Cathode Active Materials in Electric Vehicle (EV) battery Production

CASE STUDY

PIABEVBA6EN

Background

The need for continuous development and deployment of reliable and energy storage devices such as Lithium-ion rechargeable batteries has become increasingly important for EV transportation modes. In recent years, the EV industry has seen numerous developments in Cathode Active Materials (CAM) to improve their structures and properties. These materials directly affect battery performance in areas such as energy and power densities, cycle life, and safety.

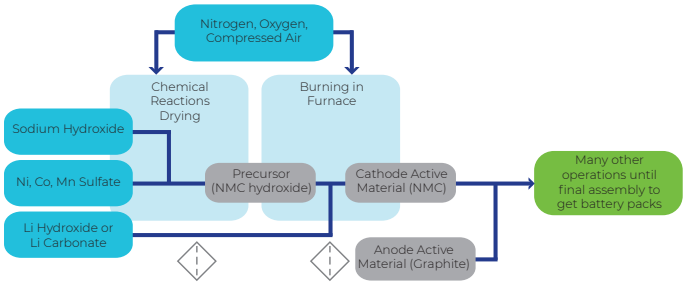
The cathode or positive electrode is made of a very pure mix of metal oxides containing lithium. The more uniform its chemical composition and crystal structure, the better battery performance and life is.

The CAM production process is very complex and requires multi-chemical transformation stages involving solid, liquid and gaseous products to get a pure mix of active materials.

Unsurprisingly, QA controls are also becoming more and more stringent for chemical companies as CAM quality impacts not only the overall performance of the battery itself, but also its cost per KWh.

To meet the EV battery manufacturers' specifications, high performance filtration solutions are required at the different fabrication stages to produce pure and uniform cathode active materials.

Example of a CAM Manufacturing Process for Nickel-Manganese-Cobalt (NMC) lithium batteries



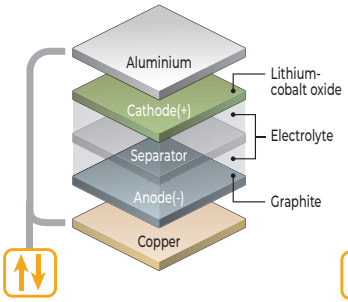
Fine filtration required at the different stages of the production of the NMC cathode active materials for lithium-ion batteries

Problem

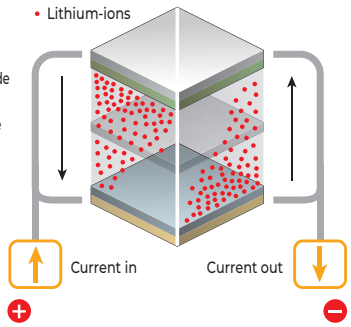
For its new manufacturing plant, a major chemical company wanted to install appropriate filtration solutions on its processing lines to help produce high-energy cathode active materials. To achieve this goal, the company needed to raise the bar in terms of process control to supply EV battery manufacturers with CAM featuring a high degree of purity and excellent product characteristics.

The Chemical company carried out the preliminary feasibility and definition studies for its entire production facilities, representing more than 30 processing lines including liquid and gaseous utilities.

Functional Principle of a Lithium Battery (example)



Electrical current reaches the cell by conductive surfaces at both ends of the stack.



During charging
Positively charged lithium-ions pass from the cathode, through the separator and into the anode where it is stored. When no more ions flow to the anode the battery is fully charged.

During discharge
Negatively charged lithium-ions travel back through the separator and into the cathode. When no more ions flow to the cathode the battery is fully discharged.

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Pall Solution

The filtration and separation solutions provided were mainly driven by 2 factors: the operating conditions of the different processing lines and the micron rating required to achieve the right degree of purity considering the very narrow size distribution of the active material.

Depending on the processing line, single or multi-element and simplex or duplex stainless-steel vessels were selected to ensure the best filtration performance while minimizing the total cost of ownership.

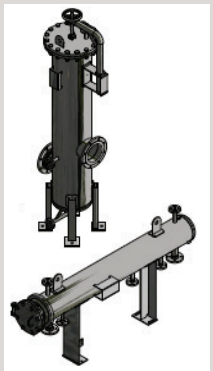
As a general overview, the technologies below were selected for use:

- Pall Ultipleat® High Flow (CAS series – 1 µm) on NiSO4 , MnSO4, CoSO4, NaOH and SO4 pure diluted or mixed solutions
- Pall Profile® Coreless 0.3 µm on utility lines (Nitrogen, Oxygen, Compressed air)
- Pall Poly-Fine® II or Pall Varafine® VFTR 0.45 µm on solvents and carbonate solutions (DMC, DEC, EC, PC)

In addition to these filter families, other liquid and gas filter elements or ceramic membranes were installed on several processing lines.

Pall Profile Coreless Series

Pall Ultipleat High Flow



Examples of Pall fabricated multi-element vessels

Conclusion

Pall partnered with the chemical company to select the optimal filtration and separation technologies and solutions to install in its new manufacturing plant in order to deliver high quality cathode active materials to EV battery manufacturers.

More than 30 processing lines including utilities were equipped with high performance filters (down to 0.3 µm filter rating). To minimize the cost of ownership, ensure a continuous production and simplify the maintenance operations, several different configurations of vessels were used on the processing lines.

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