

Optimize the calendering process in battery production

Enjoy improved production efficiency, battery quality and safety with ABB's robust, calibration-free measurement systems



ABB's proven flatness and tension measurement systems deliver reliable performance in tough settings

Measurement made easy

Introduction

Many forecasters expect the growth in demand for lithium-ion batteries to top 25 percent per year. This boom is due in part to the transitions toward more sustainable energy systems, which involves switching to electric vehicles and electrifying many other everyday technologies that would previously have relied on fossil fuels. Rechargeable, lightweight, energy-efficient and boasting a high energy density, lithium-ion batteries are also in high demand to power consumer electronics such as laptops, tablets and smart watches.

Yet the battery market remains highly competitive. Manufacturers are therefore looking to ramp up production and drive down costs while maintaining high levels of quality and safety. In such a competitive and demanding manufacturing environment, even small improvements in performance can make a big difference.

Calendering plays a vital role in battery production by improving the mechanical stability, electrical conductivity and electrochemical performance of the electrodes. Effective calendering helps ensure uniform electrode thickness, density and adhesion, contributing to the overall reliability and efficiency of the batteries.

To form the electrodes, strips of copper and aluminium foil are coated with multiple layers of slurry and dried at temperatures from 20 to 150°C before heading to the calendering process. Here, the coated electrodes pass between rollers under controlled pressure, which compresses the layers of coating, reducing their thickness and increasing their density. Compressing and compacting the electrodes in this way helps achieve a consistent thickness and improves the energy density of the finished battery.

It is therefore essential to monitor and control the calendering step closely to optimize production efficiency and maintain battery performance.

Application

Calendering takes place after the coating and drying of the electrodes. The coated foils pass at speeds up to 100m/min between a pair of rotating compression rollers. This compacts the coating layer, ensuring a consistent thickness and reducing its porosity. This in turn influences the electrodes' wetting properties once the electrolyte is introduced and thus determines the battery's energy density.

A uniform electrode structure also promotes consistent electrochemical reactions during battery operation, leading to reliable performance and longer battery lifespan.

The calendaring step improves adhesion between the underlying foil and layers of the electrode coating. This prevents delamination and ensures efficient electron and ion transport during the battery's charge and discharge cycles, minimizing internal resistance and enhancing efficiency.

Compacting the electrodes using proper calendaring can also help prevent the formation of dendrites, which are metallic protrusions that can cause short circuits and battery failure.

The calendaring process may involve multiple passes through the rollers, with adjustments made to the roller gap and pressure settings to achieve the desired electrode thickness and density. Different roller configurations may be used for the anode and cathode electrodes, according to the manufacturer's specific requirements.

Challenge

Calendaring requires a precisely defined line force between the rollers of anything up to 2,500N/mm. If the compaction pressure between the rollers is too high, it can squeeze the substrate and its coating, leading to the formation of stress cracks. If it is too low, it will not achieve the necessary consistency, compaction and adherence, seriously compromising the battery performance and lifespan.

Close monitoring of the press force during the calendaring process is therefore essential to

prevent quality issues such as strip breaks or stress cracks. Porosity can also impact on tension, making tight measurement and control more complex.

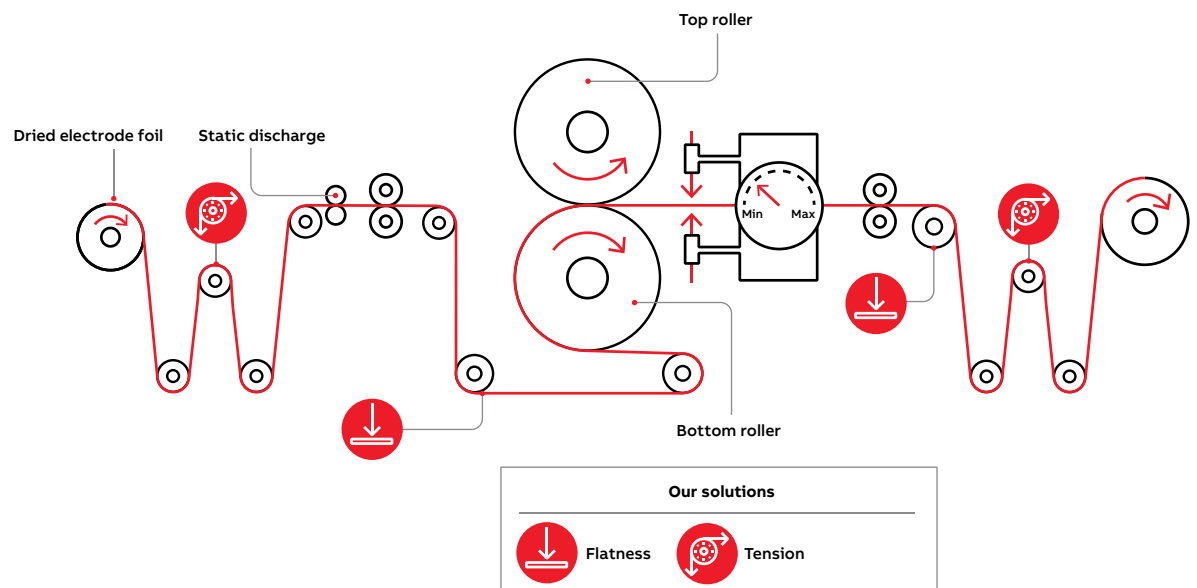
Solution

The answer is to monitor and control the flatness and tension of the foil strips throughout the coating process using accurate and reliable measurement systems.

Maintaining the accurate calibration of measurement systems for flatness and thickness can be challenging in a demanding factory environment, where equipment must be able to withstand physical vibration, impact forces and extremes of temperature. In addition, the need for calibration should be minimized, because it can halt production for several hours at a time, with further delays introduced by factors such as difficulty in accessing machinery and the need for equipment to cool before handling and maintenance.

In tension measurement applications, for example, typical load cells based on strain gauge and LVDT (Linear Variable Differential Transformer) technologies can be impacted by a variety of factors, including vibration, unexpected shock loads, electrical interference and incorrect specification and installation. This can increase the frequency of calibration checks, and/or recalibration, requiring the affected production line to be put out of service for several hours for the necessary work to be carried out.

These issues can be overcome by opting instead for devices using technologies that can function for long periods of time without drift or loss of calibration.



Example of a calendaring process in battery manufacturing showing ideal points for flatness and tension measurement.

What can ABB offer?

Built on years of experience gained in the metals and paper industries, ABB's proven flatness and tension measurement solutions deliver accurate and reliable performance throughout their operational lifetimes in the toughest industrial settings.

Flatness measurement and control

Our flatness measurement and control system combines the best strip flatness performance with the lowest cost of ownership and the highest levels of reliability and accuracy.

Offering stable, calibration-free performance, ABB stressometer flatness systems are proven to deliver unsurpassed measurement density and response time, long-term accuracy and integrated model-based multivariable control. Direct and parallel measurement provides accurate measurements within milliseconds, minimizing the likelihood of downstream issues.

ABB's solution minimizes the risk of strip breaks caused by poor flatness, reducing downtime and improving quality. It also helps to minimize rejects and pass times for improved yield.

Tension measurement

By combining electronics with ABB's robust Pressductor load cells, our strip and web tension measurement solutions provide high-accuracy

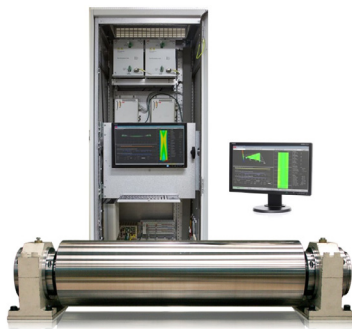
tension control. By maintaining a constant tension within the desired range, regardless of any acceleration or deceleration, our solution maintains quality and minimizes any risk of stoppages caused by strip or web breaks.

Pressductor load cells are sensitive and accurate yet rugged, reliable and compact. They are impervious to difficult factory conditions, such as high overloads and vibrations. That's because they rely on a measurement principle based on the magnetoelastic effect, whereby the magnetic properties of a material are influenced by the mechanical force applied to it. This makes Pressductor technology extremely robust and reliable, with no drift and no need for recalibration.

A complete measurement solution for battery manufacture

Calendering is just one of the steps in battery production that calls for careful monitoring and control. ABB offers a complete set of measurement solutions for high-quality, efficient and safe battery production.

To find out more about ABB's solutions, visit <https://new.abb.com/products/measurement-products/industry-and-application/battery>



Flatness measurement and control



Tension measurement