Chemical Data Collections 13–14 (2018) 84–103

Contents lists available at ScienceDirect

Chemical Data Collections

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Data Article

Solvent extraction of thorium (IV) from chloride solution using Schiff base and its application for spectrophotometric determination

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ARTICLE INFO

Article history:
Received 13 October 2017
Revised 22 December 2017
Accepted 24 January 2018

Keywords:
Solvent extraction
Determination
Thorium (IV)
Schiff base

ABSTRACT

Thorium (IV) was separated from chloride medium by solvent extraction with Schiff base chelating agent, (E)-4-(2-hydroxyphenyl imino) pentane-2-one (AcPh) that was prepared and characterized by FT-IR, ^{1}H NMR, and elemental analysis. The extraction step was studied with regard to experimental parameters such as diluent type, pH, AcPh concentration, A:O ratio, contact time, temperature and interference of diverse ions on the recovery of thorium ion. The thorium (IV) was then back-extracted into aqueous media containing 0.5 M HNO_3 to study the stripping conditions that were A:O ratio, contact time and room temperature. The optimum parameters were applied in the studied sample solution for the spectrophotometric determination at 540 nm with Thoron I. The accuracy of the developed method was tested with B2 standard reference material. Furthermore, the proposed method was successfully applied for the spectrophotometric determination of thorium ions in the geologic sample with good accuracy and precision.

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https://doi.org/10.1016/j.cdc.2018.01.003
2405-8300/

Specifications table

Subject area	Separation and analytical chemistry
Compounds	Schiff base, acetylacetone, 2-aminophenol, Thorium chloride, Thoron I indicator
Data category	Solvent extraction, syntheses, spectral and analyses
Data acquisition format	FT-IR, ^{1}H NMR, elemental analysis, ICP-OES, and Spectrophotometer.
Data type	Separated and analyzed
Procedure	Synthesis, solvent extraction, separation, determination and application
Data accessibility	Data is directly available within article

1. Rationale

Thorium has a tremendous importance in the nuclear energy field. In the context of growing world population whose demand for energy is increasing, and the threat of global warming due to carbon dioxide emissions (caused by coal and hydrocarbon burning), the nuclear technology may be an attractive option, especially in the developing countries [1]. Thorium element is also used in numerous industrial and technological applications. Thorium is widely distributed in small amounts over the earth surface. It occurs in several minerals; the most common ones are monazite sand, thorianite, thorite and thoganite [2].

In the recent years, extraction and isolation of thorium ions and their subsequent analysis from several geological and environmental samples have attained significant importance, due to the wide range of growing interest in the fields of industrial applications, energy, and environmental concerns [3]. To achieve this goal, some of the commonly employed separation methods which are precipitation [4], electrophoresis [5], electrodialysis [6], chromatography [7,8], flotation [9], ion exchange separation [10,11] and solvent extraction [12] were studied prior thorium determination.

Several strategic methods for the separation and extraction of thorium were developed, among which solvent extraction was most frequently used. Numerous common extractants which have selective groups had been carried out for the solvent extraction of thorium ions, these groups such as phosphoric acids [13,14], neutral phosphates [15], amines [15,16], Schiff bases [17], and oximes [18].

Solvent extraction techniques were employed for the extraction of thorium (IV) using various organic extractants such as di-(2-ethylhexyl) 2-ethylhexyl phosphonate [19], bis (2,4,4-trimethylphenyl) phosphinic acid (Cyanex 272) [20], organo phosphoric compounds from various media [20–26], N-n-heptylamine [27], N-n-octylamine [28] and 2-octylaminopyridine [29] as well as TODGA in ionic liquids which were successfully applied for the recovery of thorium (IV) in industry [30]. Solvent extraction of thorium (IV) by triphenylarsine oxide in chloroform diluent had been applied from salicylate media [31]. The stripping behavior of thorium (IV) from HEH/EHP (2-(ethylhexyl) phosphoric acid mono-2-ethylhexyl ester) with H_2SO_4, HCl and HNO_3 were studied [32]. The extraction of thorium by β–hydroxy naphthaldoxime in presence of neutral organo-phosphorous compounds in o-xylene was studied [33]. The extraction of thorium (IV) from nitric acid solutions by di-n–butyl sulfoxide (DBSO) in o-xylene was evaluated [34]. The tri-n-octyl phosphine oxide (TOPO) in cyclo hexane was used to extract thorium from nitrate solution [35]. Thorium (IV) was extracted from 0.01 M sodium malonate medium by using 0.05 M 2-octylaminopyridine in xylene [36] .

On the other hand, two extractive spectrophotometric techniques were utilized for thorium estimation based on an isoamyl alcohol extractable ion pair complex of thorium (IV) with 2-hydroxy-1-naphthaldehyde iso nicotinoyl-hydrazone in the pH 3 at 420 nm [37]. Thorium determination in monazite sand involved by fusion with potassium hydrogen fluoride, separation of the insoluble rare earths and thorium fluorides by centrifugal action, followed by extraction of thorium into mesityl oxide where it was spectrophotometrically determined in the extract with Thorin [38]. The colorimetric determination of the extracted thorium from chloride solution with di-(2-ethyl hexyl) orthophosphoric acid was studied [39]. Thorium (IV) was quantitatively extracted at pH 7.5 with 0.0001 M of hexaacetate calix(6)arene in toluene and after stripping with 0.05 M nitric acid, it was determined spectrophotometrically at 545 nm with thoron I [40]. Two sensitive spectrophotometric methods were used for the determination of thorium with phenylfluorone (PF) and quercetin (Quer) in the presence of cetylpyridinium bromide (CPB) and polyvinylpyrrolidone (PVP), respectively [41].