



NETL Life Cycle Inventory Data

Process Documentation File

Process Name: Passenger Vehicle, 2005 U.S. Average, E10, Operation
Reference Flow: 1 MJ of Ethanol Blend (E10)
Brief Description: This process calculates emissions incurred from 1 MJ of ethanol blend E10 in an average U.S. passenger vehicle operating in 2005.

Section I: Meta Data

Geographical Coverage: US **Region:** N/A
Year Data Best Represents: 2005
Process Type: Transport Process (TP)
Process Scope: Gate-to-Grave (End-of-Life) Process (GE)
Allocation Applied: No
Completeness: All 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:

None.

Tracked Input Flows:

Ethanol E10 [Fuel]

The ethanol-gasoline blend (10/90 percent ratio) needed for the combustion of 1 MJ of fuel

Tracked Output Flows:

None.



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Section II: Process Description

Associated Documentation

This unit process is comprised of this document, as well as the data sheet (DS) *DS_Stage5_O_Passenger_Vehicle_2005_US_Average_Ethanol_E10_2011.01.xls*, which provides additional details regarding calculations, data quality, and references as relevant.

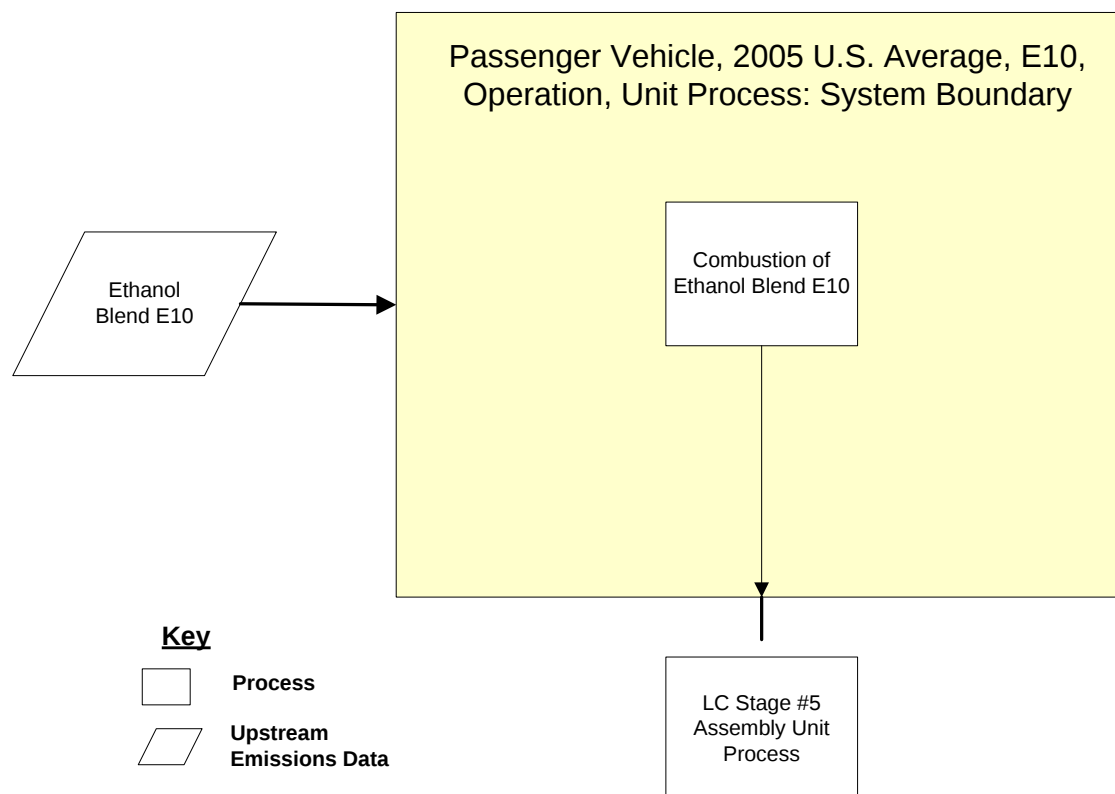
Goal and Scope

The scope of this process covers the combustion of 1 MJ ethanol blend E10 in a passenger vehicle in LC Stage #5. The calculations for the vehicle are based off of a representative data set for a U.S. average fuel economy for 2005. The emissions factors were adjusted based on the expected blend of gasoline and ethanol. This unit process is combined with a vehicle construction process to calculate the total emissions caused by the use of ethanol blend E10 in a vehicle.

Boundary and Description

Figure 1 provides an overview of the boundary of this unit process. Emissions related to the construction, assembly, and final disposal of the vehicle are considered in another unit process. The process of refueling the vehicle is contained within LC Stage #4 in a refueling station operations unit process. As shown in Figure 1 and discussed above, the vehicle operated in this unit process is incorporated into the LC Stage #5 assembly process.

Figure 1: Unit Process Scope and Boundary



As ethanol blends are at the commencement of their widespread use, sources from gasoline combustion emission have been modified such that they could be applicable to the blends. The primary source for greenhouse gas emissions from the combustion of gasoline is the EPA's proposed rule (May 26, 2009) for *Regulation of Fuels and Fuel Additives: Change to Renewable Fuel Standard Program* (EPA 2009). Other air emissions, including criteria air pollutants, are taken from a life cycle inventory completed at the University of California, Berkeley (Chester 2008). However, all data from both sources originate from the EPA MOVES model version 6.2.

Emissions data were reported in terms of mass per vehicle mile traveled. In order to determine the emissions on the basis of ethanol blend energy consumed, using the estimated average vehicle fuel economy for 2005 gasoline vehicle adjusted based on the energy density of the blends using 2007 data from the ORNL 2007 Transportation Energy Data Book (22.5 mpg gasoline).

Table 1 shows relevant properties used to calculate the emissions from combustion of 1 MJ ethanol blend E10. **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 DS sheet.

Table 1: Properties of Ethanol Blend E10 Vehicle

Property	Value	Reference
Gasoline Energy Content (LHV) MJ/m ³ (Btu/gal)	32,354 (116,090)	NETL 2008
Ethanol Energy Content (LHV) MJ/m ³ (Btu/gal)	21,181 (76,000)	EIA 2007
Ethanol Blend E10 Energy Content (LHV) MJ/m ³ (Btu/gal)	31,237 (112,081)	NETL Engineering Calculation

Table 2: Unit Process Input and Output Flows

Flow Name*	Value	Units (Per Reference Flow)
Inputs		
E10 [Fuel]	1	MJ
Outputs		
Carbon dioxide [Inorganic emissions to air]	76018.38	kg
Carbon dioxide (biotic) [Inorganic emissions to air]	5721.81	kg
VOC (unspecified) [Organic emissions to air (group VOC)]	63.98	kg
Methane [Organic emissions to air (group VOC)]	4.28	kg
Nitrogen oxides [Inorganic emissions to air]	216.02	kg
Nitrous oxide (laughing gas) [Inorganic emissions to air]	6.08	kg
Sulphur oxide [Inorganic emissions to air]	2.80	kg
Particulate Matter, unspecified [Other emissions to air]	83.15	kg
Carbon monoxide [Inorganic emissions to air]	3488.16	kg

* **Bold face** clarifies that the value shown *does not* include upstream environmental flows.

Embedded Unit Processes

None.

References

- Chester 2008
Chester, M.V. 2008. Life-cycle Environmental Inventory of Passenger Transportation in the United States. Dissertation. Institute of Transportation Studies, University of California, Berkeley.
- EIA 2007
Energy Information Administration. 2007. Annual Energy Outlook 2007.
<http://www.eia.doe.gov/oiaf/archive/aeo07/pdf/0383> (accessed February 22, 2010).
- 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.
- EPA 2009
EPA. May 26, 2009. Regulation of Fuels and Fuel Additives: Changes to Renewable Fuel Standard Program; Proposed Rule. Federal Register. Vol. 74, No. 99.

Section III: Document Control Information

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