ID 1020

Uranium Recuperation from Aqueous Effluents Using Algerian Bentonite

Sabrina BERKANI[1], Nassima KAOUS[1], Ouardia REBAS[2*] and Mohammed BESSALAH[2]

[1] CRND, Division of Materials Process Engineering, Draria, Algiers, Algeria

[2] Laboratory of valorization of fossil energies, Department of Chemical Engineering. École Nationale Polytechnique, Algiers, Algeria

*Corresponding author's email: ouardia.rebas@g.enp.edu.dz

ABSTRACT

The use of uranium produces radioactive waste which presents a real danger to the mankind and source of environmental degradation, due to its activity. Uranium-bearing effluents must be checked and treated beforehand, in order to meet radiation protection standards (acceptable standards). The objective of our study is to highlight the effectiveness of the process of adsorption of uranium by bentonite in the treatment of uranium effluents. The choice of this clay is motivated by its availability in large quantities and by its advantageous cost, on the one hand, and the properties that its affinity with aqueous uranium gives it, on the other hand. From the adsorption tests, carried out in batch mode, and their experimental planning, it turns out that the adsorption follows a pseudo-second order kinetics and responds to the Langmuir model. In addition, the analysis of the design of experiments by the JMP PRO 16 software, made it possible to identify the influence of the following parameters: the pH of the solution, the initial concentration of uranium and the proportion of the adsorbent in the system adsorbent-adsorbate.

Keywords: Adsorption, uranium, bentonite, factorial plane, optimization, kinetics, isotherm.

1. Introduction

Nowadays, everyone agrees, at every level, on the need to reduce the quantity of waste discharged into the environment. Indeed, industrial activities and nuclear techniques used in research generate effluent discharges, polluting the natural ecosystem. Awareness of the vulnerability of the environment has led world leaders, governments and experts to take and implement measures to treat and eliminate, or reduce, hazardous waste of all kinds, in order to protect the environment. With this in mind, we took an interest in the treatment of uranium effluents in the Process and Materials Engineering Division of the Draria Nuclear Research Centre. Our study focused on the uranium adsorption separation process. Adsorption as a process represents a fundamental operation in chemical engineering. It uses porous solid materials which concentrate the elements to be separated from the effluent on their surface. Retention by adsorption is linked to the selectivity of the adsorbent material with regard to the element to be recovered, namely uranium. This is why the addition of a clay material, in particular bentonite, enables us to characterize the recovery of aqueous uranium in the effluent. The aim of this study is to achieve maximum adsorption of uranyl ions from the real radioactive solutions resulting from the purification stage of uranium concentrates on bentonite.

2. Results and Discussion

2.1 Adsorption kinetics

The adsorption kinetics of uranium on bentonite can be divided into two stages:

The first, where adsorption was found to be rapid during the first few minutes of contact and then slowed down, providing an explanation for the interpretation based on the availability of bentonite active sites. Indeed, at the start of agitation, active sites are progressively occupied until their number is considerably lower after a few minutes of contact, thus encouraging less adsorption;

The second, in which adsorption takes place in the stationary phase, represented by a horizontal plateau corresponding to the retention maximum, with 6.67 g of aqueous uranium adsorbed by one gram of

DOI: 10.21467/abstracts.169 ISBN: 978-81-970666-4-1 (eBook)

bentonite. Adsorbent-adsorbate equilibrium is confirmed by this capped value, which remains constant beyond the equilibrium time (50 min).

2.2. Modeling adsorption kinetics

The correlation coefficient is the statistical tool used to compare the validity of the two models, pseudo-first-order and pseudo-second-order. The value of the correlation coefficient, linked to the pseudo-second-order kinetic model, clearly surpasses that obtained with the pseudo-first-order model. This value of 0.9997 is very close to 1, reflecting the strong linear link provided by the pseudo-second-order model across all experimental points.

2.3. Modeling adsorption isotherms

Comparing the different correlation coefficients of the isotherm models, we note that the Langmuir model fits the experimental data of the L-type adsorption isotherm better, meaning that adsorption is of the mono-molecular type. This adsorption takes place in a monolayer and reflects a chemical phenomenon. So we can see that uranium adsorption by bentonite is chemical in nature.

3. Conclusion

Throughout this study, the performance of the clay used as an adsorbent, bentonite, in retaining uranium in the adsorption process was highlighted. The bentonite characterization study revealed the amorphous behavior of this clay, with a pH at the point of zero charge, mainly 1.92. Furthermore, monitoring of the adsorption kinetics of aqueous uranium on bentonite showed that our adsorbent reached 74.03% of its uranyl ion binding capacity in a period of three (03) min. Equilibrium is established in a contact time of 50 min. On the other hand, modelling of the experimental kinetic equilibrium results revealed that adsorption follows a pseudo-second-order kinetic model and a Langmuir-type isotherm. It is also important to note that the Langmuir model informed us of the maximum adsorption quantity of 45.392 $mg.g^{-1}$. The factorial planning of adsorption tests led us to identify the impact of the various parameters involved in the adsorption of uranium by bentonite, namely solution pH, solid/liquid ratio and initial uranium concentration. Indeed, through modeling, an optimization of the adsorption yield to 77.51%. The adsorption test carried out on synthetic and real effluent under optimum conditions gave adsorption efficiencies of 76.18% and 75.6% respectively. The results obtained in this laboratory-scale study confirm the practical and economic benefits of using bentonite and the factorial plan for effluent treatment in terms of time and cost.

ISBN: 978-81-970666-4-1

Series: AIJR Abstracts

DOI: 10.21467/abstracts.169