Identification arsenic (V) by cyclic voltammetry and recovery of arsenic by electrodeposition

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ABSTRACT: This work is focuses in to develop an As(V) identification technique in an aqueous medium with KCl and KI as background electrolytes, in low and high concentrations from water purification technologies and water wells. A technique of electro recovery of arsenic was developed by the application of a potential in acid solution in order to reduce As(V) and As(III) present in drinking and rejection water coming to mining activities, and process like Capacitive deionization and inverse osmosis.

1 INTRODUCTION

Electrochemical methods are an alternative for the determination of arsenic in its reduced state, determinations have been reported in the range of 0.007 to 270.0 mg L⁻¹ and have the advantage over the spectroscopic in sensitivity, selectivity and especially in speciation (Mays & Hussam, 2009). The redissolution voltammetry technique is characterized by its selectivity to As(III), high sensitivity and low detection limits that can be compared with other techniques. Considering the advantages of electrochemical methods such as Anodic Redissolution Voltammetry (AVS), the present work aims to develop a technique to identify the As(V) metalloid in an aqueous medium different process, like inverse osmosis and capacity deionization for low concentration and reject water from mines, for the investigation was using a platinum working electrode with a KCl bottom solution (Cavicchioli *et al.*, 2004; Gibbon-Walsh *et al.*, 2012; Litter *et al.*, 2009; Noskova *et al.*, 2012).

2 METHODS/EXPERIMENTAL

2.1 Identification of arsenic (V)

All the solutions used in the development of this research were standard solution at low concentrations of 0.01 to 1 mg L⁻¹, a medium concentrations 1 to 10 mg L⁻¹, and highs of 30, 50, 80 and 100 mg L⁻¹, As carrier electrolyte 0.001 mol L⁻¹ KCl. All As(V) samples were added with IK and adjusted to pH 2 with 0.1 mol L⁻¹ HCl.

Three electrode cell was used in the detection of arsenic (V). A double-jacketed Ag/AgCl (E = ECS) as the reference electrode (RE), a platinum electrode as the working electrode (WE), that was manufactured with a glass tube and epoxy resin and a graphite electrode as an auxiliary electrode (AE).

Readings of cyclic voltammetry were carried out using a potentiostat/galvanostat/ZRA 09096 – Gamry instruments, with an electrochemical window of initial potential of 0.0 to +0.800 V with a scanning potential of 100 mV s⁻¹.

2.2 Arsenic (V) recovery by electrodeposition

Arsenic recovery tests were carried out with solutions containing a mixture of 5 mg L⁻¹ As(V) and As(III) with a pH adjusted to 2 by HCl, these solutions were prepared with analytical grade reagents. Potentiostatic test were performed in a range of 0.8 V at -0.6 V in a potentiostat/galvanostat/ZRA 09096, in order to observe at cathodic or reduction potential necessary to electrodeposit the arsenic in the metal electrodes, were used a working electrode, with 1 cm² area, encapsulated and mirror polished. A double jacket Ag/AgCl reference electrode (E = ECS) and the graphite auxiliary electrode, said process was carried out in a hermetically sealed glass cell. Finally, the electrodeposition of As(III) and As(V) was performed using 3 × 3 cm, two-sided copper electrodes 9 cm² of area, for 60 min at different voltages of 0.5, 1.0 and 1.5 V using an Agilent brand energy source, model E3642A. In order to eliminate the oxygen present and avoid undesirable reactions was maintained constant bubbling of N₂.

3 RESULTS AND DISCUSSION

Experimental tests were performed with high (10 to 100 mg L⁻¹), medium (1 to 10 mg L⁻¹) and low (0.001 to 1.0 mg L⁻¹) concentrations pH 2 adjusted with HCl, experiment was exposed to constant bubbling to N₂. Figure 1 shows the displacement of the anodic peak by identifying As(V) at 10 mg L⁻¹ at an amperage of -3.84 μA and -4.39 μA at a concentration of 100 mg L⁻¹ confirming that the magnitude of

Figure 1. Voltamperogram high concentrations of As(V) at 1.33×10^{-4} M, 4.00×10^{-4} M, 6.67×10^{-4} M, 1.06×10^{-3} M, 1.33×10^{-3} M, plus 0.001 M KCl and a concentration of 0.01 M IK.

Figure 2. Voltamperogram medium concentrations of As(V) 1.33×10^{-5} M, 2.66×10^{-5} M, 4.00×10^{-5} M, 5.33×10^{-5} M, 6.67×10^{-5} M, 8.00×10^{-5} M, 9.34×10^{-5} M, 1.06×10^{-4} M, 1.20×10^{-4} M, 1.33×10^{-4} M, of 0.001 KCl and 0.01 M IK.

the anodic peak is proportional to the Amount of As present. Identifying the oxidation and reduction of the metalloid. The behavior of the oxidation reduction in medium concentrations is shown in Figure 2. Figure 3 shows the behavior of low concentration of As(V).

3.1 Electrodeposition of arsenic

The electrodeposition was developed with a concentration 5 mg L^{-1} of As(III) and As(V), with electrodes of carbon with a 9 cm^2 of area. Theoretically using the Faraday equation, it is note than it is possible remove up 45% with us conditions 1V during 60 min. However in reality the experiments show that removed 62% but a percentage of this Arsenic is removed that arsine gas. Figure 4 shows the electrode with arsenic electrodeposited.

4 CONCLUSIONS

The identification of As(V) by cyclic voltammetry is a technologically viable option due to the reduction

Figure 3. Voltamperogram low concentrations of As(V) 1.0×10^{-7} M a 1×10^{-5} M, of 0.001 KCl and 0.01 M IK.

Figure 4. Images obtained in the MED, metal with arsenic. of time and costs, with high sensitivity and friendly to the environment. It is possible to recover the arsenic by electrodeposition with efficiencies greater than 50%.

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