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Removal of Zinc from Industrial Wastewater using Rice Husk and Activated Carbon

Manoj Kanoje[1], Mayuri Bhor[1], Saurabh Toche[1], Pranav Jadhav[1]

[1]*Student, Department of Civil Engineering, KBT College of Engineering, Maharashtra, India*

Abstract - *Every year lots of heavy metals are discharged into water bodies from various industries which are toxic and cause serious damage to aquatic life as well as human health. Thus, the removal of heavy metals from industrial wastewater is a serious problem. There are many conventional methods used for the treatment of industrial wastewater such as chemical oxidation, membrane separation, reverse osmosis, electrodialysis, etc. but these are very costly and time-consuming methods. This method becomes very expensive especially when the metal ion concentration is less than 100 mg/lit. The adsorption process is proved to be effective for the removal of heavy metals from wastewater because of its low cost, availability, and eco-friendly nature of adsorbents. Many eco-friendly adsorbents like fruit peels, activated charcoal, rice husk, sawdust, etc. are used for the removal of heavy metal ions such as lead (Pb), cadmium (Cd), chromium (Cr), zinc (Zn), copper (Cu), arsenic (As), etc.*

Key Words: adsorption capacity, heavy metals, wastewater, rice husk, charcoal powder, agricultural waste.

1. INTRODUCTION

Water pollution thanks to development in technology, continues to be of great concern. Discharge from industry contains various organic and inorganic pollutants. Among these pollutants are heavy metals which may be toxic and/or carcinogenic and which are harmful to humans and other living species. Heavy metals can easily enter the organic phenomenon due to their high solubility in water [1]. Cadmium, copper, chromium, nickel, mercury, arsenic, lead, and zinc are extremely toxic heavy metals of widespread use in many industries. They originate from sources like metal complex dyes, pesticides, fertilizers, fixing agents (which are added to dyes to enhance dye adsorption onto the fibers), mordants, pigments, and bleaching agents. In developed countries, legislation is becoming increasingly stringent for heavy metal limits in wastewater [1]. Heavy metals pollution represents a crucial problem, with human health concerns and high ecological consequences. Its therefore essential to get rid of heavy metals from industrial wastewaters before their disposal. Various treatment technologies employed for the removal of heavy metals include chemical precipitation, natural process, chemical oxidation, reduction, reverse osmosis, ultrafiltration, electrodialysis, and adsorption [2]. The adsorption method may be a relatively new process and is emerging as a potentially preferred alternative for the removal of heavy metals because it provides flexibility in design, high quality treated effluent and is reversible and therefore the adsorbent is often regenerated [1]. Natural adsorbents are those obtained from biological material and are comparatively cheap. Surface characteristics and pore structures of adsorbents are the most properties in determining adsorption equilibrium and rate properties that are needed for the treatment of wastewater. New adsorbents are continuously being developed, introducing new applications for adsorption.

1.1 OBJECTIVES

To reduce the heavy metals from industrial wastewater using natural adsorbents and to reduce the bacterial as well as the chemical load on the treatment plant to reduce the maintenance as well as operating cost of treatment.

1.2 SCOPE OF THE STUDY

The adsorption method is an excellent way to treat effluent and also a cost-effective technique. Low-cost adsorbents can be used for water treatment. There is a requirement to develop more efficient selective, inexpensive, and eco-friendly low-cost adsorbents for water treatment. Much work is to be carried out in the area of the desorption process.

2. MATERIALS AND METHODOLOGY

2.1 Materials

2.1.1 Rice Husk

Rice husk is an agricultural waste that is generated in rice-producing countries. The husk is a layer of cellulose protecting rice grain and It can be easily available at rice mills. In recent years attention has been focused on the utilization of unmodified and modified rice husk as

an adsorbent for the treatment of wastewater. It was observed that modified rice husk is a potentially useful material for the removal of heavy metals from industrial wastewater.

2.1.2 Activated Charcoal

Activated charcoal is considered one of the most common materials for the treatment of water. It is very effective in the removal of heavy metals from wastewater. It is not harmful to human health and does not have significant drawbacks. Hence it can be applied for the treatment of wastewater.

2.1.3 Industrial Sample

The wastewater sample for this study was collected from the target site which was the electroplating industry which contains Zinc concentration up to 88.72 mg/lit. The studying of water quality for Industrial Wastewater is considered very significant due to the huge volume of industrial effluents containing heavy metals discharged into treatment plant leading to deterioration in the quality of wastewater.

2.2 Adsorption

Adsorption is considered to be one of the simplest of the technologies for the decontamination of water because it's an efficient, economical, and ecofriendly treatment technique. Adsorption is essentially a mass transfer process by which the metal ion is transferred from the answer to the surface of sorbent, and becomes bound by physical or chemical interactions. The classical mechanism of adsorption is split into three steps in (a) diffusion of adsorbate to the adsorbent surface, (b) migration into pores of adsorbent, and (c) monolayer build-up of adsorbate on the adsorbent [3].

2.2.1 Effect of pH

The adsorption capacity of the majority of agro wastes increases with increasing pH of the solution until an optimum value is reached. After that optimum value, the adsorption capacity remains constant or decreases [4].

2.2.2 Effect of Contact Time

The metal ions removal efficiency was increased with an increase in contact time before equilibrium was reached. After this equilibrium period, the amount of metal adsorbed remains constant. The fast adsorption at the initial stage was probably due to the availability of a sufficient number of vacant sites on the surface of the adsorbent [4].

2.2.3 Effect of Adsorbent Dosage

Increasing adsorbent dosage indicates an increase in the number of the site available for adsorption. As dosage increases adsorption capability also increases [4].

2.3 Adsorption Experiment

The batch adsorption experiments were carried out by preparing a series of 1000-mL wastewater samples, containing the amount of adsorbent as 5 g/lit, 10g/lit, and 15g/lit of rice husk and activated carbons separately. The samples were shaken at room temperature for 1hr and 2 hr. At the end of the reaction time of 1hr and 2hr, the samples were filtered through a Whatman filter. The residual metal concentration in the filtered samples were determined by atomic absorption spectrophotometry using IS 3025-part49-1994.

3. RESULTS

Table -1: Removal efficiency of Zinc using rice husk

Adsorbent dose	Removal efficiency after 1 hr	Removal efficiency after 2 hr
5 g/lit	73.86 %	78.12 %
10g/lit	80.35 %	84.07 %
15 g/lit	84.38 %	86.20 %

Table -2: Removal efficiency of Zinc using activated carbon

Adsorbent dose	Removal efficiency after 1 hr	Removal efficiency after 2 hr
5 g/lit	81.53 %	85.02 %
10g/lit	84.68 %	90.30 %
15 g/lit	91.21 %	94.55 %

4. CONCLUSION

From the above results, it was found that rice husk and activated carbon both are effective for the removal of zinc from the industrial wastewater but activated carbon is more efficient as compared to rice husk. It was observed that the efficiency of adsorption depends on the amount of dose of adsorbent and contact time which is necessary for maximum adsorption. A dose of 15 g/lit of activated carbon with a contact time of 120 min was proved to be the most effective for the removal of Zinc.

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