Desiccant Dehumidification essential in manufacture of Lithium-Ion Batteries

There are plenty of examples one could give of mainstream product manufacturing or use that are obvious candidates for humidity solutions: pharmaceuticals, food and IT equipment are just a few.

Sometimes, however, it's the least obvious areas of the industry that require the most support. Manufacturing simple lithium batteries, like the ones you would put in your TV remote, takes place in ultra-low humidity facilities known as "dryrooms". These dryrooms vary from small R&D labs up to large-scale mass production facilities. But why is this, and what would happen if the humidity wasn't right?

Like many devices in the modern world, lithium battery technology is changing all the time, and in quite dramatic ways. New materials and chemical reactions are being tested every day, all in the name of reducing costs and meeting the ever-growing demand.

But to be done efficiently and safely, these tests must be done in specially designed, ultra-low humidity dryrooms. This requirement is primarily because of the chemical reactions that can happen if they aren't.

Low moisture to high yield

The environment you work in must be very carefully considered when working with chemicals. With batteries, you have chemical components like lithium-ion, lithium iron phosphate, graphene and more, which means you need a stable environment with less than 1% humidity as these particular chemicals are highly sensitive to moisture.

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Here's where it gets scientific. A reaction between lithium and water is exothermic, which means it generates heat and produces a substance called lithium hydroxide, along with hydrogen. If left unchecked, the heat from that reaction can potentially lead to burning or an explosion. To minimise the risk, manufacturers need to reduce the water content in the air at all times, maintaining an ultra-ow humidity environment.

On top of the safety concerns, keeping air moisture levels low is necessary to help achieve high levels of product yield, better quality control, energy efficiency, cycle life and even end storage capacity for every batter produced in the plant. In short, it might be the single most important element in creating a manufacturing space for lithium batteries.

Dryroom applications

A wide range of applications takes place in dryrooms. With the advent of consumer electronics, electric vehicles, solar power and grid storage, there is a huge variety of battery production processes, each using a unique chemical process needing its own environmental controls.

As well as the chemistry, other conditions are factored before deciding on the dehumidification capacity for a dryroom. The dehumidification system must be custom designed with enough drying capacity to be able to maintain the specified conditions. Most

battery manufacturers require that a room's humidity/average moisture level be kept as low as -40°C dew point (0.5% Relative Humidity at 72°F) and sometimes even lower.

Some of the factors that need to be considered in the bespoke humidity solution include the dryroom size, type of chemistry and process, moisture infiltration, personnel activity within the room, airlocks for material and personnel movement.

And that's just the beginning. It is challenging to find a single solution that can address all of these issues, falls within budget and is reliable enough to stand up to the rigorous safety standards required by the industry.

Nexeon case study

Humidity Solutions is able to design and deliver bespoke humidity control systems due to strategic distribution partnerships with dehumidification specialists around the world who can address every unique project without having to buy multiple systems from multiple places. One of such examples is the solution provided by Cotes, the Danish dehumidification equipment manufacturer, to Nexeon in the UK.

A UK expert on silicon materials for batteries, Nexeon has been working to bring ground-breaking silicon anodes to market for the next generation of lithium-ion batteries. The company has patented a new way of structuring and etching silicon for use in such anodes, resulting in extended cycle life and a significant increase in battery capacity.

As well as boosting capacity, Nexeon technology reduces the amount of material used in lithium-ion batteries, providing the required performance at a lower cost than graphite. This breakthrough has substantial commercial potential, with the added advantage of not requiring significant changes to existing manufacturing processes.

The Nexeon pilot plant is configured to represent a commercial-scale manufacturing facility. An advanced technology dryroom is crucial for this capability because moisture dramatically reduces the performance of the electrolyte. It is essential that the levels of moisture in the air are kept as low as possible.

According to Nexeon, one of the biggest practical challenges of the process lies in the moisture introduced by the unusually many visitors to this new facility. Moisture from their bodies has a relatively big effect on the very low humidity levels in the dryroom.

Processing exceptional volumes of air

Nexeon opened a fully automated pilot plant for silicon anode production in 2010. The site was set up based around a manufacturing dryroom delivered by Scientific Climate Systems Ltd. The site was equipped with a Cotes CRP40000 adsorption dehumidification system, configured to remove unwanted moisture from 13,000 cubic metres of air per hour.

The dryroom and the CRP40000 dehumidifier — installed outdoors in a corrosion-resistant AISI 304 stainless steel cabinet — were commissioned during torrential downpours in summer 2010. Nevertheless, the new installation met or exceeded all the required specifications, and achieved an exceptionally low -74.5°C dew point.

According to Nexeon's Engineering and Operations Director Ian McDonald, the Cotes CRP40000 adsorption dehumidifier makes it possible to maintain the required dew point

and to quickly return humidity to the desired -60°C level, minimising fluctuations after visitors have exited.

This large-capacity dehumidifier unit was specially configured to comply with Nexeon requirements, with a focus on minimising energy consumption.

The CRP40000 dehumidifier was therefore fitted with an indirect gas-fired regeneration heater to dry the air, and an unusually large proportion of the dry air is recycled.

Also, a pre-cooling system was fitted to help avoid any extra energy consumption caused by temperature fluctuations and other variations in operating conditions.

Specialised control systems also give Nexeon considerable operating flexibility, either manually or automatically. This control includes reducing the dew point from the design figure of -60°C to -30°C (or higher) to meet different requirements, and reducing both dehumidification effects and energy consumption at times with less activity or lower manning levels, such as nights and weekends.

Nexeon has been able to rely on the Cotes dehumidification system truly. "It would be catastrophic for us if it were out of operation for any prolonged period. We simply wouldn't be able to make any cells at all," McDonald concluded.