## Streszczenie w języku angielskim

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Temat rozprawy doktorskiej: Opracowanie technologii odzysku surowców z odpadowych kabli żelowych z wykorzystaniem termicznych i fizyko-chemicznych metod przeróbczych w kontekście Gospodarki o Obiegu Zamkniętym.

The scientific objective of the doctoral dissertation was to test multiple options for recovering raw materials from waste gel cables under laboratory conditions. The objective of the implementative aspect was to develop a comprehensive technology for the recovery of raw materials from waste gel cables, in accordance with the principles of the circular economy.

The recycling of cables filled with hydrophobic gel represents a complex technological challenge in the field of copper cable processing. The presence of a hydrophobic gel within gel cables serves two primary functions: firstly, it provides a protective barrier against moisture, and secondly, it significantly hinders the processing of waste gel cables. Following the shredding of the cable, the hydrophobic gel effectively binds the metal and polymer components of the cable, thereby preventing their separation through the utilisation of standard processing methodologies. The most commonly used gel cable recycling technologies are not aligned with the principles of the Circular Economy. In particular, wet methods are responsible for the generation of secondary waste, and the gel is treated as contamination. The research focuses on the development of innovative technology for the recovery of raw materials, analysing physical and chemical methods and their hybrid combinations. A particular focus was put on the potential for the reuse of the materials that had been recovered, with the hydrophobic gel being a notable example.

The work was conducted in a laboratory scale, using four different types of gel cables manufactured by Bitner and Telefonika as research materials. A morphological analysis of the tested materials was performed, including the identification and quantitative determination of the share of individual raw materials. Preliminary tests included thermogravimetric analysis (DTA/TG),

granulation tests and gel tear assessment during cutting. The cryogenic tests entailed subjecting the samples to sub-zero temperatures by freezing them in liquid nitrogen, followed by grinding. In addition, the pyrolysis of the tested cables was conducted in a laboratory furnace, with the temperature set at 600°C. The solid, liquid and gaseous fractions were subjected to analyses including the measurement of the heat of combustion of pyrolytic oil, in addition to chemical and chromatographic analysis.

Literature review and the state of the art analysis was performed, leading to the development and testing of three methods of gel separation: hot water, hot air, and hexane extraction and vacuum distillation. Following the separation of the gel from the other raw materials, the gel was sent to a manufacturer to determine its potential for reuse. The remaining raw materials were then processed in a laboratory simulation of a copper cable processing line. The result of this research was a plastic mixed with aluminium and 99.9% pure copper. Wastewater and gas analyses have confirmed the compliance of Methods I and II with the relevant environmental regulations. For Method III, a life cycle assessment (LCA) was performed using specialised SimaPro software. The LCA analysis demonstrated the environmental benefits of using the developed technology.

The research confirmed the potential for the effective recovery of raw materials from gel cables, including hydrophobic gel, copper and plastic. It is evident that the developed technology can also be applied to other types of copper cables. The fundamental assumptions of the work are met by the method of using an organic solvent, particularily hexane. The technology aligns with the principles of sustainability and the circular economy, offering high efficiency, low emissions, and the possibility of reusing recovered materials.

Podpisał Dawid Sojka