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Flowsheet Design and Modelling for High Purity Praseodymium and Neodymium by Solvent Extraction

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Abstract

Purifying rare earth elements (REEs) from ion-adsorbed clay (IAC) deposits demands complex solvent extraction (SX) setups to achieve commercial-grade purity. This study presents the design and validation of a four-train counter-current SX flowsheet for processing a pre-treated REE chloride liquor sourced from Malaysia's Jeli deposit. Using an iterative steady-state mass-balance simulation in Microsoft Excel, the research determines the operational parameters needed to achieve a 4N (99.99%) terminal purity target for each REE stream. The methodology involved pinpointing critical A/B separation cuts and optimising the organic-to-aqueous (O/A) ratios across the cascade. The results show that the flowsheet effectively fractionates the feedstock, starting with a bulk LREE/HREE separation (Train 1) and culminating in the challenging separation of praseodymium (Pr) and neodymium (Nd) (Train 4). The simulation identified Pr/Nd separation as the primary technical bottleneck, requiring 62 equilibrium stages (NE) due to a low separation factor (beta) of 1.70. In contrast, simpler bulk splits needed as few as 16 stages. These findings confirm the theoretical minimum stage requirements (Nmin) and provide a detailed stage-wise concentration profile for each train. The study concludes that the Pr/Nd circuit dictates the overall plant footprint and capital intensity. The developed flowsheet offers a solid technical blueprint for commercialising Malaysian IAC resources, ensuring high-purity REE recovery through optimised metallurgical design.

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