A review on Removal of Cobalt from Wastewater

S.Sophie Beulah
Government College of Engineering
Tirunelveli-627 007
Tamilnadu

ABSTRACT

Heavy metal pollution of water has become one of the environmental problems today due to their persistence in the environment. Heavy metals like lead , zinc, Cobalt, mercury , nickel , cadmium , copper , chromium, arsenic, antimony etc. are found in wastewater and need to be removed. The presence of these metals in wastewater can cause various acute and chronic diseases. Various methods for heavy metal removal from wastewater have been extensively studied. Cobalt has various adverse effects on human health. This paper reviews the removal of Cobalt from wastewater.

Key words: Heavy metals, Cobalt, removal, wastewater

INTRODUCTION

Cobalt, a natural element present in certain ores of the Earth's crust, is essential to life in trace amounts. It exists in the form of various salts. Cobalt is used in industries such as nuclear, medicine, enamels and semiconductors, grinding wheels, painting on glass and porcelain, hygrometers and electroplating. It is also used in vitamin manufacture, as a drier for lacquers, varnishes, paints. Cobalt can have various adverse effects on health such as asthma, heart damage, heart failure, damage to the thyroid and liver. The removal of cobalt from wastewater can be carried out by various chemical, biological and physical methods [1]. Cobalt occurs in two oxidation states, Co^{2+} and Co^{3+}, in aquatic environment. Advanced wastewater-treatment methods, such as ion exchange, precipitation, membrane separation, and electrolysis, have been used for cobalt removal from wastewater. The permissible limits of cobalt in drinking water, irrigation water and for livestock watering are 2µg/L, 0.05mg/L and 1 mg/L respectively [2]. This review summarizes studies on cobalt removal from wastewater

LITERATURE REVIEW

Waghmare and Chaudhari investigated on removal of cobalt from wastewater using Moringa Oleifera Bark. Their studies were aimed at utilizing the locally available material for removing the heavy metal. They studied effect of various parameters such as adsorbent dosages, pH, and contact time on adsorption of cobalt. The equilibrium contact time was observed to be 360 minutes with 85.33 percent efficiency in these studies [3]

Musapatika etal utilised coal fly ash for the adsorption of cobalt(II) ions from synthetic petrochemical wastewater and characterised its performance. The effects of pH, initial concentration and adsorbent dose on cobalt(II) removal were assessed using response surface methodology. Although the focus was on removal of cobalt(II), the adsorption was carried out in the presence of phenol and other heavy metal ions using the batch technique. The equilibrium data was found to conform more favourably to the Freundlich isotherm than to the Langmuir isotherm. Coal fly ash had a maximum adsorption capacity of 0.401 mg/g for cobalt(II)[4]

Hashemian etal studied Fe_3O_4/Bentonite Nanocomposite for removal of cobalt from aqueous solutions. They used chemical co-precipitation method for preparation of Fe_3O_4/Bentonite nanocomposite. In their investigations, they observed that spinel structure of Fe_3O_4 and the presence of Fe_3O_4 significantly affect the surface area and pore structure of the bentonite. They also observed that pseudo second-order kinetics explained adsorption isotherms [5].

Galedar and Younesi used saccharomyces cerevisiae cells for removal of cobalt and other metal ions from waste water. They studied effect of parameters like pH, initial biomass dose and initial metal ion concentration on cobalt removal. They observed that pH value of 8 was optimum for cobalt removal. The optimum biomass concentration was 8 mg/l. Also Langmuir model was found to be a better fit [6]

Guixia Zhao et al synthesised few layered graphene oxide nanosheets from graphite and used as sorbents for the removal of Cd(II) and Co(II) ions from large volumes of aqueous solutions. The abundant oxygen containing functional groups on the surfaces of graphene oxide nanosheets played an important role on Cd(II) and Co(II) sorption. The maximum sorption capacities of Cd(II) and Co(II) were about 106.3 and 68.2 mg/g respectively[7]

Al-Shahrani assessed removal of cobalt from wastewater using Saudi activated clay (bentonite). The removal characteristics were investigated under various operating variables such as contact time, solution pH, clay dosage and initial metal concentration. It was found that adsorption of cobalt ions on Saudi activated bentonite was relatively fast and the equilibrium was reached after 30 min. Adsorption was also dependent on solution pH where cobalt removal percentage gradually increased with increasing solution pH up to 99% at pH 8. Moreover, about 100% cobalt removal was observed when solution pH was increased to more than 8. The adsorption isotherm data were well fitted with both the linearized Langmuir and Freundlich models [8]

Ahmadpour et al chemically treated Almond green hull, an agriculture solid waste and used for the adsorption of Co(II) from aqueous solutions. The efficiency of this adsorbent was studied using batch adsorption technique under different experimental conditions such adsorbent amount, initial metal-ion concentration, contact time, adsorbent particle size, and chemical treatment. Optimum dose of sorbent for maximum metal-ion adsorption were 0.25 g for 51.5 mg l^{-1} and 0.4 g for 110 mg l^{-1} solutions, respectively. The adsorption of Co(II) on almond green hull followed the pseudo second-order kinetics. The maximum adsorption capacity of this new sorbent was found to be 45.5 mg g^{-1}[9]

Rengaraj and Seung-Hyeon Moon analysed the capacity of ion exchange resins, IRN77 and SKN1, for removal of cobalt from aqueous solution has been investigated under different conditions namely initial solution pH, initial metal-ion concentration, and contact time. The equilibrium data obtained in this study have been found to fit both the Langmuir and Freundlich adsorption isotherms. The adsorption of Co(II) on these resins follows first-order reversible kinetics. The film diffusion of Co(II) in these ion exchange resins was shown to be the main rate limiting step[10]

Santos et al showed a simple and effective treatment for the removal of cobalt ions from simulated industrial wastewater, based on cathodic eletrolytic removal using a carbon steel screen. As a result, a 73% removal of cobalt ions from solutions was achieved with a concentration of 400 mg Co^{2+}/L, a current of 0.30 A and a voltage of 30 V. In the same conditions, 84% and 88% was removed from 200 mg Co^{2+}/L and 100 mg Co^{2+}/L, respectively[11]

Mohammed studied the removal of heavy metals (Cobalt, Cadmium, and Zinc) from waste water using black teawaste. Adsorption was observed for the three metals at 180 min. The pH level allowing for an optimum rate of adsorption was found to be 6 for Co, Cd, and Zn. The quantities adsorbed per a half gram of black teawaste at equilibrium (q_e) are 15.39 mg/g for Co, 13.77 mg/g for Cd, and 12.24 mg/g for Zn[12].

CONCLUSION

A number of technologies have been developed over the years to remove toxic cobalt from water, including chemical precipitation, electrofloatation, ion exchange, reverse osmosis and adsorption on activated carbon. Future perspective needs large scale removal of metals from contaminated waste streams.

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