# NETL Life Cycle Inventory Data
# Process Documentation File

**Process Name:** Petro Tank Breathing Losses

**Reference Flow:** 1 kg of stored petroleum product emissions

**Brief Description:** Emissions associated with storing petroleum products in 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:**

| | |
|---|---|
| percent_full | *[dimensionless] Percent of storage tank that is full* |
| T_avg_ambient | *[deg F] Daily average ambient temperature for the trip* |
| T_del_ambient | *[deg F] The daily temperature change for the trip* |
| solar_insol | *[btu/ft²/day] Total solar insolation* |

| | |
|---|---|
| vent_set_psi | *[psig] Pressure setting for tank vent valve* |
| tank_absorp | *[dimensionless] Tank absorption factor - dependent on tank color* |
| API | *[deg API] API gravity of crude oil* |
| station_trans | *[binary] 0 - stationary tank; 1 - transport tank* |
| station_days | *[days] Number of days that petroleum products are stored in stationary tanks* |
| distance | *[km] One way distance for transportation tanks* |
| speed | *[km/hr] Speed of transportation* |
| travel_hours | *[hrs/day] Hours per day spent travelling* |

**Tracked Input Flows:**

None.

**Tracked Output Flows:**

stored petroleum product emissions [Intermediate product] *Reference flow*

## Section II: Process Description

### Associated Documentation

This unit process is composed of this document and the data sheet (DS) *DS_Stage12345_O_Petro_Tank_Breathing_Losses_2013.01.xlsx*, which provides additional details regarding relevant calculations, data quality, and references.

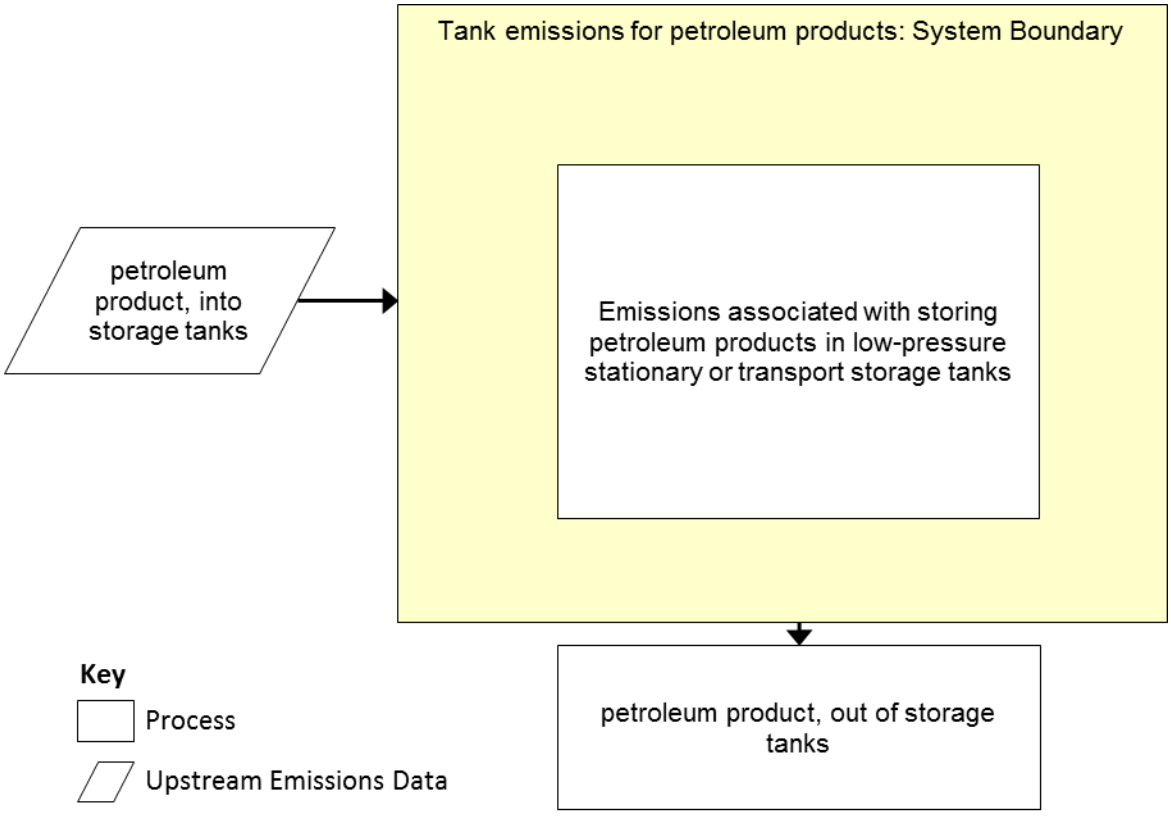
### Goal and Scope

This unit process provides a summary of relevant output flows associated with storing petroleum products in low-pressure tanks. Outputs are speciated volatile organic compound (VOC) emissions for 1 day of storage given user-defined temperature changes and solar insolation. Default values for different products are provided in the scenarios. The reference flow of this unit process is: 1 kg-day of stored petroleum product emissions

## Boundary and Description

**Figure 1** provides an overview of the boundary of this process. There are no inputs to this process because the process is expected to be called by transportation or storage processes that store crude oil or fuels.

**Figure 1: Unit Process Scope and Boundary**




This unit process estimates the VOC emissions using calculations provided by the Environmental Protection Agency (EPA) for storage tank breather losses with one modification to provide results on a per kg of product basis. See the EPA documentation for detailed discussions of the calculations (EPA, 2006) and the Eastern Research Group (ERG) report for the modifications (ERG, 2010). The calculation results are considered applicable for storage tanks on land and in waterborne transportation vessels such as ocean freighters and barges, despite the fact that temperature change in water is expected to be less than for a land-based storage tank.

Two of the parameters required for the EPA calculations are the vapor pressures of the transported liquid for minimum and maximum temperatures, which are defined by user parameters "Daily average ambient temperature" and "Daily temperature change". These are calculated within the DS using an exponential regression of the vapor pressures at 40ºF, 70ºF, and 100ºF from the ERG report (ERG, 2010).

VOC speciation was determined using data from EPA (EPA, 2011). The database was queried for entries that matched keywords for the desired fuel type (e.g., entries with the keywords "crude" and "tank"). The database returns the percent of each species for a given study. Each species percent is then averaged across all studies to provide a factor for the UP. To limit the number of species in the process, only those species with an average higher than 1 percent are reported by the UP. The averages are normalized so that the sum of the species is 100 percent. These normalized average percentages are multiplied by the calculated VOC emissions to provide the speciated results.

**Table 1** shows the model results for 1 day of storage for the five scenarios: crude (RVP 5), summer mix gasoline (RVP 7.8), winter mix gasoline (RVP 13), diesel, and Jet Fuel (kerosene).

## Table 1: Unit Process Input and Output Flows

| Flow Name | Crude | Gasoline (Summer) | Gasoline (Winter) | Diesel | Jet (Kerosene) | Units (Per Reference Flow) |
|---|---|---|---|---|---|---|
| **Inputs** | | | | | | |
| petroleum product, into storage tanks [Intermediate products] | 1.00E+00 | 1.00E+00 | 1.00E+00 | 1.00E+00 | 1.00E+00 | kg |
| **Outputs** | | | | | | |
| **petroleum product, out of storage tanks [Intermediate products]** | 1.00E+00 | 1.00E+00 | 1.00E+00 | 1.00E+00 | 1.00E+00 | kg |
| 1,2,4-Trimethylbenzene [Group NMVOC to air] | 0.00E+00 | 0.00E+00 | 0.00E+00 | 3.28E-11 | 0.00E+00 | kg |
| 2,2,4-Trimethylpentane [Group NMVOC to air] | 0.00E+00 | 3.23E-07 | 1.25E-06 | 3.78E-11 | 0.00E+00 | kg |
| 2,3,4-Trimethylpentane [Group NMVOC to air] | 0.00E+00 | 1.18E-07 | 4.58E-07 | 0.00E+00 | 0.00E+00 | kg |
| 2,3-Dimethylbutane [Group NMVOC to air] | 0.00E+00 | 1.12E-07 | 4.35E-07 | 0.00E+00 | 0.00E+00 | kg |
| 2,3 Dimethylpentane [Group NMVOC to air] | 0.00E+00 | 9.74E-08 | 3.77E-07 | 0.00E+00 | 0.00E+00 | kg |
| 2,4-Dimethylpentane [Group NMVOC to air] | 0.00E+00 | 7.69E-08 | 2.98E-07 | 0.00E+00 | 0.00E+00 | kg |
| 2-Methyl-2-butene [Group NMVOC to air] | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | kg |
| 2-Methylhexane [Group NMVOC to air] | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | kg |
| 2-Methylpentane [Group NMVOC to air] | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | kg |
| 3-Methylhexane [Group NMVOC to air] | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | kg |
| 3-Methylpentane [Group NMVOC to air] | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | kg |
| Benzene [Group NMVOC to air] | 0.00E+00 | 8.34E-08 | 3.23E-07 | 0.00E+00 | 0.00E+00 | kg |
| Ethane [Group NMVOC to air] | 1.28E-08 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | kg |
| Ethanol [Group NMVOC to air] | 0.00E+00 | 0.00E+00 | 0.00E+00 | 3.36E-10 | 0.00E+00 | kg |
| Ethyl benzene [Group NMVOC to air] | 0.00E+00 | 0.00E+00 | 0.00E+00 | 4.66E-11 | 0.00E+00 | kg |
| Formaldehyde (methanal) [Group NMVOC to air] | 0.00E+00 | 8.73E-08 | 3.38E-07 | 0.00E+00 | 0.00E+00 | kg |
| iso-Butane [Group NMVOC to air] | 1.39E-08 | 0.00E+00 | 0.00E+00 | 1.32E-10 | 0.00E+00 | kg |
| iso-Butene [Group NMVOC to air] | 0.00E+00 | 8.41E-08 | 3.26E-07 | 0.00E+00 | 0.00E+00 | kg |
| Hexane (isomers) [Group NMVOC to air] | 0.00E+00 | 2.31E-07 | 8.93E-07 | 0.00E+00 | 0.00E+00 | kg |
| iso-Pentane [Group NMVOC to air] | 3.68E-08 | 2.31E-06 | 8.94E-06 | 2.08E-10 | 0.00E+00 | kg |
| Octane [Group NMVOC to air] | 0.00E+00 | 3.39E-07 | 1.31E-06 | 0.00E+00 | 0.00E+00 | kg |
| Xylene (dimethyl benzene) [Group NMVOC to air] | 0.00E+00 | 2.20E-07 | 8.51E-07 | 1.71E-10 | 0.00E+00 | kg |
| Methane [Organic emissions to air (group VOC)] | 1.83E-08 | 4.96E-07 | 1.92E-06 | 0.00E+00 | 0.00E+00 | kg |
| Methyl tert-butylether [Group NMVOC to air] | 0.00E+00 | 4.37E-07 | 1.69E-06 | 0.00E+00 | 0.00E+00 | kg |
| Methyl cyclohexane [Group NMVOC to air] | 2.98E-09 | 0.00E+00 | 0.00E+00 | 5.61E-11 | 0.00E+00 | kg |
| Methyl cyclopentane [Group NMVOC to air] | 4.43E-09 | 1.03E-07 | 4.00E-07 | 0.00E+00 | 0.00E+00 | kg |
| 2-Methyl-1-pentene [Group NMVOC to air] | 0.00E+00 | 3.56E-07 | 1.38E-06 | 0.00E+00 | 0.00E+00 | kg |
| m-Xylene [unspecified] | 0.00E+00 | 9.93E-08 | 3.84E-07 | 0.00E+00 | 0.00E+00 | kg |
| Butane (n-butane) [Group NMVOC to air] | 5.62E-08 | 0.00E+00 | 0.00E+00 | 5.35E-10 | 0.00E+00 | kg |
| Decane [Group NMVOC to air] | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 5.00E-10 | kg |
| Dodecane [Group NMVOC to air] | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 4.65E-10 | kg |

| | | | | | | |
|---|---|---|---|---|---|---|
| Heptane (n-Heptane) [Organic intermediate products] | 9.80E-09 | 0.00E+00 | 0.00E+00 | 4.29E-11 | 2.55E-12 | kg |
| Hexane (n-hexane) [Organic intermediate products] | 1.22E-08 | 1.29E-07 | 4.98E-07 | 4.92E-11 | 0.00E+00 | kg |
| Nonane [Group NMVOC to air] | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.20E-10 | kg |
| Octane (n-Octane) [Organic intermediate products] | 7.40E-09 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.28E-11 | kg |
| Pentane (n-pentane) [Group NMVOC to air] | 2.83E-08 | 3.31E-07 | 1.28E-06 | 8.57E-11 | 0.00E+00 | kg |
| 1-Tridecane [Group NMVOC to air] | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 4.52E-10 | kg |
| 1-Undecane [Group NMVOC to air] | 0.00E+00 | 7.16E-08 | 2.77E-07 | 0.00E+00 | 5.18E-10 | kg |
| o-Xylene [unspecified] | 0.00E+00 | 8.23E-08 | 3.19E-07 | 4.21E-11 | 0.00E+00 | kg |
| 1-Pentadecane [Group NMVOC to air] | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 1.84E-10 | kg |
| Propane [Group NMVOC to air] | 4.65E-08 | 0.00E+00 | 0.00E+00 | 5.64E-11 | 0.00E+00 | kg |
| 1-Tetradecane [Group NMVOC to air] | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 | 2.99E-10 | kg |
| Toluene (methyl benzene) [Group NMVOC to air] | 0.00E+00 | 4.43E-07 | 1.71E-06 | 6.62E-11 | 0.00E+00 | kg |
| trans-2-Pentene [Group NMVOC to air] | 0.00E+00 | 8.19E-08 | 3.17E-07 | 0.00E+00 | 0.00E+00 | kg |

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

## Embedded Unit Processes

None.

## References


EPA. (2006). Environmental Protection Agency. 2006. AP 42 Fifth Edition Chapter 7: Organic Liquid Storage Tanks. Environmental Protection Agency. Retrieved from http://www.epa.gov/ttn/chief/ap42/ch07/index.html

ERG. (2010). Eastern Research Group. 2010. Barge Emission Estimates: Final Report. Austin, TX: I. Eastern Research Group. Retrieved December 2, 2013 from http://www.tceq.texas.gov/assets/public/implementation/air/am/contracts/reports/ei/5820783985FY1002-20100831-ergi-barge_emission_estimates.pdf

EPA. (2011). Environmental Protection Agency. 2011. SPECIATE Version 4.3. In Environmental Protection Agency (Ed.). Washington, D.C. Retrieved, from http://www.epa.gov/ttn/chief/software/speciate/index.html#documentation

## Section III: Document Control Information

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