NETL Life Cycle Inventory Data
Process Documentation File

Process Name: Wellhead Compressor, Gas-Powered, 200 HP

Reference Flow: 1 kg of Natural Gas

Brief Description: This unit process quantifies the amount of natural gas required and methane emissions associated with the operation of a 187 horsepower, gas-fired centrifugal wellhead compressor for natural gas wells.

Section I: Meta Data

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

Year Data Best Represents: 2010

Process Type: Extraction Process (EP)

Process Scope: Gate-to-Gate (GG)

Allocation Applied: No

Completeness: All Relevant Flows Recorded

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 Pollutants	☐ Other
Releases to Water:	☐ Inorganic Emissions	☐ Organic Emissions	☐ Other
Water Usage:	☐ Water Consumption	☐ Water Demand (throughput)	
Releases to Soil:	☐ Inorganic Releases	☐ Organic Releases	☐ Other

Adjustable Process Parameters:

None.

Tracked Input Flows:

Natural gas [intermediate product]	*[Intermediate Product] Natural gas to be compressed*
Internal Combustion Engines, Commercial/Institutional, Natural Gas, Turbine, Uncontrolled [Intermediate product]	*[Intermediate Product] Natural gas combusted in a centrifugal compressor*

Tracked Output Flows:

Natural gas [Intermediate product]	*Reference flow of natural gas, pressurized and ready for pipeline distribution*
Vented gas [Intermediate product]	*Intermediate product to venting and flaring*

Section II: Process Description

Associated Documentation

This unit process is composed of this document and the data sheet (DS) *DS_Stage1_O_NG_WellCompression_GasCentrif_2011.02.xlsx*, which provides additional details regarding relevant calculations, data quality, and references.

Goal and Scope

The scope of this unit process encompasses the operation of 187 horsepower (HP), gas-powered centrifugal compressors at a natural gas wellhead. The unit process is based on the reference flow of 1 kg of natural gas (NG). It is applicable to all natural gas well types considered, and the proportion of this versus other compressor types are identified in a separate unit process. The process is based on the reference flow of 1 kg of natural gas, and relevant flows of this unit process are described below and shown in **Figure 1.**

This unit process is used under Life Cycle (LC) Stage #1 to prepare extracted natural gas for pipeline distribution. This unit process is combined with other relevant equipment for LC Stage #1 in a separate operations assembly process, DS_Stage1_O_NG_WellCompression_GasCentrif_2011.02.doc. The assembly process quantifies the relevant flows and emissions associated with each portion of the natural gas extraction profile being modeled, in order to complete extraction and in-field processing of 1 kg of natural gas.

Boundary and Description

Compressors are used at the natural gas wellhead to increase the gas pressure for pipeline distribution. The performance of a compressor depends on the natural pressure at the wellhead, which varies from reservoir to reservoir and decreases with increasing well life. This analysis assumes that the inlet pressure to a wellhead compressor is 50 psig and the outlet pressure is 800 psig. The inlet pressure depends on the pressure of the natural gas reservoir and thus introduces uncertainty into the natural gas model. The outlet pressure of 800 psig is a standard pressure for pipeline transport of natural gas.

The energy required for compressor operations is based on manufacturer data that compares power requirements to compression ratios (the ratio of outlet to inlet pressures). A two-stage centrifugal compressor with an inlet pressure of 50 psig and an outlet pressure of 800 psig has a power requirement of 187 horsepower per MMCG of natural gas (GE Oil and Gas 2005). Using a natural gas density of 0.042 lb/scf and converting to SI units gives a compression energy intensity of 1.76E-04 MWh per kg of natural gas. This energy rate represents the required *output* of the compressor shaft; the *input* fuel requirements for compression vary according to compression technology. The two types of compressors used for natural gas extraction operations are reciprocating compressors and gas or electrically-powered centrifugal compressors. Gas powered centrifugal compressors are considered within this unit process, and relevant energy use, efficiency, and other values relevant to gas powered centrifugal compressors are shown in **Table 1**.

Figure 1 provides an overview of the boundary of this unit process. Natural gas, extracted and ready to be pressurized, is the sole input to this unit process. Within the system boundary, compressor energy use is determined as a function of engine power and the energy needed to run the compressor. Output from this unit process feeds into a downstream assembly unit process for natural gas. The external unit process linking this unit process to natural gas emissions is also included.

Figure 1: Unit Process Scope and Boundary

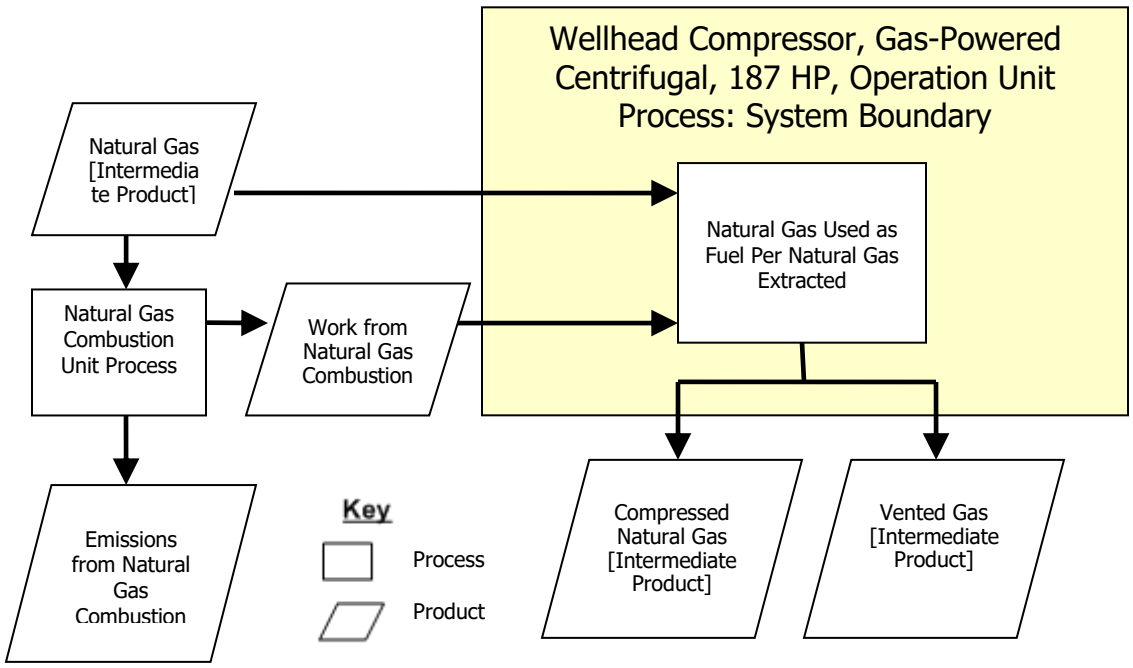

Table 1 summarizes key compressor properties and emissions applied within this unit process. **Table 2** provides a summary of modeled input and output flows. Additional detail regarding input and output flows, including calculation methods, is contained in the associated DS. These emissions are considered outside the system boundary for this particular unit process.

Table 1: Wellhead Compression for a Gas-Powered Centrifugal Compressor

Energy inputs and outputs			
Flow Name	**Value**	**Units**	**Reference**
Output shaft energy	1.76E-04	MWh/kg	GE 2005
Heat rate	201	kg NG/MWh	API 2009
Fuel input[1]	3.53E-02	kg NG/kg NG	NETL Engineering Calculation
Vent rate	6.90E-03	Kg NG/kg NG	Bylin, 2010

[1] The fuel input is the product of output shaft energy and heat rate.

Table 2: Unit Process Input and Output Flows

Flow Name*	Value	Units (Per Reference Flow)	DQI
Inputs			
Natural Gas [Intermediate Product]	**1.007E+00**	**kg**	**1,2**
Internal Combustion Engines, Commercial/Institutional, Natural Gas, Turbine, Uncontrolled [Intermediate product]	**3.53E-02**	**kg**	**2,3**
Outputs			
Natural Gas [Intermediate Product]	**1.00**	**kg**	**2,3**
Vented Gas [Intermediate Product]	**6.90E-03**	**kg**	**1,2**

* **Bold face** clarifies that the value shown *does not* include upstream environmental flows. Upstream environmental flows were added during the modeling process using GaBi modeling software, as shown in Figure 2.

Inventory items not included are assumed to be zero based on best engineering judgment or assumed to be zero because no data was available to categorize them for this unit process at the time of its creation.

Embedded Unit Processes

None.

References

API 2009 — American Petroleum Institute. 2009. *Compendium of Greenhouse Gas Emissions for the Oil and Natural Gas Industry.* 2009. http://www.api.org/ehs/climate/new/upload/2009_GHG_COMPENDIUM.pdf (accessed May 18, 2010).

GE Oil and Gas 2005 — GE Oil and Gas. Reciprocating Compressors. Florence, Italy: General Electric Company, 2005.

Section III: Document Control Information

Date Created: April 7, 2011

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Revision History:

31DECEMBER2014	Combustion emissions removed and linked to external UP. Added DQI data to the data summary tab

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Section IV: Disclaimer