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REMOVAL OF NI FROM ITS AQUEOUS SOLUTION BY USING SUGARCANE BAGASSE ACTIVATED CARBON (SCBAC) AS LOW COST ADSORBENT

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ABSTRACT

In the present study the removal of Ni was achieved from its aqueous solution by using sugarcane bagasse activated carbon (SCBAC) as low cost adsorbent. Low cost activated carbon was prepared by the waste product of sugar cane and also shows the utility of the activated carbon as an adsorbent. A good percentage removal (90%) of Ni from its aqueous solution was achieved by the studies. The studies also highlight the effect of various factors like pH, adsorbent dose and initial concentration etc on adsorption efficiency. The validity of adsorption was confirmed by using Langmuir adsorption isotherm and Freundlich isotherm.

KEYWORDS: *Adsorption, Sugar cane, activated charcoal, waste product*

I. INTRODUCTION

Most of the developing countries of the world now a days facing a great problem of pollution caused by different industries, these industries generate a huge amount of effluent which in most of the cases discharges directly into water bodies without any pretreatment. India is also facing this situation. Infect, the water pollution problems of the country is highest among the Asian countries. This environmental pollution arises from various industries developed in an unorganised way, rapid growth of urban population, deforestation, and water logging, etc, are few main causes for this situation. Continuous mixing of untreated industrial effluents into water bodies severely damages the aquatic life. Most of the industries produce effluent containing heavy metals and discharge it into water bodies without any pretreatment process. As a result, many heavy metals which are toxic get dissolved in these water bodies and contaminate these. It is estimated that a large number of heavy metals are continuously introduced into natural water. These pollutants are very dangerous for human health if are present in more than the required limit. [1-10].

Moradabad is one of the important city of Uttar Pradesh, India, has been facing water pollution problems due to rapid industrialization, urbanization and an unorganized sewage system of Municipal Corporation, polluting the river ram Ganga which passes through the heart of the city. The city is also known as the Brass city of India having hundreds of small scale industries which are established in a very unorganized way and discharging high amount of wastewater directly into the river without any pretreatment process. In general, these industrial wastes contain copper which is highly toxic and exist in aqueous system. Many small scale industries and electroplating plants are the major cause for the high amount of nickel to the river water. Thus it is very much necessary to remove the nickel before mixing of industrial effluent to river water. Several methods have been used for removing heavy metal industrial effluents, some of which are electrolysis, filtration and adsorption [11-14].

These methods are used for removing heavy metals and dyes from industrial wastewater. Amongst all the above methods adsorption is one of the most effective method for the treatment of industrial effluents.

A review of the literature shows that number of adsorbents is used was given by various researchers [15-20]. Activated carbon is prepared previously by various researchers by using different types of agricultural and industrial waste [8-10]. In the present studies, sugarcane bagasse activated carbon (SCBAC) has been utilized for the removal of Ni from its aqueous solution [21-36].

II. EXPERIMENTAL

2.1 Preparation of Materials

The standard solution 1 mg/mL of Ni was prepared from nickel sulphate. The stock solution is used to prepare the required solutions with different dilutions. The adsorbent was prepared from dry sugarcane bagasse. The sugarcane bagasse was collected from local market. This bagasse was first washed with deionized water and dried in sunlight for four days and then grinded in mixer grinder. The powdered bagasse was again dried in sunlight for three days. Now, after treating sugarcane bagasse with conc. H_2SO_4, bagasse are allowed to soak for one day at room temperature so that the reaction is completed and after drying the bagasse at 110^0C for 10 hours in an oven, it is sieved to the particle of size 225 μm.

2.2 Characterization of Adsorbent

The elemental analysis shows that carbon is the major quantitative element present in the prepared adsorbent. The percentage amount of elements and physical properties investigated are given in Table- 1.

2.3 Batch Adsorption Experiment

Adsorption study had been done by using batch adsorption experiment. The agitations were conducted at constant temperature of 25^0 C with varying the initial concentration of metal ion, agitation time and speed etc (Table- 2 to Table- 6). The study was conducted at constant pH 2 by adjusting metal ion solution concentration through dilute HNO_3 or NaOH. A spectrophotometer is used to analyze the concentrations of Ni in residual solutions [37-38].

III. RESULT AND DISCUSSION

3.1 Effect of Time

The agitation time plays a significant role on the adsorption of Ni. The removal of adsorption of Ni was done at different time intervals (Table- 2). The adsorption of Ni was maximum 90% at initial concentration of 250 mg/L at 180 min. It was analyzed during the study that adsorption rate of Ni was fast initially, as it was 45% in first 30 min and 71.23% in next 90 min and reaches up to 90% after 180 min. (Fig. 1).

3.2 Effect of Initial Concentration of Ni

The study was conducted at constant pH and temperature. It was observed by data analysis that removal of Ni was depending on the initial concentration as the removal percentage of Ni decreases from 90 to72.23% with an increase in initial Ni concentration (Fig. 2, Table- 3).

3.3 Effect of Adsorbent Dosage

The effect of changing the adsorbent dosage was shown in Fig. 3 (Table- 4), which shows that the adsorption as the adsorbent dose was increased quantitative nickel removal also increased. A maximum of 90% adsorption was obtained at equilibrium.

3.4 Adsorption Isotherm

Adsorption isotherm described a relation between the surface of adsorbent and adsorbate. In the present study, Langmuir and Freundlich isotherm models were used to show adsorption of Ni.

3.4.1 Langmuir Isotherm

The Langmuir adsorption isotherm is widely used for identifying the nature of adsorption. The verification of this model shows a monolayer adsorption of Ni on SCBAC with a homogeneous

distribution of adsorption sites. Fig. 4 (Table- 5) clearly indicates that adsorption follows Langmuir isotherm as the value of R_L is below 1, which favors the adsorption. The high value of correlation coefficient R^2 confirms the monolayer adsorption of Ni on the SCBAC surface.

3.4.2 Freundlich isotherm

The Freundlich isotherm is applied to heterogeneous surfaces as well as for multilayer adsorption. Fig. 5 (Table- 6) shows that the adsorption is not fit for Freundlich equation.

4. Conclusions

From the above study following points are concluded:

1) The present study clearly shows that adsorbent sugarcane bagasse is easily available and could be easily converted into activated carbon which showed a good percentage removal (90%) of Ni as an adsorbent.

2) The activated carbon prepared by sugarcane bagasse has good adsorption capacity as it adsorbs Ni from an aqueous solution with amount adsorbed 15.93 mg/g at the initial concentration 250 mg/L and the required period was only 180 min.

3) Both isotherm models Langmuir and Freundlich were studied and results showed that the adsorption fits better in the Langmuir equation.

Table- 1: Analysis of SCBAC

S. No.	Property	Result
1	Ash content	10.23
2	Bulk density	0.6585 gm/ cm^3
3	Moisture content	5.2 %
4	Carbon	71.2%
5	Hydrogen	3.21%
6	Sulphur	3.24%

Table- 2 : Percentage removal of Ni with different time intervals on SCBAC.

Ni = 250 mg/L T= 25^0C, SCBAC=700 mg, pH=2

S. No.	Time (min.)	Amount Adsorbed q (mg/g)	Removal % of Ni
1	30	8.03	45
2	60	10.95	61.32
3	90	12.72	71.23
4	120	13.64	76.40
5	150	14.68	82.21
6	180	15.93	89.23
7	210	15.93	89.23

Table- 3 : Percentage removal of Ni with different initial concentration on SCBAC.

T= 25^0C, SCBAC=700 mg, pH=2, Time = 180 min.

S. No.	Initial concentration of Ni (mg/L)	Amount Adsorbed , q (mg/g)	Removal % of Ni
1	250	15.93	89.23
2	300	18.69	87.24
3	400	24.8	86.80
4	500	30.07	84.20
5	600	35.31	82.40
6	700	40.16	80.32
7	800	44.80	78.41
8	900	46.41	74.20
9	1000	51.59	72.23

Table- 4 : Percentage removal of Ni with different adsorbent dose

T= 25^{0}C, pH=2, Time = 180 min. , Ni = 250 mg/L

S. No.	SCBAC (mg)	Amount Adsorbed q (mg/g)	Removal % of Ni
1	100	15.29	12.23
2	200	15.45	24.71
3	300	16.00	38.42
4	400	16.50	52.82
5	500	15.78	63.12
6	600	16.29	78.00
7	650	16.42	85.40
8	700	15.93	89.23

Table - 5 : Langmuir adsorption isotherm of Ni on SCBAC

T= 25^{0}C, pH=2, Time = 180 min., SCBAC =700 mg

S. No.	Ce	Ce/q
1	26.925	1.69
2	38.28	2.048
3	52.8	2.129
4	79	2.627
5	105.6	2.99
6	137.76	3.43
7	172.72	3.855
8	232.2	5.003
9	277.7	5.382

Table- 6 : Freundlich adsorption isotherm of Ni on SCBAC

T= 25^{0}C, pH=2, Time = 180 min., SCBAC =700 mg

S. No.	log Ce	log qe
1	1.430	1.202
2	1.583	1.271
3	1.723	1.394
4	1.897	1.478
5	2.024	1.547
6	2.139	1.603
7	2.237	1.651
8	2.365	1.666
9	2.443	1.7125

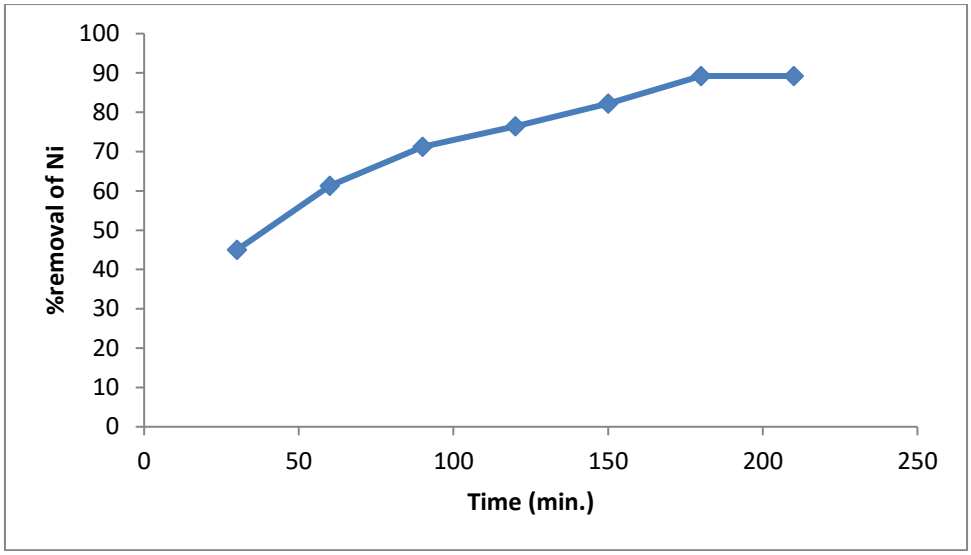

Fig. 1: Effect of time on % removal of Ni on SCBAC.
Ni = 250 mg/L T= 25^{0}C, SCBAC=700 mg, pH=2

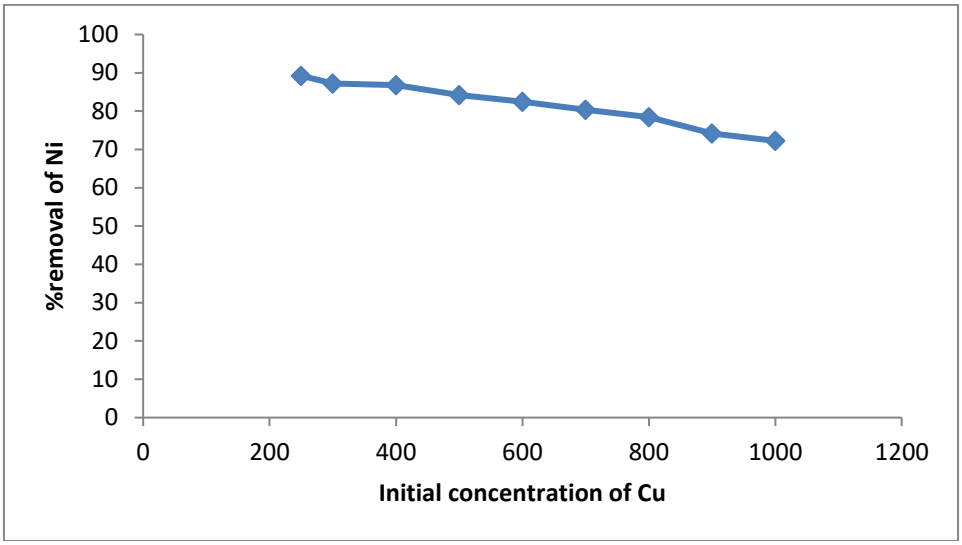

Fig. 2 : Effect of initial concentration of Ni on the % removal and amount adsorbed (mg/g) on SCBAC
T= 25^{0}C, SCBAC=700 mg, pH=2, Time = 180 min.

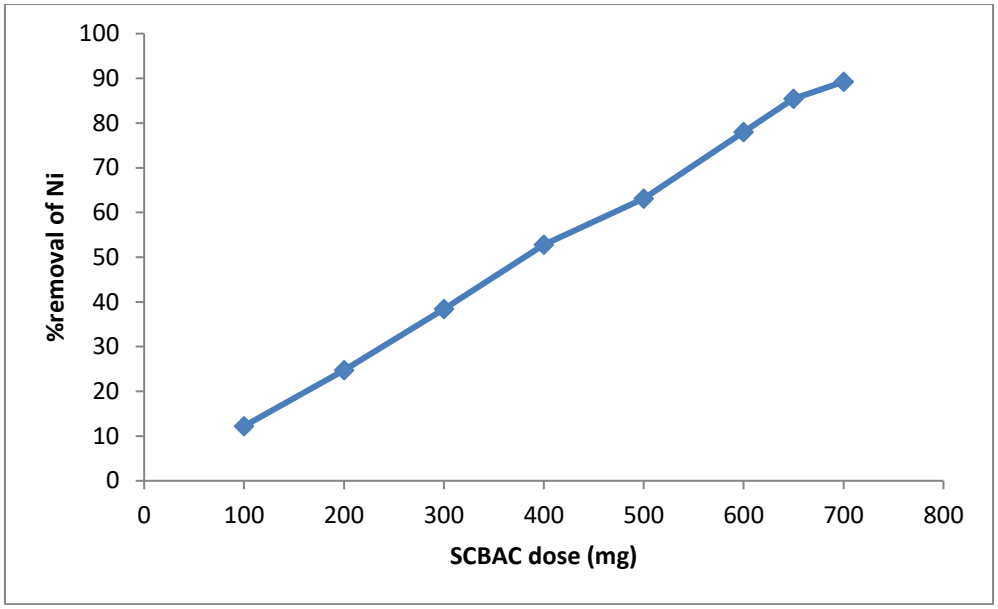

Fig. 3 : Effect of adsorbent dose on the % removal and amount adsorbed (mg/g)
T= 25^{0}C, pH=2, Time = 180 min. , Ni = 250 mg/L

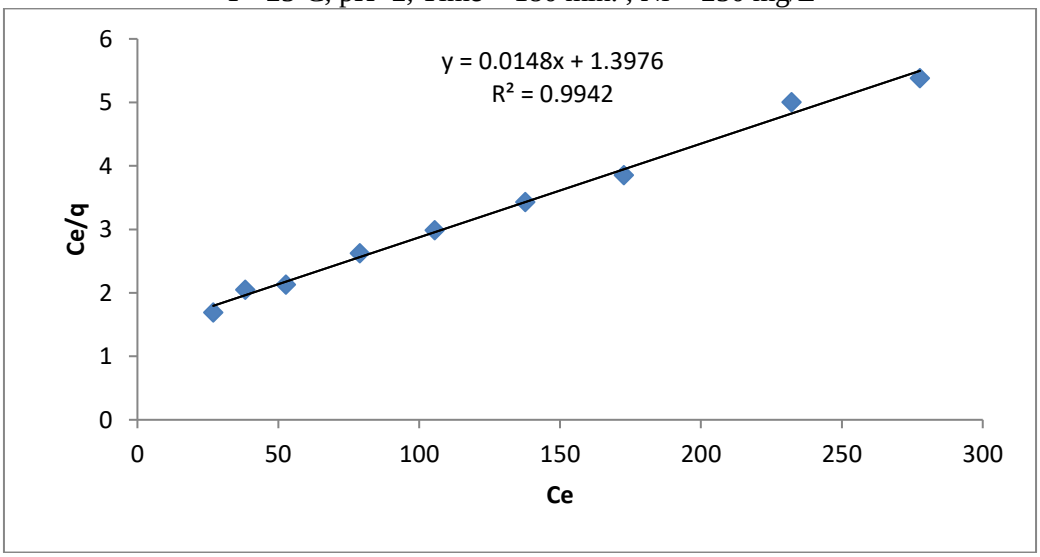

Fig. 4 : Langmuir adsorption isotherm of Ni on SCBAC

T= 25^{0}C, pH=2, Time = 180 min., SCBAC =700 mg

Slope of the curve = 1/qm= 0.0148, Intercept of the Nirve = 1/KL qm = 1.3976

KL=0.0106 and R^2= 0.9942

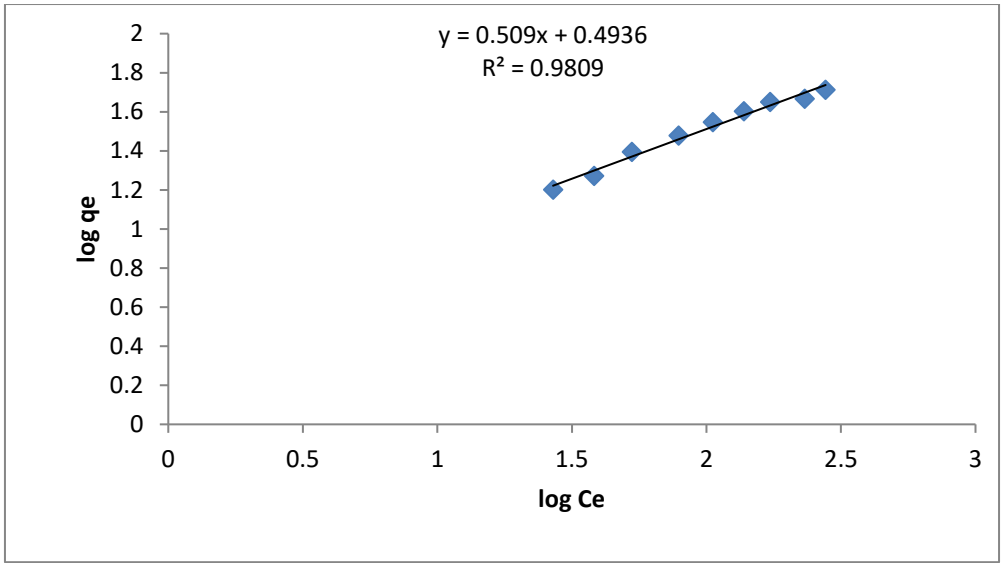

Fig. 5 : Freundlich adsorption isotherm of Ni on SCBAC
T= 25^{0}C, pH=2, Time = 180 min., SCBAC =700 mg
Slope = 1/n = 0.509 intercept = log K_f = 0.4936 R^2 = 0.9809

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