

Challenges and Technologies for Production of Lithium Carbonate from Ores to attend the EV Market

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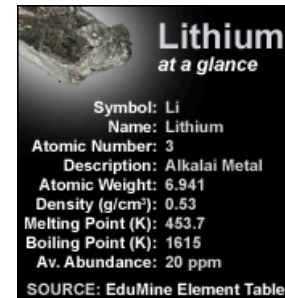
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Introduction – Lithium industry in Brazil

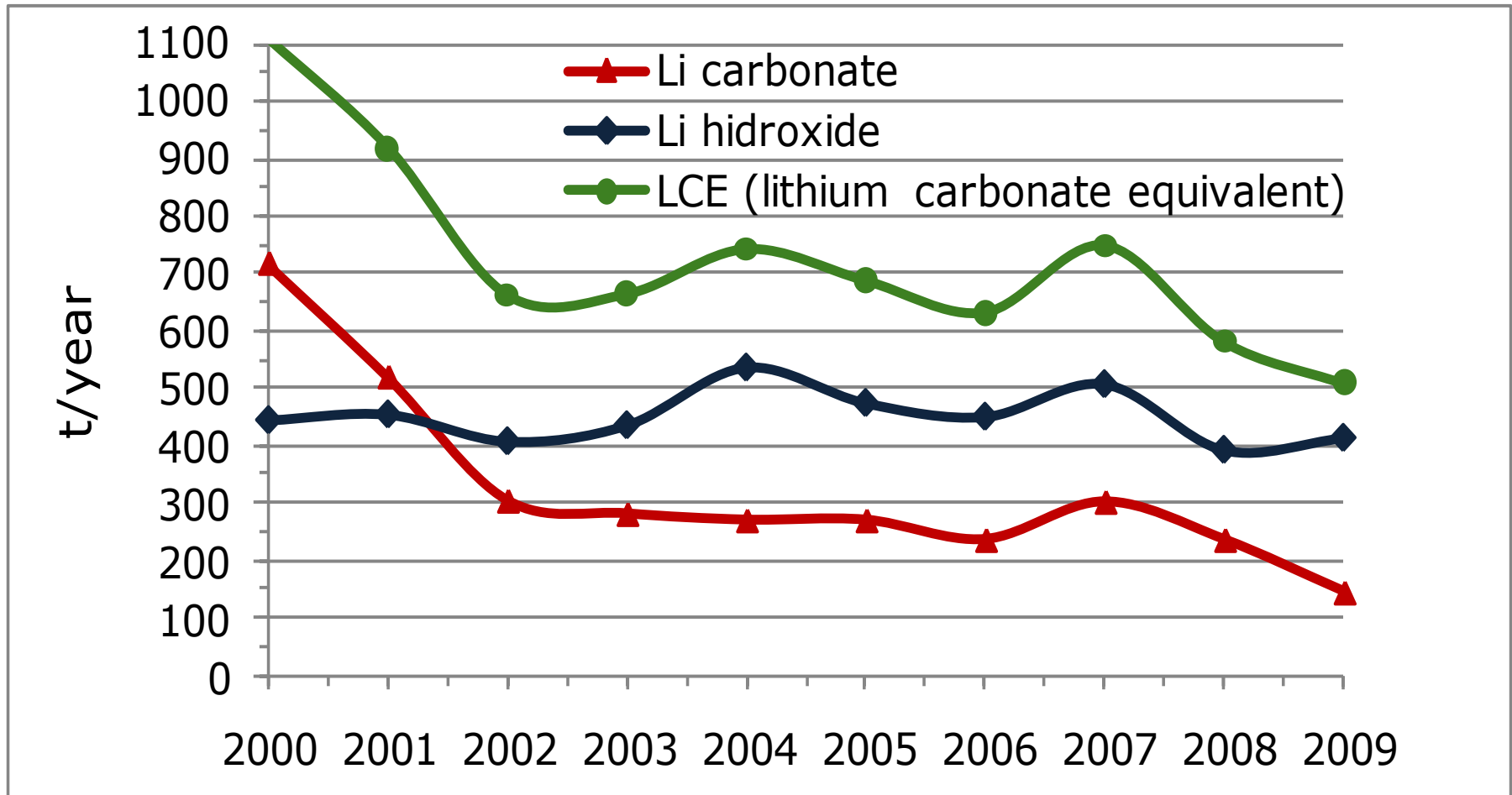


Lithium
at a glance

Symbol: Li
Name: Lithium
Atomic Number: 3
Description: Alkali Metal
Atomic Weight: 6.941
Density (g/cm³): 0.53
Melting Point (K): 453.7
Boiling Point (K): 1615
Av. Abundance: 20 ppm
SOURCE: EduMine Element Table

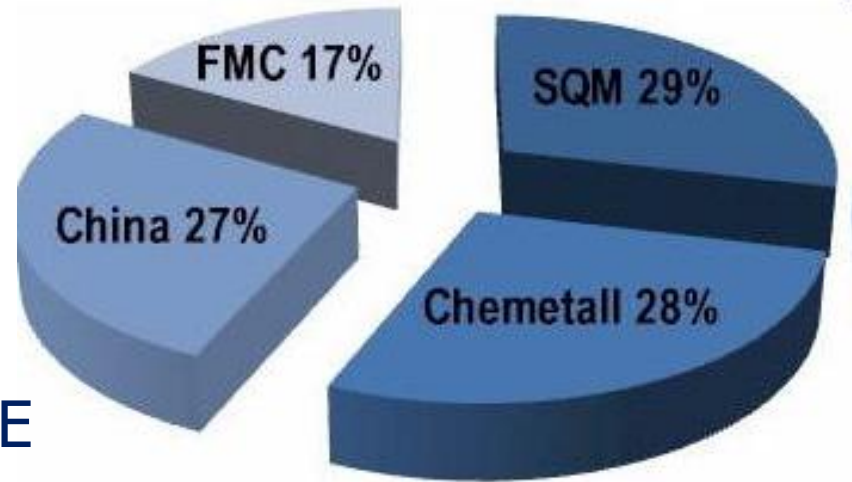
- The lithium industrialization in Brazil started in the 1970's, by using petalite, leipolite and spodumene in the ceramic industry;
- 1970's – Nuclemon (Government company) started the production of lithium salts from amblignonite ore (120 t/year); the imports were around 250 t/year.
- 1980's – Domestic production: 30 t/year X Imports: 500 t/year;
 - ore supply (low quality and regularity)
 - environmental problems (downtown, São Paulo)
 - 1987 – Nuclemon operation was over
- 1990's - CBL was established
 - raw material availability (spodumene)
 - growing market
 - 1,000 t/year capacity

Brazilian Market - Domestic Production



Source: DNPM, 2000-2010 (Brazil)

World Scenario: Bid



Production (2010) ~110,000 t LCE

| Mean producers | Country | Resources | Deposit | Products |
|-------------------|------------|-----------------|----------------------|---------------------------------------|
| Chemetall | Chile /USA | Brines | Atacama Salar/Nevada | Li ₂ CO ₃ /LiOH |
| FMC Lithium | Argentina | Brines | Hombre Muerto Salar | Li ₂ CO ₃ /LiOH |
| SQM | Chile | Brines | Atacama Salar | Li ₂ CO ₃ /LiOH |
| Chinese companies | China | Brines/Minerals | Diverses | Li ₂ CO ₃ /LiOH |
| Talison Minerals | Australia | Minerals | Greenbushes | Concentrates |

| DEMAND | | |
|--------|-------------------------|-----------------------|
| | LCE (10 ³ t) | Source |
| 2010 | 105/115 | Metal Bulletin |
| 2020 | 290/380 | Metal Bulletin |
| 2020 | 187 | SignumBOX |
| 2020 | 249 | TRU Group |
| 2020 | 283 | Byron Capital Markets |

Source: Ind. Minerals, apr 2011

Lithium World Reserves (t Li) (Brines & Minerals)

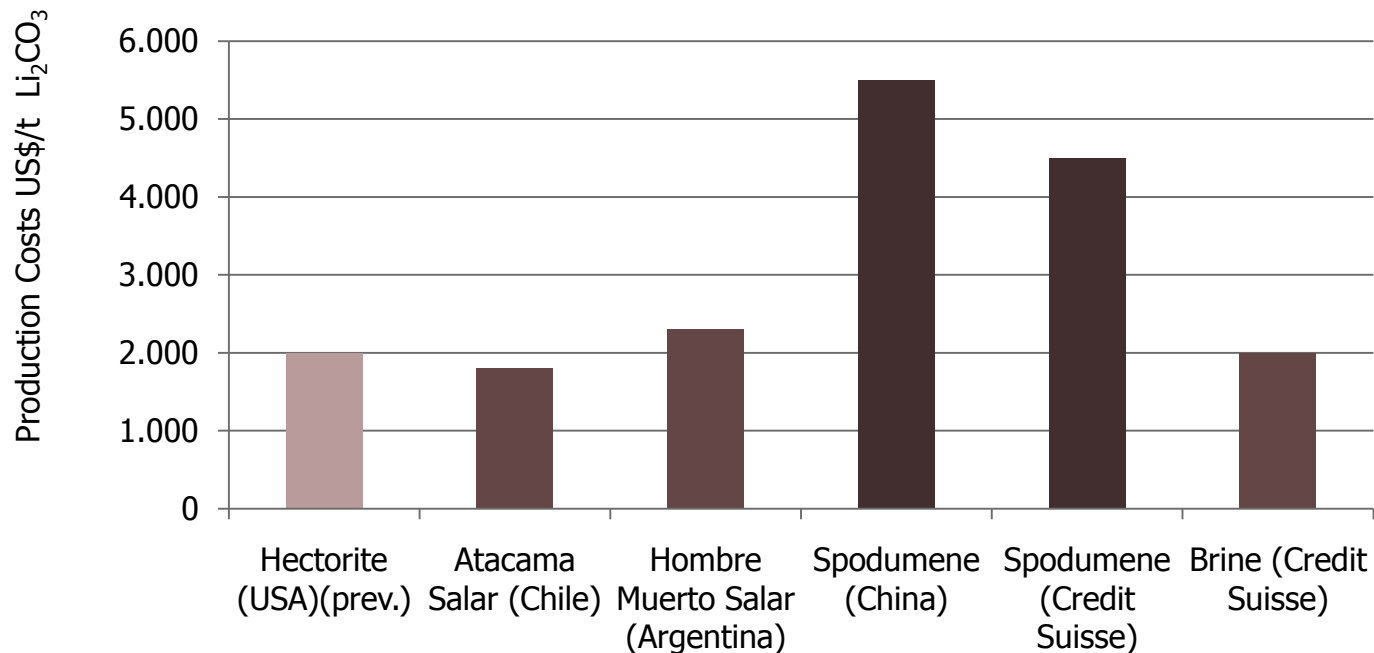
| World Reserves (t Li) | | | | | |
|------------------------------|------------------|------------------|------------------|------------------|-------------------|
| | 2006 | 2007 | 2008 | 2009 | 2010 |
| USA | 38,000 | 38,000 | 38,000 | 38,000 | 38,000 |
| Argentina | | | | 800,000 | 850,000 |
| Australia | 160,000 | 160,000 | 170,000 | 580,000 | 580,000 |
| Brazil | 190,000 | 190,000 | 190,000 | 48,000 | 64,000 |
| Canada | 180,000 | 180,000 | 180,000 | 180,000 | |
| Chile | 3,000,000 | 3,000,000 | 3,000,000 | 7,500,000 | 7,500,000 |
| China | 540,000 | 540,000 | 540,000 | 540,000 | 3,500,000 |
| Portugal | | | | | 10,000 |
| Zimbabwe | 23,000 | 23,000 | 23,000 | 23,000 | 23,000 |
| Bolivia | | | | | ????? |
| Total | 4,131,000 | 4,131,000 | 4,141,000 | 9,709,000 | 12,565,000 |

???? = the same as the world reserve (~12,5 Mt)

Source: USGS, MCS, 2007/2011

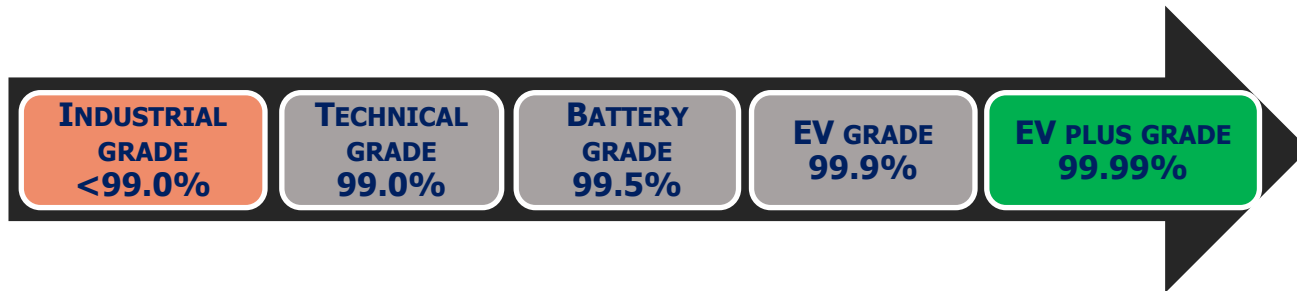
World scenario: Prices & Production Costs

✓ Lithium carbonate (price): 5.0-5.3 US\$/kg (industrial grade)



World scenario: Prices & Production Costs

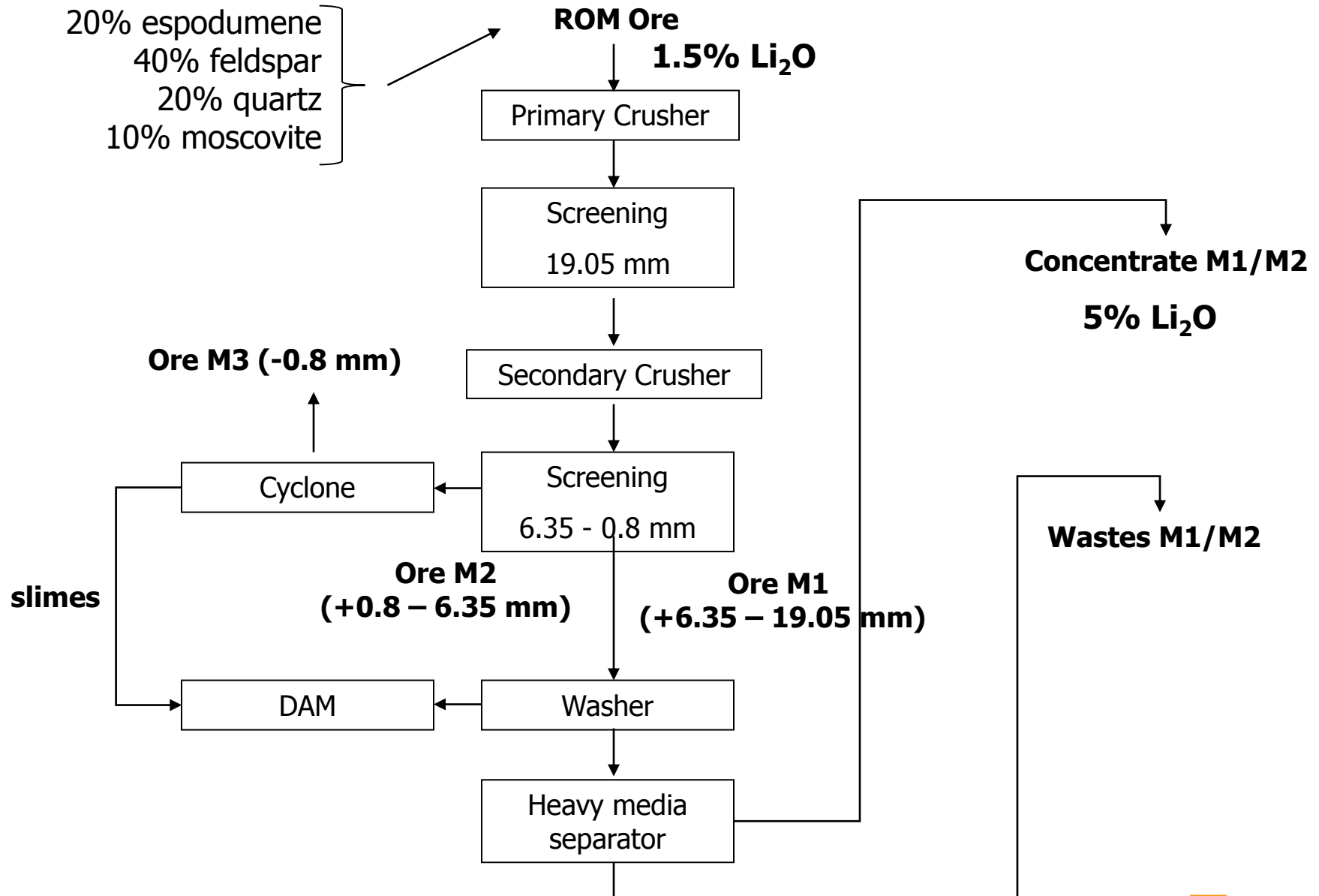
- ✓ Lithium carbonate (price): 5.0-5.3 US\$/kg
- ✓ Spodumene concentrate (>7.25% Li₂O): 720-770 US\$/t
- ✓ Spodumene – glass grade (5% Li₂O): 460-510 US\$/t



- ✓ Minerals:
 - ✓ Low contaminant grade: Mg, Cl⁻, SO₄²⁻

Production & Technologies

Beneficiation Process (CBL)



Acidic Process Spodumene/Lithium carbonate

✓ Lithium carbonate (1 t):

9 t ore (5.4% Li₂O);

2 t H₂SO₄;

0.1 t Ca(OH)₂;

0.8 t Na₂CO₃.



✓ Lithium hydroxide (1 t):

0.9 t Li₂CO₃;

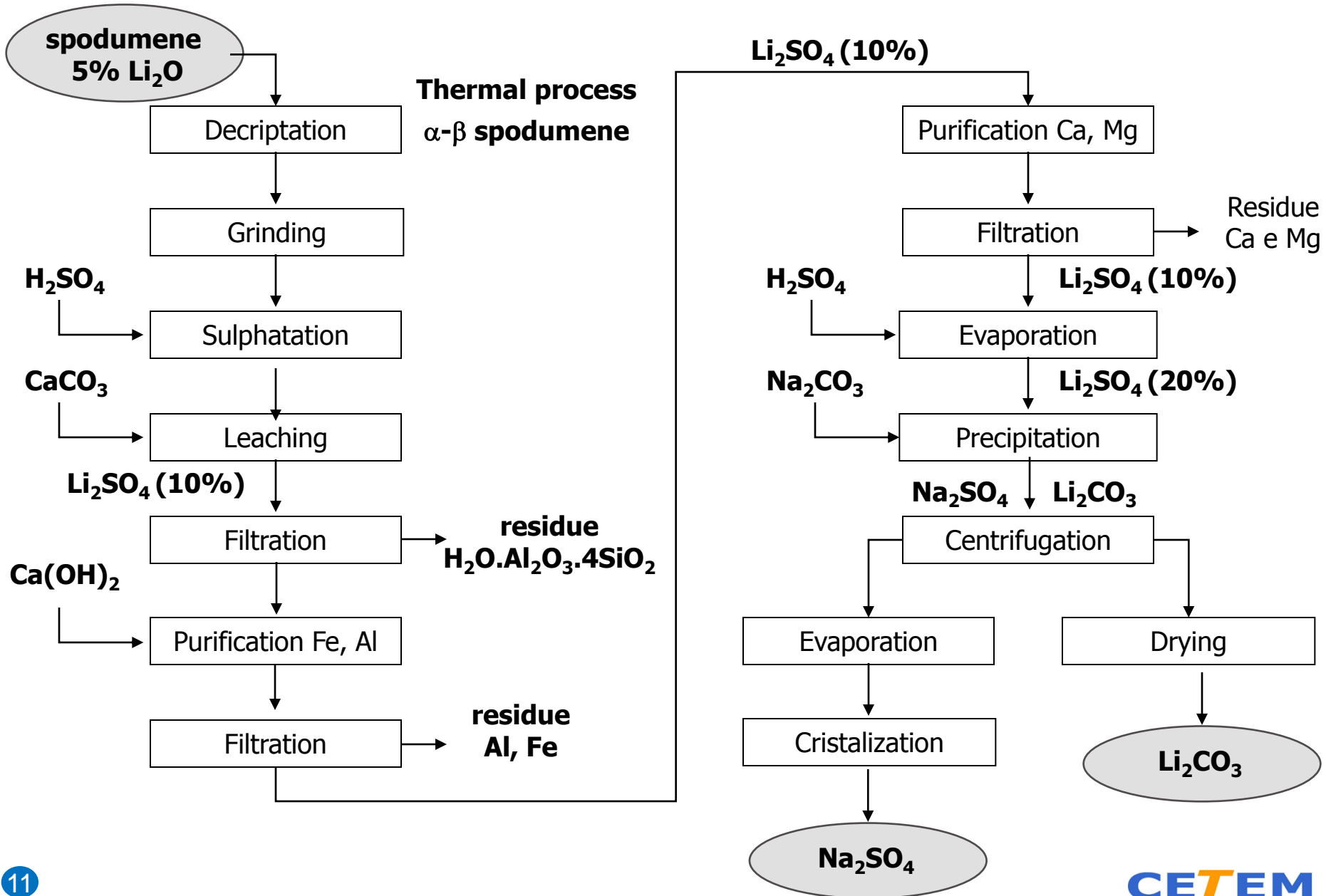
1.1 t Ca(OH)₂.



Chemical Reactions:



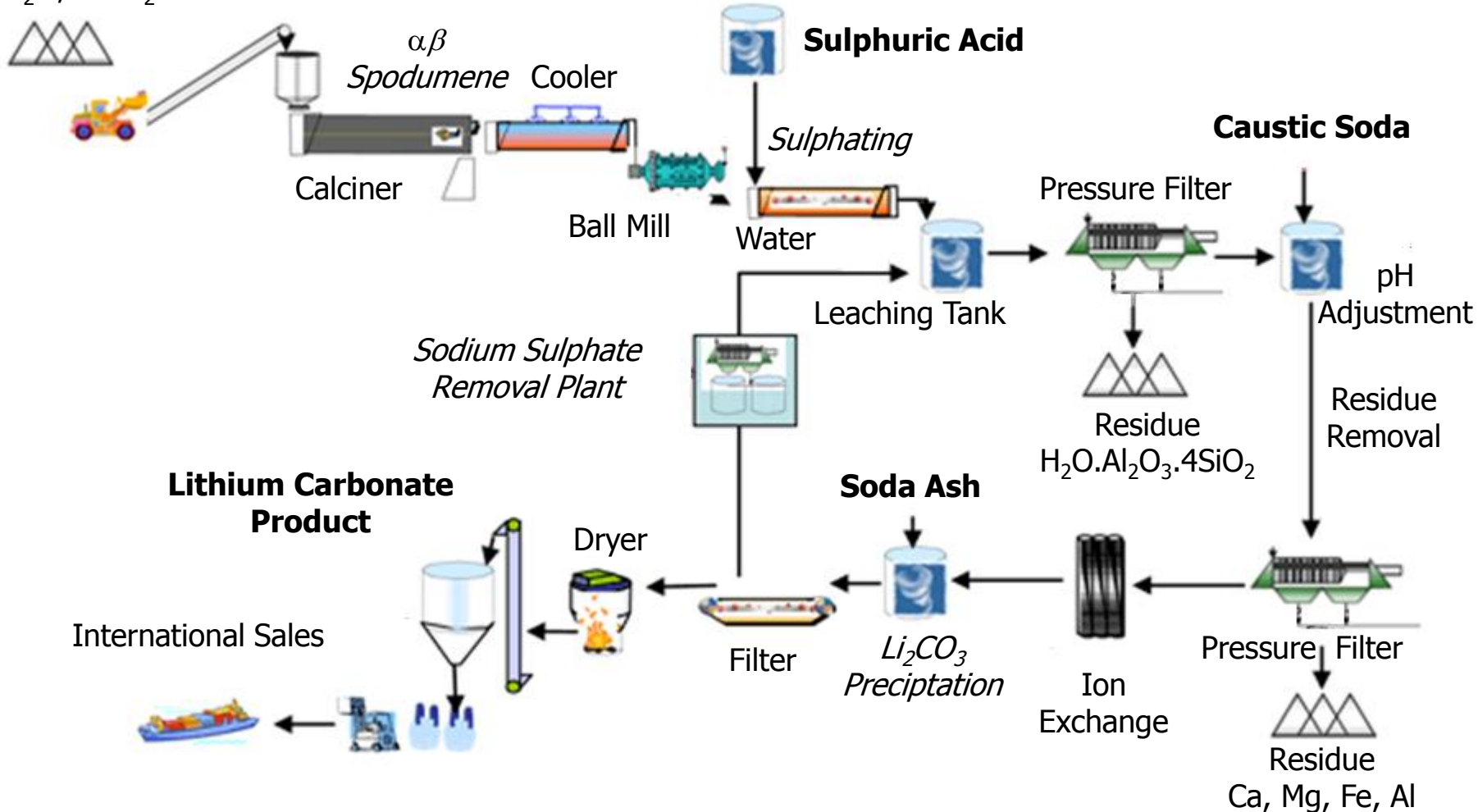
Acidic Process – Spodumene/Lithium carbonate



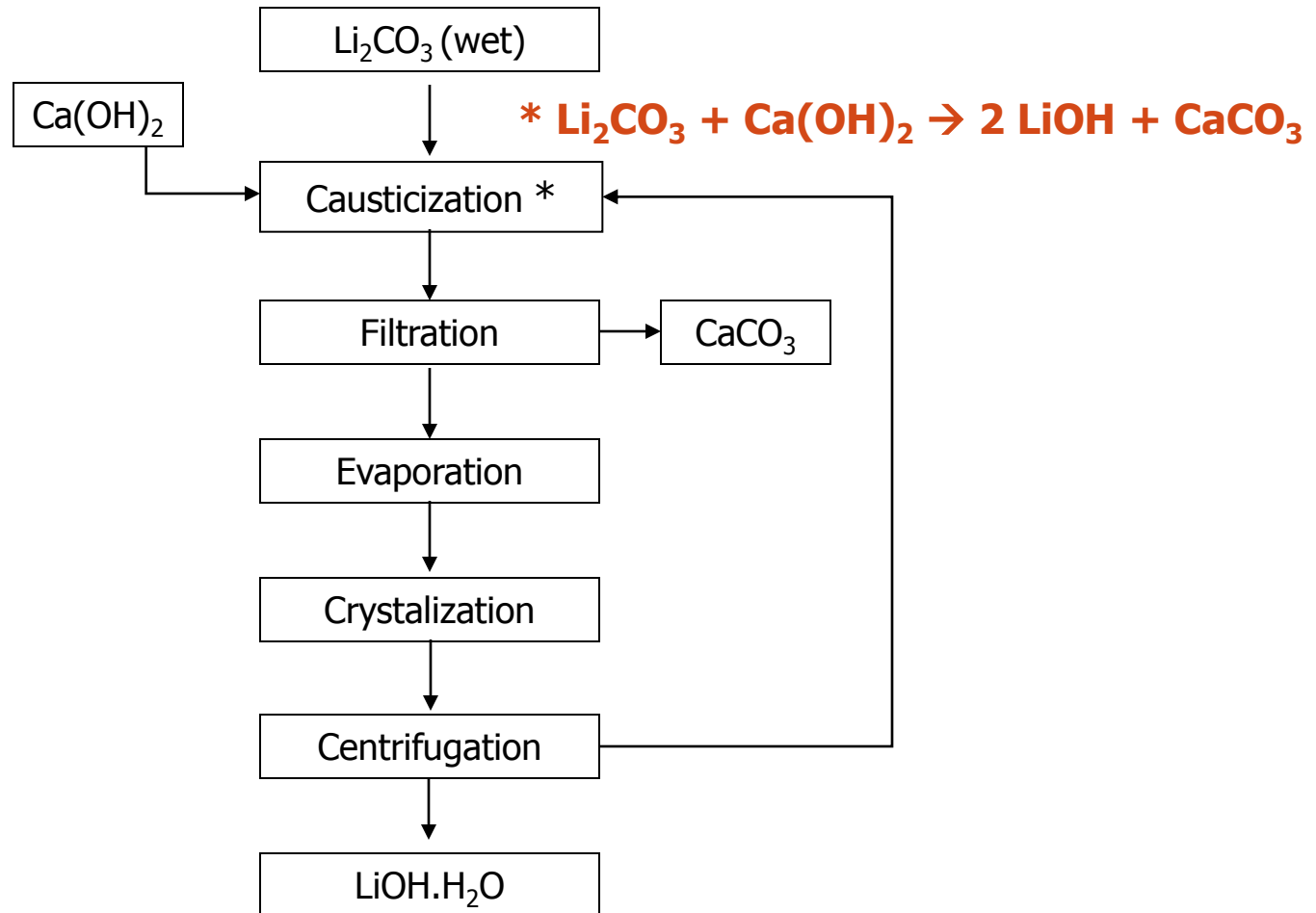
Jiangsu Lithium carbonate plant (Galaxy & China)

17,000 t/y Li_2CO_3 battery grade

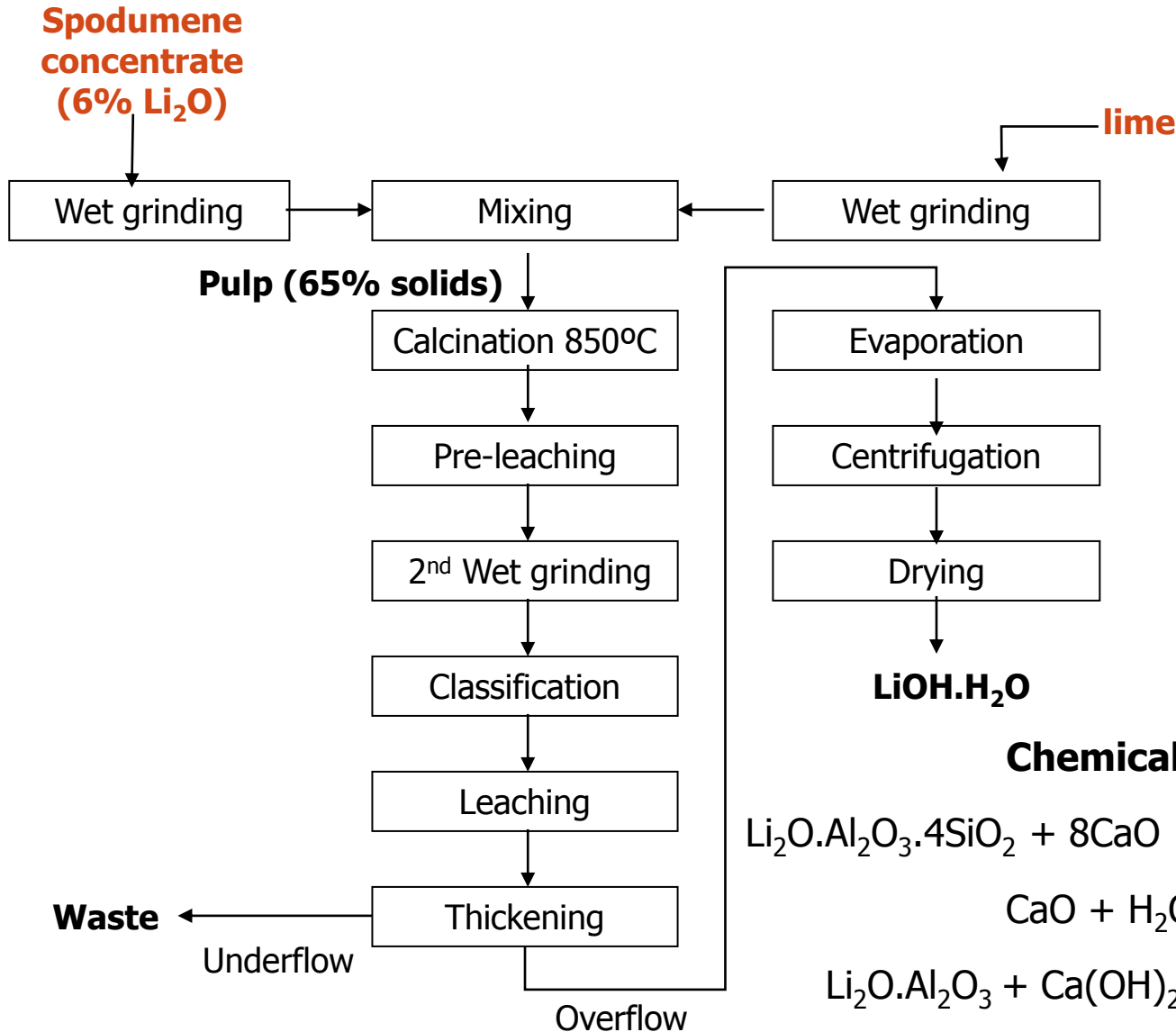
Spodumene
6% Li_2O ; 5% H_2O



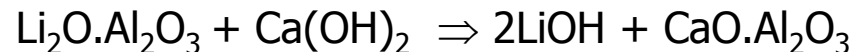
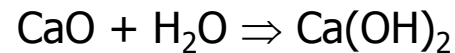
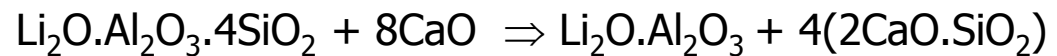
Lithium Hydroxide Production



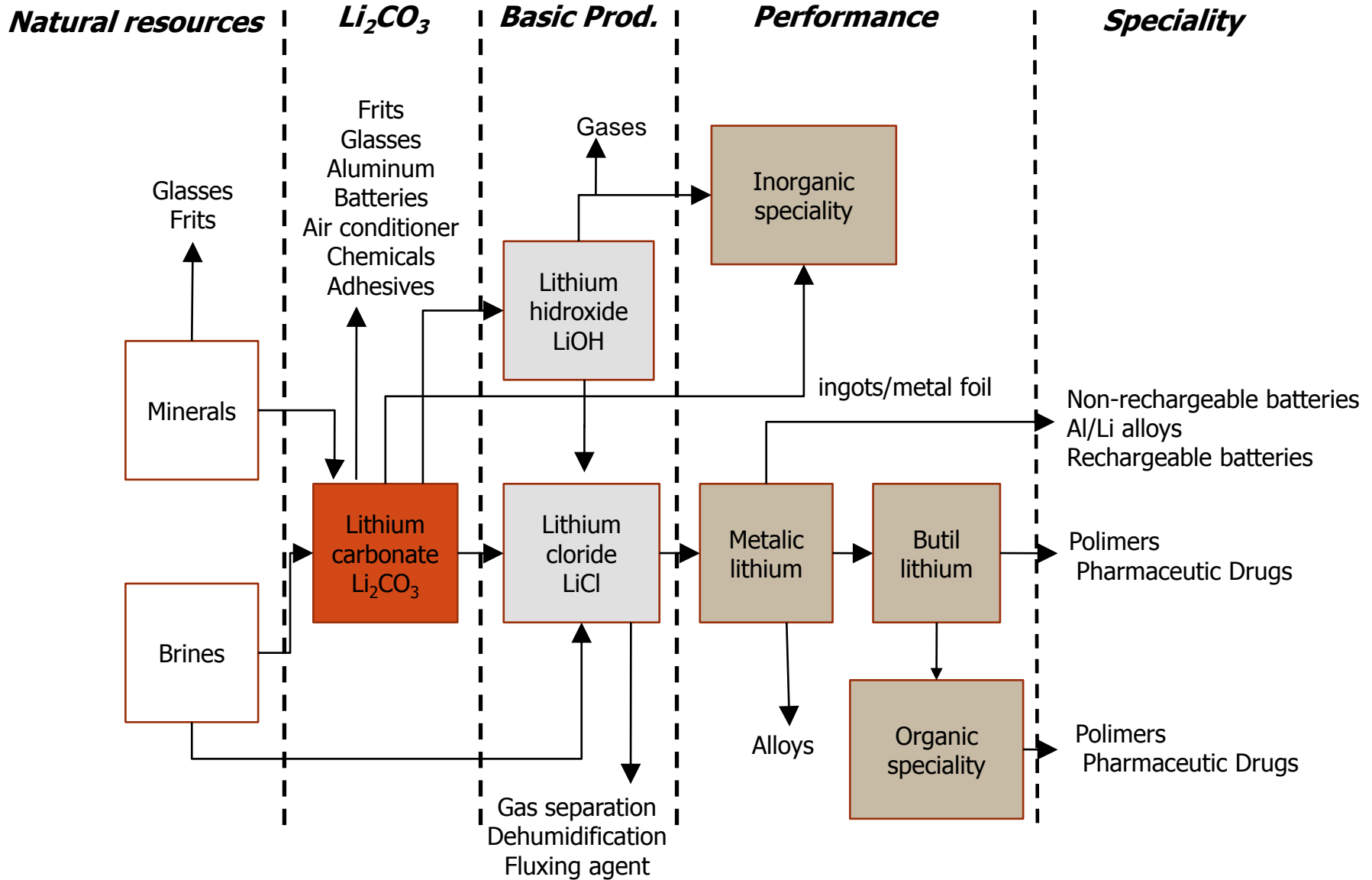
Alkaline Process – Spodumene/Lithium carbonate



Chemical Reactions:



Lithium network



Consideratons for the Brazilian and World Markets

- ✓ Brazil has plenty lithium reserves;
- ✓ The international market is under Government protection;
- ✓ Therefore, the use of lithium concentrates is being motivated in different industry sectors:
 - ✓ Brazil is the 3rd ceramic world producer and the 2nd world consumer;
 - ✓ Brazilian glass industry represents 3% of the world production;
 - ✓ Brazil is the 4th automobile world producer – EV & HEV are comming soon!
 - ✓ Brazil is part of the BRIC´ s group.

Thank you!

