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Sorption of Pb(II) onto a mixture of algae waste biomass and anion exchanger resin in a packed-bed column

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HIGHLIGHTS

- The sorption of Pb(II) onto algae waste biomass and Purolite A-100 was studied.
- The experiments followed the effect flow rate and initial Pb(II) concentration.
- Column regeneration efficiency reached 98%, when using 0.1 mol L^{-1} HCl.
- The applicability of biosorbent mixture was tested using synthetic wastewater.

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ABSTRACT

Sorption of Pb(II) was studied by using a biosorbent mixture of algae waste biomass and Purolite A-100 resin in a packed-bed column. Mixing these two components was done to prevent the clogging of the column and to ensure adequate flow rates. Increasing of solution flow rate and initial Pb(II) concentration make that the breakthrough and saturation points to be attained earlier. The experimental breakthrough curves were modeled using Bohart–Adams, Thomas and Yoon–Nelson models, and the parameters for all these models were calculated. A regeneration efficiency of 98% was achieved using 0.1 mol L^{-1} HCl and not significant changes in lead uptake capacity after three biosorption/desorption cycles were noted. The biosorbent mixture was able to remove Pb(II) from synthetic wastewater at pH 5.0 and flow rate of 3.5 mL min^{-1}, and the obtained effluent has better quality characteristics. The biosorbent mixture it is suitable for a continuous system for large-scale applications.

1. Introduction

Among heavy metals present in industrial wastewaters, Pb(II) is one of the most hazardous, because it cannot be detoxified biologically and is toxic for most life forms (Gupta and Rastogi, 2008). Due its numerous applications and industrial importance, especially in battery manufacturing and metal plating (Lyer et al., 2005; Han et al., 2006), considerable amounts of Pb(II) are discharged in wastewater. Thus, it is essential to remove Pb(II) from aqueous waste stream, before it reaches the environment.

Biosorption onto living or non-living biomass, such as fungi, bacteria, yeast, moss, aquatic plants and algae (Akar and Tunali, 2006; Tunali et al., 2006; Sari and Tuzen, 2008 ; Wang and Chen, 2009), can be a feasible method for Pb(II) removal, because it is efficient, minimizes secondary wastes and utilizes low-cost materials (Montazer-Rahmati et al., 2011). Marine green algae could be especially useful, as they are fairly abundant in many regions of the world, have a greatly metal recovery potential and large surface areas (Hamdy, 2000; Pavasant et al., 2006). The metal-binding capacities of these algae are due to the presence of polysaccharides, proteins and lipids on the cell wall surface (Uncun et al., 2003; Deng et al., 2007).

Large quantities of marine green algae are used in the cosmetics industry and for production of biofuels (Singh et al., 2011; Halim et al., 2011), and the biomass obtained after extraction of oils is usually discharged as waste or incinerated. In a previous study (Bulgariu and Bulgariu, 2012), it was shown that this waste biomass can be used as a low-cost biosorbent for the removal of heavy metals from aqueous solutions in batch systems, and that the metal uptake capacity was not significant affected by the extraction step. Unfortunately, batch-type biosorption is not suitable for large-scale waste treatment and a continuous system, where the

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