NETL Life Cycle Inventory Data
Process Documentation File

Process Name: Steam Methane Reforming

Reference Flow: 1 kg of Hydrogen, >99.90 vol-%, 925 psig (6.48 MPa)

Brief Description: Energy use, feedstocks (including feedstock and water use), and emissions associated with conventional steam methane reforming (SMR) of natural gas to produce >99.9 vol-% hydrogen for generic industrial use.

Section I: Meta Data

Geographical Coverage: United States **Region:** Midwest

Year Data Best Represents: 2021

Process Type: Basic Process (BP)

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:

steam_credit

[binary] If excess steam generated in facility is routed to another facility and used in place of on-purpose steam, value = 1. If steam is released to atmosphere, value = 0.

groundwater_pct

[%] Percent of water supply sourced from groundwater.

potw_pct

[%] Percent of water supply sourced from publicly-owned treatment works.

export_steam_pct

[%] Percent of export steam available delivered to another facility and credited (if steam_credit = True). Default is 100%

Tracked Input Flows:

natural gas, delivered

[Technosphere] Mass flow rate of natural gas entering the facility, scaled to the reference flow.

Electricity, AC, 2300-7650 V

[Technosphere] Auxiliary grid electricity required to operate the full SMR facility.

Water, purified

[Technosphere] Water filtered to acceptable purity by water treatment train.

Tracked Output Flows:

Hydrogen, >99.90 vol-%, 925 psig (6.48 MPa)

[Reference flow]

Steam, medium pressure, 399°C

[Technosphere] Amount of export steam delivered to another facility and credited.

Section II: Process Description

Associated Documentation

This unit process is composed of this document and the data sheet (DS) DS_O_*Steam Methane Reforming_2022.01.xlsx*, which provides additional details regarding relevant calculations, data quality, and references.

Goal and Scope

This unit process provides a summary of relevant input and output flows associated with steam methane reforming (SMR) of natural gas to produce hydrogen. This process occurs in a single-train, vertical tube steam methane reformer that is externally heated by recycled syngas and supplemental natural gas. The reference flow of this unit process is: 1 kg of >99.9 vol-% hydrogen at 925 psia. The facility is assumed to be located at a generic, greenfield plant site in the Midwestern U.S.

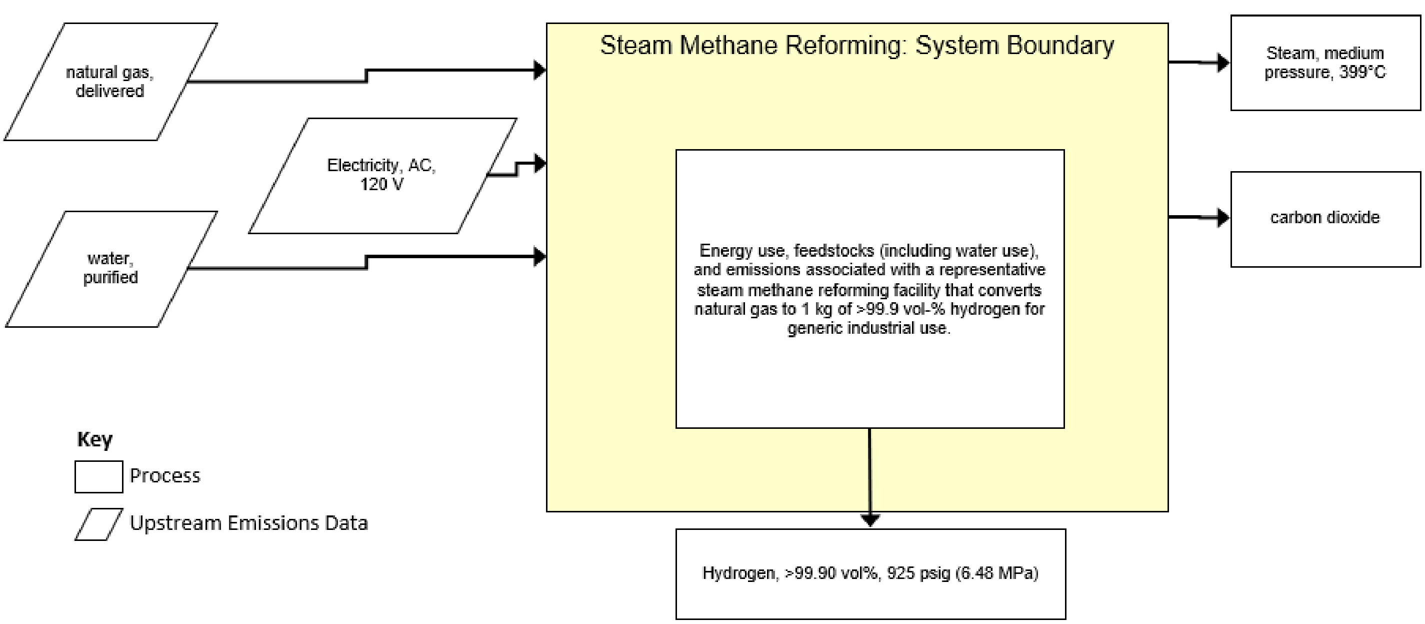
Boundary and Description

This unit process provides a summary of hydrogen production produced commercial via conventional steam methane reforming (SMR). SMR is a two-step process that converts methane or natural gas with steam to concentrated hydrogen. The first step is reformation, where excess steam reacts with the methane at high temperatures (700°C - 1000°C) to form synthesis gas (syngas, H_2 + CO). This is followed by the water-gas shift reaction, where remaining steam reacts with carbon monoxide to form additional hydrogen and carbon dioxide. SMR is considered very mature, with 95% of hydrogen generation in the United States manufactured using the technology.

The material, energy, and emissions reported in this unit process are based on the NETL publication "Comparison of Commercial, State-of-the-Art, Fossil-Based Hydrogen Production Technologies" (2022). The plant modeled is a single-train, vertical tube steam methane reformer that is externally heated by recycled syngas plus supplemental natural gas, configured to produce 20,125 kg/hr, or 200 MMSCFD, of >99.90 vol-% hydrogen suitable for generic industrial use. This unit process profile is a static representation of the process design of this facility.

Inputs and outputs have been scaled to a reference flow of 1 kg of gaseous hydrogen (>99.90 vol-%) at 925 psia. The facility is assumed to be located at a generic, greenfield plant site in the Midwestern U.S.

Figure 1: Unit Process Scope and Boundary



Embedded Unit Processes

None.

References

Lewis et al. 2022

Lewis, E., McNaul, S., Jamieson, M., Henriksen, M. S., Matthews, H. S., Walsh, L., Grove, J., Shultz, T., Skone, T. J., and Stevens, R. 2022. Comparison Of Commercial, State-of-the-Art, Fossil-Based Hydrogen Production Technologies. DOE/NETL-2022/3241. U.S. Department of Energy, National Energy Technology Laboratory. April 12, 2022. Pittsburgh, PA.

Section III: Document Control Information

Date Created: October 25, 2021

Point of Contact: Timothy Skone (NETL), Timothy.Skone@netl.doe.gov

Revision History:

None

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

NETL (2022). NETL Life Cycle Inventory Data – Unit Process: Steam Methane Reforming. U.S. Department of Energy, National Energy Technology Laboratory. Last Updated: August 2022 (version 01). www.netl.doe.gov/LCA (http://www.netl.doe.gov/LCA)

Section IV: Disclaimer

Neither the U.S. Department of Energy (DOE) National Energy Technology Laboratory (NETL) nor any person acting on behalf of these organizations:

A. Makes any warranty or representation, express or implied, with respect to the accuracy, completeness, or usefulness of the information contained in this document, or that the use of any information, apparatus, method, or process disclosed in this document may not infringe on privately owned rights; or

B. Assumes any liability with this report as to its use, or damages resulting from the use of any information, apparatus, method, or process disclosed in this document.

Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by NETL. The views and opinions of the authors expressed herein do not necessarily state or reflect those of NETL.