SUCCESS STORY

FuLIBatteR
Future Lithium Ion Battery Recycling for Recovery of Critical Raw Materials.

Programme:
COMET – Competence Centers for Excellent Technologies

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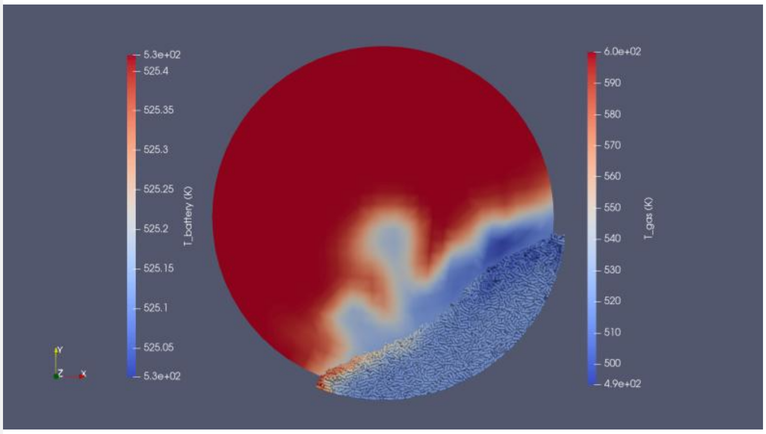

Figure 1: Numerical simulation of batteries during thermal runaway in a rotary drum (Source: K1-MET).

BATTERY THERMAL DEACTIVATION – NUMERICAL AND EXPERIMENTAL APPROACH

THE BATTERY THERMAL DEACTIVATION HAS THE POTENTIAL TO COMBINE KNOWN STEPS IN A BATTERY RECYCLING CHAIN WHILE INCREASING THE BLACK MASS QUALITY FOR THE DOWNSTEAM PROCESSES.

Adopting lithium-ion batteries (LIBs) is essential for achieving carbon neutrality in energy storage, encouraging sustainable transportation and supporting the wider energy transition. To meet the growing energy demand, it is essential to establish large-scale recycling closed-loop processes. Currently, LIB recycling relies primarily on hydro and pyrometallurgical methods to recover valuable metals. To increase the recovery rate, mechanical pretreatment is an alternative method that aims to separate the cathode material from the current foils, steel casing, and plastic separators. A key consideration prior to mechanical pretreatment is whether the battery has a residual charge, as this could pose a thermal runaway risk. Additionally, organic binder material must be considered, as it can affect the hydrometallurgical route due to the difficulty of separating the cathode material from the other components, which can lead to excess agglomeration.

To enhance recovery rates and ensure safety, battery thermal deactivation is a promising strategy. This pretreatment process can unify the mechanical and discharging steps in one and increase the quality of the black mass for the downstream process. The idea is to subject end-of-life batteries to controlled thermal runaway at a temperature at which most of the components can be recovered, as in mechanical pretreatment, while removing the organic binder from the product and releasing its residual electrical energy.

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Figure 2 shows the schematic of the box test experiment, as well as the state of the battery sample before and after the test. The experiment can detect temperatures and off-gas composition during thermal deactivation. The experimental data is used to develop a model to simulate industrial-scale thermal deactivation (see cover picture).

Impact and effects

The experiment investigates how different types of cylindrical batteries at a specific state of charge affect the concentration and temperature evolution of off-gas chemical species when subjected to controlled thermal runaway conditions. The data collected from the experiments is then used by the numerical model. The goal of the model is to study the industrial application of the thermal deactivation process by identifying the key variables and understanding how transport phenomena (heat transfer, chemical reactions and the behaviour of gas and batteries) occur on a large scale. This integrated approach aims to optimise lithium-ion battery (LIB) recycling efficiency and increase the quality of the black mass and battery components supplied to downstream recycling processes.

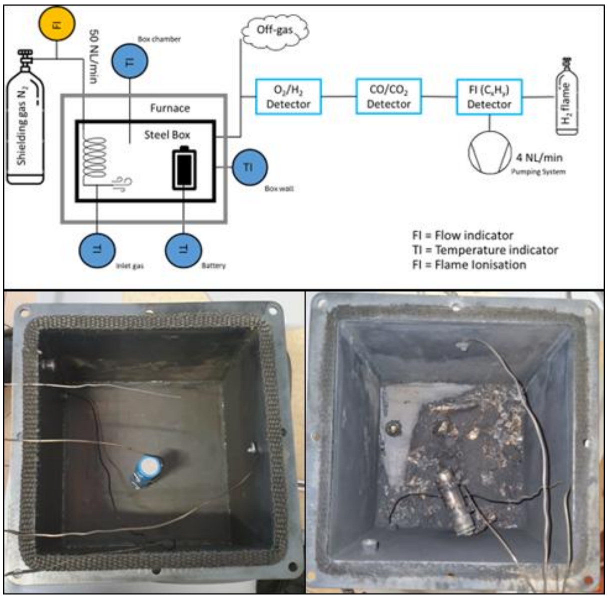

Figure 2: Box test schematic with the battery before and after the experiment (Source: K1-MET)

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