



NETL Life Cycle Inventory Data

Process Documentation File

Process Name: Processing reciprocating compression
Reference Flow: 1 kg of natural gas
Brief Description: Processing 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: Yes
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:

3_RECIP_CH4

[tonnes] Methane emissions from processing reciprocating compressors.

3_NG_processed

[MCF] Annual natural gas processed at a processing facility

3_NGL_processed

[bbf] Annual natural gas liquids processed at a processing facility

nat_mCO2

EPA. 2017. Greenhouse Gas Reporting Program. Environmental Protection Agency. <https://www.epa.gov/enviro/greenhouse-gas-customized-search>. Accessed August 22, 2018.

nat_mCH4

[dimensionless] Mass fraction of CH4 in natural gas

3_RECIP_power

[hp] Operating reciprocating compressor horsepower at a processing facility

3_RECIP_time

[hours] Operating reciprocating compressor hours at a processing facility

Recip_thermalefficiency

[dimensionless] Thermal efficiency of reciprocating engines.

3_NG_equiv_mcf

[MCF] Annual natural gas and natural gas liquids processed at a processing facility, converted to equivalent energy of natural gas and then converted to units of volume.

3_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.

3_NG_equiv_kg

[kg] Mass of natural gas equivalents processed per year.

Vent_NG

[kg] Natural gas vented from reciprocating compressors.

Compressor output_energy

[HPH] Output power rating of reciprocating engine, based on compressor rating and runtime.

Compressor_input_energy

[HPH] Input power requirement for reciprocating engine, based on compressor rating, runtime, and engine thermal efficiency.

Compressor input_fuel

[kg] Mass of natural gas fuel used by processing facility for reciprocating compression per unit of natural gas processed. 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).

NG_gathered

[kg] Mass of natural gas gathered per mass of natural gas processed.

Tracked Input Flows:

Natural gas [intermediate flow]

[Intermediate flow] Mass of natural gas gathered per mass of natural gas processed

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.

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_Processing_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 processing compression, including fuels used by reciprocating 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 processed natural gas) 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 processing compression, including fuels used by reciprocating 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 processed natural gas) 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

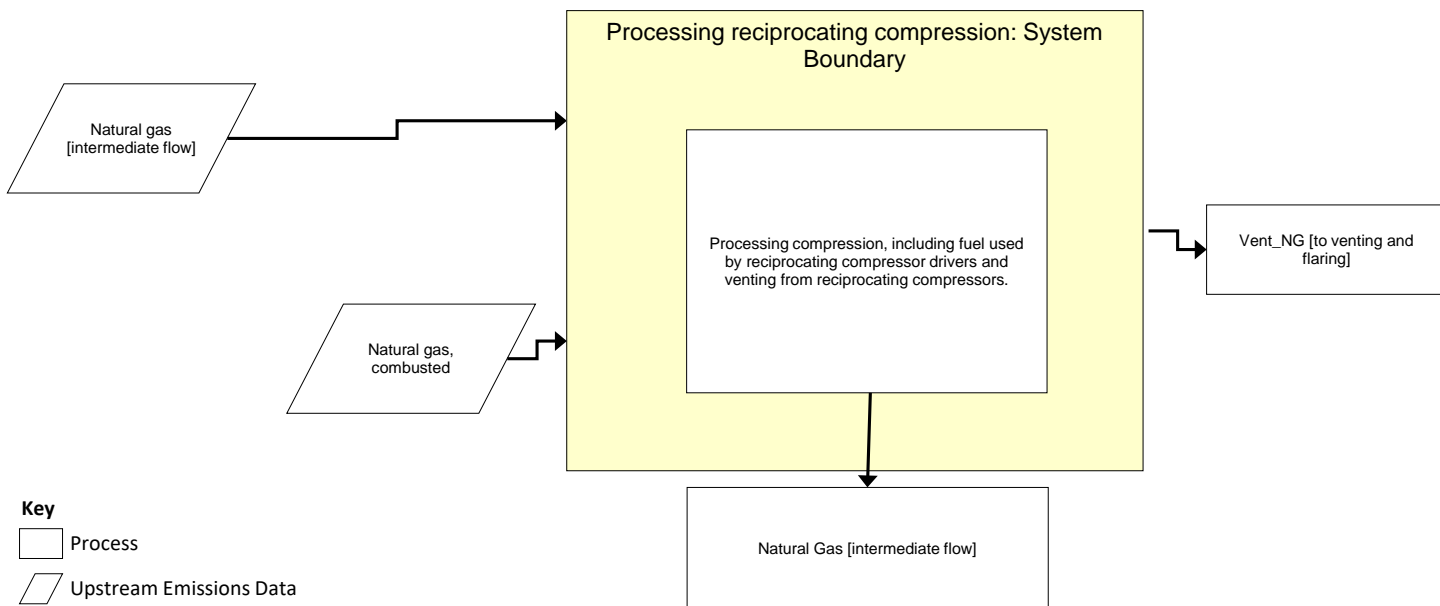


Table 1 shows the input parameters, which include emission factors and activity factors for the emission source, as well as natural gas processed at the facility. The emission and activity factors are based on EPA’s Greenhouse Gas Reporting Program (GHGRP) (EPA, 2016a) and EPA’s Greenhouse Gas Inventory (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 processed natural gas.

Table 1: Input Parameters

Parameter	Expected Value	Low	High	Units	Description
3_RECIP_CH4	9.73E+01	7.36E+01	1.26E+02	tonnes	Methane emissions from Processing reciprocating compressors
3_NG_processed	3.36E+07	2.84E+07	3.88E+07	MCF	Annual natural gas processed at a processing facility
3_NGL_processed	0.00E+00	0.00E+00	0.00E+00	bbl	Annual natural gas liquids processed at a processing 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
3_RECIP_power	2.46E+04	2.13E+04	2.77E+04	hp	Operating reciprocating compressor horsepower at a processing facility
3_RECIP_time	4.67E+03	4.36E+03	4.98E+03	hours	Operating reciprocating compressor hours at a processing 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 [intermediate flow]	1.0019E+00	1.0018E+00	1.0019E+00	kg NG
Natural gas, combusted	1.84E-02	1.76E-02	1.92E-02	kg NG
Outputs				
Natural Gas [intermediate flow]	1.00	1.00	1.00	kg NG
Vent_NG [to venting and flaring]	1.99E-04	1.78E-04	2.22E-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

DrillingInfo. 2018. DI Data & Insights.

INGAA. 2010. Interstate Natural Gas Pipeline Efficiency.

Section III: Document Control Information

Date Created: January 14, 2019

Point of Contact: Timothy Skone (NETL), Timothy.Skone@NETL.DOE.GOV

Revision History:

Original/no revisions

How to Cite This Document: This document should be cited as:

NETL (2018). NETL Life Cycle Inventory Data – Unit Process: Processing reciprocating compression. U.S. Department of Energy, National Energy Technology Laboratory. Last Updated: October 2018 (version 01). www.netl.doe.gov/LCA (<http://www.netl.doe.gov/LCA>)

Section IV: Disclaimer

Neither the U.S. Department of Energy (DOE) National Energy Technology Laboratory (NETL) nor any person acting on behalf of these organizations:

- A. Makes any warranty or representation, express or implied, with respect to the accuracy, completeness, or usefulness of the information contained in this document, or that the use of any information, apparatus, method, or process disclosed in this document may not infringe on privately owned rights; or
- B. Assumes any liability with this report as to its use, or damages resulting from the use of any information, apparatus, method, or process disclosed in this document.

Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by NETL. The views and opinions of the authors expressed herein do not necessarily state or reflect those of NETL.