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RESEARCH ARTICLE

Removal of Ni from its aqueous solution by using low cost adsorbent prepared from wood apple shell.

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Abstract

In present study, micro porous activated carbon was developed from *Limonia acidissima* (Apple wood) fruit shell in very simple manner and applied for removal of Ni from aqueous solution. The results of study indicate that the prepared adsorbent was very effective in removal of nickel from its aqueous solution. More than 80 % percentage removal of nickel was found to with an effective dose of adsorbent. The adsorbent is prepared from waste material and conveniently used for the treatment of industrial waste water containing nickel heavy metal. The effect of pH, contact time , concentration and amount of adsorbent dose was also studied and it was found that maximum adsorption occurred at pH 2 and at 180 minutes. The study clearly shows the dependence of adsorption on concentration of the adsorbate solution.

1. INTRODUCTION

The quality of surface water and ground water is continuously deteriorating due to rapid increase in population and industrial growth all over the world. The use of metals in Industrial and other processes have introduced high amounts of toxic heavy metals into the environment [1,2]. In modern societies the use of metallic product in many goods and amenities is also increasing. High consumptions, frequent disposal and replacement of disposable items are generating diverse types of metallic wastes. These wastes are regularly discharged into the environment and thus are poisoning the environment [3]. Heavy metals have toxic effect to aquatic flora, animals and human beings, even at very low concentrations.

The presence of heavy metals in drinking water sources and in edible agricultural crops can be harmful to human. Heavy metals are highly toxic and they can damage nerves, liver, bones and also can block functional groups of vital enzymes. The major sources of heavy metals in water and soil are the effluents discharged from many industrial processes [4]. Heavy metals like chromium, nickel, copper, lead, mercury, etc. are present in waste water of several industries such as brass and steel, refineries, pulp and paper, dyes and pigments, chemical manufacturing etc. Various technologies are used for removing toxic metal ions from water, which include chemical precipitation, reverse osmosis, evaporation, ion-exchange and adsorption [5,6]. Out of these method adsorption by activated carbon is one of the effective techniques for Ni removal from waste water because of high surface area, highly porous character and relatively low-cost. The use of activated carbon for removing nickel from waste water has been received a great attention of researchers [7,8]. Activated carbon is very effective in removing heavy metal pollutants from industrial effluents [9,10]. Some authors reported the adsorption of metallic complexes on activated carbon is an effective and versatile method for removing Ni.

Wood apple fruit is widely used in India for making sweet and juice and shell of these fruits are waste. The shell of this fruit is tough and it was proposed to prepare activated carbon which can have good adsorption capacity.

The removal of toxic metal ions from waste water is an important and widely studied research area. One of the heavy metal that has been a major focus in waste water treatment is Ni which is generally used in steel industries. The toxicity caused by Ni is very high and therefore priority is given to regulate this pollutant at the discharge level. In

recent years, the researchers have developed many adsorbents for removal of heavy metals like silica gel, polymer, carbon nanotubes, fly ash, clays, zeolites, peat moss, biosorbent, food waste etc.
Activated carbon adsorption seems to be an attractive choice for nickel removal both for its removal efficiency and for the rapid adaptation to pollutant loading alteration.
However, commercially available activated carbons are expensive and, for this reason, the need of developing low cost adsorbent is very much required. In recent years, development of surface modified activated carbons using plant biomass is generating a diversity of activated carbon with superior adsorption capacity. These are available in large quantities and can be disposed off without regeneration due to their lower cost. A variety of natural plant biomass like Groundnut husk, Rice husk and saw dust have been used as adsorbent after sulphuric acid treatment to develop activated carbon.
In present study, micro porous activated carbon was developed from *Limonia acidissima* (Apple wood) fruit shell in very simple manner and applied for removal of Ni from aqueous solution. The activated carbon developed from wood apple shell was economical and have good quality, so it could be used for further application

2. MATERIAL AND METHOD

2.1 Preparation of adsorbent and adsorbate solution

Standard solution of 1 mg/mL of nickel was prepared from nickel sulphate. Sample of *Limonia acidissima* (wood apple) was collected from local market. Wood apple shells were washed thoroughly with distilled water and kept for sun dry. After drying, the shells were crushed in small pieces and again washed with deionized water and dried in an oven at 110^0 C for 24 hrs. The crushed pieces were soaked in concentrated H_2SO_4 for 24 hrs. This material was then washed with deionized water and was kept for activation in muffle furnace at 300^0 C for 1 hrs. The excess acid was washed off with distilled water till neutral pH was obtained. The dried activated carbon was then sieved to prepare fine powder of 200 µm particle size and used the same throughout the study.

2.2 Batch adsorption experiment

Batch adsorption experiments were conducted by varying concentrations of Ni from 5mg/L to 100mg/L at constant adsorbent dose 1.5 gm. While adsorbent dosage was varied from 0.5 gm to 1.5 gm at constant concentration of Ni of 5mg/L. The effects of time, pH were studied with Ni concentration of 5 mg/L and an adsorbent dosage of 1.5 mg. The concentration of free Ni ions in the solution was determined spectrophotometerically.

3. RESULT AND DISCUSSION

3.1 Effect of pH

The nickel removal efficiency of WASAC at different pH values with an initial concentration of 5 mg/L is shown in Fig.1. To each flask containing 50 mL of Ni solution, 1.5 gm of adsorbent was added and agitated for 180 min at pH varying from 1 to 10. After agitation the whole solution was filtered through Whatmann filter paper no.1 and Ni was determined spectrophotometerically. The nickel removal efficiency was 84.1% in the pH range 2-3. For further study pH 2 was used as maximum adsorption of Ni was observed at the acidic pH. This is may be because at lower pH there is increase in H+ ions on the carbon surface, and the presence of SO_4^- ions resulting in significant strong electrostatic attraction. As the pH increases there was exponential decrease in the Ni adsorption and at pH values greater than 7.0 there was no significant adsorption.

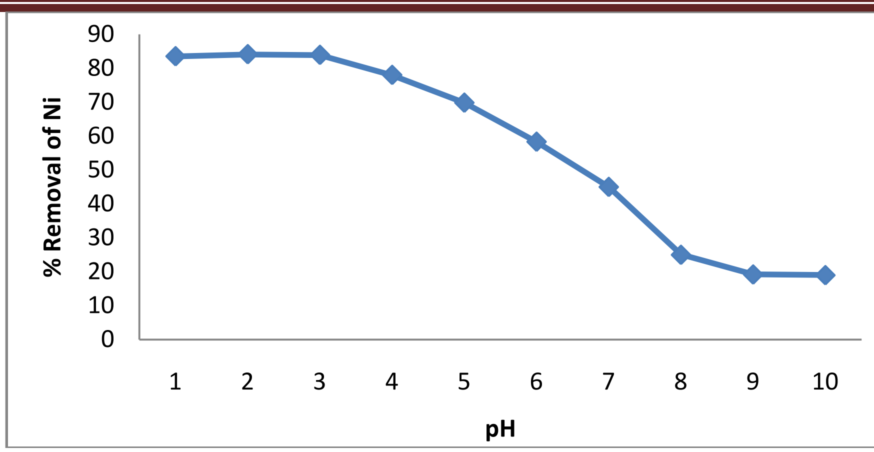

Fig. 1: Variation of % removal of Ni with pH

3.2 Effect of time

By keeping all other variables constant, the time was varied from 30 min to 240 min . Adsorption initiated at 30 min with 35.2% and reached up to 84.1% from 180 min. There was no significant change in adsorption of Ni after 180 min (Fig. 2). Further study was made at 180 min. The initial rapid rate of adsorption was may be due to the availability of the positively charged surface of the adsorbent for anionic species present in the solution. The later slow adsorption rate was may be due to the electrostatic hindrance caused by already adsorbed negatively charged adsorbate species and the slow pore diffusion of the ions [11].

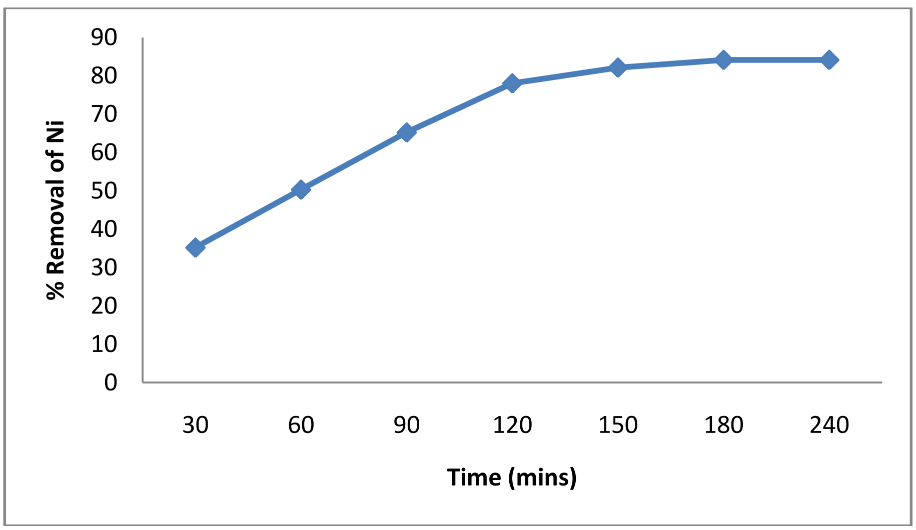

Fig. 2: Variation of % removal of Ni with time

3.3 Effect of initial concentration of Ni

The percentage removal of Ni was 84.1 for 5 mg/L as shown in Fig. 3. As the initial concentration of Ni was increased from 5 mg/L to 100 mg/L at the constant temperature the percentage removal of Ni was decreasesed. It may be due to an increase in the number of Ni ions for the fixed amount of WASAC. A higher initial concentration provides an important driving force to overcome all mass transfer resistances of the pollutant between the aqueous and solid phases, thus increases the uptake. Uptake of the Ni also increased with increasing the initial metal concentration tending to saturation at higher metal concentrations [12].

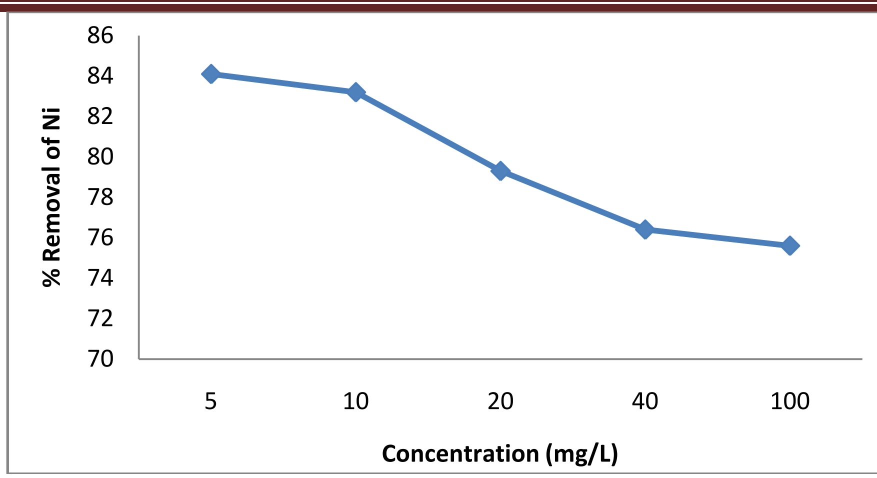

Fig.3: Variation of % removal of Ni with concentration

3.4 Effect of adsorbent dosage

The experiments were carried out under the conditions described earlier and varying adsorbent dosage from 0.5gm to 1.5 gm. The effect of adsorbent dose on the adsorption of Ni by WASAC is presented in Fig. 4. The Ni removal efficiency increases with increase in adsorbent dose, since contact surface of adsorbent particles increased and it would be more probable for anions to be adsorbed on adsorption sites [13]. Maximum adsorption was observed at 1.5gmwas 84.1%. It can be observed that removal efficiency of the adsorbents generally increased with increasing the quantity. It is due to the availability of exchangeable sites for the adsorbate [14].

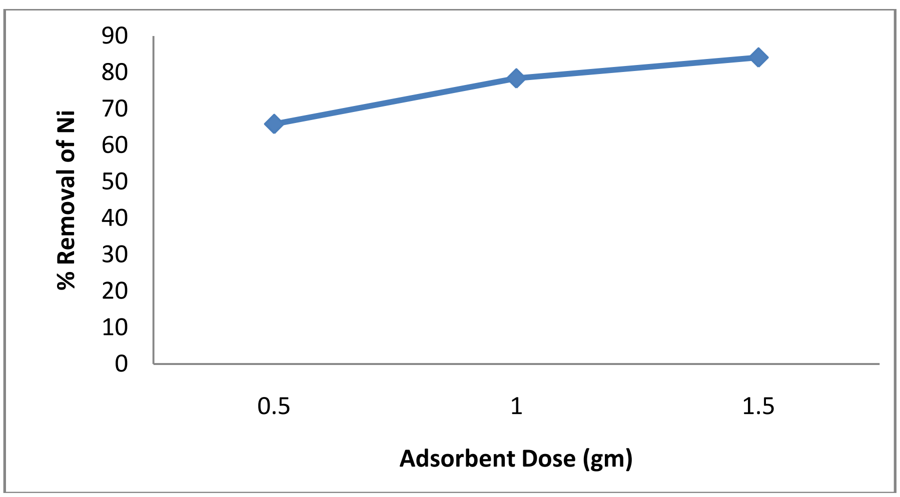

Fig. 4: Variation of %removal of Ni with adsorbent dose

4. CONCLUSIONS

The removal of nickel from its aqueous solution by using carbonous adsorbent prepared from wood apple (*Limonia acidissima)* shell (waste) was studied. On the basis of result it was found that the prepared adsorbent was very effective in removal of nickel from its aqueous solution. The percentage removal of nickel was found to be 84.1with an effective dose of 1.5 gm of adsorbent. The adsorbent is prepared from waste material and conveniently used for the treatment of industrial waste water containing nickel heavy metal.

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