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USE OF RED MUD AS ADSORBENT FOR THE REMOVAL OFNI(II) FROM WATER AND WASTEWATER

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ABSTRACT
The feasibility of Ni(II) removal from water and wastewater was investigated by adsorption onto Red mud. Ni(II) is a highly toxic metal ion and considered a priority pollutant released from various industries. Batch adsorption process is an important technique for the removal of Ni(II). Different parameters such as initial metal ion concentrations, contact time, adsorbent doses and pH were studied.

KEYWORDS: Adsorption, Nickel, Red mud, Batch adsorption technique, pH.

1. INTRODUCTION

Contamination of water by toxic metals through the discharge of industrial wastewater is a worldwide environment problem. Water is an important constituent of environment due to one of the most essential requirement for human being, animals, and plants. Due to rapid growth of populations and industrialization throughout the world water is highly polluted and has thus become undesirable for all living beings. Metals such as Lead, Cadmium, Copper, Arsenic, Nickel, Chromium, Zinc and Mercury have been recognized as hazardous heavy metals.[1] Nickel and its compounds are widely used in many industries such as metal plating industry[2], silver refineries[3], automotive plating of zinc base castings[4] and platting plants.[5] The permissible limit of nickel in drinking water is 1.0 mg/l.[6] Nickel affects the air pockets of lungs resulting in respiratory symptoms and causing lung cancer. Doses of Nickel sulphate induce myocardial and liver damage.[7]

Red mud is a waste product obtained from aluminums producing industries. It has been used in the manufacture of different types of ceramic products since long time. Production of bricks[8,9,10], thermal insulators[11], acoustic tiles[12], corrosion inhibition primer[13], heavy clay products[14], additive for concrete and mortar[10] are prepared from it. Recently, it has been used as a cheap adsorbent for the removal of organic substances like 1-butanethiol from kerosene oil.[15]

2- MATERIAL AND METHOD USED

The batch adsorption method was carried out in 250ml flask using Red mud as an adsorbent. Red mud sample were collected from aluminium producing industries. Physicochemical characteristics of Red mud such as bulk density, particle size, porosity, water holding capacity and surface area makes it suitable for use as an adsorbent.

Nickel samples were prepared by dissolving a known quantity of nickel sulphate in distilled water and used as stock solutions. 1.0 gm Red mud was mixed with 100 ml of aqueous solutions of various initial concentrations (1.0gm/l, 2.0gm/l, 3.0gm/l and 4.0gm/l) of Ni(II) in each flask. The stirring speed was kept constant at 120 rpm. Dimethylglyoxime method was used and absorbance was measured at 445 nm with spectronic-20 spectrophotometer. The concentrations of Ni(II) at different time adsorbed onto Red mud was calculated.

$$Qt = (Co - Ce)V/M$$

Where, Qt is the amount of Ni(II) adsorbed on the surface of Red mud at different time t. Co is the initial concentration of Ni(II) and Ce is the aqueous phase concentration of Ni(II) at time t. V is the volume of aqueous phase. M is the weight of Red mud.

Table: Chemical analysis of Red mud Adsorbent.

Constituents	Percentage by weight
Fe_2O_3	39.45
Al_2O_3	22.65
TiO_2	13.80
SiO_2	8.55
CaO	5.20
Loss of ignition	10.25

3-RESULT AND DISCUSSION

A-Effect of initial concentration and contact time.

It is clear that at all concentrations of adsorbate species, the extent of adsorption in each case increases rapidly in the initial stages followed by a gradual increase till the equilibrium is attained and thereafter the extent of removal remain constant for a long time of contact. The time required for the attainment of equilibrium in the adsorption of Ni(II) onto Red mud is 140 minutes. The result further indicate that the saturation time remains unchanged with the change in concentration of Ni(II) solutions. The temperature was maintained at 30^0 C and pH 6.5. 1.0gm adsorbent is taken for the determination of adsorption at different concentrations. It was found that the percentage removal increases with decrease in initial concentrations of Ni(II) (Figure:1).

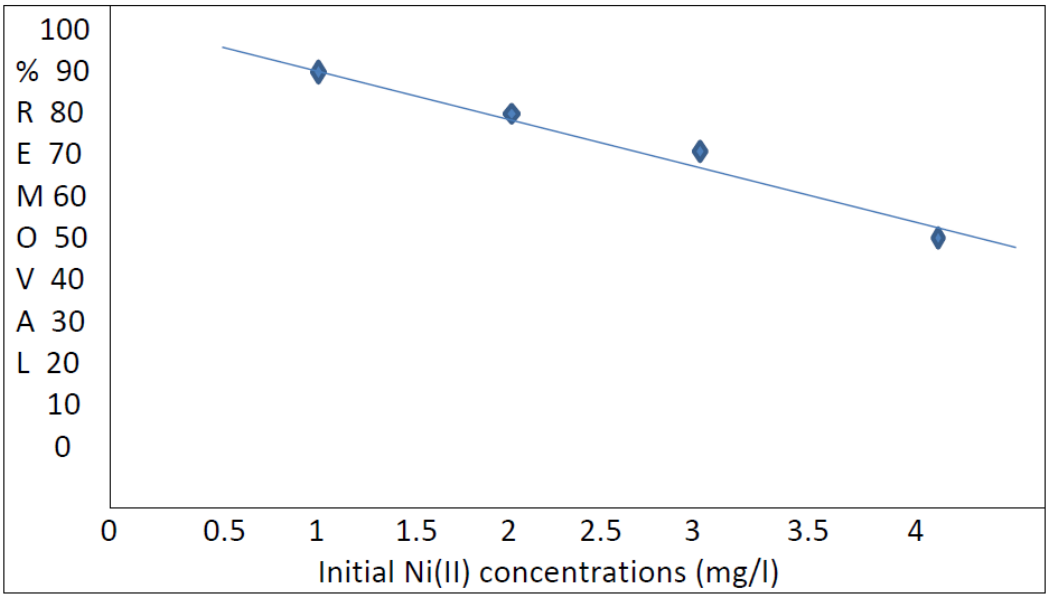

Figure 1: Effect of different initial concentrations of Ni(II) onto Red mudB-Effect of Red mud amount.

Red mud was taken 1.0gm, 1.5gm, 2.0gm and 2.5gm. the temperature was maintained at 30^0 C and Ni(II) concentration 1.0mg/l. The results indicate that the percentage adsorption increases as the amount of Red mud increases (Figure:2). It is due to presence of more adsorption sites on the outer surface of adsorbent. As the adsorbent dosage increased, more active sites and surface area of the adsorbent become available for adsorption.[16] The adsorbent dosage is an important parameter for adsorption studies because it determines the capacity of adsorbent for a given initial concentration of Ni(II) solution.[17]

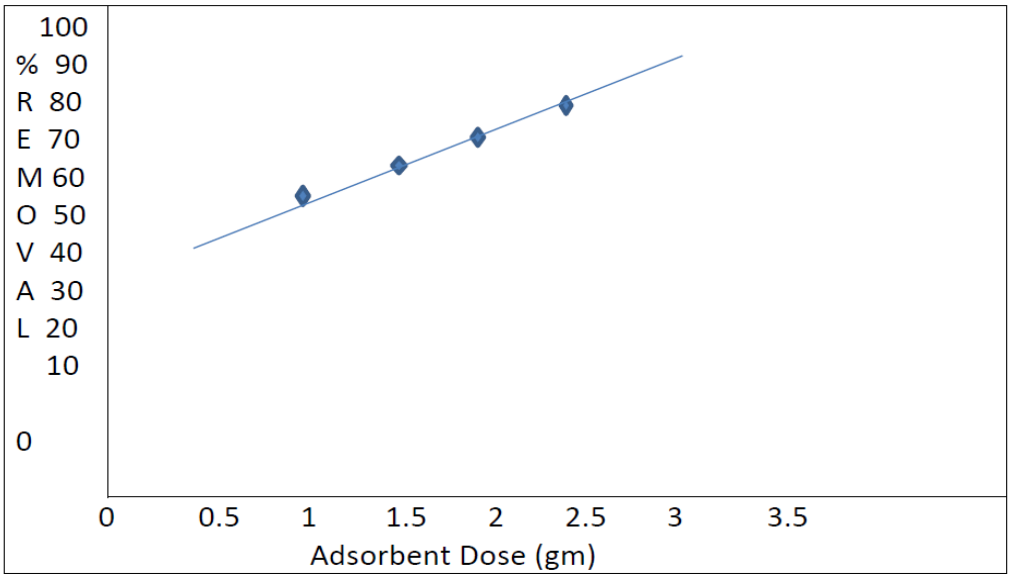

Figure 2: Effect of Red mud amount on adsorption of Ni(II).C-Effect of Ph.

The removal of Ni(II) from water and wastewater by adsorption on Red mud is mainly influenced by the pH of the system. It affects the surface charge of the adsorbent, degree of ionization and speciation of

aqueous Ni(II) solutions. Three types of mechanism were suggested by Mac-Naughton and James[18] for heavy metals removal from aqueous solutions.

(i) Ion exchange reactions.
(ii) Metal ion adsorption at hydrated oxides of the surface.
(iii) Metal hydroxyl species adsorption at hydrated oxide surface.

The effect of pH on adsorption of Ni(II) on Red mud was studied at pH 3.0, 4.0, 5,0, 6.5, 7.0, 8,0 and 9.0. The maximum adsorption capacity of Red mud was found to be at pH 7.0(Figure:3). It was observed that Ni(II) adsorption increases with increasing pH value in the range 3.0-7.0 and thereafter adsorption decreases up to 9.0 pH.

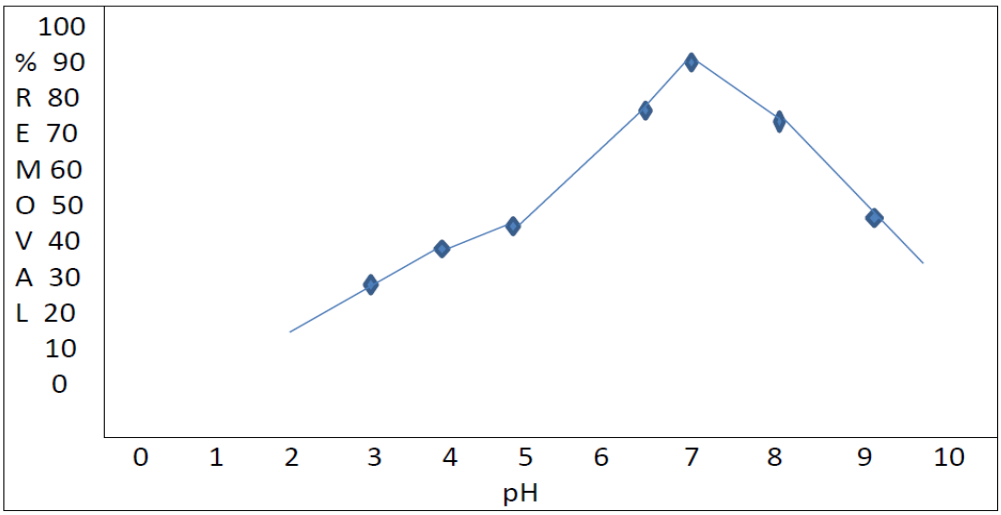

Figure-3: Effect of pH on adsorption of Ni(II)

CONCLUSION

The study concludes that Red mud appears to be a suitable adsorbent for the removal of Ni(II). Red mud, a low cost material was found to be an effective ion. The data thus obtained may be helpful for designing and fabricating a treatment plant for the removal of nickel present in wastewaters.

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