NETL Life Cycle Inventory Data
Process Documentation File

Process Name: Liquid Storage Tank Flash Emissions

Reference Flow: 1 kg of stored produced liquid

Brief Description: Emissions associated with the flashing of entrained gas from pressurized produced liquids entering low-pressure tanks.

Section I: Meta Data

Geographical Coverage: USA **Region:** N/A

Year Data Best Represents: 2010

Process Type: Basic Process (BP)

Process Scope: Gate-to-Gate Process (GG)

Allocation Applied: No

Completeness: Individual 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:

Crude_or_PW	*[Boolean] 0 = crude entering tank, 1 = produced water entering tank*
Per_flare	*[percent] Percent of VOCs flared (The sum of Per_flared and Per_captured must not exceed 100)*
Per_capture	*[percent] Percent of VOCs captured (The sum of Per_flared and Per_captured must not exceed 100)*

API	*[deg API] API gravity of crude oil*
Per_sep	*[percent] Percent of liquid flow from separator*
T_separator	*[deg F] Operating temperature of the separator*
T_heat_treat	*[deg F] Operating temperature of the heater treater*
P_separator	*[psig] Operating pressure of the separator*
P_heat_treat	*[psig] Operating pressure of the heater treater*
T_atm	*[deg F] Ambient temperature*
P_atm	*[psig] Atmospheric pressure*

Tracked Input Flows:

Crude oil from separator [Valuable substances]	*[Intermediate Product] Crude with entrained gas entering tank*
Water, from separator [Water]	*[Intermediate Product] Produced water with entrained gas entering tank*

Tracked Output Flows:

Crude oil from separator [Valuable substances]	*Reference flow*
Water, from separator [Water]	*Reference flow*
Tank_mass	*[Intermediate Product] Venting of associated gas from tank flashing*
flare_mass	*[Intermediate Product] Flaring of associated gas from tank flashing*

Section II: Process Description

Associated Documentation

This unit process is composed of this document and the data sheet (DS) *DS_Stage1_O_Liquid_Storage_Tank_Flash_Emissions_2014.01.xlsx*, which provides additional details regarding relevant calculations, data quality, and references.

Goal and Scope

This unit process provides a summary of relevant output flows associated with the flashing of entrained gas from pressurized produced liquids entering low-pressure storage tanks. Outputs are the mass of produced liquids stored in tanks and the mass of flashed associated gas vented, flared and captured. Default values for different produced liquids are provided in the scenarios. The reference flow of this unit process is: 1 kg of stored liquid product.

Boundary and Description

As the pressure of a liquid is decreased, lighter end gases dissolved in the liquid will volatilize in a process called flashing. This unit process estimates the emissions of associated gas due to the flashing of entrained gas as a produced liquid enters an atmospheric storage tank from a higher pressure separator or heater treater. **Figure 1** provides an overview of the boundary of this process.

Parameter scenarios for liquid as crude oil or produced water are available in this unit process. The ratio of flashed gas to crude oil entering the storage tank is estimated using the Vasquez-Beggs equations (VBE) originally reported in 1980 and an Excel based VBE tool developed by the Oklahoma Department of Environmental Quality (Vasquez, 1980; Milligan, 2004). The ratio of flashed gas to produced water entering the storage tank was calculated from primary data presented in a 2010 study conducted by the Texas Commission on Environmental Quality (TCEQ, 2010).

The ratio of liquid entering the tank from the separator or the heater treater is an adjustable parameter; the default values are assumed 100 percent separator input and 100 percent heater treater input for produced water and crude respectively. The percentages of flashed gas that is flared and captured are also adjustable parameters; default values are assumed as zero for both flared and captured. It is unlikely that the flared fraction is actually zero in current operations because of continuously increasing regulations of crude production GHG emissions and numerous studies demonstrating ease of GHG reduction through flash gas flaring and the favorable payback of flash gas capture. However, due to a lack of available information zero was assumed at this time.

The flared gas quantity is tracked as an intermediate process output while the captured gas is not tracked.

Other adjustable parameters are the operational pressures and temperatures of the separator and heater treater. The default temperature and pressure values for the separator are 90°F and 14.3 psig (Manning, 1995; Kylling, 2009). The default temperature and pressure values for the heater treater are 165°F and 14.3 psig (El-Houjeiri; Kylling, 2009). The ambient pressure and temperature are assumed to be 70°F and 14.7 psia respectively.

Figure 1: Unit Process Scope and Boundary

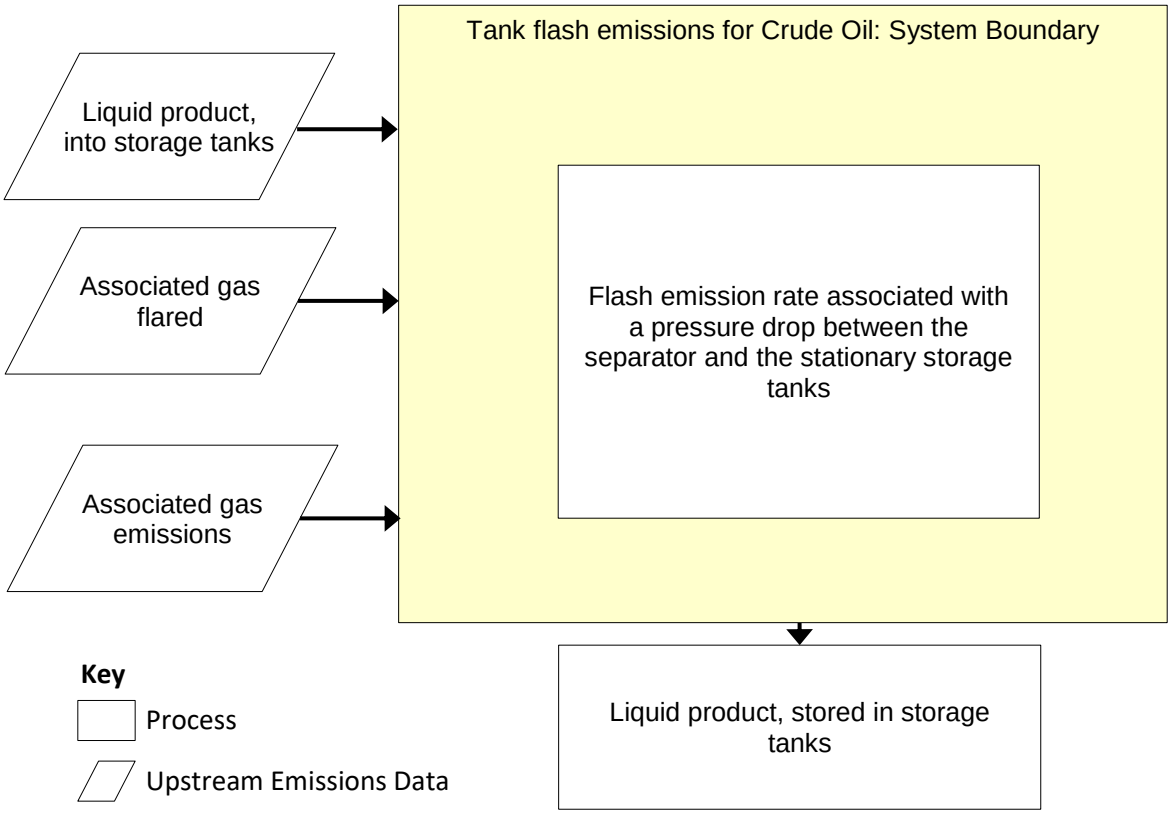

Table 1 shows the model results for 1 kg of crude entering an atmospheric storage tank and **Table 2** shows the model results for 1 kg of produced water entering an atmospheric storage tank.

Table 1: Unit Process Input and Output Flows: Crude

Flow Name	Value	Units (Per Reference Flow)
Inputs		
Crude oil from separator [Valuable substances]	**1.00**	**kg**
Outputs		
Crude oil from separator [Valuable substances]	**1.00**	**kg**
Tank flash emissions [Intermediate products]	**4.74E-04**	**kg**
Flaring associated gas [Intermediate products]	**0.00**	**kg**
Captured associated gas [Intermediate products]	**0.00**	**kg**

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

Table 2: Unit Process Input and Output Flows: Produced Water

Flow Name	Value	Units (Per Reference Flow)
Inputs		
Water, from separator [Water]	**1.00**	**kg**
Outputs		
Water, from separator [Water]	**1.00**	**kg**
Tank flash emissions [Intermediate products]	**2.04E-04**	**kg**
Flaring associated gas [Intermediate products]	**0.00**	**kg**
Captured associated gas [Intermediate products]	**0.00**	**kg**

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

Embedded Unit Processes

None.

References

El-Houjeiri (2013) — El-Houjeiri, H. M., McNally, S., & Brandt, A. R. (2013). *Oil Production Greenhouse Gas Emissions Estimator OPGEE v1.1 DRAFT A: User guide & Technical documentation*.

Keesom (2009) — Keesom, W., Unnasch, S., & Moretta, J. (2009). *Life cycle assessment comparison of North American and imported crudes: Alberta Energy Research Institute.*

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TCEQ (2010)	TCEQ (2010). *Emission Factor Determination for Produced Water Storage Tanks.*
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Milligan (2004)	Milligan, L. Eric (2004). *Vasquez-Beggs Equation (VBE)*. Oklahoma Department of Environmental Quality.
Kylling (2009)	kylling, Oyvind W. (2009) *Optimizing Separator Pressure in a Multistage Crude Oil Producing Plant.* NTNU. Retrieved from: http://www.diva-portal.org/smash/get/diva2:347760/FULLTEXT01.pdf
Manning (1995)	Manning, F.S.; Thompson, R 1995. *Oil processing, Volume 2: Crude oil*; Pennwell: Tulsa, OK

Section III: Document Control Information

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Revision History:

Original/no revisions

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

NETL (2013). NETL Life Cycle Inventory Data – Unit Process: Liquid Storage Tank Flash Emissions –March 2014 Version 01. U.S. Department of Energy, National Energy Technology Laboratory. Retrieved [DATE] from www.netl.doe.gov/LCA

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