

Direct Lithium Extraction via Adsorption Technology

PEP Review 2026-07

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Table of contents

1 Introduction	8
2 Summary	10
Technical aspects	10
Operating conditions and process	10
Process economics	10
Conclusion	11
3 Industry status	12
Background	12
Lithium uses	12
Lithium demand	13
Lithium supplies	13
Lithium resources	14
Lithium solid ores	14
Lithium-bearing clay	15
Salar brine in the Lithium Triangle (Chile, Bolivia, and Argentina)	15
Geothermal brine	15
Other brine resources	16
Saltwater lakes	16
Produced water from oil wells	16
Seawater	17
Lithium price and economics	17
Upcoming projects	19
Table 3.6 shows adsorption-based DLE projects under development	19
Standard Lithium’s project — Arkansas	19
Vulcan Energy Resources Ltd.’s geothermal project — Germany	21
Social and political aspects of lithium projects	22
Incentives	22
Public protests	22
Government policy	22
Summary of major DLE development status by country/region	23
4 Technology review	26
Lithium production technologies	26
Lithium from ore	26
Lithium recovery using evaporation ponds	26
Direct lithium extraction	26
Lithium recovery from spent batteries	27

DLE technologies	27
Adsorption-based DLE technology	29
Hybrid DLE process using adsorption technology	31
DLE balance of plant (BOP) development	32
5 Process description and economics	37
Direct lithium extraction (DLE) process plant description	37
Introduction	37
Important parameters	38
Discussion of selected process scheme	38
Exclusions and items of concern	40
Major equipment list	41
Cost estimate	44
Capital cost	45
Production cost	47
Economic discussion	48
Appendix A — Design and cost basis	50
Design conditions	51
Cost basis	51
Capital investment	51
Project construction timing	52
Available utilities	52
Production costs	53
Effect of operating level on production costs	53
Appendix B — Cited references	54
Appendix C — Process flow diagrams	56

Tables

Table 3.1 Conversion factors for lithium compounds and minerals	12
Table 3.2 Lithium demand (1,000 MMt/y of LCE)	13
Table 3.3 Estimated LCE production in recent years	13
Table 3.4 Lithium concentration in produced water brine	16
Table 3.5 Lithium carbonate price history	18
Table 3.6 Summary of adsorption-based projects under development	19
Table 4.1 Existing DLE processes	27
Table 4.2 Ion exchange and adsorbent DLE processes	28
Table 4.3 Comparison of DLE technologies	28
Table 4.4 Companies with sorbent-based DLE processes	29
Table 4.5 Deposit characteristics in mainland China	30
Table 4.6 Commercial DLE-based projects in operation	30
Table 5.1 Simulated brine quality used for design	39
Table 5.2 Adsorption-based DLE: Material balance	41
Table 5.3 Adsorption-based DLE: Major equipment	42
Table 5.4 Adsorption-based DLE: Utilities summary	44

Table 5.5a Adsorption-based DLE: Total capital investment	45
Table 5.5b Adsorption-based DLE: Total capital investment by section	46
Table 5.6 Adsorption-based DLE: Variable cost	47
Table 5.7 Adsorption-based DLE: Production cost	48

Figures

Figure 1.1 Global lithium demand	8
Figure 4.1 DLE lithium production process	32
Figure 4.2 Osmotically assisted reverse osmosis	33
Figure 4.3 Concentration method	34
Figure 4.4 Conversion to lithium carbonate	34
Figure 4.5 Electrolysis process general description	35

Appendix C Figures

Figure C1 Adsorption-based DLE: Extraction and disposal of brine	57
Figure C2 Adsorption-based DLE: Adsorption columns	58
Figure C3 Adsorption-based DLE: Eluate conditioning	59
Figure C4 Adsorption-based DLE: Initial concentration of eluate	60
Figure C5 Adsorption-based DLE: Final concentration of eluate	61
Figure C6 Adsorption-based DLE: Conversion to LCE	62
Figure C7 Adsorption-based DLE: Final product drying and packaging	63

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 electro dialysis
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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