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Synthesis of a Bifunctional Chitosan Derivative and Its Applications in Removal of Metal Ions in Aqueous Solutions

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Abstract

Chitosan has proved to be versatile for so many environmental applications as it possesses major functional groups including -OH and -NH_2. As a natural polymer ligand, chitosan shows good metal binding properties towards various metal ions. However, the efficiency of chitosan is limited at some instances due to several reasons such as acid instability, lower selectivity towards metal ions etc. These constraints can be overcome by modifying chitosan structure to produce various derivatives with the introduction of different functional groups. This study was mainly based on two such derivatives namely Carboxymethyl Chitosan (CMC) and Ethylenediaminetetraacetic acid Chitosan (EDTA-CS) which are already reported in literature as excellent adsorbents for various metal removal purposes. As a further development in this direction, the main objective of this research study was to synthesise a new bifunctional chitosan derivative namely Ethylene-diamine-tetra-acetic acid Carboxymethyl Chitosan (EDTA-CMC) by attaching both Carboxymethyl and EDTA functional groups on to the polymer backbone and thereby enhancing the metal binding properties furthermore. Combined synthetic procedures of CMC and EDTA-CS given in literature were used in the synthesis of bifunctional derivative. Synthesised EDTA-CMC was characterised qualitatively by FT-IR Spectroscopy and TGA. According to TGA, thermal stability of derivatives were in the order of EDTA-CMC>EDTA-CS>CMC. In adsorption experiments, different colors were observed for different metal ions indicating the metal adsorption behavior. Metal uptake by EDTA-CMC was almost 100% in 100 ppm, 200 ppm and 300 ppm Cu^{2+} solutions with an adsorbent dose of 5 mg and for a contact time of 4 hours. Therefore EDTA-CMC appeared to be efficient as a polymer ligand in binding Cu^{2+} compared to other two derivatives; CMC and EDTA-CS. However, such successful results were not obtained for Co^{2+} and Mg^{2+}.

Keywords: Polymer ligand, Chitosan derivatives, Metal adsorption