NETL Life Cycle Inventory Data
Process Documentation File

Process Name: Venting and Flaring of Gas from Vapor Recovery Unit

Reference Flow: 1 kg of Vented or Flared Gas

Brief Description: This unit process quantifies the carbon dioxide and other GHG emissions associated with the flaring and venting of gas.

Section I: Meta Data

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

Year Data Best Represents: 2012

Process Type: Auxiliary Process (AP)

Process Scope: Cradle-to-Gate Process (CG)

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:

comp_VOC	*[dimensionless] Adjustable parameter; fraction of inlet stream that is VOC. 0<= Value <=1.*
comp_CH4	*[dimensionless] Adjustable parameter; fraction of inlet stream that is methane. 0<= Value <=1.*

Flare_rate	*[dimensionless] Adjustable parameter; fraction of vented gas that is flared. 0<= Value <=1.*
EF_flare_CO2	*[kg/kg] CO_2 emissions per flaring of kg of methane/VOC mix*
EFflare_CH4	*[kg/kg] CH_4 emissions per flaring of kg of methane/VOC mix*
EFflare_VOC	*[kg/kg] CH_4 emissions per flaring of kg of methane/VOC mix*
flare_CO2	*[kg/kg] CO_2 emissions from flaring per kg of vented and flared gas.*
flare_CH4	*[kg/kg] CH_4 emissions from flaring per kg of vented and flared gas.*
flare_VOC	*[kg/kg] CH_4 emissions from flaring per kg of vented and flared gas.*
Vent_rate	*[dimensionless] Fraction of vented gas that is NOT flared*
EFvent_CH4	*[kg/kg] kg of CH_4 per kg of vented NG*
EFvent_VOC	*[kg/kg] kg of NMVOC per kg of vented NG*
vent_CH4	*[kg/kg] CH_4 emissions from venting per kg of vented and flared gas.*
vent_VOC	*[kg/kg] CO_2 emissions from venting per kg of vented and flared gas.*
total_CO2	*[kg/kg] Total CO_2 emissions from venting and flaring*
total_CH4	*[kg/kg] Total CH_4 emissions from venting and flaring*
total_VOC	*[kg/kg] Total VOC emissions from venting and flaring*

Tracked Input Flows:

Gas from Vapor Recovery [Intermediate product]	*[Intermediate Product] Reference flow (gas from a VRU)*

Tracked Output Flows:

Carbon dioxide [Inorganic emissions to air]	*Emission to air*
Methane [Organic emissions to air (group VOC)]	*Emission to air*
NMVOC (unspecified) [Group NMVOC to air]	*Emission to air*

Section II: Process Description

Associated Documentation

This unit process is composed of this document and the data sheet (DS) *DS_Stage3_O_VRU_Flaring_Venting_2012.01.xls*, 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 the flaring and venting of gas recovered by a vapor recovery unit (VRU). The outputs are the GHG emissions from the venting and/or flaring of gas. The reference flow of this unit process is: 1 kg of Vented or Flared Gas

Boundary and Description

This unit process provides a summary of relevant input and output flows associated with the flaring and venting of gas recovered by a vapor recovery unit (VRU). The outputs are the GHG emissions from flaring or the methane and/or volatile organic compounds (VOC) emissions from venting. **Figure 1** shows the boundaries of this unit process.

This unit process has a parameter for flaring rate. The possible values for this parameter range from 0 to 1, where 0 represents no flaring and 1 represents 100 percent flaring. Gas that is not flared is vented to air.

This unit process has a parameter for the mass share of VOC in the incoming gas. The possible values for this parameter range from 0 to 1, where 0 represents no VOC and 1 represents 100 percent VOC. The gas stream is composed of only VOC, only methane, or a mix of VOC and methane. If the gas stream is partially VOC, then this unit process calculates the mass of methane required to achieve a total input of 1 kilogram of gas input.

If gas is vented, there is no chemical change between the incoming gas stream and the gas stream vented to air. When gas is flared, most of it is converted to carbon dioxide. This unit process uses a 99 percent conversion efficiency of carbon to carbon dioxide. For example, for every 1.00 kilogram of carbon that is flared, 0.99 kilogram is converted

to carbon dioxide. Based on this 99 percent conversion efficiency and the stoichiometry of fuel combustion, the flaring of 1.00 kg of methane results in 2.72 kg of CO_2 emissions and 0.01 kg of methane emissions. Similarly, using pentane to represent VOCs, the flaring of 1.00 kg of VOCs results in 3.03 kg of CO_2 emissions and 0.01 kg of VOC emissions.

No data are available on the composition of VOCs from oil and gas extraction and processing operations. Pentane was chosen to represent the combustion profile for flared VOCs, but there is not much variability among the emission factors of C2 through C5 hydrocarbons. The CO_2 emissions from pentane combustion are only 4 percent higher than those for ethane combustion (3.03 vs. 2.90).

Table 1 shows the emission factors for methane and VOC, which are based on the combustion math described above. **Table 2** shows the inputs and outputs of this unit process; the flows in **Table 2** are representative of a scenario with a 95 percent flaring rate and a 90/10 percent split (by mass) between VOC and methane, respectively.

Figure 1: Unit Process Scope and Boundary

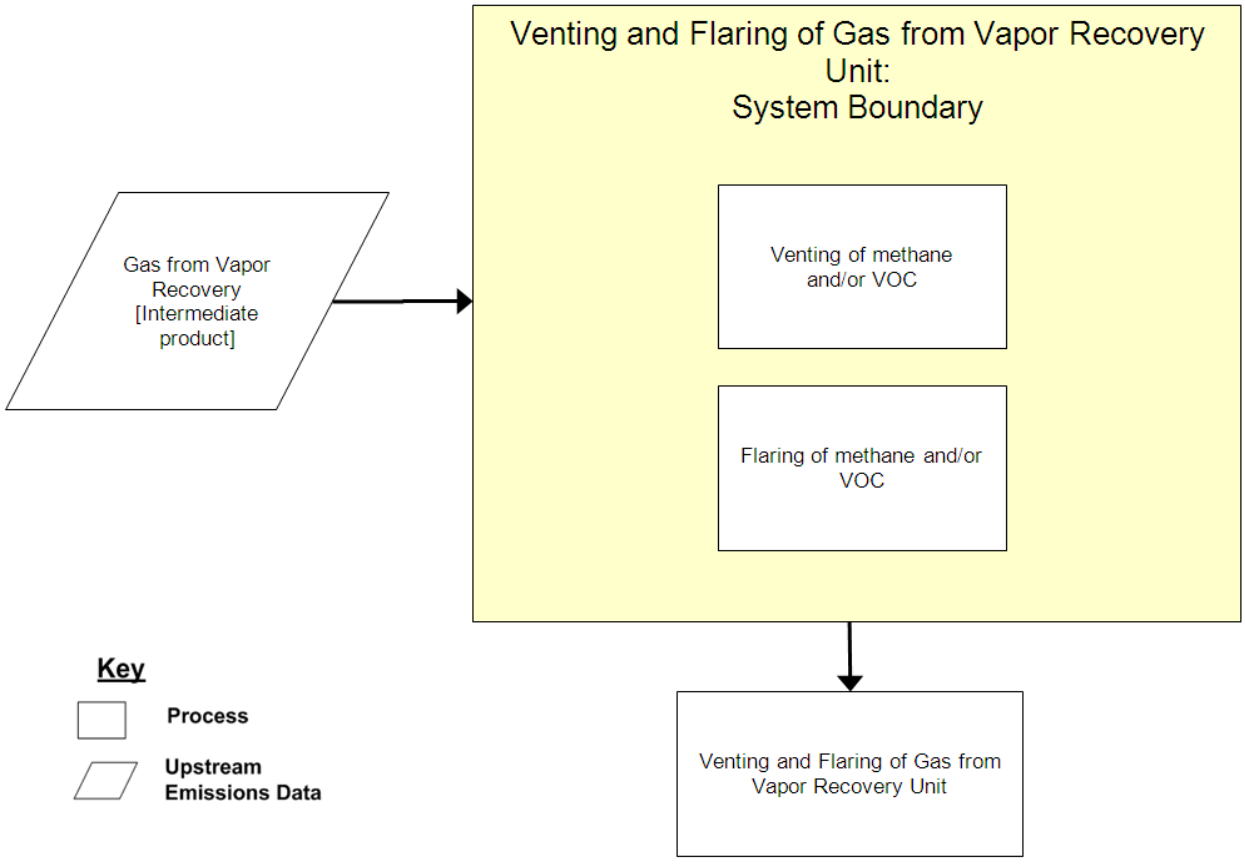

Table 1: Emission Factors for Methane and VOC Flaring

Gas Type	CO_2 Emission (kg CO_2/kg gas combusted)	Methane (kg CH_4/kg gas combusted)	VOC (kg VOC/kg gas combusted)
Methane	2.72	0.01	0
VOC	3.03	0	0.01

Table 2: Unit Process Input and Output Flows

Flow Name	Value	Units (Per Reference Flow)
Inputs		
Gas from Vapor Recovery [Intermediate product]	1.00	kg
Outputs		
Carbon dioxide [Inorganic emissions to air]	2.84	kg
Methane [Organic emissions to air (group VOC)]	5.95E-03	kg
NMVOC (unspecified) [Group NMVOC to air]	4.50E-02	kg

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

Embedded Unit Processes

None.

References

None.

Section III: Document Control Information

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