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# ELIMINATION OF NICKEL (I) FROM SYNTHETIC WASTE WATER USING BAGASSE PITH WITH COLUMN STUDIES

M Murali Naik[1], P Akhila Swathanthra[2]

[1,2] *Department of Chemical Engineering, SVUCE, Tirupati, 517502 (India)*

**ABSTRACT**

In the current investigation naturally existing adsorbent such as bagasse pith are used as adsorbent to separate the Nickel (I) from synthetic waste water [4,5]. The studies of equilibrium are methodically carried out in a batch studies which covering various process parameters that include effect of initial concentration, pH, contact time, adsorbent dosage and temperature.

The column studies were carried out using bagasse pith in order to obtain the break through curve. In column studies, the ratio of effluent concentration to initial concentration rises with time up to the break point. After a short time the ratio remain constant with increase in time, which indicates that saturation has been reached. The percentage removal of Nickel (I) of concentration 60 ppm using bagasse pith is 32% at a volumetric flow rate of 0.6 ml per minute.

For bagasse pith the effective % removal of Nickel (I) is at a temperature of $50^0$ C and at low concentrations. Langmuir constants were found to be $q_m$ =8.16, b=0.146 and Freundlich constants are $K_f$=2.45, n=2.583.Freundlich isotherms better fitted the experimental data since the correlation coefficients for Freundlich isotherms were higher than the Langmuir isotherms. The high correlation coefficient $R^2$ for Freundlich isotherm which gives an better indication of favourable adsorption.

***KEYWORDS: Bagasse pith, Nickel (I).***

## I. INTRODUCTION

Waste water is a potential cause for the environment, because of admitting of various contaminants such as variety of different metals into the land which contains soil and water resources. The strong weight of metals are more released into the surrounding environment due to rapid large scale industries and have created a higher global concern.

These metals are used in large number of industries such as metal plating, mining activities, smelting, battery manufacture, refining of petroleum, manfacture of paint, pharmaceutical, printing, cemented hard metal industry and photographic industries, etc.

Nickel is a naturally occurring element. This metal which is used to make stainless steel and other different metal alloys. People who are sensitive to the nickel metal ion and it causes Skin allergy. Nickel in drinking water is a well-known pollutant though out the world. Like any other pollution like nickel pollution can also occur due to both natural and manmade reasons [1,2].

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Though a minimum concentration of less than 0.1 mg/l in water can cause no harm to the health of the people, the concentrations of more than 0.1 mg/l for longer period causes stomach pain and effects to their blood and urinary systems. Adsorption is one of the most important method in extracting heavy metal ions like Nickel (I) from aqueous solutions. The aim of the present investigation is to find out the performance characteristics of Bagasse Pith on Nickel (I) removal from aqueous solutions by changing Nickel(I) concentration, pH, contact time, adsorbent dosage, , initial concentration and temperature.

## II. MATERIALS

Nickel Nitrate, Dimethyl glyoxime, Sodium Hydroxide, Sulphuric acid, Distilled water and Bagasse pith collected from sugar factory which is located Pandyapuramu in Karnataka state. All chemicals used are of analytical reagent grade only.

## III. METHODS

### A. Preparation of Bagasse Pith

The Bagasse pith is collected from the sugar factory located at Pandyapuram in Mandya district in Karnataka state. It is sieved using a 200 Tyler mesh and the mesh opening is 72 µm. Firstly the adsorbent is washed with distilled water to avoid the release of colour by adsorbent into the aqueous solution. The activation of adsorbent is carried out by treating with 0.1N Sulphuric acid and dried at room temperature. Again it is washed with distilled water to remove acid traces.

**Fig. 1. Bagasse pith**

### B. Preparation of Nickel Stock Solution

The aqueous solutions of Nickel (I) were prepared by 10g of nickel nitrate hexahydrate soluble in 1 liter of double distilled to prepare 10000 ppm of nickel stock solution. Dilution of this 10000ppm solution is prepared to the required concentrations. From this, 10000ppm nickel stock solution, different initial concentration of 10, 20, 30 40, 50 and 60 ppm were prepared. Solutions of 0.1 N sodium hydroxide (NaOH) and 0.1 N ulphuric acid ($H_2SO_4$) were used for pH adjustment.

### C. Column Studies

The column was designed with an outer diameter 4.4 cm and height 65 cm. At the top of the column, an adjustable plunger was attached with a 0.5mm stainless sieve [6, 7]. A 2cm high layer of glass beads were placed at the column base in order to provide a uniform inlet flow of the solution into the column followed by glass wool [9]. A known quantity of adsorbent was placed in the column to yield the desired bed height (27.5 cm). Nickel solution of known concentration is fed to the column. The pH of the nickel solution was adjusted

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using 0.1N HCL (hydrochloric acid). Samples of nickel solutions were collected at the column outlet for different time intervals. The samples were analysed for nickel concentration by using a spectrophotometer [5]. The samples were collected until the system reaches steady state [i.e, columnexhaustion].

**Fig. 2.** Experimental setup of column studies

## IV. RESULTS AND DISCUSSIONS

### A. Effect of Initial concentrations

The effect of initial concentration on percentage removal of nickel was studied at pH of 8, adsorbent dosage of 2 g/l and contact time of 90 minutes. The initial concentration range which varies from 10 mg/l to 60 mg/l.

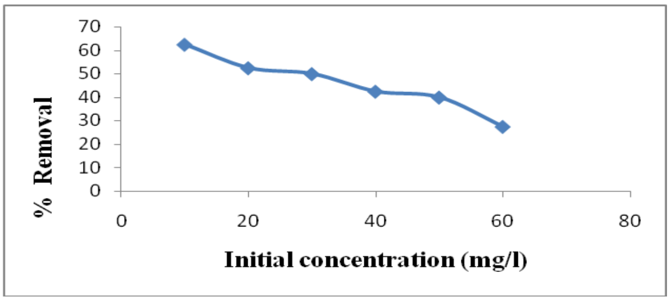


**Fig. 3. Effect of Initial concentration on % removal of Ni (I) by Bagasse pith**

From the above graph it was observed that the percentage removal of nickel ions decreases with increase in initial concentration. The percentage removal of nickel falls sharply from 62.5% to 27.5% when the concentration was increased from 10 mg/l to 60 mg/l for Bagasse pith.

### B. Effect of pH

The effect of pH on percentage removal of nickel was studied at initial nickel concentration of 20 mg/l, adsorbent dosage of 2g/l and contact time of 60 minutes using Bagasse pith. The pH varies from 2 to 12.

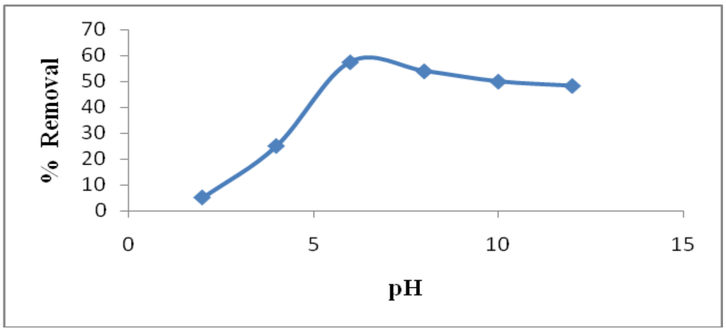


**Fig. 4. Effect of pH on % removal of Ni (I) by Bagasse pith**

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From the above graph it was observed that the removal of nickel ions decreases with increase in pH, thus pH of 6, which gives maximum nickel removal.

## C. Effect of contact time

The effect of contact time on percentage removal of nickel was studied at pH of 8, initial concentration of 20 mg/l and adsorbent dosage of 2g/l**.** The contact time varies from 15 to 90 minutes.

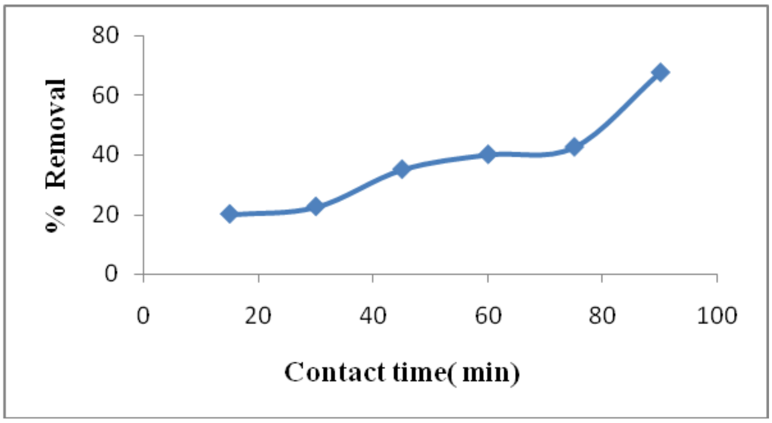


**Fig. 4. Effect of contact time on % removal of Ni (I) by Bagasse pith**

From the above graph it was observed that removal of nickel ion increases with increase in contact time, attaining an equilibrium. Further increase in contact time did not increase the uptake due to the deposition of nickel ions on the available adsorption sites of adsorbent. The nickel ion removal increases from 20% to 67.5% for Bagasse pith at 15 to 90 minutes of contact time.

## D. Effect of Adsorbent dosage

The effect of adsorbent dosage on percentage removal of nickel was studied at pH of 8, initial concentration 20mg/l and contact time 60 minutes. The adsorbent dosage varies from 2 g/l to12 g/l.

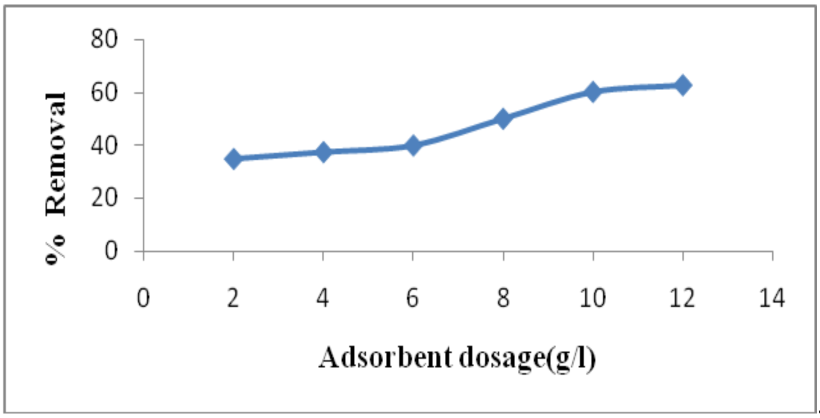


**Fig. 5. Effect of Adsorbent dosage on %removal of Ni (I) by Bagasse pith**

From the above graph it was observed that the removal of nickel ions increases with increase in adsorbent dosage. The percentage removal of nickel increases from 2.5% to 75.5% for Bagasse pith at 2 g/l to 12 g/l of adsorbent dose [8].

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### E. Effect of Temperature

The effect of temperature on percentage removal of nickel was studied at pH of 8, initial concentration of 20 mg/l, contact time 60 minutes and adsorbent dosage of 2 g/l. The temperature varies from 32° C to 80° C.

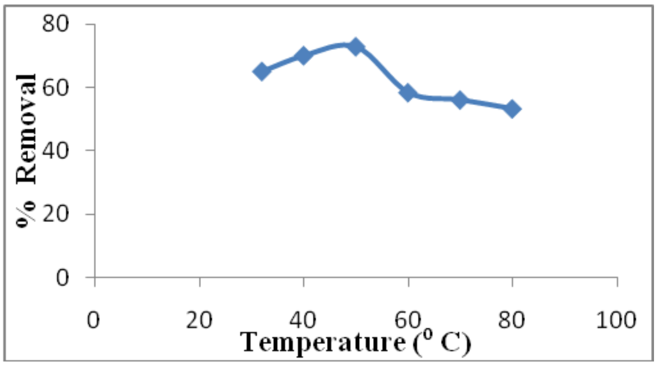


Fig. 6. Effect of Temperature on % removal of Ni (I) by Bagasse pith

From the above graph it was observed that the removal of nickel ion increases with increase in temperature up to certain extent and then decreases with increase in temperature. It is clear that the maximum percentage removal of nickel is at 50° C.

### E. Langmuir isotherm

The Langmuir adsorption isotherm is the plot between Ce/qe verses Ce. The Freundlich adsorption isotherm is the plot between ln qe verses ln Ce. Langmuir and Freundlich equation are given as Ce/qe = 1/(bqm) + (1/qm) Ce

ln qe = ln Kf + (1/n) ln Ce

From the below figure it was observe that the Ce of Bagasse pith increases with increase in Ce/qe. The Correlation coefficient of this isotherm is $R^2 = 0.979$.

Freundlich isotherms better fitted the experimental data since the correlation coefficients for Freundlich isotherms were higher than the Langmuir isotherms. The high correlation coefficient $R^2$ for Freundlich isotherm which gives a better indication of favourable adsorption.

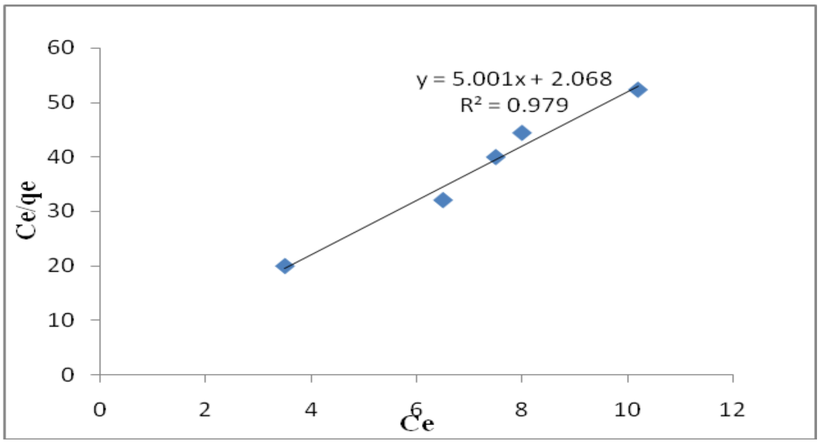


**Fig. 7. Langmuir isotherm for adsorption of Nickel (I) on Bagasse pith**

### F. Freundlich isotherm

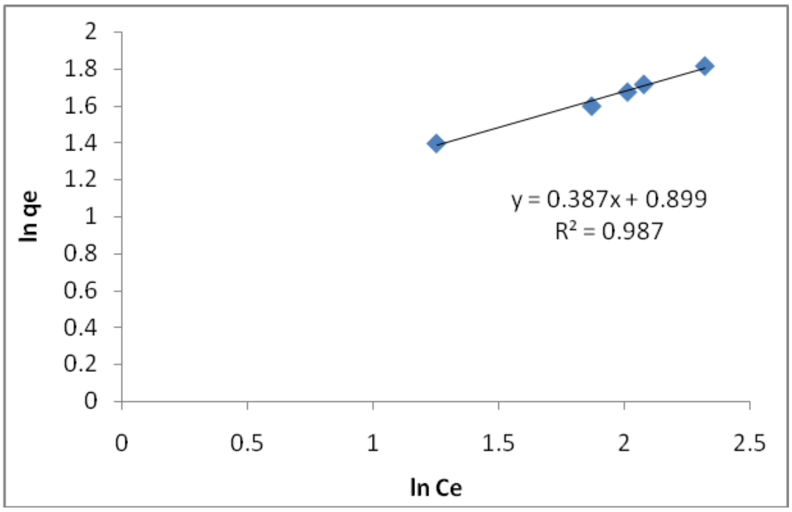


**Fig. 8.** Freundlich isotherm for adsorption of Nickel (I) on Bagasse pith

## V. CONCLUSIONS

- The maximum adsorption of nickel for bagasse pith (72.8%) was observed at temperature $40^0$ C and $50^0$ C.
- The percentage removal of nickel decreases with increase in initial concentration and pH. However adsorption capacity increases with increases in initial concentration.
- With the increase in the adsorbent dosage, the percentage removal of nickel increases due to the availability of more surface area for adsorption.
- The optimum pH corresponding to the maximum adsorption for bagasse pith is 6 and the percentage removal of nickel increases with increase in contact time.
- In column studies, the ratio of effluent concentration to initial concentration increases with time up to the break point. After sometime the ratio remain constant with increase in time, which indicates that saturation has been reached.
- The % removal of Nickel (II) of concentration 60ppm using bagasse pith is 32% at a volumetric flow rate of 0.6 ml per minute.
- Freundlich isotherms better fitted the experimental data since the correlation coefficients for Freundlich isotherms were higher than the Langmuir isotherms.
- The high correlation coefficient $R^2$ for Freundlich isotherm which gives a better indication of favourable adsorption.

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