World Academy of Science, Engineering and Technology
International Journal of Physical and Mathematical Sciences
Vol:8, No:11, 2014

A Comparison of Biosorption of Radionuclides Tl-201 on Different Biosorbents and Their Empirical Modelling

Authors : Sinan Yapici, Hayrettin Eroglu

Abstract : The discharge of the aqueous radionuclides wastes used for the diagnoses of diseases and treatments of patients in nuclear medicine can cause fatal health problems when the radionuclides and its stable daughter component mix with underground water. Tl-201, which is one of the radionuclides commonly used in the nuclear medicine, is a toxic substance and is converted to its stable daughter component Hg-201, which is also a poisonous heavy metal: Tl201 → Hg201 + Gamma Ray [135-167 Kev (12%)] + X Ray [69-83 Kev (88%)]; t1/2 = 73,1 h. The purpose of the present work was to remove Tl-201 radionuclides from aqueous solution by biosorption on the solid bio wastes of food and cosmetic industry as bio sorbents of prina from an olive oil plant, rose residue from a rose oil plant and tea residue from a tea plant, and to make a comparison of the biosorption efficiencies. The effects of the biosorption temperature, initial pH of the aqueous solution, bio sorbent dose, particle size and stirring speed on the biosorption yield were investigated in a batch process. It was observed that the biosorption is a rapid process with an equilibrium time less than 10 minutes for all the bio sorbents. The efficiencies were found to be close to each other and measured maximum efficiencies were 93,30 percent for rose residue, 94,1 for prina and 98,4 for tea residue. In a temperature range of 283 and 313 K, the adsorption decreased with increasing temperature almost in a similar way. In a pH range of 2-10, increasing pH enhanced biosorption efficiency up to pH=7 and then the efficiency remained constant in a similar path for all the biosorbents. Increasing stirring speed from 360 to 720 rpm enhanced slightly the biosorption efficiency almost at the same ratio for all bio sorbents. Increasing particle size decreased the efficiency for all biosorbent; however the most negatively effected biosorbent was prina with a decrease in biosorption efficiency from about 84 percent to 40 with an increase in the nominal particle size 0,181 mm to 1,05 while the least effected one, tea residue, went down from about 97 percent to 87,5. The biosorption efficiencies of all the bio sorbents increased with increasing biosorbent dose in the range of 1,5 to 15,0 g/L in a similar manner. The fit of the experimental results to the adsorption isotherms proved that the biosorption process for all the bio sorbents can be represented best by Freundlich model. The kinetic analysis showed that all the processes fit very well to pseudo second order rate model. The thermodynamics calculations gave ΔG values between -8636 J mol-1 and -5378 for tea residue, -5313 and -3343 for rose residue, and -5701 and -3642 for prina with a ΔH values of -39516 J mol-1, -23660 and -26190, and ΔS values of -108.8 J mol-1 K-1, -64,0, -72,0 respectively, showing spontaneous and exothermic character of the processes. An empirical biosorption model in the following form was derived for each biosorbent as function of the parameters and time, taking into account the form of kinetic model, with regression coefficients over 0.9990 where At is biosorbtion efficiency at any time and Ae is the equilibrium efficiency, t is adsorption period as s, ko a constant, pH the initial acidity of biosorption medium, w the stirring speed as s-1, S the biosorbent dose as g L-1, D the particle size as m, and a, b, c, and e are the powers of the parameters, respectively, E a constant containing activation energy and T the temperature as K.

Keywords : radiation, diosorption, thallium, empirical modelling
Conference Title : ICMCC 2014 : International Conference on Mathematical and Computational Chemistry
Conference Location : Venice, Italy
Conference Dates : November 13-14, 2014

Open Science Index, Physical and Mathematical Sciences Vol:8, No:11, 2014 publications.waset.org/abstracts/12849.pdf