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OPTIMIZED NICKEL AND COBALT RECOVERY FROM BATTERY WASTE USING SOLVENT EXTRACTION

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ABSTRACT

A new thermodynamic database has been developed for solvent extraction using DHEPA and Cyanex 272 for the purification of nickel and cobalt in battery recycling applications. The database was developed using a combination of experimental data and theoretical calculations. The experimental data included phase equilibrium data for the extraction of nickel and cobalt from sulfate and chloride solutions using DHEPA and Cyanex 272. The theoretical calculations were used to develop models for the prediction of phase equilibria and other thermodynamic properties of the system.

The new database was used to model and optimize a hydrometallurgical battery recycling process. The process flowsheet included the following steps:

1. Leaching of the spent lithium-ion batteries in a sulfuric acid solution
2. Separating the transition metals into the pregnant liquor (PL) using standard hydrometallurgy techniques
3. Solvent extraction of nickel and cobalt from the leach solution using DHEPA and Cyanex 272
4. Stripping the separated nickel and cobalt from the organic phase

Process simulation software was used to model the solvent extraction units. The model predicted the nickel and cobalt extraction performance as a function of the separation pH, temperature, solvent-PL mixing ratio, separation efficiency, extractant concentration in the diluent, and number of stages. The validated model was then used to optimize the operating conditions of the solvent extraction unit in order to maximize the extraction efficiency while minimizing the co-extraction of impurities.

The results of the modeling and optimization study showed that the new thermodynamic database can be used to effectively predict the partitioning of Ni and Co between the water and organic phases. When coupled with a process simulation software, it accurately predicted the heat, mass, and speciation balance among the separation units, and optimized the processes within the constraints of the existing operating conditions.

Keywords: Solvent extraction, DHEPA, Cyanex 272, Battery recycling, hydrometallurgy, thermodynamic database, process simulation, phase partitioning, process optimization