# Dewpoint Measurement in Lithium-Ion Battery Manufacture

APPLICATION NOTE

SHAW MOISTURE METERS

*Accurate dewpoint measurement ensures lithium-ion battery manufacturing environments remain dry enough to prevent hazardous chemical reactions and ruined battery batches. A cell is built in stages: electrodes are coated, dried, and calendered, then stacked or wound, filled with electrolyte, and sealed. All but the last step happens with the cell open to the surrounding air. That happens inside a dry room, a production space held far drier than any occupied space would otherwise need to be. It is split into zones because the different process stages are not equally sensitive to moisture.*

*Trace moisture is the contaminant a dry room exists to control. Water vapour reacts with the LiPF6 electrolyte and with residual lithium left on the cathode surface. Both reactions degrade cells before they're even sealed, and the gas they generate can swell a finished pouch cell. Dewpoint, not relative humidity, is the figure that measures and controls that risk.*



## Why Moisture is a Problem in Lithium-Ion Battery Manufacture

Moisture specifications in a dry room are strict for good reason. Process modelling published by Argonne National Laboratory puts the working target below 100 ppm(v). Holding that figure in a modest 16,000 cubic-metre dry room took roughly 400 kW of dehumidification energy in that same study. Four mechanisms explain why the number has to be that tight.

### Electrolyte Hydrolysis and HF Formation

LiPF6, the lithium salt dissolved in the electrolyte, reacts with trace water to form hydrofluoric acid and other decomposition products. HF attacks current collector foils and inter facial layers, degrading the electrolyte and the cell's capacity over its working life.

### Slurry Gelation at the Coating Line

High nickel cathode materials carry residual surface lithium compounds that react with atmospheric moisture to form lithium hydroxide and lithium carbonate. Enough exposure during coating changes the slurry's viscosity and rheology. That shows up as gelation on the coating line rather than later at the finished cell, which makes it a yield problem long before it's a safety one.

### Disrupted SEI Formation at the Anode

The solid electrolyte inter phase, the passivation layer that forms on the anode during the first controlled charge, needs a moisture free surface to form correctly. Water reaching the anode before or during formation increases irreversible capacity loss and drives gas generation during that first cycle.

### Gassing and Pouch-Cell Swelling

The gas these reactions generate raises internal pressure, most visibly as swelling in a finished pouch cell. In lithium metal and solid state work, lithium itself reacts directly with water to give lithium hydroxide and hydrogen gas, a safety hazard as much as a quality one.

Each mechanism starts the same way: water vapour reaching a moisture-sensitive material before the cell is sealed. Each is preventable by keeping the room that material sees inside its specified dewpoint tier, which is why the measurement matters as much as the dehumidification equipment itself.

## Dry Room System Diagram

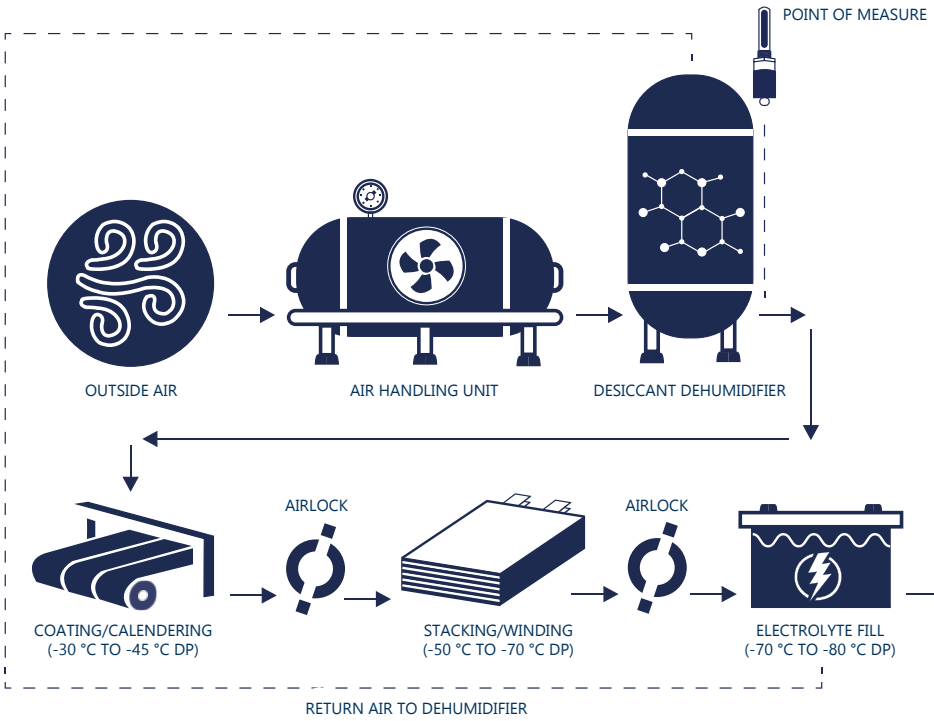



*Figure 1. Dry room air-handling architecture common to lithium-ion cell assembly. Zone dewpoint tiers vary by process and chemistry; formation runs on sealed cells at ambient conditions.*

## Measuring Dewpoint in Lithium-Ion Battery Dry Rooms

Measure dewpoint continuously, in each zone, not only at the dehumidifier supply.

That rule exists because the zone reading is what the product actually sees, not the supply reading. Standard relative humidity probes are built and calibrated for the ordinary human comfort range, so they lose resolution as conditions approach the extremes a dry room runs at, well under 1% RH. Dewpoint stays a meaningful, resolvable figure at those extremes, which is why it, not %RH, is the number a dry room is specified and controlled against.

### Dry Room Supply and Zone Monitoring

A fixed transmitter at the dehumidifier outlet confirms the desiccant unit is performing. Further transmitters inside each zone (coating and calendering, stacking or winding, electrolyte fill) confirm what that zone is actually holding. Each zone runs its own dewpoint tier: typically -30 °C to -45 °C for general assembly, -50 °C to -70 °C for higher-sensitivity chemistries, and -70 °C to -80 °C or lower for solid-state and lithium metal work. A supply side dewpoint reading alone cannot show which specification a given zone is meeting.



### Electrolyte Fill and Glovebox Atmospheres

These are usually the driest, most tightly controlled points in the building. They are often run through a centralized panel with alarm outputs and a calibration certificate traceable to national and international humidity standards. The room's dewpoint confirms the atmosphere the electrolyte is exposed to during filling. It does not measure the electrolyte's own water content once sealed in the cell. That is a separate result, one that comes from Karl Fischer titration on a liquid sample, not from dewpoint instrumentation.

### Airlocks and Material Transfer Points

Personnel and incoming material are the largest moisture load a dry room carries. Airlocks between zones get their own spot checks. Some lines add a dedicated fixed sensor there too, to catch a leaking door seal or an underperforming purge before it drifts an entire zone out of tier.

### Commissioning and Troubleshooting

A portable hygrometer with fast response and desiccant dry down lets an engineer walk every zone in one pass. It verifies fixed transmitters against a second reference and localizes an excursion to a specific door, seal, or process step, rather than an entire wing of the building. Coating lines running NMP based slurries add solvent vapour extraction near the drying ovens, where explosion protected instruments are the appropriate choice rather than a standard dewpoint transmitter.

## In Summary

Accurate dewpoint measurement is what lets a dry room do its job. It protects the electrolyte and active materials from the moisture that degrades them, and it catches an excursion before it becomes a swollen or capacity-faded cell. In a process that keeps cells open to the air for most of their assembly, that measurement is the control that makes the rest of the process possible.

## References to Applicable Standards

No single published regulation sets a dewpoint limit for lithium-ion battery manufacture. Targets are set by the cell and process engineering team against electrolyte and active-material specifications and they vary by chemistry and process step.

**ISO 14644-1:2015** Clean rooms and associated controlled environments, Part 1: Classification of air cleanliness by particle concentration. Governs the particulate cleanliness class many dry rooms also hold alongside their dewpoint specification.



## Suitable Products




**Dewpoint Transmitters**

Intrinsically safe, continuous online monitoring for dehydration outlet and custody-transfer points inside a classified hazardous area, wired into a control system on a 4-20 mA loop.




**Handheld Hygrometers**

Handheld spot-check meters for commissioning, troubleshooting and periodic verification at remote or unmanned stations, using the same aluminium oxide sensing and AutoCal function as the fixed instruments.



**Sample Systems**

Sample conditioning built for line pressure natural gas, with a heated pressure reduction stage, filtration and hazardous area certification, matched to the transmitter or hygrometer in use.

### Talk to our applications team

We design and manufacture dewpoint instruments for many different applications. Tell us about your application and we will help you choose the right product for your pressure, your hazardous area rating and your dewpoint range.

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