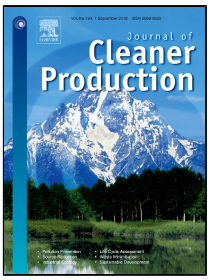
Accepted Manuscript



Perspectives for the recovery of critical elements from future energy-efficient refrigeration materials

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PII:	S0959-6526(18)31835-3
DOI:	10.1016/j.jclepro.2018.06.185
Reference:	JCLP 13331
To appear in:	*Journal of Cleaner Production*
Received Date:	29 November 2017
Accepted Date:	16 June 2018

Please cite this article as: Cristian Tunsu, Martina Petranikova, Perspectives for the recovery of critical elements from future energy-efficient refrigeration materials, *Journal of Cleaner Production* (2018), doi: 10.1016/j.jclepro.2018.06.185

Word count: 7348

Perspectives for the recovery of critical elements from future energy-efficient refrigeration materials

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Abstract

Rare earth elements (REEs) are the core of many future-sustainable technologies. One example is magnetocaloric refrigeration, an emerging field essential for the efficient use of energy. Future adoption of this technology will require adequate processing of end-of-life units and production residues. Currently, REEs have very high supply risk, and their recovery rates are below 1 %. So far, their recovery from magnetocaloric materials has not been addressed. This work reports on a leaching and solvent extraction process to recover REEs from genuine magnetocaloric materials comprising cerium, iron, lanthanum, manganese and silicon. Leaching was studied using nitric, hydrochloric and sulfuric acid solutions, with optimizations in terms of temperature, acid concentration and solid-to-liquid ratio. Recovery of REEs from nitric, hydrochloric, and sulfuric acid leachates was investigated with three types of solvating extractants: tributyl phosphate (TBP), trioctylphosphine oxides (Cyanex 923) and tetraoctyl digylcol amide (TODGA). Extraction was most effective from nitric acid media. Very good extraction selectivity between REEs and non-REEs was achieved with TODGA. Cyanex 923 showed better extraction efficiency than TBP, and performed best in aliphatic diluents. A separation factor of 3.3 between cerium and lanthanum was achieved with 1 mol/L Cyanex 923 in Isopar L.

Keywords: magnetocaloric material, magnetic refrigeration, recycling, rare earth elements, hydrometallurgy, Cyanex 923