METALS RECOVERY FROM END-OF-LIFE LI-ION BATTERIES BY PHYSICAL PROCESSING AND HYDROMETALLURGICAL TREATMENT

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INTRODUCTION

- Rising demand for lithium-ion batteries (LIB) in electric mobility and energy storage is increasing pressure on critical metal markets, including lithium (Li), nickel (Ni), cobalt (Co), and manganese (Mn).
- Recycling is essential for securing critical raw materials (CRM) and to manage effectively end-of-life (EoL) batteries [1].
- LIB recycling is typically carried out using hydrometallurgical methods, which combine physical/mechanical steps (e.g., electrode fraction concentration) with chemical processes such as leaching, separation, and metal recovery.
- Physical operations also involve safe discharge and dismantling, followed by shredding and fraction separation [2].
- Research on the physical and chemical treatment of EoL LIB (Ni-Co-Mn/NCM type) can enhance the recovery efficiency and yield of CRM.

GOALS

- To evaluate black mass (NCM) and contaminants recovery in the fine fractions of shredded material during physical processing.
- To compare H_2SO_4 and oxalic acid for Li, Ni, Co and Mn leaching yields.

METHODOLOGY

Physical processing → **Sampling** → **Hydrometallurgical test** → **Chemical analysis**

- **Physical processing:** LIB-NCM pouch cells grounded with a laboratory shredder and sieved for particle size characterization.
- **Sampling:** Samples collected to determine metal content and recovery.
- **Hydrometallurgical test:** Stirred laboratory reactors under controlled conditions, including black mass leaching, contaminant removal, and metal recovery.
- **Chemical analysis:** Solutions and solids analysed by atomic absorption spectrometry to determine metal yields.

RESULTS & DISCUSSION

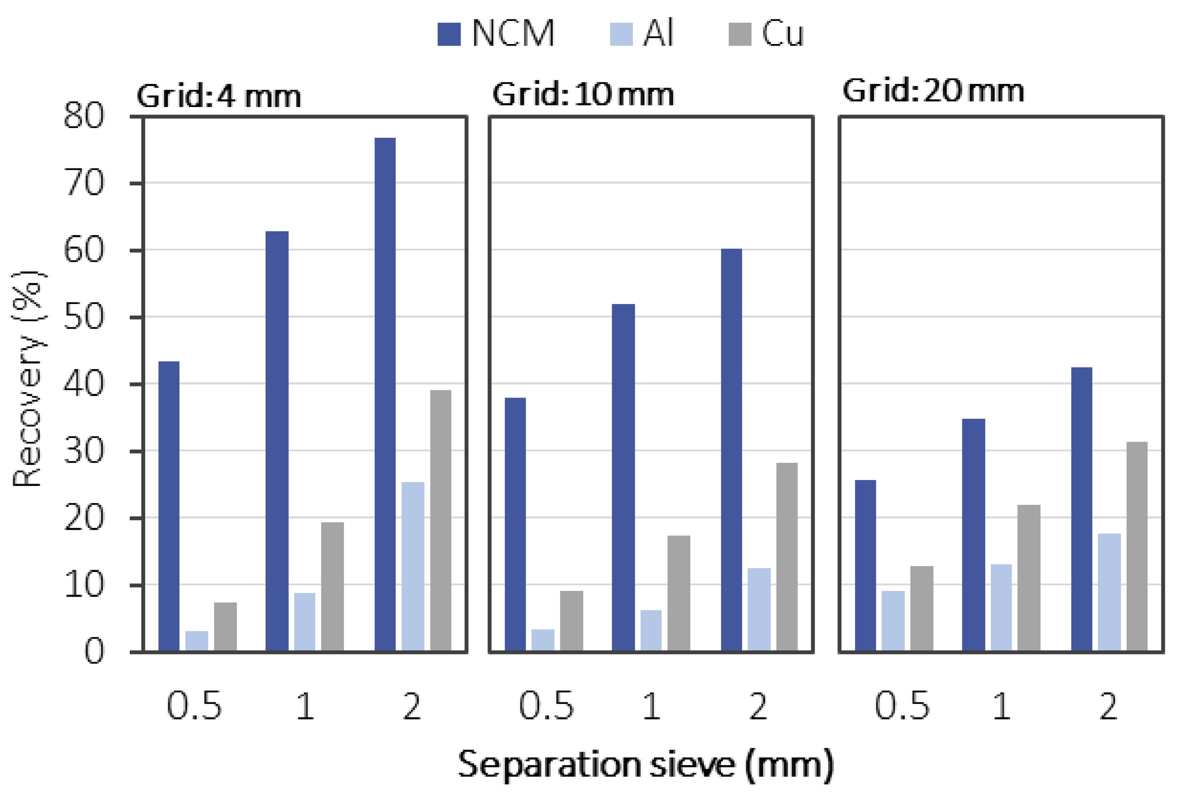

Fig. 1. Recovery of cathode black mass (NCM) and contaminants (Al, Cu).

Physical processing

- Smaller shredder grid apertures (4 mm) improved black mass separation and recovery.
- Sieving after shredding identified an optimal 1 mm sieve for recovering fine electrode fractions with minimal Al and Cu contamination - Fig.1.
- A 4 mm shredder grid combined with 1 mm sieving yielded over 60% NCM recovery with high selectivity.

Chemical processing

- Oxalic acid showed selectivity for Li recovery (80%) - Fig. 2.
- H_2SO_4 enabled a high recovery for all metals (89–96%). These leachates can be subsequently purified to remove Al and Cu, and to recover Ni, Co, Mn as mixed hydroxides and Li as carbonate.

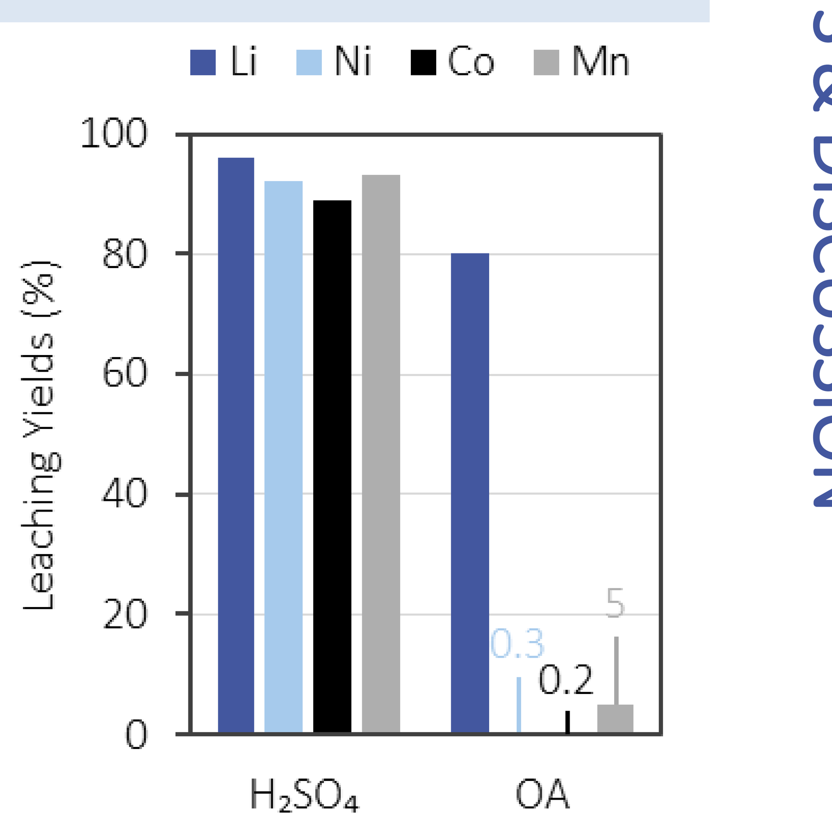

Fig. 2. Metal leaching yields using of H_2SO_4 and oxalic acid (OA) - (1 M, 60°C, 1h).

CONCLUSIONS

Physical and chemical processing are essential for recycling spent LIB. The physical stage concentrates cathode metals in the fine black mass, with minimal Al and Cu contamination. Chemical stage uses leaching and separation processes to recover these metals for new cathode production, supporting a circular economy.

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ACKNOWLEDGMENTS

This work is a result of the Innovation Pact "NGS – New Generation Storage" (C644936001-00000045) by the "NGS" consortium, cofinanced by NextGeneration EU, through the Incentive System – "Agendas for Business Innovation", within the Recovery and Resilience Plan (PRR).

Funded by the European Union NextGenerationEU