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A Review on Recent (2013 -2017) Investigations for Cadmium Removal from Wastewater

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ABSTRACT

The removal of cadmium can be carried out by various physic-chemical and biological methods. The author has carried out review of investigations for cadmium removal in 2013. He reported various investigations carried out till 2013. His study indicated that adsorption and electrocoagulation were two efficient methods along with many other chemical, biological and physical methods for cadmium removal. In recent years, the use of mixed adsorbent and experiments with simulated wastewater, with resemblance to industrial wastewater can be considered as step close to actual conditions. Some investigations on industrial waste water yielded excellent results. Regeneration and reuse of adsorbent remains thrust area in the wide acceptance of low cost adsorbent methods industrially. The current review is aimed at summarizing research and studies on cadmium removal from wastewater in last five years.

***Key words*:** Bioaccumulation, electroco-agulation, adsorption, ion exchange, pH adsorption.

INTRODUCTION

Cadmium removal from waste water is an important area of investigation because of its tendency to bio-accumulate. The removal of cadmium can be carried out by various physico-chemical and biological methods. The author has carried out review of investigations for cadmium removal in 2013. [1] He reported various investigations carried out till 2013. His study indicated that adsorption and electrocoagulation were two efficient methods along with many other chemical, biological and physical methods for cadmium removal. [2-5] He, along with Dr Kaware investigated effect of various parameters on cadmium removal in batch and column experiments. Also the author has reported various effects of heavy metals on man and environment. [6] He reported various investigations for effect of heavy metals. [7-8] Also various adsorbents used for adsorption of heavy metals were reported by him. [9-10] Since then, many investigations have been carried out for cadmium removal. The current review is aimed at summarizing research and studies on cadmium removal from wastewater in last five years [2013-2017].

REVIEW ON CADMIUM REMOVAL SINCE 2013

Tadepalli and Murthy investigated copper and cadmium removal from industrial effluents and synthetic solutions. [12] They carried out experiments in batch mode with mixed adsorbents. For adsorption, the adsorbents used were mixture of activated charcoal (AC) and bone charcoal (BC) in 1:1 proportion. They used nearby industrial effluent with copper and cadmium concentration 350 ppm and 180 ppm respectively. They found that the metal removal was highly pH dependent. The maximum removal was obtained in pH range 2 to 6. They obtained lesser percentage removal for industrial effluent for both the metals as it contains other heavy metals, phenols, cresols, and waste contaminants, biodegradable mass and suspended solids. They also studied Effect of point of zero charge on mixed adsorbent. The zero charge point was defined by them as the pH at which the mixed adsorbent has

a net zero charge. Above the pH value of 8, ions get precipitated. They performed all the experiments in acetate buffer of pH 3.

An investigation was carried out by Visa and Chelaru for exploring use of hydrothermally modified fly ash for heavy metals removal from effluent. [13] They modified flyash with NaOH and hexadecyl trimethylammonium bromide. They used sample size of 50 ml in their investigation. They discussed adsorption kinetic mechanisms, and the substrate capacities and related them to with the surface structure (XRD), composition (EDS, FTIR), and morphology (SEM, AFM).Their investigation indicated that the adsorbent had excellent adsorption capacity. Their surface analysis also indicated that substance has a high crystallinity degree and a surface with broad open pores.

A review was done by Singh and Gupta on adsorption of heavy metals. [14] They reviewed application of various adsorbents such as activated carbon, activated alumina, iron acetate activated alumina, silica gel, hydro gels, magnetic graphene oxide. for removal of heavy metal from effluent. They emphasized that adsorption process has great potential for the elimination of heavy metals from industrial wastewater using low cost adsorbents. Swain et.al. used water hyacinth, eichhornia crassipes for phytoremediation of copper and cadmium. [15] Their studies indicated that the presence of these metals has effect on the plant growth. Percentage removal by plant was as high as 90 percent for both the plants. In first five days the metal removal was very fast. They found that accumulation of Cu and Cd in roots and stems increased with the initial concentration.

An investigation was carried out by Venkatesan and Senthilnathan on the Removal of Cadmium using Wood of Derris indica based activated carbon. [16] They carried out batch experimentation for studying the cadmium removal. They studied effect of adsorbent dosage and contact time on removal of the cadmium ion. They found that for removal of 80 mg/L of cadmium from the wastewater, 0.5gms/150 mL adsorbent was required with contact time of 20 minutes. An investigation was carried out by Abdul-Talib et.al. for cadmium removal by fungal pleurotus ostreatus biosorbent. [17] For 50 ml of effluent they obtained optimum values for various parameters. These parameters were initial pH 6, 10 minutes contact time, 10 mg/L cadmium (II) concentration, 125 rpm speed on orbital shaker and room temperature (26 ± 1 °C).

Mwanyika et.al. carried out an investigation aimed at assessing the efficiency of a constructed wetland for heavy metal removal. [18] They also analyzed parameters like temperature, pH, and electrical conductivity and dissolved oxygen. They observed that with the exception of cadmium and zinc, lead and copper were above the regulatory limits in wastewater stabilization ponds. It was observed that effluent from the constructed wetland contained lead, copper and zinc at levels below prescribed limit. Escobar et.al. carried out an investigation to study the heavy metal removal from natural and simulated wastewater. [19] They used electrocoagulation method for this purpose. They observed decrease in metal removal with increase in the spatial separation of electrodes. According to them, the reason for this is, decrease in current flow and coagulant generation. Jain et.al. investigated use of carbonaceous adsorbents prepared from sunflower waste for cadmium removal. [20] They used two adsorbents prepared from sunflower, Sunflower Head Carbon (SHC) and Sunflower Stem Carbon (SSC). Their investigation indicated that the cadmium removal was dependent on pH, Cd(II) ion concentration, adsorbent dose, contact time and temperature. Freundlich isotherm fitted the data.20 g/l of the adsorbent and pH value of 6 indicated maximum removal. At 125 mM concentration, they obtained highest desorption efficiency i.e. 55.6 and 52.6% from SHC and SSC.

Alfarra et.al. reviewed investigations on natural adsorbents for heavy metal (cadmium) removal from wastewater. [21] They reviewed use of leaves, plants' seeds, barks, and agricultural wastes and their efficiency on heavy metals adsorption. They explored the removal efficiency of Moringa oleifera leaves on cadmium. They listed advantages and disadvantages of biosorbents in heavy metal removal. Shorter life span and early saturation are disadvantages of biosorbents. Cost and solid waste management are advantages of biosorbents. An investigation was carried out by Sharmila and Muthusamy, for removal of heavy metal from industrial effluent. [22] In their investigation, they used the spent tea leaves as biosorbent. Their study indicated 75% of biosorption of lead and 69% of cadmium.

Kulkarni and Kaware reviewed adsorptive removal of cadmium from wastewater. [23] This review indicated that fly ash, peanut shells, activated carbon, rice husk, rice husk ash, barley hull and barley hull ash, coconut shells activated carbon, cashew nuts activated carbon, tamarind seeds activated carbon, calcite, Leca, nettle ash have been tried by various researchers with good results. According to them, effective regeneration can be very important factor in choosing the adsorbent. [24] Also contact pattern such as fixed, fluidized, moving beds are important areas of investigations. [25]

Santos et.al. carried out an investigation on electrolytic removal of heavy metals from wastewater. [26] They used a metallic screen cathode of carbon steel and platinum anode. To quantify the concentrations, they employed the methodology of cathodic-stripping voltammetry with a mercury drop electrode. They obtained 94.07 percent removal of cadmium by using this method. Kulkarni and Kaware used adsorbent prepared from low cost material, rice husk waste for cadmium removal. [27] In their investigations, they obtained the optimum values of initial concentration, adsorbent dose, pH and contact time as 60 mg/l, 2.5 grams per 100 ml, 5.5 and 40 minutes respectively. They also found that Langmuir and Freundlich isotherms described batch experimental data reasonably well. Also second order rate equation described kinetics of cadmium removal.

Abbas carried out an investigation on isolation and characterization of cadmium resistant bacteria from industrial wastewater. [28] They isolated six bacterial stains from industrial wastewater.At 7.0pH and 35 °C, all the stains showedoptimum growth and cadmium removal. According to these studies pH and temperature largely affected the cadmium removal. Kulkarni and Kaware investigated packed bed cadmium removal in their investigation. [29] They used groundnut shell derived adsorbent (GNSA) in their investigation. They studied effect of parameters like initial concentration, flow rate and bed height on the break through curve. They observed that the exhaustion time decreases with increase in initial concentration and flow rate. Also, it increased with bed height. They also fitted the data in various models such as Thomas-BDST, Yoon Nelson and Adam Bohart. They found that the Thomas model was most satisfactory for the packed bed cadmium removal by groundnut shell. Kulkarni and Kawarehave also reported use of rice husk adsorbents (RHA) in packed beds. [30] They observed that the parameters like initial concentration, flow rate, bed height and pH affect the model parameters significantly. The data agreed with Thomas and Yoon & Nelson model. They also observed that the time required for 50 percent break through decreased with flow rate and initial concentration.

Muthulakshmi and Anuradha reviewed use of Chitosan for removal of cadmium from wastewater. [31] They reviewed use of chitosan derivatives, grafting chitosan and chitosan composites for cadmium removal. They found that chitosan grafted with γ- cyclodextrin possesses better chelating ability. They studied chitosan derivatives prepared by

various methods namely thiocarbomyl, PVA blend, xanthate, Nano based and grafting. Kulkarni also investigated effect of chromium and nickel on removal of cadmium from wastewater. [32] They found that ionic radius affected selectivity of adsorbate. Due to higher ionic radius than nickel and chromium, Cd was most preferred adsorbate of the three metals.

Desorption experiments carried out by Kulkarni and Kaware indicated cadmium desorption up to 25.1 and 26.1 for GNSA and RHA adsorbents. [33] They used three solvents namely namely dil. HCL, distilled water and dil. sulfuric acid. They observed that the maximum desorption was 25.1 percent for dil. sulphuric acid followed by dil. HCl for GNSA. Also maximum desorption 26.1 percent was obtained by using dil. sulphuric acid for RHA.

CONCLUSION

The removal of cadmium can be carried out by various physic-chemical and biological methods; the author has carried out review of investigations for cadmium removal in 2013. He reported various investigations carried out till 2013. His study indicated that adsorption and electrocoagulation were two efficient methods along with many other chemical, biological and physical methods for cadmium removal. The current review is aimed at summarizing research and studies on cadmium removal from wastewater in last five years [2013-2017]. The use of mixed adsorbent and experiments with simulated wastewater, with resemblance to industrial wastewater can be considered as step close to actual conditions. Some investigations on industrial waste water yielded excellent results. Regeneration and reuse of adsorbent remains thrust area in the wide acceptance of low cost adsorbent methods industrially.

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