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Carbon dioxide Liquefaction for Shipping Transport

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Glossary

bara	Bar absolute
barg	Bar gauge
bhp	Brake horsepower
BLI	Battery limits investment
°C	Degree Celsius
CAS	Chemical Abstracts Service
CCS	Carbon capture and storage
CCUS	Carbon capture, utilization, and storage
¢/lb	Cents per pound
¢/kWh	Cents per kilowatt-hour
¢/Mgal	Cents per thousand gallons
CW	Cooling water
$/h	Dollars per hour
$/t	Dollars per metric ton
dia	Diameter
EPC	Engineering procurement and construction
°F	Degree Fahrenheit
FOB	Freight on board
ft dia	Feet diameter
G&A	General and administrative
gal	Gallons
g/mol	Grams per mole
gpm	Gallons per minute
GWP	Global warming potential
h	Hours
kg/h	Kilograms per hour
kg/m^3	Kilograms per cubic meter
KO	Knockout
kW	Kilowatts
kWh	Kilowatt-hour
lb/h	Pounds per hour
lb/y	Pounds per year
LCO_2	Liquefied CO_2
LNG	Liquefied natural gas
LTCS	Low-temperature carbon steel
m^3	Cubic meter
MMBtu/h	Million British thermal units per hour
MMlb/y	Million pounds per year
MMscf/d	Million standard cubic feet per day
MMt	Million metric tons
MMtpa	Million metric tons per annum
MMt/y	Million metric tons per year
MOC	Material of construction
mol%	Molar percent
MPa	Megapascals
NO_x	Nitrogen oxides
OSBL	Outside battery limits
OSHA	Occupation Safety and Health Administration
PEP	Process Economics Program
PFD	Process flow diagram
ppm	Parts per million
ppmv	Parts per million by volume
psi	Pounds per square inch
psia	Pounds per square inch absolute
psig	Pounds per square inch gauge

ROI	Return on investment
SMR	Steam methane reforming
SO_x	Sulfur oxides
sq ft	Square feet
SS	Stainless steel
STP	Standard temperature and pressure
Syngas	Synthesis gas
t	Metric ton
t/d	Metric tons per day
TEG	Triethylene glycol
TFC	Total fixed capital
TSA	Temperature swing adsorption
t/t	Metric ton per metric ton
TWA	Time-weighted average
t/y	Metric tons per year
VOC	Volatile organic compound
wt%	Weight percent

Abstract

As global efforts to combat climate change intensify, the need for effective carbon management strategies has become increasingly critical. CO_2 emissions from industrial sources, particularly fossil fuel-based processes, significantly contribute to greenhouse gas levels in the atmosphere. Liquefaction of captured CO_2 is increasingly viewed as a key step in the early deployment of carbon capture and storage (CCS) because it facilitates the safe and efficient transport of CO_2 over long distances to storage sites or utilization facilities. It is expected that by the end of this decade, at least 20% of the captured CO_2 will be transported via ships.

PEP Report 180I *Carbon Dioxide Capture Economic Model — Part II* (May 2024) has reviewed carbon capture from synthesis gas (syngas) for blue hydrogen and provided an Excel-based Economics Model. In this review, we present a technoeconomic analysis for the liquefaction of CO_2 captured from syngas originating in a blue hydrogen plant having a steam methane reforming (SMR) unit. We have included a comprehensive technology review of the industrially relevant liquefaction technologies along with material balance tables, a sized equipment list, and process flow diagrams for the CO_2 liquefaction process, which employs a closed-cycle configuration. The economic assessment is for a CO_2 liquefaction plant based at a US Gulf Coast location, with a production capacity of 1,000 metric tons per day [t/d] (724 million pounds per year [MMlb/y]).

The technological and economic assessment of the process is the Process Economics Program (PEP)'s independent interpretation of a potential commercial process. It is based on the information presented in the open literature, such as patents or technical articles, and may not reflect in whole or in part the actual plant configuration. We do believe that these sources are sufficient to represent the process and process economics within the range of accuracy necessary for the economic evaluations of the conceptual process designs.

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