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Evaluation of chemically modified polysaccharide pullulan as an efficient and regenerable supersorbent for heavy metal ions uptake from single and multiple metal ion systems

Azhar Abbas[a], Muhammad Ajaz Hussain[a,*], Muhammad Sher[a], Syed Zajif Hussain[b], Irshad Hussain[b]

[a]*Ibne Sina Block, Department of Chemistry, University of Sargodha, Sargodha 40100, Pakistan, Tel. +92 346 8614959; Fax: +92 48 322121; emails: majaz172@yahoo.com (M.A. Hussain), azharabbas73@yahoo.com (A. Abbas), msherawan@yahoo.com (M. Sher)*
[b]*Department of Chemistry, SBA School of Science & Engineering (SSE), Lahore University of Management Sciences (LUMS), DHA, Lahore 54792, Pakistan, emails: syed.hussain@lums.edu.pk (S.Z. Hussain), ihussain@lums.edu.pk (I. Hussain)*

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ABSTRACT

Pullulan succinate (Pull-Suc) was synthesized by esterification of pullulan with succinic anhydride and converted into its sodic form (Pull-Suc-Na) by treating with saturated $NaHCO_3$ solution. These acidic (Pull-Suc) and sodic forms (Pull-Suc-Na) of the sorbent were characterized by solid-state CP/MAS ^{13}C NMR and scanning electron microscopy–energy dispersive X-ray spectroscopy (SEM–EDS) techniques. SEM analysis showed that surface of the sorbent was rough and rigid. The Pull-Suc-Na was used to sorb Pb(II), Cr(VI), Co(II), Cu(II) and Ni(II) ions from aqueous solution using batch methodology. Sorption data were fitted to various kinetic and isothermal model. Pseudo-second-order kinetic model and Langmuir isotherm model fitted well to the experimental data. Ion-exchange model was applied to verify the involvement of ion-exchange mechanism during initial rapid phase of sorption. Langmuir isotherm model was used to find maximum sorption capacities of Pull-Suc-Na for Pb(II), Cr(VI), Co(II), Cu(II) and Ni(II) which were found to be 714.28, 588.2, 416.6, 357.1 and 250 mg g^{-1}, respectively. Competitive removal of a metal ion from binary, tertiary and mixture of five metal ions was studied to check the potential of sorbent for wastewater treatment procedures. Thermodynamic parameters determination showed that sorption process was spontaneous and exothermic in nature. The sorbent was regenerated using green conditions, that is, by treating with brine. The sorbent showed negligible decrease in sorption capacity after five sorption–desorption cycles.

Keywords: Competitive sorption; Heavy metal ions; Regeneration; Succinylated pullulan

* Corresponding author.