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Low-carbon Methanol Value Chain

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Glossary

atm	Atmospheres
bara	Bar absolute pressure
Bcm	Billion cubic meters
BFD	Block flow diagram
BLI	Battery limits investment
Btu	British thermal units
¢/MMBtu	Cents per million British thermal units
¢/gal	Cents per gallon
¢/kWh	Cents per kilowatt-hour
¢/lb	Cents per pound
¢/Mgal	Cents per thousand gallons
¢/Mlb	Cents per thousand pounds
¢/Mscf	Cents per thousand standard cubic feet
¢/scf	Cents per standard cubic foot
CCS	Carbon capture and storage
cP	Centipoise
CR	Controlled rheology
cf/ft^3	Cubic feet
$/t	Dollars per metric ton
DAC	Direct air capture
DME	Dimethyl ether
g	Grams
gal	Gallons
gpm	Gallons per minute
h	Hour(s)
kg	Kilograms
kJ	Kilojoules
KO	Knockout
kPa	Kilopascals
kWh	Kilowatt-hours
lb	Pounds
Mgal	Thousand gallons
Mlb	Thousand pounds
MMlb/y	Million pounds per year
MMt	Million metric tons
MMt/y	Million metric tons per year
mol%	Molar percent
mPa	Megapascals
MTG	Methanol-to-gasoline
MTO	Methanol-to-Olefins
MTP	Methanol-to-Propylene
OSI	Off-sites investment
PEP	Process Economics Program
PFD	Process flow diagram
PP	Polypropylene
ppb	Parts per billion
ppm	Parts per million
psi	Pounds per square inch
psia	Pounds per square inch absolute
psig	Pounds per square inch gauge
ROI	Return on investment
RWGS	Reverse water gas shift
s	Second(s)
scf	Standard cubic feet
scm	Standard cubic meters

syngas	Synthesis gas
t	Metric ton
t/y	Metric tons per year
TEAl	Triethyl aluminum
TFC	Total fixed capital
VOC	Volatile organic compound
vol%	Volume percent
wt%	Weight percent
w/w	Weight for weight
y	Year

Abstract

Methanol is a crucial feedstock in industrial chemistry, playing an important role in the synthesis of various chemicals, such as formaldehyde (HCHO), acetic acid (CH_3COOH), and methyl methacrylate ($C_5H_8O_2$). These chemicals are essential for producing polymers, plastics, and advanced materials. In recent years, particularly since the early 2010s, interest in low-carbon methanol has significantly increased. This trend gained considerable momentum from 2018 onward due to substantial investments and technological innovations in the low-carbon methanol industry. The growing awareness of climate change and urgent need for sustainable energy alternatives have highlighted the importance of decarbonization and transitioning to renewable energy sources.

Supportive policies and regulations that encourage the adoption of low-carbon fuels have further accelerated the development and acceptance of low-carbon methanol. This aligns with global initiatives aimed at achieving net-zero carbon emissions, particularly in industries like transportation and chemicals. Consequently, these factors have collectively increased interest in low-carbon methanol as a viable alternative to conventional fossil fuels.

This review analyzes the production economics of three sets of integrated processes, starting with biomethanol as a raw material. The integrated processes include the conversion of biomethanol to acetic acid and then to acetic anhydride, biomethanol to formaldehyde and then to resol syrup, and biomethanol to propylene and then to polypropylene, with production capacities of 750 million pounds per year (lb/y) for acetic anhydride, 80 million lb/y for resol syrup, and 1,199 million lb/y for polypropylene, respectively. The production economics discussed are based on a US Gulf Coast location and data from the first quarter of 2025, using a PEP Cost Index of 1,634. Additionally, this review will assess the carbon and water footprints of the integrated processes.

The technoeconomic assessments of these processes represent PEP’s independent interpretation of commercial processes, relying on data from publicly available sources such as patents and technical journals. We believe that our analysis and process economics provide a sufficiently accurate representation for a conceptual process design assessment, although they may not completely reflect the actual plant configuration.

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