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Removal of Cu(II) and Ni(II) from Solution Using Aegal-Marmelose Fruit Shell Substrate

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The dried and powdered Aegal-marmelose fruit shell substrate is concentrated with 1% NaOH and the resin product so obtained is efficient in removing Cu(II) and Ni(II) from the solution. The metal ions uptake increases with increase in pH of the solution. It is observed that the maximum sorption efficiency of aegal-marmelose was found to be 5 and 6 respectively. It was found that more than 60% of the metal ions are removed by the substrates from the solution instantanously by using packed column of the substrates. The metal ions concentration from the wastewater can be reduced to very low levels conforming to the acceptable water quality standards.

Key Words: Cu(II), Ni(II), Aegal-marmelose fruit shell substrate.

INTRODUCTION

In view of toxicity of heavy metal ions stringent limits have been imposed by the public health authorities regarding their effluent concentration, agricultural products and byproducts (such as peanut skin, rice straw, wheat flour, onion skin, mango cotyledon residue, garlic skin, etc.) have been reported to remove the heavy metal cations from wastewater to below the discharge limits efficiently and economically[1-10]. The present paper deals with the use of aegal-marmelose fruit shell substrate for the removal and recovery of Cu(II) and Ni(II) from wastewater.

EXPERIMENTAL

All reagents used in the experiment were of analytical grade. All glasswares used were leached with 10% nitric acid, washed with distilled water and dried in an oven. The initial stock Cu(II) and Ni(II) solution was prepared by dissolving over-dried copper sulphate ($CuSO_4$) and nickel sulphate ($NiSO_4$) in concentrated nitric acid and distilled water; standard solutions of Cu(II) and Ni(II) were prepared by taking different aliquots from stock solution with subsequent dilution with distilled water.

Dried fruit shells of the plant aegal-marmelose were procured and crushed to

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small size in an electric grinder. The powder was sifted and 2 g of powder was added to a mixture of 20 g of 0.2 N H_2SO_4 and 5 g of 39% HCHO. It was kept in a water bath at 50°C for 6 h and occasionally stirred. The powder was washed with distilled water several times till it was free of H_2SO_4 and then dried at 60°C in an electric oven.

RESULTS AND DISCUSSION

pH Effect: It was found that the metal ions uptake increases with increase in from 3 to 5 and then decreases with further increase in pH of the solution (Fig. 1).

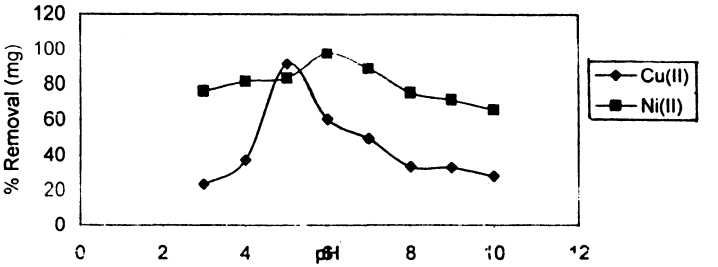

Fig. 1. Effect of pH of Cu(II) and Ni(II) from $CuSO_4$ and $NiSO_4$ solution using Aegal-marmelose fruit shell substrate.

Temperature Effect: It was found that the percentage removal of the metal ions from solution to the substrate decreases with increase in temperature (Fig. 2).

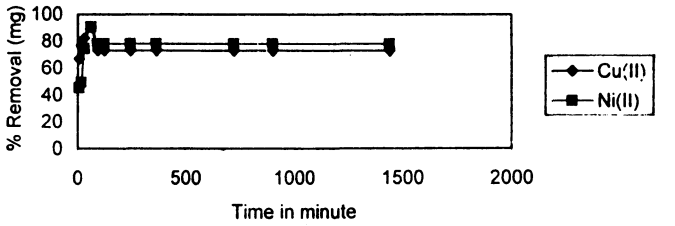

Fig. 2. Effect of temperature of Cu(II) and Ni(II) from $CuSO_4$ and $NiSO_4$ solution using Aegal-marmelose fruit shell substrate.

Contact Time Effect: It was observed that above 46.6% of Cu(II) and above 45.3% of Ni(II) ions were removed from the solution within 5 min, showing that metal ions uptake on substrate is very fast. At about an hour the removal of Cu(II) and Ni(II) ions from the solution recorded the values of Cu(II) 86.18% and Ni(II) 90.63% and values remained the same even after a contact time of 24 h (Fig. 3).

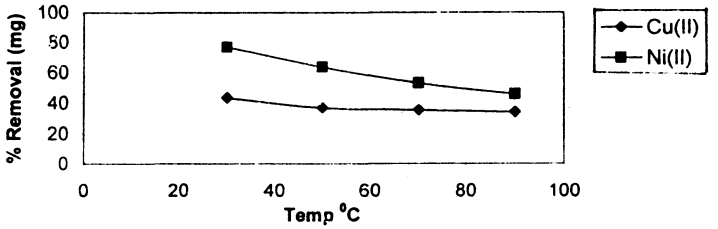

Fig. 3. Effect of contact time of Cu(II) and Ni(II) from $CuSO_4$ and $NiSO_4$ solution using Aegal-marmelose fruit shell substrate.

Effect of Doses: The effect of fruit shell substrate doses on the adsorption of Cu(II) and Ni(II) was studied and it was observed that the removal increases with the increase in doses at their optimum pH and time. The maximum removal of Cu(II) and Ni(II) was found to be 78 and 99.59% respectively with the dose of 10 g of aegal-marmelose.

Effect of Anions: The influence of anions on the sorption of the heavy metal ions on the aegal-marmelose substrate has been investigated and the results are as follows:

S.No.	Anions	Removal of Cu(II) (%)	Removal of Ni(II) (%)
1.	Chloride	73.15	59.20
2.	Nitrate	71.49	45.26
3.	Acetate	43.86	38.93
4.	Sulphate	86.16	90.63

Light Metal Ions Effect: Light metal ions such as Na^+, Mg^+ and Ca^+ have considerable effect on the sorption of Cu(II) and Ni(II) by the substrate and it was found that the sorption of the metal ions by the substrate gradually decreases in the presence of increasing concentration of these light metal ions.

Concentration Ions Effect: The effect of the initial metal ions concentration on the uptake of Cu(II) and Ni(II) by the aegal-marmelose substrate was studied and the results are shown. It is observed that the above metal ions removal from the solution the initial metal ions concentration increases, although the percentage of metal ions recovery naturally decreases (Fig. 4).

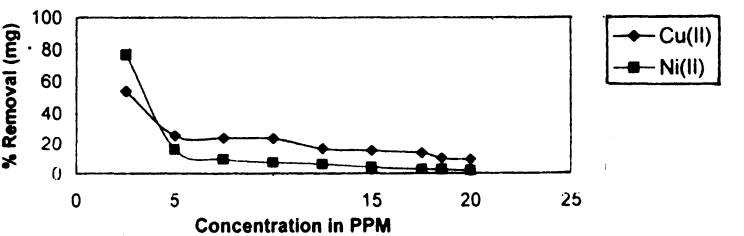

Fig. 4. Effect of concentration of Cu(II) and Ni(II) from $CuSO_4$ and $NiSO_4$ solution using Aegal-marmelose fruit shell substrate.

A packed column is a continuous employing process of Aegal-marmelose substrate and is expected to be more efficient and economical to operate than the batch process. Several column experiments have been conducted and the results are summarized as: sorption of Cu(II) at 50 mL is 35.76% and at 120 mL is 97.57%; sorption of Ni(II) at 50 mL is 29.74% and at 120 mL is 81.68%. It is observed that in each case 1000 mL metal ions solution was passed down through a column of 20 mm internal diameter packed with 10 g substrate at the rate of 4 mL/min.

Substrates Capacity: It was found that capacities of the aegal-marmelose substrate for the binding of Cu(II) and Ni(II) are 0.338 and 0.239 meq per g of substrate, respectively.

Conclusion

The aegal-marmelose substrate seems to be very efficient and economical for removing toxic heavy metal ions such as Cu(II) and Ni(II) from industrial waste-water. Adequate columns of the substrate by employing the residual metal ions concentration in the effluent can be reduced to very low levels that are within the acceptable discharge limits. For the preparation of the substrate raw materials employed are widely available and inexpensive. Its metal ions binding capacity is appreciably high. Thus, it can be concluded that aegal-marmelose substrate seems to offer a very cheap and useful product for effective removal and recovery of toxic heavy metal ions from industrial wastewater by using such substrate.

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