Process Name: Fuel Transport Pipeline, Construction

Reference Flow: 1 piece (pcs) of Fuel Transport Pipeline per kg Fuel Transported

Brief Description: Construction of a fuel transport pipeline, on the basis of pcs/kg fuel transported over the plant lifetime. Includes steel pipe for pipeline; amount of pipe is variable based on length and diameter.

Section I: Meta Data

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

Year Data Best Represents: 2008

Process Type: Manufacturing Process (MP)

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 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:

Fuel Transport Pipeline Length	*Length of the fuel transport pipeline, used to transport finished fuel from the plant to the bulk storage facility, in miles*
CBTL Output	*Daily production rate of CBTL facility, based on outflow, in liters per day*
V fraction	*Fraction of total transported fuel that is F-T jet fuel, 1.0 for pipeline from CBTL facility to blending station/refinery, 0.5 for refinery to airport(s), [dimensionless]*

Tracked Input Flows:

Steel, pipe welded, BF (85% Recovery Rate) [Metals]	*Amount of steel pipe required for the construction of one fuel transport pipeline, per kg fuel transported over plant lifetime*
Diesel [Crude oil products]	*Amount of diesel fuel required for the installation/deinstallation of one fuel transport pipeline, per kg fuel transported over plant lifetime*

Tracked Output Flows:

Fuel Transport Pipeline per kg Fuel Transported [Construction]	*Construction of a single pipeline to transport finished fuel to a bulk storage facility (reference flow)*

Section II: Process Description

Associated Documentation

This unit process is composed of this document and the data sheet (DS) *DS_Stage4_C_Fuel_Transport_Pipeline_2012.01.xls*, which provides additional details regarding relevant calculations, data quality, and references.

Goal and Scope

The scope of this unit process covers the elements required for the construction of a single pipeline needed to transport finished fuel under Life Cycle (LC) Stage #4, from the plant to the bulk storage facility over the 30-year study period, as described below and in **Figure 1**. Steel pipe is the sole input flow for the construction of a single transport pipeline, and it is based on the length of the pipeline, the diameter of the pipeline, and the total amount of fuel transported over the study period. This unit process calculates the fraction of a single steel pipe needed as an input to transport 1 kg of finished fuel, based on these parameters.

Boundary and Description

Figure 1 provides an overview of the boundary of this unit process. The total amount of fuel transported over the lifetime of the plant was obtained from Appendix D, Table D-1 of NETL's Coal and Biomass to Liquids (CBTL) Baseline (NETL 2009). The plant fuel output in gal/hr was converted to lbs/hr, and then to kg/lifetime, which is assumed to be 30 years. The amount of fuel transported through the pipeline over the plant lifetime can be selected from one of three values, based on the percent of biomass used:

3,670,451,335 kg (5,000 bpd biomass to liquids [BTL] cases), 24,683,819,479 kg (30,000 bpd, 30% biomass CBTL cases), or 41,129,301,735 kg (50,000 bpd, coal to liquids [CTL] and 15% biomass CBTL cases. The default value is for the minimum output of the 5,000-bpd BTL plant.

The weight of the fuel transport pipeline was calculated based on the required diameter of the pipeline, which was in turn calculated based on the plant output. The pipeline diameter was determined based on specifications for the density (URS 2004), temperature, pressure, and viscosity of diesel fuel (Norton *et al*. 1998) and formulas for the roughness and friction of steel (Heddle, Herzog, and Klett 2003; Perry and Green 1997). Based on the diameter of the pipeline, the weight per meter of pipe was determined, either 21.74 kg/m (5-inch diameter pipe), 60.24 kg/m (10-inch diameter pipe), or 79.77 kg/m (12-inch diameter pipe) (Engineering Toolbox 2005). It was assumed that there would be an additional 10% of the total steel weight added to account for valves and fittings not included in the specified weight of the pipeline, resulting in values of 23.914 kg/m (5-inch), 66.264 kg/m (10-inch), and 87.747 kg/m (12-inch). Once converted to a weight of steel pipe per mile, there were three available pipe weights for the transport pipeline, depending on the selected pipeline diameter: 38,485.9 kg/mile for 5-inch, 106,641.6 kg/mile for 10-inch, and 141,215.1 kg/mile for 12-inch. Which of these weights is used in the unit process is determined by selecting one of three binary parameters. The default for this unit process is for the minimum value of 38,485.8 kg/mile.

The total amount of steel for piping was calculated by multiplying the default transport pipeline weight per unit length (38,485.9 kg/mile) by the pipeline length (adjustable parameter default value of 100 miles), for a total of 3,848,585.2 kg. This weight was divided by the default amount of fuel to be transported over the plant lifetime (3,670,451,335 kg) for a value of 1.0485E-03 kg steel/kg fuel.

The total amount of fuel to be transported over the plant lifetime is an adjustable parameter and varies due to the production rate of the plant and the percentage of biomass feedstocks used as fuel for the plant, based on the plant pathway. The other adjustable parameter for this unit process is the transport pipeline distance, with a default value of 100 miles. This variable can be adjusted as needed to reflect assumptions regarding plant location and the distance from the plant to a bulk storage facility.

Relevant properties of a fuel transport pipeline used for the calculation of input and output flows for this unit process are shown in **Table 1**. **Table 2** provides a summary of modeled input and output flows. Additional details showing calculation methods for input and output flows, and other relevant information, are contained in the associated DS.

Figure 1: Unit Process Scope and Boundary

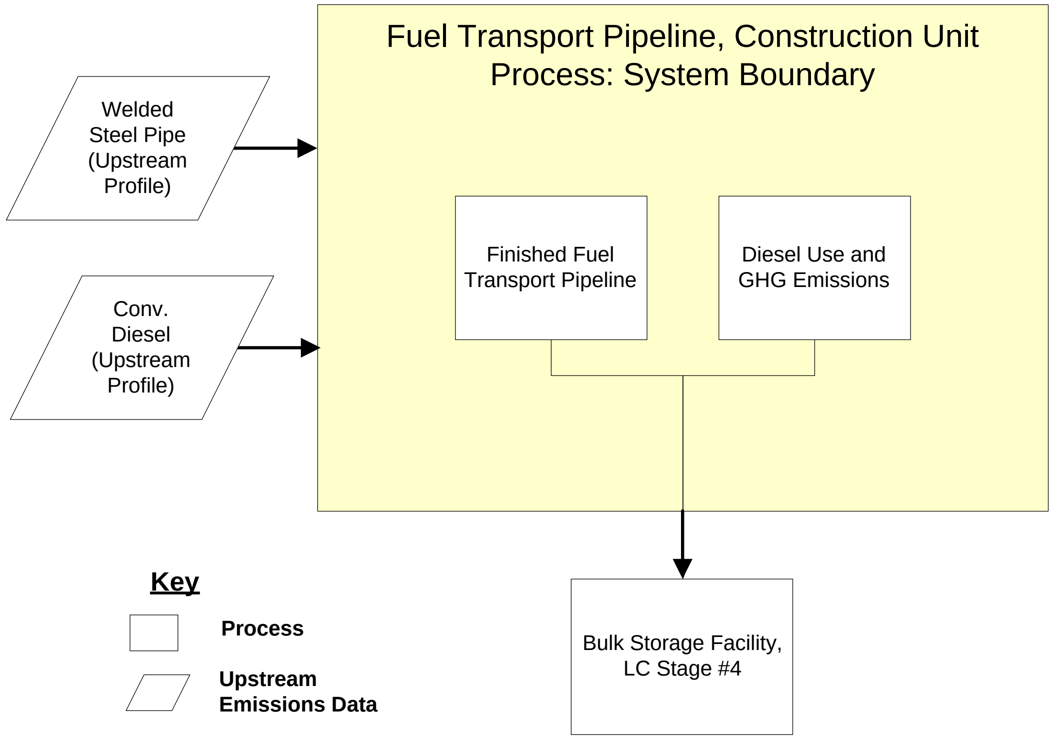

Table 1: Properties of a Fuel Transport Pipeline

Pipeline and Fuel Properties		
Property	**Value**	**Units**
Pipeline length	20	miles
5-inch diameter pipe weight	38,485.9	kg/mile
10-inch diameter pipe weight (default)	96,947	kg/mile
12-inch diameter pipe weight	141,215.1	kg/mile
Steel pipe, transport pipeline	1,938,938	kg
Fuel produced over plant lifetime, 5,000 bpd plant pathways	13,544,278,555	kg
Fuel produced over plant lifetime, 30,000 bpd plant pathways (default)	86,346,268,847	kg
Fuel produced over plant lifetime, 50,000 bpd plant pathways	135,442,870,743	kg

Table 2: Unit Process Input and Output Flows

Flow Name*	Value	Units (Per Reference Flow)
Inputs		
Steel, pipe welded, BF (85% Recovery Rate) [Metals]	**2.246E-05**	**kg**
Diesel [Crude oil products]	**1.990E-06**	**kg**
Outputs		
Fuel Transport Pipeline per kg Fuel Transported [Construction]	1	pcs/kg
Carbon dioxide [Inorganic emissions to air]	6.22187E-06	pcs/kg
Methane [Organic emissions to air (group VOC)]	3.58218E-10	pcs/kg
Nitrous oxide (laughing gas) [Inorganic emissions to air]	1.60999E-10	pcs/kg

* **Bold face** clarifies that the value shown *does not* include upstream environmental flows. See also the documentation for embedded unit processes, as shown below.

Embedded Unit Processes

None.

References

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URS 2004 — URS Corporation. 2004. *Compendium of Greenhouse Gas Emissions Methodologies in the Oil and Gas Industry*. American Petroleum Institute. http://www.api.org/ehs/climate/new/upload/2004_COMPENDIUM.pdf (Accessed December 17, 2009).

Section III: Document Control Information

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