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Removal of Zinc from Effluent: A Review

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ABSTRACT: Removal of heavy metals from industrial effluent is major part of research carried out by researchers to improve the environment and protect human population from adverse effects of industrialization. Zinc is one of the major heavy metal which finds application in pharmaceutical, paint, catalyst, piping , battery, insecticides and many other industries. Various physical, chemical and biological methods can be used for zinc removal. Selection of suitable treatment method depends on the concentration of effluent, composition of effluent, available resources, desired final concentration, end use of effluent, disposal method and economical viability. The present review is aimed at summarizing various methods used for zinc removal with respect to methodology, effectiveness and affecting parameters.

KEYWORDS: Removal, adsorption, isotherms, pH, concentration.

I. INTRODUCTION

Wastewater treatment is becoming important factor in the growing industrialization and economical development. Industrial and domestic waste treatment is a major problem in the modern world. The waste from chemical industries like sugar, dye, and distillery contains organic matter measured as chemical oxygen demand (COD). The waste from the industries like fertilizer, dye, paint, electroplating, battery, pipe, catalyst, steel contains heavy metal ions. The effluent is conventionally treated in three stages namely primary, secondary and tertiary. In primary treatment physical unit operations like settling and screening are used. Secondary treatment is biological treatment and tertiary treatment is chemical or advanced treatment. For removal of heavy metals methods such as adsorption, biological methods, electro-coagulation, electro dialysis, floatation, membrane separations, and extraction can be used.

II. RELATED WORK

The waste water needs to be treated for various organic and inorganic pollutants [1, 2, 3, 4]. The organic matter, heavy metal and biological material causes various health problems to human being and environment [5, 6, 7]. Various methods are available for removal of organic matter from wastewater [8, 9, 10]. These methods include biological treatment, adsorption, membrane separation, chemical treatments etc [11, 12, 13]. Heavy metals cause, both short term and long term deceases to human beings. Various biological methods were used successfully by investigators for removal of heavy metals [14, 15]. Adsorption was also investigated by using various low cost adsorbents [16, 17]. Waste water was treated for heavy metals and phenol by using these adsorbents [18, 19, 20]. Zinc is one of the major heavy metal pollutants from industries like paint, pipes, galvanic industries, battery production, fungicides and insecticides, catalyst and many other industries. It is desired to remove zinc from this effluent in order to save the environment from its adverse effects. The present review summarizes the studies carried out on zinc removal by various methods.

III.METHODS FOR ZINC REMOVAL FROM EFFLUENT

Kanawade and Gaikwad used cork powder as Adsorbent for removal of zinc from the wastewater[21]. According to them adsorption is one of the cost effective and efficient way to remove zinc from wastewater. They used electroplating effluent for the treatment with cork powder. For synthetic waste, they observed 98 percent removal, while for the actual industrial waste they obtained 91 percent removal. They used fine cork powder of size 80µm sieve size. The optimum pH value was 6 in batch studies. They observed maximum 81 percent removal for initial concentration of 6 mg/l. Trivunac et.al used a complexation–microfiltration process for zinc removal from wastewater[22].They used stirred dead-end cell for microfiltration experiments. In the pH studies, the percentage removal increased with pH up to pH value of 8 and then it remained constant after that. According to them At low pH values, a large number of the H_3O+ groups occupy the positions, which prevent the target zinc ions from form complexes with Sodium carboxymethyl

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cellulose(Na-CMC). They observed that the removal process was characterized by less energy, high selectivity and fast rate. Kouakou et.al. carried out studies on zinc removal by using commercial activated carbon[23]. They observed, in case of isotherms, Langmuir model was more suitable for the process. They found 70 percent removal of zinc in their studies. Aluyor and Oboh carried out investigation on removal of zinc from an activated carbon prepared from animal horn[24]. The adsorption was well described by Freundlich isotherm and first order kinetics. The commercial activated carbon followed second order kinetics. They concluded that this adsorption was cheap alternative for zinc removal. Ghorbani et.al. used polyaniline nanocomposite coated on rice husk for removal of zinc ions from aqueous solution[25]. They found that the optimum conditions for zinc removal by this methods were pH value of 3, adsorbent dosage of 10 g/L and equilibrium time of 20 minutes. Also it was observed that the equilibrium adsorption isotherm was better described by Langmuir adsorption isotherm model. Johnson et.al. carried out studies on removal of zinc in primary treatment using coagulation and flocculation techniques.[26]. They used chemical agents like ferric chloride, alum, and anionic polymer for increasing the heavy metal removal during the primary stage. They observed that dosing of 40 mg/L ferric chloride and 0.5 mg/L polymer enhanced heavy metals removal efficiencies by over 200% for zinc. Wang et.al used modified Lava particles for zinc removal[27]. They found that the optimum pH value was 6. During the investigation, it was also confirmed that, the process was endothermic and spontanious. Calotropis procera as an adsorbent was used for zinc removal by Vaishnav et.al.[28]. With initial concentration of 60 ppm and pH value of 6, they obtained maximum removal of 75.2 percent. The equilibrium time was 105 minutes. The adsorption followed both, Freundlich and Langmuir isotherms. According to the review carried out by Parmar and Thakur[29], adsorption was cheap and effective method for heavy metal removal. The research has shown encouraging results for removal of various metals including zinc for various adsorbents like cheap zeolites, clay, coal fly ash, sewage sludge, agriculture waste, tea waste, rice husk, coconut husk, neem leaves and biomass. According to research carried out by Dermentzis et.al. for electrochemical treatment of various heavy metals including zinc from industrial wastewater, parameters such as initial pH, current density, initial metal ion concentration, COD and contact time affect the heavy metal and zinc removal to significant extent[30]. They got best removal capacity in the pH range of 4-8. The removal rate increased with current intensity. In their investigation, they concluded that this elecrocoagulation method was a reliable, safe and cost-effective alternative for heavy metal treatment. .A review was carried out by Wasewar on use of tea factory waste for removal of heavy metals including zinc[31]. He found that the research on used of tea factory waste, was encouraging for the application of this low cost adsorbent on larger scale. Thakur and Parmar obtained 90 percent zinc removal in their studies by using tea factory waste[32].They obtained the optimum conditions for adsorption. These conditions were pH value of 5, 120 minute contact time, 0.5g/100ml adsorbent dose and 20ppm concentration. Sharma et.al studied. Aspergillus sp. for Biological removal of zinc from wastewater[33]. In 650ml and 3 lit. reactors, they obtained specific zinc uptake of 44 mg and 77 mg per gram dry biomass. The sugar concentration and dilution 10g/l and $0.02h^{-1}$.

IV. CONCLUSION

Removal of zinc from effluent is widely studied area of research because of presence of zinc in wide range of industries. Various physical, chemical and biological methods have been studied with satisfactory results. The factors like initial concentration, pH and contact time affect the removal percentage of zinc in adsorptive removal of zinc. The chemical treatments like coagulation and flocculation can be coupled with primary treatment methods to increase the zinc removal. It can be concluded that adsorption and biosorption techniques are most widely investigated methods because of cost, efficiency, flexibility and simplicity.

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