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Recovery of Rare Earth Elements from Multi-Metal Mixtures using 8-Hydroxyquinolines

Rare Earth Elements (REEs) (Y, Sc, La-Lu) are widely used for their outstanding magnetic and luminescent properties. Their applications range from fluorescent light tubes to electric car batteries to permanent magnets. However, the supply of REEs is presently struggling to meet the demand. REEs deposits are located only in some regions leading to delicate geopolitical considerations and the current recycling rates reach the 5% mark [1]. REEs are currently considered among the highest Critical Raw Materials by both European Commission and the U.S. Department of Energy. The need for a large scale, green, cheap, and selective process for the separation and recycling of REEs is therefore important. The widespread use of in everyday objects, makes Waste Electrical and Electronic (WEE) and End-of-Life (EOL) products valuable sources of those elements. In particular, permanent neodymium magnets (NdFeB) are among the richest and most readily available sources of lanthanide containing scraps.
We investigated the separation and recovery of the REEs contents in NdFeB magnets (usually composed by 65% Fe, 30% Nd and 2% Dy). The use of 8-Hydroxiquinolines (8-HQs) enables the fine tuning of the complexes topologies upon changing the steric hindrance of the substituents, the metal ion and the base used for the deprotonation of the ligand [2]. The different complexes formed were separated *via* simple selective precipitation of one of the metal complexes. We systematically tested differently substituted 8-HQs and various reaction conditions for the complexation of Fe(III), Nd(III) and Dy(III). Two separation processes were successfully developed: 1) The separation of Fe(III) from the REEs using 5-chloro-7-iodo-8-hydroxyquinoline (5Cl,7I-8HQ); 2) The intra-series separation of Nd(III) and Dy(III) using 5-chloro-8-hydroxyquinoline (5Cl-8HQ). The simplicity and cost effectiveness of the process developed could help increasing the current recycling rate of REEs and in reducing the supply risk associated to those resources.

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