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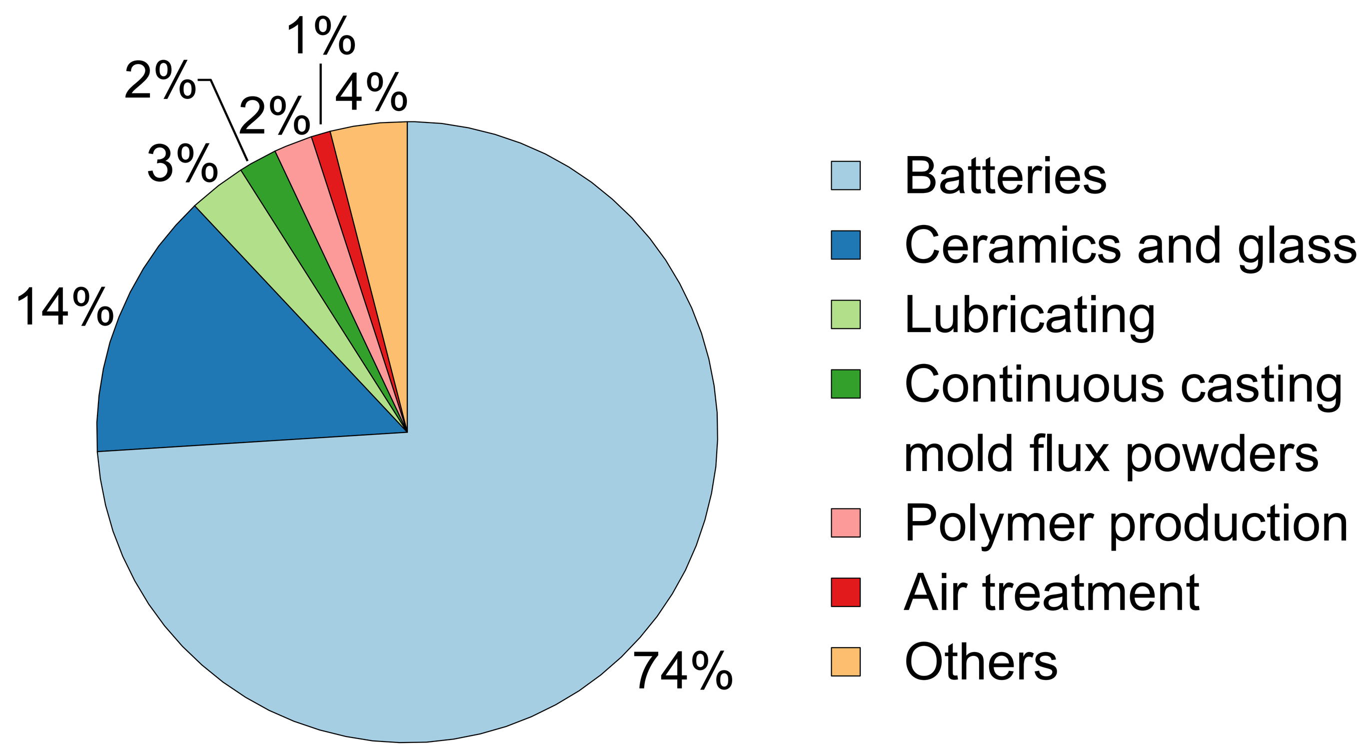
Conversion of lithium chloride into battery-grade lithium hydroxide by solvent extraction

Global lithium end-use 2021 (USGS)



Lithium-ion batteries

Rise in LiOH demand for production in the Li-ion battery industry vs. Li_2CO_3

➔ Shift in ratios of Ni-Mn-Co in NCM cathodes: 6-2-2 & 8-1-1

Aim: Higher battery capacity

Li_2CO_3: Higher nickel content = Higher synthesis T

➔ damages crystal structure + changes oxidation state Ni

⬍

LiOH: Rapid + complete synthesis at lower T

Increase in performance + lifespan

A cost-effective, environmentally friendly process for direct transformation of LiCl into $LiOH{\cdot}H_2O$, bypassing the Li_2CO_3 intermediate

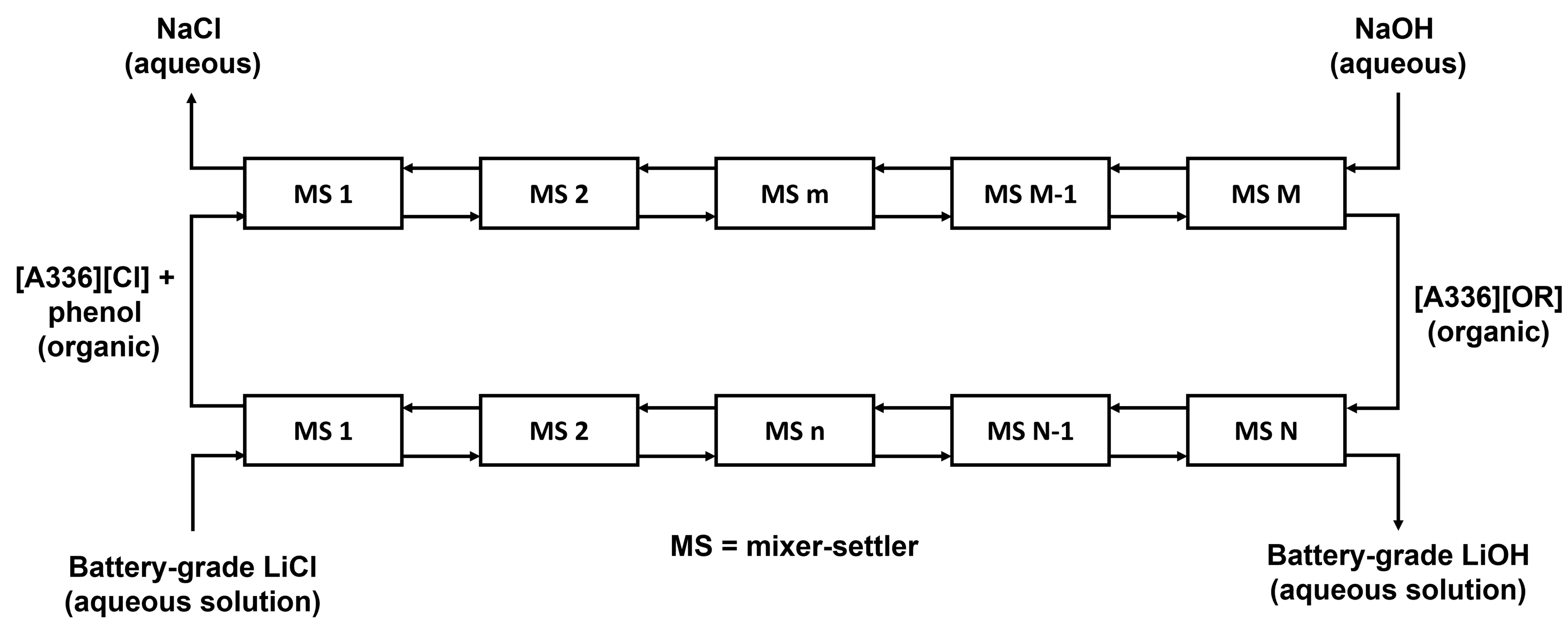
Parameters investigated

- Alcohol vs. phenol
- Aliquat 336 vs. Cyphos IL 101
- NaOH vs. NH_3
- Diluent
- Concentrations
- Volume phase ratio

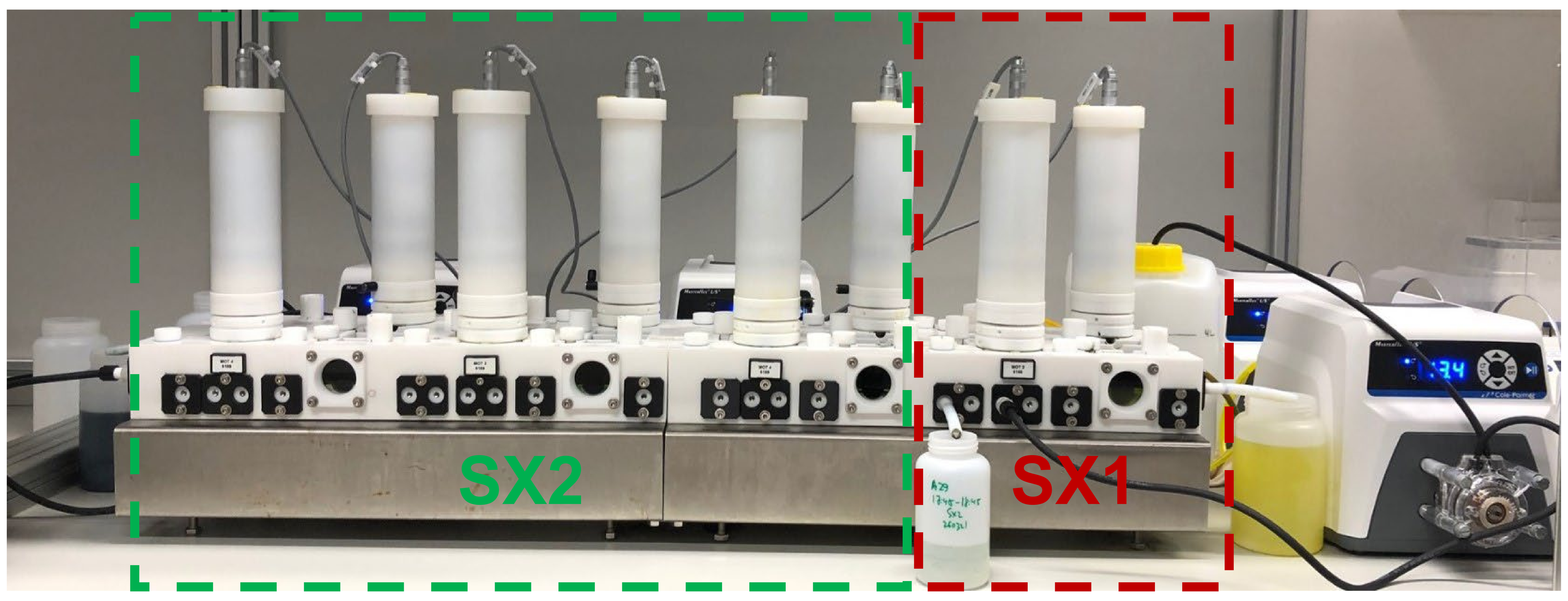
Alcohols/phenols	%*E*-Total Diluent: GS190	%*E*-Total Diluent: D70
1-pentanol	16.8 ± 0.9	16.8 ± 0.2
2-pentanol	11.7 ± 0.1	11.9 ± 0.2
3-pentanol	10.7 ± 0.1	11.1 ± 0.3
1-penten-3-ol	15.7 ± 0.3	16.0 ± 0.8
3-methyl-3-pentanol	6.3 ± 0.4	8.9 ± 0.2
2,4-dimethyl-3-pentanol	4.8 ± 0.2	9.4 ± 0.9
1-hexanol	11.5 ± 0.1	16.4 ± 1.3
2-ethyl-1-hexanol	14.2 ± 0.1	13.7 ± 1.2
1-octanol	15.1 ± 1.9	17.5 ± 1.3
1-decanol	14.1 ± 0.7	15.9 ± 0.8
2-ethyl-1,3-hexanediol	11.1 ± 0.8	9.2 ± 0.5
2-methyl-2,4-pentanediol	10.4 ± 0.4	9.8 ± 0.4
p-cresol	24.4 ± 0.2	32.7 ± 1.75
2,6-di-tert-butylphenol	**59.7 ± 0.4**	**78.0 ± 1.4**
2,4,6-trimethylphenol	22.4 ± 0.8	24.3 ± 0.9
2,6-dimethylphenol	16.6 ± 0.9	18.5 ± 0.8

SX1: 10 M NaOH (aq), [A336][Cl] + 2,6-di-tert-butylphenol (molar ratio = 1:1) (org)
SX2: 0.25 M LiCl (aq), [A336][OR] (org)

Schematic representation of the conversion of an aqueous LiCl solution into a LiOH solution with two solvent extraction steps, SX1 at the top and SX2 at the bottom



Mixer-settler experiments



SX1: O/A = 1/2, 2.0 M NaOH (aq), 0.65 M [A336][Cl] + 2,6-di-tert-butylphenol (molar ratio = 1:1) in Shellsol D70 (org)
SX2: O/A = 3/1, 1.64 M LiCl (aq), 0.58 M [A336][OR] in Shellsol D70 (org)

➔ %*E* SX1 = 87.1% [A336][OR], %*E* SX2 = 98.5% LiOH

- LiCl can be efficiently converted into a solution of LiOH by a two-step solvent extraction process
- The developed process was upscaled using a small battery of mixer settlers
- No waste is produced, with the exception of NaCl (aq).
- LiOH can be obtained in high purity and high yield by antisolvent precipitation with isopropanol

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