NETL Life Cycle Inventory Data
Process Documentation File

Process Name: Corn Wet Milling

Reference Flow: 1 kg of Dextrose

Brief Description: This unit process models the wet mill processing of corn to produce dextrose. This unit process includes co-products. The reference flow is 1 kg of dextrose.

Section I: Meta Data

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

Year Data Best Represents: 2003

Process Type: Manufacturing Process (MP)

Process Scope: Gate-to-Gate (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:

Corn	*[kg] kg corn per kg dextrose input*
Electricity	*[kWh] kWh electricity per kg dextrose input*
Steam	*[Btu] Btu steam per kg dextrose*
Natural_Gas	*[kg] kg natural gas per kg dextrose input*
Ethanol	*[kg] kg ethanol per kg dextrose output*

Dextrose	*[kg]kg dextrose per kg dextrose output*
Corn_Glut_Feed	*[kg] kg corn gluten feed per kg dextrose output*
Corn_Glut_Meal	*[kg] kg corn gluten meal per kg dextrose output*
Corn_Oil	*[kg] kg corn oil per kg dextrose output*
NG_Combusted	*[kg] kg combusted natural gas per kg dextrose output*

Tracked Input Flows:

Corn	*[Technosphere]*
Electricity	*[Technosphere]*
Steam	*[Technosphere]*
Natural_Gas	*[Technosphere]*

Tracked Output Flows:

Ethanol	*Coproduct dextrose*
Dextrose	*Reference flow*
Corn_Glut_Feed	*Coproduct dextrose*
Corn_Glut_Meal	*Coproduct dextrose*
Corn_Oil	*Coproduct dextrose*
NG_Combusted	*Emission to air*

Section II: Process Description

Associated Documentation

This unit process is composed of this document and the data sheet (DS) *DS_Stage3_M_Corn_Wet_Milling_2014.1.xlsx*, which provides additional details regarding relevant calculations, data quality, and references.

Goal and Scope

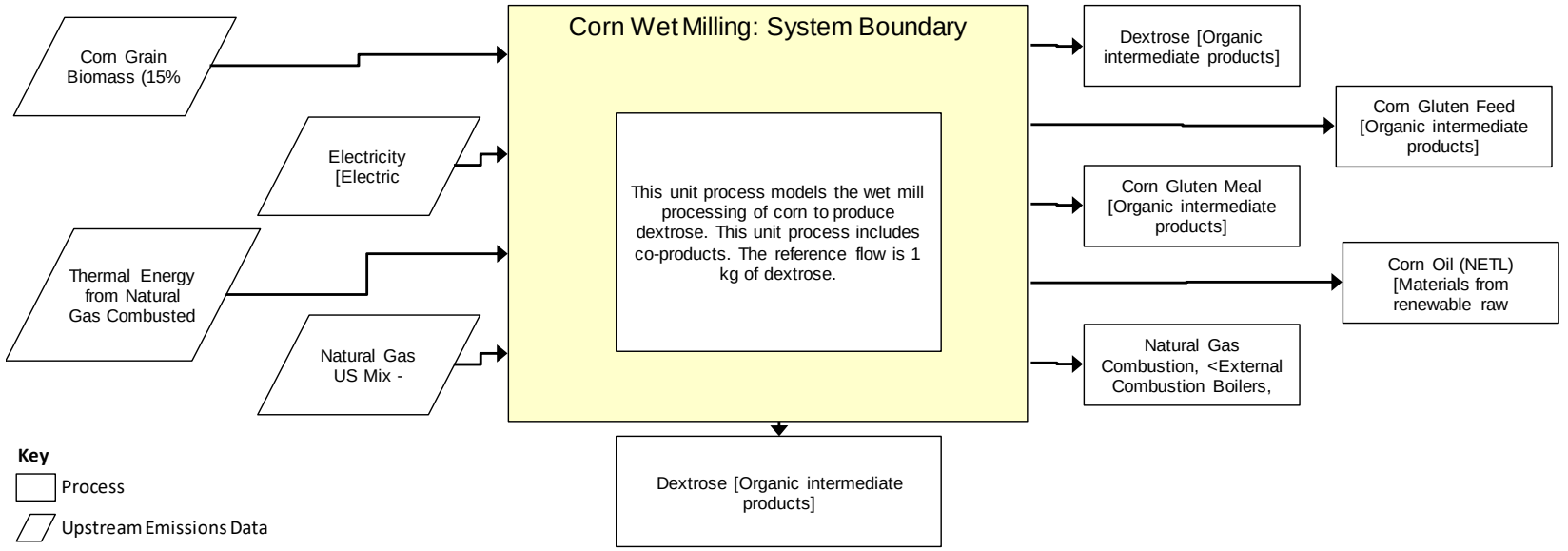
The scope of this unit process covers corn wet milling including feedstock inputs and outputs, energy requirements, and emissions to air. Aspects covered in this unit process are shown in Error! Reference source not found.. At the end, one kilogram of dextrose is extracted and ready to be used as an input in other unit processes.

Boundary and Description

The first step in the wet milling process is steeping, where the de-cobbed corn is soaked in water. Steepwater from this step is used in making feed and meal products. The next step is degermination, where the corn is ground to separate the germ and kernel. The germ in this step is used to make corn oil. In the next step, the remaining corn kernels go through grinding and screening. This step filters out the fiber, which is used for feed and meal products. In the next step, the remaining kernel is separated into gluten and starch using centrifugation. The gluten is used in feed and meal products. The starch is further processed to become sugars or ethanol. Syrup refining produces sugars, while fermentation and distillation produces ethanol. Dextrose is the sole output of the syrup refining process for this unit process. Other sugars that can be produced in the sugar refining process include corn syrup, high fructose corn syrup, and glucose syrup (Galitsky et al 2003).

The entire wet milling process is included in the unit process boundary, but not all relevant parameters are included in this unit process. For example, water consumption is not included in this unit process for wet milling. **Figure 1** describes what parameters are included in the corn wet mill unit process.

Figure 1: Corn Wet Milling Unit Process Boundary



Parameters and Balances

Table 1 presents the input and output balances for resources and emissions of interest for the corn wet mill.

Table 1: Input and Output Balances for Corn Wet Milling (kg/kg dextrose)

Flow Name	Value	Units (Per Reference Flow)
Inputs		
Corn Grain Biomass (15% Moisture) [Biomass fuels]	1.70E+00	kg
Electricity [Electric power]	2.12E-01	kWh
Thermal Energy from Natural Gas Combusted in Industrial Boiler [Valuable substances]	1.74E+03	Btu
Natural Gas US Mix - NETL [Natural gas (resource)]	6.98E-02	kg
Outputs		
Ethanol (96%) [Organic intermediate products]	4.99E-01	kg
Dextrose [Organic intermediate products]	1.00E+00	kg
Corn Gluten Feed [Organic intermediate products]	3.79E-01	kg
Corn Gluten Meal [Organic intermediate products]	7.58E-02	kg
Corn Oil (NETL) [Materials from renewable raw materials]	4.55E-02	kg
Natural Gas Combustion, <External Combustion Boilers, Industrial, Natural Gas, > 100 Million Btu/hr, SCR> [Natural gas products]	6.98E-02	kg

Embedded Unit Processes

None.

References

Galitsky (2003)	Galitsky, C. W., Ernst; Ruth, Michael (2003). Energy Efficiency Improvement and Cost Saving Opportunities for the Corn Wet Milling Industry, Ernest Orlando Lawrence Berkeley National Laboratory.
DOE (2014)	DOE (2014). GREET Model, U.S. DOE Argonne National Laboratory.
Murphy (1993)	Murphy, W. J. (1993). Tables for Weights and Measurement: Crops, University of Missouri Extension
NETL (2012)	NETL (2012). Role of Alternative Energy Sources: Natural Gas Technology Assessment. Pittsburgh, PA, National Energy Technology Laboratory.
Unnasch (2014)	Unnasch, S. (2014). Life Cycle GHG Analysis of White Dog Lab's Fuel Butanol Process, Life Cycle Associates.

Section III: Document Control Information

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Section IV: Disclaimer