FABRICATION OF CONTINUOUS ADSORBER FOR DIRECT TREATMENT OF ELECTROPLATING WASTE WATER USING DRIED FLOWER WASTE

Shruti Tanga[1], Sampriti Chaudhuri[2], Priyangi Vashistha[3], Archna[4], Rajeswari M Kulkarni[5]

[1]*Dept of Chemical Engineering, M S Ramaiah Institute of Technology, MSRIT post, Mathikere, Bangalore-54*
[2]*Dept of Chemical Engineering, M S Ramaiah Institute of Technology, MSRIT post, Mathikere, Bangalore-54*
[3]*Dept of Chemical Engineering, M S Ramaiah Institute of Technology, MSRIT post, Mathikere, Bangalore-54*
[4]*Dept of Chemical Engineering, M S Ramaiah Institute of Technology, MSRIT post, Mathikere, Bangalore-54*
[5]*Dept of Chemical Engineering, M S Ramaiah Institute of Technology, MSRIT post, Mathikere, Bangalore-54*

Abstract

Water is an indispensable part of our lives. The waste water released from industries has the potential to be hazardous to human health. The safe and effective disposal of industrial waste water is thus a challenging task for industrialists and environmentalists. The industrial waste water released as effluent contains heavy metal ions such as cadmium, lead, nickel, chromium etc., which are toxic in nature. In this project, removal of Nickel – an important toxic metal coming from electroplating waste water, using flower waste (whose management is also important) as bio-sorbent was studied and carried out batch wise, continuously , finally fabricating a continuous adsorber that can handle electroplating waste directly. In order to remove color and other impurities Granulated Activated Carbon (GAC) is also incorporated in the adsorber. In batch study, the effectiveness of adsorbents (i) Dried flower waste (ii) Granular activated carbon prepared from flower waste sequentially used in treating metal ion solution was determined. The efficiency of nickel removal was studied in both batch and continuous adsorber and compared.

Keywords: *Biosorption, flower waste, Granular activated carbon, metal ion.*

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1. INTRODUCTION

Heavy metals are natural components of the Earth's crust. They cannot be degraded or destroyed. To a small extent they enter our bodies via food, drinking water and air. As trace elements, some heavy metals (e.g. copper, selenium, zinc) are essential to maintaining the metabolism of the human body. However, at higher concentrations they can lead to poisoning by binding to and interfere with the functioning of vital cellular components. Heavy metal poisoning could result, for instance, from drinking-water contamination (e.g. lead pipes), high ambient air concentrations near emission sources, or intake via the food chain. Heavy metals in surface water bodies, ground water, and soils can be either from natural or anthropogenic sources. Currently, anthropogenic inputs of metals exceed natural inputs due to increased urbanization and industrialization. Industrial wastes, atmospheric deposition from crowded cities and other domestic wastes are among the major sources of heavy metals in the urban sewage [Elen Aquino Perpetuol et al].

Heavy metals, once emitted, can reside in the environment for hundreds of years. These metals are dangerous because they tend to bio-accumulate. Bioaccumulation means an increase in the concentration of a chemical in a biological organism overtime, compared to the chemicals concentration in the environment. Compounds accumulate in living things once they are taken up and stored faster than they are broken down (metabolized) or

Excreted. Therefore, a tendency towards their accumulation in the soils, seawater, freshwater and sediments is observed. The toxicity of heavy metals has been documented throughout history[Wilkins et al] With the advancement of technology, toxicology has become a science. Now, much more is known about the health effects of heavy metals. Exposure to heavy metals has been linked with development of various cancers, retardation, kidney damage and in worse conditions, even death [G. Rich et al]. Various sources of heavy metals have been indentified in our environment. Some of them are [Haq Nawaz et al], Natural sources such as Geochemical (volcanic eruptions), Soils and rock erosion and Forest wildfires, anthropogenic sources such as Mining (coal, metal ores, minerals), Energy (fossil fuel combustion), Metallurgy (cast iron, steel, aluminum, chromium, nickel productions), Agriculture (fertilizers and pesticides), Metal (various metal production) and Chemical industry. In this study, our source was an electroplating industry's waste water.

Metal removal processes are the most common way of obtaining the required metals from a solution. There are several ways in which metals can be obtained.

These methods include chemical precipitation, chemical coagulation, ion exchange, membrane separation, adsorption process etc. For our study, Adsorption process was selected because of various advantages over conventional treatment methods such as low cost, high efficiency, minimum of chemical and or biological sludge, no additional nutrient requirement, regeneration of adsorbent and possibility of metal recovery. The mechanism of adsorption is not so complex, no reagent is used in this process. It is frequently found to be more economical to pass the fluid mixture to be treated through a stationary bed of adsorbent. In this process product recovery is possible by desorption and have minimum generation of chemical and biological sludge as in sedimentation and coagulation process. It has very high efficiency of 60% to 90% and effective purification between the ranges of 1 ppm to 1000 ppm.

Due to industrialization and advancement of life style, the amount of products being produced has increased exponentially. As a result, the amount of wastes generated has also increased more than the amount that can be treated. This calls for more efficient ways of treatment of these wastes with causing much damage to the environment. Due to research carried out in recent times, some of these wastes that are naturally occurring, have the potential of removing pollutants from water such as heavy metals. These industrial and agricultural by-products usually are composed of lignin and cellulose as major constituents. It may include other polar functional groups of lignin, such as alcohols, aldehydes, ketones, carboxylic, phenolic, and ether groups. These groups have ability to some extent to bind heavy metal ions by donation of an electron pair from these groups to form complexes with the metal ions in solution. Flower waste is an example for agricultural waste which is abundantly found around us.

Keeping in mind these facts, dried rose waste was chosen as the adsorbent in this project. Various studies have been done by researchers which have proved the potential of rose powder in removing heavy metals from waste water such as water discharged from electroplating industry. Waste biomass of red rose was exploited for removal of Pb(II) and Co(II)from synthetic effluents. A maximum bio-sorption capacity of 99.72 and 51.68 mg/g was observed for Pb (II) and Co(II).The results clearly indicated that red rose waste biomass has a potential to remove heavy metals from aqueous solutions[Arslan et al]. Similar studies showed the potential of rose in adsorbing Cr (VI) and Cr (III) from waste water. A maximum uptake capacity of 55.55 and 57.68 mg/g was observed with sodium alginate modified biomass for Cr(III) and Cr(VI)respectively[Aoyama M et al]. Easy availability, economical to use and proven potential for other metals, have been the reason for selection of this adsorbent powder of red rose to adsorb heavy metals. It is estimated that there are around 100 and 150species of rose but there is a lot of debate that many of them are similar. Roses come from the Rosaceae family which is the third-largest plant family and bear the Latin name Rosa. The chief value of a rose comes in its being a symbol of beauty. It appears in art, is exchanged as a symbol of love, its fragrance is captured in perfumes, and it adorns gardens and public spaces and most of this flower is thrown out as a waste [Arslan et al]. Hence in this study, we have exploited the adsorption nature of rose in removal of nickel from electroplating waste water.

2. MATERIALS AND METHODS

Preparation of Adsorbents:In this project, we have used three adsorbents namely: dried rose waste, granular activated carbon and activated sand, which are used at various stages of treatment.

Preparation of Dried Flower Waste: Red rose was collected from the college premises. The biomass was washed extensively. It was dried in the sun for approximately 6 hours to remove the moisture content. It was further dried by placing in oven at 50-60^{0}C for approximately 6 hours. Dried biomass was ground to fine powder using food processor. The dried, powdered biomass is sieved through 72 mesh.

Preparation of Granular Activated Carbon: Rose was washed, dried and grounded as above. The powder was treated with concentrated sulphuric acid (1:1), in order to make a thick paste, as shown in Figure 3.1. The thick paste was kept in the oven for approximately 24hrs. The biomass had turned black by now as shown in Figure 3.2, and then was washed with bicarbonate in order to settle free ions. The biomass is again dried and kept in an air tight container.

Preparation of Activated Sand: Two kg of sand was taken from construction site in Mathikere. Sand was washed thoroughly to remove the impurities and unwanted materials. Then sand was treated by 1N Nitric acid in order to activate the sand. The acid was washed out. The sand was washed again to remove acid from the sand. The dried sand was sieved using mesh (size 8).

Electroplating Waste Water: Thirty litres of direct electroplating waste water has been collected from an electroplating industry in Peenya, Bangalore.

Small Scale Batch Study: Preparation of Stock Solution: Stock solution of Nickel of 50 ppm was prepared by dissolving 0.223 g of Nickel sulphate in 1 litre of distilled water.

Preparation of Standard Solution: Standard solutions of Nickel (6.25, 12.5, 25, 50ppm) were prepared in 100ml volumetric flasks from diluting the main stock solution in appropriate amounts. These standards were used for generation of calibration curve

Analysis of Electroplating Waste Water: The Atomic absorption spectroscopy (AAS) was standardized using the prepared standard solutions. The concentration of Nickel metal in the waste water was analyzed. The wavelength of nickel adsorption is 351.5 nm

Instruments Used were pH meter, Centrifuge, Continuous column, Atomic absorption spectrometer, Wrist action shaking machine, Hot air oven.

Batch Study using Dried Rose Waste Powder: Batch adsorption studies for Nickel were carried out to study the effect of adsorbent dosage. The electroplating waste water solution (50ml) containing an adsorbent was taken in 4 different 250ml conical flask. The amount of biomass was varied as 0.5, 1, 1.5, 2 g. The adsorbate and bio-sorption solution were agitated in mechanical shakers at a predetermined time interval. The solution was filtered and the adsorbent was separated from the solution. Then the solution was subjected to centrifugation and the supernatant was analyzed for nickel using AAS.

Batch Study using Activated Carbon: Batch adsorption studies for Nickel were carried out to study the effect of different adsorption dosages. 50 ml of waste water was taken in 4 different 250ml conical flasks. The amount of activated carbon was varied as 0.5, 1,1.5, 2 g The adsorbate and bio-sorption solution were kept on mechanical shaker. Solution was withdrawn after 1.5 hours. The metal concentration was measured using AAS.

Batch Studies in Series: Larger Scale: The results obtained from above batch studies were very satisfactory. Hence batch studies in series were carried out in a larger scale using both synthetic and direct electroplating waste water containing 300ppm of Ni as shown in Figure 3.6.

Three 2 lt containers were used to perform batch studies. The water was treated in 1 st container using 20g of dried rose waste for 1hour. Stirrer was used to maintain the contact between adsorbent and waste water. Then the rose treated water was filtered using cotton cloth and then the same water was treated with 10g of granular activated carbon for 1 hour. The same water was filtered and passed through 25g of activated sand. Procedure was repeated for 2hour and 3hour. Readings were taken after every time period from each outlet. The concentration of nickel was measured using atomic absorption spectroscopy.

Fabrication of Mixer and Settler for Continuous Studies: The column studies were conducted at a laboratory scale using various components: Overhead tank- A plastic container of capacity 10 liters was used as overhead tank and kept at the height of 6.5 feet above the ground, 1st Mixer- A beaker of capacity 2 liters was used as 1st mixer. It is equipped with a small stirrer connected to a EW 9 volts battery. This mixer is for using 1st adsorbent rose for adsorbing heavy metals. 1st mixer is kept at 4.5 feet above the ground level, 2nd Mixer- A beaker of capacity 2 liters is used as 2nd mixer it is equipped with small stirrer connected to EW 9 volts battery. This mixer is for using 2nd adsorbent Granular activated carbon for adsorbing rest of heavy metals and rose color from the waste water. This is kept at 2.5 feet above the ground level. Dispenser- Water dispenser used for domestic purpose is used for the final adsorption using activated sand and activated alumina. The overhead tank was connected to the 1st fixer using surgical I V set to maintain the different flow-rates. The mixers were connected by rubber pipe and flow-rates were maintained using clamp pin.

The operating condition for the waste water was maintained throughout at room temperature and atmospheric pressure and at pH 6. To study the adsorption rate with time, the flow rate was maintained at 20ml per min throughout the experiment by gravity flow. Flow rate was cross checked at the exit of the setup at regular intervals to prevent and minimize the flow rate fluctuations, if occurred inside the setup. After a time interval of 3hrs, 2.5 ml of water was collected from each outlet. This was filtered and centrifuged. The concentration was measured using atomic adsorption spectroscopy.

Fabrication of Continuous column: Continuous studies were further carried out using a glass column of diameter 3.5 cm and length 56 cm. The setup consisted of overhead tank which was connected to the column. The column was packed with varying quantity of treated adsorbent (rose powder) to obtain a particular bed depth. To increase porosity of the fixed bed, alumina beads were used along with the rose powder. A silk cloth was fitted to an asbestos ring, which acts as a filter, allowing water to pass through, retaining the adsorbent in the column. The operating condition for metal solution was pH 6 at room temperature and atmospheric pressure. To study the effect of bed height, the influent Ni ion solution was fed at a particular flow rate and maintained throughout the experiment by gravity flow at a flow rate of 10 ml/min..To study the effect of bed height, the flow rate was kept fixed and bed height were varied. The metal ion concentration was kept constant at 300 ppm throughout the experiment. The sample solution after passing through adsorbent in fixed bed column was collected in a tank. Samples for analysis of metal ion concentration were collected at a regular interval of 3 hrs, filtered and centrifuged. The flow through the column was continued until the effluent Ni concentration (Ct) approached C0.In order to study the behavior of Ni removal in column mode, column experiments were conducted with varying bed depth.

Effect of Bed Height: The initial metal ion concentration was kept constant at 300 ppm with a 10 ml/min flow rate and pH of 6 at room temperature. Two bed depths of 5 and 10 cm were selected for the fixed-bed adsorption of Ni on rose waste. The adsorbents were weighed before being packed in the column. The weight to height ratio was maintained constant for both the heights. Treated solution samples were collected from the exit of column at predetermined time intervals. The samples were analyzed using Atomic Absorption Spectroscopy (AAS).

3. RESULTS AND DISCUSSION

3.1 Analysis of Electroplating Waste Water

The electroplating waste water (50ml) was subjected to analysis after dilution. It was found that the concentration of Nickel ion was 300ppm.

Batch Study using Dried Rose Waste Powder: Effect of Adsorbent Dosage: Here, the concentration of bio-sorbent is varied to study its effect on the percentage adsorption. The adsorption dosage was varied between 0.5 to 2g with the interval of 0.5 for 50 ml electroplating waste water. Figure 1 depicts the variation of % adsorption of Ni with change in adsorbent dosage. It is observed that the rate of adsorption increases with increase in dosage and for 1.5g of dosage, the adsorption percentage is the highest.

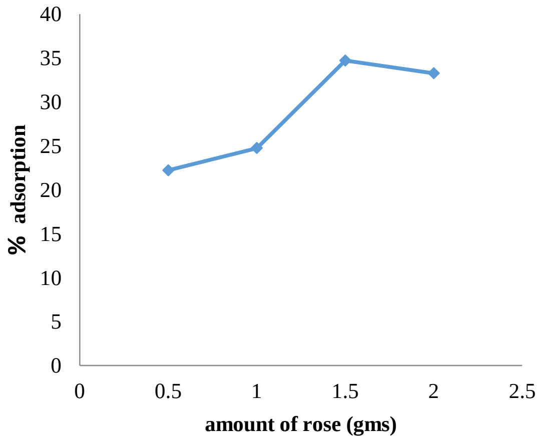


Fig 1: Effect of adsorbent dosage of dried rose powder on Ni concentration at room temperature and atmospheric pressure

Batch Study using Activated Carbon: Effect of Adsorbent Dosage: To study the effect of activated carbon dosage on Ni removal, the adsorption dosage was varied between 0.5 to 2g with the interval of 0.5 for 50ml electroplating waste water. Figure 2 depicts the variation of %adsorption of Ni with change in adsorbent dosage. It is observed that adsorption percentage increases gradually and then decreases. The highest adsorption percentage is observed at 1.5g of activated carbon dosage.

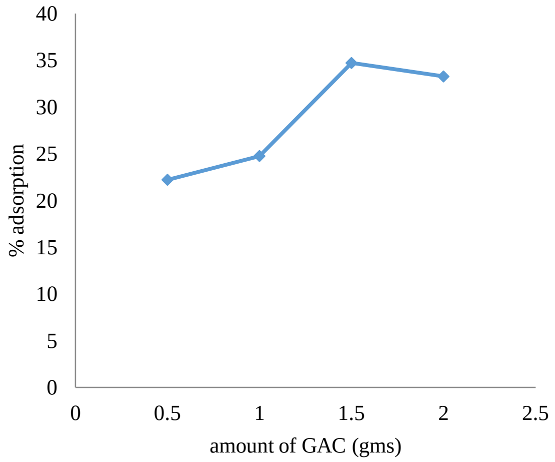


Fig 2: Effect of activated carbon dosage on nickel concentration at room temperature

Batch Studies in Series- Larger Scale:
Using 20g of rose powder, 10g of activated carbon made out of rose biomass, and 25 g of activated sand (1st, 2nd, 3rd stages respectively), observations were obtained as shown in Table 1, after analyzing using AAS for Ni. The experiment was carried out at room temperature and atmospheric pressure at a pH of 6, for 2 liters of synthetic Ni solution.

Table 1: Variation of Ni concentration with time, for larger scale batch study

Time(h)	Initial Ni concentration(ppm)	Ni left after 1st stage (ppm)	Ni left after 2nd stage (ppm)	Ni left after 3rd stage (ppm)	%Adsorption (1st stage)	%Adsorption(2nd stage)	%Adsorption(3rd stage)
1	300	62.11	43.6	22.77	79.3	85.47	92.41
2	300	38.325	22	2.61	87.23	92.67	99.13
3	300	26.94	12.3	0.015	91.02	95.9	99.995

Figure 3 depicts the variation of %adsorption of Ni with change in contact time, for rose, rose+activated carbon, rose+activatedcarbon+sand(at 1st,2nd, 3rd stage cummulatively). It is observed that adsorption percentage increases gradually with more contact time.

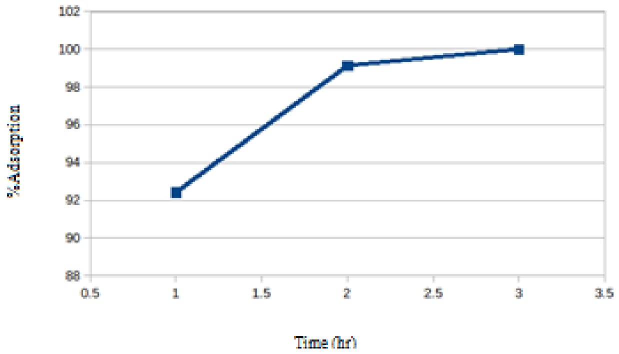


Fig 3: Effect of rose followed by activated carbon and sand (1^{st}, 2^{nd} and 3^{rd} stages cumulative) at room temperature

Since the above scaled up batch process proved to be have an efficiency of adsorption to be quite high, the same was conducted using direct electroplating waste water. The following data presented in table 4.5 was generated after analysis using AAS, for 2 liters of water and 20g of flower waste, followed by 10 g of activated carbon and finally 25 g of sand. (Table 2)

Table 2: Variation of Ni concentration with time, for larger scale batch study, for direct electroplating waste water

S. No.	Time(h)	Initial Ni concentration (ppm)	Ni left after 1^{st} stage (ppm)	Ni left after 2^{nd} stage (ppm)	Ni left after 3^{rd} stage (ppm)	% Adsorption by 1^{st} stage	% Adsorption by 2^{nd} stage	% Adsorption by 3^{rd} stage
1	1	300	132.16	112.68	102.36	55.95	62.44	65.88
2	2	300	104.92	89.44	75.67	65.03	70.19	74.78
3	3	300	91.63	77.23	65.50	69.46	74.26	78.167

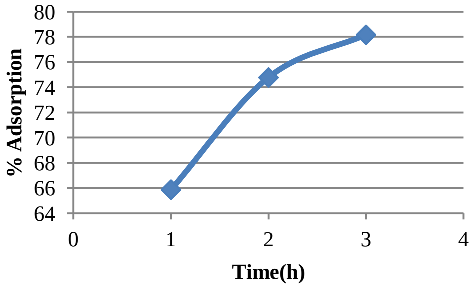


Fig 4: Effect of contact time of adsorption by rose, activated carbon and sand on direct electroplating waste (1^{st}, 2^{nd},3^{rd} stages cumulatively)

From the above observations and graphs it can be observed that with increase in contact time % adsorption increases, and the maximum adsorption is seen at 3 hours of contact time with each of the adsorbents. The maximum % adsorption is 78.167% with 2 liters of direct electroplating water.

Mixer-Settler for Continuous Studies: Effect of Adsorbent Dosage:

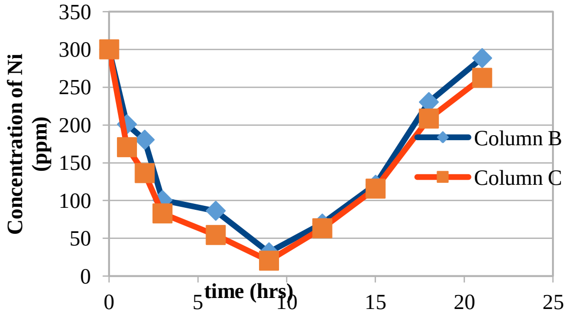
The parameter studied for mixer-settler continuous studies was adsorbent dosage of rose powder, keeping dosage of activated carbon constant. The operating pH was 6.0, at room temperature and atmospheric pressure.

The effect of adsorbent rose waste on Ni solution was studied using constant flow rate of 20 ml/min and at initial Ni concentration of 300 ppm kept constant at pH 6. The adsorbent dosage was changed between 5-20 gm of rose powder (5g, 10g, and 20g) Using 10g of rose in 1st mixer, 10g of activated carbon in 2nd mixer, continuous studies was conducted, taking readings after every 3 hours (Table 3)

Table 3: Variation of final Nickel concentration with time, continuously in mixer-settler for 10g of adsorbent rose

S. No.	Time	Ni left after rose (ppm)	Ni left after activated carbon(ppm)
1	1	200.84	170.55
2	2	180.4	136.26
3	3	100.56	82.89
4	6	86.36	54.32
5	9	31.425	20.36
6	12	69.48	63.25
7	15	120.82	115.68
8	18	230.24	208.45
9	21	288.46	262.32
10	22	299.52	291.47

Figure 5 depicts the amount of Ni left behind after adsorption by 10g rose, followed by activated carbon. Breakthrough is reached at 9 hours, and exhaustion time is 22 hours.



Note: Column B represents adsorption by rose, column C by rose and activated carbon

Fig 5: Variation of final Ni concentration with time using rose, followed by activated carbon, continuously in mixer settler using 10 g of rose

Simliarly, using 20g of rose in 1st mixer, 10g of activated carbon in 2nd mixer, continuous studies was conducted, taking readings after every 3 hours.

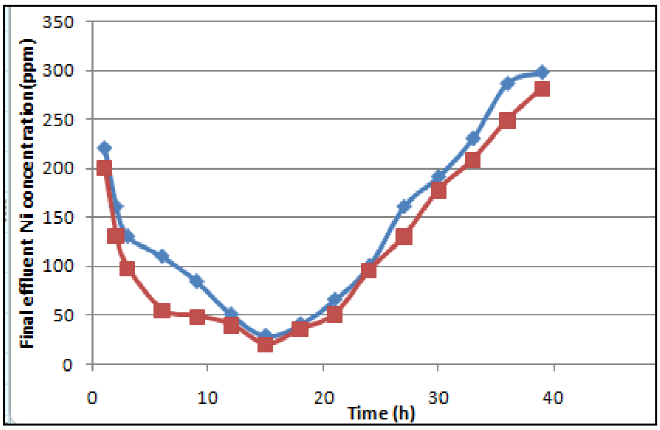


Fig 6: Variation of final Ni concentration with time using rose, followed by activated carbon, continuously in mixer settler using 20 g of rose

Figure 6 depicts the reduction in Ni concentration after adsorption using 20 g of rose, followed by activated carbon. The breakthrough is reached at 15 hours. Also exhaustion time is reached at 39 hours Maximum adsorption is reached at 15 hours, having % adsorption of 93.14%.Using 5g of rose in 1st mixer, 10g of activated carbon in 2nd mixer, continuous studies was conducted, taking readings after every 3 hours.

After analyzing the above data, for increase in adsorbent dosage, it can be inferred that an increase in adsorbent dosage increases % adsorption. Breakthrough is achieved later, and exhaustion time also increases. After deducing the above inference, a run was carried out using direct electroplating waste water of initial Ni concentration of 300 ppm. Adsorbent dosage used was 20g of rose, 10 g of activated carbon, at room temperature and pressure. The following observations were recorded:

Table 4: Variation of effluent Ni concentration after treatment of direct electroplating waste water with time, using 20 g of rose and 10 g of activated carbon

S. No.	Time (h)	Ni concentration after rose (ppm)	Ni concentration after activated carbon(ppm)
1	1	240.13	210.33
2	3	200.82	190.64
3	6	170.45	162.38
4	9	132.28	127.48
5	12	109.74	102.57
6	15	102.31	82.35
7	18	122.54	109.73
8	21	163.92	146.88
9	24	192.51	175.41
10	27	217.63	195.83
11	30	236.35	210.82
12	33	268.54	234.58
13	36	282.91	279.64
14	39	297.65	285.32

Figure 7 depicts the reduction in Ni concentration after adsorption using 20 g of rose, followed by activated carbon. The breakthrough is reached at 15 hours. Also, exhaustion time is reached at 39 hours. Maximum adsorption is reached at 15 hours, having % adsorption of 72.55%. This is in concordance with the observations made for synthetic solution of Ni, which also had breakthrough time at 15 hours and exhaustion time at 39 hours, only % maximum adsorption differed and is less than that of synthetic solution. This might be due to the presence and interference of other metal ions present in the direct waste.

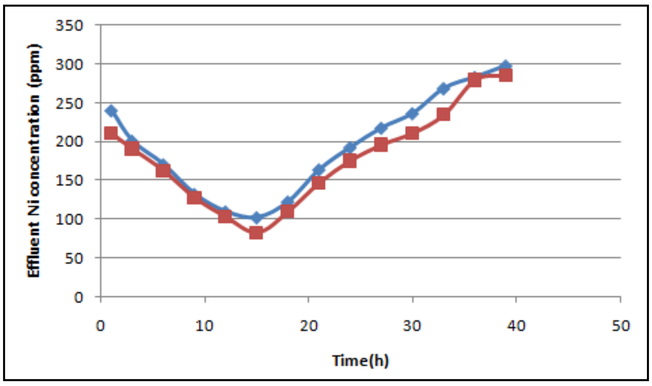


Fig 7: Variation of final Ni concentration of direct electroplating waste
water with time using rose, followed by activated carbon, continuously in mixer settler using 20g of rose

3.2 Continuous Column Studies: Effect of Initial Bed Height

The effect of bed height on adsorption of chromium using rose petals as adsorbent in the packed column is studied. The effect of bed height was studied at an initial metal ion concentration of 300ppm and a flow rate of 10ml/min. The bed height was varied from 20 -30cm.

The effect of bed height was studied for a height of 5 cm at an initial metal ion concentration of 300 ppm and flow rate of 10ml/min and the results are tabulated in the Table 5

Table 5: Variation of final Ni concentration with time for bed height of 5 cm

Time (h)	Initial Ni Concentration(ppm) Co	Final Ni Concentration(ppm)	Cf/Co

		Cf	
0	300	0	0
3	300	74.28	0.246
6	300	98.27	0.3275
9	300	130.42	0.4347
12	300	178.33	0.5944
15	300	203.81	0.6794
18	300	229.75	0.7658
21	300	240.53	0.8018
24	300	279.36	0.9312
27	300	289.46	0.9649
30	300	299.12	0.9971

The effect of bed height was studied for a height of 10 cm at an initial metal ion concentration of 300 ppm and flow rate of 10ml/min and the results are tabulated in the Table 6.

Table 6: Variation of final Ni concentration with time for bed height of 10 cm

Time(h)	Initial Ni concentration Co (ppm)	Final Ni concentration Cf (ppm)	Cf/Co
0	300	0	0.3381
3	300	101.44	0.3381
6	300	132.35	0.4412
9	300	160.77	0.5359
12	300	198.43	0.6614
15	300	246.58	0.8219
18	300	282.36	0.9412
21	300	289.62	0.9654
24	300	299.48	0.9983
27	300	299.57	0.9986

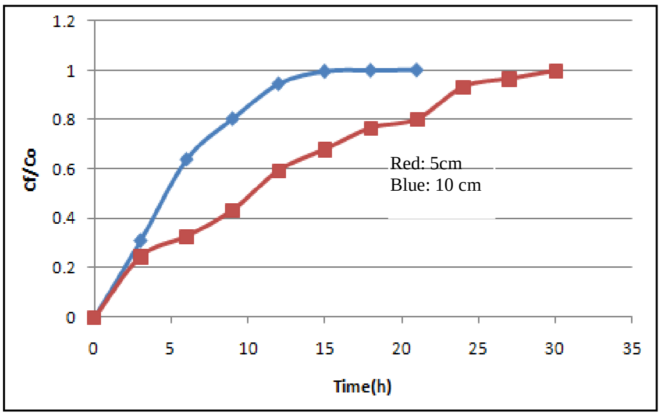


Fig 8: Breakthrough curves for Ni adsorption at different bed heights with constant flowrate of 10ml/min and initial concentration of 300ppm.

From Figure 8, the breakthrough point was observed at the time of 1 hour for 5 cm bed height and at 3 hours for 10 cm bed height. Figure 4.10 shows that the slope of breakthrough curve decreased with increasing bed height. It may be because of the reason that with the increase in bed height the adsorbate has more time to contact with the powder which in turn results into higher removal capacity and lower solute concentration in the effluent. Besides, at higher bed height the availability of the effective surface area of adsorbent is more which offers more active sites to adsorption and it also broadens the mass transfer zone length [Arslan et al].

% Adsorption for 5 cm bed height is 68.93% and for 10 cm bed height is 75.24%. Hence increasing bed height increases % adsorption and capacity because adsorption in a column which is a mass transfer operation is linearly related to the height of bed.

A run was carried out with direct electroplating waste water based on the bed height which seemed optimum that is 10 cm at room temperature and atmospheric pressure, at a pH of 6. The flowrate maintained was 10 ml/min and following observations were noted with time in table 7.

Table 7: Variation of final Ni concentration with time for bed height of 10 cm for direct electroplating waste water

Time (h)	Initial Ni Concentration(ppm) Co	Final Ni Concentration(ppm) Cf	Cf/Co
0	300	0	0
3	300	93.22	0.3107
6	300	191.61	0.6387
9	300	240.84	0.8028
12	300	283.28	0.9443
15	300	298.34	0.9945
18	300	299.45	0.9982
21	300	299.84	0.9995

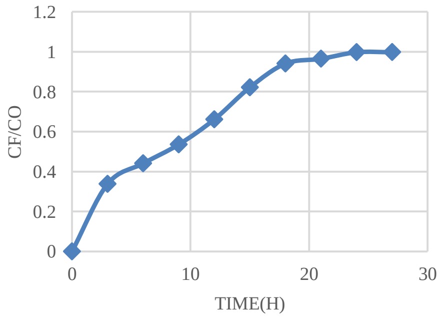


Figure 9: Breakthrough curve for Ni adsorption from direct electroplating waste water at 10 cm bed height with constant flowrate of 10ml/min

The above graph (Figure 9) shows that a maximum adsorption of 66.2% of Ni from electroplating waste water is achieved. The corresponding breakthrough time is 3 hours and exhaustion time is 27 hours. This is in accordance with the data obtained for synthetic Ni solution, with only % adsorption reducing, mainly due to interference by other metal ions.

4. CONCLUSION AND FURTHER SCOPE

For achieving the objectives of the present work the experiments were conducted and the following inferences were drawn:

Removal of Ni from aqueous solutions can be accomplished by several techniques which include ion exchange, reverse osmosis, adsorption,chemical precipitation, solvent extraction and Bio-sorption. Bio-sorption is one of the most studied techniques.

By conducting AAS, the electroplating waste water was found to have a concentration of Ni about 300 ppm and has a pH of 6.

According to batch studies, dried rose powder, and the activated carbon made out of the powder has a high affinity to remove Ni.

The main experimental parameters which are studied to evaluate the bio- sorption batch wise are adsorbent dosage and for larger scale batch study contact time. With the increase in adsorbent dosage for small scale batch study for rose and activated carbon, the % adsorption increases to a considerable extent and then decreases again. It is observed to be at 1.5g for 50ml electroplating waste water for both. The %adsorption for rose is 51.22% and for activated carbon is 34.7%
For larger scale batch study, by varying contact time it was observed that with increase in contact time % adsorption increases. For 3 hours of contact time in each stage of the series comprising of rose, activated carbon and sand, % adsorption is maximum having the value of 91.02% after rose, 95.9% after activated carbon and 99.995 after sand. Rose removes most of the Ni, activated carbon helps remove the color from rose treated water and the remaining Ni.

For mixer settler continuous studies, % adsorption increases with adsorbent dosage and is maximum at 20 g of rose powder and 10 g of activated carbon, with a value of 93.14%, with initial metal ion concentration of 300 ppm. For mixer settler studies with direct electroplating waste water, % adsorption is 72.55% for Ni, using 20 g of rose powder and 10 g of activated carbon. The exhaustion time and breakthrough time are the same as that for synthetic Ni solution.

For continuous column studies, breakthrough and exhaustion time is reached later when a greater bed height is used. The % adsorption reached at the bed height of 30 cm is 75.24%.

From the configurations used, it can be observed that batch wise larger scale series study is more efficient in removing Ni, followed by mixer settler andultimately followed by column.

Scope for further studies include using the above studies one can further carry out the studies on effects of Bio- sorption for different parameters like Effect of temperature, Effect of initialmetal ion concentration, effect of one metal on another, removal of more heavy metals such as Lead, Cadmium, Chromium using flower waste, desorption and regeneration study for metal recovery and effective usage of bed, production of activated carbon of better quality, via other chemical means,application for real effluents from different industrial sources, to improve efficiency of adsorption carrying out column studies in serially arranged columns, extraction of dyes from water used to treat flower wastes, carrying out column studies using dried flower waste pellets.

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