THE PRODUCTION OF HIGH PURITY BATTERY GRADE LITHIUM CARBONATE PRODUCT FROM LITHIUM BRINE SOURCES

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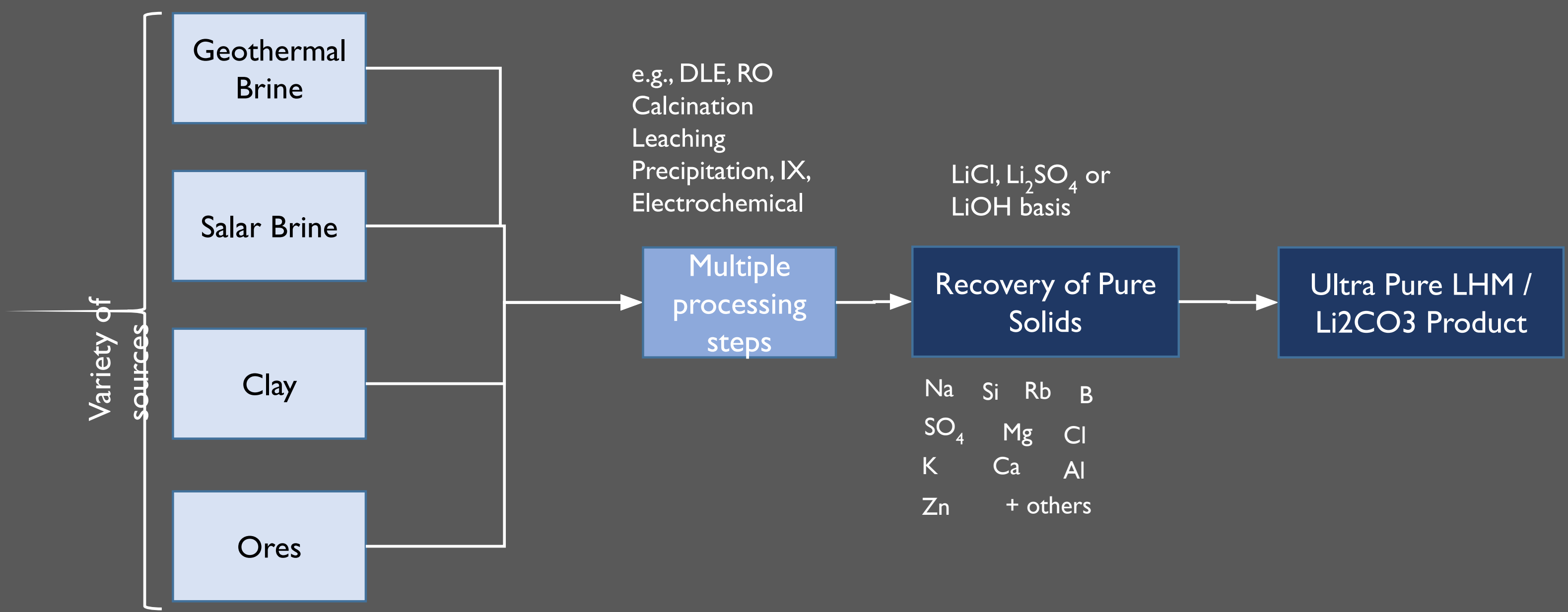
Li Sources



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Design Approach

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- PURITY - Free from impurities
- SUSTAINABILITY – Heat integration and water recovery
- VALUE – Delivery, schedule, costs

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Design Objectives

- Maximise purity
- Maximise yield
- Minimise CAPEX and OPEX costs
- Ease of operation with robust design

- Simulation using thermodynamic software
- Mass & energy balances
- Test work
- Flowsheet optimisation
- Equipment design

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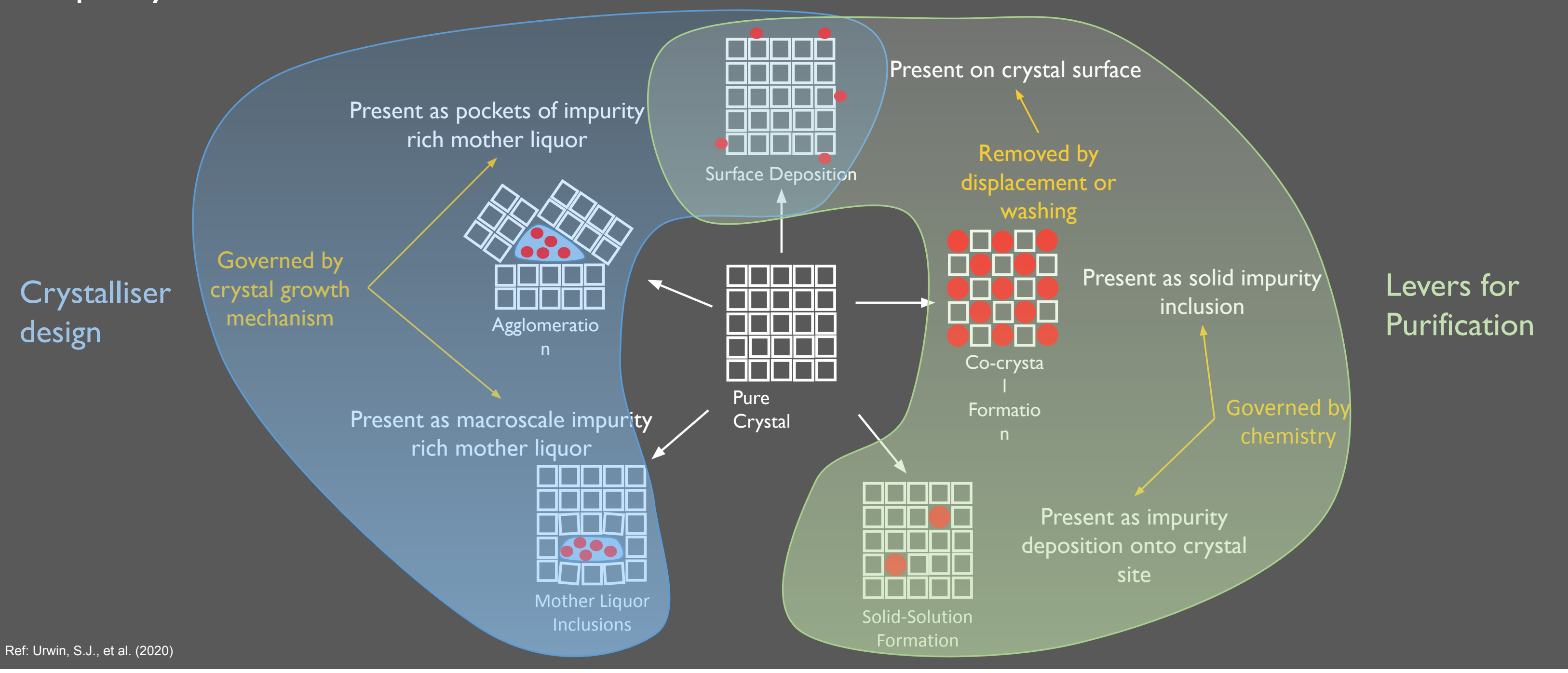
Impurity Entrainment



Ref: Urwin, S.J., et al. (2020)

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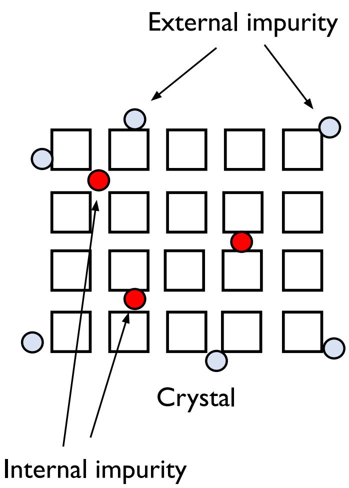
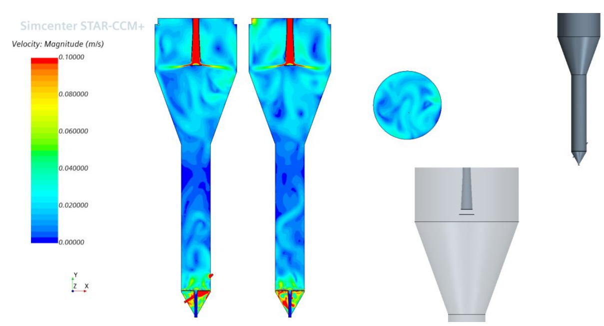
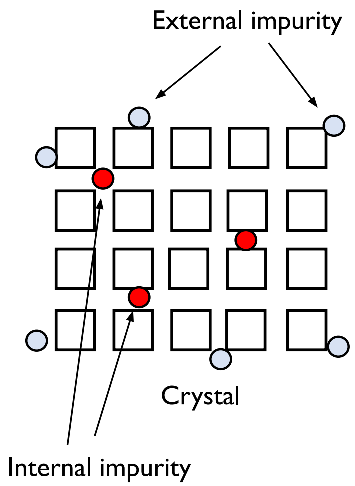
Levers for Purification



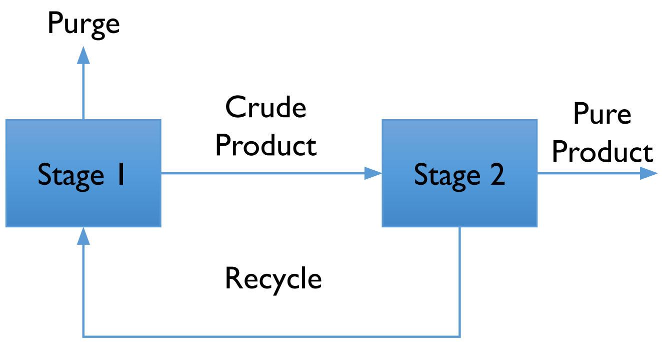
- **<u>Centrifugation</u>** displaces surface depositions by washing and ML removal.
- **<u>Wash legs</u>** reduce surface depositions by partly displacing high impurity ML with feed. (LHM only)



Levers for Purification



- **Staged crystallisation** reduces ML impurity fingerprint profile.
- **Purge/Recycle rates** reduce ML impurity fingerprint profile.



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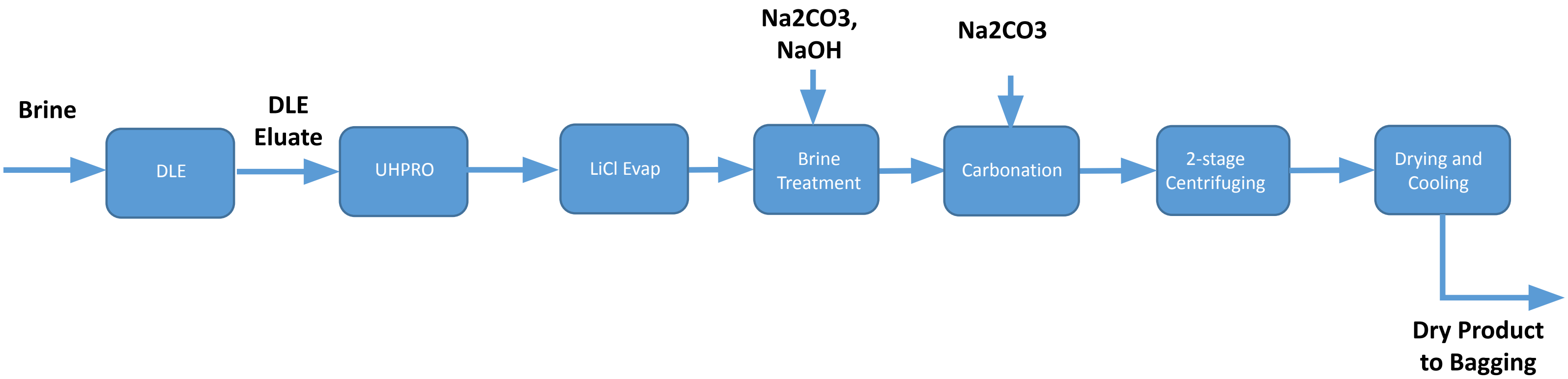
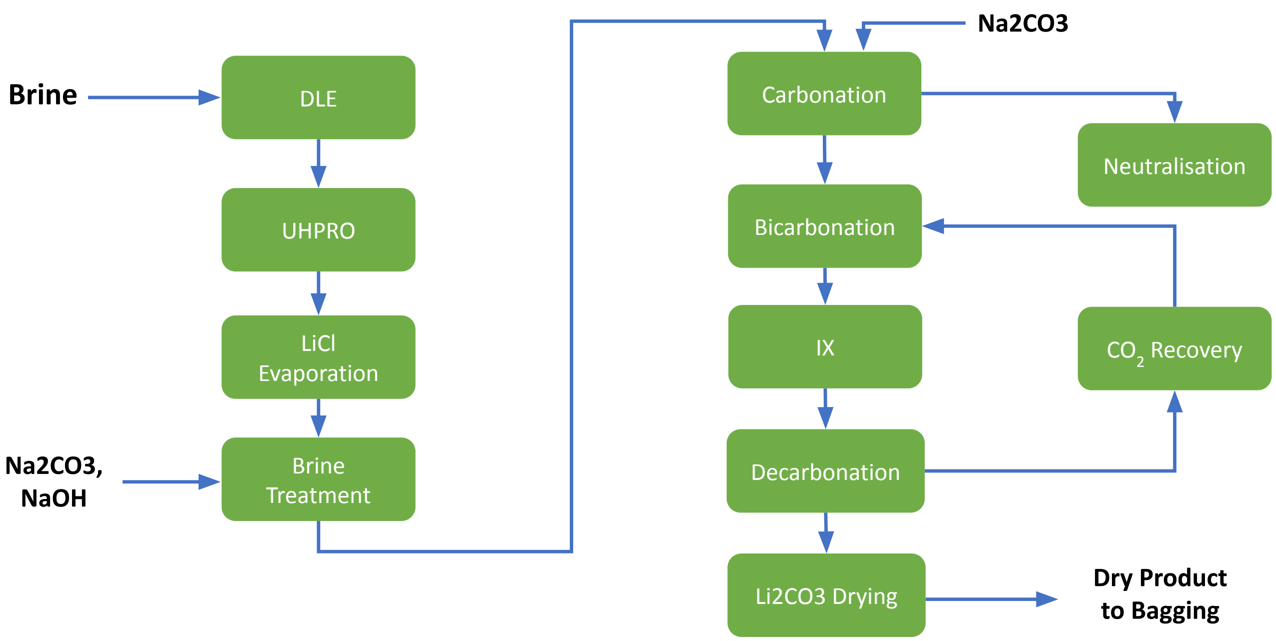
Flow sheet and Design Considerations



Brine
DLE
DLE Eluate
UHPRO
LiCl Evap
Na2CO3, NaOH
Brine Treatment
Na2CO3
Carbonation
2-stage Centrifuging
Drying and Cooling
Dry Product to Bagging



Brine
DLE
UHPRO
LiCl Evaporation
Na2CO3, NaOH
Brine Treatment
Na2CO3
Carbonation
Neutralisation
Bicarbonation
IX
CO_2 Recovery
Decarbonation
Li2CO3 Drying
Dry Product to Bagging

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Lithium Chloride Evaporation

- Falling film evaporator to pre-concentrate LiCl brine before the carbonation step
- 2 or 3 stage MVR fans required depending upon the BPE
- Concentration up to 25 g/L Li or 40 g/L depending upon the process requirements

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Lithium Chloride Carbonation Reactor

$$2LiCl + Na_2CO_3 \longrightarrow Li_2CO_3 + 2NaCl$$

- Intense mixing zone of lithium chloride with bulk solution
- Separate sodium carbonation inlet to provide a slight excess
- Agitator provides homogenous mixing in reactor zone for dissipation of supersaturation and growth of crystals
- Gentle mixing to minimise crystal breakage

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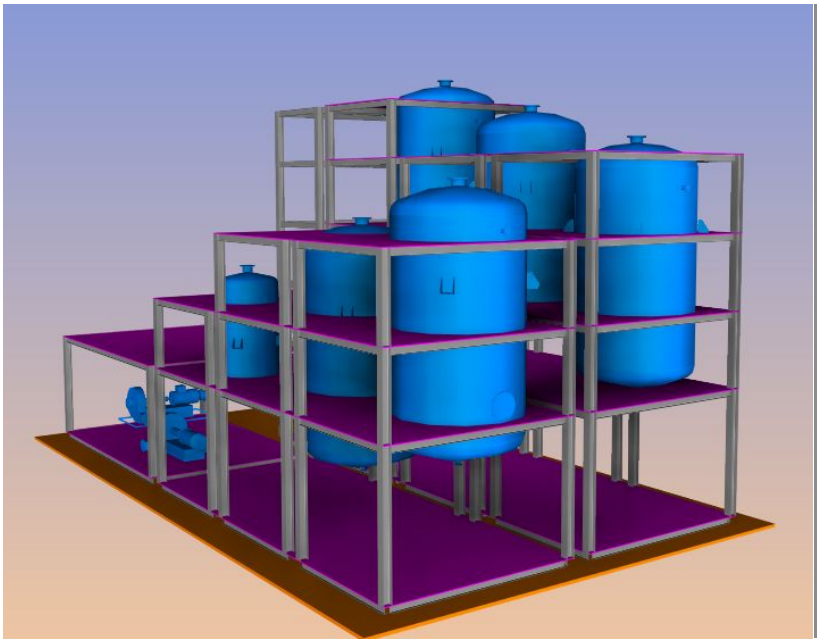

Lithium Carbonate Dissolution (Bicarbonation)

$$Li_2CO_{3\,(s)} + CO_{2(g)} + H_2O_{(l)} \rightarrow 2LiHCO_{3(aq)}$$

- Bicarbonation reactors used for re-dissolution of the crude lithium carbonate into lithium bicarbonate in a series of reactors
- Intense mixing to disperse CO_2 and encourage mass transfer and dissolution of carbonate

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Impurity Removal

- Divalent IX system to remove Ca and Mg impurities before recrystallising Li2CO3
- Regeneration with HCl and NaOH
- Merry-go-round configuration (lead-lag)

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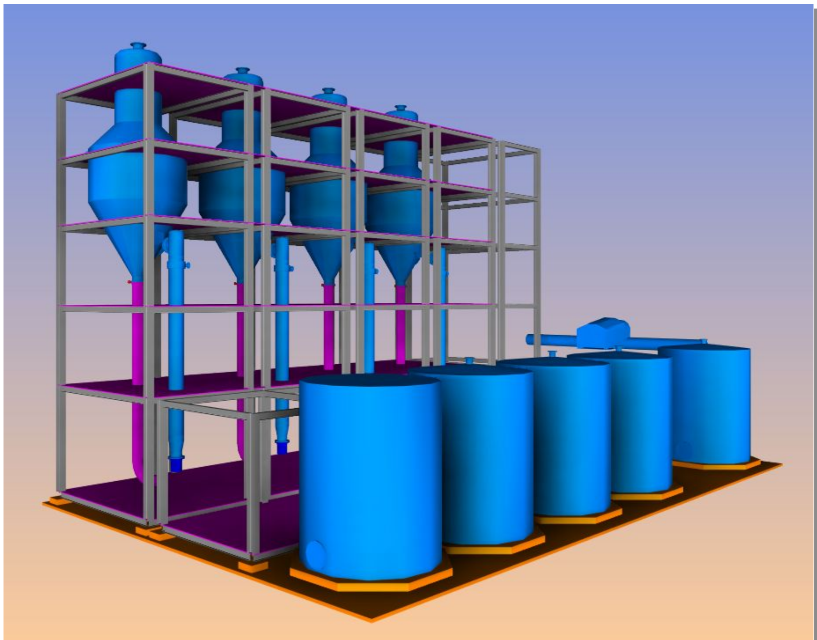

Lithium Carbonate Recrystallisation (Decarbonation)

$2LiHCO_{3(aq)} \text{ ---> } Li_2CO_{3(s)} + H_2O_{(aq)} + CO_{2(g)}$

- FC crystalliser design with vertical heater for heat input (Steam)
- Homogenous mixing with slow speed axial flow pump
- Dispersion of bicarbonate feed with high dilution in slurry to reduce the effect of supersaturation on crystal growth.

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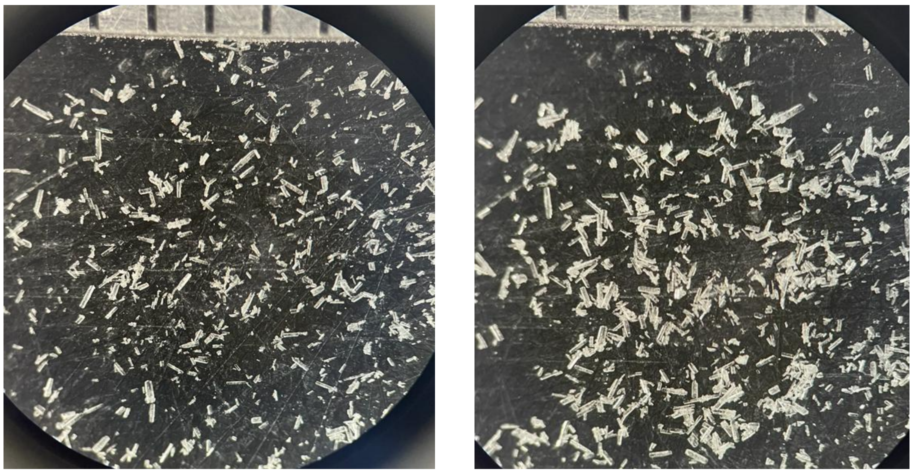
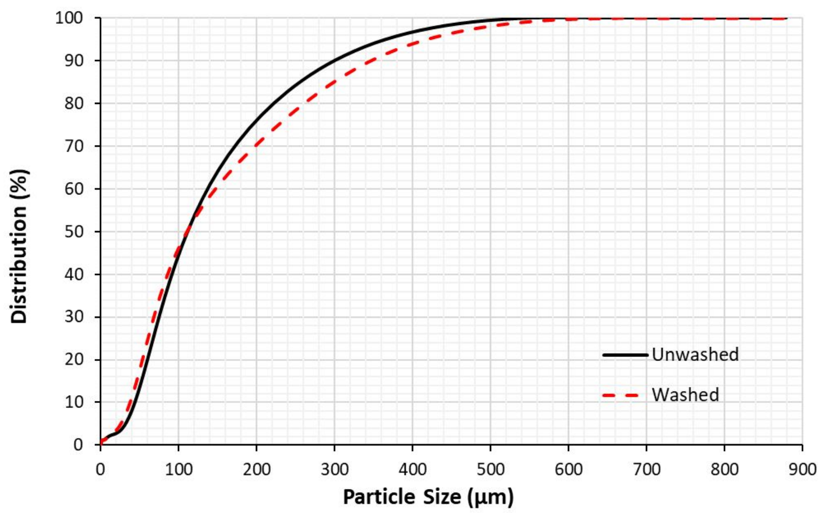
Crystals of Lithium Carbonate produced by JordProxa



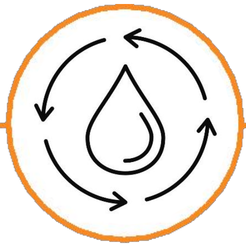
Scale divisions = 1mm

Crystal size distribution for Lithium Carbonate

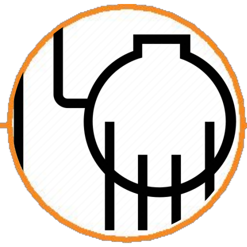


Flowsheet Optimisation

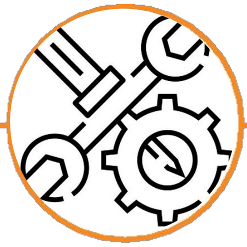
Heat Recovery & Integration



Water Recovery & Management



Utilities & Reagent



Maintenance & Cleaning

Conclusions

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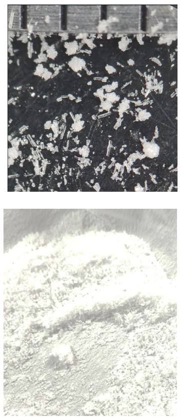
CONCLUSIONS

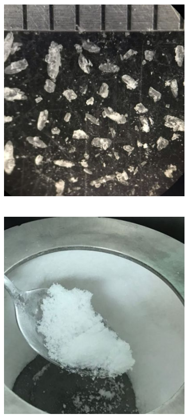
- Crystallisation is a key step in the processing of battery materials such as lithium carbonate to achieve the desired product purity.
- A carefully designed crystalliser can produce crystals large enough for effective dewatering and washing.
- Battery grade lithium carbonate can be produced by either repulping and centrifuging crude Li_2CO_3, or through bicarbonaton and decarbonation steps, depending upon the brine chemistry.
- Impurity removal steps are critical to produce the battery grade product.

Expertise in Battery Chemicals

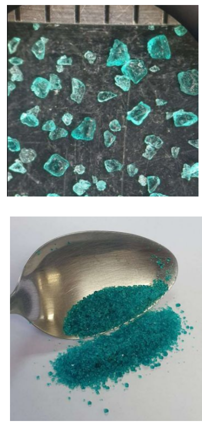
Li_2CO_3



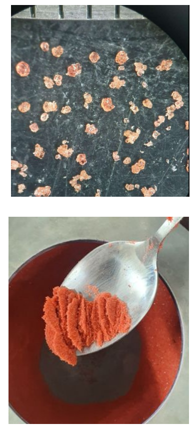
$LiOH.H_2O$



$NiSO_4.6H_2O$



$CoSO_4.7H_2O$



$MnSO_4.H_2O$

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Thank you.