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Synthesis, characterization of salicylic-HCHO polymeric resin and its evaluation as a boron adsorbent

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HIGHLIGHTS

- Salicylic-HCHO typed resin (DFP) was prepared by inverse suspension polymerization.
- The resin containing salicylic acid showed good boron adsorption capability.
- The sorbent (DFP) maintained high capacity in neutral and alkaline conditions.
- Isotherms of boron adsorption could be represented by Freundlich model reasonably.
- Boron uptake onto adsorbents (DFP) followed the pseudo-second order model.

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ABSTRACT

In this study, a novel salicylic-HCHO typed functional polymeric spherical resin (DFP) was prepared by inverse suspension polymerization. Starting with 2,4-dihydroxybenzoic acid, phenol and formaldehyde as monomers, using liquid paraffin as dispersed phase, span 80 as dispersant, 2-methoxyethanol as porogen and HCl as catalyst. The resulted polymer resin containing salicylic acid functions showed a powerful adsorption characteristic towards boron. The boron adsorption behavior of the adsorbent was studied in batch mode by varying different parameters such as pH value, initial concentration of boron and the adsorption time under noncompetitive conditions. It was found that the sorbent always maintained high capacity in neutral and alkaline conditions. The adsorption capacity was considerably increased by an increase in the concentration of boric acid. The existence of sodium ion and calcium ion could promote the boron adsorption to some extent. Langmuir, Freundlich and Dubinin–Radushkevich (D–R) isotherms are applied in order to determine the efficiency of DFP used as a boron adsorbent. Results show that the equilibrium data fits Freundlich model well. Gibbs free energy (ΔG), change in enthalpy (ΔH) and change in entropy (ΔS) were calculated. The adsorption process for boron was proved to be a chemical process of an exothermic nature. Kinetics studies demonstrated that boron uptake onto DFP followed the pseudo-second order model. The load capacity was attributed to specific chemical affinity and physical adsorption.

1. Introduction

Boron is an important micronutrient for plants, animals and humans, but it can be toxic at high concentrations. Boron contamination of water is a serious environmental problem. Numerous works have been done for boron removal and/or recovery from aqueous solution and wastewaters. Chelating resins with different functionalities have potential applications in the selective removal of boron from water and waste solutions.

Several kinds of functional groups such as polyol, carbohydrate, vicinal-diphenol and salicylic acid could react with boric acid to form stable complex, which provide multiple ways to develop efficient boron selective resins.

Vicinal polyalcohol functional groups could react with boric acid to form a stable complex-borate ester, the complex could also decompose and then boron can be released under acidic conditions [1]. A considerable amount of research has been conducted on boron selective resins containing N-methyl D-glucamine (MG). The most commonly used commercial resin Amberlite IRA-743 (XE-243) is manufactured by Rohm and Haas [2], which has a macroporous polystyrene matrix and MG functional group. The resin is popular for its ability of lowering boron concentration from 100 mg/L to less than 1 mg/L [3]. What is more, commercial boron selective resins Diaion CRB 02 and Dowex XUS 43594.00 have been also tested for boron removal from model seawater [4].

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