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The promise of a specially-designed graft copolymer of acrylic acid onto cellulose as selective sorbent for heavy metal ions

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ABSTRACT

A specially-designed graft copolymer of acrylic acid onto in-situ formed cellulose-fulvate hybrid showed privileged tendency for uptake of Pb(II) during competitive removal from a mixture containing Cd(II) and Ni(II) within 5 min. at pH 5. This novel trend is attributed mainly to the crowded high content of coordinating centers within the designed graft copolymer along with the acquired superabsorbency. This provides an outstanding tool to separate some metal ions selectively from mixtures containing multiple ions on kinetic basis. Thus, the designed graft copolymer structure exhibited superior efficiency that reached ~95% for sole removal of Pb(II). Kinetic modeling for Pb(II) individual removal showed excellent fitting with a pseudo second-order model. Intraparticle diffusion model on the other hand ensured governance of boundary layer effect over diffusion during the removal process due to the superabsorbency feature of the graft copolymer. The experimental findings were described with models such as Freundlich, Langmuir, and Dubinin–Radushkevich. The Langmuir and Freundlich models showed convenience with the adsorption isotherm of Pb(II) onto the developed graft copolymer.

Keywords: Cellulose, graft copolymer, heavy metal ions, elimination, selectivity.

1. Introduction

The elimination of metal ions from water is an obligation due to the associated risks arising from their survival in water, not only on environmental level but also on the health level. Buildup of heavy metal ions beyond their threshold levels causes serious rigorous problems to living organisms. This raises the necessity for developing efficient cost-effective methods to remove these elements [1-3]. However, it is not an easy task to eliminate these elements efficiently away from water [4-8]. Sorbents that show superior elimination capacity alongside with elevated selectivity to specific metal ions are considered as effectual sorbents [9,10].