ASSESSMENT OF MAGNETITE TO REMOVE Cs (TOTAL) AND Am-241 FROM RADIOACTIVE WASTE

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ABSTRACT

Radioactive waste can affect human health and the environment, thus their safe management has received considerable attention worldwide. Radioactive waste treatment is an important step in its management. Sorption technique is one of the most studied methods to reduce the volume of radioactive waste streams and it has been successfully used for treatment of radioactive liquid wastes. Herein, the experiments were performed using magnetite (Fe_3O_4) as adsorbents for removal the cesium and americium from different radioactive aqueous solution. An aqueous solution with 13.9 ppm of Cs-133 was stirred with 20-25 mg of magnetite and another solution of 117.94 Bq/mL Am-241 was stirred with 50 mg using the same adsorbent but in different contact times and pH. After the experiments the magnetite was removal using a super magnet and the solutions were analyzed by ICP-OES for Cs-133 and Am-241 remaining in solution was quantified by a gamma spectrometry. The results suggested that the biosorption process for Cs is more efficient at pH 6 and 30 minutes of contact time and for Am-241 the most efficient pH was also 6 and 40 min of contact time with 93 % of removal of this radionuclide from the solution.

INTRODUCTION

To ensure the protection of human health and the environment from the radioactive waste is necessary applied a radioactive waste management practice. Treatment is an important step in the management of radioactive waste. At this stage the volume of waste is reduced to enhance the safety and/or reduce the cost of further management phases [1].

Aqueous liquid radioactive wastes that are produced on nuclear reactor, industrial and institutional research may be treated using exchange/sorption, chemical precipitation, and/or evaporation, reverses osmosis, filtration and solvent extraction.[1]

Magnetite can be used as adsorbent in removal of radioisotopes from liquid waste due to its ability to remove metal ions, particulate matter, and biological materials in aqueous medium through adsorption phenomenon.

Cesium has long half live, and it exists as ionic forms in aqueous solutions and it is easily assimilation by living organisms and it is produced by nuclear fission [2]. Americium is very toxic when ingested or inhaled and has a long half live.

In this present study the potential of magnetite to remove Cs (total) and Am-241 from radioactive liquid waste

EXPERIMENTAL

To assessment the removal of metals by adsorption, the experiments were carried out using different quantities of material adsorbent.

In order to study the behavior of adsorption process for cesium and americium from aqueous solution, the following parameter: contact time and, pH for Am-241, were analyzed.

Adsorbent

The adsorbent material used was magnetite (Fe_3O_4). It was synthesized as described by Leal (2006) [3] .
For the cesium solution, 20 and 25 mg of magnetite were added in the solution and for americium solution 12, 25 and 50 mg of the same adsorbent were added.

2.2. Solution of Am-241 and Cs-133

Stock solution of CsCl (Fluka) at concentration 1.0 mol L^{-1} was prepared by dissolving 132,9g CsCl in deionized water.

The solution of americium was prepared from standard solution (3007.08 Bq/mL)that was diluted with deionized water for a final concentration of 190 Bq/mL.

As americium precipitated in pH above 7 all the experiments were performed at pH 4, 5 and 6 [4].

2.3. Adsorption process

2.3.1 Cesium removal

The adsorption experiments were performed using 20mg of magnetite and 10 ml solution of chloride cesium (Cs-133), under agitation at room temperature at pH 6 in different contacts time: 5, 15, 30, 60 and 90 minutes. After the contact time, the magnetite was removed using a super magnet The cesium remaining in the solution was analyzed by using ICP–OES (inductively coupled plasma optical emission spectrometry) - Perkin Elmer, model Optima 7000DV. All experiments were performed in triplicate.

2.3.2 Am 241 removal

The experiments were carried out in batch using different amount of magnetite (12, 25 and 50 mg) in 5 ml solution of Am 241 at 190 Bq/mL, under agitation at room temperature for about 40 minutes at pH 4. For pH studies the experiments were performed in 5 mL of solution with a contact time of 40 minutes and 50 mg magnetite. For contact times studies, the Am 241 removal was analyzed in different times: 5, 10, 20, 40 and 60 minutes. After the process, magnetite was removed using a super-magnet and the solutions were analyzed by gamma spectrometry in hyperpure of germanium detector (Canberra and model GX2518) with aid of Gennie 2000 that allows the acquisition and the analysis the data.

To insure reproducibility all experiments were measured and analyzed in triplicate.

1. RESULTS

To measurement of percentage removal of metal was used the expression 1 for all the samples.

$$\%R = 100 - \frac{100 * C_f}{C_i} \quad (1)$$

Where C_F is the final concentration, C_I is the concentration of standard. The unit of concentration used was Bq/mL

3.1. Cs^+ removal

Relating the values of removal with the contact time was possible to define the time of saturation of the solution. These values are presented in the figure 1. It is possible to observe that the best contact time for Cs^+ removal was 30 min and 21% was removed from the solution.

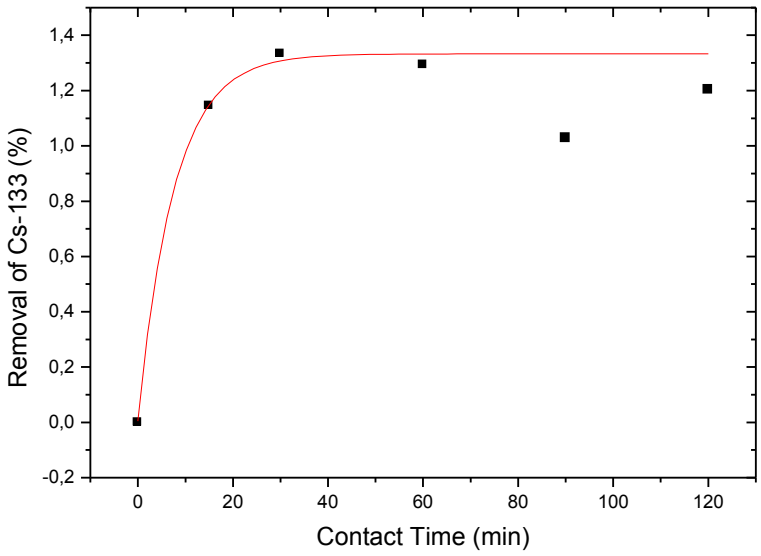

Figure 1: Cs-133 removal in percentage versus contact time with 20 mg of magnetite.

3.2 Am-241 removal

Table 1 shows the removal of americium using different quantities of magnetite

Table 1: Removal of americium using different mass of magnetite with**.**

Mass of Magnetite (mg)	Removal of americium (%)
12	43
25	53
50	73

It was observed that increasing the amount of adsorbent the removal of Am 241 also increases. The maximum of Am 241 removal reached to 73%.

Table 2 shows the removal of Am-241 for different pH using 50 mg magnetite.

Table 2: Relationship between the pH by removing americium.

pH of solution	Removal of americium (%)
4	73
5	72
6	93

At pH 6 the maximum americium-241 removal was 93% and no difference was observed for pH 4 and 5. These results showed that in low pH the active centers that uptake the Am 241 are likely to be positively charged and hinders the adsorption on these binding sites.

Based on the results from table 1 and 2, 50 mg of magnetite were used at pH 6 for different contact times. In figure 2 it as possible to observed that the best contact time was 40 minutes with a removal of 93% It is noteworthy that after 50 minutes a desorption process was observed

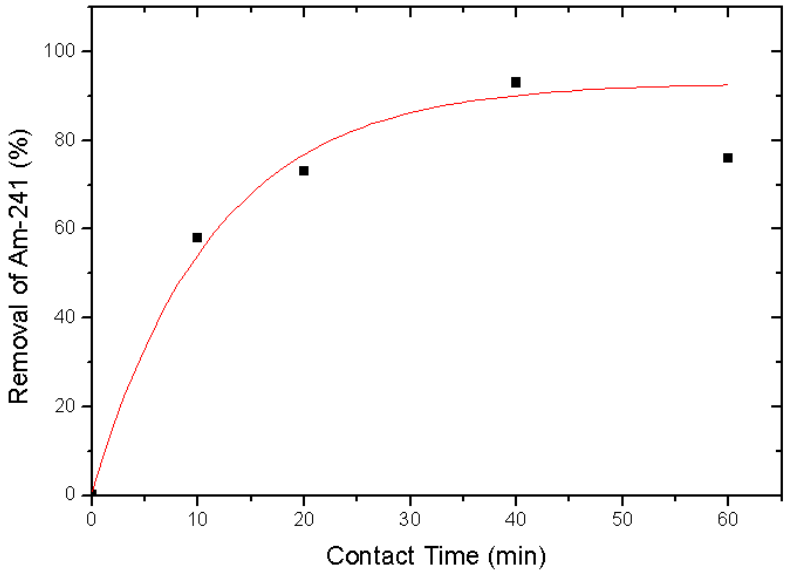

Figure 2: Removal of americium a function of time for different contact times for 50 mg Fe_3O_4 and pH 6.

2. CONCLUSIONS

For Cs-133 solution the best contact time was 30 minutes using 20 mg of magnetite was removed 21 % of Cs-133. The best condition for americium solution was with 50 mg of magnetite, pH 6, contact time of 40 minutes and removal of 93 %.

Using magnetite as adsorbent is possible the removal of radionuclides from radioactive liquid wastes.

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