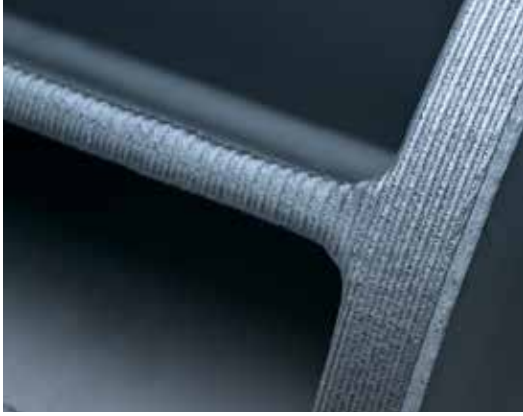
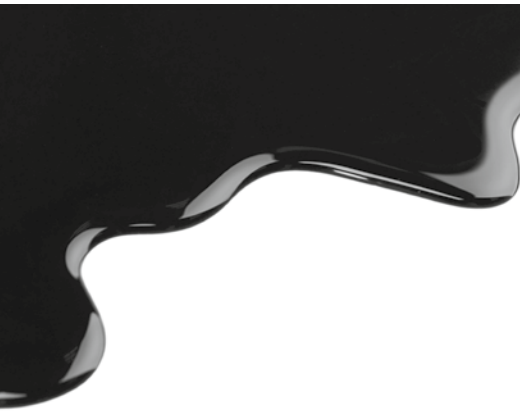
Manufacturing of Battery Compounds. Increasing Production Efficiency with Continuous Processes.

coperion
confidence through partnership

Coperion and Coperion K-Tron offer first-class, reliable technology for manufacturing top-quality battery compounds. As a system provider, our solutions encompass the entire manufacturing process for battery compounds: from bulk material handling to precise feeding and extrusion - including containment concept planning and implementation for every step.

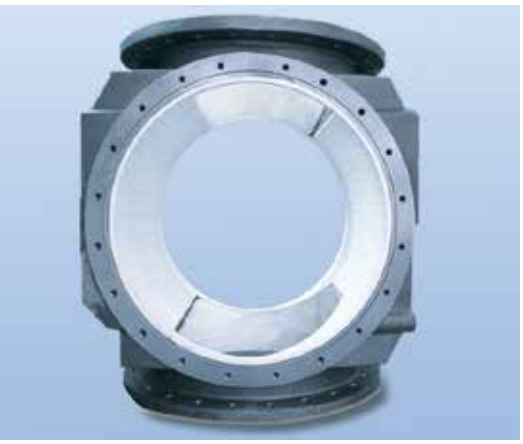
We offer everything you need for your project, all from a single source. With our inhouse planning, engineering, and process expertise, as well as proprietary key components, we can offer individual machine concepts and realize them safely and economically, responding flexibly to all customer- and market-specific requirements all along the way.



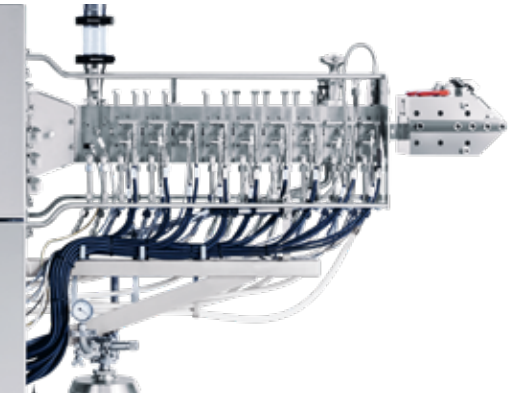





Li-Ion
Battery

coperion



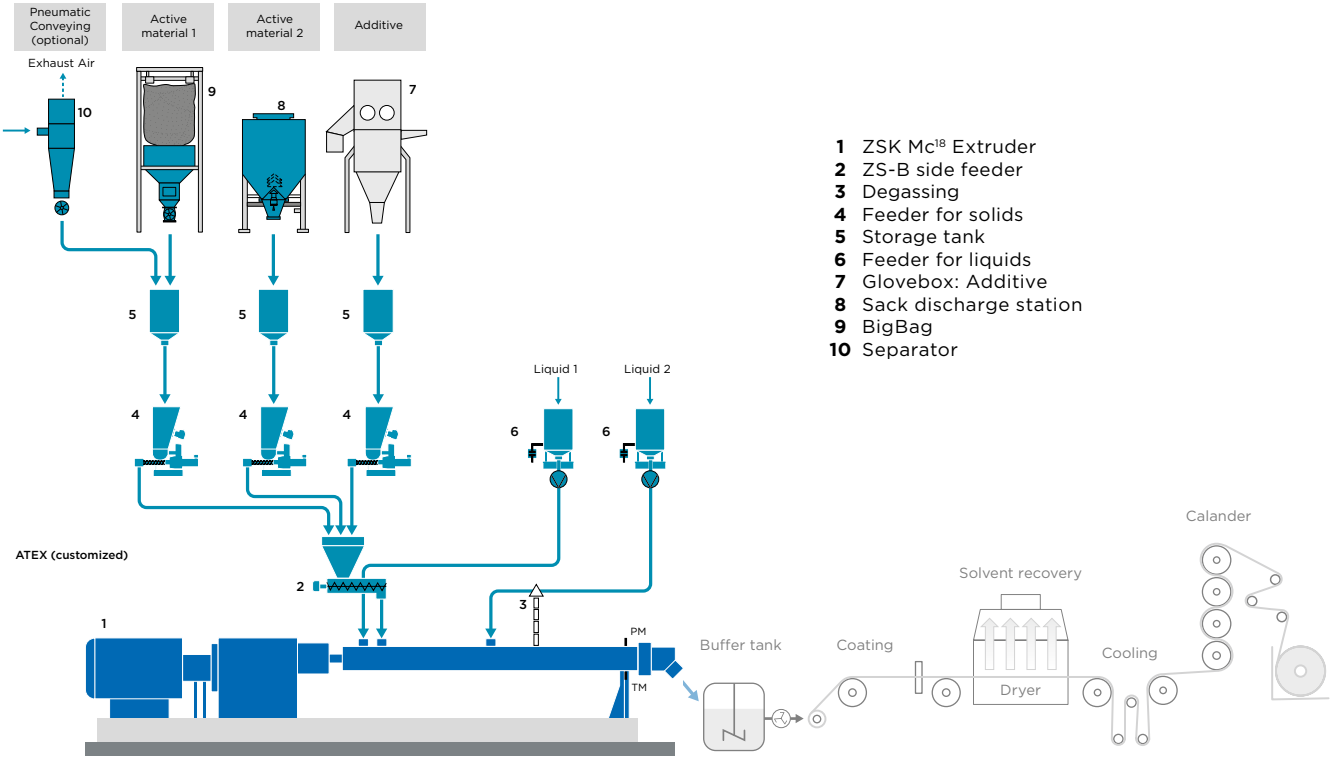
CONTINUOUS MANUFACTURING OF BATTERY COMPOUNDS

Our primary focus lies in continuous production processes for electrode compounds. Continuous production can optimize the manufacturing process significantly. The Coperion ZSK twin screw extruder, in combination with high-accuracy Coperion K-Tron feeders, offers high process stability and precision to ensure excellent, reproducible end product quality. Our systems are highly reliable and offer a long service life. Furthermore, continuous production achieves greater material efficiency as well as more cost-efficient and climate-friendly battery cell production compared to conventional batch processes.

ADVANTAGES OF CONTINUOUS MANUFACTURING (VERSUS BATCH PROCESSES):

- Increased profitability:
  - Reduced space and personnel requirements
  - High reliability, minimizing downtimes
  - Lower investment costs
- Tailor-made machine concept and high flexibility:
  - Production range between 2 l/h up to 2,000 l/h possible, depending upon machine size
  - Wide variety of recipes possible
- Extrusion allows for climate-friendly recipes with high proportions of solid content:
  - Significant reduction in solvent content or substitution with water in existing recipes
  - Energy use decreases due to shorter drying times
- Reduced Cleaning Times
  - Continuous processing results in fewer starts and stops, leading to reduced downtimes and machine cleaning
- Quick recipe changes
  - Ingredient ratios can be changed quickly and easily by modifying feed rates
  - Operators can continuously check product quality and rapidly correct deviations

The range of Coperion products and services from bulk material handling to precise feeding and extrusion



1 ZSK Mc[18] Extruder
2 ZS-B side feeder
3 Degassing
4 Feeder for solids
5 Storage tank
6 Feeder for liquids
7 Glovebox: Additive
8 Sack discharge station
9 BigBag
10 Separator

TYPICAL SET-UP OF A BATTERY LINE

SUITABLE MATERIALS FOR EVERY TASK

Due to the often abrasive and somewhat corrosive properties of the raw materials being processed, Coperion ensures that all product contact parts are fabricated from material compounds with especially high wear and corrosion resistance.

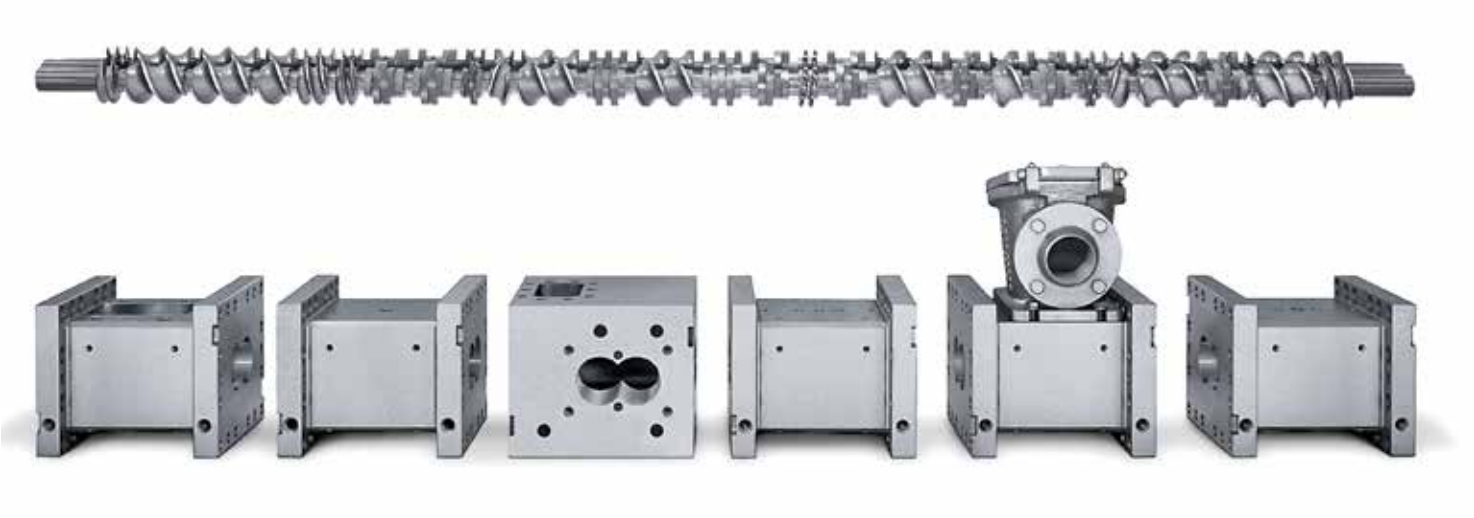
This makes it possible to avoid end product contamination from metal particles over the long term, even when processing heavy-wearing raw materials. The result: optimal end product quality.

Coperion's ZSK Mc^{18} twin screw extruder impresses manufacturers with innumerable technical achievements, all perfectly attuned to one another. These make it the ideal extruder for maximum reliability and profitability, achieving the highest quality and exceeding throughput requirements.

When manufacturing battery compounds, slurry homogeneity is of vital importance. The ZSK twin screw extruder is ideally suited for this process, as it offers highly dispersive mixing capacity, breaking up solid agglomerates very effectively. Subsequent distributive mixing ensures the homogeneity required for high end product quality in battery compounds.

The process section of all ZSK series extruders features a modular design. It consists of several barrel segments in which the co-rotating screws operate. Using this modular construction, our process engineers can configure the barrel and screw elements individually to your application.

Moreover, the ZSK extruder's interlocking, intermeshing twin screws generate a constantly high conveying efficiency and an optimal self-cleaning function within the process section, minimizing residual material in the extruder and ensuring more material-efficient production.



MODULAR CONSTRUCTION OF THE EXTRUDER PROCESS SECTION FOR INDIVIDUAL SOLUTIONS

Your advantages at a glance

Extruder throughput can be quickly adapted to the requirements of downstream production steps, optimizing the overall process
The process section's modular construction allows for flexible and individual modifications to recipes and changes within the process
Precise dispersive and distributive mixing leads to higher homogeneity and excellent product quality
The extruder's high conveying efficiency and self-cleaning function increase material efficiency
Short residence times in the extruder — little thermal stress on the material
Good devolatilization, even with materials that are difficult to devolatilize
Excellent feed behavior, even when processing materials with low bulk density
Special materials of construction avoid end product contamination

MODERN CONTROLS AND REMOTE SERVICE FOR COMPLEX PRODUCTION PROCESSES

Because battery compound manufacturing is a demanding and complex process, a manufacturer's requirements for system controls are high. Coperion's control systems, built on industry standard interfaces and the latest technology, offer a large number of functions such as seamless recording of production data, reporting, recipe management, and much more.

The Coperion Servicebox 4.0 combines both existing remote servicing and future-proof digitization strategies such as OEE, traceability, and data analysis. The OPC UA interface facilitates integration into Coperion's proprietary C-Beyond platform and supervisory client-side systems; moreover, the OPC40084 model is supported by the VDMA.

Coperion K-Tron Feeding Technology: Comprehensive process expertise and reliable feeding solutions. Even for hard-to-handle and toxic materials.

One vital aspect of battery compound manufacturing is the safe introduction of raw materials into the process. A variety of feeder technologies are available, depending upon the raw material and process step. With their comprehensive expertise and variety of feeding solutions, Coperion K-Tron has the right feeder for every application.

FEEDERS FOR SOLID INGREDIENTS

Coperion K-Tron's high-accuracy loss-in-weight feeders are outstanding for highly accurate, reliable feeding of even the most difficult flowing ingredients used in manufacturing electrode compounds. When feeding powders into the process, twin screw feeders offer certain advantages:

- High recipe precision: high, continuous feeding accuracy, thanks to the latest weighing and control technologies. Optimal end product quality and efficient use of expensive raw materials is ensured
- Material efficiency due to twin screws' self-cleaning function
- Thanks to the twin screw feeder's geometry, in combination with the screw filler, material flows more reliably into the screws than with a single screw configuration
- Flexibility: Changing the screw profile accommodates feeding of different materials
- Safe handling of process material in accordance with OEB3 and OEB4 as the standard for toxic materials.
- Modular construction allows for easy disassembly or removal of process components in a safe cleaning area

LIQUID LOSS-IN-WEIGHT FEEDERS

For the safe addition of fluids such as binders and solvents, Coperion K-Tron loss-in-weight feeders are particularly well suited as they provide accurate and continuous volumetric or gravimetric flow control for fluids.

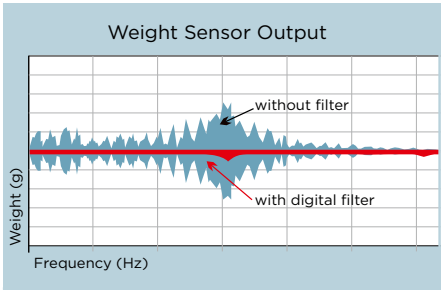
In order to achieve an optimal result, the pump must be selected based on the fluid to be metered, especially in the case of variable viscosity. Coperion K-Tron has a variety of pumps and tanks available that can be combined into a liquid feeder. The feed pump is selected according to the material to be fed and the feeder capacity.

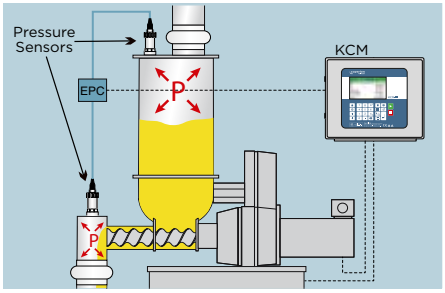
Liquid loss-in-weight feeders fulfill the same requirements for high-accuracy feeding, containment, and cleaning options as solid material feeders.

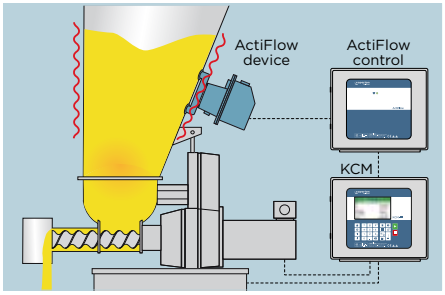
COPERION K-TRON LOSS-IN-WEIGHT FEEDERS

COPERION K-TRON LIQUID FEEDERS

THE RIGHT TECHNOLOGY FOR OPTIMIZING THE ENTIRE PROCESS







INTELLIGENT WEIGHING TECHNOLOGY

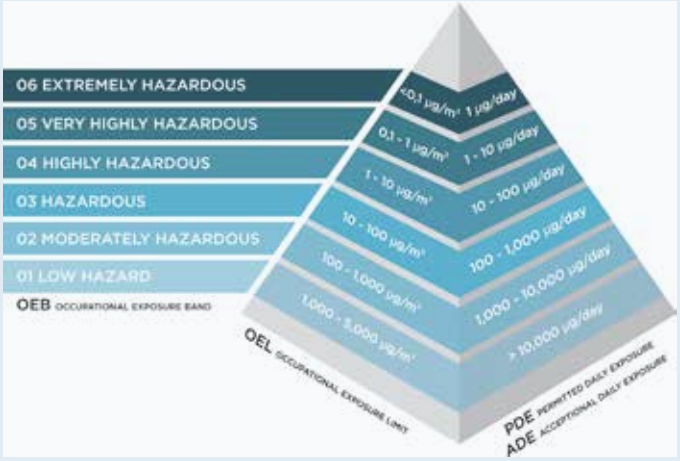
Coperion K-Tron's "Smart Force Transducer" SFT technology with vibrating wire technology makes high-accuracy weighing possible, even in difficult plant environments. The dynamic filter algorithm continuously identifies and extracts disruptive mass components from the weight measurement, even under difficult process conditions. Thanks to this digital filter, SFT load cells are able to deliver precise, stable, and reliable weight measurements under any operating conditions. The high resolution (1:8,000,000 in 20 ms) and 90% fewer parts, together with the fast-acting KCM-III control unit, provide maximum output and reliability.

ELECTRONIC PRESSURE COMPENSATION

Electronic Pressure Compensation (EPC) for high-accuracy loss-in-weight feeders is an efficient yet simple electronic solution for reliable and continuous pressure compensation in the feed hopper. This modular system is based on high-accuracy pressure sensors and electronic components that integrate seamlessly with the Coperion K-Tron feeder control. In comparison to conventional mechanical pressure compensation systems, EPC improves feeding accuracy and reliability with lower costs and simple installation.

ACTIFLOW BULK SOLID ACTIVATOR

The ActiFlow™ bulk solid activator is a device with no product-contact parts that reliably prevents poor flowing and cohesive materials from bridging in loss-in-weight feeders. This intelligent system emits gentle vibrations onto the hopper wall, carefully activating the bulk material inside with the optimal amplitude and frequency. The ActiFlow Control Module communicates continuously with the KCM feeder controller in order to achieve optimal material flow in the hopper and maintain very high feeder accuracy.



Containment & Cleaning When Handling Toxic Materials

Since many materials used in manufacturing battery materials are toxic, containment is an important factor when selecting suitable equipment. With their modern, dustproof seal design, Coperion K-Tron feeders and conveying components are ideal for strict containment requirements.

Along with containment, component cleaning also plays an important role. Products must be safe and easy to clean following production. By using a dry cleaning concept, easy disassembly, and isolation from the process, equipment can be cleaned thoroughly and with minimal risk of contamination.

>CONTAINMENT CLASSIFICATION

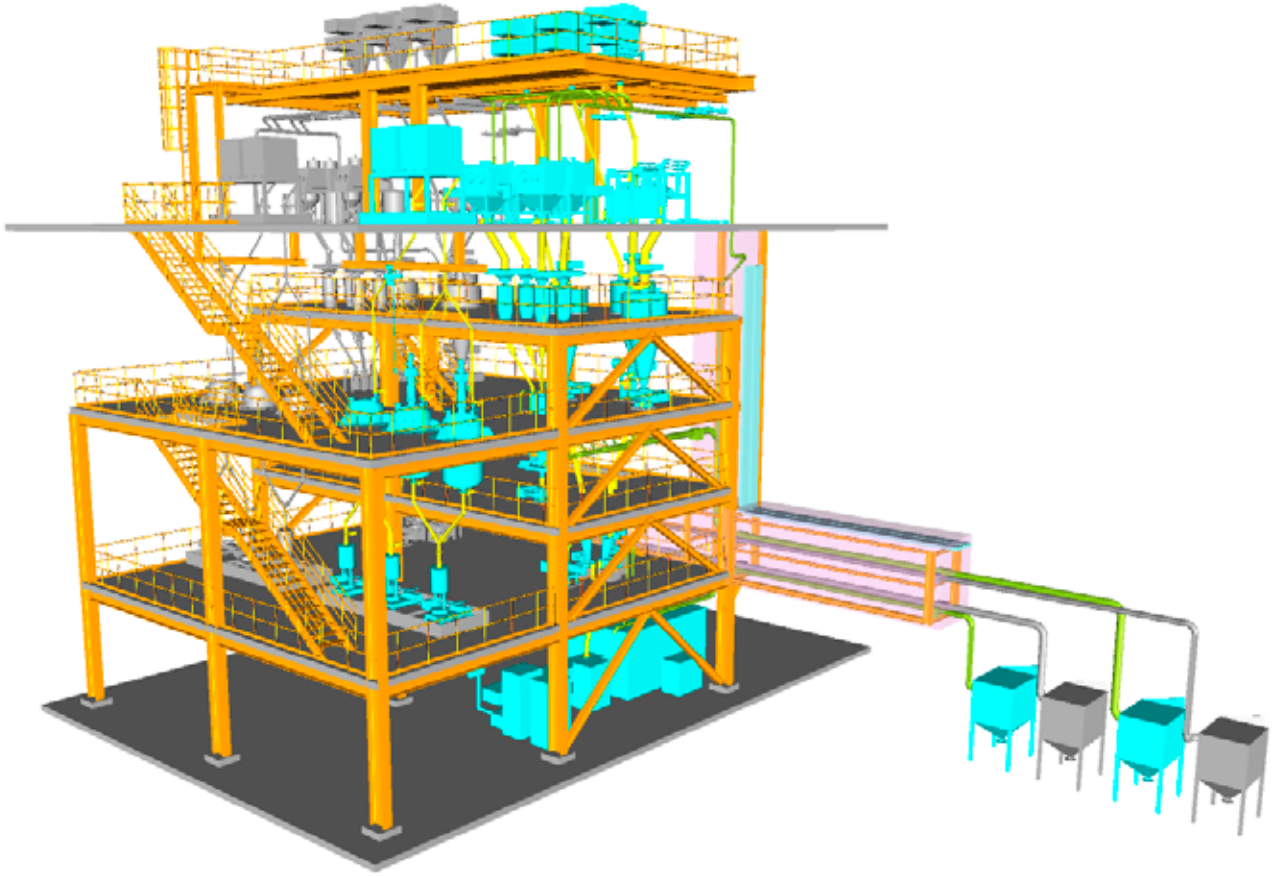
Expertise in system design: From raw material handling and conveying to feeding and extrusion, Coperion delivers everything from a single source.

Coperion realizes complete systems — from raw material handling and conveying to feeding and extrusion — all from a single source. Many years of experience and comprehensive process expertise in the areas of system planning, development, and realization make us your ideal partner. We ensure that a corresponding containment concept is developed, planned, and implemented for the entire system.

At every step — from raw material to slurry handling — production takes place under suitably protected conditions, including aspiration concepts and dust-tight component designs, to name a few examples. Many years of expertise in bulk solids technology, as well as plant engineering (planning, manufacturing, assembly, commissioning), make Coperion the right partner to optimally design the supplied system, both technically as well as with regard to work and environmental safety, even for hard-to-handle bulk materials. Coperion pneumatic conveying systems are available to support production systems. Requirements regarding containment, ATEX and cleanability are taken into account accordingly during plant design.

CAREFUL PLANNING ENSURES SUCCESS

Moving from batch processing to continuous production of cathode and anode masses offers battery manufacturers a variety of long-term advantages. As with any process changeover, however, it is important that goals and expectations be clearly defined. With comprehensive expertise in the field of battery production that reaches far beyond manufacture of the process plant, Coperion supports you in the changeover to continuous production. Together, we will examine requirements and adapt to changing factors in the course of the project to shorten the time to production startup and to deliver products in the expected high quality right from the start.



COPERION OFFERS ENTIRE SYTEMS FROM A SINGLE SOURCE FOR CONTINUOUS BATTERY COMPOUND MANUFACTURING

Development of battery compounds at the Coperion test lab. We help you safely optimize your processes.

Coperion test labs offer you the ideal platform for testing changes or innovations to your products or recipes. In addition to our simulation and scale-up expertise, we have outstanding equipment at our disposal for comprehensive tests and development of processes under realistic production conditions.

Your advantages at a glance:

- Individual questions and problems can be addressed in test environments
- All tests take place under adherence to local regulations for handling CMR substances
- Tests from raw material feeding to discharge of battery compounds: Various extruder sizes and a broad portfolio of over 100 suitable Coperion K-Tron feeders are available for use
- Analysis of bulk material properties of the raw materials being used

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the worldwide Coperion network,
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