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COIR PITH OF THE GREEN COCONUT IN THE DECONTAMINATION OF RADIOACTIVE AQUEOUS EFFLUENT

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ABSTRACT

Industrial segments as plant of mining, hospitals and university generate considerable volumes of radioactive wastewater containing uranium. The increasing development of the use of the nuclear energy to lead away to an expansion of the sectors of the nuclear fuel cycle, but it leads to security problems and it appears the necessity of control of the removing of uranium and radioactive effluent treatments. Researches evaluate if the technique of the biosorption would promote an alternative process with attractive characteristics of cost-benefit. The residual biomass from agricultural activities has been studied and used as adsorbent of metals and organic composts by low cost, abundance and for being biodegradable. In this work, it is presented the efficiency of the coir pith for the adsorption of ions UO_2^{2+}. The coir pith is a by-product of the harvest of the coconut, a renewable natural source. The study was accomplished using the batch techniques. The influence from pH 2 to 5, the dose of the coir pith, equilibrium time and the models of kinetic reaction were investigated. It was verified that the adsorption increased with the increase of pH and of the dose. The equilibrium time was of 30min and the best correspondence with the model of pseudo second-order was observed. The results obtained has been promising, so use as adsorvent of metallic ions represents an economic alternative in relation to the conventional treatment of effluent.

1. INTRODUCTION

World-wide 10,000 tonnes per year of radioactive residues are generated [1]. The increasing development of the use of the nuclear energy to lead away to an expansion of the sectors of the nuclear fuel cycle, but it leads to security problems and it appears the necessity of control of the removing and/or treatment of radioactive effluents [2]. It is mainly for this reason that studies of adsorption or biosorption involving the residual biomass to treat effluent has awaked great interest in recent years. It is a natural material, practically no cost, abundance and presents adsorption capacities for metals and organic composts.

Researches evaluate if the technique of biosorption would promote an alternative process with attractive characteristics of cost-benefit. The materials that promote the biosorption are called biosorbent.

In this paper, the coir pith is presented as one biosorbent alternative for the radioactive effluent treatment containig uranium. The utilisation of the green coconut as material adsorbent, presents great potential due to active sites of organic substance composed of lignin and cellulose [3]. Thus, it was evaluated the process of adsorption with relation to pH, dose

of biosorbent, equilibrium time and the kinetic models of the reaction.

Biosorbent used and loaded with metals can be incinerated in moderate temperatures and be deposited in landfill reducing the volume of the liquid effluent converted into solid material**.** Alternatively, the regeneration of biosorbent is possible by desorption of the metal with acid or salt solutions**.** The resultant solution, highly concentrated in metals, can be processed by others techniques as for example the electrochemical to recovery the metal. The natural resources are each time more scarce. In the current industrial development, the recycling and reutilisation of mineral assets are each time more necessary, since they are not renewed.

2. EXPERIMENTAL

2.1 Coir Pith

It was used of thick fibrous layer of the green coconut, which partially was ground in the blender, with a portion of water. It was washed 3 times with distilled water. It was left to dry at the room temperature. Fibres of 2 to 3mm of coir pith were triturated in a triturator Chopper He 275 and sieved. Thus, the powder of coir pith of 80 mesh was used for adsorption studies.

2.2 Batch Adsorption Experiments

An aliquot of 3mL of each solution of metal ions of U was placed in contact with 0.050g of coir pith, in a bottle of 10mL. The bottles were agitated in agitating model Q225M of the QUIMIS during 60 min, centrifuged during 20 min and the supernatant solution was separated by filtration. The analytical control of ions UO_2^{2+} was carried out in a spectrophotometer using the method of Arsenazo III [4]. The results are the average of determination of U carried out in duplicate at room temperature (25 ± 3ºC) for each experiment of adsorption. For difference of concentrations of the solution before and after the agitation, amount of the adsorbed ions by the coir pith was determined.

The following variables were studied: influence of pH and the dose. The adsorption potentiality was evaluated by the percentage of removal (% rem) of ions of U calculated by the equation 1:

$$\% \text{ rem} = (C_o - C) \times 100 / C_o \qquad (1)$$

where: C_o = concentration of U ions (g/L), before equilibrium
C = concentration of U ions (g/L), in the equilibrium

2.3 Kinetic Models

With the intention to investigate the order of reaction the adsorption process, two models of kinetic had been considered to interpret the experimental data: pseudo-first-order, equation 2, and pseudo-second-order, equation 3.[5]

$$\frac{1}{q_t} = \frac{k_1}{q_{max}} \frac{1}{t} + \frac{1}{q_{max}} \qquad (2)$$

$$\frac{t}{q_t} = \frac{1}{k_2(q_{max})^2} + \frac{1}{q_{max}} t \qquad (3)$$

q_t = amount of ions UO_2^{2+} adsorbed (mg/g) in different times
q_{max} = capacity of adsorption maximum (mg/g)
k_1 = Constant of model pseudo-first-order (1/min)
k_2 = Constant of model pseudo-second -order [g/(mg min)]

3. RESULTS AND DISCUSSION

3.1 Influence of pH Solution

The solutions of uranium were prepared maintaining constant its concentration and varying pH. The result of removal percentage is illustrated in Fig.1 where it is observed that the adsorption of ions of U by the coir pith varied with pH of the solution.

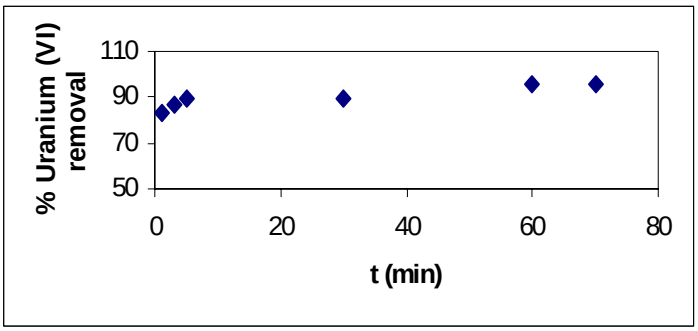

Figure 1: Effect of pH on the uranium removal by coir pith.

The adsorption increased with the increasing of pH. This behaviour suggests the adsorption of ions UO_2^{2+} by the groups hydroxyl (-OH) and carbonyl (C=O) present in the chemical

structure of the coir pith. In acid medium, of low pH, ions H^+ compete with ions uranyl by the groups (-OH), so, the adsorption is lower. In higher value of pH, lesser is the amount of ions H^+ in the solution therefore lesser competition between ions H^+ and UO_2^{2+} by OH and C=O occurred increasing the adsorption of ions uranyl.

3.2 Effect of Adsorbent Dosage

In this study, the dose (g/L) was defined as the amount of coir pith in contact with a certain volume of solution of uranium. Amount of coir was varied from 5 to 70 mg in a volume of 3 ml of solution of uranium 0.1 g/L and pH 5. The result is showed in Fig. 2.

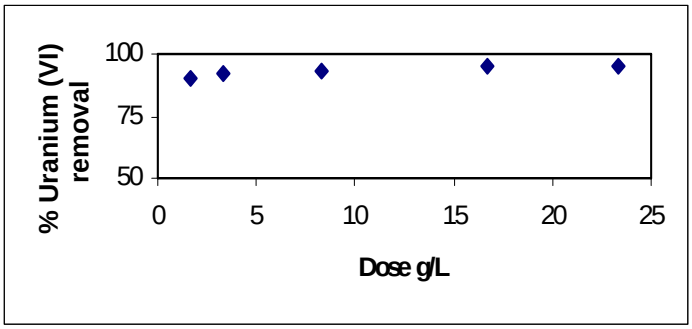

Figure 2: % removal of U in relation to dose of coir pith

Based on the result it is possible to observe that the increase of the dose of coir pith increases the percentage of removal of ions UO_2^{2+}, however with a very small variation. From 8.3g/L the removal tends to become constant, reaching its equilibrium. For further studies, the dose of coir pith was kept in 16.7 g/L.

3.3 Equilibrium Time

This study involves the relation of dependence of shaking time on the efficiency of adsorption for the determination of the equilibrium time. The concentration of the adsorbate that remains in the solution decreases with the time until to reach a constant value which removal of adsorbate of the solution does not happen. From this point the amount that is being adsorbed by the biosorbent is in dynamic equilibrium with the amount that is being desorbed. The time to reach this state is called equilibrium time.

In this study the mass of biosorbent of 50mg was fixed and varied the time of agitation from 1 to 70 min. The experiments were accomplished in solutions of U 0.1g/L of pH 5 and with agitation speed of 360 rpm. The result is presented in Fig. 3.

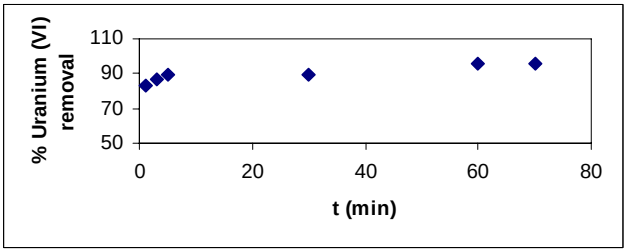

Figure 3: Influence of time for U removal by coir pith

The kinetic studies show that the adsorption increased with the increase of the shaking time, reaching its equilibrium in 30 min.

3.4 Order of the reaction

The order of the reaction in relation to each reagent indicates the existing dependence between the concentration of reagent and the speed of the global reaction [1]. In Fig. 4 and 5, the correspondent curves to equations 2 and 3 may be observed considering the maximum time of agitation of 70 min. The two equations were used to obtain important parameters, as values of k_1 and k_2, q_{max} (mg/g) and the coefficient of linear correlation r_1 and r_2 that are shown in Tab.1.

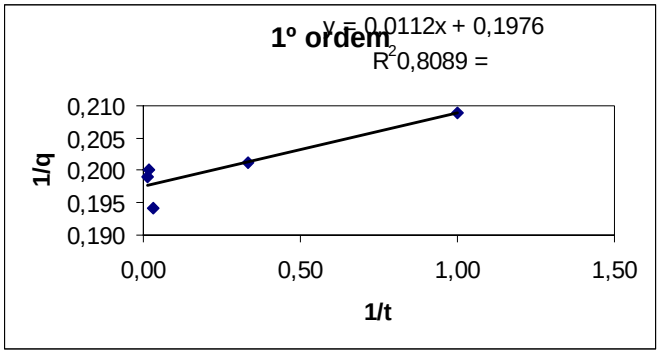

Figure 4: Pseudo-first-order for U adsorption process by coir pith.

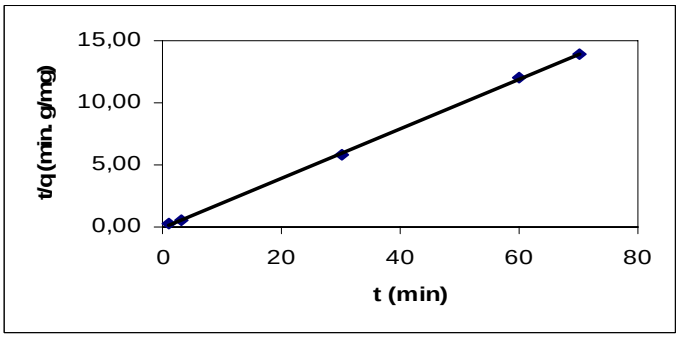

Figure 5: Pseudo-second-order for U adsorption process by coir pith.

Table 1: Kinetic parameters for adsorption of UO_2^{2+} in the coir pith. Adsorbent dose:100mg/L

Adsorbent	k_1 (1/min)	r_1	k_2 [g/ (mg min)]	r_2	q_{max} (mg/g)
coir pith	0.0568	0.8089	2.2647	0.9998	5.071

Based on the coefficient of linear correlation r_1 and r_2, it was verified that the pseudo-second-order model adjusted better to the adsorption results.

4. CONCLUSIONS

It was verified that the process of adsorption of ions UO_2^{2+} is influenced by pH of the solution. A higher removal than 90% was obtained in pH 5. In the dose study, it was evidenced that the removal of uranium by the coir pith increases with the increasing of the dose, reaching equilibrium and becoming constant in 16.7 g/L. The kinetic studies showed that the time equilibrium was of 30 min and the pseudo-second-order model was the best model for describe the adsorption process of U by coir pith.

For further studies it is recommended to verify the selectivity of the coir pith evaluating the influence of other metals as zinc, nickel, thorium in the adsorption of uranium and to carried out studies of desorption for the U from the coir pith.

ACKNOWLEDGMENTS

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