NETL Life Cycle Inventory Data
Process Documentation File

Process Name: Transmission centrifugal compression

Reference Flow: 1 kg of natural gas

Brief Description: Transmission compression, including fuel used by centrifugal compressor drivers and venting from centrifugal compressors.

Section I: Meta Data

Geographical Coverage: United States **Region:** United States

Year Data Best Represents: 2016

Process Type: Basic Process (BP)

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 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:

4_CENT_CH4

[tonnes] Methane emissions from transmission centrifugal compressors.

4_NG_trans

[MCF] Annual natural gas volume through a transmission facility

nat_mCO2

[dimensionless] Mass fraction of CO2 in natural gas

nat_mCH4

[dimensionless] Mass fraction of CH4 in natural gas

4_CENT_power

[hp] Operating centrifugal compressor horsepower at a transmission facility

4_CENT_time

[hours] Operating centrifugal compressor hours at a transmission facility

Turbine_thermalefficiency

[dimensionless] Thermal efficiency of gas-fired turbines

4_NG_density

[kg/MCF] Density of natural gas, using reported methane and CO2 compositions and assuming that the balance of the product gas is ethane.

4_NG_trans_kg

[kg] Annual natural gas mass through a transmission facility

Vent_NG

[kg] Natural gas vented from centrifugal compressors.

Compressor output_energy

[HPh] Output energy of turbine, based on compressor rating and runtime.

Compressor_input_energy

[HPh] Input energy requirement for gas-fired turbine, based on compressor rating, runtime, and engine thermal efficiency.

Compressor input_fuel

[kg] Mass of natural gas fuel used by transmission facility for centrifugal compression per unit of natural gas throughput. Converted from horsepower-hour to Btu (2544 Btu/HP-hr), from Btu to scf (1031 Btu/scf), from scf to lb (.042 lb/scf), and from lb to kg (2.205 lb/kg).

Input_electricity

[MWh] Input electricity to power centrifugal turbines for natural gas transmission. (Electricity acounts for approximately 5% of transmission compression energy; 1 HPh = 0.00075 MWh.)

NG_processed

[kg] Mass of natural gas into transmission facility per mass of natural gas exiting transmission facility

Tracked Input Flows:

Natural gas [intermediate flow]

[Intermediate flow] Natural gas product input, including what ends up as marketed product and what is vented at gathering and boosting

Natural gas, combusted

[Process] Unit process for natural gas combustion emissions. Accounts for emissions only, not natural gas quantity, which is already accounted for in this unit process.

Electricity, grid

[Process] Cradle-to-gate emission for U.S. grid electricity mix.

Tracked Output Flows:

Natural Gas [intermediate flow]

Reference flow

Vent_NG [to venting and flaring]

[kg] Natural gas vented from centrifugal compressors.

Section II: Process Description

Associated Documentation

This unit process is composed of this document and the data sheet (DS) *DS_NG_Transmission_Compressor_Centrif_2018.01.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 emissions from transmission centrifugal compression, including fuels used by centrifugal compressor drivers and venting from centrifugal compressors. Natural gas (from the product stream) is consumed as a fuel; electricity is also used by a portion of transmission centrifugal compressor drivers; there are no other purchased fuels (e.g., diesel). Outputs include the reference flow (1 kg of natural gas throughput)

and the quantity of gas vented from the compressor; gas vented from the compressor is sent to another NETL unit process for component speciation. The reference flow of this unit process is: 1 kg of natural gas

Boundary and Description

This unit process provides a summary of relevant input and output flows associated emissions from transmission centrifugal compression, including fuels used by centrifugal compressor drivers and venting from centrifugal compressors. Natural gas (from the product stream) is consumed as a fuel; electricity is also used by a portion of transmission centrifugal compressor drivers; there are no other purchased fuels (e.g., diesel). Outputs include the reference flow (1 kg of natural gas throughput) and the quantity of gas vented from the compressor; gas vented from the compressor is sent to another NETL unit process for component speciation. The reference flow of this unit process is: 1 kg of natural gas

Figure 1: Unit Process Scope and Boundary

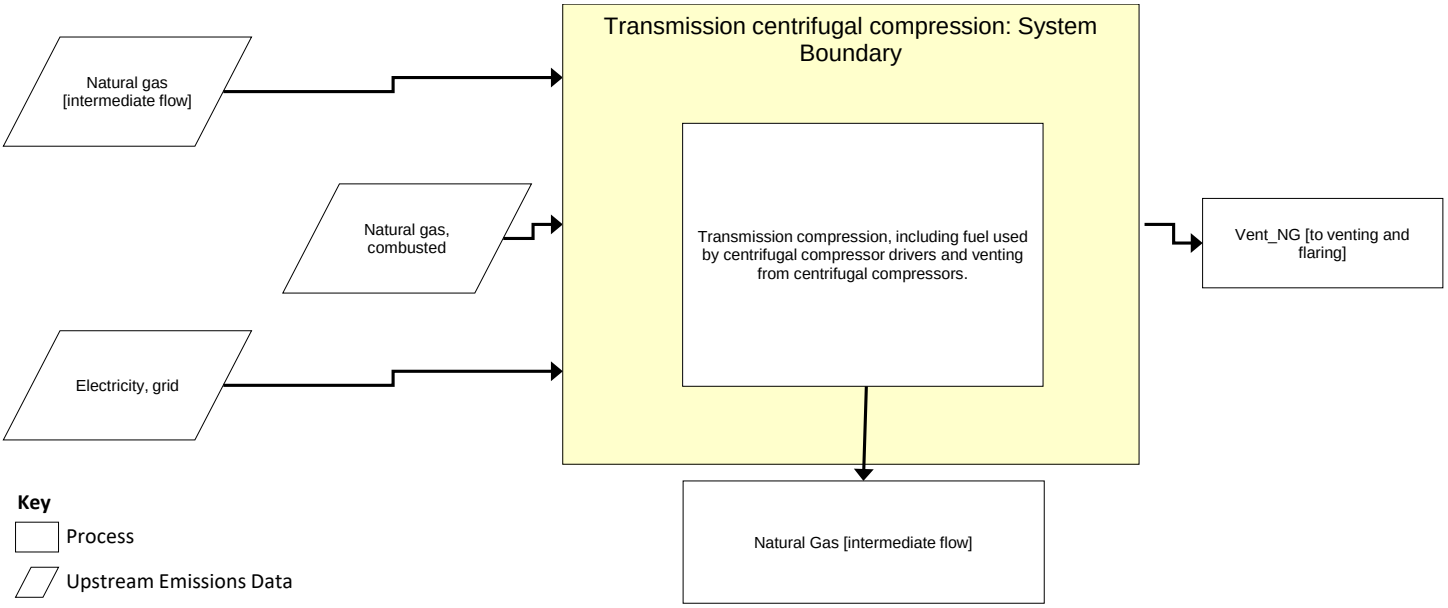

Table 1 shows the input parameters, which include methane emissions and natural gas throughput. The vented emission data are based on EPA's Greenhouse Gas Reporting Program (GHGRP) (EPA, 2016a). The low, expected, and high bounds represent the variability in the underlying data and were developed via throughput-weighted statistical bootstrapping. The bootstrapping technique allows computation of the confidence intervals around average activity factors. The DS file has a parameter scenario (PS) worksheet with 27 scenarios that match the scenarios for the onshore production unit processes, but at this stage in the supply chain, the average U.S. is the only supply chain scenario that is modeled. After natural gas is gathered, the remaining supply chain stages model it as a commodity for which the energy requirements and emissions are the same for all sources of natural gas.

Table 2 shows the inputs and output for natural gas throughput and venting for Appalachian production scenario. The produced natural gas input accounts for total natural gas vented by the unit process plus the reference flow of the unit process (1 kg of natural gas gathered and boosted). Vented natural gas (which is emitted through centrifugal compressor seals and does not include the gas that is vented through combustion exhaust from the compressor driver) is an output that should be linked to NETL's "venting and flaring" unit process, which speciates the vented gas into hydrocarbons and other components. The reference flow of this unit process is 1 kg of transmitted natural gas.

Table 1: Input Parameters

Parameter	Expected Value	Low	High	Units	Description
4_CENT_CH4	6.21E+01	4.58E+01	8.03E+01	tonnes	Methane emissions from transmission centrifugal compressors.
4_NG_trans	1.24E+08	9.54E+07	1.59E+08	MCF	Annual natural gas volume through a transmission facility
nat_mCO2	7.67E-03	6.89E-03	8.45E-03	dimensionless	Mass fraction of CO2 in natural gas
nat_mCH4	7.34E-01	7.31E-01	7.38E-01	dimensionless	Mass fraction of CH4 in natural gas
4_CENT_power	2.48E+04	2.27E+04	2.68E+04	hp	Operating centrifugal compressor horsepower at a transmission facility
4_CENT_time	3.97E+03	3.70E+03	4.24E+03	hours	Operating centrifugal compressor hours at a transmission facility
Turbine_thermalefficiency	2.60E-01	2.60E-01	2.60E-01	dimensionless	Thermal efficiency of gas-fired turbines

Table 2: Unit Process Input and Output Flows

Flow Name	Expected	Low	High	Units (Per Reference Flow)
Inputs				
Natural gas [intermediate flow]	1.007E+00	1.008E+00	1.007E+00	kg NG
Natural gas, combusted	7.20E-03	8.01E-03	6.53E-03	kg NG
Electricity, grid	5.746E-06	6.392E-06	5.211E-06	MWh
Outputs				
Natural Gas [intermediate flow]	1.00	1.00	1.00	kg NG
Vent_NG [to venting and flaring]	3.43E-05	3.31E-05	3.46E-05	kg NG

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

Note: 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

EPA. 2016a. Greenhouse Gas Reporting Program. Environmental Protection Agency. https://www.epa.gov/enviro/greenhouse-gas-customized-search. Accessed August 22, 2018.

EPA. 2018. Inventory of U.S. Greenhouse Gas Emissions and Sinks, 1990-2016. Environmental Protection Agency. EPA 430-R-18-003. https://www.epa.gov/sites/production/files/2018-01/documents/2018_complete_report.pdf Accessed August 20, 2018

INGAA. 2010. Interstate Natural Gas Pipeline Efficiency.

Section III: Document Control Information

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