

Sustainable hydrometallurgy for lithium-ion: sharpening today's process



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Most black mass reaching recyclers today comes from lithium-ion cells, and many recyclers consider hydrometallurgy to be the solution. However, this method still faces challenges including low recovery rates, use of toxic chemicals, and other environmental impacts. REVITALISE has applied green chemistry principles, closed-loop and sustainable processing to solve these challenges and produce battery-grade precursors.

The process has been redesigned to reduce energy and chemical consumption while improving extraction efficiency of nickel, manganese, cobalt, lithium, iron, phosphorous, and graphite, and the chemicals used in the process are recycled and reused whenever possible.



3 Li Lithium 6.94	26 Fe Iron 55.85	3 P Phosphorous 30.97
28 Ni Nickel 58.69	25 Mn Manganese 54.94	27 Co Cobalt 58.93
6 C Carbon 12.01		

RESULTS IN PRACTICE

- High-purity cathode and anode precursors, suitable for reuse in new battery production
- High recovery rates across nickel, manganese, cobalt, lithium, iron, phosphorus and graphite
- Leaching reagents redesigned to handle different battery chemistries
- Compact recycling flowsheet to reduce energy and chemical consumption
- AI-guided process optimization

PAIN POINTS ADDRESSED

- Most recycling processes are designed to handle a specific battery chemistry
- High energy cost and toxic waste from conventional hydrometallurgy
- Value lost when metals aren't fully captured from existing lithium-ion feedstock
- Cost of treatment and disposing of waste streams

≥92%
recovery

NMC sulfate

≥99%
purity

NMC sulfate

TECHNOLOGY IN DETAIL

How it works

A change in the conventional extraction order. Our process starts conventionally with acid leaching to release all the metals in the black mass. Through a series of solvent extraction and precipitation steps, we recover elements as groups: first Li (a departure from the conventional route), then Ni-Mn-Co as a group, or FePO_4 (depending on the initial chemistry), and finally impurities are removed from the leachate.

What goes in

Not tied to one battery chemistry. The process can handle black mass from diverse battery types, including NMC, LFP, and Na-ion chemistries, without pre-requisites on grade or purity of the black mass, and without any thermal pre-treatment.

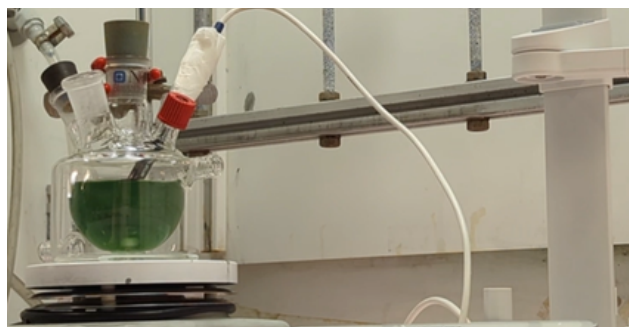
What comes out

Battery grade salts. The outputs of the process are: for NMC feedstocks, NMC sulphate (in the ratio it was present in the original cathode) and for LFP feedstock, FePO_4 at $\geq 99\%$ purity – both ready for reuse in new batteries of the same type. Lithium is output as its carbonate salt, and graphite is also recovered – both at the same $\geq 99\%$ purity.

What sets it apart

Circularity and economics brought together. Contrary to conventional routes, Li is extracted first from the leachate – allowing better recovery and higher purity to be achieved in fewer steps. This new generation of hydrometallurgy routes are designed to be flexible enough to handle different battery chemistries – including LFP – while removing common impurities such as Cu and Al. Where suitable, metals are output in groups to reduce the number of processing steps, and overall process cost.

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