Studies on the removal of Ni (II) ions from aqueous solution using natural adsorbent Prosopus Juliflora bark carbon

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Heavy metal ion pollutants released from industrial effluents to water bodies are highly toxic, non degradable and accumulate in living organism through food chain and cause harmful effects on human beings. Activated carbon (PJBC) was prepared from Prosopus Juliflora bark powder using sulphuric acid . The ability of the activated carbon (PJBC) to remove Ni(II) ion from aqueous solution by PJBC has been investigated under several conditions such as pH, contact time and adsorbent concentration. The optimum contact time was found to be 4h. The removal of Ni(II) was found to be maximum at the carbon dosage of 100 mg at a pH of 5. Freundlich adsorption isotherm was studied and the studies revealed that the adsorbent capacity K and the adsorption intensity 1/n values of the natural adsorbent Prosopus Juliflora bark carbon PJBC can be used in the removal of Ni(II) efficiently.

INTRODUCTION

ENVIRONMENT

The term environment which etymologically means surroundings, is considered as a composite term for the conditions in which organisms live andthus consists of air,water,food and sunlight which are the basic needs of all living beings and plant life, to carry on their life functions. "Environmental pollution may be defined as the unfavorable alternation of our surroundings ,wholly or largely as a by –product as of man's actions, through direct or indirect effects of changes in energy patterns, radiation levels, chemical any physical constitution and abundances of organisms .These changes may effect man directly or through his supplies of water and agricultural and other biological products, his physical objects are possessions , or his opportunities for recreation and appreciation of nature.

WATER POLLUTION

Water pollution is contamination of water by foreign matter that deteriorates the quality of the water. Water pollution involves the release of toxic substances, radio activity etc., that become deposited upon the bottom and their accumulations will interfere with the condition of aquatic ecosystems[5].

EFFECTS OF WATER POLLUTION

Diseases can spread via polluted water. Infectious diseases such as typhoid and cholera can be contracted from drinking contaminated water. The human heart and kidneys can be adversely affected. Other health problems are poor blood circulation, skin lesions, vomiting and damage to the nervous system.

Pollutants in the water will alter the overall chemistry of the water, causing changes in acidity, temperature and conductivity. These factors have an effect on the marine life.

HEAVY METAL

Heavy metal refers to metals having a density and specific gravity more than five times greater than that of water. Industrial pollution releases a number of heavy metals. The important toxic metals are Cr, Zn, Ni, Mn, Sb, As, Pb, Cd, Sc, U, Co, Te, V, Hg, Pt, Os and Be.

Nickel:

Nickel is a metal, commonly used to make coins, magnets, jewellery, stainless steel, electronics, and components of industrial machines and its salts also used in several industrial applications such as electroplating, storage batteries, automobile and aircraft parts, spark plugs, electrodes, etc. Nickel is toxic at higher concentration. Nickel is found to be toxic for most of plants and fungi. Growth of woody plants were hindered

by high nickel concentrations in the soil. Most people are familiar with the attractive mirror-finish that can be achieved by nickel plating. However, despite the beautiful appearance, nickel exposure, especially in industrial and occupational settings, can produce significant health hazards.

Exposure to Nickel:

Nickel is one of many carcinogenic metals known to be an environmental and occupational pollutant. The New York University school of Medicine warns that chronic exposure has been connected with increased risk of lung cancer, cardiovascular diseases, neurological defects, developmental defects in childhood, and high blood pressure.

Nickel pollution:

In animals excessive quantities cause toxic effects such as dermatitis and respiratory disorders including lung cancer following inhalation. Initial symptoms of toxicity due to nickel are nausea, dizziness, headache, chest-pain etc[8].

2. MATERIALS AND METHODS

2.1 Preparation of sulphuric acid treated Prosopis Juliflora Bark carbon (PJBC)

In order to have sufficient carbon for systematic studies of nickel removal, several 50g lots of prosopis juliflora bark carbon is carbonized using 20ml of concentrated sulphuric acid in each instance. After mixing thoroughly, the samples were let stand in an oven at 140^0C -160^0C for 24 hours to facilitate charring of the material. They were then washed to free from acid with tap water. Finally they were washed with distilled water, dried in an air oven at 110^0C for 8 hours

2.2 STANDARD CALIBRATION CURVE FOR Ni(II)

From the stock solution of 1000 ppm, 10 ppm of Nickel Sulphate solution was prepared. Various volumes of this solution were pipette out into a series of 50 ml standard flasks. To each flask added 20ml of HCl,10ml of sodium citrate,2ml of iodine solution and 4ml Dimethyl glyoxime and the solution were made up to the mark. The flasks were kept for 20 minutes. Required amount of solution were taken in the cuvette. Using spectronic-200 spectrophotometer absorbance for each solution were noted. A graph was drawn between concentration of Nickel Sulphate solution taken along X-axis and absorbance along Y-axis. Thus a standard calibration curve for Nickel was obtained.

2.3 EFFECT OF EQULIBRIUM TIME

An equal amount of PJBC was transferred into 10 stoppered bottles. To each stoppered bottle 100ml of 10 ppm solution were added .Then all the bottles were kept in an electrical shaker for adsorption. At every one hour, intervals one bottle was taken out from the shaker and allowed to stand for few minutes and filtered. The instrument spectronic-200 spectrophotometer was standardized using blank solution. Then absorbance of experimental solution were noted. The percentage of Nickel adsorbed was obtained from the standard calibration curve. A graph was drawn between equilibrium time along the x axis and percentage of Ni adsorbed along y axis.

2.4 EFFECT OF pH

Different buffer solutions with 1, 2, 3, 4, 5, 6, 7, 8, 9,10 were prepared from 10 ppm of Nickel sulphate solution. About 0.5g of PJBC are transferred into 10 different stoppered bottles. To this added 100ml of each of these pH solutions and the bottles were kept in an electric shaker for 4 hours. After 4 hours all the bottles containing PJBC were taken out and allow to stand for few minutes and filtered. Then the absorbance of experimental solution were noted. A graph was plotted using percentage of nickel adsorbed against pH of the

solution for both adsorbents. The maximum adsorption took place at particular pH and that was considered as the optimum pH

2.5 EFFECT OF CARBON DOSAGE

100 ml of 10ppm nickel sulphate solution which was adjusted to the pH 5 was taken in ten stoppered bottles. Various carbon dosage such as 0.5 g, 1 g, 1.5 g,2 g , 2.5 g, 3g ,3.5 g, 4 g, 4.5 g and 5 g of PJBC were separately weighed and transferred into 10 different stoppered bottles. The bottles were kept in an electric shaker for 4 hours to attain equilibrium. Then all the bottles were taken out, allowed to stand for some time and filtered.. Then absorbance of each solution were noted, using spectronic 200 spectrophotometer for the corresponding weight of carbon dosage. The amount of adsorbent for which maximum adsorption took place was found out from the graph. A graph was plotted using percentage of nickel adsorbed against carbon dosage of the solution for the both adsorbents. The maximum adsorption took place at particular carbon dosage that was considered as the maximum dosage for both the adsorbents.

2.6 FREUNDLICH ADSOPRTION ISOTHERM

A series of 5ppm, 10ppm, 15ppm, 20ppm, 25ppm, 30ppm, 35ppm, 40ppm, 45ppm, 50ppm, nickel solution were prepared in 100ml standard flask. 100mg of PJBC was weighed and transferred into 10 separate stoppered bottles. To this added 100ml of the above series of solution. These bottles were kept in the shaker for 4 hours. Then the absorbance of experimental solution were noted. . The graph were plotted by taking log C_{eq} along x axis and log (x/m) along y axis.

2.7 DESORPTION OF NICKEL

100 mg of PJBC mixed with 100ml of 10ppm nickel solutions in each of the 10 stoppered bottles and kept in the electric shaker for 7 hours. The bottles were taken out allowed to stand for few minutes. The residue were washed thrice with distilled water and mixed with a series of 100ml of 0.01N, 0.02N, 0.03N,0.04N ,0.05N, 0.06N, 0.07N, 0.08N, 0.09N and 0.1N HCl solutions in separate stoppered bottles and kept in the shaker for 4 hours. Then all the bottles were taken out, allowed to stand for few minutes, filtered and first few ml of the filtrate were discarded from each bottle. Then 20 ml of 0.5N HCl , 10 ml of sodium citrate solution ,2 ml of iodine solution ,and 4 ml of Dimethyl glyoxime were added and kept for few minutes. Then absorbance of each solution were measured using spectronic-200 spectrophotometer.

3 RESULTS AND DISCUSSIONS

S.No	Characteristics	ProsopisJuliflora Bark carbon(PJBC)
1.	Moisture content	15.24
2.	Ash content	3.34
3.	Apparent density	0.74
4.	Matter soluble in water	2.64
5.	Matter soluble in acid	0.61
6.	pH	3.12
7.	Decolorizing power	180
8.	Iron content	15.40
9.	Ion Exchange Capacity	0.05

Figure 1: Standard calibration curve for Nickel (II)

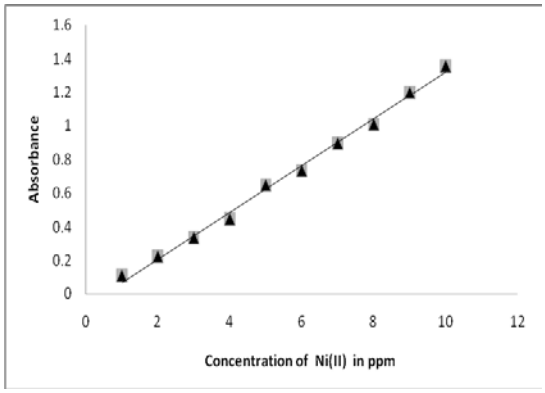

FIGURE 4 EFFECT OF CARBON DOSAGE

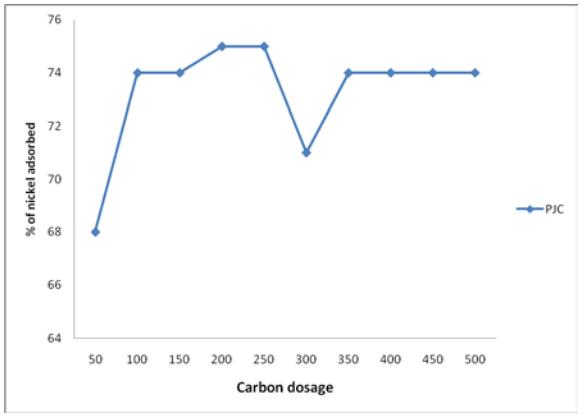

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FIGURE – 2 EFFECT OF EQULIBRATION TIME

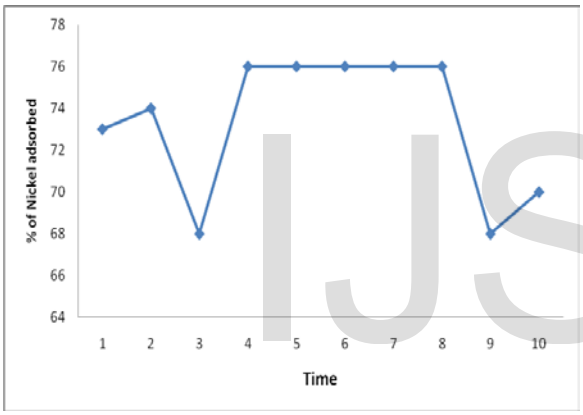
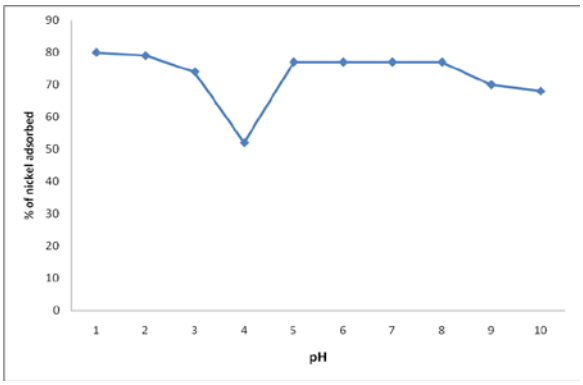


FIGURE – 3 EFFECT OF pH



3.5 FREUNDLICH ADSORPTION ISOTHERM

$$\mathbf{Log_{10}\ (x/m) = log_{10}K + 1/n\ log_{10}C_{eq}}$$

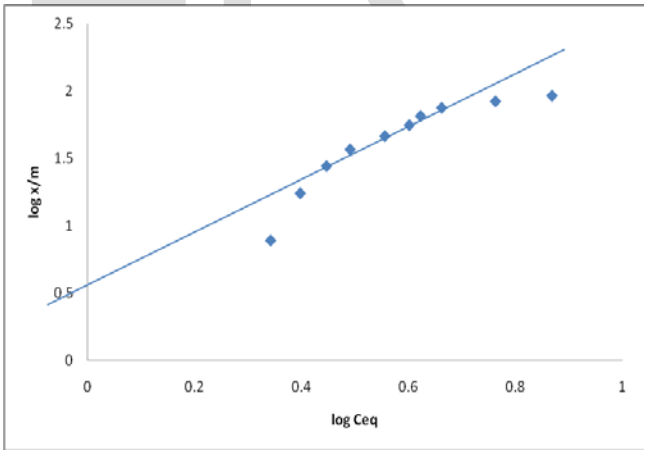
Where

K = Equilibrium constant

C_{eq} = Equilibrium concentration (mg/L)

x/m = Amount adsorbed per unit mass of PJBC and CAC.

FIGURE 5 FREUNDLICH ADSORPTION ISOTHERM FOR PJBC



DESORPTION OF Ni (II)

Desorption helps to elucidate the nature of adsorption and help to remove the metals from water and the adsorbent. Attempts were made to regenerate Ni(II) from the spent carbons using HCl of various strengths ranging from 0.01N to 0.1N.

Table 6: Desorption of Nickel

Concentration of HCl (N)	Absorbance	Final concentration	Percentage of Ni(II) adsorbed
0.01	0.851	6.7	33
0.02	0.781	6.2	38
0.03	0.730	5.9	41
0.04	0.684	5.4	46
0.05	0.514	4.2	58
0.06	0.420	3.5	65
0.07	0.340	3	70
0.08	0.270	2.9	71
0.09	0.251	2.2	78
0.10	0.181	1.7	83

4. SUMMARY AND CONCLUSION

In this work, the following significant conclusions could be drawn from the investigation on the removal Ni(II) using Prosopis Juliflora Bark carbon (PJBC) as the adsorbents. By Batch mode studies, the removal was found to increase with time and attains equilibrium at 4^{th} hour for PJBC. The percentage of removal was found to be 76 for PJBC The percentage of removal has reached a maximum at pH 5 0 For the quantitative removal of Ni(II) from 100ml of solution containing 10mg/L a minimum carbon dosage of 100mg of PJBC was required. From Freundlich adsorption isotherm study, the k values were found to be 0.6 for PJBC. The values of 'n' were calculated to be 1.25 for PJBC This reveals that there is favourable adsorption of Ni(II) from aqueous solution It has been found that a concentration of 0.1N of HCl is required to 83% of PJBC. Hence, it has been concluded that, PJBC is an effective adsorbent used in the removal of Ni(II) from H_2O

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