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Have Manufacturing Shutdowns and Delays Spoiled Your Raw Materials?

What to Look for When Restarting Manufacturing Operations

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COVID-19 has caused serious delays and logistics interruptions for raw material suppliers and component manufacturers. After prolonged shutdowns due to travel restrictions and local public health precautions, manufacturing lines preparing to resume operations may lack the staff needed to properly handle incoming raw materials or those already in stock in a timely manner. Unfortunately, delayed use of raw materials and goods-in-process (GIPs, also called work-in-process) may create issues that lower the quality of manufactured products. Manufacturers can help protect product quality and mitigate the risk of financial loss by building sound strategies to assess raw materials, GIPs, and the overall manufacturing process when restarting operations.

Battery Quality and Safety Risks Associated with Delayed Use of Raw Materials

A battery electrolyte is a prime example of a sensitive raw material. State-of-the-art lithium-ion batteries contain aprotic organic solvents (such as ethylene carbonate, dimethyl carbonate, and diethyl carbonate, amongst others) and conductive salts (such as lithium hexafluorophosphate and lithium tetrafluoroborate) as the main components. Contamination of the electrolyte with protic impurities, even in the parts-per-million range, can adversely affect battery performance. For example, trace amounts of water can lead to the production of hydrofluoric acid capable of attacking the protective layers on the electrode active materials and the metallic current collectors. This can lead to a host of deleterious effects, including but not limited to reduced capacity, high self-discharge rate, reduced cycle life, and increased safety risks.

Metallic foil current collectors can also spoil while in storage. Today's lithium-ion batteries typically use aluminum and copper foils as the positive and negative electrode current collectors, respectively. Both can corrode if not used within their designated storage period. Corrosion of the current collector can affect active material adhesion and lead to electrode delamination and lithium plating. These problems can result in both reduced performance (e.g., low capacity, high self-discharge rate, reduced cycle life) and elevated safety risks (e.g., internal short circuit and thermal runaway).

Battery Quality and Safety Risks Associated with Delayed Use of Goods-In-Process

GIPs in battery manufacturing are partially completed goods that are in the process of being turned into a battery. For example, the production of a typical cylindrical battery includes many steps to produce an

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arrangement capable of storing and releasing energy over many cycles. During manufacturing, the time spent by a GIP in each step is carefully controlled with tolerances typically on the order of hours, with some steps more sensitive than others. If a GIP is stored beyond its specifications, it may become damaged beyond recovery.

Moisture contamination is one example of how a GIP can become defective. Because of the significant performance degradation and safety concerns associated with moisture ingress, it is an important concern in any lithium-ion battery production facility. As a result, a number of production steps are typically performed in a dry room, where moisture content inside the cell is maintained at a low level before the cell is sealed. If a GIP is improperly stored before the sealing step (e.g., during suspension of operations), the moisture content of the cell can become unacceptable. This could lead to performance and safety degradation in the field.

Building a Strategy to Restart Operations

Manufacturers of all types of goods should follow appropriate precautions when resuming operations. A sound reopening strategy would generally entail the following:

1. Evaluating how delays in the use of raw materials and GIPs could affect manufacturing processes and final products;
2. Designing and implementing methods to detect spoilage in raw materials and GIPs as early in the manufacturing process as possible; and
3. Appropriately revising sampling and testing plans to give manufacturers confidence that the produced goods will meet their quality goals.

How Exponent Can Help

Exponent's multi-disciplinary team of engineering and scientific consultants brings together a wealth of experience and expertise in numerous industries to help manufacturers build and implement strategies to quickly and reliably resume manufacturing operations. This includes confronting numerous cross-disciplinary challenges to formulate operations ramp-up strategies, establish new test and analysis capabilities for incoming quality control and GIP monitoring, and devising product sampling and testing plans customized for identified failure modes.

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