

Chloride Removal from Industrial Waste Water using Bio Adsorbents

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ABSTRACT: Industrial, domestic and agricultural wastewaters that are generated from the human society may contain large amount of chlorides, which can cause salinization. Many mechanisms have been adopted in order to reduce the amount of chlorides in wastewater. Among the possible techniques, adsorption process, are most effective methods. This paper makes an effort towards putting forth a biological alternative for the removal of chlorides from wastewater. Therefore, the suitability of low cost organic adsorbent like coconut shell powder and rice husk ash for reducing chlorides from industry effluent is considered here. Further, variation in the efficiency of bio-adsorbent, with respect to dosage and contact time, was investigated. The paper concluded that coconut shell powder and rice husk ash are capable of achieving up to 60% and 70% reduction in the chlorine content respectively at Laboratory scale.

KEYWORDS: waste water, Bio adsorbent, chloride removal, Coconut shell power, Rice husk ash

I. INTRODUCTION

Wastewater high in chloride can promote animal mutagens; reduce plant germination rates and also harm the healthy development of the environment. A variety of techniques have been found to be extremely suitable for the removal of chlorides which includes ion exchange, reverse osmosis, norcure, etc. (Apte et al., 2011) However, these techniques, though effective, are not feasible from the cost perspective. Therefore, it is the need of time to come up with newer, low cost treatment methods. In the removal efficiency, now a day's adsorption technique emerges as promising technique. Adsorbents are highly porous materials and adsorption occurs primarily on the walls of pores or at specific sites inside the particles, until all available adsorption sites are covered. Commercially used adsorbents are, activated carbon, diatomaceous earth and certain type of clays. For waste water treatment, utilizing abundantly available biomaterials, bio sorption is an emerging technique. Researchers reported that among several bio sorbents studied, for waste water treatment, the use agricultural waste as bio adsorbent has been of great importance. For the removal of various aquatic pollutants, agricultural wastes have gained wide attention as effective bio sorbents due to low-cost and significant adsorption potential (Bhatnagar et al., 2010). Natural materials, or certain waste products from industrial or agricultural operations, may have high potential as inexpensive bio-sorbents. After, these materials have been expended, they can be disposed off without expensive regeneration, due to their low cost. Many carbonaceous materials such as bark, coal, lignite, coconut shells, wood, rice husk, dead biomass, seaweed, pecan shell and peat can be used in the production of commercial activated carbons-which are effective bio adsorbents (Chuah et al., 2005). The abundance and availability of agricultural by-products make them good source of bio adsorbents.

This study therefore emphasizes the use of a highly resilient bio adsorbents in order to work out an effective solution to waste water treatment. The potential ability of rice husk ash and coconut shell powder as bio sorbent for the removal of chlorine from wastewater is investigated here. The optimum dosage and contact time required for maximum removal of chlorine from waste water using rice husk ash and coconut shell powder were studied and reported in this work.

II. MATERIALS AND METHODOLOGY

Wastewater sample was collected from outfall of a plywood industry at Perumbavoor in Kerala. Effluent collected from the industry was placed in containers and transported to the laboratory and stored at 4° C in a refrigerator. All the initial parameters of the wastewater were analysed in the laboratory as per the standard methods.

Rice husk ash and coconut shell powder are the bio sorbents used in the present study. Rice husk ash which is a byproduct from rice mill is obtained after burning rice husk. Rice husk ash consists of 20% silica and reported to be a good adsorbent (Chuah et al., 2005). Coconut shell obtained from the waste sources of coconut, is grounded to fine powder and sieved to the required size to get coconut shell powder. Compared with groundnut cake and activated charcoal, coconut shell powder has been reported to be the best adsorbent Nath and Sujatha (2012). It was also reported that coconut shell is one of the low-cost adsorbents as it contains lignocellulose (Brígidaa et al., 2010)

In order to determine the optimum dosage of adsorbent and optimal contact time for removing chloride, experiments were conducted. In 250 ml conical flasks, different dosage of adsorbents were added and the conical flasks were subjected to agitation at a stirring speed of 150rpm for 15 minutes in rotary shaker. The samples collected at different time interval was titrated for chloride content using the argentometric titration method.

The pH of the sample was maintained at 7, and the chloride concentration at 100% of the initial wastewater solution. The mixture was then incubated in a rotary shaker incubator at 150 rpm and 300 C for 60 minutes. On the termination of contact time, the solution was filtered using an ordinary filter paper. The sample was titrated for chloride content using the argentometric titration method specified in the APHA handbook for water and wastewater analysis. The tests were repeated by carrying out variations in pH, by using different chloride concentration levels, and with variable contact times.

III. RESULTS AND DISCUSSIONS

Characterization of Wastewater: The characteristics of the plywood industry effluent collected are given in Table 1. The pH was found to be slightly acidic with a value of 5. The high value chlorides indicate its presence above permissible limits. The high chloride may be due to the use of detergents and sanitizers for cleaning equipment in the industry. The COD value was observed to be greater than BOD, which indicate that the organic components in the effluent are slowly biodegradable (Qasim and Mane, 2013). This study deals with the chloride removal efficiency of bio adsorbents, coconut shell powder and rice husk ash, from industrial waste water collected from ply wood industry. Chloride removal efficiency of both with respect to time and concentration was analyzed and the best of them was reported.

Table 1: Characteristics of wastewater used

Parameters	Unit	Value
pH	-	5
Chloride	mg/L	6000
COD	mg/L	15,000-20,000
BOD	mg/L	4500
Total Suspended Solids	mg/L	8000

Effect of bio adsorbent dosage: Experiments were done under the conditions of constant temperature (30°C), constant agitation speed (150 rpm) and constant pH of 5. To find the effect of time, contact time of 30 minutes, 45 minutes and 60 minutes were chosen. In order to find the effect of bio adsorbent dosage, 4g/L, 6g/L, 8g/L, and 10 g/L coconut shell powder dosage and 6 g/L, 8 g/L, 10 g/L and 12 g/L rice husk ash dosage were used. Initially, the adsorbent (coconut shell powder and rice husk ash) dosages were varied and the percentage removal as a function of adsorbent dosage was calibrated for each contact period. Fig.1 and Fig.2 shows the chloride removal efficiency of coconut shell powder and rice husk ash for different dosages

It was observed that the removal efficiency increases initially and then decreases with increase in dosage of both bio adsorbent. The reduction was quite steep up to 8 g/L for coconut shell powder and 10mg/l for rice husk ash. Due to the increase in surface area of adsorbent, the rate of adsorption increases initially with increase in dosage. Eventhough the bio

sorbent materials is highly pervious, the porous volume is associated with numerous minute pores causing additional diffusional resistance that causes decrease in removal efficiency with increase in dosage (Crini, 2006 and Gong et al., 2005). This may be the reason for decrease in the removal efficiency after the initial increase.

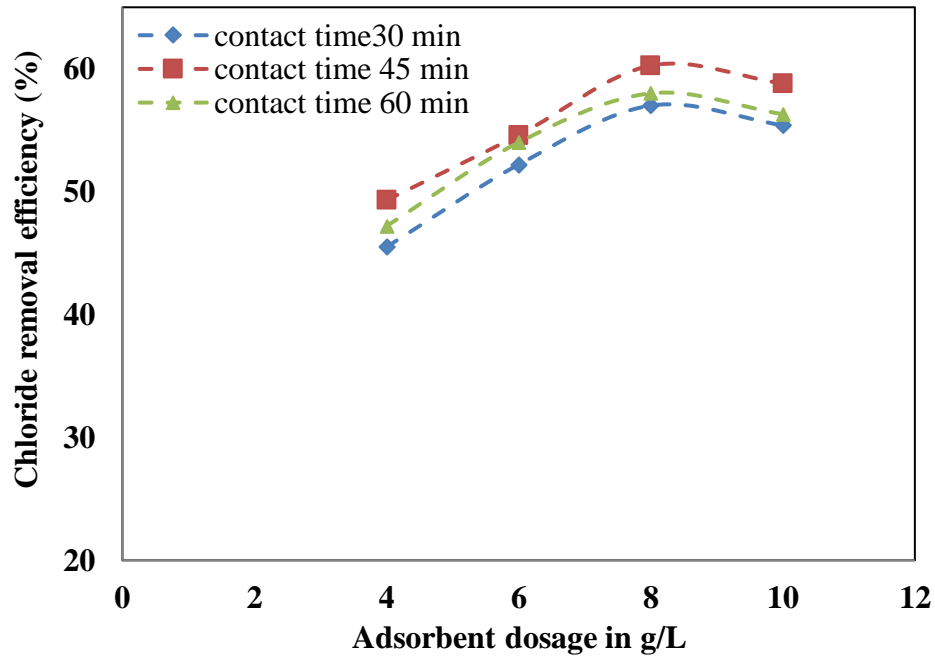


Fig.1: Chloride removal efficiency of coconut shell powder for different dosages

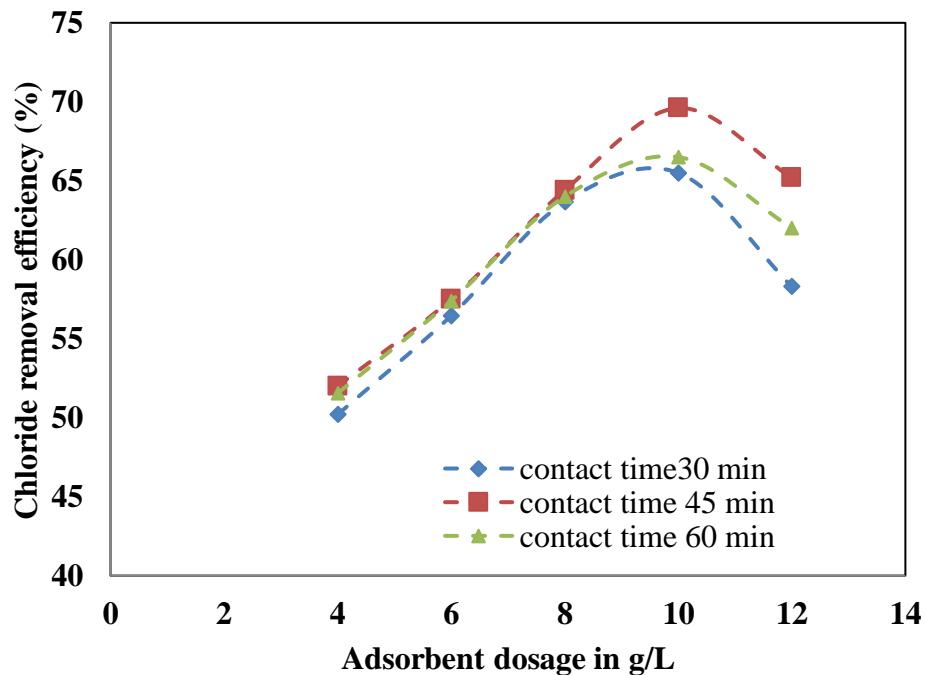


Fig.2: Chloride removal efficiency of rice husk ash for different dosages

Effect of contact time: Variation of chloride removal efficiency of optimum coconut shell powder and rice husk ash dosage, with contact time are examined and results are presented in Fig.3. The effect of contact time was examined by varying the contact time from 30 to 60 min. From Fig.3 it is clear that for coconut shell powder in the initial 45 min, the chloride removal efficiency increases with time, which later shows a decreasing trend with the passage of time. After 45min, no remarkable change in the reduction of chloride was observed, for the effluent treated with coconut shell powder. So contact time of 45 min was found to be the optimum time for maximum removal of chloride, if coconut shell powder is used as adsorbent. For rice husk ash also in the initial 45 min, the chloride removal efficiency increases and reaches 70% and later reduces with time.

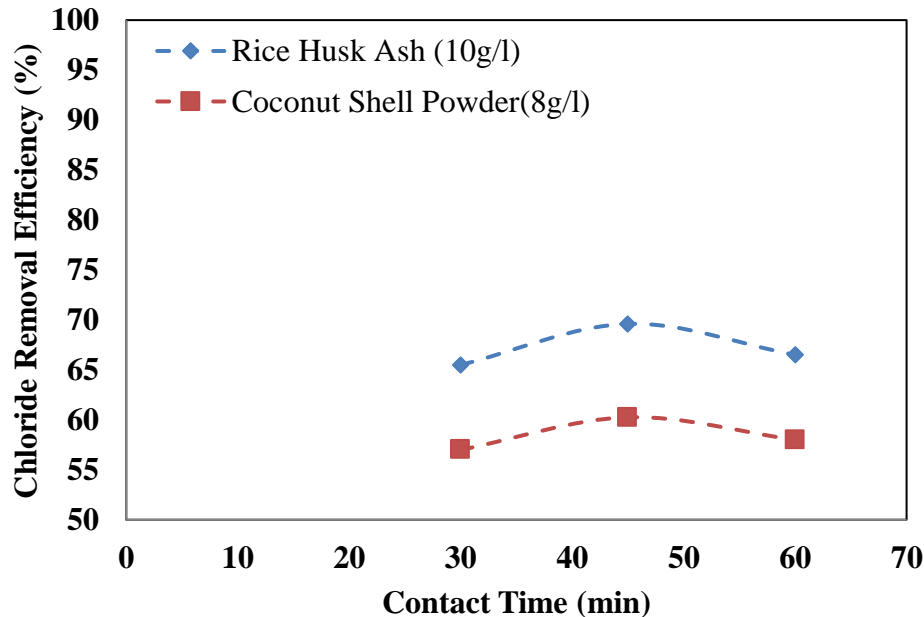


Fig.3 : Chloride Removal Efficiency of rice husk ash and coconut shell powder with contact time

The rapid reduction in chloride, in the initial period, might be due to the presence of a large number of binding sites on the surface of biomass, which helps in the quick attachment of solute to the bio-sorbent surface (Sadaf and Bhatti, 2015). After some time, the bio sorption began to slow down due to slow attachment of solute molecules into the interior of the bio sorbent (Asgher and Bhatti., 2012) As contact time increases, the saturation of the bio-sorbent may occur which leads to the slowdown of bio sorption process.

IV. CONCLUSIONS

In this study the utilization of waste materials as bio adsorbent for the reduction of chloride in plywood waste water is discussed. Coconut shell powder and rice husk ash are the low cost adsorption materials used for the removal of chlorides from the plywood waste water. The results indicated that both coconut shell powder and rice husk ash can be effectively used as adsorbent for removing chlorides from as it could bring the removal up to 60 % and 70% respectively at a contact time of 45 minutes. The optimum dosages of coconut shell powder and rice husk ash are obtained as 8 g/L and 10g/l respectively. Both coconut shell powder and rice husk ash are cost effective bio adsorbents since it is cheaply available raw material.

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