg] Weight fraction of extracted natural gas that are undefined volatile organic compounds.*

Ext_Xyl   *[kg/kg] Weight fraction of extracted natural gas that is xylene.*

Pr_Benz   *[kg/kg] Weight fraction of processed natural gas that is benzene.*

Pr_C2H6   *[kg/kg] Weight fraction of processed natural gas that is ethane.*

Pr_C3H8   *[kg/kg] Weight fraction of processed natural gas that is propane.*

Pr_CH4   *[kg/kg] Weight fraction of processed natural gas that is methane.*

Pr_CO2   *[kg/kg] Weight fraction of processed natural gas that is carbon dioxide.*

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Pr_i_hexanes   *[kg/kg] Weight fraction of processed natural gas that are isomers of hexane.*

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Pr_isopentane   *[kg/kg] Weight fraction of processed natural gas that is iso-pentane.*

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Pr_undef_VOC   *[kg/kg] Weight fraction of processed natural gas that are undefined volatile organic compounds.*

Pr_Xyl   *[kg/kg] Weight fraction of processed natural gas that is xylene.*

Tracked Input Flows:

Electricity [Electric power]   *[Technosphere] Electricity Input*
Natural gas (production) [Valuable substances]   *[Technosphere] Natural Gas Product Input*
Natural gas, combusted in boiler [Natural gas products]   *[Technosphere] Natural Gas Combustion Input*

Tracked Output Flows:

Natural gas (production) [Valuable substances] [Insert]   *Reference flow*
Natural Gas Liquids [Natural gas products]   *Natural Gas Liquids Co-Product*

Section II: Process Description

Associated Documentation

This unit process is composed of this document and the data sheet (DS) *DS_Stage3_O_Natural_Gas_Liquid_Separation_2015.1.xlsx*, which provides additional details regarding relevant calculations, data quality, and references.
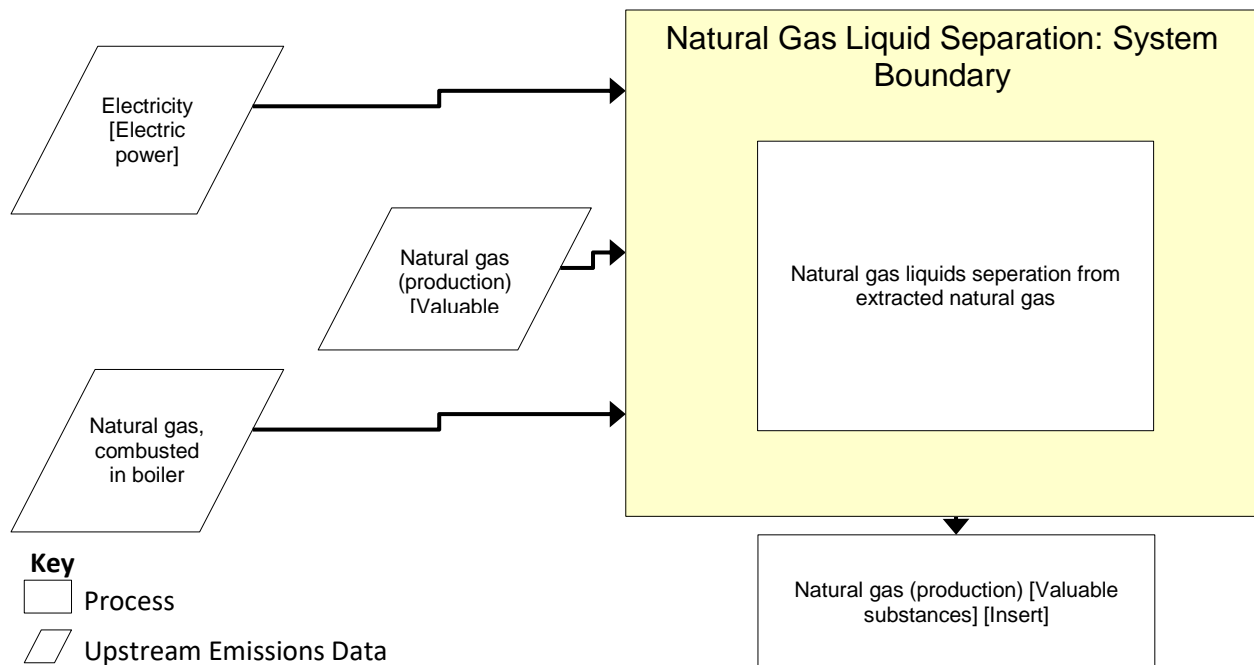

Goal and Scope

This unit process provides a summary of relevant input and output flows associated with processing extracted natural gas to separate the pure natural gas (methane) from the other hydrocarbons and fluids (natural gas liquids (NGL)). Inputs include extracted natural gas (methane) and energy (natural gas and electricity). Outputs include pure natural gas (methane) and NGL. The reference flow of this unit process is 1 kg of Natural gas produced.

Boundary and Description

Figure 1 provides an overview of the boundary of this unit process. Rectangular boxes represent relevant sub-processes, while trapezoidal boxes indicate upstream data that are outside of the boundary of this unit process. As shown, this unit process accounts for the energy requirements, emissions, and types of products (natural gas and natural gas liquids) for the liquid separation process at a natural gas processing plant.

Figure 1: Unit Process Scope and Boundary

Liquids separation is the process by which natural gas is separated from other hydrocarbons, which become natural gas liquids (NGL). It consists of two basic steps: extracting natural gas liquids from the natural gas stream and separating the natural gas liquids to their base components. The NGLs themselves are then sold as separate

products. The natural gas itself then continues through the processing to be sold as gas for heat and power.

This unit process uses another unit process, NGL Extraction from EOR Gas – Refrigeration, as the basis of calculations. That unit process provides a summary of relevant input and output flows associated with separating natural gas liquids (NGLs) from recovered enhanced oil recovery (EOR) gas using propane refrigeration and optional distillation processes. It is based on a theoretical process that uses propane refrigeration to chill the CO2-rich recovered EOR gas stream, allowing the separation of CO2 from ethane (C2) and higher hydrocarbons (Vargas, 2010, NETL, 2012).

The Natural Gas Liquid Separation unit process adds the electricity and natural gas inputs required to run the process in a plant. The electricity input uses information from literature and calculations from the NGL Extraction from EOR Gas – Refrigeration unit process refrigeration tab. The natural gas input is the requirement to run the auxiliary boiler. This was found using information from literature, industry and an NETL report. This information was then input into calculations from the NGL Extraction from EOR Gas – Refrigeration unit process Auxiliary boiler tabs. The adjustable parameters used in the Natural Gas Liquid Separation unit process are shown in **Table 1**. The resulting input and output flows are shown in **Table 2**.

DF_Stage3_O_Natural_Gas_Liquid_Separation_2015.1.docx

Table 1: Adjustable Parameter Values

Variable Name	Expected Value	Minimum Value	Maximum Value	Unit
Aux_boiler_NG	1.45E-06			kg
Elect_in	1.38E-05			MWh
Ext_Benz	3.89E-04	0.00E+00	8.78E-04	kg
Ext_C2H6	6.26E-02	5.35E-02	1.30E-01	kg
Ext_C3H8	8.13E-02			kg
Ext_CH4	7.25E-01	5.89E-01	7.54E-01	kg
Ext_CO2	3.12E-02	1.46E-02	4.99E-02	kg
Ext_cyclohexane	9.51E-05			kg
Ext_cyclopent	3.22E-04			kg
Ext_Ebenz	7.01E-05	0.00E+00	1.23E-04	kg
Ext_H2S	3.22E-04	0.00E+00	2.51E-03	kg
Ext_i_heptanes	7.52E-04			kg
Ext_i_hexanes	7.53E-04			kg
Ext_isobut	1.74E-02			kg
Ext_isopentane	5.90E-03			kg
Ext_methcychex	1.54E-04			kg
Ext_N_but	3.22E-02			kg
Ext_N_hex	1.15E-02			kg
Ext_N_pentane	7.41E-03			kg
Ext_N2	1.36E-02	1.16E-02	2.83E-02	kg
Ext_Tol	2.72E-04	0.00E+00	7.82E-04	kg
Ext_trimetpen2	7.35E-06			kg
Ext_undef_VOC	8.83E-03			kg
Ext_Xyl	1.25E-04	0.00E+00	2.22E-04	kg
Pr_Benz	1.80E-04			kg
Pr_C2H6	6.40E-02			kg
Pr_C3H8	1.50E-02			kg
Pr_CH4	8.62E-01			kg
Pr_CO2	1.80E-02			kg
Pr_cyclohexane	0.00E+00			kg
Pr_cyclopentane	0.00E+00			kg
Pr_Ebenz	1.20E-05			kg
Pr_H2S	0.00E+00			kg

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Pr_i_heptanes	0.00E+00			kg
Pr_i_hexanes	4.30E-05			kg
Pr_isobut	0.00E+00			kg
Pr_isopentane	0.00E+00			kg
Pr_methcychex	0.00E+00			kg
Pr_N_but	5.50E-03			kg
Pr_N_hex	3.20E-04			kg
Pr_N_pentane	2.20E-03			kg
Pr_N2	3.30E-02			kg
Pr_Tol	7.00E-05			kg
Pr_trimetpen2	1.10E-04			kg
Pr_undef_VOC	0.00E+00			kg
Pr_Xyl	1.90E-05			kg

DF_Stage3_O_Natural_Gas_Liquid_Separation_2015.1.docx

Table 2: Unit Process Input and Output Flows

Flow Name	Value	Units (Per Reference Flow)
Inputs		
Electricity [Electric power]	**1.38E-05**	**MWh**
Natural gas (production) [Valuable substances]	**1.19**	**kg**
Natural gas, combusted in boiler [Natural gas products]	**1.45E-06**	**kg**
Outputs		
Natural gas (production) [Valuable substances] [Insert]	**1.00**	**kg**
Natural Gas Liquids [Natural gas products]	0.19	kg

* **Bold face** clarifies that the value shown *does not* include upstream environmental flows.

Embedded Unit Processes

None.

References

NETL, 2012   NETL Life Cycle Inventory Data – Unit Process: Natural Gas Liquids Extraction from Recovered EOR Gas. U.S. Department of Energy, National Energy Technology Laboratory. Last Updated: October 2012 (version 01). www.netl.doe.gov/LCA

Vargas, K. J. 2010   Refrigeration provides economic process for recovering NGL from CO2-EOR recycle gas. Oil & Gas Journal, 108(2).

Section III: Document Control Information

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Original/no revisions

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