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Review article

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Environmental impact of direct lithium extraction from brines

SUPPORTING INFORMATION

for

Environmental impact of direct lithium extraction from brines

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Deposit (country)	**Ca^{2+}**	**Mg^{2+}**	**Na^{+}**	**K^{+}**	**Li^{+}**	**Cl^{-}**	**SO_4^{2-}**	**B**	**TDS**	**References**
	$g\ L^{-1}$									
Uyuni (Bolivia)	0.46	7.68	98.40	7.92	0.32	177.6	12.96	0.19	305.5	[1]
Atacama (Chile)	0.45	9.65	91.0	23.6	1.57	189.5	15.9	0.44	332.3[A]	[1]
Olaroz (Argentina)	1.10	2.00	111.50	5.30	0.57	177.50	9.80	NR	309.20[B]	[2]
Hombre Muerto (Argentina)	0.12	0.14	103.00	9.70	0.90	168.00	11.40	0.54	294.00	[1]
Zabuye Lake (China)	0.00	0.00	127.90	45.96	0.66	147.6	26.29	1.58	434.47	[1]
Clayton Valley (USA)	0.45	0.23	63.70	8.00	0.36	100.00	6.60	0.09	180.10	[1]
Taijinar Salt Lake brine (China)	0.30	13.50	102.30	NR	0.21	188.10	24.00	0.31	328.70[C]	[3]
Southern Tibet geothermal (China)	0.05	0.02	1.70	NR	0.13	2.00	1.70	ND	212.00	[3]
Chott Djerid (Tunisia)	1.60	3.40	80.00	5.60	0.06	144.10	6.70	NR	400.00	[4]
Cerro prieto (USA)	30.80	3.20	60.00	23.50	0.25	175.50	46.00	0.50	339.70 [C]	[1]
Salton Sea (USA)	25.70	0.11	49.20	14.50	0.20	142.00	0.10	0.30	236.00	[5]
Rincon (Argentina)	0.60	3.00	97.90	6.60	0.30	158.00	0.00	0.40	266.80	[1]
Soultz-sous-Forêts (France)	7.20	0.13	28.10	3.20	0.17	58.60	0.16	0.04	99.0	[6]
Buhl geothermal well (Germany)	11.60	1.93	64.00	0.49	0.04	120.30	1.60	0.00	201.00	[6]
Landau geothermal well (Germany)	7.70	0.08	28.20	4.00	0.18	64.20	0.10	0.00	106.00	[6]
Dieng geothermal power plant (Indonesia)	0.40	0.003	0.039	2.20	0.04	13.60	0.003	0.30	23.70	[7]
Coipasa (Bolivia)	0.16	13.60	75.10	11.00	0.35	151.00	24.60	0.80	323.30	[8]
Cauchari (Argentina)	0.30	1.45	93.30	4.20	0.51	148.60	15.70	1.10	265.90	[8]

Supplementary Table 1: Composition of selected lithium rich brines. [A]: TDS as reported in the reference. Value not in agreement with the addition of reported concentrations. [B] all values correspond to the average of 4 samples from the same reference. Selected samples correspond to same depths, pH, and sampling date (Oct 2016). [C]: TDS not reported in cited reference. Value listed here correspond to addition of reported concentrations.

Technique	Novelty	Brine	Cycling test	Efficiency	[Mg]/[Li](0)	[Mg]/[Li](f)	[Na]/[Li](0)	[Na]/[Li](f)	Li^+ recovery	Estimation of energy or water consumption - Analysis of scalability - Circular production	Ref
Ion pumping	Improve electrode performance	Simulated	5	Reported as ion exchange capacity= 35.2 mg/g	NR	NR	1	0.02	29%	NR	9
Ion pumping	Improve energy consumption	Simulated	30	Reported as ion exchange capacity= 34.8mg/g	NR	NR	NR	NR	NR	Distilled water is used for washing step	10
Ion pumping	A compressive study on the competitive effect of other ions on lithium adsorption	Simulated	50	Reported as ion exchange capacity= 13.88 mg/g	1	0.008	1	0.03	20%	Distilled water is used for washing step	11
Ion pumping	MOFs is tested as a new ION PUMPING film for Li uptake from dilute solutions	Simulated	NR	Reported as ion exchange capacity= 37.55 mg/g	1	0.006	1	0.01	NR	NR	12
Ion pumping	Self-electrical energy recuperation (almost the system is not self-sufficiency)	Simulated	100	Reported as Li^+ uptake capacity = 10.88 mg/g	NR	NR	50	0.01	44%	Reported energy consumption= 1.007 Wh/mol.	13
Ion pumping	N-doping carbon encapsulated LMO film electrode for efficient Li electrosorption	Simulated	10	Reported as Li^+ uptake capacity = 37.14 mg/g. With a charge capacity of 79.58% and discharge of 82.38% after 50 cycles	3.75	NR	36.72	NR	NR	NR	14
Ion pumping	An electrochemical flow reactor for the extraction of LiCl was designed and tested (part II)	Real brine from Olaroz, Argentina	NR	Extraction efficiencies achieved up to 36 mg/g	0.65	NR	27.94	NR	NR	For washing, 2.5- 3L of fresh water is needed for 0.03L of brine	15
Ion pumping	A flow-by sustainable electrochemical reactor was assessed for extraction of Li from brine	Real brine, from Hombre Muerto, Argentina	NR	Maximum extraction capacity= 38.2mg/g	0.66	NR	26.08	NR	4.9% (limited by the mass of the $Li_{1-x}Mn_2O_4$ cathode)	Current efficiency= 85%. Specific energy consumption= 2.16 Wh/mol Li. 1L of fresh water is needed for each 1L of brine	16
Ion pumping	Redox-mediated lithium recovery system is	Simulated	NR	Li uptake capacity= 3.1 mg/g	1.82	0.25	15.3	14.22	NR	1.05L of fresh water is needed for each 1L of brine. Charge	17

	proposed for continuous lithium recovery									efficiencies of approximately 83–100%, and energy consumption of 133–141 kJ/mol	
Ion pumping	A fast, energy-saving, and environment-friendly process is proposed	Simulated	20	Reported as the LiCl production rates= 50−60 mmol Li/ m^2 h	0.42	0.01	20	0.04	Final Li concentration= 23.3mM with a purity= 95%	Average freshwater production rate can reach around 12.6 kg/ m^2 h. Average energy consumption= 4.83 Wh/mol Li. Current efficiency >90%	18
Electromembrane	A new liquid carrier with high Li^+ selectivity for an ED process	West Taijinair salt lake brine	NR	A reduction equal to 99.5% is reached for Mg/Li ratio	3.09	0.054	0.14	0.136	NR	Current efficiency= 65%. Specific energy consumption= 16 Wh/g	19
Electromembrane	A new methodology for greatly reduce the Na/Li ratio from real brines precipitating a pure Na salt	Real, from the north of Argentina	3000 h	Coulombic efficiency= 95%	0	0	NR	NR	NR	Energy consumption= 331.3 kWh for the lowest I applied. High purity by-product and desalinated water are obtained	20
Electromembrane	Membrane electrolysis is used for the removal **of Ca^{+2} and Mg^{+2} from** brines	Real, from the north of Argentina	500 h	Coulombic efficiency= 95.5%	6.96/ 13.03/ 19.7	0	NA	NA	100%	62 kWh.m^{-3} for brine with 3090 ppm of Mg^{2+}. High purity by-products are obtained. No waste is generated	21
Electromembrane	An EM process is proposed as a new technology to crystallize Li_2CO_3 without water evaporation	Simulated	300 h	Coulombic efficiency= 99.7%. Purity of obtained Li_2CO_3= 97.5%	NA	NA	1.2	0.0004	90%	Energy consumption= 70.6 kWh.m^{-3}. Low salinity water is recovered	22
Electromembrane	Prototype of a solar-powered electrodialyser	Seawater	NR	NR	NR	NR	NR	NR	NR	For lithium release a washing step is needed	23
Electromembrane	Propose a clean production process for the utilization of concentrated seawater/salt lake brine	Seawater concentrate	NR	Reductions equal to 88.9%; 83.2% and 76.7% are reached for Mg/Li ratio for different brines	35.18/ 54.3/ 72.72	3.91/ 9.13/ 16.97	NR	NR	76.5%	Optimal condition for Tajinar Brine: 0.66 kWh/(mol Li). Circular production schematized, target product: Li_2CO_3, by products will be NaCl, KCl, $MgCl_2$ and Mg_2SO_4	24
Electromembrane	A study on Li^+/Mg^{2+} separation performance	Simulated	NR	Mg/Li ratio decreased 21.8 times	43.81	≤5	NR	NR	90%	Reported energy consumption= 0.0019 KWh/gL, at 5.9 A/m^2	25
					17	2	NR	NR			

Electromembrane	An study on Li^+/Mg^{2+} separation performance for simulated real brines by a selective ED process	Simulated	NR	Li^+ is concentrated by a factor of 1.4 with a reduction equal to 88.3% on Mg/Li ratio	NR	NR	NR	NR	72.4%	At optimal voltage of 5 V, reported current efficient= 8.68%	26
Electromembrane	Simultaneously recovery of lithium and boron	Single or binary mixture	NR	99.6% for Li separation and 72.3% for boron	NR	NR	NR	NR	83.6%	NR	27
Electromembrane	Reduction of heat requirements to obtain LiOH from brines with high LiCl concentration	Simulated	NR	Produced LiOH with a purity between 96.0–95.4%	NR	NR	NR	NR	NR	Specific electricity consumption: 7.57 and 9.45 kWh per kilogram of LiOH	28
Electromembrane	A novel method based on electro-electrodialysis to produce LiOH	Single or Binary mixture	NR	Li^+ is concentrated by a factor of 3.9 times and LiOH is produced with a purity of 95.3%	NR	NR	NR	NR	NR	$USD 2.56/ Kg LiOH	29
Electromembrane	S-ED is employed to desorb lithium from LMO sieves, instead of acid treatment	Simulated	NR	Desorption time is reduced by 180 minutes compared to conventional treatment	NR	NR	NR	NR	70%	NR	30
Electromembrane	Focus on competitive effect of K^+ and Na^+ respect to Li^+ migration	Simulated	NR	The efficiency of Mg-Li separation decreases by 79% with increasing Na^+/Li^+ and by 74.4% with increasing K^+/Li^+	NR	NR	NR	NR	67.6%	Energy consumption at optimized voltage (6V): 0.17 – 0.23 KWh/mol Li	31
Electromembrane	An ED process is validated with real brine. Focus is on improvement of efficiency and reduce energy cost	Real brine	NR	A reduction of 90% on Mg/Li ratio	20	2.07	0.36	0.56	90.5%	Reported energy consumption 0.0045 KwH/g Li (20 V)	32
Electromembrane	Two different ED stacks were compared for separation of B and Li simultaneously	Single or Binary mixture	NR	62-69% for B removal and 93% for Li removal from feed solution	NR	NR	NR	NR	60-70%	NR	33
Membrane development	A new synthesis strategy to obtain a selective membrane with enhance properties	Single or Binary mixture	4	Reported as Li^+ uptake capacity= 50.87 mg/g; 43.94 mg/g after 4 cycles	NR	NR	NR	NR	NR	NR	34
Membrane development	Synthesis of an ion imprinted membrane with enhanced hydrophilicity and stability	Single or Binary mixture	10	Reported as Li^+ uptake capacity= 21.55 mg/g	NR	NR	NR	NR	70%	NR	35

Electromembrane -Ion pumping	Monovalent cation exchange membrane integrated with MCDI system to enhance the separation of Li from Mg	Single or Binary mixture	NR	38.4% for Li removal and 19.2% for Mg removal in large module	1	0.39	NR	NR	NR	Energy consumption of large module= 0.0018 kWh mol-1. Freshwater is used for Li recovery	36
Electromembrane -Ion pumping	LMO is employed as electrode for MCD system, improving adsorption capacity	Single or Binary mixture	5	NR	NR	NR	NR	NR	NR	Freshwater is used for washing and desorption steps	37
Electromembrane -Ion pumping	An electro-enhanced lithium ion recovery system is proposed	Simulated	5	NR	0.1/ 1	0.057/ 0.1	0.1/ 1/ 48.6	0.27/ 0.04/ 4.6	NR	Energy consumption: Wads and Wdes were 4.4 Wh/g-Li and 23.3 Wh/g-Li. Freshwater used for washing and desorption steps.	38
Electromembrane -Ion pumping	LMO is coated with a thin film of carbon to improve material capacity and process time	Single or Binary mixture	8	Reported as electrode capacity for Li uptake= 61%	NR	NR	NR	NR	NR	Freshwater used for washing and desorption steps	39
Nanofiltration	A higher separation factor for $LiCl/MgCl_2$ was gotten after membrane modification with EDTA	Simulated	8	A reduction of 89.1% is reached for Mg/Li ratio	6.8	0.74	NR	NR	NR	NR	40
Nanofiltration	Evaluation of NF process over different operational parameters	Simulated	NR	A reduction of 99.2% is reached for Mg/Li ratio; negatively affect by monovalent cations and negatively by divalent ones	9.91	0.031	NR	NR	95%	NR	41
Nanofiltration	Exceedingly high permselectivity	Single or Binary mixture	NR	Reported as Mg-Li separation factor= 71; decreases to 47 with increasing TDS of feed solution. Na-Li separation is deficient	5.57/ 14.44/ 17.17	0.079/ 0.18/ 0.23	NR	NR	NR	NR	42
Nanofiltration	High Li rejection due to the coupling strategy, NF + reverse electric field	Single or Binary mixture	A long experiment for 168 h	Reported as Li^+ rejection of 97.01%	NR	NR	NR	NR	92.5%	The energy consumption of the RENF process only has a 0.17% increase as compared with the NF process, an order of magnitude lower than that of the RO process	43

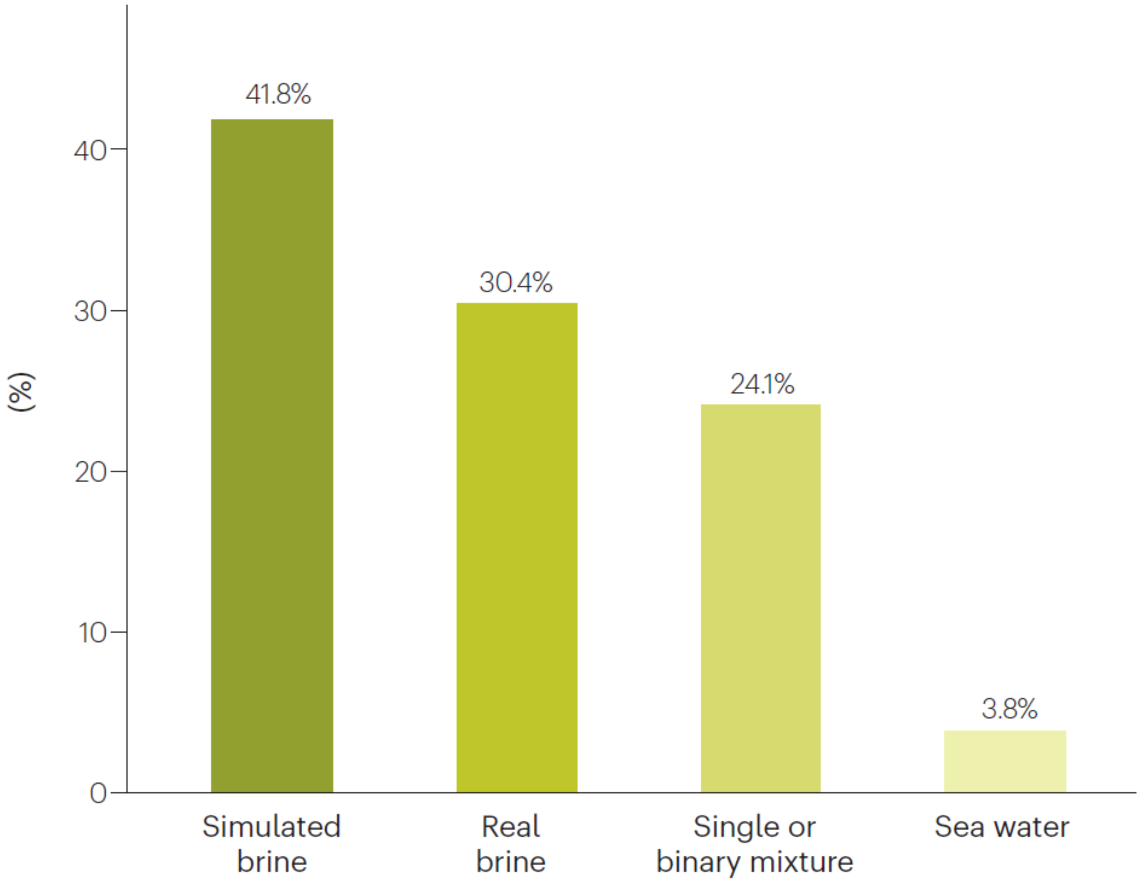
Nanofiltration	Different polymers were studied to enhance Li recovery	Single or Binary mixture	4	Reported as Li removal efficiency= 80%; decreases to 40% with the addition of for Na^+ or K^+ and to 20% with the addition of Mg^{2+}	NR	NR	NR	NR	NR	A washing step is needed for Li recovery	44
Nanofiltration	Enhancement in salt permeation and selectivity by NF membrane functionalization	Single or Binary mixture	A long experiment for 192 h	A reduction of 97.5% is reached for Mg/Li ratio	20.82	0.53	NR	NR	NR	NR	45
Membrane distillation + Nanofiltration	An hybrid system for lithium concentration	Simulated	NR	Li+ is concentrated by a factor of 12	0.28	0.014	NR	NR	NR	The membrane process represents about 14% of the capital cost of solar evaporation. On the other hand, the operating costs are higher due to thermal energy and membrane replacement costs	46
Nanofiltration + electromembrane	Combine: NF (to separate magnesium from salt lake brine) + RO-CED (to enrich NF permeates) + BMED (to produce Lithium hydroxide)	North-Western of Qinghai province, China	NR	$LiOH·H_2O$ is produced with a purity of 99.6% was produced	0.06	0.001	NR	NR	92%	Under optimized conditions, current efficiency and energy consumption were 36.05% and 6.20 kWh/kg LiOH, respectively. Employs freshwater for BMED test	47
Ion exchange resins	A superior Li^+ adsorption is reached	Simulated	6	Reported as ion adsorption capacity= 59.1 mg/g	NR	NR	NR	NR	NR	0.76 L of fresh water is needed for each 1 L of bine	48
Ion exchange resins	The process of Li^+ uptake from a real brine is studied	Real, Qinghai West Taijinar Salt Lake	5	Reported as ion adsorption capacity= 19.22 mg/g	NR	NR	NR	NR	NR	1.04 L of fresh water is needed for each 1 L of bine	49
Ion exchange resins	Synthesis of an aluminium-doped ion-sieve with enhanced adsorption performance	Single or Binary mixture	4	Reported as ion adsorption capacity= 32.6 mg/g	NA	NA	NA	NA	37.6%	2.5 L of fresh water is needed for each 1 L of brine	50
Ion exchange resins	Porous fiber-supported HTO was prepared to improve Li recovery	Real, from a Geothermal Power Plant, Tibet	6	Reported as ion adsorption capacity= 24.67 mg/g	NR	NR	7.94	NR	96.6%	0.1L of fresh water is needed for each 1 L of brine	51
Ion exchange resins	Spherical PVB-HTO composites having excellent Li extraction	Simulated	15	Reported as ion adsorption capacity= 12 mg/g	1	0	1	0	85.5%	1L of fresh water is needed for each 1 L of brine	52

	performance were synthetized										
Ion exchange resins	A novel hierarchical cubic Li_xTiO_2-based hollow Li-ion sieve is constructed	Real brine, from Qinghai Province, China	5	Reported as ion adsorption capacity= 6.9 mg/g	56	NR	NR	NR	NR	NR	53
Ion exchange resins	α-Al_2O_3 supported membranes are prepared for Li extraction	Single or Binary mixture	5	Reported as ion adsorption capacity=9.74 mg/g	NA	NA	NA	NA	38.6%	0.62L of fresh water is needed for each 1 L of brine	54
Ion exchange resins	A novel lithium-ion sieve is synthetized	Real brine from Qaidam Basin	4	Reported as ion adsorption capacity=13.32 mg/g	225	15	145	25	99.98%	1.4L of fresh water is needed for each 1 L of brine	55
Ion exchange resins	A Cr-Doped Lithium Ion Sieve is synthetized and characterized	Real brine	20	Reported as ion adsorption capacity=28.35 mg/g	135.7	NR	6.78	NR	81.7%	0.3L of fresh water is needed for each 1 L of brine	56
Ion exchange resins	A Fe3O4-doped magnetic lithium ion-sieve is prepared for Li extraction	Simulated	5	Reported as ion adsorption capacity=29.33 mg/g	NA	NA	NA	NA	NR	0.07L of fresh water is needed for each 1 L of brine	57
Ion exchange resins	Different TiO_2 precursors are employed to control the ion sieve wettability	Simulated	8	Reported as ion adsorption capacity=30.11 mg/g	NA	NA	0.3	0.003	NR	0.1L of fresh water is needed for each 1 L of brine	58
Ion exchange resins	A novel composite lithium ion-sieve is synthetized and proved	Geothermal water from Tibet	5	Reported as ion adsorption capacity=11.35 mg/g	NA	NA	7.94	NR	79.13%	0.01L of fresh water is needed for each 1 L of brine	59
Ion exchange resins	A superior lithium adsorption capacity is reached	Simulated	20	Reported as ion adsorption capacity= 15.5 mg/g	0.2	0	0.097	0	NR	NR	60
Ion exchange resins	A novel synthetic method is employed to improve Li recovery	Geothermal water from Tibet	4	Reported as ion adsorption capacity= 11.4 mg/g	NA	NA	0.21	0	88.42%	0.2L of fresh water is needed for each 1 L of brine	61
Selective precipitation	A new precipitation method is proposed to extract Li from salt lake brines	Real brine from West Taijinar	NR	A reduction of 98.5% is reached for Mg/Li ratio	14.04	0.05	NR	NR	93.2%	Precipitating reagents can be recycled	62
Selective precipitation	Significant reduction of precipitation temperature by using seed induction process	Simulated	NR	Li_3PO_4 is obtained with a purity of 99.15%.	NR	NR	NR	NR	84%.	Freshwater for wash the obtained Li_3PO_4	63
Selective precipitation	High Li+ enrichment from a complex brine, Dead Sea	Real brine from Dead sea	NR	Lithium enrichment from 30 −40 mg/L in the EB to 1000–1700 mg/kg in the obtained solid precipitate	NR	NR	NR	NR	40%	Fresh water for washing step	64

Selective precipitation	Enhance divalent separation and Li recovery as Li_2CO_3, by a co-precipitation process	Industrial refined brine from Albemarle industrial plant "La Negra"	NR	Li_2CO_3 with Mg concentrations from 1% to 3% was obtained with yields >85%	0.35	0.16	NR	NR	NR	Employs hot water, for wash	65
Selective precipitation	A closed loop process is proposed to prepare Li_2CO_3 battery grade	Arizzaro Salt Lake, Argentina	A long experiment for 24 h	Almost 90% for each step	0.93	0	11.37	0	74.9%	Cost estimation= 1700 \$/ton(Li_2CO_3); employs freshwater for anolyte	66
Liquid-liquid extraction	Li was recovered by centrifugal extraction	Simulated	NR	NR	NR	NR	NR	NR	NR	No freshwater needed	67
Ion pumping	A novel redox reagent is employed for fast lithium sequestration reactions	Simulated	NR	Reported as Li uptake capacity of host material= 45 mg/g	5/ 6.5	0.01/ 0.01	77/ 15	0.006/ 0.002	NR	NR	68
Ion pumping	A chemical redox method to direct lithium extraction	Simulated	5	Absorption 90%, desorption 90%.	73.71	0.007	248.61	0.48	91.11%	NR	69
Ion pumping	Improve the cell design in order to solve the problem of mass transfer in diluted lithium solutions	Simulated	9; (200 were simulated for an optimal long test)	60%	NR	NR	NR	NR	37%	6.1 Wh/mol, 30% pumping; 5ml freshwater/1.35L brine; No circular production	70
Ion pumping	A pilot scale demonstration	Seawater concentrate	NR	An enrichment in Li concentration of 1800 times	2028	0.048	18000	0.04	NR	A $1m^3$ tank is proposed at pilot scale for the distilled water needed for the process.	71
Immobilized solvent for Li^+ extraction	Focus on Na/Li ratio, from a composite lithium membrane	Single or Binary mixture	5	NR	NR	NR	NR	NR	22.1%, after 27 days	Freshwater for membrane rinse.	72
Electrocoagulation	An alternative for chemical precipitation	Single or Binary mixture	NR	95%	NR	NR	NR	NR	95%, by continuous mode	Operating cost per gram of Li= 0.023 US\$	73
Liquid-liquid extraction	Enhancement in Li^+ stripping with HCl	Single or Binary mixture	6	70%	40	1.79	NR	NR	63%	Water consumption = 3/10 of brine volume	74
Liquid-liquid extraction	A novel ionic liquid as co-extractant in a green process	Simulated	10	99.47% after a 4 stages of a cross flow process	274	0	NR	NR	100%	Water consumption = 7/6 of brine volume	75
Liquid-liquid extraction	A new co-extractant ($NaBP_{h4}$) to enhance Li^+ recovery	Simulated	10	99.84% after 5 stages of a cross flow process	80	0	NR	NR	87%	Water consumption = 6/5 of brine volume	76

Liquid-liquid extraction	A mixed ternary solvent extraction system is validated with real brine	Real brine, East Tajinar Salt Lake	10	87%	21.5	1.06	NR	NR	54%	Water consumption = 9/10 of brine volume	77
Liquid-liquid extraction	A functionalized ionic liquid is employed to improve Li extraction efficiency	Single or Binary mixture	NR	83.3%	NR	NR	15/7.5	NR	83.3%	Water consumption = brine volume	61
Liquid-liquid extraction	A new separation process to extract lithium ions from salt lake brines is developed	Simulated	10	58.9%	77.88	NR	1.57	NR	58.9%	Water consumption = 0.2 brine volume	78
Liquid-liquid extraction	Li recovery from South America salt lakes by LLE is first proposed	Salt lake brine from South America	10	99.6%	1.05	0.001	24.63	0	99.6%	Water consumption = 0.17 brine volume	79
Liquid-liquid extraction	A novel synergistic extraction with hydrophobic deep eutectic solvents is proposed	Simulated	5	95.7%	NR	NR	33.23	0	95.7%	Water consumption = brine volume	80
Liquid-liquid extraction	A more stable and efficient extraction system is proposed	Real brine from West Taijinar	NR	96.7%	18.17	0	0.39	0.002	96.7	Water consumption = 0.25 brine volume	81
Liquid-liquid extraction	A novel application of HBTA-TOPO-kerosene extraction system is proposed	Real, from lithium carbonate precipitation	NR	96%	0	0	7.98	0.008	96%	Water consumption = 0.9 brine volume	82
Liquid-liquid extraction	A novel ternary synergistic solvent extraction system is proposed	Single or Binary mixture	NR	48.4%	NR	NR	NR	NR	48.4%	Water consumption = 0.08 brine volume	83
Liquid-liquid extraction	A novel fluoride-free ionic liquid is synthesized and used as co-extractant	Simulated	10	99.2% after 5 stages of a cross flow process	NR	NR	NR	NR	99%	Water consumption = 7/24 of brine volume	84

Supplementary Table 2: Summary of reported data for selected articles in the period 2017-2022. The selection criteria for compiled articles are: it should have been published in English, in a SCOPUS listed journal, and it should include enough experimental data to plot no less than 3 of the performance indicators plotted in Figure 4.



Supplementary Figure 1: Feed solutions used for testing the proposed DLE technologies. Compilation of different performance indicators for a selection of articles in the period 2017-2022 (analysed articles are those listed in Supplementary Table 2).

Technology	**Freshwater requirements (m^3 of water per tonne of Li_2CO_3)**	**Final Li^+ concentration after DLE processing (g l^{-1})**	**Reference**
Liquid-liquid extraction	0.06	4.40	[74]
	2591	0.09	[75]
	756.5	0.30	[76]
	0.81	1.25	[85]
	29.60	20.92	[77]
	2.11	1.27	[78]
	188.62	20.00	[79]
	1.99	0.99	[80]
	0.08	1.18	[81]
	1.12	15.05	[82]
	0.18	8.25	[83]
	60.25	3.43	[86]
Ion Exchange resins	N/R	N/R	[48]
	N/R	N/R	[49]
	9.09	0.620	[87]
	32.88	0.240	[88]
	2684	0.014	[89]
	188	0.050	[50]
	7994	0.005	[90]
	226.2	0.041	[91]
	8.20	0.229	[51]
	462	0.061	[52]
	N/R	N/R	[53]
	60604	0.003	[54]
	18787	0.001	[55]
	20.35	0.277	[56]
	18.1	0.347	[57]
	2.74	0.342	[58]
	0.11	1.74	[59]
	N/R	N/R	[60]
	82.4	0.114	[61]
Ion-pumping	N/R	N/R	[10]
	229.6	0.09	[11]
	N/R	0.49	[13]
	N/R	N/R	[12]
	N/R	N/R	[14]
	4169.3	0.14	[92]
	90.3	0.21	[93]
	41.4	13.8	[15]
	757.5	0.06	[16]
	2119.8	0.19	[17]
	N/R	N/R	[94]
	N/R	0.16	[18]
	N/R	N/R	[95]
	N/R	N/R	[96]
	857.7	0.05	[97]
	773.5	0.24	[98]
	N/R	1.32	[99]
	137.7	0.07	[100]

Supplementary Table 3: Volume of freshwater spent per ton of lithium carbonate produced, and final lithium concentration achieved for selected articles in the period 2016-2023. The numbers listed in the table were in many cases calculated from reported data in the corresponding data, and is not directly given by the original authors of the articles. NR: not reported, or not enough experimental data reported to perform calculation.

Solubility	**$CaSO_4$**	**Na_2CO_3**	**$NaHCO_3$**	**$MgCO_3$**	**K_2CO_3**	**Li_2CO_3**	**$CaCO_3$**	**NaOH**	**$Mg(OH)_2$**	**KOH**	**LiOH**	**$Ca(OH)_2$**	**$Ca(BO_2)_2$**	**$Na_2B_4O_7$**
g_{salt}/kg_{water}	2.05	307	103	1.8	1110	13.0	0.0066	1000	0.0069	1210	125	1.6	1.3	31.7
Molal	0.02	2.90	1.23		8.04	0.18		25.0		21.61	5.22			
K_{SP}				$6.82x10^{-6}$			$3.36x10^{-9}$		$5.61x10^{-12}$			$5.02x10^{-6}$		

Supplementary Table 4: Solubility values in pure water at 25°C for compounds that could potentially crystallize during brine processing. First and second rows in units of g_{salt} kg_{water}^{-1} and molal, respectively. For compounds with low solubility values, the K_{SP} value is listed instead of solubility value in molal units. Values taken from reference 1.

Solubility	**NaCl**	**$MgCl_2$**	**KCl**	**LiCl**	**$CaCl_2$**	**Na_2SO_4**	**$MgSO_4$**	**K_2SO_4**	**Li_2SO_4**
g_{salt}/kg_{water}	360	560	355	845	813	281	357	120	342
Molal	6.15	5.88	4.77	19.9	7.32	1.98	2.97	0.69	3.11

Supplementary Table 4 (CONTINUATION).

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THIS REFERENCE NUMBERS ARE NOT THE SAME AS IN THE MAIN MANUSCRIPT

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