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STUDIES ON REMOVAL OF NICKEL (II) AND ZINC (II) USING LOW COST ADSORBENT

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ABSTRACT

Rapid industrialization and urbanization have resulted in the discharge of various toxic pollutants into the water bodies. Heavy metals constitute the major part of toxic waste let out by many industries. These metals are toxic to both human beings and aquatic life when they exceed their permissible limits. There are several methods used for the removal of heavy metals in the wastewater. Out of this adsorption is one of the effective techniques for removal of heavy metals like Ni (II) and Zn (II) from wastewater. In the present study, adsorbent was prepared from pouteria sapotta and studies are carried out for removal of Ni (II) and Zn (II) removal. The effect of pH, contact time, adsorbent dosage and initial metal ion concentration on the percentage removal of Ni (II) and Zn (II) were studied in batch process. The results revealed that Ni (II) and Zn (II) were considerably adsorbed on pouteria sapotta and it could be economic method and cheap adsorbent for the removal of Ni (II) and Zn (II) from aqueous solutions.

INTRODUCTION

The tremendous increase in the use of heavy metals over the past few decades has inevitably resulted in an increased flux of metallic substance in aquatic environment. Industrial wastewater contains higher amount of heavy metals that can pollute the water when it is discharged to the nature. Toxic heavy metals of particular concern in treatment of industrial wastewaters include zinc, copper, nickel, mercury, cadmium, lead and chromium.

The heavy metals may be found in waste water discharges from mining, electroplating, plastics manufacturing, metal finishing, pigments and ceramic industries, pigments, battery and accumulator manufacturing. An uptake of large quantities of heavy metal may lead to higher instances of cancer, vomiting, diarrhea, respiratory failure, birth defects, pulmonary fibrosis, asthma and chronic bronchitis, kidney damage and heart disorders. Therefore, it is necessary to develop effective and inexpensive methods to removal of heavy metal.

In general, the heavy metal is removed from waste water by various conventional technologies such as chemical precipitation, ion exchange, membrane separation electro dialysis, reverse osmosis, ultra-filtration, coagulation, floatation and adsorption. However, these technologies are cost intensive and are unaffordable for large scale treatment of wastewater that is rich in heavy metal like nickel and zinc (Low et al., 1999). In recent years, a number of agro wastes are used as adsorbent for the removal of heavy metal from wastewaters like neem leaves (Innocent oboh et al.,2009), tea waste (Malkoc and Nuhoglu, 2006), rice husk (Mukesh Parmar et al., 2013) corncobs (Zacaria, 2002), strawberry lead powder (Liu et al., 2010), peanut shells (Wafwoyo et al., 1999), bagasse (Azhar et al., 2005) and sawdust (Argun et al., 2007). Agricultural waste materials being economic and eco-friendly due to their unique chemical composition, availability in abundance, renewability, low cost and more efficiency seem to be a viable option for heavy metal remediation.

In the present research work, the removal of Ni (II) and Zn (II) from aqueous solution was studied by adsorption technique using pouteria sapotta seed as adsorbent. The effect of various process parameter namely pH, adsorbent dosage, contact time and initial metal ion concentration on the removal of Ni (II) and Zn (II) have been investigated. The research may be useful for removal of heavy metal from waste water using cheapest and agro based adsorbent.

MATERIALS AND METHODS

Chemical

All the chemicals used were of analytical reagent grade. Nickel sulphate and Zinc sulphate were used for preparation of stock solutions. Hydrochloric acid and Sodium hydroxide were used to adjust the solution pH. Distilled water was used throughout the experimental studies.

Adsorbent

The pouteria sapota seed was collected from agricultural fields from Melanikuzhi village, Ariyalur district. The seeds were washed in 0.1N HCl solution. It was sundried for 3 days. Then the seeds were dried in hot air oven for 90°C and pulverized into powder, this powder was subjected to sieve analysis in sieve shaker, to get 150μm retained powder. This powder was washed several times with distilled water to remove soluble, coloring matter and then it was sun dried and stored in air tight containers for further studies.

Stock solution

Stock solution of Nickel (II) and Zinc (II) was prepared (1000mg/L) separately by dissolving the desired quantity of $NiSO_4 6H_2O$ (A.R Grade) and $ZnSO_4 6H_2O$ (A.R Grade) respectively.

Batch Experiment

The batch experiments were carried out in 250ml conical flasks by agitating a pre-weighed amount of the pouteria sapota seed powder as adsorbent with 25 ml of the aqueous solution of nickel (II) and zinc (II) separately for a predetermined period on a water bath-cum-mechanical shaker. After the completion of adsorption, the sample was filtered and filtrate was analyzed by spectrophotometric method for metal ion concentration.

The percentage removal of nickel from the aqueous solution of nickel (II) and zinc (II) were calculated according to the following equation:

$$\% \text{ removal} = [C_i - C_f / C_i] \times 100$$

Where C_i and C_f are the initial and final concentration (mg/L) of Ni (II) and Zn (II) respectively.

Effect of several parameters such as pH, adsorbent dosage, contact time and initial metal ion concentration on adsorption of Ni (II) and Zn (II) on powdered raw pouteria sapota seed was studied by batch technique. All experiments were carried out at pH values ranging from 2 to 10, Adsorbent dose of 0.5 to 3.0 g, contact time of 30 to 180 min and the initial concentration of metal ion from 15 to 90 mg/L. based on equilibrium conditions.

RESULT AND DISCUSSIONS

Effect of pH

Fig.1 shows the effect of pH on removal of Ni (II) and Zn (II) by the adsorbent sapota was carried out in the pH range of 2 to 10. It can be noticed that the removal of metal ions increased with increasing pH of aqueous solution and reached maximum value at pH 5 and thereafter it decreases with further increase in pH for Ni (II). It is clear that the metal-binding capacity was highly pH dependent. However, in the case of Zn (II), the maximum removal was observed at pH 7 and thereafter it decreases with further increase in pH for Zn (II). At higher pH values, a diminution of the percentage uptake for Zn (II) was observed. This could be due to the hydrolysis reaction of metal cations. The formation of soluble hydroxylated complexes of metal ions hindered the metal-binding capacity (Rengaraj et al., 2001). The maximum removal of Cu (II), Zn (II) and Ni (II) at pH 6 were found to be nearly 88.8, 93.3 and 69%, respectively (Misra et al., 2005).

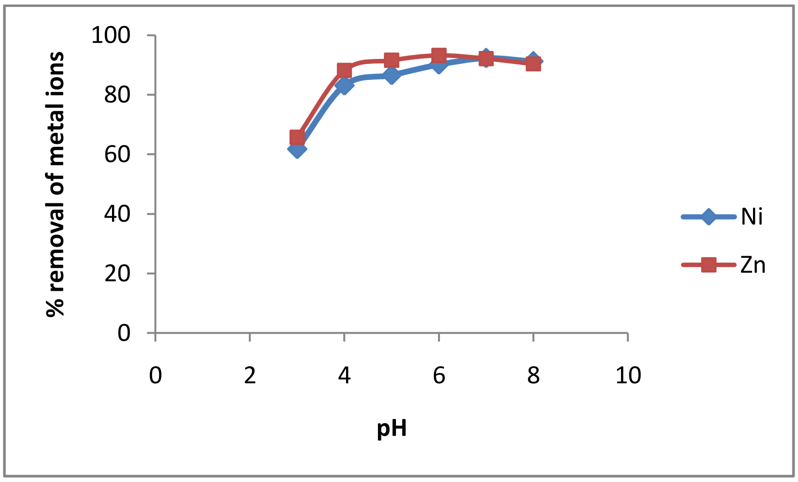

Fig. 1 Effect of pH on removal of Ni (II) and Zn (II) metal ion by sapota seed powder as adsorbent [Adsorbent dose = 2.0 g/l and 2.5 g/L for Ni (II) and Zn (II); contact time = 120 min; initial metal ion concentration = 60 mg/L]

Effect of Adsorbent Dosage

The effect of adsorbent dosage on the adsorption of Ni (II) and Zn (II) process is shown in Fig.2. Removal of Ni (II) and Zn (II) increases with increase of adsorbent dosage. The removal of metal ion studies were conducted at room temperature with an initial metal ion concentration of 60 mg/L with pH of 7 for Ni (II) and 6 for Zn (II) at contact period of 120min. Effect of amount of adsorbent was conducted at adsorbent doses of 0.5g, 1.0g, 1.5g, 2.0g, 2.5g and 3.0g respectively for 100ml of stock solution of Ni (II) and Zn (II). Removal is highly effective at the dose of 3g for both Ni (II) and Zn (II).

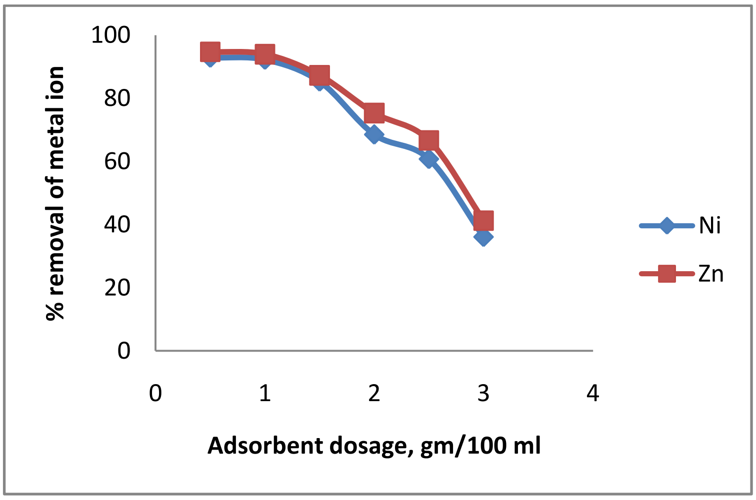

Fig. 2 Effect of adsorbent dosage on removal of Ni (II) and Zn (II) metal ion by sapota seed powder as adsorbent [pH= 7 and 6 for Ni (II) and Zn (II) ; contact time = 120 min; initial metal ion concentration = 60 mg/L]

Effect of contact time

Fig. 3 shows the effect of contact time on the extent of adsorption of Ni (II). It has been observed that adsorption rate decreased from 95.33% to 93.05 % with increased in contact time from 30 to 180 min and 96.47% to 95.15 % with increased in contact time from 30 to 180 min for Ni (II) and Zn (II) respectively. It may be explained by the fact that initially for adsorption large number of vacant sites was available, which slowed down later due to exhaustion of remaining surface sites and repulsive force between solute molecule and bulk phase (Saravanane et al., 2002).

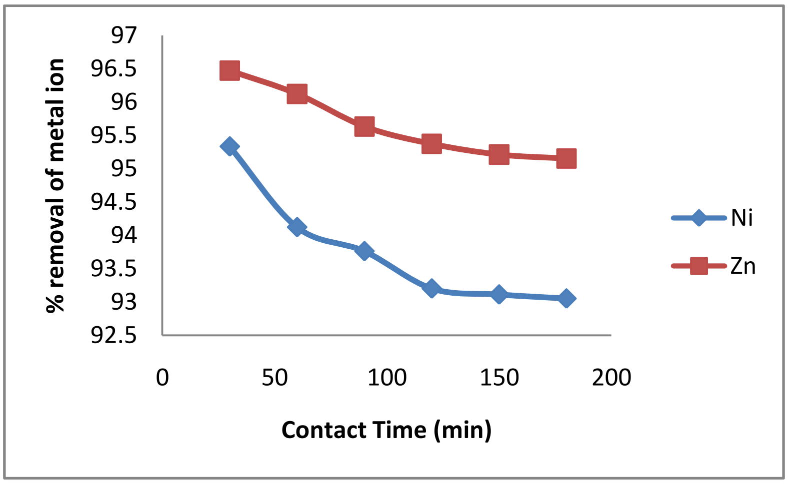

Fig. 3 Effect of contact time on removal of Ni (II) and Zn (II) metal ion by sapota seed powder as adsorbent [pH= 7 and 6 for Ni (II) and Zn (II) ; Adsorbent dose = 2.0 g/l and 2.5 g/L for Ni (II) and Zn (II) ; initial metal ion concentration = 60 mg/L]

Effect of initial metal ion concentration

The effect of initial Ni (II) and Zn (II) concentration in the range of 15 to 90 mg/L on removal of metal ion was investigated and the results are shown in Fig.4. It was found that the percentage nickel removal decreased with increase in initial Ni (II) and Zn (II) concentration, in other words percentage removal of Ni (II) decreased from 95.12% to 65.12 % with increased in initial metal ion concentration from 15 to 90 mg/L and percentage removal of Zn (II) decreased from 96.87% to 63.11 % with increased in initial metal ion concentration from 15 to 90 mg/L respectively.

The initial concentration provides an important driving force to overcome all mass transfer resistance of metal between the aqueous and solid phases. Decrease in resistance for the uptake of solute from solution with increase in metal concentration (Mukesh Parmar et al., 2013).

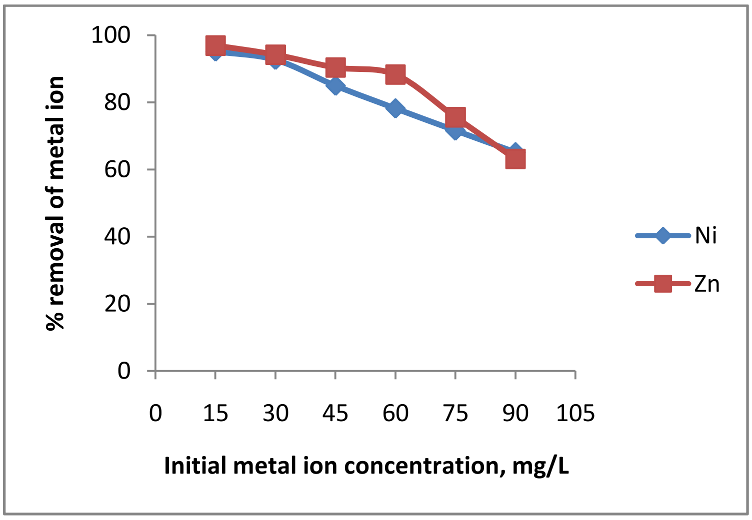

Fig.4 Effect of initial metal ion concentration on removal of Ni (II) and Zn (II) metal ion by sapota seed powder as adsorbent [pH= 7 and 6 for Ni (II) and Zn (II) ; Adsorbent dose = 2.0 g/l and 2.5 g/L for Ni (II) and Zn (II) ; contact time = 120 min]

CONCLUSION

The removal of two heavy metals Ni (II) and Zn (II) from their aqueous solution, using pouteria sapotta as an adsorbent was studied. The effect of pH, contact time, adsorbent dose and initial metal ion concentration on the percentage removal of Ni (II) and Zn (II) were studied in batch process. The maximum removal of Ni (II) and Zn (II) were found to be 95.12 % and 96.87 % at for a contact time of 120 min with initial metal ion concentration of 15 mg/L and pH 7 and pH 6 respectively.

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REFERENCES

1. Rengaraj S., Yeon KH., Moon SH, Removal of chromium from water and wastewater by ion exchange resins. J. Hazard. Mater, 2001; 87: 273-287.
2. Mishra GK., Meena AK., Rai PK., Chitra RG., Nagar PN., Removal of heavy metal ions from aqueous solutions using carbon aerogel as an adsorbent, Elsevier, 2005; DOI :10.1016
3. Saravanane R., Sundararajan T., and Sivamurthyreddy S., Efficiency of chemically modified low cost adsorbents for the removal of heavy metals from wastewater: A comparative study, Indian J. Env. Health, 2002; Vol. 44: 78-81.
4. MukeshParmar., Lokendra Singh Thakur., Adsorption of Heavy Metal (Cu^{2+}, Ni^{2+} and Zn^{2+}) from Synthetic Waste Water by Tea Waste Adsorbent, IJCPS, 2013; 2(6): 6-19.
5. Innocent oboh., Emmanuel aluyor., and Thomas audu., Biosorption of heavy metal ions from aqueous solutions using a biomaterial, Leonardo journal of sciences, 2009; 14: 58-65.
6. Low KS., Lee CK., Ng AY., Column study on the sorption of Cr (VI) using quarternized rice hulls. Bioresour. Technol, 1999; 68: 205-208.
7. Malkoc E., Nuhoglu Y., Removal of Ni (II) ions from aqueous solutions using waste of tea factory: Adsorption on a fixed-bed column. J. Hazard. Mater, 2006; 135: 328-336.
8. Zacaria R., Adsorption of several metal ions onto low-cost biosorbent: kinetic and equilibrium studies, Environ. Sci. Technol., 2002; 36: 2067-2073.
9. Liu HW., Dong YH., Wang HY., Liu Y., Ammonium adsorption from aqueous solutions by strawberry lead powder: Equilibrium, kinetics and effects of coexisting ions. Desalination, 2010; 263: 70-75.
10. Argun ME., Dursun S., Ozdemir C., Karatas M., Heavy metal adsorption by modified oak sawdust: Thermodynamics and kinetics. J. Hazard. Mater., 2007; 141: 77-85.
11. Azhar SS., Liew AG., Suhardy D., Hafiz KF., Hatim MDI., Dye removal from aqueous solution by using adsorption on treated sugarcane bagasse, Am. J. Appl. Sci, 2005; 11: 1499-1503.
12. Wafwoyo W., Seo CW., Marshall WE., Utilization of peanut shells as adsorbents for selected metals, J. Chem. Technol. Biotechnol, 1999; 74: 1117-1121.