

Solutions for lithium processing

Our take – GEA drives the change



Engineering solutions for sources of clean energy.

GEA provides its customers with an unrivalled combination of process expertise that covers the spectrum of lithium production, from brine concentration to high-purity particles.

The challenge

As economies grow, so does the transport activity around the world since it is fundamental for economic growth and development. At the same time, emissions from the mobility sector are on the rise as well because 95 percent of the world's transport energy still comes from fossil fuels.

Today this is changing and the search for breaking the link between increased mobility and increased emissions is in full motion. Low-carbon mobility can reduce pollution while also creating jobs, making streets safer, strengthening infrastructure and stimulating local economies, which is why rechargeable lithium batteries have come to revolutionize our panorama. Even better is the fact that lithium batteries have not only impacted the mobility sector but also that of telecommunications among others. As the demand for power from "clean" energy sources increases, so too, does the demand for lithium.

Our take – Expertise at your service

GEA is an established and globally recognized supplier for the chemical and metallurgical industries, most particularly in lithium production. Our aim is to offer innovative and creative solutions which respond to your needs. Our strength lies in global CAPEX-OPEX cost effectiveness and the long-term reliability of our systems.

GEA helps you leverage advantages of scale and partnership, making possible solution shortcuts and functional benefits that simply cannot be obtained from separate providers.



Technologies that lead to the future of energy storage.

Our portfolio starts at the mine and goes beyond the dried battery powder. It includes the solvent refining during battery production and supporting in closing the loop with recycling the batteries with purification of critical metals such as cobalt, lithium and nickel.



Making raw materials accessible.

GEA successfully bridges engineering challenges and helps customers to process mineral, renewable and secondary raw materials.

In the case of Lithium GEA provides solutions for:

- Lithium brine concentration
- Lithium salt crystallization
- Lithium salt purification by re-crystallization
- By-product recovery from lithium processing
- Impurity removal (precipitation, membrane filtration)
- Solid/liquid centrifugal separation equipment
- Fluid bed drying of lithium hydroxide and lithium carbonate

Customize next-generation Lithium battery materials

GEA provides and develops technologies that lead to the future of energy storage. We engineer powders and support your production process with:

- Spray drying of lithium cathode and anode materials
- Solid powder conveying & handling
- Purification of battery grade solvent
- NMP recovery and refining
- Emission Control

Testing to commercial success

To ensure that we provide the optimal process and plant solution for each customer, our process specialists are available for both test work and process development.

Our focus on project management – from the earliest stages of the project, through to the plant coming on stream, on schedule – means stakeholders are aligned to meet all key performance indicators (KPIs).

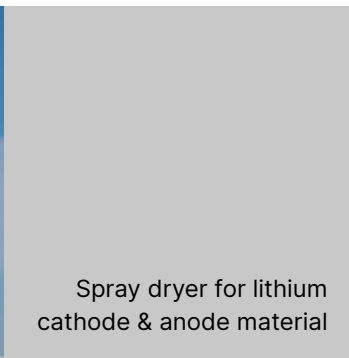
GEA's commitment does not stop after the plant begins operation. A comprehensive service and upgrade program is available to guarantee both the performance and the longevity of the facility.

Outstanding references

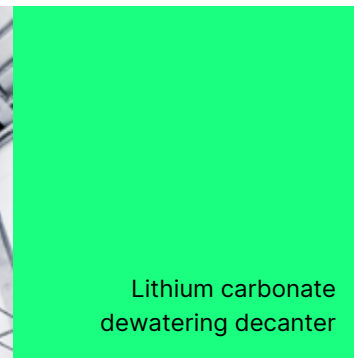
Lithium hydroxide
crystallizer



Spray dryer for lithium
cathode & anode material



Lithium carbonate
dewatering decanter



Lithium sulfate
crystallizer



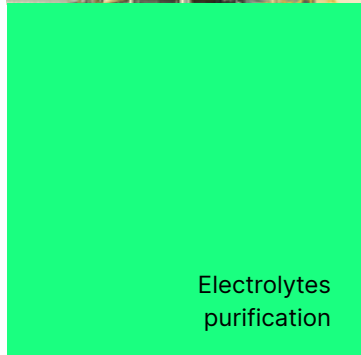
Lithium
hydroxide fluid bed



Glauber's salt
crystallizer



Electrolytes
purification



Lithium sulfate
evaporator



Research & Development
Test Center



Pure Li-compounds

Major steps in the lithium value chain

We provide multiple technologies for major upstream and midstream lithium process steps, including evaporative concentration, precipitation, crystallization, purification, separation and drying. Our process systems give customers a competitive advantage resulting from higher rates of production under tighter specifications, combined with reduced costs and improved efficiency. And all of our plants comply with the complex safety requirements of the chemical industry.

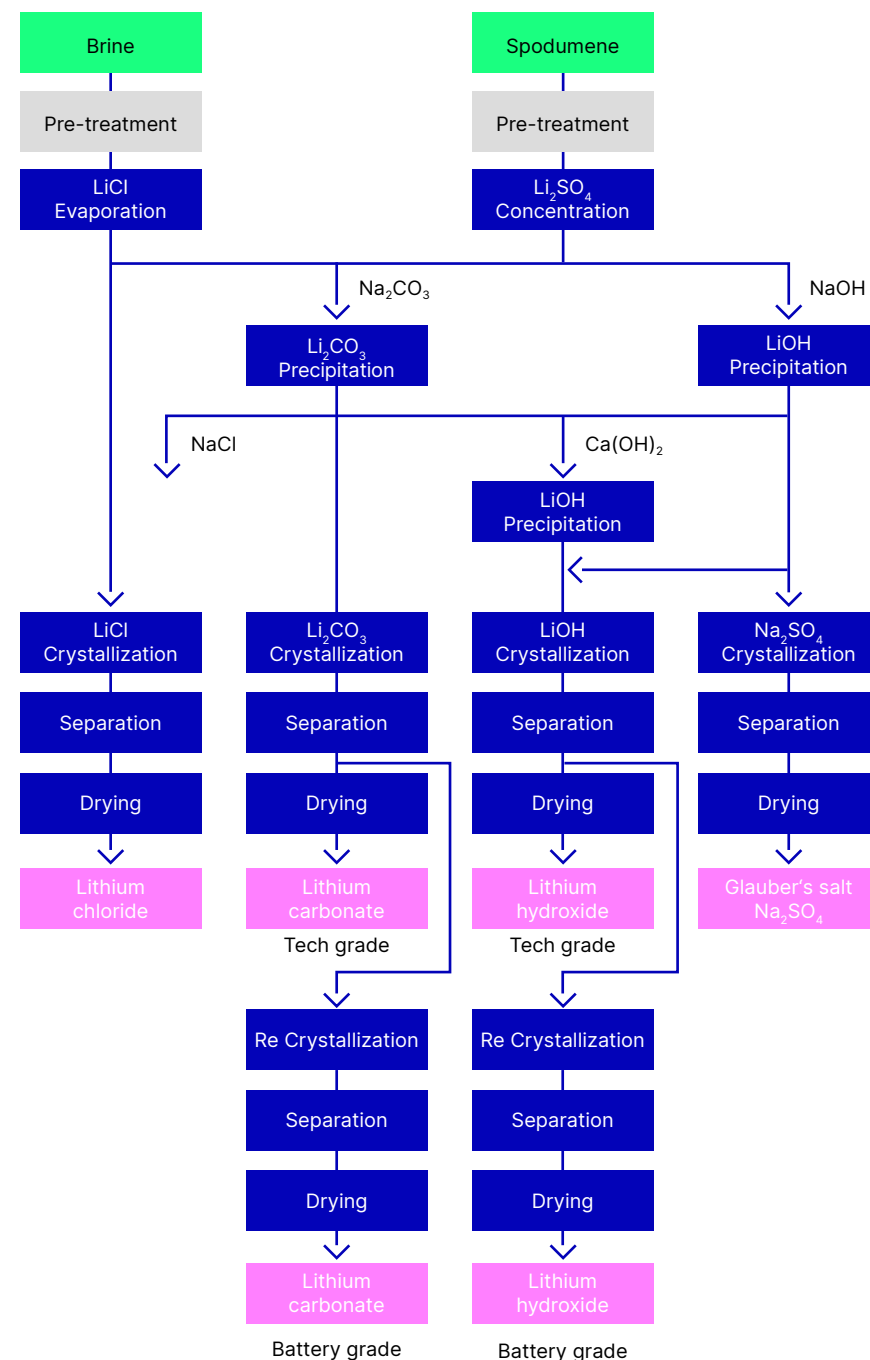
Beginning with the initial concentration of lithium chloride or lithium sulfate from the raw material (brine or spodumene), GEA delivers the technology that brings upstream processes to completion. The product produced, battery-grade lithium carbonate or lithium hydroxide, can then move on to midstream production.

The flow chart on the right highlights our upstream capabilities, with the blue boxes showing where GEA processes are utilized. Our evaporation, crystallization and fluid bed drying technologies can be tailored to produce one or more of the lithium salts as well as their by-products, including sodium or Glauber's salts, and lithium chloride for alloy applications. And we have a team of experts that will work with you during every step of the process.

A century of evaporation, crystallization and drying expertise

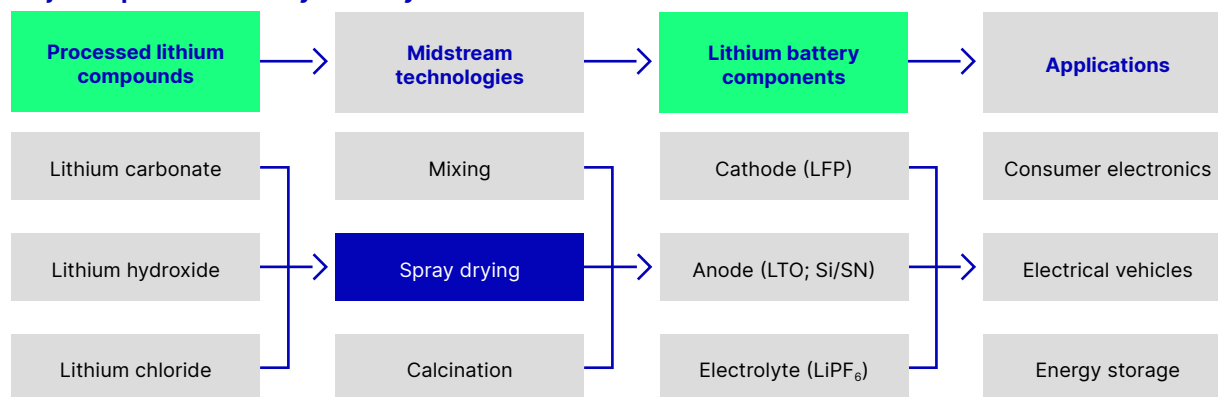
We design and fabricate evaporators and crystallizers from start to finish. With lithium projects, turn-key supply is an option. Equipment is shop- or field-fabricated to ASME, ANSI, AS, PED and ASTM specifications. Installation is always conducted under our supervision. Further, with the implementation of strict environmental regulations, rigorous permitting processes, lack of water availability, and the economic benefits of water reuse, many industrial facilities are implementing Zero Liquid Discharge (ZLD) systems. ZLD systems from GEA combine membrane filtration, evaporation and crystallization to eliminate or reduce wastewater effluent from the plant. The end result is environmental compliance and production of highly pure water for reuse.

GEA fluid bed dryers are ideally suited to multi-zone operation with drying and cooling taking place in the same unit. The equipment can be designed for high temperatures and is available in an all metal, washable design. Contact tubes or plates can be incorporated with non-cohesive materials. The result is a significant reduction in airflow compared with the typical standard fluid bed, providing a higher thermal efficiency as well as lower electrical consumption with a reduced footprint.



Take charge with GEA spray drying.

Major steps in the battery industry value chain



No matter where you envision your lithium-ion battery materials being used, GEA has the expertise to meet your precise spray drying needs.

You deserve a spray drying specialist

There's no such thing as a "one-size-fits-all" solution when it comes to spray drying Li-ion battery material. Because individual cathode and anode powders vary widely in composition and characteristics, GEA's powder engineers tailor each solution to the specific downstream components.

Comprehensive pilot plant testing enables us to select and optimize the process design, so that you can produce powders of consistent superior quality – in the most energy efficient and cost-efficient way.

Get a system that's right for you

When we develop spray drying solutions, we consider two types of atomization devices: rotary or nozzle. Nozzles are available with pressure and pneumatic configurations. We also offer combination or multiflow nozzle systems.

We recommend rotary atomization most frequently, since the equipment is particularly easy to operate and uses little energy. Rotary atomization of Li-ion battery material typically produces a mean particle size from 10 microns to greater than 100 microns.

GEA's proprietary nozzle technology, including the COMBI-NOZZLE®, enables us to cover an even wider size range, from just a few microns up to several hundred microns. Regardless of the atomization approach, GEA offers compact, single-line spray drying plants of any desired capacity.



Expect more



Purification of battery grade electrolyte

Melt crystallization is a perfect technology for ultra-high purity organic electrolytes like ethylene and vinylene carbonate. The target component becomes solid while the other molecules are concentrated in the remaining liquid and can now be separated from the liquid as pure product:

- Crystallization is highly specific
- Significantly less energy than distillation/evaporation due to the lower operating temperature
- Efficient one or two stage separation
- Achieve purities up to 99,99% – 99,999%
- Do not require process aids like adsorbents



Battery grade NMP refining

The usage of high-boiling solvents, like NMP in the coating process of anodes or cathodes to produce Li-Ion Batteries is a widespread technology. In this process, the battery constituents are dissolved in the solvent before coating. After drying the solvent is condensed/recovered and needs to be refined.

- For this application, where a high purified solvent is required, GEA provides energy saving distillation solutions using MVR technology (Mechanical Vapor Recompression).



Emission Control

GEA-design venturi or compact gas scrubbers are made for the exhaust gas treatment in the chemical industry. They are in use for absorbing pollutants, separating dust and aerosols. Key advantages are:

- Broad range of applications, flexible in use
- Self-extracting, no pressure loss
- Wide load range, efficient partial load behavior
- High reliability, low maintenance effort required

Rethink the cycle.

Second-life solutions for lithium-ion batteries

After a decade or more of use, a lithium-ion battery is no longer suitable for its original purpose. However, the battery often still retains valuable materials and allow to recover lithium, cobalt, manganese and nickel from the battery for reuse in the production of new batteries.

Mechanical processing

The lithium-ion batteries are first disassembled and treated during a mechanical process which enables to recover plastics, aluminum, copper, and black mass. The battery's black mass, containing critical metals, is collected and then taken for hydrometallurgical processing. Other recovered materials are recycled in separate processes.

Hydrometallurgical processing

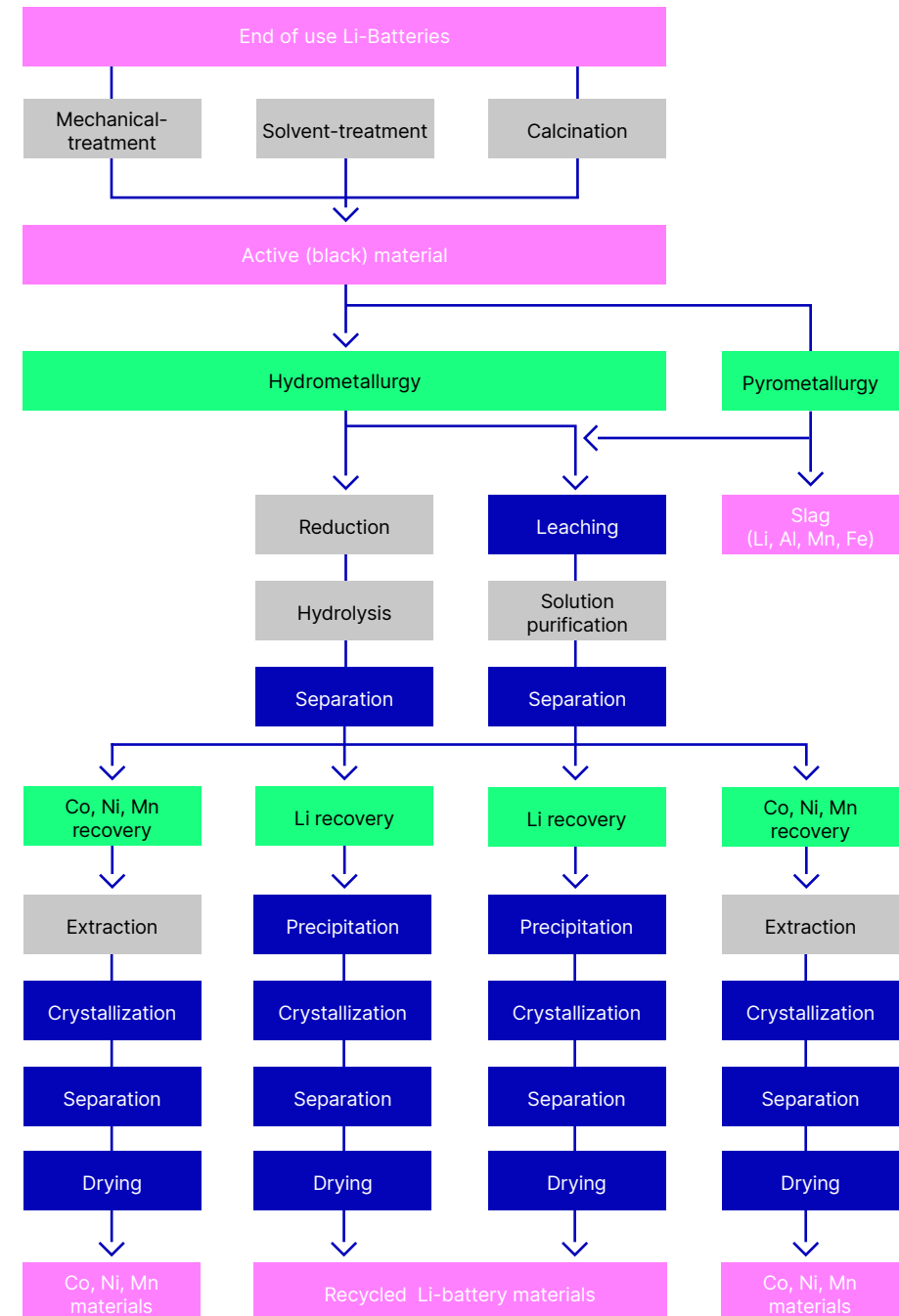
Hydrometallurgy is the most used method for lithium extraction. The hydrometallurgical recycling process involves a chemical precipitation methodology that allows scarce minerals to be recovered from the black mass and delivered to battery manufacturers for reuse.

Hydrometallurgical methods use primarily aqueous solutions to extract and separate metals from LIBs. Once metals have been extracted into solution, they are precipitated selectively as salts using pH variation or extracted using organic solvents containing extractants.

Often combinations of hydrometallurgical and pyrometallurgical methods are used to process lithium-ion batteries today.

A century of evaporation, crystallization and drying expertise

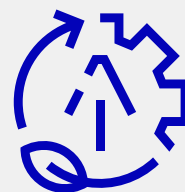
The hydrometallurgical process is well known to GEA. We design and fabricate centrifugal separators, evaporators and crystallizers suitable for all process steps involved at the recycle process. Our Equipment is shop- or field-fabricated to ASME, ANSI, AS, PED and ASTM specifications. Installation is always conducted under our supervision.





PERFORMANCE PARTNERSHIP

Empower your business with a partnership designed to optimize your performance. Together with you, we create services that matter: We focus on your specific goals and help you increase **Availability, Productivity and Sustainability** – enabled by digitalization.



AVAILABILITY PRODUCTIVITY SUSTAINABILITY

Enabled by digitalization.



Enhancing Availability

Proactively minimize down-time with maintenance strategies and innovative technologies that ensure smooth, uninterrupted operations.



Boosting Productivity

Optimize efficiency with process improvements, staff training, and actionable, data-driven insights to maximize your production potential.



Driving Sustainability

Reduce environmental impact, improve resource-efficiency, and extend machine lifespans with tailored solutions and expert support.

Enabled by digitalization

- **Optimize and automate** your processes
- **Solve problems early** with predictive analytics
- **Identify untapped opportunities** through actionable insights
- **Make data-based decisions** – anytime, anywhere

Let's talk to unlock
your full potential



[GEA.com/service](https://www.gea.com/service)

GEA Wiegand GmbH
Am Hardtwald 1
76275 Ettlingen, Germany

Tel +49 7243 705-0

gea.com/lithium-processing