

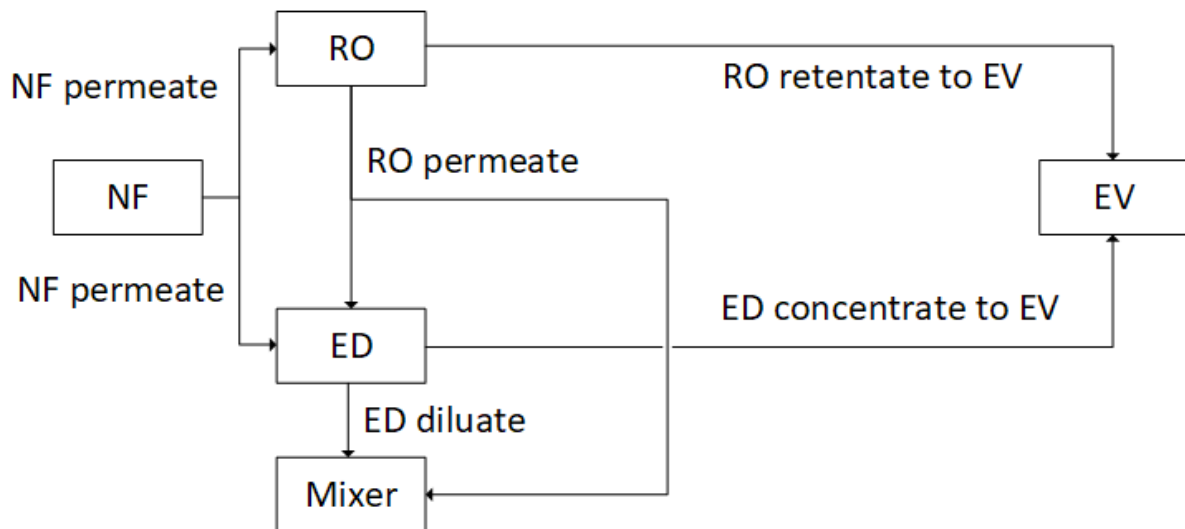
LITHIUM PURIFICATION USING ELECTRODIALYSIS AND ELECTRODIALYSIS METATHESIS

Possible applications

1. **Primary mining**
 - Brines like LiCl (Chile, Argentina, etc.)
 - Minerals like spodumene Li_2SO_4 (Australia, etc.)
2. **Recovery from batteries**
 - Car batteries (electromobility)
 - Energy storage devices
 - Mobile phones

Electrodialysis possibilities for LiCl

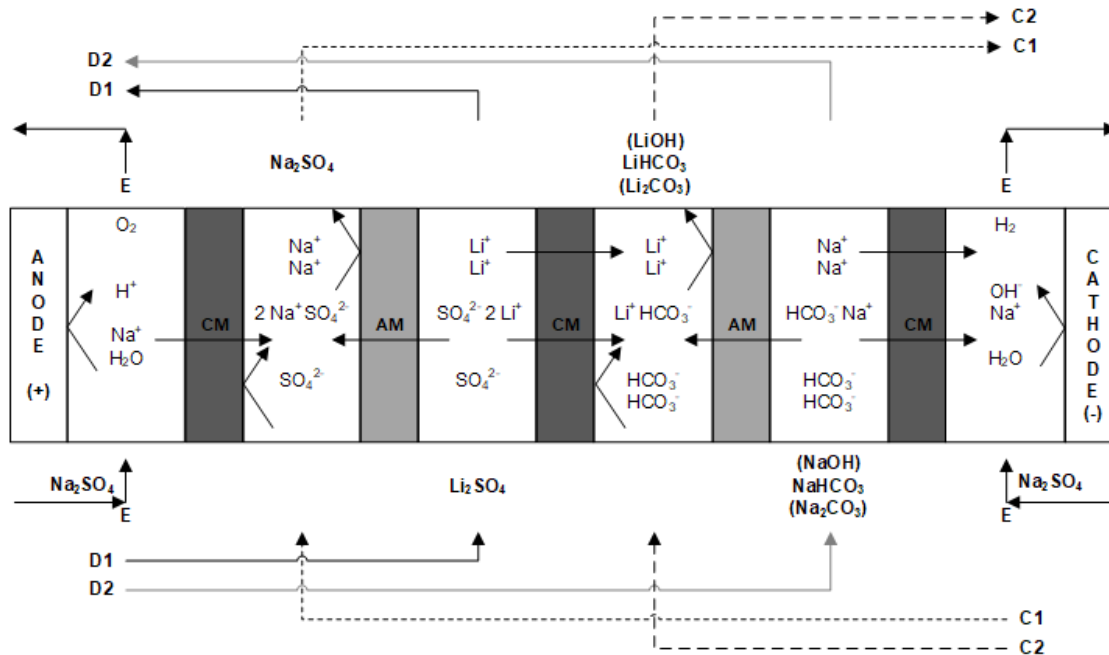
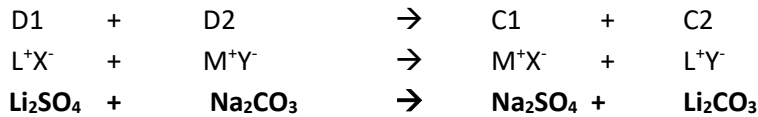
- Separation and concentration of NaCl and LiCl mixture from feed solution containing trace sulfate, hardness ions, **silica and boron (more than 97 % of both remains in diluate)**
- The pH plays a vital role in NF setup



- **Partial concentration by RO and ED**
- Maximum LiCl concentration is 8 % w/v
- Silica and Boron retention is > 97 % using electrodialysis
- Concentration factor: RO = 4x, ED = 8x
- Optimal block flow diagram: NF → RO + ED → EV →

Electrodialysis metathesis possibilities for Li_2SO_4

- Electrodialysis can act as **double replacement reaction** system in special configuration:



- Patented technology**
- MemBrain technical solution in step 1:**

$$\text{Li}_2\text{SO}_4 + 2 \text{NaHCO}_3 \rightarrow \text{Na}_2\text{SO}_4 + 2 \text{LiHCO}_3$$
 solubility @ 35°C near 50 g/L using Electrodialysis Metathesis
 Li purity > 97.6 % Li/(Li + S)
- Technical solution in step 2:

$$2 \text{LiHCO}_3 (\text{L},\text{s}) \rightarrow \text{Li}_2\text{CO}_3 (\text{s}) + \text{CO}_2 (\text{g}) + \text{H}_2\text{O} (\text{g})$$
 Temperature = 60 – 95 °C, p < atmospheric
 Li purity > 99.8 % Li/(Li + S)
- Electrodialysis metathesis benefits:
 - Huge reduction of unit operation steps (technology complexity)
 - Double replacement reaction aided with membranes
 - Achieved high Li_2CO_3 purity
 - Price of production
- ED Metathesis step** estimated cost of production recalculated to lithium carbonate equivalent (LCE) is **approximately 600 EUR/Ton**
- Possibility in battery recycling:**

$$\text{LiCl} + \text{NaHCO}_3 \rightarrow \text{NaCl} + \text{LiHCO}_3$$

$$\text{LiNO}_3 + \text{NaHCO}_3 \rightarrow \text{NaNO}_3 + \text{LiHCO}_3$$