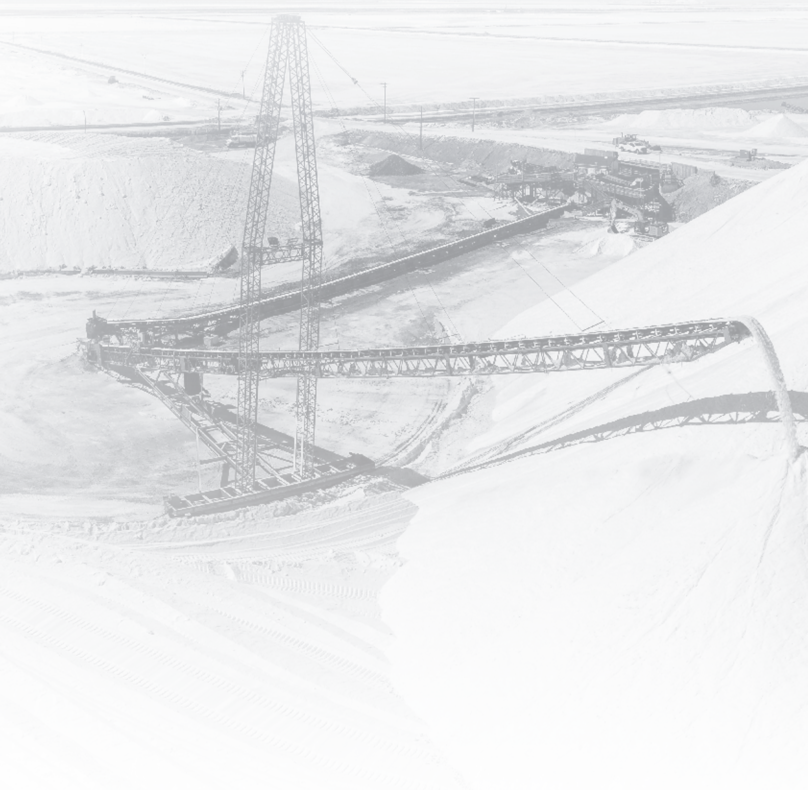
Conversion of Lithium Carbonate to Lithium Hydroxide

APPLICATION PAPER

DOCUMENT NUMBER



Introduction

The Electrical Vehicle (EV) market is undergoing a revolution that is transforming the transportation landscape using Lithium-Ion battery technology. The demand for electrical vehicles is projected to increase over five times the current 2022 production values by 2030[1]. To meet this challenge, high purity Lithium Hydroxide and Lithium Carbonate are required as essential materials to formulate these batteries.

The primary sources of Lithium are either brine lakes (Salars) or mineral deposits of mostly Spodumene ore. The Spodumene ore contains up to 6 % weight Lithium and is extracted from the ground in conventional mining operations that can be either underground pit excavation or surface strip mining depending on the location of the mineral lode.

Lithium Conversion

In many cases Lithium Carbonate may be produced that is a lower quality then needed for EV batteries. It may also be desirable to use high grade Lithium Hydroxide as part of the cathode materials instead of the carbonate form. Additionally, plants that are designed to produce the lower quality Lithium Carbonate may be difficult to modify to produce a high quality battery grade material or lack resources such as fresh water needed in the conversion. A number of plants currently produce the Lithium Carbonate and then ship this material to plants specially designed to convert the lower grade Lithium Carbonate to a high quality battery grade Lithium Hydroxide with most of these currently found in China.

Process to Convert Lithium Carbonate to Lithium Hydroxide

The Lithium Carbonate solution is converted to high quality battery grade Lithium Hydroxide for use as an essential component to make Lithium-Ion Batteries. The process for this conversion is illustrated in Figure 1.

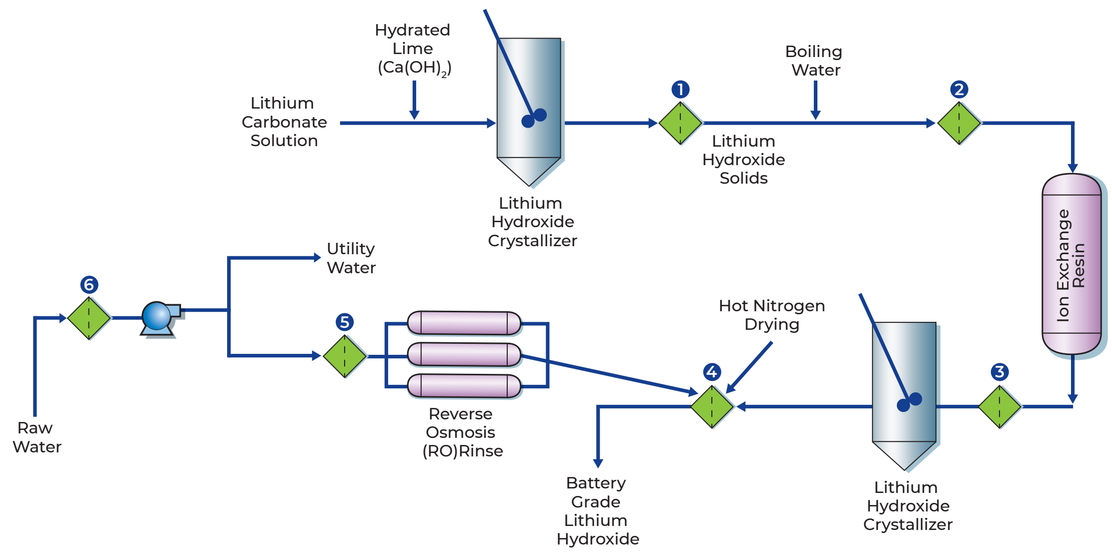
The first step is to convert the Lithium Carbonate solution into Lithium Hydroxide by adding hydrated lime (Ca (OH)2). This initiates the chemical conversion into Lithium Hydroxide and solids are created in the crystallizer step. The bulk solids are typically separated using either a filter pressor or a centrifuge coupled with a belt filter at location (1). An improved method has been developed using automated regenerable cartridge filtration that can replace the centrifuge, filter press and belt filter.

The collected Lithium Hydroxide is then re-dissolved by adding boiling water. Following this step at location (2), filter cartridges rated at 1-5 micron are used to separate contaminant particulates. An ion-Exchange resin bed is deployed to remove dissolved species and another cartridge filter rated at 1 micron is used at location (3) to prevent fine particulates from contaminating the final product.

Lithium Hydroxide product is then separated from the liquid stream using a crystallizer. The solid Lithium Hydroxide product is collected typically using either a filter press or centrifuge coupled with a belt filter at location (4). An improved method has been developed using automated regenerable cartridge filtration that can replace the centrifuge, filter press and belt filter.

The Lithium Hydroxide particles are rinsed using deionized water to remove contaminants. A filter cartridge rated at 10 micron is used at location (5) to protect the Reverse Osmosis Membrane System from fouling prematurely. The rinsed solid particles are then dried using hot Nitrogen. Additional filters rated at 10-20 micron are used for utility water at location (6).

To achieve battery grade final Lithium products, multiple crystallization, re-dissolution and rinsing stages are often required that are not shown in this flow schematic for simplicity. Also, the process depicted is based on conventional operating plants and there are many new methods in development in this emerging industry.



Filter	Filtration Value	Separation Product
1	Collect Technical Grade Lithium Hydroxide Product	Automated regenerative cartridge
2	Protect Ion-Exchange (IX) resin and crystallizer from carryover solids	1 - 5 Micron Filter
3	Remove trace solids and Ion Exchange resin fines before crystallizer	1 Micron Filter
4	Collect Battery Grade Lithium Hydroxide Product	Automated regenerative cartridge
5	Protect RO filtration unit from fouling	10 Micron Filter
6	Removal of contaminant from raw water feed to RO & utility water for other uses including flushing out equipment	10 - 20 Mircon Filter

Figure 1: Process to Convert Lithium Carbonate to Lithium Hydroxide

Material Purity Specifications

Lithium-Ion batteries have strict purity requirements for the materials used in their manufacture. Impurities can lead to poor charging performance including reduced vehicle range of operation, more frequent need to charge, problems with batteries starting at colder temperature and in some extreme cases to the batteries catching on fire. A major issue with the current Lithium conversion practice is reliable operation in producing the high-quality Lithium products. Battery grade purity specs are provided in Table 1 for Lithium Hydroxide and Lithium Carbonate. For Lithium Carbonate the minimum purity requirement is 99.5 wt % and for Lithium Hydroxide Monohydrate (LiOH-H2O) it is 56.5 wt% for Lithium Hydroxide (LiOH) out of a theoretical maximum purity of 57.0 wt % (due to the water monohydrate molecule).

Improved filtration and separation can play an important role in improving both the process reliability for producing consistent high purity products and also for improving the product yields, reducing product re-work, and reducing operation costs.

Battery Grade $LiOH-H_2O$ (Lithium Hydroxide Monohydride) Purity Specs		
LiOH, wt%	56.5	min
CO_2, wt%	0.35	max
Cl, wt%	0.0020	max
SO_4, wt%	0.010	max
Ca, wppm	15	max
Fe, wppm	5	max
Na, wppm	20	max
Al, wppm	10	max
Cr, wppm	5	max
Cu, wppm	5	max
K, wppm	10	max
Ni, wppm	10	max
Si, wppm	30	max
Zn, wppm	10	max
Heavy metals as Pb	10	max
Acid Insolubles, wt%	0.010	max

Table 1: Battery Grade Purity Specifications[2]

EV Battery Value Chain

The various stages in the Electric Battery (EV) value chain are given in Figure 2. For each segment, filtration and separation play a vital role in meeting process goals for yield, purity, and reliability. For base materials, mining and unique material processing are required for Nickel, Cobalt and Aluminum as well as Lithium as described in this paper. Active materials involve treating of chemicals, specialty chemicals and polymers to make the essential battery components consisting of the separator, electrolyte, and anode/cathode. The battery cells also use chemicals and specialty chemicals that must be at rigorous purity levels for preparing the casing, filling operations, and preparing slurries.

Pall Corporation is your partner for filtration and separation needs and has experience throughout the EV battery value chain. Pall has over 400 qualified Engineers and Scientists that can provide: prototype testing, on site pilot testing, best practice training, process optimization, audits, contaminant analysis, application troubleshooting, validation services, presentations at scientific forums, and journal publications.

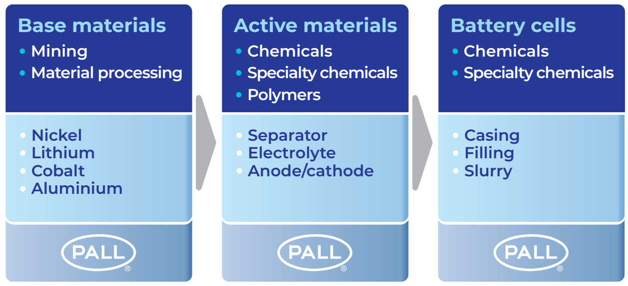


Figure 2: *Applications in the EV Battery Value Chain*

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