Lithium Processing - Carbonate

APPLICATION PAPER

PIAPLITH2EN

Conversion of Lithium Carbonate to Lithium Hydroxide

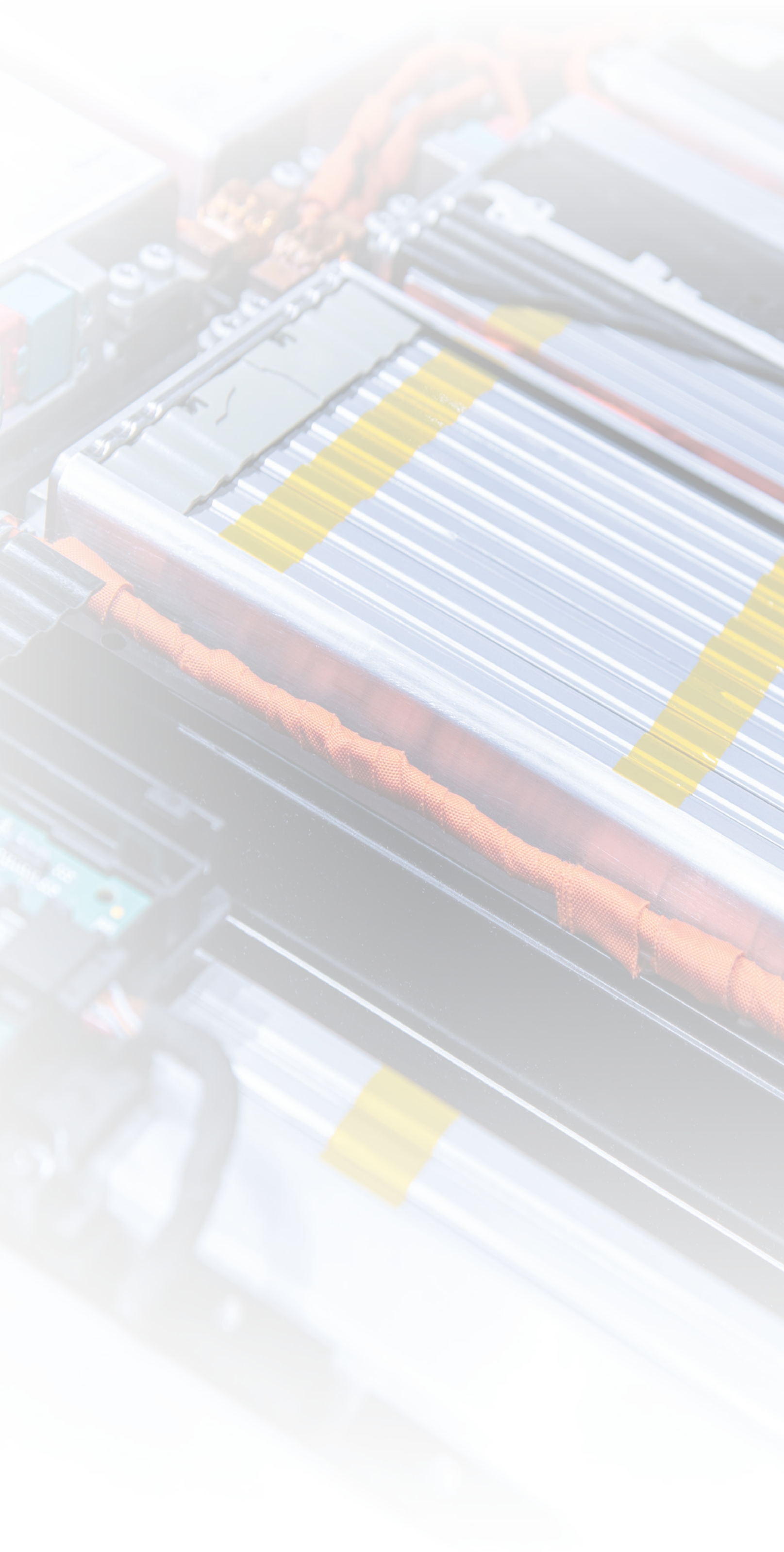
Introduction

The Electrical Vehicle (EV) market is undergoing a revolution that is transforming the transportation landscape using Lithium-Ion battery technology. The demand for lithium ion battery is projected to increase to 4900 Gwh in 2030 as compared to 1500 Gwh in 2024[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 (see Figure 1) 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.

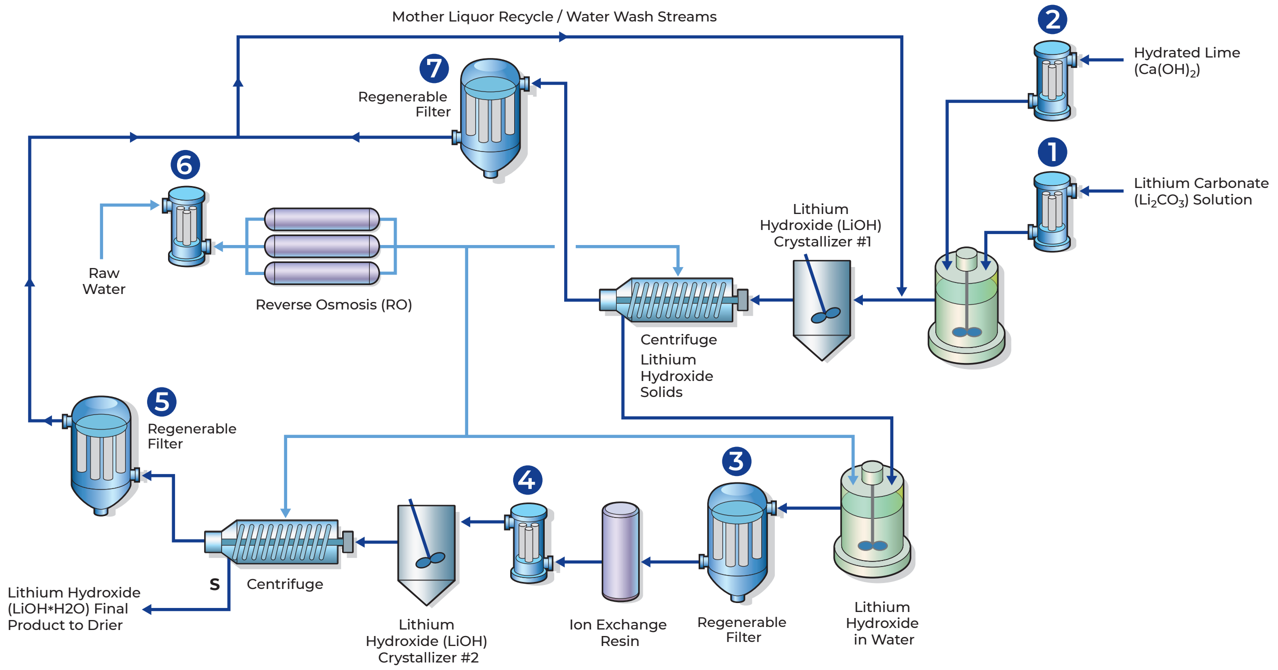
The first step is to convert the Lithium Carbonate solution into Lithium Hydroxide by adding hydrated lime ($Ca(OH)_2$). Both the hydrated lime and the feed Lithium Carbonate solutions are passed through cartridge filters rated at 1-5 micron grade at locations (1) and (2) to prevent ingression of contaminants into the process. The hydrated lime initiates the chemical conversion of Lithium Carbonate into Lithium Hydroxide and Lithium Hydroxide solids are created in the first crystallizer step. The crystallized solids are separated using a first stage centrifuge. The solids collected in the first stage centrifuge are then washed with RO quality water and then re-dissolved in hot water to increase the purity.

Any solids remaining in the Lithium Hydroxide solution are then removed by a regenerable filter (3) that serves to protect the downstream Ion Exchange Resin Bed and prevent further contamination from passing to the second stage crystallizer. Following the Ion Exchange Resin Bed, the stream is processed through a I micron filter prior to the second stage crystallizer to catch any trace solids and Ion Exchange Resin fragments at location (4).

A second stage crystallizer is then used to achieve battery grade purity. The solids are formed in the crystallizer and are separated out of the stream in a second stage centrifuge. The Lithium Hydroxide solids collected in the centrifuge for both stages are rinsed with RO quality water with a cartridge filter rated at 10 microns used to protect the RO membrane systems at location (6).

For both centrifuge stages, any carryover solids in the mother liquor recycle stream are collected by regenerable filters located at (5) and (7). These same filter units are used during the water rinse of the collected Lithium Hydroxide solids to catch any carryover product solids.

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	Prevent ingression of impurities into system from feed Lithium Carbonate solution	1 - 5 Micron Filter
2	Prevent ingression of impurities into system from injected hydrated lime solution	1 - 5 Micron Filter
3	Recover fine Lithium Hydroxide particles and protect Ion Exchange (IX) from carryover solids coming from the centrifuge	Regenerable Filter
4	Remove trace solids and Ion Exchange resin fines before the crystallizer	1 Micron Filter
5	Recover fine particles of Lithium Hydroxide from mother liquor recycle and water wash streams	Regenerable Filter
6	Protect RO filtration unit from fouling enabling consistent supply. RO water used to rinse final product	10 Micron Filter
7	Recover fine particles of Lithium Hydroxide from mother liquor recycle and water wash streams	Regenerable 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 ($LiOH\text{-}H_2O$) 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).

Battery Grade $LioH\text{-}H_2O$ (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

Grade	$LioH\text{-}H_2O$	Li_2CO_3
Battery	56.5% LiOH	99.5

Max Theoretical Purity of LiOH in $LiOH\text{-}H_2O$ is 57.0 wt%

Table 1: Battery Grade Purity Specifications [2]

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.

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.

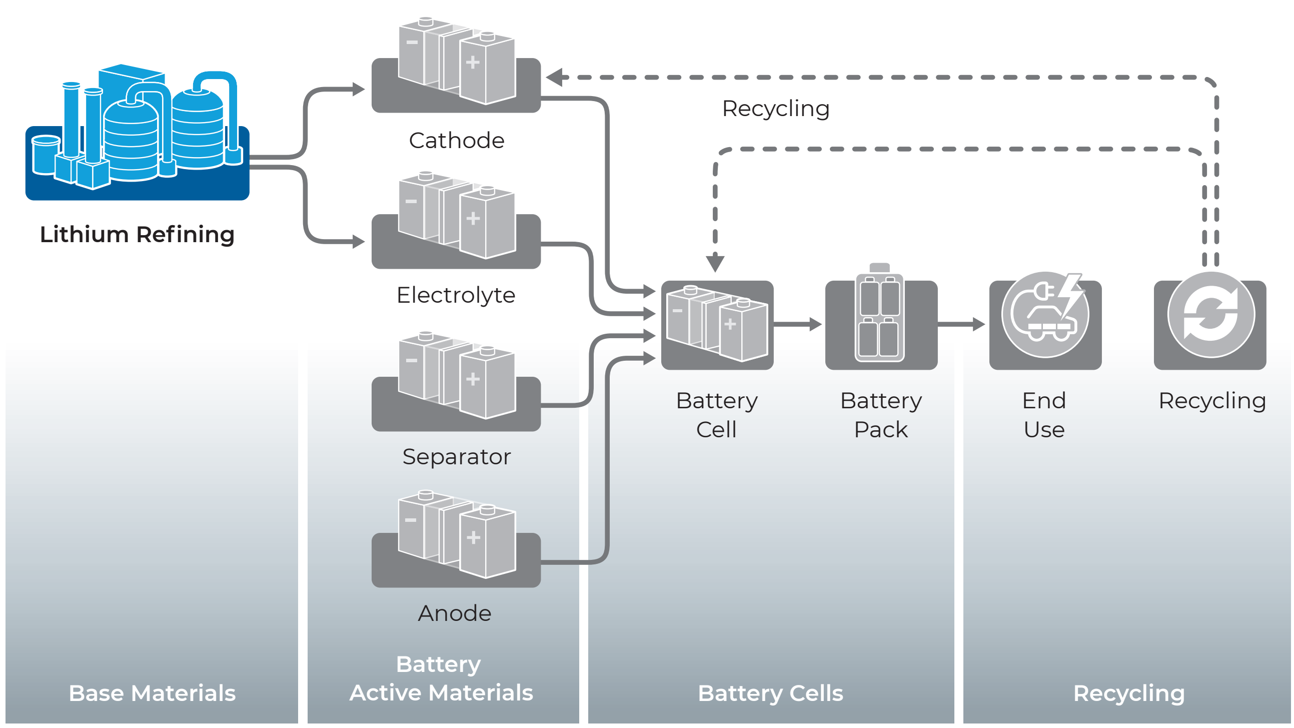


Figure 2: Applications in the EV Battery Value Chain

References

1. *Battery monitor 2023 (Roland Berger & RWTH Aachen university)*
2. *https://livent.com/wp-content/uploads/2018/09/QS-PDS 1021-r3.pdf*

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