J Radioanal Nucl Chem (2012) 293:789–795
DOI 10.1007/s10967-012-1734-x

Uranium micelle-mediated extraction in acetate medium: factorial design optimization

Naït-Tahar Sanaa · Mohamed Amine Didi · Didier Villemin

Received: 27 February 2012 / Published online: 18 March 2012

Abstract A micelle-mediated extraction (CPE) procedure has been developed to remove trace amounts of uranium from wastewater using a non-ionic surfactant (Triton (X-100)) and lipophilic chelating extracting agent (D2EHPA) in acetate medium. The methodology used is based on the formation of metal complexes soluble in a micellar phase of a non-ionic surfactant. The uranyl ions complexes are then extracted into the surfactant-rich phase at a ambient temperature. The effects of different operating parameters such as the concentrations of Triton (X-100), D2EHPA and metal ions, temperature, sodium acetate rate and pH on the cloud point extraction of uranyl ions were studied in details and a set of optimum conditions were obtained. The results showed, without contribution of energy (ambient temperature), that up to 1000 ppm of uranyl ions can quantitatively be removed (>97 %) in a single CPE extraction using optimum conditions.

Keywords Cloud-point extraction · Uranium · D2EHPA · Triton X-100 · Factorial design

N.-T. Sanaa · M. A. Didi (✉)
Laboratory of Separation and Purification Technologies, Department of Chemistry, Faculty of Sciences, University of Tlemcen, Box 119, 13000 Tlemcen, Algeria
e-mail: madidi13@yahoo.fr

D. Villemin (✉)
Laboratoire de Chimie Moléculaire et Thioorganique, Université de Caen, UMR CNRS 6507, INC3M, FR 3038, ENSICAEN & Centre de Recherche, 14050 Caen, France
e-mail: Didier.villemin@ensicaen.fr

Introduction

Uranium (U) is a heavy metal that can be found at low levels within many rocks, sediments and soils. The average U concentration in the earth crust is between 2 and 4 ppm, but it can be enriched in soil and groundwater by several anthropogenic activities, such as by the release from mill tailings of U mines, or by agricultural application of phosphate fertilizers, which are often, associated with U or by nuclear industries wastes [1, 2].

Due to its radioactivity and toxicity (carcinogenic for humans), it is a hazardous contaminant in the environment. Therefore, the World Health Organization (WHO) recommends a drinking water limit of 0.015 mg/L [3].

Various procedures for the separation and preconcentration of trace amounts of uranyl ions have been developed, including flotation [4]; adsorption on porous and/or high surface area materials (activated carbon [5], membranes [6–10], clays [11]); extraction with solvents and supercritical fluids [12]; electrokinetic methods (electromigration and electroosmosis) [13–16]; biosorption by different microorganisms (bacteria [17–19], actinomycetes [19, 20], fungi [21], yeasts [22] or algae [23]); phytoremediation (the use of plants for containment, degradation or extraction of xenobiotics from water [24]) and cloud point extraction (CPE) [25]. The use of micellar systems such as CPE has attracted considerable attention in the last few years mainly because it is in agreement with the "green chemistry" principles. It has many advantages, such as low cost, safety, and speed, and is a simple method with a high capacity to concentrate a wide variety of analytes of widely varying nature with high recoveries and high concentration factors. CPE also provides results comparable to those obtained with other separation techniques. Accordingly, any species that interacts with the micellar system,