NETL Life Cycle Inventory Data
Process Documentation File

Process Name: Advanced Ethanol Dry Mill Plant, Construction

Reference Flow: 1 pcs Advanced Ethanol Dry Mill Plant per kg Fuel Produced

Brief Description: Calculates the amount of materials (including concrete, steel plate, and stainless steel) needed to construct an individual Advanced Dry Mill plant. Data based on construction of a conventional dry mill plant.

Section I: Meta Data

Geographical Coverage: US **Region:** Midwest

Year Data Best Represents: 2006

Process Type: Manufacturing Process (MP)

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:

Tracked Input Flows:

Concrete, ready mix, R-5-0 [Concrete_Cement]	*Concrete needed in the construction of the ethanol plant, normalized to the reference flow*
Stainless steel, 316 2B, 80% Recycled [Metals]	*Summation of stainless steel needed in the construction of the ethanol plant, normalized to the reference flow*

Steel plate, BF (85% Recovery Rate) [Metals]	*Summation of carbon steel needed in the construction of the ethanol plant, normalized to the reference flow*

Tracked Output Flows:

Advanced Ethanol Dry Mill Plant per kg of Fuel Produced [Construction]	*Reference flow, one piece of plant per kg of fuel produced*

Section II: Process Description

Associated Documentation

This unit process is composed of this document and the data sheet (DS), DS_Stage3_C_Advanced_Dry_Mill_2010.01.xls, which provides additional details regarding calculations, data quality, and references as relevant.

Goal and Scope

The scope of this unit process covers the materials required for the construction of a single Advanced Dry Mill Ethanol Plant for the production of ethanol. Inventory results are normalized to the production of a single kg of ethanol, as described below. The materials included in the plant construction are concrete, carbon steel, and stainless steel. The process is based on the reference flow of 1 piece of plant per kg fuel produced, as described below and shown in **Figure 1**.

This unit process is used under Life Cycle (LC) Stage #3 to characterize material and energy flows associated with construction of an ethanol plant fed by either corn or corn stover for the production of transportation fuel, which will be blended with gasoline and transported (LC Stage #4) to a refueling station for use by an end user (LC Stage#5). It has been developed for use with other relevant unit processes for LC Stage #3, including plant operation and plant commissioning and decommissioning.

Boundary and Description

The flows calculated in this unit process are based on a reference flow of 1 piece (pcs) Advanced Ethanol Dry Mill Plant w/CCS per kg Fuel Produced. Within this unit process, “piece” is used to refer to a single, constructed/completed Advanced Ethanol Dry Mill Plant w/CCS.

Because no data of sufficient quality were available for the construction of an Advanced Dry Mill Ethanol Plant, having an annual nameplate capacity of 114 million L of ethanol per year. For the purposes of this unit process, the plant is assumed to operate at its nameplate capacity. This unit process is based on the assumption that it would be similar in design to a conventional Dry Mill Ethanol Plant. As there are additional components needed for the removal of corn oil from the biomass to be sold as a co-product, it is assumed that an additional 5

percent by weight of materials will be needed for these components. The relatively low increase in equipment requirements due to the additional oil extraction system is supported by manufacturer specifications (Watkins 2009) that show that the retrofit of a corn oil extraction unit is a relatively low expense to ethanol producers. These types of systems have not gained broad commercial acceptance and thus there is limited primary data for corn oil extraction and CCS systems used by ethanol dry mills. This is a data limitation on the actual material weights for the construction of the Advanced Dry Mill Ethanol Plant. All values are normalized per kg of ethanol being produced in the plant.

The total construction mass for the dry mill ethanol plant is reported by Hill (2006) and references therein. This source cites an assumed plant life of 20 years. The time frame of this unit process is 30 years. This difference in assumed time frames does not affect the validity of the construction requirements; the total material requirements for the construction of a facility are not affected by the assumed lifetime of the facility.

Figure 1 provides an overview of the boundary of this unit process. Emissions related to the physical assembly of the plant (e.g., emitted while constructing the plant or while transporting the components for the construction) are not considered in this study. Upstream emissions from the production of raw materials used for the construction of the plant (e.g., concrete, stainless steel, and carbon steel) are calculated outside of the boundary of this unit process, based on proprietary profiles available in the GaBi model. As shown in Figure 1 and discussed above, the plant constructed in this unit process is included under LC Stage #3 with plant operation and plant commissioning/decommissioning unit processes.

Table 1 summarizes the relevant properties and assumptions used to calculate the amount of concrete, stainless steel, and carbon steel contained in a single Advanced Dry Mill Ethanol Plant. **Table 2** provides a summary of modeled input and output flows. Additional details regarding input and output flows, including calculation methods, are contained in the associated Data Summary sheet.

Figure 1: Unit Process Scope and Boundary

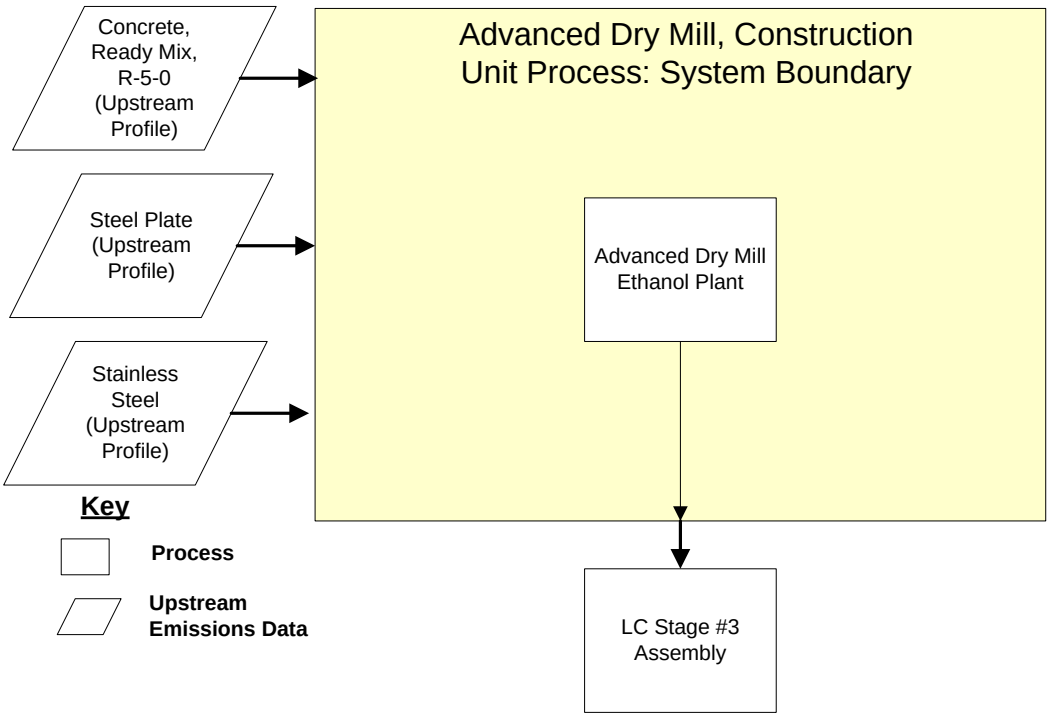

Table 1: Commissioning and Decommissioning Information

Data Point	Value	Unit	Reference
Plant Life	30	years	NETL Engineering Judgment
Total Plant Ethanol Output	2.6984E+09	kg	NETL Engineering Calculation
Total Concrete	1.2810E+07	kg	Hill 2006 and references cited therein
Total Stainless Steel	6.1950E+05	kg	Hill 2006 and references cited therein
Total Carbon Steel	9.7650E+05	kg	Hill 2006 and references cited therein

Table 2: Unit Process Input and Output Flows

Flow Name*	Value	Units (Per Reference Flow)
Inputs		
Concrete, ready mix, R-5-0 [Concrete_Cement]	**5.5255E-03**	**kg**
Stainless steel, 316 2B, 80% Recycled [Metals]	**2.2958E-04**	**kg**
Steel plate, BF (85% Recovery Rate) [Metals]	**3.6188E-04**	**kg**
Outputs		
Advanced Dry Mill Ethanol Plant per kg of Fuel Produced [Construction]	1.00E+00	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

Hill 2006 — Hill, J. Nelson, E. Tilman, D. Polasky, S. et al. Proceedings of the National Academy of Sciences. Environmental, economic, and energetic costs and benefits of biodiesel and ethanol biofuels. Vol 103, No 30. www.pnas.org/content/103/30/11206.full.pdf+html (Accessed September 26, 2009)

Watkins 2009 — Watkins, C. (2009). Two Fuels from One Kernel. International News on Fats, Oils and Related Materials (INFORM). AOCS Press. November 1, 2007 http://www.greenshift.com/pdf/EPM_One_Kernel_Two_Fuels.pdf (Accessed September 28, 2009)

Section III: Document Control Information

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