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Delayed Coking Technology for Needle Coke Production

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Roberto Tapia, **Associate Director, Process Economics Program**

Rajiv Narang, **Executive Director, Global Head, Process Economics Program**

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Glossary

$/t	Dollars per metric ton
API	American Petroleum Institute
barg	bar gauge
BEV	Battery electric vehicle
BFW	Boiler feedwater
BL	Battery limits
BLI	Battery limits investment
BMCI	Bureau of Mines correlation index
bpd	Barrels per day
Btu	British thermal units
BTX	Benzene, toluene, and xylene
°C	Degrees Celsius
capex	Capital expenditure
CCR	Conradson carbon residue
CCSS	Closed coke slurry systems
CDLP	Coal direct liquefaction pitch
ft^3	Cubic feet
CLG	Chevron Lummus Global
CLO	FCC decant oil
cP	Centipoise
CTE	Coefficient of thermal expansion
CW	Cooling water
DAO	Deasphalted oil
DCU	Delayed coking unit
EAF	Electric arc furnace
ECHO	Environmental coke handling operation
EDLCs	Electric double-layer capacitors
EOR	End-of-run
EV	Electric vehicle
FCC	Fluid catalytic cracking
FG	Fuel gas
FOB	Free/freight on board
g	Grams
GE	Graphite electrodes
gpm	Gallons per minute
h	Hours
HGI	Hardgrove grindability index
HGO	Heavy gas oil
HGVO	Hydrotreated vacuum gas oil
HT	Hydrotreating
HPNA	Heavy polynuclear aromatic hydrocarbon
kg	Kilograms
kJ	Kilojoules
kPa	Kilopascals
kt	Thousands of tons
KO	Knockout (as in “compressor KO drum”)
ISBL	Inside battery limits
La	Lateral carbon-layer size
Lc	Crystallite height
LDV	Light-duty vehicle
LGO	Light gas oil
LPG	Liquefied petroleum gas
MDEA	Methyldiethanolamine
mgal	Thousand gallons
MHDV	Medium heavy-duty vehicle

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
MW	Molecular weight
OLS	Online spalling
opex	Operating expenditure
OSBL	Outside battery limits
OTP	Optical texture parameter
PAH	Polycyclic aromatic hydrocarbons
PEP	Process Economics Program
PFD	Process flow diagram
PHEV	Plug-in hybrid electric vehicle
ppb	Parts per billion
ppm	Parts per million
ppmwt	Parts per million by weight
psi	Pounds per square inch
psia	Pounds per square inch absolute
psig	Pounds per square inch gauge
QI	Quinoline insolubles
ROI	Return on investment
s	Second(s)
scf	Standard cubic feet
scm	Standard cubic meter
SDA	Solvent deasphalting
SS	Stainless steel
t	Metric ton
t/y	Metric tons per year
TFC	Total fixed capital
TFCI	Total fixed capital investment
USGC	United States Gulf Coast
VCM	Volatile combustible matter
VGO	Vacuum gas oil
VOC	Volatile organic compounds
vol%	Volume percent
VPCD	Vertical plate coke drums
VR	Vacuum residue
wt%	Weight percent
w/w	Weight for weight
WEO	Waste engine oil
XRD	X-ray diffraction

Abstract

Needle coke is the preferred precursor for synthetic graphite used in lithium-ion battery anodes and the primary raw material for ultra-high-power graphite electrodes. Demand for needle coke continues to increase with the growth of electric arc furnace steel production and lithium-ion battery manufacturing. Needle coke is distinguished from conventional fuel-grade petroleum coke by its low coefficient of thermal expansion (CTE) and high electrical conductivity.

The evaluated process converts highly aromatic fluid catalytic cracking (FCC) decant oil into green needle coke via delayed coking. The operation begins by preheating the FCC decant oil feed to 490°C for thermal cracking in a coker furnace. The material then undergoes semi-continuous carbonization in coke drums operating at 6.5 barg. Fractionation separates the cracked vapors from the drums into fuel gas, LPG, unstabilized naphtha, light gas oil (LGO), and heavy gas oil (HGO). Following the coking cycle and a subsequent post-coking phase, the green needle coke is removed from the drums via hydraulic cutting.

This Process Economics Program (PEP) analysis provides an economic evaluation for a delayed coking facility located on the US Gulf Coast (USGC). The conceptual plant processes 20,000 barrels per day (bpd) of FCC decant oil, producing 688 million pounds per year (MMlb/y) of green needle coke. The financial model calculates capital expenditure (capex) and operating expenditure (opex) using a PEP Cost Index of 1,719 for the fourth quarter of 2025.

The process flow diagrams, material balance, major equipment list with specifications, cost information for battery limits, variable costs, capex and opex, and total production costs are evaluated in this analysis. The technological and economic assessment of the process is the PEP's independent interpretation of a potential commercial process. Each of these is based on information presented in open literature, such as patents and 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 evaluation of a conceptual process design.

Contacts

Roberto Tapia

Associate Director, Process Economics Program
roberto.tapia@spglobal.com

Rajiv Narang

Executive Director, Global Head, Process Economics Program
rajiv.narang@spglobal.com

CONTACTS

Europe, Middle East, Africa: +44 (0) 203 367 0681
Americas: +1 800 332 6077
Asia-Pacific: +60 4 296 1125

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