Direct Lithium Extraction via Adsorption Technology

PEP Review 2026-07

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Glossary

$/t	Dollars per metric ton
atm	Atmosphere(s)
Bcm	Billion cubic meters
BHE	Berkshire Hathaway Energy Renewables
BFD	Block flow diagram
BLI	Battery limits investment
BMED	Bipolar membrane electrodialysis
BOP	Balance of plant
Btu	British thermal units
CAGR	Compound annual growth rate
capex	Capital expenditure
cP	Centipoise
cf/ft^3	Cubic feet
CSTR	Continuous stirred-tank reactor
CLP	Central lithium plant
CPF	Central processing facility
CTR	Controlled Thermal Resources
DLE	Direct lithium extraction
DLS	Direct lithium sorption
DOE	Department of Energy
EPC	Engineering, procurement and construction
ESS	Electric/energy storage systems
EVs	Electric vehicles
FO	Forward osmosis
g	Gram(s)
gal	Gallon(s)
gpm	Gallons per minute
GWh	Gigawatt-hour(s)
h	Hour(s)
HPRO	High-pressure reverse osmosis
IEA	International Energy Agency
JV	Joint venture
kg	Kilogram(s)
kg/m^3	Kilograms per cubic meter
kJ	Kilojoules
kPa	Kilopascals
KTPA	Kilotons per year
KTS	Koch Technology Solutions
LADH	Lithium-aluminum layered double hydroxides
LCE	Lithium carbonate equivalent
LHM	Lithium hydroxide monohydrate
LIBs	Lithium-ion batteries
LPRO	Low-pressure reverse osmosis
LSS	Lithium selective sorption
mΩ·cm	Milliohm-centimeters
mg/L	Milligrams per liter
Mgal	Thousand gallons
Mlb	Thousand pounds
MMgal	Million gallons
MMt	Million metric tons
MMt/y	Million metric tons per year
mol%	Molar percent
mPa	Megapascals
OARO	Osmotically assisted reverse osmosis
opex	Operating expenditure

ORP	Oxidation-reduction potential
PFD	Process flow diagram
PEA	Preliminary economic assessment
PEP	Process Economics Program
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
RO	Reverse osmosis
ROI	Return on investment
s	Second(s)
scf	Standard cubic feet
scm	Standard cubic meter(s)
SWA	Southwest Arkansas Project
t	Metric ton(s)
TBP	Tributyl phosphate
TDS	Total dissolved solids
t/y	Metric tons per year
TFC	Total fixed capital
TWh	Terawatt-hour(s)
URV	Upper Rhine Valley
URVBF	Upper Rhine Valley Brine Field
USGC	United States Gulf Coast
USGS	United States Geological Survey
VMD	Vacuum membrane distillation
vol%	Volume percent
w/w	Weight for weight

Abstract

Lithium use for lithium-ion batteries (LIBs) is increasing exponentially with the expanding use of electric vehicles (EVs) and energy storage systems. The continued increase in demand makes it necessary to develop new sources of lithium and new processes to extract lithium from these sources.

This challenge is being met by direct lithium extraction (DLE) technology development. Multiple brine resources (such as geothermal brine, produced water, saltwater lakes, and naturally occurring brine reservoirs) contain varying concentrations of lithium ions and are specially suitable for DLE processes. Adsorption-based DLE process is a promising environmentally friendly technology which minimizes stress on water resources and produces waste that can be easily handled. It is more advanced compared to alternate DLE technologies and is being considered for multiple new DLE projects in advanced stages of commercial development.

This review examines an adsorption-based DLE project from surface water salt lakes with relatively low lithium concentrations.

Apart from industry status and technology review, the review examines process economics of a sample DLE plant. It includes material balance, PFDs, and sized equipment list, along with variable costs, capital expenditure (capex), operating expenditure (opex), and overall production costs.

The economic evaluation presented by the Process Economics Program (PEP) is an independent interpretation of the commercial process based on information presented in open literature and discussions with several industry-specific individuals. While this assessment may not reflect the actual plant data fully, 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.

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