NETL Life Cycle Inventory Data
Process Documentation File

Process Name: Canadian Oil Sands Synthetic Crude Oil, Extraction and Post-processing, Operation

Reference Flow: 1 kg Canadian oil Sands Synthetic Crude Oil

Brief Description: Module models the operation, energy requirements, and emissions for production of synthetic crude oil from Canadian oil sands.

Section I: Meta Data

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

Year Data Best Represents: 2005

Process Type: Extraction Process (EP)

Process Scope: Cradle-to-Gate Process (CG)

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:

None.

Tracked Input Flows:

Natural gas USA [Natural gas (resource)]	*Natural gas use for all extraction and post-processing activities.*

Tracked Output Flows:

Canadian Oil Sands Synthetic Crude Oil	*Reference flow.*

Section II: Process Description

Associated Documentation

This unit process is composed of this document and the data sheet (DS) *DS_Stage1_O_Canadian_Oil_Sands_Synthetic_Extraction_2010.01.xls*, which provides additional details regarding relevant, calculations, data quality, and references.

Goal and Scope

This unit process outlines the resource requirements and emissions associated with production of synthetic crude oil from Canadian oil sands. It specifically models the operations of Syncrude Canada Ltd and the production of Syncrude Sweet Blend crude oil. Syncrude operations represented the largest consolidated oil sands production/upgrading operation in 2005. While this process is not representative of all oil sands operations and upgrading, it will be used as a surrogate for oil sands-derived crude oil (including diluted bitumen). Using the Syncrude emissions profile for all oil sands operations will overestimate emissions because diluted bitumen does not undergo extensive post-processing and upgrading.

Boundary and Description

Figure 1 provides an overview of the boundary of this unit process. All emissions from the extraction of crude oil and post-processing of the oil are included in the boundary of this unit process. Upstream emissions from the extraction of natural gas used are calculated outside the boundaries of the process, based on proprietary profiles available within the GaBi model. Data from Syncrude is used as representative of energy use, water consumption, and emissions from extraction and post-processing of 1 kg of Canadian oil sands synthetic crude oil. Upon exit from this unit process, the crude is considered of sufficient quality to be ready for transport (LC Stage #2) to the petroleum refinery (LC Stage #3). This statement is consistent with claims on Syncrude's Utilities Support Website (Syncrude 2006b).

Information about production operations and associated emissions were derived from Syncrude Sustainability Reports and the Canadian National Pollutant Release Inventory (NPRI). While 2005 was the base year for modeling, most emissions were modeled using 2007 data. This was done because extensive maintenance and turnaround work, reduced production of plant fuel gas, and start-up of new Stage 3 units impacted operational performance (Syncrude 2006a).

Resource Consumption

According to the Syncrude 2007 Sustainability Report, Syncrude generates all required power on-site and can even be a net exporter of power (Syncrude 2008). The amount

exported is assumed to be zero based upon the fact that Syncrude is selling the power to the grid for $0.00 because of limited and unsteady supply (Langevin 2006).

Based upon the Syncrude 2005 Sustainability Report, Syncrude had been self-sufficient in meeting its diesel fuel needs for many years, and produces a diesel product that is already in compliance with new ultra low-sulphur specifications (Syncrude 2006a). Therefore, there is no diesel input in the model.

Natural gas is the only other resource utilized in oil sands operations. Natural gas consumption was estimated based on data found in the 2005 sustainability report. The natural gas consumption is estimated to be 0.85 gigajoule per barrel of synthetic crude oil (Syncrude 2006a). This estimate accounts for the increased requirements for power production required to make the facility electrically self-reliant in 2007.

Emissions

Water withdrawal, consumption, and discharge were estimated from the 2007 Sustainability Report and were placed on a per kg of Syncrude produced basis.

Solid waste was also estimated from the 2007 Sustainability Report and placed on a per kg of Syncrude produced basis.

Air emissions of criteria and toxic pollutants were taken from Canadian National Pollutant Release Inventory (NPRI) data for Syncrude operations (Aurora mine and Mildred Lake processing plant). The NPRI report showed no emissions of any waterborne pollutants of interest (Environment Canada 2008b).

GHG emissions were determined from government reporting to Canada's GHG Inventory (Environment Canada 2008a). Per the reporting, only CO_2, N_2O, and CH_4 are emitted from the facilities. These values have been inflated to correspond to Syncrude's GHG emissions listed in the 2007 Sustainability Report since that value is larger than that listed in the GHG registry. Syncrude notes that this is due to the inclusion of "all possible Syncrude sources, including combustion of clear diesel and gasoline, biomass combustion, aerobic decomposition, and industrial process." (Syncrude 2008).

Land Use

According to Syncrude, the original landscape comprised a mixture of indigenous aspen and white spruce forests, grassland and marshy wetlands (Syncrude 2008). In 2007 a total of 20,572 hectares had been disturbed and 4,556 hectares had been reclaimed, resulting in a net of 16,016 hectares disturbed (Syncrude 2008).

Table 1 shows relevant properties and data for Canadian oil sands synthetic crude oil used to calculate the inputs and outputs to this process. **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 Inputs, Outputs, and Boundaries

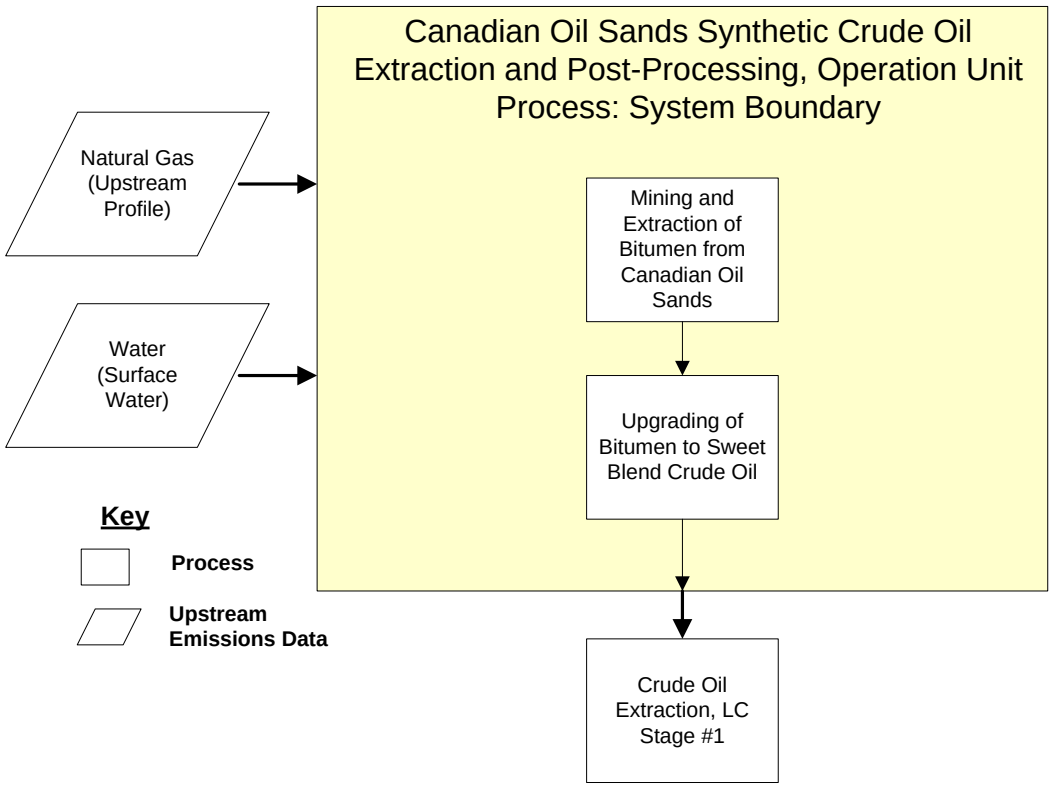

Table 1: Properties of Canadian Oil Sands Synthetic Crude Oil

Property	Value	Reference
Syncrude 2007 Synthetic crude output m^3 (bbl)	17695286 (111,300,000)	Syncrude 2008
Average API (30^o to32^o)	31^o	Syncrude 2006b
Density kg/L (lb/ft^3)	0.8708 (54.36)	IOR energy 2010

Table 2: Unit Process Input and Output Flows

Flow Name*	Value	Units (Per Reference Flow)
Inputs		
Natural gas USA [Natural gas (resource)]	**0.127027501**	**kg**
Water (surface water) [Water]	0.00233119	m^3
Outputs		
Canadian oil sands synthetic crude oil	1	kg
Water discharge	1.69381E-05	m^3
Carbon dioxide [Inorganic emissions to air]	0.921872895	kg
Nitrous oxide (laughing gas) [Inorganic emissions to air]	2.77155E-05	kg
Methane [Organic emissions to air (group VOC)]	0.002077993	kg
Lead (+II) [Heavy metals to air]	1.94042E-08	kg
VOC [emissions to air]	0.001799656	kg
Nitrogen Oxides [Inorganic emissions to air]	0.001020763	kg
Sulphur dioxide [Inorganic emissions to air]	0.005449588	kg
Particulate Matter, unspecified [Other emissions to air]	0.000310272	kg
Carbon monoxide [Inorganic emissions to air]	0.00069232	kg
Ammonia [Inorganic emissions to air]	6.63246E-05	kg
Mercury (+II) [Heavy metals to air]	2.0118E-09	kg
Nickel (+II) [Heavy metals to air]	1.81711E-07	kg
Cadmium (+II) [Heavy metals to air]	1.23304E-09	kg
Arsenic (+V) [Heavy metals to air]	2.98526E-09	kg
Copper (+II) [Heavy metals to air]	2.97228E-08	kg
Vanadium (+III) [Heavy metals to air]	4.1534E-07	kg
Zinc (+II) [Heavy metals to air]	2.64779E-08	kg
Solid Waste (unspecified) [Solid Waste]	0.004125756	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

Environment Canada 2008a — Environment Canada. 2008. *Canada's GHG Inventory*. Alberta, Canada. http://www.ec.gc.ca/pdb/ghg/onlineData/FacilityAndGHG_e.cfm?facil=1068&year=2007 (Accessed February 11, 2010).

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Section III: Document Control Information

Date Created: June 6, 2009

Point of Contact: Timothy Skone (NETL), Timothy.Skone@NETL.DOE.GOV

Revision History: Original/no revisions

How to Cite This Document: This document should be cited as:

NETL (2010). *NETL Life Cycle Inventory Data – Unit Process: Canadian Oil Sands Synthetic, Extraction and Post-Processing, Operations.* U.S. Department of Energy, National Energy Technology Laboratory. Last Updated: February 2010 (version 01). www.netl.doe.gov/energy-analyses (http://www.netl.doe.gov/energy-analyses)

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