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Removal of lead(II) from aqueous solution with ethylenediamine-modified yeast biomass coated with magnetic chitosan microparticles: Kinetic and equilibrium modeling

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HIGHLIGHTS

- The EYMC is an excellent adsorbent for the removal of Pb(II) ions.
- The EYMC can be separated from reaction medium easily.
- The experiment data fitted best with Langmuir and pseudo-second-order models.
- The adsorption showed a spontaneous and endothermic adsorption process.
- EYMC was regenerated successfully and only lost 0.61 mg g^{-1} after four cycles.

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ABSTRACT

The adsorption of Pb(II) ions from aqueous solution with ethylenediamine-modified yeast biomass coated with magnetic chitosan microparticles (EYMC) was studied in batch adsorption system. The adsorption of Pb(II) ions increased with the rising pH and a higher adsorption capacity was achieved at the pH 4.0–6.0. The experiment data was well matched by Langmuir model and Freundlich model, while Langmuir model showed the best description. The maximum adsorption capacities obtained by Langmuir model were 121.26, 127.37 and 134.90 mg g^{-1} at 20, 30 and 40 °C, respectively. Kinetic studies indicated that the pseudo-second-order model was appropriate to describe the adsorption process and film diffusion maybe governed the rate of the adsorption. Thermodynamic studies revealed that a spontaneous and endothermic adsorption process. The adsorbents, EYMC can be well recovered by 0.1 M EDTA.

1. Introduction

The release of lead has recently attracted great attention because of its widespread adoption, toxic effects, accumulation in living tissues and adverse impact on human health [1]. Therefore, disposal of metal ions from source water is necessary before discharging into the environment. Innovative and improved methods have developed to remove metal ions from metal-laden wastewater, such as chemical precipitation, ion exchange, electrolysis, coagulation, membrane separation, reverse osmosis processes, and adsorption [2]. However, great challenges are faced by these methods due to the technological problems, ineffectiveness at low metal concentration and high cost [3]. Biosorption is considered as one of the promising technologies and has been continuously studied in recent years. A variety of living and dead microorganisms or biomaterials, such as bacteria, fungi, algae, yeast, and mosses have been proved their credibility in dilute metal ions [4–6]. Since no growth media or nutrients are required, the use of dead cells has more advantages than living cells. Moreover, dead cells have lower sensitivity to the pollutant concentration and an easy mathematical modeling [7]. In the practical application of industrial operation, immobilization is regarded as an effective method to improve the applicability of the adsorbents. This technique provides the superiorities of improved mechanical strength, good performance, rigidity and porosity characteristics to the

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