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Polyacrylonitrile-encapsulated amorphous zirconium phosphate composite adsorbent for Co, Nd and Dy separations

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Abstract

Recycled Nd and Dy from the end-of-life NdFeB permanent magnet is an important supplement for the increasing demand of rare-earth elements. Thus, there is an urgent need to develop an environmentally friendly recycling method. Amorphous zirconium phosphate exhibits selective separation properties towards the ternary Co-Nd-Dy system, however, its powdery form limits development of scaled-up applications. We present an efficient amorphous ZrP/Polyacrylonitrile (am-ZrP/PAN) composite ion exchanger for uptake and separation of Nd, Dy and Co. The am-ZrP/PAN composite was synthesized and its structural, morphologic and acidic properties were investigated by various methods. X-ray tomography revealed rather evenly distributed am-ZrP in the PAN polymer matrix. The selectivity and ion-exchange kinetics of the am-ZrP/PAN composite were determined in relation to the individual elements. Due to dimethylformide (DMF) intercalation into the interlayer of ZrP, the uptake of Co, Nd and Dy increased 50% compared with that of the pristine am-ZrP. Column separation of Co, Nd and Dy from the Co-Nd-Dy ternary system was assessed by varying the feed concentration, loading degree, temperature, running speed and elution agent (HNO_3) concentration. Finally, gradient elution was employed for Co, Nd and Dy separation from a simulated ternary leachate. Fractions with 87.9% pure Co, 96.4% pure Nd and 40% pure Dy were collected through a single-column operation.