Removal of Cd(II) from wastewater by adsorbents-A review

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ABSTRACT

Water pollution due to toxic heavy metals has been a major cause of concern for mankind. Metals are non biodegradable and can accumulate in the living tissues causing ill effects. The important toxic metals Cd, Ni, Pb, Cr etc. find their way to the water bodies through waste waters. The release of large quantities of these metals into the natural environment results in environmental contamination. Adsorption of heavy metals by bio wastes is an effective way of removal of heavy metals from wastewater. In this review paper the various adsorbents used for the removal of cadmium from wastewater has been analysed.

Key words : Cadmium, adsorption, adsorbents, wastewater

1.INTRODUCTION

Cadmium is one of the most toxic metals found in the environment. Cadmium occurs naturally in the environment by the gradual process of erosion, abrasion of rocks and soils, and due to forest fires and volcanic eruptions. The best known cadmium mineral is greenockite, cadmium sulfide (77.6% Cd). Other minerals are otavite, cadmium carbonate (61.5% Cd) and pure cadmium oxide (87.5% Cd). Greenockite (CdS) is nearly always associated with sphalerite (ZnS). As a consequence, cadmium is produced mainly as a byproduct from mining, smelting, and refining of sulfide ores of zinc[1]. The main anthropogenic pathway through which cadmium enters environment is via wastes from industrial processes such as electroplating, smelting, alloy manufacturing, pigments, plastic, cadmium-nickel batteries, fertilizers, pesticides, mining, pigments and dyes, textile operations and refining[2]. Cadmium exposure causes hypertension or high blood pressure, dulled sense of smell, anaemia, joint soreness, hair loss, dry scaly skin, loss of appetite, decreased production of T cells and, therefore, a weakened immune system, kidney diseases and liver damage, emphysema, cancer and shortened lifespan [3]. According to WHO's recommendation Cd(II) limit in drinking water is 0.005 mg/L Methods used predominantly for cadmium removal are Adsorption ,Biological Methods ,Electro coagulation and Electro dialysis, Floatation, Membrane Separations, Extraction[4].Among them Adsorption using adsorbents has been found to be an effective method. .

B.C.Lowitz established the first use of charcoal for the removal of bad tastes and odours from water on an experimental basis in 1789-90. The credit of developing commercial activated carbon however, goes to Raphael Von Ostrejko whose inventions were patented in 1900 and 1901. Wetonabe & Ogawa first presented the use of activated carbon for the adsorption of heavy metals [5]. Commercial activated carbon available either in powdered or granular form is commonly used as an adsorbent. Activated carbon is costlier and its practical applications are limited. Hence, various investigators focused their attention on the use of alternative locally available low cost adsorbent materials and their technical feasibility by modifying the adsorbent chemically. Agricultural Waste can be used as adsorbent material in removal of heavy metals as they are less costly, require little processing, easily available and possess good adsorption capacity[6]. This review article provides an overview of use of agricultural wastes as adsorbents for removal of cadmium from wastewater

2. LITERATURE REVIEW

2.1Tea waste

A K Dwivedi etal investigated the use of tea waste as the low-cost adsorbents for removing heavy metal ions from aqueous solutions. The experiment results showed that maximum removal of copper and cadmium ion by tea waste is 89% and 87% respectively at optimum condition[7]

2.2Papaya seed, egg shell, coconut leafpowder

Zahir et al revealed that the potential of papaya seed, egg shell and coconut leafpowder as adsorbent for the removal of heavy metals such as lead, cadmium and chromium from known concentration of waste water. The study revealed that the low cost adsorbent of Chicken egg Shell is used for removing 85, 82 and 86 % of chromium, lead and cadmium respectively. Coconut leaf powder used for removing 87, 90 and 85 % of chromium, Lead and Cadmium respectively. Papaya seed powder is used for removing 80, 85 and 79 % Chromium, Lead and Cadmium respectively from wastewater from the initial metal ion concentration of 100 ppm solution. Batch adsorption studies demonstrated that the adsorbents had significant capacity to adsorb the chromium, Lead and Cadmium from aqueous solution. It was found that the adsorption increased with increase in contact time[8]

2.3 Barley hull and barley hull ash

Afshin maleki et al prepared adsorbent from barley hull and barley hull ash, an agricultural waste product, to remove cadmium from an aqueous solution in batch mode as a function of appropriate equilibrium time, amount of adsorbent, concentration of adsorbate, pH and particle size. Studies showed that pH of aqueous solutions affected cadmium removal as a result of removal efficiency increased with increasing solution pH. The maximum adsorption was about 95.8 and 99.2 % for barley hull and barley hull ash, respectively, at pH 9, contact time 180 min and initial concentration of 30 mg L-1. Desorption of cadmium was 8 % at pH 9. The cadmium sorption obeyed both the Langmuir and Fraundlich isotherms. The sorption kinetics are well described by the pseudo-second-order kinetic model. The studies showed barley hull ash was more favourable than barley hull in removing cadmium and thus was a better adsorbent as low-cost alternatives in wastewater treatment for cadmium removal[9].

2.4 Luffa cylindrica

C.AD et al analysed the removal of toxic metal, cadmium, by using adsorption into Algerian Luffa Cylindrica, LC. The biosorption process was studied with respect to contact time, particle size, pH and temperature. The results showed that equilibrium was reached within 1 h. The used biosorbent gave the highest adsorption capacity at pH 6. The experimental isotherm data were analysed and modelled. The maximum adsorption capacity, Langmuir's q_{max}, improved from 5.46 to 7.29 mg/g as the temperature increased from 10 to 40 °C. Besides, the adsorption kinetics was found to follow the second-order model, as well as the micropore diffusion model described the Kinetic data well, suggesting a possible physisorption process[10]

2.5Melon husk

Giwa et al evaluated the removal of cadmium from simulated wastewater (aqueous solution) using melon husk (an agricultural residue) modified with concentrated sulphuric acid at room temperature. Adsorption studies were carried out to determine the influence of contact time, initial cadmium ion concentration, adsorbent dosage and particle size on removal efficiency. Removal efficiency was observed to decrease with increasing initial cadmium ion concentration (2-10 mg/L), but increases with decreasing particle size (45-355 μm), and increasing adsorbent dosage (0.02-0.30 g). The data obtained fit into three equilibrium isotherms in the order: Freundlich > Langmuir > Temkin. Modeling of kinetics results showed that the adsorption process was best described by Pseudo-second order model with regression coefficients higher than 0.998[11].

2.6 Neem leaf powder

Sharma et al studied adsorption of cadmium using neem leaf powder. The kinetics of the interactions was tested with pseudo-first-order Lagergren equation, simple second order kinetics, Elovich equation, liquid film diffusion model and intra-particle diffusion mechanism[12].

2.7 Husk of lathyrus sativus

Panda et al used husk of lathyrus sativus. They have reported that scanning electron micrographs showed that cadmium to be present as micro precipitate on the surface of the adsorbent. Cadmium replaced calcium of the biomass as revealed from the EDX analysis indicating that the adsorption proceeds through ion exchange mechanism. Cadmium could be desorbed from the loaded biomass by lowering pH 1.0 with mineral acid. Husk of black gram (Cicer arientinum)[13]

2.8 Orange Peel

Li et al modified orange peel with 0.6 mol/L citric acid under 800 C after alkali saponification was found to be effective in removing cadmium from waste waters. Desorption was done with 0.15 mol/L HCl[14]

2.9 Mango peel

Iqbal et al. studied cadmium and lead adsorption with mango peels waste. Their FTIR analysis revealed that carboxyl and hydroxyl functional groups were mainly responsible for the adsorption of Cd2+ and Pb(II). Chemical modification of MPW for blocking of carboxyl and hydroxyl groups showed that 72.46% and 76.26% removal of Cd(II) and Pb(II), respectively, was due to the involvement of carboxylic group, whereas 26.64% and 23.74% was due to the hydroxyl group[15].

3. CONCLUSION

In this paper, a study of different adsorbents used for the removal of Cd(II) has been reviewed. It could be implied that various agricultural wastes are effective in removal of cadmium from wastewater. Use of large scale application of the adsorbents in industries is needed to be focussed further.

4. REFERENCES

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