Munters

White paper

How to get the right climate

for your lithium-ion battery manufacturing

Introduction

The demand for lithium-ion batteries is greater than ever before, and this trend looks set to continue long into the future. They are in the phones we use every day, the laptops we work on, the tools we fix things with, the medical devices we rely on, and they are in the cars that we could be driving tomorrow. This, in particular, is leading to a boom in the amount of production facilities opening all over the world.

Electric vehicles are becoming more popular every day, and as battery technology improves, they are also becoming more viable. As countries look to reduce vehicle-related emissions, with some even banning the sale of new combustion-engine-equipped cars from 2025, battery manufacturers need to increase capacity and capability when it comes to producing lithium-ion batteries.

The technology has advanced significantly over the years, and will likely continue to do so. Manufacturers want batteries that have higher storage capacities, that last longer, and that charge quicker. Through research and development this is all realistic, but one of the most important factors will continue to be the production environment.

Extremely dry conditions are required for lithium-ion battery manufacturing, which means production facilities need specially designed dry rooms. Since these dry rooms play a vital role in the manufacturing process and have a significant impact on the final product, it is essential to choose the best solution that suits your needs.

In this white paper we will cover:

- → Why you need a dry room
- → How it works
- → Why it is crucial to production
- → Key design considerations
- → Optimizing dry room designs for the future

Why you need a dry room

Lithium and other materials are highly reactive to moisture, so when using them as the basis for battery production, it is essential to operate in exactly the right dry environment. Lithium-ion technologies involve a variety of chemistries, but all variations benefit from precisely controlled climates including humidity control. There are a number of reasons for this, from ensuring the highest possible quality and production yield to providing a safe working space for employees. So what makes dry rooms the ideal solution?

Meeting the required dew point

More important than anything else, you need a dry room to be able to meet the right dew point. The dew point is the temperature at which water vapor in ambient air starts to condense. Dew point is an indication of water content, so the lower the dew point, the lower the water vapor content in the air.

The dryness is essential due to the reactivity of lithium. If there is too much moisture in the air, the lithium could cause fires or even an explosion. At the very least, it would ruin the integrity and quality of the final product.

The generally accepted dew point for lithium-ion battery production is -40°F, although there are signs of this dropping further in the future due to new battery chemistries which may be more moisture sensitive.

Glove boxes or inert chambers can be used for small-scale R&D lab tests but for pilot production or high-volume production, more equipment and more space will be needed. The only alternative to reach the necessary dew point is by using efficient dehumidification technology designed specifically to create this environment within an enclosed space, which is known as a dry room.

Ensuring the best battery quality

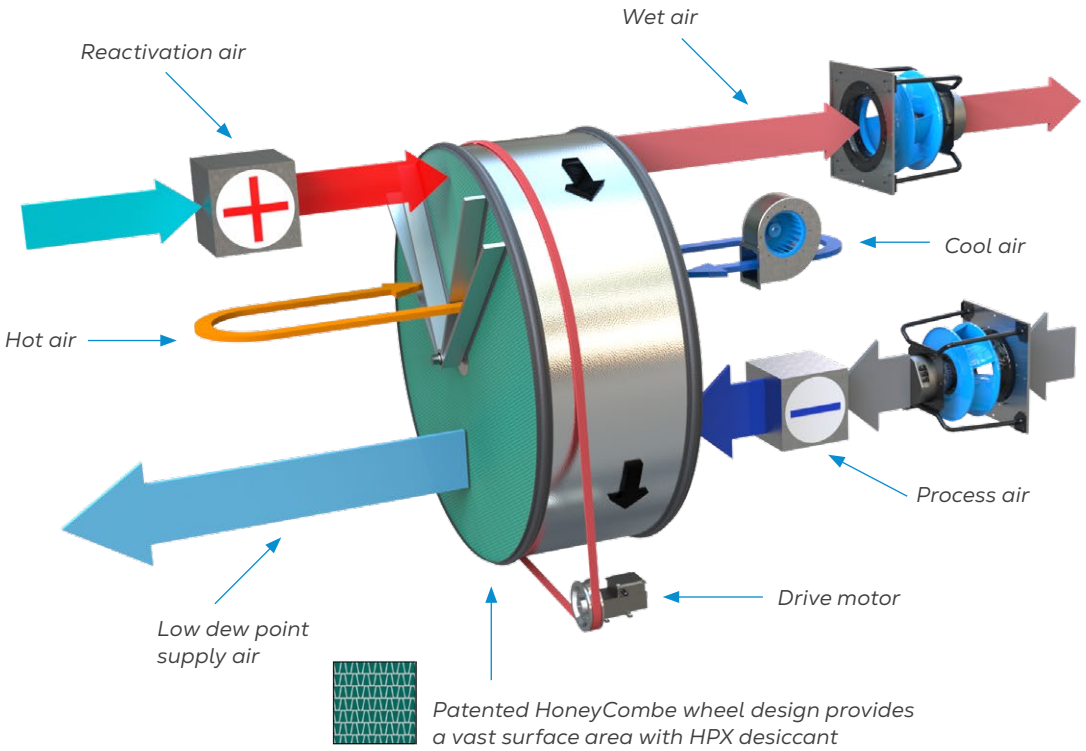
Lithium-ion batteries are more important than ever before, as we rely on them for essential parts of our everyday lives, including some of the vehicles we drive or ride. People need to be able to rely on the technology, and any issues could result in quality or safety issues for a manufacturer or specific production facility.

Any moisture in the air, even if it is not enough to cause a noticeable reaction, can compromise the quality of the battery once it is finished. This can impact anything from the cell performance to the lifetime of the battery, so an effective dry room can ensure that only the best products get into the hands of the customers.

Health and safety

The people working with lithium-ion battery production need to be able to do so in a safe, secure environment. Dry rooms help ensure that there is no risk of an adverse lithium reaction, as they maintain a suitably dry and stable climate and prevent excess moisture which is a potential source of problems at certain points in the production process.

The dry room technology must also account for the number of occupants at any given time, and adjust to compensate for the increases in temperature and moisture they generate, as well as any fresh air requirements.



How it works

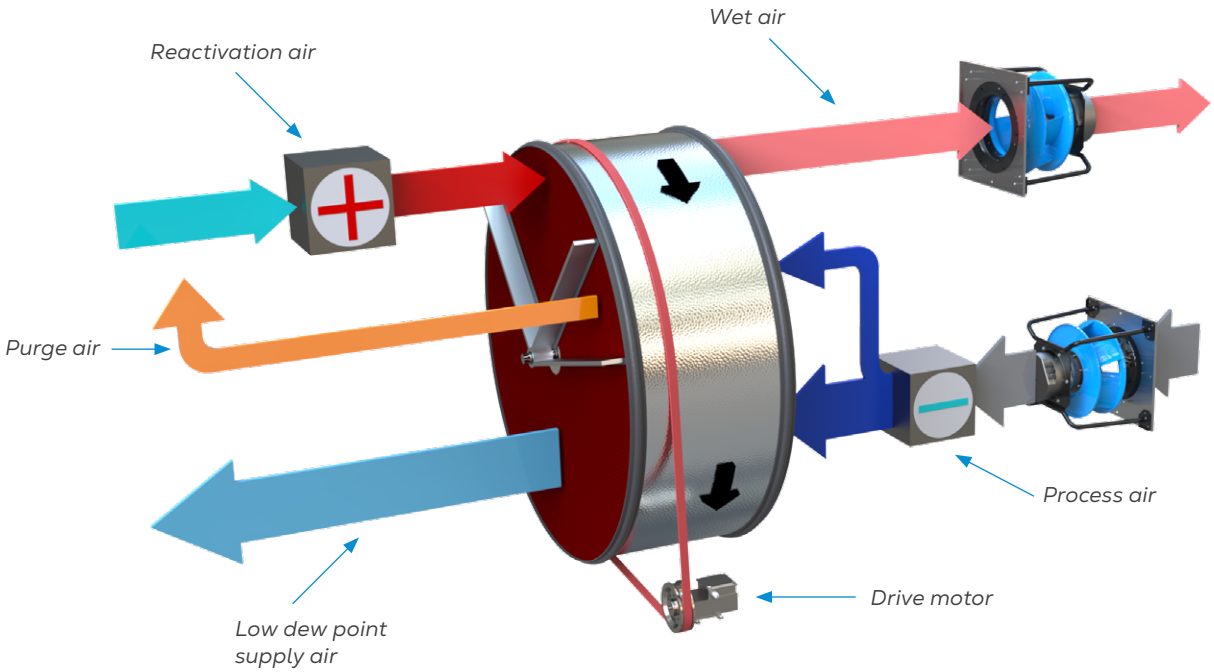
The task of a dry room is, as the name suggests, to provide an atmosphere as free from water vapour as possible. In lithium-ion battery production, dew point is commonly used to define the required level of moisture, and above which there would be a major problem. For example, the technical specification for a dry room may call for the room dew point to be at -40°F. This equates to about 0.55 gr/lb (grains of moisture per pound of dry air) or 79 PPM.

The optimal way to achieve this is through desiccant dehumidification. The better the technology, the drier the air can be, and the less energy that needs to be expended to achieve it.

For example, desiccant rotor dehumidifiers use heated reactivation air to continuously regenerate the rotor for further moisture adsorption. Munters innovative purge technology reduces the required reactivation energy by up to 45%.

Green PowerPurge technology

- → Process air (return air from dry room plus fresh outside air) passes through the drying wheel and leaves as low dew point dry air
- → Heated reactivation air collects the moisture adsorbed by the drying wheel and is exhausted as “wet” air
- → Green PowerPurge loop provides additional energy recovery by recovering the heat left over in the wheel after reactivation, which is then used to preheat the wheel media before reactivation
- → Reactivation energy needed to collect the moisture adsorbed by the drying wheel is reduced by 45%



Industry standard energy purge

- → Process air (return air from dry room plus fresh outside air) passes through the drying wheel and leaves as low dew point dry air
- → Heated reactivation air collects the moisture adsorbed by the drying wheel and is exhausted as “wet” air
- → Purge air provides nominal energy recovery by recovering heat from the wheel as it exits the reactivation section and supplements reactivation air

Industry standard purges steal process air for reactivation, which leads to a reduction in the volume of dry supply air available for the dry room. As a result, larger equipment becomes necessary to provide the same amount of air.

Since dry rooms consume significant amounts of energy, manufacturers can greatly benefit from adopting more energy-efficient designs that minimize energy consumption and optimize operational costs.

Energy comparison

Munters GreenPowerPurge vs industry standard purge technology

The case below compares energy usage for dehumidification systems using the Munters Green PowerPurge (GPP) and industry standard energy purge technologies. Reactivation gas consumption and refrigeration/cooling energy consumption is shown for an example dry room requiring 9,618 scfm of low dew point supply air.

Supply airflow rate	9,618 scfm
Ambient air conditions	90°F DB, 154 gr/lb
Room conditions	68°F DB, 0.49 gr/lb (-42°F DP)
Operating hours per year	8,760

Utility cost assumptions		
Refrigeration costs	$ 0.044 per kWh	$ 0.16/ton
Natural gas costs	$ 0.033 per kWh	$ 1.02/therm

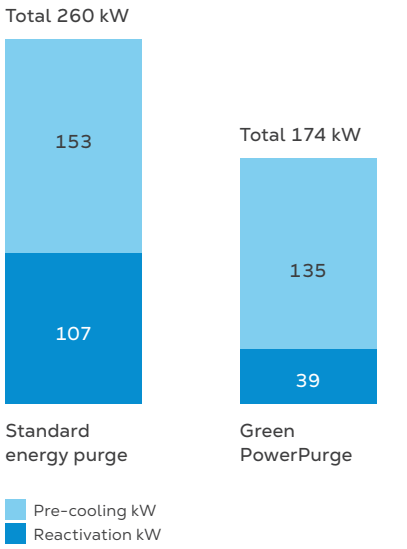
** Note: Costs based on US rates in 2023.*

	Munters Green PowerPurge	Standard energy purge
Annual reactivation gas	$11,253/year	$30,889/year
Annual refrigeration	$51,948/year	$58,878/year
Annual total cost	$63,209/year	$89,756/year
Annual savings with GPP	$26,559/year	No savings

** Note: Costs based on natural gas reactivation. However, electricity and steam are also available as reactivation options.*

***scfm = standard cubic feet per minute*

Green PowerPurge comparison



Why it is crucial to production

Achieving the right dew point is absolutely essential, and it can have a serious impact on your battery production if your dry room does not meet the necessary standards. Issues with moisture in the air can cause:

Health and safety problems

Workers could potentially be injured if handling lithium when it reacts to moisture in the air.

Production issues

Optimal uptime is essential for any kind of production. If your dry room is not working as you need it to, you may need to stop production unexpectedly, which can lead to lost product and significant cost implications.

Poor product integrity

Batteries produced in a sub-optimal environment tend to be less safe and reliable, as well as offering lower energy densities, performance levels and lifespan. In the long term, these quality problems will have a negative impact on future business contracts.

Increased waste

Moisture in the air could lead to throwing away batches of faulty batteries, which is bad for the environment and will hit your bottom line.

High operating costs

Less efficient systems can not only lead to more moisture in the air, but they can also cost much more in annual energy consumption for the life of the factory.

Reputational damage

If sub-standard batteries make it to market, this could hurt your reputation, and lead to loss of future business.

Key design considerations

If you are in the process of designing a dry room, you need to know what to consider. 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. The most important thing to consider is your required dew point – this will depend on the intended use of your batteries, type of electrode chemistry, liquid or solid electrolyte and scope of operations in the dry room.

Also important is to consider the number of workers that will be present at any one time as this is the largest contributor to moisture load in a dry room.

With this checklist, you can help make sure you have considered many of the key aspects that will help result in the best possible solution for your business:

What dew point is required?	
Will the dry room be used for manufacture, R&D or both?	
What is the level of automation, and thus expected number of occupants?	
What level of cleanliness/filtration is required?	
Do you need to meet a specific ISO classification?	
Do you need to provision for redundancy?	
Do you need to account for future expansion?	
Do you need flexibility to modify operations in any way? (e.g, adjusting environmental conditions or changing the room layout)	
Are there any requirements to change/service/incorporate new equipment?	
To minimize OPEX, what types of energy are available; heat recovery opportunities; low cost/ waste/green energy; Munters patented Green PowerPurge?	
What are your daily control requirements? (e.g. night set-back mode, remote monitoring and diagnostics)	
What is the product workflow, and implications for door activity and discipline?	
What are the requirements for service and maintenance access, and any related downtime?	
What is the heat load generated in the room from operating equipment?	
What is the exhaust air volume to ambient e.g from coating, electrolyte filling and any other operations that may contain contaminants/require air extraction?	
Are there any 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.*

Optimizing dry room designs for the future

Munters can offer the most advanced, efficient dry room dehumidification solutions, and has a global network of expert engineers dedicated to equipment reliability and preventive maintenance services. We know that the design process and partnership is important, and we are there to offer advice and answers every step of the way.

One innovation that really sets our solutions apart is our Green PowerPurge technology. With this unique technology, you use up to 45% less reactivation energy and less pre-cooling, while also achieving your optimal dew point. As dry rooms can be costly to run, these savings (total annual system savings of 30% include react energy, pre-cooling and motor loads) can make a real difference to your bottom line, offering a quick return on investment alongside a lower total cost of ownership (TCO) than the competition.

When it comes to preparing for the future, we are able to provide the best in dehumidification technology. Today's standard dew point is -40°F, but this could easily drop in the future as scientists uncover new, potentially more powerful chemistry for batteries.

Powering tomorrow

The adoption of electric vehicles and lithium-ion batteries will accelerate once more cost-effective high-volume battery manufacturing comes on-line. Lithium, nickel, cobalt and other material costs are significant but expected to drop as additional mining capacity comes online. Similarly, factory OPEX energy costs are a significant cost implication on the ultimate battery cost and thus the electric vehicle cost to the consumer. Choosing the most energy-efficient dry room solution incorporating Munters Green PowerPurge dehumidification technology will reduce factory OPEX, allowing more competitive battery prices that fuel market growth. We invite you to the advent of a more sustainable energy future.

Munters LDP Dehumidification System

Specially developed for low dew point applications

Munters has been a trusted partner of lithium-ion battery manufacturers for over 40 years, providing them with the perfect climate for their production needs. Our latest innovation, the Munters LDP, is specially developed for low dew point applications and features the battery-specific HPX rotor. Munters LDP maintains a continuous -40°F to -70°F or even lower dew point, 24/7/365, providing uninterrupted quality production.

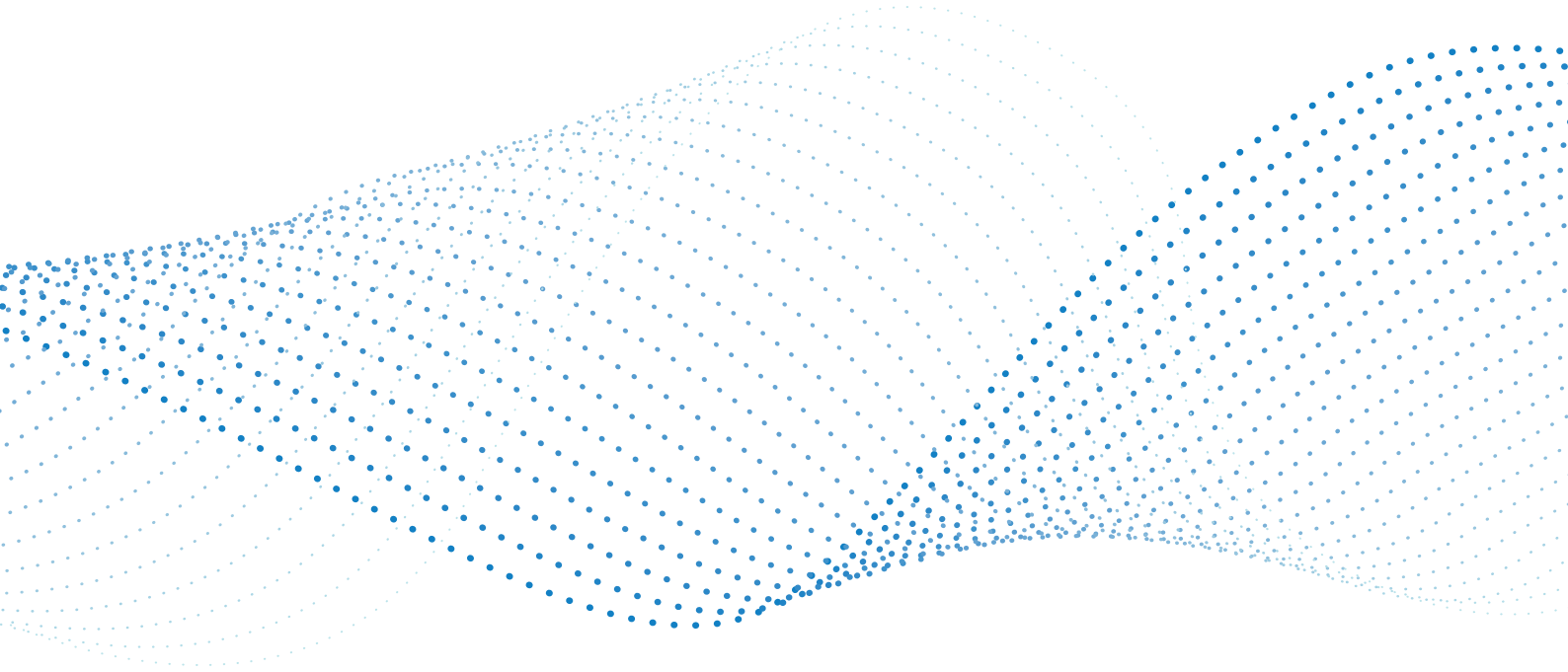
Munters LDP offers a standard design that is cost-effective, and simplifies maintenance, service, and spare parts management. With a 40% smaller footprint than the industry standard, Munters LDP is easier and less expensive to ship and install, and saves valuable space for other revenue-generating activities.

Munters LDP's optimized purge provides 30-45% energy savings compared to the industry standard purge. And the battery-specific HPX desiccant rotor is specially designed to meet high performance for low dew point applications.

Munters offers more than a benchmark dehumidification system with the LDP. As a partner with the knowledge and expertise to ensure indoor climate is always exactly as it needs to be, Munters provides support from design and quotation to on-going project management and service from our offices throughout the USA.

Our range of service includes:

- → A global network of Munters Service Engineers
- → Comprehensive commissioning service
- → Training and competence development
- → Preventative maintenance and spare parts
- → Perfomance checks and optimization
- → And much more...



Munters is a global leader in energy-efficient air treatment and climate solutions. Using innovative technologies, Munters creates the perfect climate for customers in a wide range of industries.

Munters has been defining the future of air treatment since 1955. Today, around 4,000 employees carry out manufacturing and sales in more than 30 countries.

For more information, please visit www.munters.com

LDP Battery-WP-US-202310