



## Electrochemical removal of selenate from aqueous solutions

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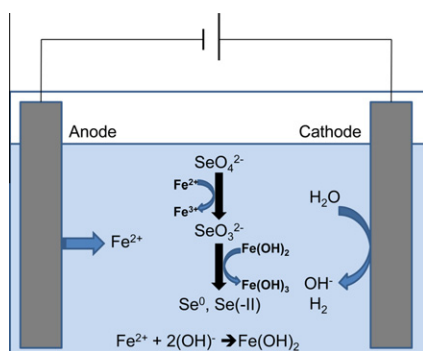
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### HIGHLIGHTS

- ▶ The selenate removal using an iron anode was compared with that with an inert anode.
- ▶ Iron anodes produced ferrous ions and ferrous hydroxide leading to complete removal of selenate.
- ▶ The process variables were evaluated for the removal of selenate.

### GRAPHICAL ABSTRACT



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### ABSTRACT

Removal of selenate from solution is investigated in batch electrochemical systems using reactive iron anodes and copper plate cathode in a bicarbonate medium. Iron anodes produce ferrous hydroxide, which is a major factor in the removal of selenate from solution. Iron anodes also generate a significant decrease in the oxidation–reduction potential (ORP) of the solution because it prevents generation of oxygen gas at the anode by electrolysis. The removal rates varied from 45.1% to 97.4%, depending on current density and selenate concentration. The transformation of selenate by the process is modeled based on a heterogeneous reaction coupled with electrochemical generation of ferrous and hydroxide. The rates are optimized at lower initial concentrations, higher electrical currents, and the presence of anions. Presence of dissolved oxygen does not cause any significant effects the removal of selenate.

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## 1. Introduction

Selenium (Se) is an essential trace element for animals and humans. It plays an important role in glutathione peroxidase, which protects cell membrane from damage caused by the peroxidation of lipids [1]. At low concentrations, its deficiency is known to cause an increase in heart and liver disease and may be associated with

an increased risk of cancer [2,3]. At high concentrations, selenium is toxic, can cause skin disease, gastrointestinal disturbance, damage to the central nervous system, and birth defects manifested in waterfowls [3]. Therefore, US EPA set the standard of selenium as 0.01 mg Se/L in drinking water. Selenium can be released into the environment from mining activities, fossil fuel combustion, oil refining, and agricultural irrigation. Selenium exists in the environment in four oxidation states (+VI, +IV, 0, and –II) and in several organic forms. Oxyanionic forms, selenate ( $\text{Se}^{\text{VI}}\text{O}_4^{2-}$ ) and selenite ( $\text{Se}^{\text{IV}}\text{O}_3^{2-}$ ) are the common forms in oxidized systems. Elemental selenium ( $\text{Se}(0)$ ) and selenides ( $\text{Se}(-\text{II})$ ) exist in reducing zones and unweathered mineral formations. Selenate is mobile in

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