

Chapter 14

Effective Removal of Heavy Metals From Aqueous Solution by Nano-Composites: Bio Remediation Using Nano Technology

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ABSTRACT

Heavy metal contamination in industrial effluents presents a serious threat to the environment and human health because of their toxicity, non-biodegradability, carcinogenicity, and bioaccumulation in living organisms. Recently, the preparation and application of iron oxides, especially magnetite nanoparticles, for metals removal have been investigated due to their nano size, magnetic separation, and the ease of synthesis, coating, and modification. However, magnetic nanoparticles lose some magnetization due to air oxidation. Magnetite nanoparticles coating with inorganic shell, like silica and carbon, have been reported and were capable of improving chemical stability. The effects of pH, contact time, and initial concentrations on the removal of heavy metals should be studied using nano-composites in water. In this chapter, the authors present a technical review on different nano-composites used for bioremediation and their limitations.

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INTRODUCTION

Rapidity in urbanization and industrialization results in release and discharge of hazardous heavy metal ions and synthetic organic dyes into the water resources. The industrial process responsible for the release of the carcinogenic and mutagenic substances into the environment includes, mining, tannery, paper and pulp, textile, leather, metal plating, pesticide, fertilizer, batteries manufacturing and like. The discharge of these substances primarily leads to elusive and pervasive threat to the environment and the world occupants. Distinguishing feature of these substances attributes to stability, non-biodegradability and higher toxicity. Most significantly, the heavy metal that are causing serious environmental issues and that endangers the human survival in the world comprises the metal ions such as arsenic ($\text{As}^{3+/5+}$), lead (Pb^{2+}), cadmium (Cd^{2+}), chromium ($\text{Cr}^{3+/6+}$), cobalt (Co^{2+}), copper (Cu^{2+}), mercury (Hg^{+2+}), nickel (Ni^{+}), and zinc (Zn^{2+}) (Mahmud et al., 2016). In order to maintain the environmental sustainability and effluent standard levels of these inorganic toxic moieties, an efficient treatment strategies need to be adopted before being discharged into the water bodies.

Several managerial techniques that are extensively studied for the purpose includes physical, chemical and biological methods for mitigating the metal ion concentration from the wastewater includes adsorption, coagulation/ flocculation, chemical precipitation, membrane filtration, electrochemical, and ion exchange methods. Of these, adsorption is the far reaching and promising technology for treating huge quantity of wastewater at lower concentration. Thus synthesis of advanced adsorbent characterized with higher efficacy in complete removal of heavy metal is of resented research interest and is essential for achieving sustainable water resource. With emergence of nano-bioremediation, several opportunities are in progress in remediating the contaminated sites with facile, rapid, efficient, green and low-cost technology (Yang et al., 2008; Yan et al., 2014; Zhu et al., 2014). In the recent past, use of natural polymer contained nano-composites, layered nanomaterials and nanofiltration membranes (De et al., 2011; Sarkar et al., 2015; Zhu et al., 2015) finds wider application in handling of heavy metals from the contaminated wastewater.

Amid of number of nano-composite materials used for remediating the heavy metal in water pollution control, zeolites, activated carbon, zero valent iron, metal oxides and like nanomaterials find an important role due to the fact of lower toxicity, larger surface area, and degradability with ageing. The heavy metal released into the environment percolates into soil and causes threat to ground water and surface water. Exposure of heavy metals or its ingestion can cause serious consequences. In general, the human physiology attempts to eliminate the toxic substances in all possible excision human mechanisms or otherwise gets accumulated in various storage sites. These toxicants might lead to serious threat to the human health.

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