Abstract

[Project Information]

Project Title :	Design of Pilot-Scale Wet Milling Separation Process for Polyvinyl Chloride Coverings and Copper Recovery from Waste Wire Harness Cables Toward Practical Implementation
Project Number :	JPMEERF20223M02
Project Period (FY) :	2022-2024
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Cooperated by :	Mitsubishi Materials Corporation
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[Abstract]

The goal of this project is to design a pilot-scale process—based on the combined poly(vinyl chloride) (PVC) swelling by *n*-butyl acetate and moderate impact ball-milling technique—to recycle high purity copper conductors and PVC coatings from end-of-life wire harnesses (WH).

Sub-theme 1 (Tohoku University): This workstream focused on designing a pilot-scale ball-mill reactor. Bench-scale experiments, a purpose-built simulator, life-cycle assessment (LCA), and machine-learning-based optimization were seamlessly integrated to derive a high-precision, high-efficiency reactor configuration. In parallel, we evaluated the material value of the recovered PVC coatings as feedstock for mechanical recycling through detailed characterization. In addition, dechlorination treatment of the recovered PVC coatings and subsequent pyrolysis was conducted to assess their potential for chemical-feedstock recovery.

Sub-theme 2 (Mitsubishi Materials Corporation): This workstream evaluated the feasibility of closed-loop recycling of copper conductors to electrolytic-grade copper. We established analytical and evaluation protocols for bench-scale samples, assessed the influence of recovered-copper quality on existing recycling processes, investigated crushing and sieving pretreatments to collect cables from WH, and carried out an economic analysis of copper and PVC recovery from end-of-life WH using the new technology.

By integrating the outcomes from two sub-themes, this project achieved a comprehensive pilot-scale process design encompassing pretreatment of end-of-life WH for cable collection; separation of PVC

coatings and copper conductors via the newly developed combined PVC swelling and ball-milling method; and recycling potential of both streams. Through combined experimental work and simulations (discrete-element modelling and machine learning), we identified optimal swelling and ball-milling conditions that enable high-purity recovery of both copper and PVC coatings without comminution. A pilot-scale reactor capable of treating 25 t/year of WH cables was subsequently designed. The studies further demonstrated that the recovered PVC coatings are suitable for mechanical recycling and that the recovered copper can be recycled to electrolytic-grade quality. These outcomes provide a robust technical and economic foundation for scaling up the combined PVC swelling and ball-milling technology and for advancing circular-economy practices in WH recycling.

[References]

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