STUDY ON THORIUM REMOVAL FROM EFFLUENT BY ELECTROCOAGULATION

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Introduction

Indigenously designed Advanced Heavy Water Reactor (AHWR–LEU) utilises thorium and LEU in the form of (Th-LEU)\(\text{O}_2\)MOX as fuel [1]. During the fuel fabrication process various thorium bearing effluents will be generated. The biological half-life of thorium is greater than uranium. Besides, the daughter products of thorium decay like \(^{228}\text{Ac}\) and \(^{208}\text{Tl}\) are radioactive as compared to uranium decay. Hence, more stringent measures are to be followed in case of thorium bearing effluent treatment and disposal at Hyderabad which is a land locked area. The most common methods for low level radioactive waste treatment arising from the front end of the fuel cycle are chemical treatment, membrane separation and ion-exchange. Sinha et al. demonstrated that co-precipitation process involving calcium phosphate and cerium oxalate may be used for the separation and removal of thorium from the effluents [2]. Removal of thorium from nitric medium by Ammonium Molybdophosphate (AMP) was studied by Ali et al. [3]. Removal of uranium by electrocoagulation was developed in Nuclear Fuel Complex, Hyderabad. However, no attempt has so far been made for the removal of thorium by electrocoagulation.

Electrocoagulation is emerging as the most sought after treatment technique removal of heavy metals like arsenic, cadmium etc. Electrocoagulation presents a robust and novel alternative to conventional coagulation. It is a simple, easy to operate process involving very less maintenance. Electrocoagulation works on the principles of Faraday’s laws of Electrolysis. Unlike chemical coagulation, the coagulating metal ions are injected into the solution without any additional competing anions. Inspite of its vast deployment in other areas, electrocoagulation has not been used in the treatment of low level radioactive waste. The present study involves the establishment of electrocoagulation as a treatment process for thorium bearing non-process effluents in batch mode. This involved an electrolytic reactor with iron electrodes. The non-process water was subjected to coagulation and floatation by Fe(II) ions dissolved from the electrodes and resulting flocs floating after being captured by hydrogen gas bubbles generated at the cathode surfaces. The effect of various operational parameters like initial pH, current density, residence time and initial thorium concentration on the removal efficiency was investigated and optimized. The maximum decontamination obtained was of the order of \(10^4\).

RESULT & DISCUSSION

The electrocoagulation experiments were carried out using aqueous solution of pure thorium nitrate. The following are the steps followed:

1. Preparation of feed solution: Feed solution containing varying concentration of thorium (100 – 1000 ppm) was prepared by dilution of thorium nitrate stock solution of 400 g/L having free acidity of 2.6 N by demineralized water.
2. The pH of the feed solution was adjusted by concentrated ammonium hydroxide and concentrated nitric acid.
3. Electrocoagulation experiments were carried out in 800 mL scale.
4. The parameters like initial pH, current density, residence time and initial concentrations of thorium were varied. The effects of the parametric change on the removal of thorium were studied.
5. After the electrocoagulation experiment, the solution was filtered using Whatman 42 ash less filter paper. The resultant filtrate was analysed for thorium concentration by ICP-AES to assess the thorium removal efficiency.
Based on the thorium concentration in the filtrate, the removal of thorium in terms of decontamination factor was calculated. It was observed that decontamination of thorium increases with the increase in the pH of the solution. The possible reason for the same may be due to the presence of thorium as insoluble suspended \( \text{Th(OH)}_4 \) above pH 7 [4] facilitating better coagulation and flocculation by the generated Fe(II) ions. The percentage removal increased with increase in the current density, residence time and initial concentration of thorium. The sludge produced after electrocoagulation was easy to dewater for pH ranges above 6.

**CONCLUSION**

A detailed study on the removal of thorium from aqueous solution by electrocoagulation was carried out. The results proved to be highly encouraging. The decontamination for thorium was found to be directly dependent on various factors like current density, residence time, initial pH and initial concentration of thorium. The maximum decontamination obtained was of the order of \( 10^4 \).

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**REFERENCES**