Chapter 13
Recovery of Heavy Metals by Biosorption and Regeneration of the Adsorbents

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ABSTRACT

In recent times, significant research is carried out regarding efficient and cost-effective removal of heavy metals from water systems with the help of adsorption. Out of different absorption processes, biosorption processes have some major advantages over the other available physical or chemical processes. They have higher applicability because of their low cost and eco-friendly nature. However, no sufficient attention was paid to the recycling of adsorbents and recovery of heavy metals from the absorbents. The adsorbents themselves become toxic after absorbing the heavy metal. So, it is important to dispose of the used absorbent or reuse the absorbent by recovering and recycling process. In this chapter, the authors focus on recycling the absorbent and recovering of heavy metal that are used in various biosorption processes. Various types of acids, alkalis, and chelating agents were used regenerating agents for the recycling and recovery process.

1. INTRODUCTION

The use of different heavy metals in various industries increased the risk on global public health and enhanced ecological problems round the globe. Along with natural sources, anthropogenic activities such as metal mining, industrial production and agricultural use contribute to environmental contamination of heavy metals. Other sources of pollution include metal corrosion, air deposition, soil erosion, leaching and metal evaporation from water resources. Industrial sources include paper processing factories,

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plastics, microelectronics, textiles, wood preservation, and metal processing in refineries (Bashir et al. 2018; Chen et al. 2021).

Nowadays most of the surface water and groundwater sources are polluted with various essential and non-essential heavy metals from different source due to the industrialization and urbanization (Lata et al. 2015). Among different heavy metals, Copper (Cu), Cadmium (Cd), Nickel (Ni), Lead (Pb), Chromium (Cr), Mercury (Hg) and Zinc (Zn) are mainly responsible for the toxic effects among living organism (Tzou et al. 2007; O'Connell et al. 2008). Among the class of metalloids; boron, silicon, germanium, arsenic, antimony and tellurium are major heavy metal pollutant. However, among metalloids, arsenic toxicity is of major concern for the environment and is the most dominating toxic element found in water (Smedley and Kinniburg 2002).

Another highly toxic heavy metal which should be removed is mercury. It acts as neurotoxin that can leads to disfunction of central nervous system. High concentrations of mercury in our body can cause demage to pulmonary and kidney function, chest pain and dyspnoea (Tzou et al. 2007). Continuous exposure to lead metal can lead to anemia, diseases of the liver and kidneys, brain damage to living being and ultimately cause death (Smedley and Kinniburg 2002).

The presence of heavy metal in our ecosystem is common. However, presence of heavy metals in excess level in our eco-system leads to chronic poisoning. It affects the central nervous system, reduces energy level in body, alters blood composition of living beings and subsequently affects all vital organs like lungs, kidney, liver etc. of living organism (Baldwin and Marshal 1999). Heavy metals are non-biodegradable and it get accumulated in food chain of an ecosystem. Long-term exposure may lead to muscular and neurological disorder, including alzheimer's disease, parkinson's disease, muscular dystrophy and multiple sclerosis. Continuous exposure to higher concentration of heavy metals pollutant may even cause cancer to some people (Smedley and Kinniburg 2002).

Although heavy metals occurs naturally, does not cause environmental problems as it remains in immobilized form in sediments and as ores in nature. However, due to various anthropogenic activities like mining and industrial processes such as smelting, tannery, battery, from fly ash, electroplating, steel plant, distillery etc. causes increased deposition of heavy metals in soil and aquatic environment. Among toxic heavy metals, Arsenic, Cadmium, Lead, Mercury, Zinc and Chromium are responsible for most of the metal poisoning hazards faced by public and the environment. Arsenic is a ubiquitous element found in inorganic forms as trivalent arsenite and pentavalent arsenate and also in organic forms as monomethylarsonic acid (MMA), dimethylarsinic acid (DMA), and trimethylarsine oxide. Arsenic pollution occurs due to natural phenomena like volcanic eruptions and soil erosion, as well as human activities and industrial production of arsenic containg compounds used in agricultural applications, veterinary medicine, and medical treatment. Contamination with high levels of arsenic is of concern because it can cause various health effects, including cardiovascular and peripheral vascular diseases, developmental anomalies, neurologic and neurobehavioural disorders, diabetes, hearing loss, portal fibrosis, hematologic disorders, and carcinoma. The toxic effects to human health, sources and permissible limits of some heavy metals are listed in Table.1(Gouda et al. 2023, Hussain et al. 2021, Tripathi et al. 2023, Wierzba et al. 2022).