Chapter 10
Performance of Chitosan Micro/Nanoparticles to Remove Hexavalent Chromium From Residual Water

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ABSTRACT

Hexavalent chromium Cr(VI) is toxic to living systems and must be removed from wastewater. Chitosan is a cationic, biocompatible, biodegradable, biopolymer obtained from marine wastes. The performance of chitosan particles (CH) and chitosan nanoparticles (CHN) to remove Cr(VI) from aqueous solutions is discussed in the present chapter. CHN were obtained by reticulation with tripolyphosphate (TPP), and physico-chemically characterized. The performance of CHN decreased at higher pH due to the cross-linking process with TPP. Langmuir isotherm described the equilibrium adsorption values and pseudo-second order rate provided the best fitting to the kinetic data. Chemical analysis to determine the oxidation state of the adsorbed Cr, showed that Cr(VI) was adsorbed on CH particles without further reduction; in contrast Cr(VI) removed from the solution was reduced and bound to the CHN as Cr(III). Chitosan crosslinking was essential to adsorb Cr(VI) at pH<3 due to the dissolution of CH in acid media.

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1. INTRODUCTION

Industrial and mining wastewaters are important sources of pollution of heavy metals. The use of chromate and dichromate has many industrial applications such as in textile, electroplating, leather tanning, cement preservations, paints, pigments and metallurgy industries. Chromium is a metal potentially toxic to humans as it is considered carcinogenic. Cr (VI) is toxic to living systems and must be removed from wastewater before it can be discharged. Cr(II), Cr(III) and Cr(VI) are the three oxidation states for chromium in nature, but only the last two are stable. Cr(VI) is 500 times more toxic, mutagenic and carcinogenic than Cr(III). The maximum permissible limit of for Cr(VI) in wastewater has been recommended as 0.005mg L$^{-1}$ by World Health Organization.

For the removal of toxic pollutants from water and wastewater differences methods, such as oxidation/reduction, filtration, coagulation, membrane process, adsorption, osmosis, biological methods, etc, have generally been used. However, adsorption process is often considered the most appropriate technique owing to its advantages such as a variety of adsorbent materials and high efficiency.

Over the years, a wide range of clean-up technologies has been developed to remove toxic metals from water. The removal of metals, compounds, and particulates from solution by the biological material is recognized as an extension to adsorption and is named as biosorption.

Biosorbents have been given increasing attention as they can significantly reduce the cost of an adsorption system. Chitosan is an excellent biopolymer obtained cost-effectively by the derivation of chitin, which is a natural, abundance and non-toxicity, the material found widely in crustacean shells. Chitosan is the N-deacetylated derivative of chitin (2-acetamido-2-deoxy-β-D-glucose through a β (1→4) linkage).

Figure 1. Chitin and Chitosan

![Chitin and Chitosan](image-url)
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