NETL Life Cycle Inventory Data
Process Documentation File

Process Name: Bulk Storage Facility, Ethanol, Operation

Reference Flow: 1 kg of Ethanol Blend

Brief Description: This unit process includes emissions from the operation of a bulk storage facility for ethanol. Gasoline is mixed with ethanol to create E10 and E85. Emissions from fuel evaporation during storage and truck loading and unloading operations are included.

Section I: Meta Data

Geographical Coverage: US **Region:** Not Applicable

Year Data Best Represents: 2006

Process Type: Basic Process (BP)

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

Allocation Applied: No

Completeness: Individual Relevant Flows Recorded

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:

Evaporative Loss	*Amount of gasoline to evaporate during terminal operations.*
Ethanol Blend Type	*Determines the type of ethanol blend which is created, either E10 or E85*
Imported Gasoline Percent	*Percent of the gasoline which is assumed to be imported to the facility*

Tracked Input Flows:

Gasoline (NETL) [Crude Oil Products]	*Domestic petroleum-derived gasoline for blending, in kg*
Power [Electric Power]	*U.S. National Average electricity profile, in kilowatt hours*
Gasoline (Foreign) (NETL) [Crude Oil Products]	*Foreign petroleum-derived gasoline for blending, in kg*
Ethanol (NETL) [Organic intermediate products]	*Ethanol for blending with gasoline, in kg*

Tracked Output Flows:

Blended Fuel (E10) [Biomass fuel]	*Reference Flow*
Blended Fuel (E85) [Biomass fuel]	*Reference Flow*

Section II: Process Description

Associated Documentation

This unit process is composed of this document and the data sheet (DS) *DS_Stage4_O_Bulk_Storage_Facility_Ethanol_2010.01.xls*, which provides additional details regarding relevant, calculations, data quality, and references.

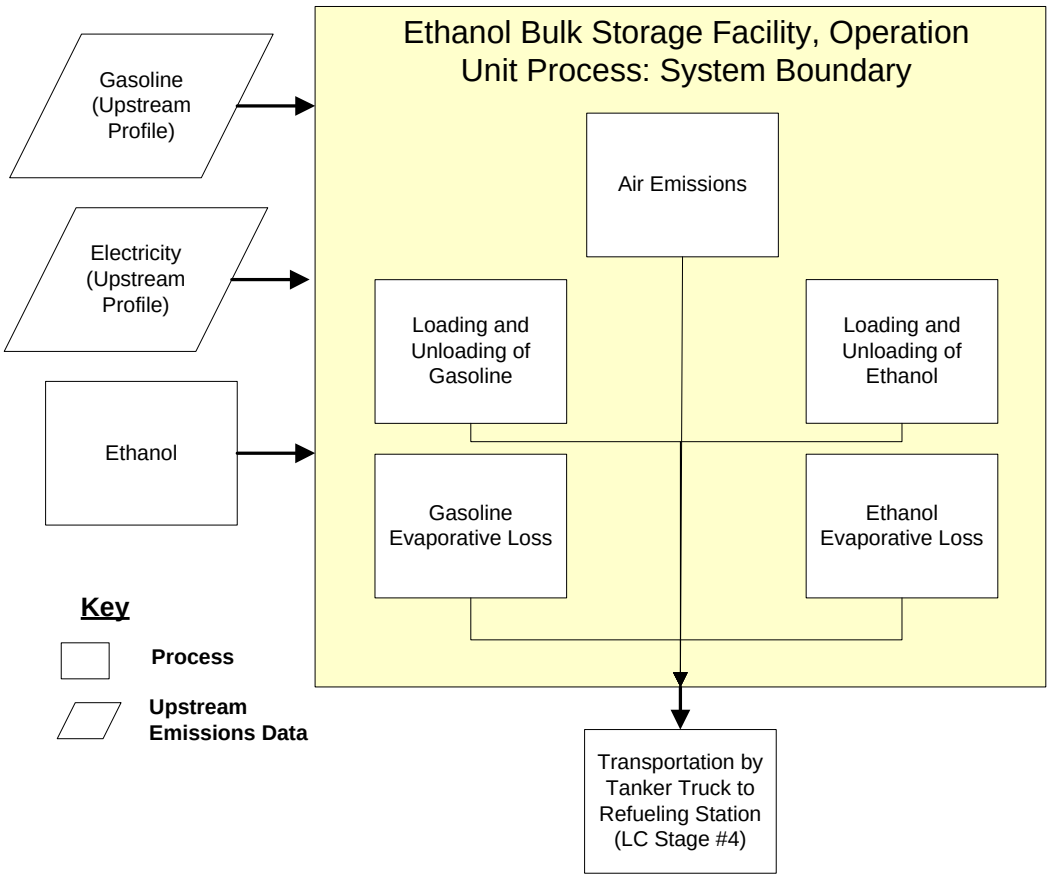
Goal and Scope

This unit process describes the operation of a bulk storage terminal for storage during the transport (Life Cycle (LC) Stage #4) of ethanol gasoline blend (E10 or E85) to a refueling station. Ethanol is refined in LC Stage #3 and transported to the bulk storage facility by pipeline in an earlier LC Stage #4 process. Similarly, gasoline is transported to the storage facility and kept in separate tanks. Splash mixing of the fuels occurs in a tanker truck under a process outside the scope of this process. The tanker truck completes transport to a refueling station for distribution and eventual use under LC Stage #5.

Boundary and Description

Figure 1 represents the boundary and contained processes within the bulk storage facility operation. Upon arrival to the bulk storage facility, ethanol and gasoline are pumped from the transport vessel to a storage tank at the facility. Evaporation occurs during both unloading and storage in the tank. The fuels are later moved from the storage tank to a truck in the correct ratios for the desired ethanol blend (E10 or E85) and splash mixing occurs to form a uniform fuel for distribution to refueling stations. This process ends when the ethanol blend is loaded into the truck and is ready for transport.

Figure 1: Unit Process Boundary and Scope



Inputs to the unit process, as shown in Figure 1, include electricity, ethanol produced under LC Stage #3, and gasoline (both domestically produced and imported finished fuel). Electricity consumption data for a bulk storage terminal were not available, so the electricity consumption of a refueling facility was used and assumed to be equivalent. This substitution is noted as a data limitation, however, the electricity used in pumping fuel from a transport vessel to a storage tank is expected to be very similar for both types of fuel storage facilities. Approximately 0.00125 kWh of electricity is consumed to transport one gallon of fuel throughout the unloading operation (NETL 2008).

Evaporative emissions of fuel during truck loading and unloading of gasoline is taken from a Colorado Department of Public Health and Environment – Permit Report (STC 2006). These emissions include non-methane VOC, carbon monoxide, and oxide. In order to provide additional flexibility to the unit process, an adjustable parameter indicating the amount of gasoline lost to evaporative emissions, during terminal operations, is included. The default value included in the DS is 1.08E-03 kg/kg gasoline. However, in the event that updated or more relevant evaporative emissions rates for gasoline are identified, an updated value may be substituted. The bulk storage facility

may contribute to water and soil emissions; however, sufficient data were not available to quantify these potential environmental releases. This is noted as a data limitation.

The unit process also has the ability to create either E10 or E85. For an E10 blend, 10 percent of the fuel loaded into the truck is ethanol while the remaining 90 percent is gasoline (combination of both imported and domestic). For an E85 blend, 74 percent of the fuel loaded into the truck is ethanol while the remaining 26 percent is gasoline. Additionally, the percent of the gasoline which is imported is an adjustable parameter. This value should never be greater than 100 percent and never be negative.

Table 1 shows gasoline properties used for calculation of evaporation of fuel in this unit process. **Table 2** provides a summary of modeled input and output flows for both the E10 and E85 scenarios. Additional detail regarding input and output flows, including calculation methods, are contained in the associated DS.

Table 1: Properties Ethanol and Gasoline Stored in the Facility

Property	Value	Reference
Gasoline Density, kg/m^3 (lb/gal)	737.04 (6.151)	NETL 2008
Gasoline Lower Heating Value (LHV), MJ/m^3 (Btu/gal)	32,356 (116,090)	NETL 2008
Ethanol 10 Density, kg/m^3 (lb/gal)	743.22 (6.202)	NETL Engineering Calculation
Ethanol 10 Lower Heating Value, MJ/m^3 (Btu/gal)	31,296 (112,274)	NETL Engineering Calculation
Ethanol 85 Density, kg/m^3 (lb/gal)	775.77 (6.474)	NETL Engineering Calculation
Ethanol 85 Lower Heating Value, MJ/m^3 (Btu/gal)	24,488 (87,852)	NETL Engineering Calculation

Table 2: Unit Process Input and Output Flows

Flow Name*	Value E10	Value E85	Units (Per Reference Flow)
Inputs			
Ethanol (NETL) [Organic intermediate products]	**0.1001**	**0.7408**	**kg**
Gasoline (Foreign) (NETL) [Crude oil products]	**0.1144**	**0.0331**	**kg**
Gasoline (NETL) [Crude oil products]	**0.7865**	**0.2272**	**kg**
Power [Electric power]	**0.0004**	**0.0004**	**kWh**
Outputs			
Blended Fuel (E10) [Biomass fuel]	1	0	kg
Blended Fuel (E85) [Biomass fuel]	0	1	kg
Nitrogen oxides [Inorganic emissions to air]	9.4340E-06	9.4340E-06	kg
Carbon monoxide [Inorganic emissions to air]	2.3585E-05	2.3585E-05	kg
NMVOC (unspecified) [Group NMVOC to air]	1.0799E-03	1.0799E-03	kg

* **Bold face** clarifies that the value shown *does not* include upstream environmental flows. Upstream environmental flows were added during the modeling process using GaBi modeling software, as shown in Figure 1.

Embedded Unit Processes

None.

References

NETL 2008 — NETL. 2008. *Development of Baseline Data and Analysis of Life Cycle Greenhouse Gas Emissions of Petroleum-Based Fuels*. DOE/NETL-2009/1346. U.S. Department of Energy, National Energy Technology Laboratory, Pittsburgh, PA. November 26, 2008.

CDPHE 2006. — Colorado Department of Public Health and Environment. (2006). *Operating Permit: Sinclair Transportation Company, Denver Products Terminal*. Colorado Department of Public Health and Environment. September 28, 2006.

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 (2010). *NETL Life Cycle Inventory Data – Unit Process: Ethanol Bulk Storage Facility, Operation.* U.S. Department of Energy, National Energy Technology Laboratory. Last Updated: October 2010 (version 01). www.netl.doe.gov/energy-analyses (http://www.netl.doe.gov/energy-analyses)

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