NETL Life Cycle Inventory Data
Process Documentation File

Process Name: Storage reciprocating compression

Reference Flow: 1 kg of natural gas

Brief Description: Storage compression, including fuel used by reciprocating compressor drivers and venting from reciprocating 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:

5_RECIP_CH4vent

[tonnes] Methane emissions from storage reciprocating compressors.

5_storcap

[MCF] Capacity of storage facility

nat_mCH4

[dimensionless] Mass fraction of CH4 in natural gas

5_RECIP_energy

[hp] Operating reciprocating compressor horsepower at a storage facility

Recip_thermalefficiency

[dimensionless] Thermal efficiency of reciprocating engine used to drive reciprocating compressors.

5_storcap_kg

[kg] Capacity of storage facility, on a mass basis.

Vent_NG

[kg] Natural gas vented from reciprocating compressors.

Compressor output_energy

[Btu] Output energy from reciprocating engine. Conversion factor: 2544 Btu/HPh.

Compressor_input_energy

[Btu] Input energy requirement for a reciprocating engine. Calculated by dividing output energy by engine efficiency.

Compressor input_fuel

[kg] Mass of natural gas fuel used by storage facility for reciprocating compression per unit of natural gas storage capacity. Conversion factors: 1031 Btu/scf, 0.042 lb/scf, and 2.205 lb/kg.

Tracked Input Flows:

Natural gas, combusted

[Intermediate Flow] Combustion of natural gas used as fuel for reciprocating compressor driver.

Tracked Output Flows:

Natural Gas [intermediate flow]

Reference flow

Vent_NG [to venting and flaring]

[kg] Natural gas vented from reciprocating compressors.

Section II: Process Description

Associated Documentation

This unit process is composed of this document and the data sheet (DS) *DS_NG_Storage_Compressor_Recip_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 storage reciprocating compression, including fuels used by compressor drivers and venting from reciprocating compressors. Natural gas (from the product stream) is the only fuel consumed; there are no other purchased fuels (e.g., diesel) or energy (e.g., electricity). Outputs include the reference flow (1 kg of natural gas storage capacity) 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 storage reciprocating compression, including fuels used by compressor drivers and venting from reciprocating compressors. Natural gas (from the product stream) is the only fuel consumed; there are no other purchased fuels (e.g., diesel) or energy (e.g., electricity). Outputs include the reference flow (1 kg of natural gas storage capacity) 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

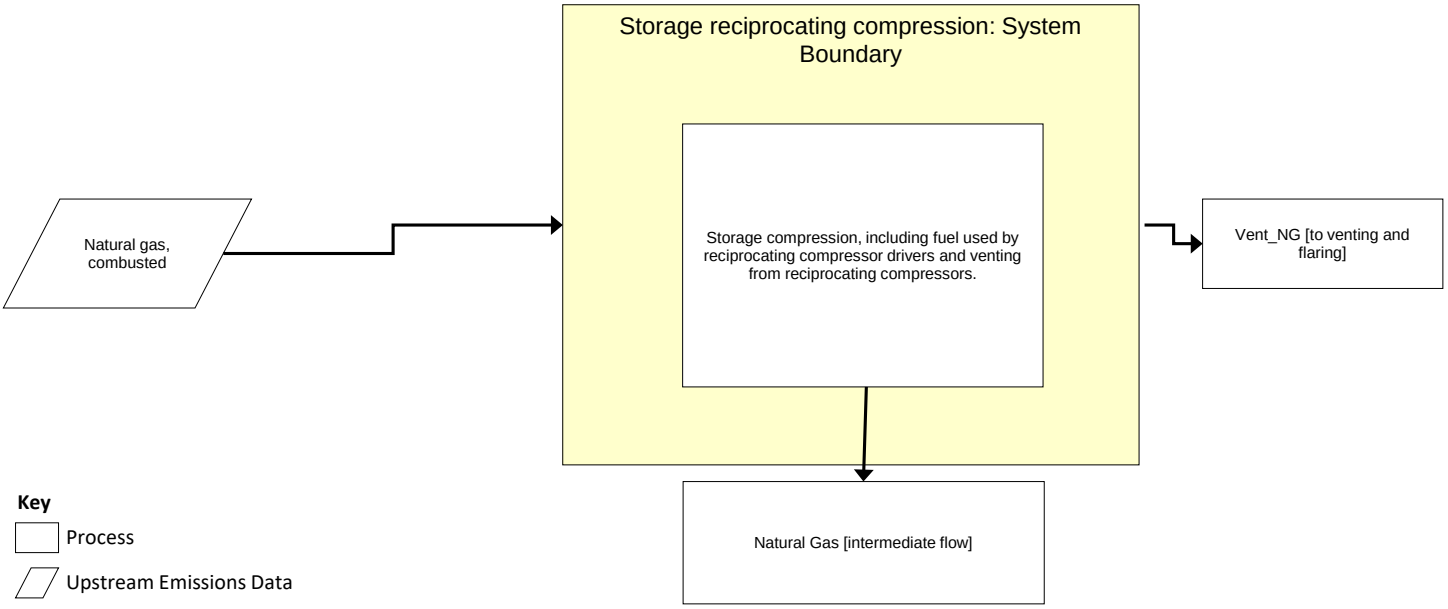

Table 1 shows the input parameters, which include emission factors and activity factors for the emission source, as well as natural gas capacity of the storage facility. The emission and activity factors are based on EPA's Greenhouse Gas Reporting Program (GHGRP) (EPA, 2016a) and EPA's Greenhouse Gas Inventory (GHGI) (EPA, 2018). 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 resource, natural gas fuel, diesel, and venting flows for Appalachian production scenario. Inputs comprise natural gas combustion emissions and diesel combustion emissions. The natural gas resource input does not link to an upstream unit process, but accounts for total natural gas consumed by the unit process plus the reference flow of the unit process (1 kg of natural gas produced). The input for natural gas combustion should be linked to an upstream unit process that accounts for combustion emissions, but not the quantity of natural gas actually combusted; the quantity of natural gas combusted is accounted for within the boundaries of this unit process. The input for diesel combustion should be linked to a unit process that accounts for both the cradle-to-gate emissions of diesel combusted and the emissions from diesel combustion. Vented natural gas (which is emitted from the reciprocating compressor crankcase, in contrast to gas that is vented through combustion exhaust) 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 stored natural gas.

Table 1: Input Parameters

Parameter	Expected Value	Low	High	Units	Description
5_RECIP_CH4vent	2.43E+02	1.02E+02	5.05E+02	tonnes	Methane emissions from storage reciprocating compressors.
5_storcap	1.07E+08	9.32E+07	1.20E+08	MCF	Capacity of storage facility
nat_mCH4	7.34E-01	7.31E-01	7.38E-01	dimensionless	Mass fraction of CH4 in natural gas
5_RECIP_energy	2.14E+04	1.84E+04	2.47E+04	hp	Operating reciprocating compressor horsepower at a storage facility
Recip_thermalefficiency	4.40E-01	4.40E-01	4.40E-01	dimensionless	Thermal efficiency of reciprocating engines.

Table 2: Unit Process Input and Output Flows

Flow Name	Expected	Low	High	Units (Per Reference Flow)
Inputs				
Natural gas, combusted	1.12E-06	2.10E-05	2.21E-05	kg NG
Outputs				
Natural Gas [intermediate flow]	1.00	1.00	1.00	kg NG
Vent_NG [to venting and flaring]	1.62E-04	7.85E-05	3.01E-04	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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