NETL Life Cycle Inventory Data
Process Documentation File

Process Name: Industrial Boiler, Diesel Fired, Over 100 Million BTU/hr

Reference Flow: 1 MJ of Thermal Energy from Diesel

Brief Description: This unit process models air emissions and heat produced by an industrial-scale diesel fired boiler, producing less than 100 million BTU/hr.

Section I: Meta Data

Geographical Coverage: United States **Region:** N/A

Year Data Best Represents: 2010

Process Type: Energy Conversion (EC)

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:

BoilerEff	*Efficiency of the diesel boiler; default value is 80%, acceptable range is 70-90%*
Diesel_LHV	*Lower heating value of diesel; default value is 43.0 MJ/kg*

Tracked Input Flows:

Diesel [Intermediate Product]	*Amount of diesel used for the boiler, per the indicated reference flow*

Tracked Output Flows:

N/A

Section II: Process Description

Associated Documentation

This unit process is composed of this document and the data sheet (DS) *DS_Stage1,3_O_DieselBoiler_Industrial_2010.02.xls*, which provides additional details regarding relevant calculations, data quality, and references.

Goal and Scope

The scope of this unit process includes diesel consumption and fuel emissions associated with the use of a diesel fired industrial boiler. The unit process models a generalized diesel fired boiler emissions profile, where the boiler's efficiency is included as an adjustable parameter. The process is based on the reference flow of 1 megajoule (MJ) of thermal energy from diesel fuel, as described below and shown in **Figure 1**.

This unit process is considered to be applicable across the United States. However, the analyst should note that some states or regions, such as California, may require adherence to more stringent emissions criteria than those contained in this process. This is considered a data limitation. The emission factors used for this unit process are based on typical, mitigated emissions values for the state of Illinois, based on US and state emissions criteria. These values are typical of emissions criteria in most, but not all, US states.

This unit process is used under Life Cycle (LC) Stage #1 or #3, and may be applied for a variety of purposes where operation of a diesel boiler is needed. These may include, but are not limited to, support services for mining, refining, and energy conversion facilities. Outputs from this process are not tracked, as reflected in **Figure 1**.

Boundary and Description

The rate of diesel consumption included in this unit process is based on a default lower heating value (LHV) for diesel of 43.0 MJ/kg. Thus, the production of 1 MJ of thermal energy from diesel (i.e., the reference flow for this unit process) requires 0.0233 kg of diesel. Diesel LHV is included as an adjustable parameter, and can be modified as warranted, within the typical range for diesel LHV

Air emissions for most constituents were calculated on a per MJ basis, based on an air emissions calculator provided by the State of Illinois Environmental Protection Agency (Illinois EPA 2010). Emissions for sulfur dioxide were calculated assuming the use of 500 ppm diesel, which is consistent with regulations for diesel boilers, under federal standards. Lead and mercury emissions were calculated separately, based on emissions factors provided by the US Environmental Protection Agency (US EPA 1999). The source for emissions data for these two constituents is over a decade old, however, these data represent the best available source that is applicable to this unit process. This is considered a data limitation.

Figure 1 provides an overview of the boundary of this unit process. As shown, emissions associated with the production and transport of diesel fuel are considered to be outside of the boundary for this unit process. Within the boundary of the unit process, energy use and air emissions are quantified, as discussed previously. Unlike most unit processes, this process does not include any tracked output flow. Therefore, the process does not directly feed into another portion of the model, although energy use and air emissions are incorporated into model results.

Table 1 summarizes the relevant properties and assumptions used to calculate diesel use and air emissions. **Table 2** provides a summary of modeled input and output flows. Additional detail regarding input and output flows, including calculation methods, is contained in the associated DS.

Figure 1: Unit Process Scope and Boundary

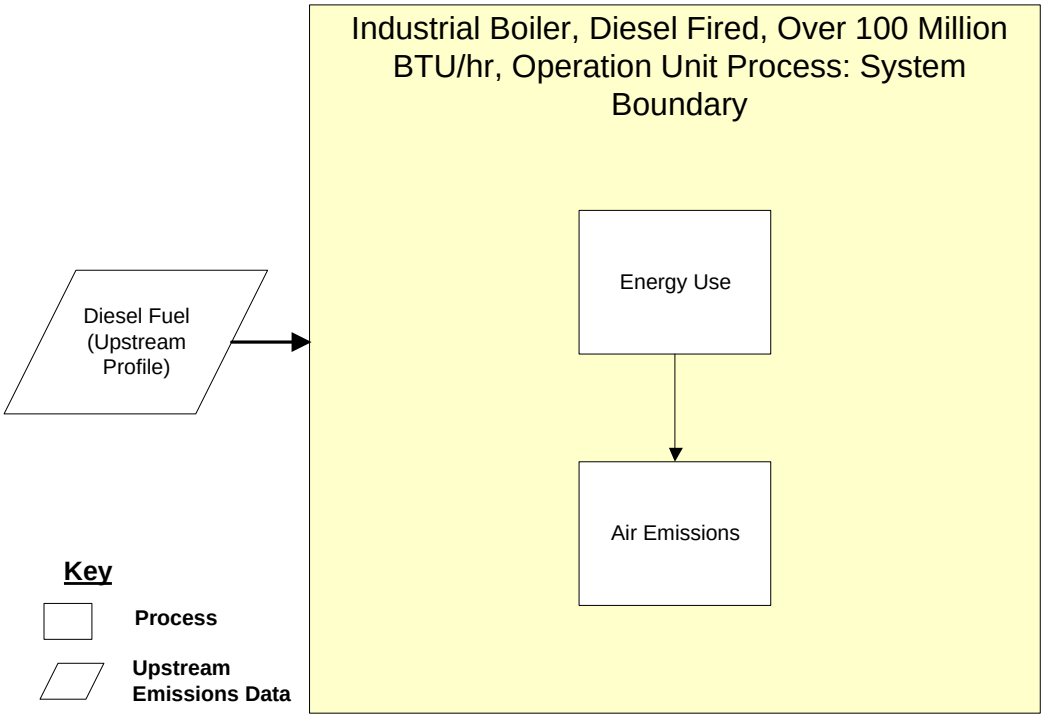

Table 1: Relevant Properties for Diesel Boiler Operation

Material Composition and Weights		
Material	Item	Reference
Diesel LHV (MJ/kg)	43.0	Study Value
Diesel required to produce 1 MJ of heat energy (L/MJ)	0.0233	NETL Engineering Calculation
Diesel Grade (ppm)	500	Illinois EPA 2010

Table 2: Unit Process Input and Output Flows

Flow Name	Value	Units (Per Reference Flow)
Inputs		
Diesel [Intermediate Product]	2.91E-02	kg/MJ
Outputs		
Thermal Energy from Diesel Fuel [Energy]	1.00	MJ
Carbon dioxide [Inorganic emissions to air]	9.20E-02	kg/MJ
Methane [Organic emissions to air (group VOC)]	2.14E-07	kg/MJ
Nitrous oxide (laughing gas) [Inorganic emissions to air]	4.54E-07	kg/MJ
Nitrogen oxides [Inorganic emissions to air]	8.25E-05	kg/MJ
Sulphur dioxide [Inorganic emissions to air]	2.93E-09	kg/MJ
Carbon monoxide [Inorganic emissions to air]	2.06E-05	kg/MJ
NMVOC (unspecified) [Group NMVOC to air]	1.04E-06	kg/MJ
Dust (unspecified) [Particles to air]	8.25E-06	kg/MJ
Lead (+II) [Heavy metals to air]	5.20E-09	kg/MJ
Mercury (+II) [Heavy metals to air]	1.73E-09	kg/MJ
Ammonia [Inorganic emissions to air]	3.30E-06	kg/MJ

* **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

Illinois EPA 2010 — Illinois Environmental Protection Agency. (2010). *Calculate Emissions.* http://www.epa.state.il.us/air/aer/calculate/boiler_ng.html (Accessed July 28, 2010)

US EPA 1999 — United States Environmental Protection Agency. (1999). *Emissions Factors & AP 42, Compilation of Air Pollutant Emission Factors.*

http://www.epa.gov/ttn/chief/ap42/ch01/final/c01s03.pdf (Accessed August 25, 2010)

Section III: Document Control Information

Date Created:	November 4, 2010
Point of Contact:	Timothy Skone (NETL), Timothy.Skone@NETL.DOE.GOV
Revision History:	
	[25OCT2013] Corrected the Diesel_use calculation to use the boiler efficiency – all inputs and outputs scaled accordingly.

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