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Liquid–liquid extraction of uranium and lanthanides from phosphoric acid using a synergistic DOPPA–TOPO mixture

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Abstract

Most of the phosphate rocks used commercially contain small quantities of metals such as uranium, lanthanides and yttrium. During the phosphate processing, by reacting the phosphate rocks with sulphuric acid, ca. 30% of lanthanide and yttrium and more than 80% of uranium, present initially in the rocks, end up in phosphoric acid. In this work the overall extraction of uranium and lanthanides from phosphoric acid has been studied. The influence of various factors such H_3PO_4, SO_4^{2-}, Fe (III), DOPPA and TOPO concentration on the degree of extraction has been established. Kinetic study shows that the initial extraction rates of uranium and lanthanides are of the same order of magnitude.

Keywords: Liquid–liquid extraction; Lanthanides; Uranium; Phosphoric acid

1. Introduction

In spite of the fact that phosphate rocks are considered as a poor source of uranium (U) and lanthanides (Ln), attention has been directed to phosphate deposits as a potential source of these elements for the following reasons:

- the mining and processing of phosphate rocks is already financed by the phosphate fertiliser industry,
- a high world production rate of phosphate rocks which is around 150 million tons/year [1],
- the great demand for these metals and in particular the shortage in uranium supplies forecast for the next few years [2],
- if these elements are not recovered, they should be lost, and will accumulate in soil, or
- they will be adsorbed by plants, which represents a health hazard.

These are the main factors that encouraged researchers to develop efficient technologies for recov-

Abbreviations: REEs, rare earth elements; TPP, tri-pentyl phosphate; TBP, tri-butyl phosphate; OPPA, octylpyrophosphoric acid; DEHPA, di-2 éthylhexylphosphoric acid; TOPO, tri-*n*-octylphosphine oxide; MOPPA, mono-octylphenylphosphoric acid; DOPPA, di-octylphenylphosphoric acid; HTTA, thenoyltrifluoracetone; Ln, lanthanides; HL, chelating extractant; Kex, extraction constant; *E*%, degree of extraction; *D*, distribution coefficient; $R_{o/aq}$, organic-to-aqueous volume ratio

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