



Solutions for Lithium Processing

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.

Electrical energy for lower carbon emissions

With global lithium reserves estimated to be 13 million metric tons (MT), the industry is working to unearth this almost feather-light metal that powers a 21st-century economy. In today's world, long-life, non-rechargeable lithium batteries are used in pacemakers, watches and calculators, while rechargeable lithium batteries have revolutionized everything from smartphones to electric drills. Moreover, this technology now allows us to use lithium-ion batteries to store energy from solar and wind farms and to power electric and hybrid vehicles. As the demand for power from "clean" energy sources increases, so too, does the demand for lithium. Other end-use markets for the metal include ceramics and glass, lubricating greases, air treatment, primary aluminum production and even some medicines.

Lithium is found in continental brines and spodumene, a hard-rock ore. Argentina, Bolivia, Chile, China and the United States lead in lithium production from brine. Argentina, Bolivia, Canada, Chile and Australia are major producers of the ore concentrates.



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.

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 major Australian lithium producer has constructed a lithium carbonate plant in China using spodumene ore as a raw material. GEA has delivered the evaporator-crystallizer that precipitates Na_2SO_4 from the mother liquor containing lithium.

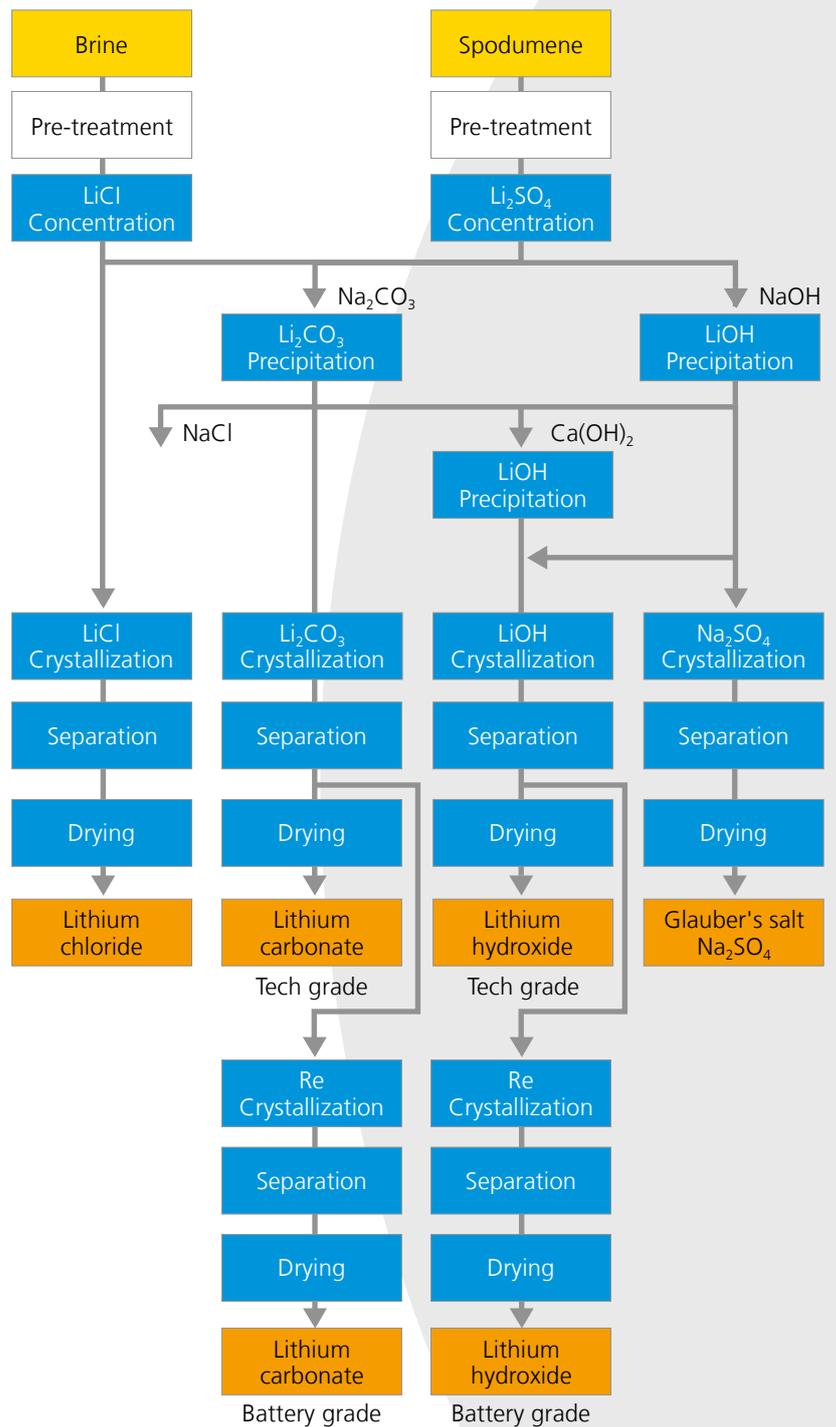
A century of evaporation, crystallization and drying expertise

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.

GEA is a one-stop supplier for all major lithium process steps, including evaporative concentration, precipitation, crystallization, purification, separation and drying.

Lithium crystals obtained as hydroxides are spheres. Lithium crystals in the form of carbonate are flakes with sharp angles. The hydroxide is more suitable for use in batteries as it provides the best energy balance.



Technologies that Lead to the Future of Energy Storage

GEA has a team of experts in process & mechanical engineering, instrumentation & control, and construction. In addition to our lab-scale test center, more than 15 pilot plants are available to test scale-up to industrial level production.

Our portfolio starts at the mine and ends with the dried powder. It includes:

- 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
- Spray drying of lithium cathode and anode materials
- Solid powder conveying & handling

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).

Our 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.

Service



Research and Development Test Center



Spray dryer for lithium cathode & anode material



Lithium carbonate dewatering decanter



Lithium hydroxide crystallizer



Lithium hydroxide fluid bed



Glauber's salt crystallizer



Sodium sulfate crystallizer



Lithium sulfate evaporator



OUTSTANDING REFERENCES

After completing extensive and successful test work at GEA facilities in Europe, GEA is delivering key process equipment, including packaging, for production of a pure lithium hydroxide monohydrate ($\text{LiOH}\cdot\text{H}_2\text{O}$), with dried sodium sulphate as a by-product, to a major Chinese/Australian lithium company.

Take Charge with GEA Spray Drying

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.

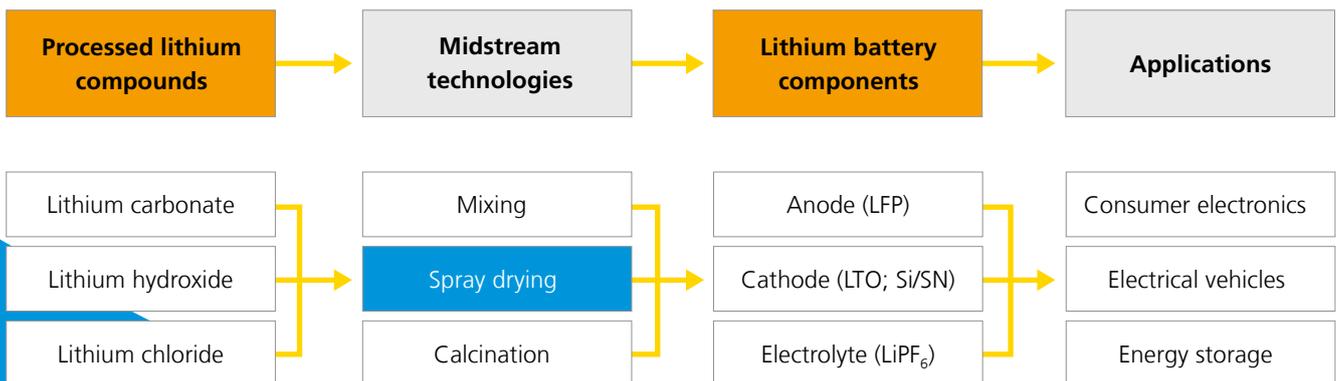
Get a system that’s right for you

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 of less than 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.

Major steps in the battery industry value chain



The world leader in spray drying

GEA pioneered spray drying and remains at the forefront of the field. We are continuously pushing the boundaries of the technology into new, even more beneficial directions. And with the largest spray drying “tool box” in the world, we offer you the most comprehensive range of solutions.

This includes plants designed for handling either aqueous or non-aqueous (organic solvent) feeds – where nitrogen is used as an inert drying medium. Furthermore, all GEA plants are designed to meet international health and safety standards.

Since you operate in a dynamic environment with rapidly changing needs, our spray drying plants can be adapted with the same speed. GEA’s unsurpassed understanding of all aspects of the spray drying process makes us your ideal partner. You get a solution with the flexibility to meet future needs, no matter where your research takes you.

Maximum plant availability and economy

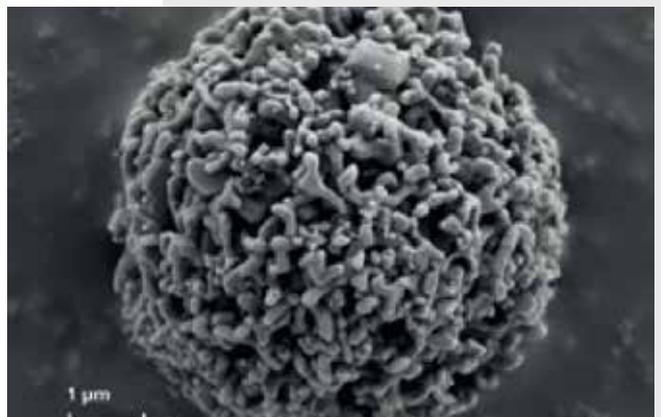
GEA’s success is based on our ability to bring maximum value to our customers. Our tailored, reliable spray dryer designs and quality components ensure maximum plant availability and the overall best plant economy. When you choose GEA, you get access to the world’s foremost spray drying expertise – which you can use to ensure continuous, optimum performance of your plant.



By tailoring each spray drying plant, GEA helps customers achieve high performance.



GEA’s COMBI-NOZZLE™ combines the best features of pressure and pneumatic nozzles. The COMBI-NOZZLE™ has been specifically developed for Li-ion battery material and offers unique advantages over other nozzle types:



Optimized particle morphology and size make powders spray dried with GEA ideal for further processing.



We live our values.

Excellence • Passion • Integrity • Responsibility • GEA-versity

GEA is a global technology company with multi-billion euro sales operations in more than 50 countries. Founded in 1881 the company is one of the largest providers of innovative equipment and process technology. GEA is listed in the STOXX® Europe 600 Index. In addition, the company is listed in selected MSCI Global Sustainability Indexes.

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