Chapter 17
Metal Recovery From Polluted Water Using Electrochemical Technologies

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ABSTRACT

Water is one of the most important issues of our time intertwined with global warming and population expansion. The management of water supplies and the conservation of water resources remains one of the most challenging yet exciting issues of our time. These rapidly growing industries spill out a lot of hazardous plastic waste, oil waste, chemicals waste, masonry and concrete, vegetable matter, and many more wastes in the water. It is of major concern that these industries are contaminating throughout the world. Oily sludge obtained as a waste from petroleum or refinery industries contain significant metal ions which thoroughly mix and pollute the water. Metal ions like As, Cr, Co, Cu, Fe, Pb, Ni, Zn, Cd, and Mn are found in oily sludge of refinery industry and may harm plants, animals, and humans due to their long-term preservation and also causes groundwater contamination. These metals are recovered by electrochemical methods, which attempt to target recycling heavy metal resources with minimizing energy consumption, boost recovery efficiency, and realize the commercial application.

INTRODUCTION

Water pollution is becoming a huge problem globally so the evaluation of water resource policy is being needed to check this problem. In India one-third of total water pollution case comes in the form of industrial effluents, solid wastes and hazardous wastes from many domestic, industrial and agricultural activities (Rana et al., 2017). Due to water pollution many deaths and diseases are being caused worldwide and approximately 15000 people die daily due to this problem (Udaiyappan et al., 2017). Not only the developing countries but also the developed countries are facing the problem of water pollution. Precipitation, nutrients, vegetation, climate, sediments, toxic contaminants, flow conditions, geology, soil type, ground water and human activities are some of the factors that influence the quality of water supply (Chaudhry & Malik, 2017). Some activities such as mining, agriculture and urban development also affects the quality of water. Urbanization and industrialization resulted in the untimely impact on our ecosystem in terms of worsening and shortage of fresh water (Wollmann et al., 2019). The increasing population and the water shortage are the two main driving forces for the reuse of the untreated wastewater for urban and peri-urban areas for irrigation in poor countries just to satisfy their food requirements (Tariq et al., 2020). Although this wastewater contains many essential nutrients which are necessary for the plants' growth, along with these nutrients it contains the toxic metal ions and pathogens which pose a significant threat to the human health as well as for the environment (Xu et al., 2018). The improper disposal of domestic and industrial wastewater affects the environment adversely so the treatment of wastewater is very important (Li et al., 2018). Domestic wastewater and industrial wastewater contains the organic and mineral materials which if discharged into environment cause the pollution of surface and groundwater and as a result the water reuse is very difficult (Liu et al., 2017). Heavy metal ions occur naturally throughout the Earth's crust. Metal ions mostly occur by environmental contamination, industrial production and uses, mining or smelting processes, domestic or agricultural use of metal and metalloids (Letry et al., 2019). Environmental contamination by introduction of harmful materials like toxic metals, gaseous pollutants, particulate matter, sewage, agricultural run offs, electronic wastes into water, industrial effluents, soil erosion of metal ions and leaching of heavy metal ions (Mokif, 2019). The industrial sources which pollute the water bodies include the coal burning, rocks crushing, extracting of coal and minerals, petroleum combustion, organic matter like food waste, slaughterhouse waste and plant wastes. Weathering and volcanic eruptions are the naturally occurring phenomena which also contribute to the pollution with heavy metals (Shen et al., 2017). The bioavailability of heavy metal ions which can also be considered as trace elements are influenced by some physical factors which include temperature, adsorption, sequestration and phase association. And the chemical factors include speciation at thermodynamic equilibrium, complexation kinetics, partition coefficients and lipid solubility (Ugwu & Agunwamba, 2020). Metal ions cannot be degraded like the organic compounds and hence require the immobilization to reduce or remove their toxicity (Crini & Lichtfouse, 2019). Some of the metal ions are essential for our life processes and some of them have no use and are affecting the plants and animals in the environment. Industrial wastewater contains many typical pollutants like BOD, COD, oil and grease, nitrogen, phosphorus and many heavy metal ions which causes the threat to the environment (Al-Khafaji et al., 2018). The heavy metals either present on the surface or in the cells of the organisms can alter the biochemical processes of living beings (Peng & Guo, 2020). The composition and the characterization of the resulting effluent is completely different and is complex due to different types of industries and their different processes involved (Devda et al., 2021). The industrial effluents from different industries contaminate the environment in different ways based on the various types of

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