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CADMIUM METAL AND COD REMOVAL FROM WASTE WATER USING RED MUD AS AN ADSORBENT

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Abstract:

Heavy metals are toxic to aquatic organisms and also to human beings. Generally heavy metals are discharged from industries or factories to the nearby water bodies. Due to this organic load also increases. Many adsorbent has been used to remove toxic metals and organic load from waste water. Therefore it is essential to search some alternate adsorbent which is economical feasible. In this study Red mud is used as an adsorbent for the removal of metals and organic load from the waste water. Red mud is a waste product generated during the extraction of aluminium from the bauxite.

It has been observed that Red mud has good adsorption capacity. Laboratory scale experiment shows that cadmium metal and organic load were removed using Activated Red Mud (ARM). Maximum removal of cadmium metal was found to be 85% at pH 8-9.The removal of COD was found to be 69% at pH 6.8.

Key words: Red mud, adsorption, COD, cadmium, toxic metals.

Introduction:

Due to increase in population, rapid industrialization and urbanization there is a huge consumption of water. The demand of water is increasing day by day. Due to excessive use of water and water pollution problems, time is perhaps not too far when good quality water is inadequate for human consumption. Therefore, a suitable and economically viable technology has to be developed to meet the increasing demand for water. Various methods are available to treat waste water but adsorption technique appears to be most economical and effective treatment methods. Activated carbon is the most efficient adsorbent for the removal of pollutants, metals and organic load from waste water but its high cost restricts the use of activated carbon. Many researchers have tried of the adsorption capacity of cheap materials like agricultural waste, fly ash, clays etc. **(1-4).**

In the present study the red mud (waste from bauxite industry) has been used as an adsorbent for the removal of organic load (COD) and cadmium metal from waste water. Composition and structural aspects of red mud encouraged us to take up further research in this direction.

Materials and Methods:

All reagents were prepared in doubled distilled and deionized water using analytical grade chemicals. The pH of the solution was adjusted with conc. HNO_3 and NaOH. Red Mud as an adsorbent was obtained from INDALCO (Indian Aluminium Company), Belgaum, Karnataka State, India. This Red Mud was activated by the procedure described by Pratt et al **(5).**The surface area of Red Mud was calculated by BET method .The surface structure of the Activated Red Mud was observed by Scanning Electron Microscope(SEM) **(6).**

Synthetic waste water containing 100mg/l cadmium ions were prepared separately by making the appropriate dilutions of stock solutions of cadmium ions. Waste water was procured from Sakkardara Lake, Nagpur. This water sample was used for COD removal.

Cadmium metal ions analysis was done with GBC Atomic Absorption Spectrophotometer model 908.COD was determined by standard method **(7).**

Jar test experiment was studied to see the effect of pH on the removal cadmium ions and COD at constant adsorbent dose of 5mg/l. pH was varied between 4 to 9.Residual concentration after each batch experiments were measured. The contact time was 3 hours. Similarly effect of adsorbent dose was studied by varying the dose in the range of 1gm to 6gm at optimized pH and optimized contact time. Effect of initial concentrations was studied by varying concentration of cadmium metal ions in the range of 40-160 mg/l. This study was not performed for COD removal.

Results and Discussion:

The surface area of Activated Red Mud (ARM) was found to vary between 20-40m²/gm. This may be due to the heterogeneous constituent of the red mud.

Fig.1. shows the effect of pH on the removal efficiencies of cadmium and COD. The maximum removal of cadmium was observed at pH 9.The removal efficiencies for the metal ions was low at lower pH and found to increase with increase in pH value up to 9.This may be explained on the basis of decrease in positive charge on the surface of Activated Red Mud (ARM) with increase

in pH. The metal oxides on the surface get hydroxylated in aqueous medium and develop positively and negatively charged surfaces at various pH **(8).**

Thus metal oxide in the Activated Red Mud (ARM) may acquire negative charge at higher pH and attract metal cations due to coulombic attraction. On the other hand the negative charge density on the surface of the Activated Red Mud (ARM) decreases with fall of pH resulting in less adsorption of metal ions at lower pH. The charges developed at the Activated Red Mud (ARM) thus play an important role.

The removal of COD was found to be 69% in the pH range of 6 to 7 and thereafter decreases rapidly with further increase in pH. This may be due to many organics form neutral species at intermediate pH**. (8 & 10).**

The effect of adsorbent (ARM) dose on cadmium and COD was studied with the adsorbent dose of 2 gm/l to 8gm/l.**Fig.2.** indicates that with increase of adsorbent dose from 2 to 5 gm/l, the removal efficiencies increases from 30% to 85% and 35 to76% respectively. This increase in adsorbent dose has increased available sites for adsorption, as a result high removal efficiency was achieved and further increase in the adsorbent dose did not improve the uptake of these pollutants significantly.

The effect of concentration of metal ions was studied at optimized pH and adsorbent dose. The result obtained is shown in **Fig.3.** From the figure it is clear that adsorption capacity decreases as the concentration of metal ions increases. The maximum removal 85% for cadmium was observed at lower concentration. This may be due to more adsorption sites are available at lower concentrations. **(9).**

Adsorption data for metal ions was treated by applying Freundlich isotherm

$$x/m = KC_0^{1/n}$$

Where, x/m is the amount of adsorbate (metal ions) per gram of adsorbent (ARM).C_o is the equilibrium concentration of metal ions in solution after the adsorption equilibrium is reached. K and n are constant known respectively as adsorption capacity and reciprocal adsorption intensity. The plot of log x/m verses log C_o **(Fig.4.)** was drawn for different initial concentration of cadmium while maintaining ARM dose at constant level. Adsorption capacities was directly obtained from this plot and found to be 2.3589 mg/gm for cadmium. Linearity of the plot shows that the adsorption of Activated Red Mud (ARM) closely obeys Freundlich isotherm. With value of K and n actual forms Freundlich equation for cadmium is as follows:

$$x/m = 2.3589 \log C_o^{0.3716}$$

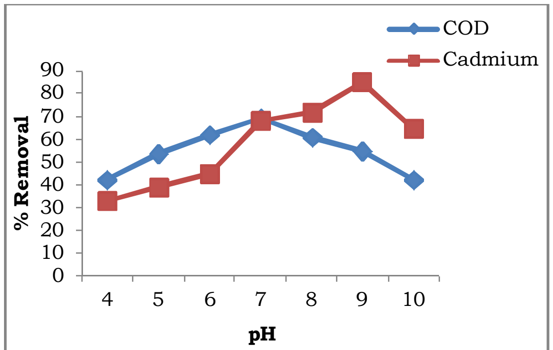

Fig.1:Effect of pH on removal of Cadmium and COD

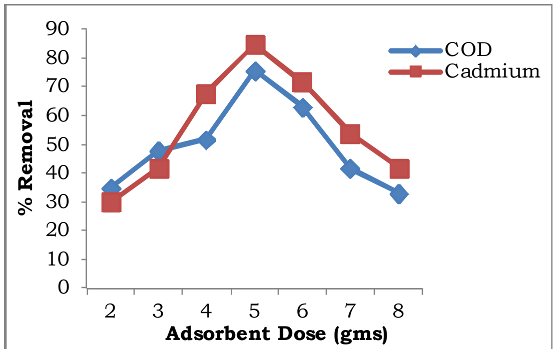

Fig. 2: Effect of Adsorbent dose on removal of Cadmium and COD

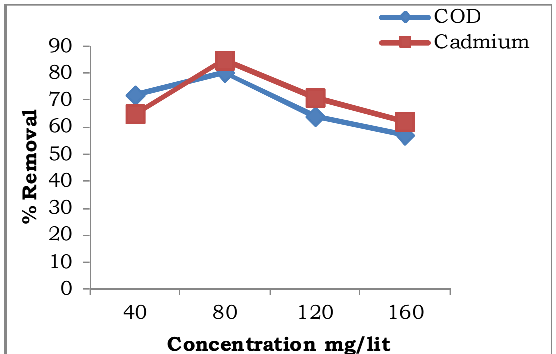

Fig.3: Effect of initial concentration on removal of Cadmium and COD

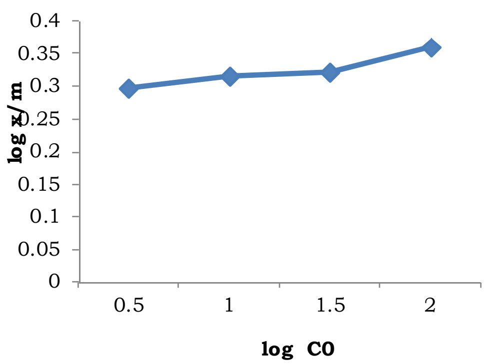

Fig.4: Freundlich adsorption isotherm for Cadmium metal

Conclusion:

This study indicates that once the Red Mud brought in suitable form (Activated), it can be used as an adsorbent. Activated Red Mud (ARM) appears to be an efficient and cheap waste material for the removal of some toxic metals and organic load from waste water. Present study reveals that Activated Red Mud (ARM) could be serving as a substitute for conventional adsorbents.

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