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The Optimization and Separation of Nickel Ions Using Biosorbent Bed of Algae

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Abstract

The use of biosorbent for heavy metal removal has revealed enormous potential of algae for biosorption. In present work the dried biomass of spirogyra hyaline was used as biosorbent for removal of nickel ions from waste water solution. The effect parameter temperature, pH and time on percentage removal of nickel ions from waste water solution is evaluated. The result showed that highest removal efficiency is 98% for nickel ions separation at optimum operating condition of 40^0c temperature, pH 6 and time 20min.

Keywords.-Nickel ions, Biosorption, spirogyra hyaline algae.

Introduction

Biosorption is an alternative to traditional methods for decontamination of liquid effluents loaded with heavy metals. In recent years scientific community has shown great interest in these techniques in view of result obtained. Moreover algae have special interest in search for and development of new biosorbent materials due to their high sorption uptake and their ready availability in practically unlimited quantities in sea and ocean. Removal of heavy metals from industrial wastewater is of primary importance because they are not only cause contamination of water bodies but also they are toxic to many life forms. Industrial processes generate wastewater containing heavy metal contaminants. Since most of heavy metals are non- degradable into nontoxic end products, their concentrations must be reduced to acceptable levels before discharging them into environment. Otherwise these could pose threats to public health and/or affect the aesthetic quality of potable water.Biosorption is a term that describes the removal of heavy metals by the passive binding to non-living biomass from an aqueous solution. The process has gained importance due to its advantages over conventional separation techniques such as chemical precipitation, ion exchange, reverse osmosis, membrane filtration and activated carbon adsorption. These advantages are the reusability of biomaterial, low operating cost, improved selectivity for specific metals of interest, short operation time and no production of secondary compounds which might be toxic. Metal removal by biosorption can be considered a relatively new technology, which can successfully be employed as a refining treatment in shallow bodies of water (1-5 m) having metal concentrations (1-20 mg l-1) . The use of biosorbents of biological origin have emerged in the last decade as one of the most promising alternatives to traditional heavy metal management strategies. Of late, the attention has shifted to non-living dry algae biomass and other microorganisms for metal removal. The algae have many features that make them ideal candidates for the selective removal and concentration of heavy metals, which include high tolerance to heavy metals, ability to grow autotrophic ally and heterotrophic ally, large surface area/volume ratios, phototaxy, phytochelatin expression and potential for genetic manipulation. Algae biomass has proven to be highly effective as well as reliable and predictable in the removal of heavy metals from aqueous solution. The term algae refer to a large and diverse assemblage of organisms that contain chlorophyll and carry out oxygenic photosynthesis.

The present work focused on the investigation of the capability of dried biomass of Spirogyra hyalina to remove heavy metal from aqueous solution at different initial concentrations of the heavy metals and at different exposure period of dry biomass.

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Materials and methods

Preparation of biosorbent: The filamentous alga Spirogyra hyaline was obtained from fresh water. The alga was washed twice with tap water and thereafter with double distilled water thoroughly to eliminate adhering foreign particles like sand and debris. The washed biomass was first air dried for 24 hrs and then in an oven at 80oC to constant weight. The dried biomass was then ground in an analytical mill and then sieved through a 2 mm mesh size sieve and stored in polyethylene bottles. Nickel sulphate Hydrochloric acid, NaoH pellets were used to adjust ph of desire value. Equipment-Atomic adsorption spectrometer used to measure the concentration of nickel ions, PH meter, and digital electronic balance. Pump to pumping the simulated solution at constant volumetric flow rate 1.5 cm3 /sec. Glass column: 100 cm height, 5 cm diameter and 2.5 mm wall thickness. Two circular glass discs 5 cm thickness were installed at a distance of 20 cm from the upper and lower end of the glass column. The discs were perforated by 0.5 mm holes maintain a uniform dawn flow of simulated solution. Biosorbent bed was made by put of dry particle of biosorbent material between two circular glass discs above.

Biosorption process.

A waste water solution was pumped at constant volumetric flow rate to column at different temperature, ph and times. The sample of treated water was taken from bottom of the column. These samples were filtered and concentration of nickel ions is calculated using atomic absorption spectrometer.

% Removal of Nickel ions= C0-Cf/C0×100

Where,

C0-Initial concentration of Nickel ions.

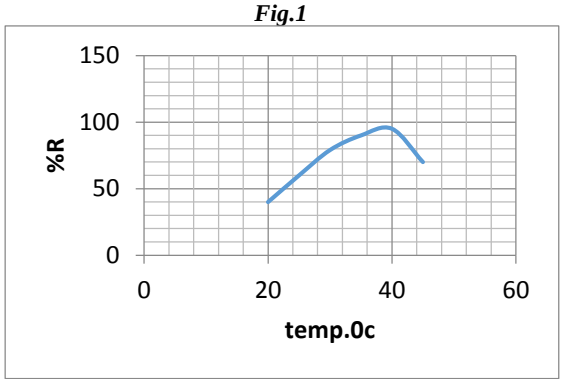
Cf-Final concentration of Nickel ions.

Result and discussion

The effect Of Temperature.

The removal of nickel ions at different temperatures showed in figure 1 and 2.It shows that maximum removal percentage of nickel ions has been obtained at 40^0c.This indicate that's biosorption between algae biomass and nickel ions has chemical interaction and physical adsorption occurred. With increased in temperature from 25-40^0c, the pores of algae become enlarged and resulted in increasing the surface area available for sortion, diffusion and penetration of nickel ions, this result in increasing the sorption.Furher increased in temperature above 40^0c leads to decreased the percentage removal of nickel ions. This is occurred due to deactivation of biosoption surface or destructing some active sites on biosorbate surface due to bond ruptures or due to the weakness of biosorption forces between the active sites of the sorbent and sorbet species.

Fig.1



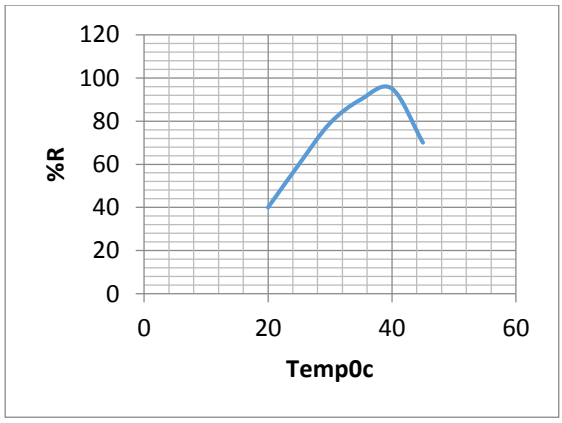


Fig.2

Effect of pH.

In order to examine the effect of pH on removal efficiency of nickel ions ,experimentation were carried at pH 2-7 with different times, the experimental result shows that optimum pH for removal of nickel ions is found out to be 4..At pH below 2possitive charge density on sites of biomass surface minimize metal sorption and above 5 pH metal precipitation formed.

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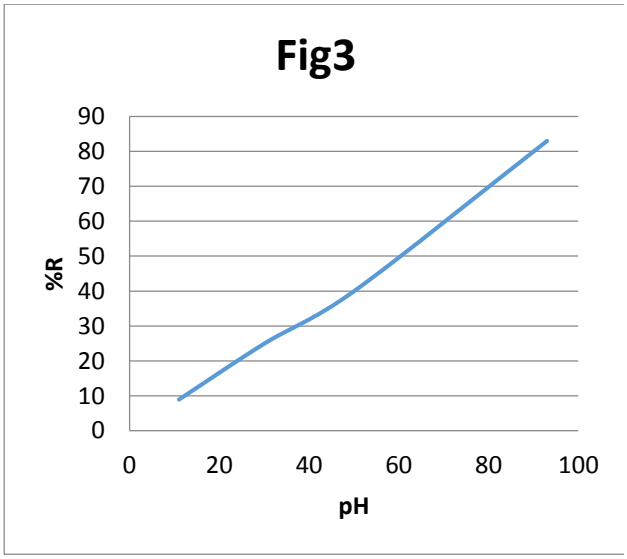
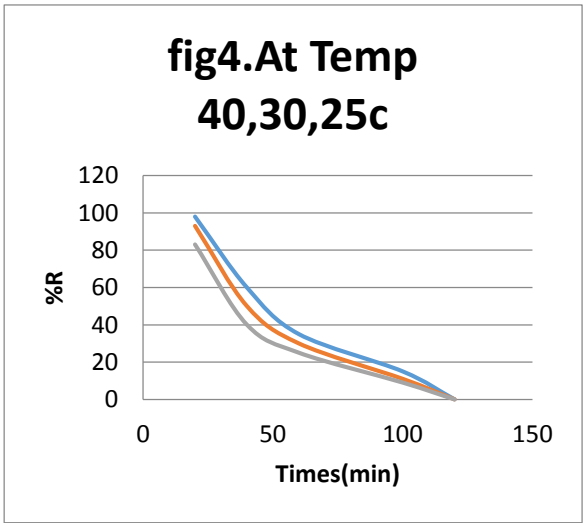


Effect of Times.

The removal of nickel ions at different time with temperature is shown in figure 4.removal efficiency of nickel ions decreased with times from 20min to 120min and best result obtained at 40^0c.sothat effect of biosorption time is very important because the bed is made of biosorption materials which will gradually saturated which will get saturated with times and decreased the ability to absorb nickel ions after 120min.



Conclusion

The biosorption bed of algae for removal of nickel ions from waste water is good efficient the effect of parameter like temperature, time and pH is very important for biosorption bed. The maximum bed efficiency of removal of nickel ions is 98% at optimum operating condition of 40^0c and at pH-6 and at time 20min**.**

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