Munters



Engineering your perfect climate

How to control moisture in battery production



Introduction

In the highly competitive world of battery production, achieving the right environmental conditions is mission critical. Lithium salts and electrolytes react aggressively with water vapor, posing serious risks to product quality, performance, and safety. Even minimal humidity can trigger dendrite formation, reduce cell longevity, and cause costly production defects. That's why precision humidity control is vital for success.

Desiccant dehumidifiers play a decisive role by creating the ultra-dry, ultra-stable conditions that protect sensitive battery materials and ensure consistent manufacturing quality. By maintaining extremely low dew points, they help battery manufacturers increase product yields, enhance safety, optimize uptime, and lower operational costs.

Munters stands at the forefront of dry room climate control, offering total solutions that cover the entire lifecycle of battery production facilities – from design and installation to long-term service and optimization. With decades of gigafactory experience, Munters helps customers worldwide scale from R&D labs to mass production, delivering reliable low dew points and energy-efficient performance, year after year.

For gigafactory applications, Munters product portfolio includes solutions specifically developed for the battery industry – the Munters LDP (Low Dew Point) and the Munters ISA (Integrated Standard Air handler) dehumidification systems, designed to meet the demanding conditions of large-scale production environments. For applications where lower flows are required, be it research, university, production or laboratory-scale operations, the Munters HCD (HoneyCombe Dehumidifier) provides flexible, high-performance options tailored to smaller dry rooms.



Dry room challenges

In battery production, dry rooms are not just an operational requirement – they are a cornerstone of manufacturing success. Yet designing and maintaining these critical environments brings a host of challenges that can directly impact product quality, factory uptime, and profitability.

Achieving and maintaining dew points of -40 to -70°F or even lower (ultra-low dew points), requires precise climate control across large and often complex facilities. Every door opening, every process exhaust, and every human presence adds moisture and heat, which can destabilize carefully controlled conditions. As battery chemistries evolve – with some becoming even more moisture-sensitive, the need for tighter, more reliable environmental control continues to grow.

Energy efficiency presents another major hurdle. Dry rooms can be among the most energy-intensive areas in a battery plant, consuming up to 40% of the total energy needed at the plant. Without optimized dehumidification systems, operating costs can spiral, hurting competitiveness and eroding margins. Designing systems that minimize energy use while delivering reliable low dew points is crucial to long-term success.

Scalability and flexibility are equally important. As production volumes increase and chemistries change, dry room systems must adapt – without costly redesigns or downtime. Building resilience into the infrastructure today protects productivity tomorrow.

With more than 40 years of experience in battery dry room solutions, Munters understands these challenges inside and out. Our proven technologies, expert design capabilities, and tailored service offerings help customers overcome complexity, safeguard product integrity, and reduce total costs – from the first cell to full-scale gigafactory operations.

Application overview

Environmental demands shift dramatically across different stages of the battery manufacturing process. Each phase – from electrode fabrication to final pack assembly – has specific humidity and cleanliness requirements. Matching the right dehumidification technology to each step is essential to maintaining product quality, optimizing operational efficiency, and supporting future scalability.

Munters offers a comprehensive range of dry room solutions engineered to meet the full spectrum of requirements, from research labs to gigafactories. Our dehumidification systems deliver exceptional performance at every stage, helping manufacturers stay ahead as battery chemistries and production demands evolve.

Most battery manufacturers today maintain dew points of < 0°F all the way down to -75°F (or sometimes lower), depending on the battery chemistry and the specific manufacturing stage. Munters systems support a wide range of advanced chemistries, including:

- → **Lithium-ion** (NMC, LFP, NCA, etc.)
- → **Sodium-ion**
- → **Lithium-sulfur**
- → **Solid-state**

Below is an overview of Munters product applications across key battery manufacturing stages:

Manufacturing stage	Dew point target (°C)	Dew point target (°F)	Cleanroom classification	Munters product
Electrode fabrication	-35	-30	ISO 8	ISA
Cell Assembly	-50	-58	ISO 5/6	LDP
Formation and Aging	-30	-22	ISO 7/8	ISA
Module and Pack Assembly	Varies by design	Varies by design	ISO 7/8	Varies by requirement

Achieving and maintaining the correct dew point is not just about compliance – it directly affects battery yield, product lifespan, and safety performance. Munters dry room climate control solutions combine innovative desiccant rotor technology, proprietary purge designs, and advanced control systems to deliver the low dew points needed with maximum energy efficiency.

Whether you are scaling up pilot production or operating a multi-line gigafactory, Munters tailored systems provide the reliability, flexibility, and total performance needed to meet today's challenges – and tomorrow's opportunities.

Product range overview

When it comes to battery dry rooms, one size does not fit all. Every facility faces a unique combination of factors – from moisture loads and airflows to room access and battery chemistry – that influences the right choice of dehumidification solution. Designing the right climate control system is about precision matching: selecting the right product and configuration to optimize both performance and total cost of ownership.

Munters dry room portfolio offers a flexible range of solutions tailored to meet these varying demands. Our LDP, ISA, and HCD desiccant dehumidifiers are engineered for superior performance across different applications, providing both the ultra-low dew points and energy efficiencies that modern battery production demands.







	LDP	ISA	HCD
Dew point	-40°F > DP > -75°F	0°F > DP > -40°F	0°F > DP > -75°F
RH	1% > RH > 0.1%	35% > RH > 1%	35% > RH > 0.1%
Flow range (CFM)	12000 - 32000	5000 - 32000	500 - 10000*
Rotor	Munters Media (HPX)	Munters Media (HPS)	Munters Media (HPX / HPS)
Purge configuration	PowerPurge Plus or Green PowerPurge*	PowerPurge	PowerPurge Plus, Green PowerPurge, or PowerPurge
Unit design	Standardized across product platforms	Standardized across product platforms	Standardized
Unit footprint	45% lower than average industry standard	45% lower than average industry standard	
Unit configuration	Preconfigured design	Preconfigured design	Modular design
Reactivation energy cost	Up to 40% lower than industry standard*	Up to 40% lower than industry standard*	Up to 40% lower than industry standard*
Chilled water cost	Up to 30% lower than industry standard*	Up to 30% lower than industry standard*	Up to 30% lower than industry standard*

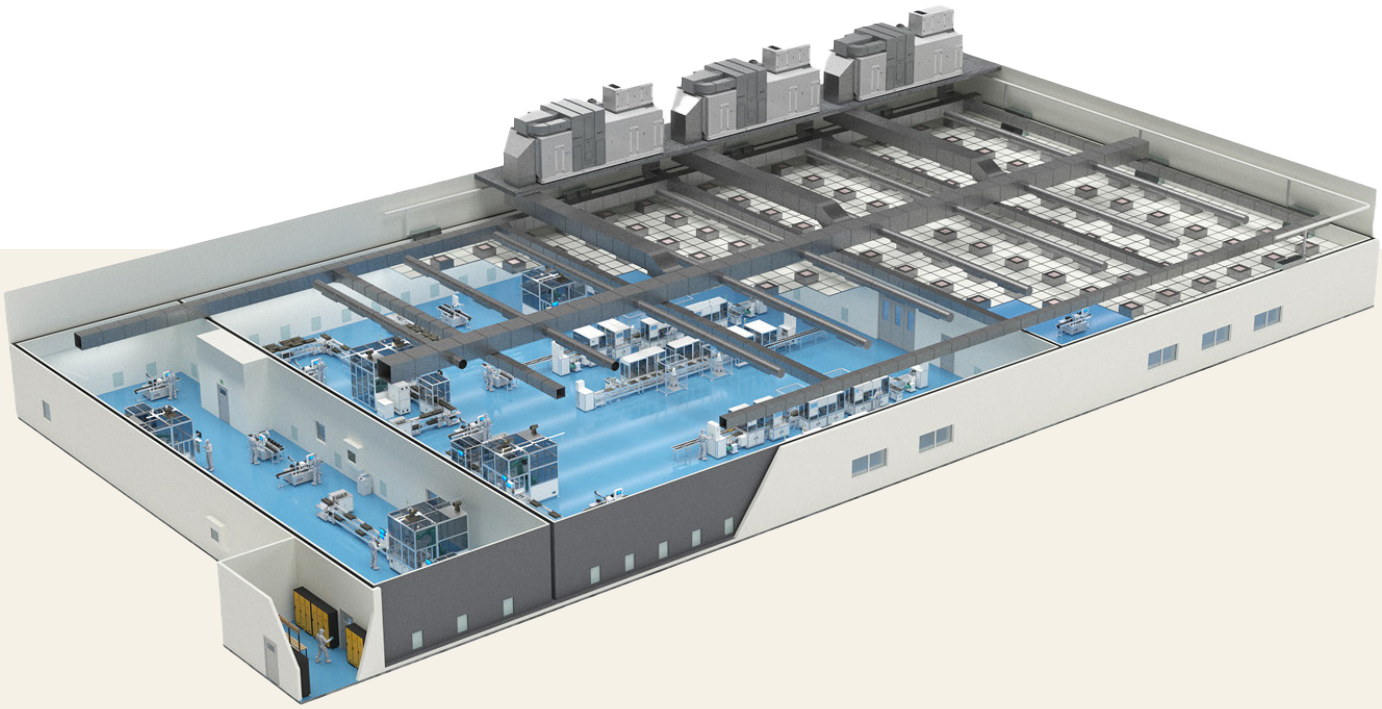
*Based on operating conditions

Product range overview

Each climate control system is configured for optimal efficiency and reliability, ensuring faster project execution while minimizing design complexity.

In addition to achieving ultra-low dew points, Munters dehumidification solutions extend to broader climate control needs across battery production facilities. The Munters ISA dehumidification system is designed for flexibility, supporting integrated air handling requirements such as temperature and moisture control, filtration, and multi-zone environmental management. Munters ISA dehumidification systems enable manufacturers to optimize energy efficiency across the plant, ensure compliance with stringent cleanroom classifications, and adapt easily to evolving battery chemistries and production layouts. This comprehensive approach highlights Munters ability to deliver total climate solutions for the entire facility environment.

Whether designing for a large-scale, multi-zone gigafactory or a specialized R&D lab, Munters solutions empower battery manufacturers to achieve higher product yields, lower operational costs, and easier expansion for future growth.



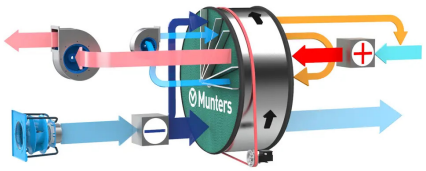
Rotor range overview

At the core of every Munters dry room solution is a technology that sets us apart: the desiccant rotor. In battery production, where maintaining ultra-low dew points is critical, the quality of the rotor and purge system directly determines energy efficiency, performance stability, and long-term operational cost.

Munters is the only company offering desiccant rotors specifically engineered for battery dry rooms. Our proprietary HoneyCombe® rotor technology, combined with advanced purge designs, delivers unmatched performance in even the most demanding production environments.

Designed to perform: Munters rotor and purge innovations

Munters offers multiple energy-saving purge designs, all built around decades of research, customer insight, and field-proven performance:



PowerPurge: Munters standard energy-saving purge, significantly reducing reactivation energy requirements.

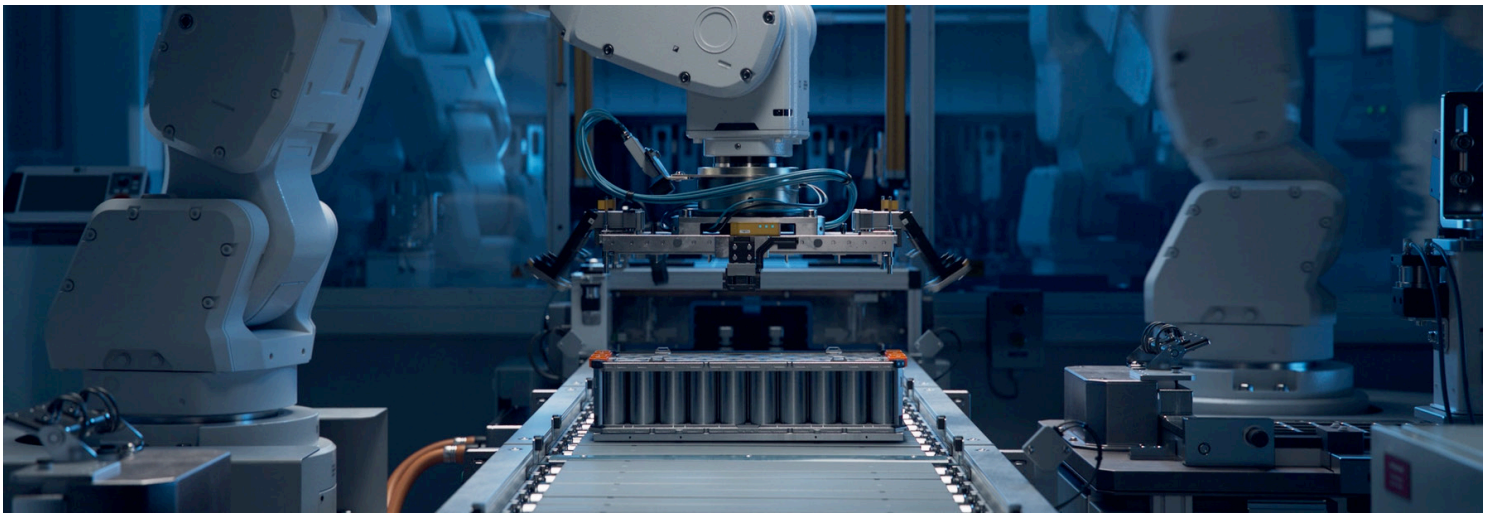
Green PowerPurge: An innovative step-up optimizing the purge and react configurations, helping provide additional operational savings through efficient design.

PowerPurge Plus: Our latest innovation, specifically optimizes dry room performance for low dew point applications between -40°F and -75°F – and even lower in some cases.

The PowerPurge Plus system represents a breakthrough in dry room efficiency. It leverages a proprietary, patent-pending design that:

- Utilizes clean, filtered process air to feed the reactivation subsystem.
- Eliminates the need for additional pre-treatment systems, reducing installation complexity and maintenance requirements.
- Recovers parasitic heat at the purge transition, improving reactivation efficiency and lowering chilled water demands.
- Delivers up to 40% lower reactivation energy costs and 30% lower chilled water requirements compared to industry standard systems.

The combination of Munters purge designs and proprietary desiccant wheel media help improve the overall dehumidification system efficiency. With reduced chilled water consumption during operation, customers can specify lower capacity chillers, further decreasing both capital costs and operating expenses.



Savings

In addition to the direct savings from the product offerings, a solution from Munters will generate a number of other economic benefits including:

Total project capital cost (CAPEX) savings

In a use case scenario, a 20% overall chilled water usage reduction translates to 20% reduction in chiller size specification, which means 20% CAPEX savings on the chiller system for the factory. This could amount to millions of dollars saved. Additional capital savings on hot water capacity, ductwork and pipe sizing will also help the bottom line.

Shorter project design duration

Munters expertise, together with our proprietary Genesys software program and flexible purge options, streamlines the design process resulting in quick customer response time with equipment specifications, drawings and energy analyses. This can reduce the factory design/build project timeline by 3-4 months.

Quicker startups

Munters expansive service network is highly experienced in commissioning and dry room controls integration at battery gigafactories. Our team is ready to help you from day one, ensuring a smooth and efficient startup of your factory.

Better factory space utilization

Munters state-of-the-art purge design systems require smaller components and more compact system designs, saving about 40% on total footprint, and reduced freight costs. This frees up valuable space in the factory for more revenue-generating activities.

Lower installation costs

Munters standard system designs require 25-30% less energy, which means fewer utility connections and lower crane placement costs for smaller systems.

The Munters difference

Choosing the right dehumidification partner is critical for battery manufacturers aiming to scale operations, enhance quality, and maintain profitability in a competitive global market. Munters stands apart as the proven leader in dry room climate control – combining decades of technical innovation with an unwavering focus on customer success.

Pioneers in dehumidification technology

Munters invented the desiccant rotor more than 70 years ago, and we have been driving dry room innovation ever since. Today, Munters is the only company offering desiccant rotors specifically engineered for the unique demands of battery production, supporting ultra-low dew points and providing exceptional energy efficiency.

Tailored, total solutions

Every battery facility is different. Munters designs and delivers systems that address every critical element – from dry room design and dehumidification equipment to installation, commissioning support, and long-term service support. Our climate control solutions are built for flexibility, scalability, and future-readiness, helping customers adapt to new chemistries and production expansions with minimal disruption.

Proven performance and reliability

Munters dry room climate control systems are trusted by major battery manufacturers around the world, with equipment still operating reliably after more than 40 years in the field. We help protect production uptime and product quality, reducing operational risk and maximizing ROI across the entire factory lifecycle.

Munters dry room solutions are engineered for full operational resilience and energy optimization across the facility:

- Built-in unit-level and plant-level redundancies help safeguard uptime and minimize production risks.
- Scalable system designs enable seamless future expansion and flexibility to adapt to changing manufacturing needs.
- Remote monitoring and diagnostics capabilities support proactive maintenance, rapid troubleshooting, and reduced downtime.
- Potential for integration with plant waste heat recovery and solvent recovery systems to help lower energy consumption and enhance sustainability.

Key factors that set Munters apart:

- → Dehumidification pioneers with a history of firsts and continual innovation.
- → Rotor technology developed specifically for battery production needs.
- → Total solutions covering design, installation commissioning support, and service.
- → Superior energy efficiency, reducing operating costs by 25–30% compared to industry standards.
- → Global service network providing expert support for faster startups, optimized performance, and ongoing reliability.
- → Future-ready designs that prepare manufacturers for new chemistries and lower dew point demands.

When it comes to creating high-performance, scalable, and cost-efficient battery production environments, Munters delivers more than equipment – we deliver peace of mind, operational excellence, and a platform for future growth.



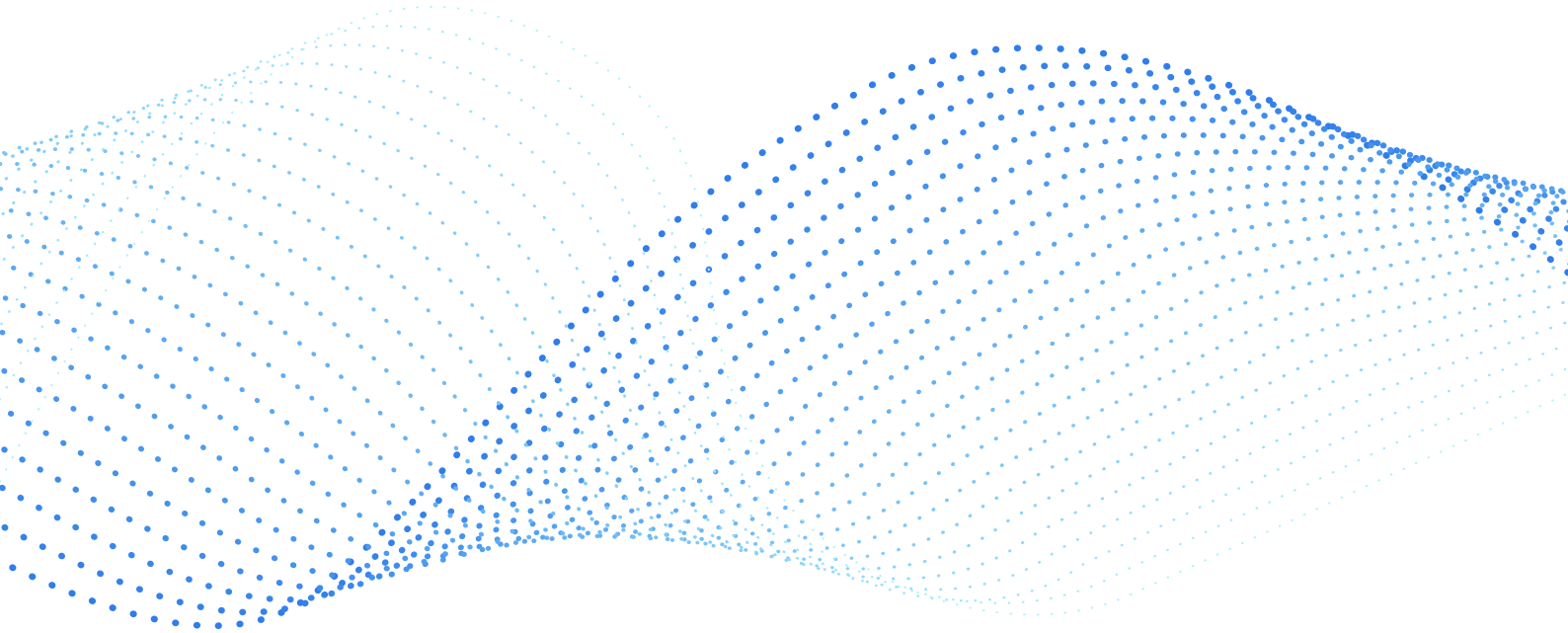
Design considerations and support

If you're in the process of designing a dry room, the most important things to consider are your required dew points and your moisture loads.

However, as with any large and/or complex project, there are many additional considerations to cover. With this checklist, you can make sure you've considered all aspects that will result in the best possible solution for your business:

- Over the life of the dry room, the OPEX is likely to be many times that of the original CAPEX, and there is a large cost impact for over specifying. Are the environmental conditions accurate and is the equipment sized appropriately?
- Will it be used for R&D, manufacturing or both?
- What's the level of automation/number of occupants?
- What level of cleanliness is required *(filtration; ISO classification)*, and do you need validation?
- Plans for future expansion? Have you accounted for this in planning?
- Do you need flexibility to modify operation, adjust conditions, or change, service or incorporate new equipment?
- Are you minimizing OPEX with the types of energy available; heat recovery opportunities, and low cost/green energy options?
- Will your plan include practical and pragmatic controls and remote monitoring?
- Have you considered product workflow, door and staff discipline?
- What are your service and maintenance access requirements?
- Will you need remote access and diagnostic capabilities?
- What are your solvent recovery requirements?

This checklist is a good start, but to really find the best solution, you need an expert partner with the best technology.



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Would you like to find out if Munters has a solution for your company too?
If so, please visit our website www.munters.com.

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