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pH Measurement Optimization in Battery Production

pH IS A KEY PARAMETER IN BATTERY PRODUCTION

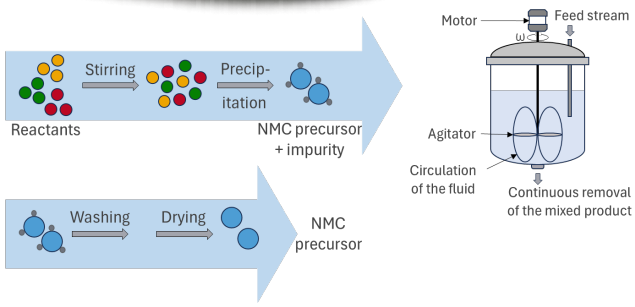
The surge in electromobility is driving an unprecedented demand for high-performance lithium-ion batteries. At the heart of every reliable battery is the cathode active material (CAM), and its quality is determined long before final assembly—during precursor (pCAM) production. Here, pH is the decisive control parameter. Even the smallest deviations (±0.1) can disrupt particle size, morphology, and chemical consistency, leading to reduced capacity, shorter cycle life, and potential safety risks.

Precise pH control isn't just a technical requirement—it's a competitive advantage. Manufacturers that maintain tight process control can deliver batteries with superior charging performance, longer service life, and proven safety, ensuring they stay ahead in the fast-moving battery market.

THE pCAM PROCESS – PRECISION IN PARTICLE SYNTHESIS

The production of precursor cathode active material (pCAM) relies on a co-precipitation reaction of nickel, manganese, and cobalt salts (NMC) in a stirred-tank reactor—commonly known in the industry as a "crystallizer." During this process, ammonia and sodium hydroxide are added to form a metal hydroxide mixture. The resulting particle size and shape are dictated by one primary factor: pH control.

Target pH values typically range from 9.0 to 12.0, depending on the required CAM specifications. Each product demands its own precise setpoint, making accurate and stable pH management essential for consistent quality and reliable battery performance.



pCAM manufacturing – active material cathode NMC

(Source: VDMA Guideline – Production of Lithium-Ion Battery Cell Components)

THE CHALLENGE OF REAL TIME pH MEASUREMENT IN THE CRYSTALLIZER

The continuous precipitation process produces solid-rich suspensions that rapidly foul conventional pH sensors, leading to:

- Diaphragm clogging from particle deposits
- Measurement drift caused by contaminated reference electrolytes
- Frequent, time-consuming manual cleaning—often several times per day
- Increased risk of off-spec batches and costly reprocessing

Traditional top-mounted installations make the problem worse. Sensors are hard to reach, making cleaning and calibration difficult. Meanwhile, particles in the reactor settle quickly on the sensing surface, accelerating drift and instability—compromising both process control and product quality.

The Effect on Particle Characteristics by pH

pH Value	Particle Distribution	Morphology	Impact on Battery
9.8	Large, irregular	Uneven	Low energy density
10.5	Optimal	Spherical	High cycle stability
11.0	Fine-grained	Porous	Potential instability

Source: Muramatsu et al., Process Data, 2023

The result: unreliable measurement, higher maintenance costs, and unnecessary production risks that directly impact profitability and competitiveness.

THE SOLUTION

Pneumatically operated retractable probe housings of the EXtract series combined with EXmatic automatic cleaning control system.

Exner Process Equipment GmbH provides the perfect solution to ensure a stable and reproducible pH value.

In combination with suitable, robust pH sensors, the Exner system can optimally exploit its strengths. The sensor stays clean, drifts less, and delivers consistent values over a longer period of time, even during longer batch processes.

Automatic, regular cleaning of the sensor keeps the diaphragm clear, significantly extending its service life and increasing measurement reliability. When the sensor is not needed for measurements, it can also be stored in a protected, moist environment in the cleaning chamber of the probe housing.

RELIABLE pH MEASUREMENT WITH EXNER TECHNOLOGY

Pneumatically operated retractable probe housings of the **EXtract series**, combined with the **EXmatic automatic cleaning control system,** provide the ideal solution for maintaining stable and reproducible pH values in demanding precipitation processes.

- When paired with robust, high-quality pH sensors, the Exner system ensures:
- A clean sensor surface with minimal drift
- Consistent, reliable measurements over extended batch runs
- Automatic, regular cleaning that keeps the diaphragm clear and maximizes service life
- Safe, moist storage of the sensor inside the cleaning chamber whenever it is not in use

With this combination, operators gain dependable process control, lower maintenance effort, and longer sensor availability—delivering measurable gains in efficiency, quality, and cost savings.

Benefits

- **Pneumatically operated retractable housing:** enables automatic cleaning by withdrawing from the process
- **Side-mount 15° inclined sensor installation:** provides optimal sensor position, accessibility for maintenance, and minimizes contamination from solids in the upper area of the reactor
- **Individually configurable cleaning cycles:** time or action controlled
- **Acid/alkali cleaning & water rinsing:** adaptable to suit contamination load and process conditions
- **Reduces the workload of maintenance personnel:** no manual disassembly required
- **Early removal of deposits:** increases measurement accuracy and long-term stability
- **Safety first:** prevents removal of the sensor unless fully retracted from the process
- **Remote control via PLC or control system:** fully integrates into existing systems

GET IN TOUCH

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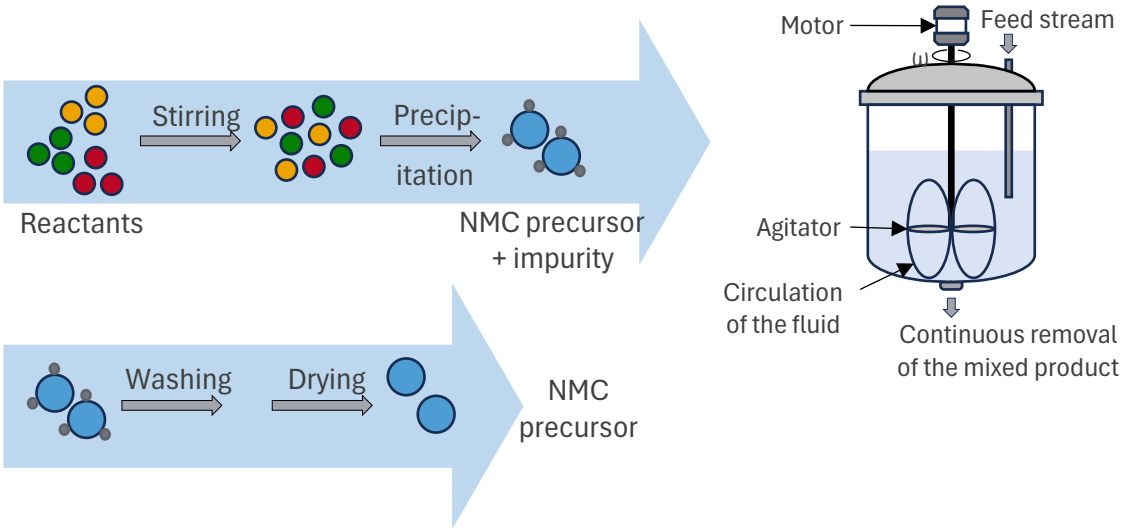
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