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Continuous ligand-assisted elution chromatography applied to separation of rare earth elements

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ABSTRACT

Rare earth elements (REEs) are metals used to make many valuable products such as magnets and electronics. Following their extraction from larger materials, REEs are to be separated into their individual components as high purity is required for product manufacture. Purification is very difficult because most (15/17) of the REEs are lanthanides (Ln's) and Ln ions have the same valence and similar atomic radii. The current industrial process for purifying REEs involves using toxic solvents to perform a series of liquid-liquid extractions. Ling and Wang (2015) proposed a ligand-assisted batch chromatography process to purify Ln's. The latter approach is a vast improvement over the former in terms of safety, however being a batch process, it is not economical for industrial use.

The purpose of this study was to design and test a continuous system based off of Ling and Wang's ligand-assisted elution chromatography process. A titania sorbent was used with a selective ligand, ethylenediaminetetraacetic acid (EDTA). The continuous system utilizes a stepwise elution process and separates a solution of praseodymium (Pr) and samarium (Sm). A Semba Octave SMB chromatography system was used to perform the experiment. Yields and purities greater than 95% were seen for each of the components in solution and the process can be run indefinitely.

This continuous process for Ln separation is of interest because safety is increased in comparison to the aforementioned industrial system, sorbent productivity is increased, and it is more robust and simpler to run than the batch process. This continuous system can be scaled up to produce high purity REEs safely and efficiently.

KEYWORDS

Rare Earth Elements, Chromatography, Lanthanides, Separations