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New electrodes for silver(II) electrogeneration: Comparison between Ti/Pt, Nb/Pt, and Nb/BDD

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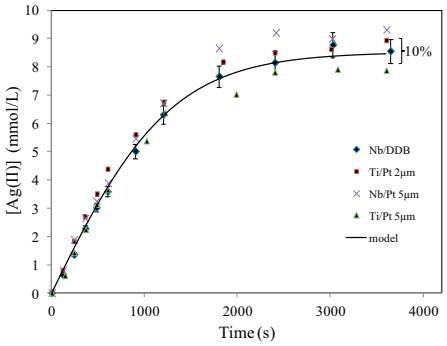
HIGHLIGHTS

- Nb/BDD electrode can efficiently generate silver(II) in nitric acid media.
- The comparison with Ti/Pt has shown that the generation rate was very similar.
- Simulation successfully predicted the behavior of the system.
- Competitive reactions with hydroxyl radical and Ag(II)/Ag(I) are negligible.

GRAPHICAL ABSTRACT



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ABSTRACT

Electrochemical processes based on the regeneration of silver(II) are very efficient for the destruction or dissolution of persistent substances. The aim of this work is to assess new anode materials to replace the conventional platinum electrode. The electrochemical generation of Ag(II) by oxidation of Ag(I) in HNO_3 (6 mol/L) was evaluated at boron doped diamond on niobium substrate (Nb/BDD) anode and results are compared with those obtained on Ti/Pt and Nb/Pt anodes. The performance of these anodes was evaluated in a filter press reactor in batch operation mode. The rate of Ag(II) generation obtained on the Nb/BDD anode is similar to that obtained on platinized electrodes. A theoretical model is presented to predict the behavior of the system. Good agreement is found between experimental results and the theoretical model.

1. Introduction

Processes involving mediated electrooxidation (MEO) have been extensively studied in the nuclear industry for the dissolution of contaminated materials or plutonium dioxide [1–5] and for the treatment of wastewater [6–9]. Among all electrogenerated oxidants, Ag(II) is one of the most convenient for such treatments, due to its high standard potential (E° = 1.98 V versus SHE). This species can be prepared by electrochemical oxidation of Ag(I) in concentrated nitric acid. The main advantages of this process are the working conditions: room temperature, atmospheric pressure, oxidant regeneration and recycling.

The kinetic process of silver(II) generation has been widely studied [4,5] on the platinum anode because of the good corrosion resistance and the electrocatalytic properties of this metal. The Ag(II) process implies several steps [5]: Ag(I) diffusion from the bulk to the anode surface, electron transfer and competitive reactions: water discharge and chemical reaction between Ag(II) and water [10–13]. The electrode activity being a key factor in the process, materials such as: glassy carbon, dimensionally stable anode

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