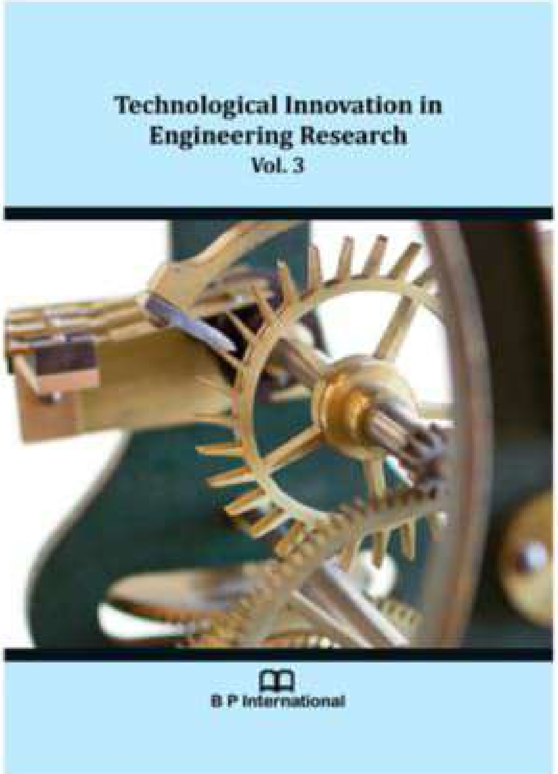

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Removal of NI (II) Ion using Low Cost Carbonaceous Sorption - A Descriptive Study

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ABSTRACT

In the past decades, water pollution is the important aspect due to heavy metal ion that present in the water bodies. Among the various types heavy metal, presence of nickel (II) is commonly found in industrial effluent. NI (II) creates many unwanted effects in our ecosystem. It menace not only the ecosystem also human beings. In the research of heavy metal removal by adsorption, activated carbon is commonly used as an adsorbent. Activated carbon is a costly component of the water treatment process. Heavy metals must, however, be removed from industrial water. The use of a low-cost adsorbent as an alternative to commercially available activated carbon compounds appeals to the researchers. The goal of this research is to help in the quest for less priced adsorbents. This research compares experiments on Nickel removal by adsorption on Corn Ash (CA) and Straw Ash (SA) (SA). These adsorbents are low-cost, non-conventional materials that can be employed in adsorption to treat water and waste water. The activation procedure was discovered to boost the high surface area and adsorption capacity of the material. This project aims to present data for the construction of a cost-effective waste water treatment plant for effluent released from a variety of industries. Contact time, adsorbent dosage, and solution PH are claimed to be experimental parameters that determine the degree of heavy metal adsorption. The impact of these variables on the amount of NI (II) ions removed by adsorption on CA and SA has been investigated. The metal removal investigations revealed that the varying operating conditions had a significant impact on their removal.

Keywords: Activated carbon; corn ash; straw ash; heavy metal; nickel (II) Ion.

1. INTRODUCTION

Heavy metal pollution in ground and surface water is found to be at very low levels. The development of current industrial technologies has resulted in a surge in pollution, particularly from silver refineries, storage industries, and zinc base casting wastes, which are contaminating ground and surface water [1-5]. Nickel, for example, is a significant contaminant. Nickel is only found in trace amounts in nature. The low-cost absorbent and high-efficiency materials were widely used in absorption experiments [6-12]. The skeletal structure of a solid material is made up of weak surface energy sites. As a result, a low-cost, readily available, and long-lasting sorbent with appropriate characteristics is created to remove the excess nickel content from those industries' waters. Activated Carbon (AC) is widely used in all studies due to its uptake capacity, pore size [13-17].AC is used for its feasibility, regeneration, low selectivity toward some specific CECs, tends to limit its effective use in water remediation [18-23]. AC obtained from various biomass sources namely coal, lignite, coconut shells, wood, bamboo, nuts sawdust, cherry stones, rice husk, peach stones, coffee waste, potato, almond shells, peanut shell [24-30]. Selective reviews of agricultural adsorbents in the removal of heavy metals from wastewater are presented in the literature.

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The main objective of my work is to prepare a low cost, easily available, and sustainable adsorbent for the nickel removal study. To analyze various parameters such as adsorbent contact time, dosage, P^H to get maximum capacity of nickel removal and find out the nickel content present in various adsorbate.

2. MATERIALS AND METHODS

The nickel solution for the adsorption studies was made from the stock solution. The 100ppm concentration chemical solution was diluted to the required 10ppm nickel solution. 50ml of the solution from 10ppm solution is taken in 250ml leak proof corning reagent bottles [with stoppers]. Exactly 0.1g amount of adsorbent was taken its weight and then transferred into one of these glass bottles. They were then kept in a mechanical shaker for required period of contact time [with the interval of 5 to 60 min]. The solution was poured through a filter paper. The filtration continued and the filtrates were collected in clean and dry bottles. Absorbance was studied using Visible- Spectrophotometer. The different dosage of the adsorbent like 0.05, 0.1, 0.15, 0.2, and 0.25g were exactly weighed and transferred into 5ml of 10ppm solution containing each one of these bottles. Then different P^H levels of 3, 5, 7, 9and 11 were conducted with 50ml of 10ppm solution. The desired P^H was adjusted with the help of 0.1M HCl and 0.1M NaOH. The bottles are kept in a mechanical shaker at constant time. The solution was filtered and then continued 8ml filtrate was added 1ml of DMG and 2% of ammonium hydroxide. The O.D was measured at 445nm.

3. RESULTS AND DISCUSSION

The extent of removal of Nickel in terms of the percentage removal of Nickel ions has been calculated by using the following relationship in the adsorption experiments.

Sorption capacity of adsorbent = $\dfrac{Ca\text{-}Cb}{L} \times \dfrac{M}{2}$

Where
Ca = initial concentration
Cb = final concentration
M = weight of the adsorbent
L = amount of solute

The adsorption of Nickel (II) ions by using low cost adsorbent by means of the experimental parameters are discussed below.

(i) Reaction of Contact time
(ii) Reaction of Dosage of adsorbent
(iii) Reaction of P^H of the solution

(i). Reaction of Contact time

The sorption capacity of the adsorbent was determined by adjusting the contact time. All the bottles containing 0.1g dose of adsorbent and 50ml of 10ppm nickel solution were placed in a mechanical shaker. The bottles were taken out at different interval gap namely 5, 10, 20, 30, 40, 50 and 60miniutes and the equilibrium concentration of nickel ions were determined by visible -Spectro photometry method. The results were tabulated analyzed and discussed.

(ii). Reaction of Dosage of adsorbent

The result of different dosage 0.05 to 0.25g of adsorbent was studied. All the bottles containing different dose of adsorbent and 50ml of 10ppm nickel solution were placed in a mechanical shaker. The bottles were withdrawn at constant time. In which the maximum time of the adsorbate removal was found out.

(iii).Reaction of p^H

The p^H of the solution was found by using digital P^H meter [ELICO MODEL NO: LI-120 silver and calomel electrode]. After shaking the solution up to constant contact time for various adsorbent, the equilibrium concentration of nickel ions was determined spectrophotometry method.

From the finding of the above parameters, the activated carbon prepared from the two low cost materials such as Corn Ash (CA) and Straw Ash (SA) are compared as follows. Comparison between Corn Ash (CA) and Straw Ash (SA).

3.1 Consequences of Contact Time on Ni (II) Adsorption

The study was carried out at different contact time (5-60 min) at constant initial concentration and dose of adsorbents. The Sorption Capacity (SC) of Nickel rises with a rise in contact time and reaches a maximum level. On comparing the SC of those various adsorbents at optimum conditions, Straw Ash (SA) showed a good removal of nickel at 30 min, rather than the Corn Ash (CA)

Table 1. Comparison of corn ash – straw ash (contact time)

Table 1. Comparison of CA and SA (contact time)

TIME	SC OF CA (mg/kg)	SC OF SA (mg/kg)
10	1350	4250
20	2700	4350
30	3650	4400
40	950	4300
50	3700	4100
60	3950	4150

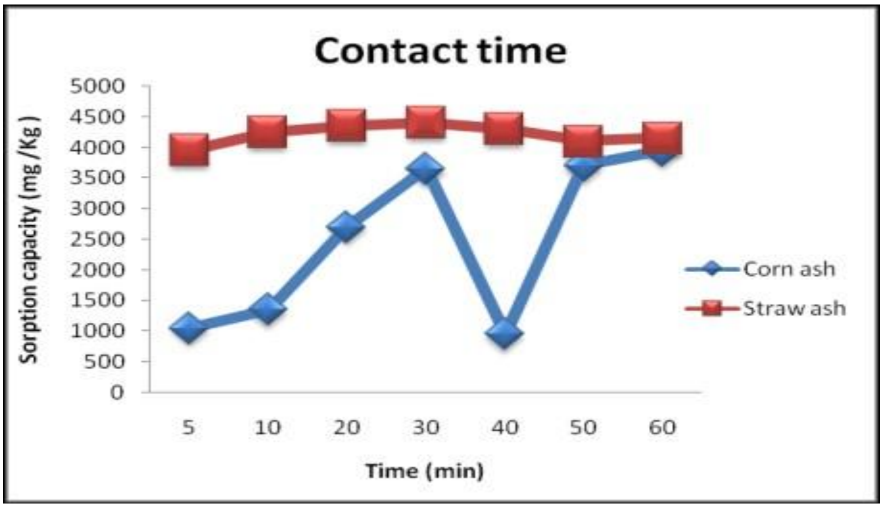

Fig. 1. Comparison of CA and SA (Contact Time)

Table 2. Comparison of Corn Ash – Straw Ash (Dosage)

DOSAGE	SC OF CA (In %)	SC OF SA (In %)
0.05	79%	79%
0.10	80%	95%
0.15	83%	97%
0.20	84%	89%
0.25	85%	88%

3.2 Consequences of Dose of Adsorbent on Ni (II) Adsorption

The extent of removal of Nickel by those adsorbents is found to increase with increase in dosage of adsorbents. By comparing the extent of removal of Ni (II), those two adsorbents showed an equal efficiency in the removal of Nickel. Straw Ash showed a maximum efficiency in removal of Nickel.

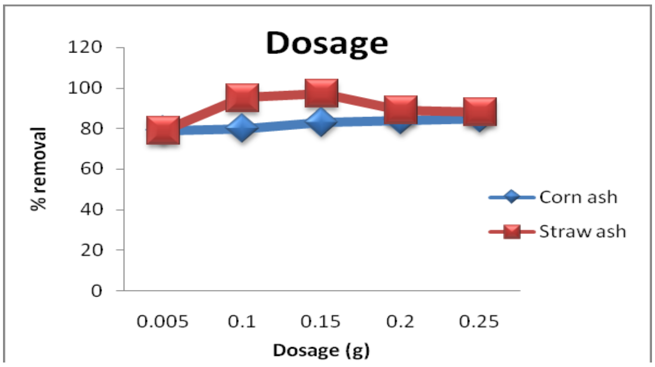

Fig. 2. Comparison of CA and SA (Dosage)

3.3 Effect of P^H on Ni (II) Adsorption

Variation of pH significantly affects Nickel adsorption. The removal of Nickel by various adsorbents and its adsorption potential where determined at various p^H levels between 3 and 11 with optimum conditions. The results indicated the adsorption is highly pH sensitive. Among the two sorbents, the removal of Nickel by CA and SA showed the maximum removal occurred at pH 5 as 4800 mg/kg.

Table 3. Comparison of Corn Ash – Straw Ash (pH)

pH	Sorption Capacity(CA) (mg/kg)	Sorption capacity(SA) (mg/kg)
3	4350	4550
5	4800	4800
7	4550	4400
9	4600	4450
11	4550	4300

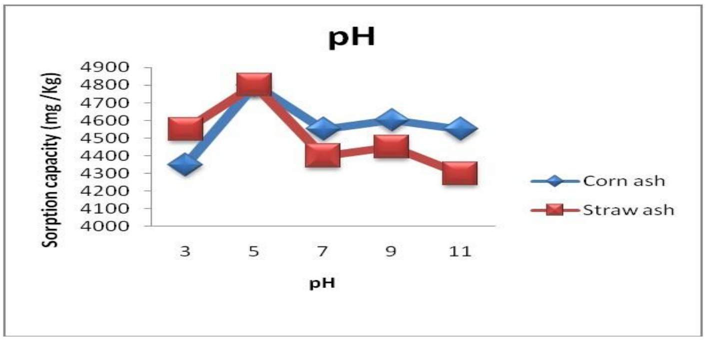

Fig. 3. Comparison of CA and SA (P^H)

FTIR: Analyzing the results obtained by using CA and SA, FT-IR was taken to prove that SA has greater absorption than CA. FT-IR spectroscopy of straw ash before and after adsorption of metal ions was recording in the frequency range 400-4000cm^{-1} on a FT-IR – shimadzu IR affinity 1. The samples were prepared as KBr disc. 3360cm^{-1} [C-OH &NH] stretching vibration 2978 & 2900 cm^{-1}[-CH stretching in –CH & - CH_2], 1641cm^{-1} [-NH Bending vibration in –NH_2],1395cm^{-1} [-NH depending vibration in –NH_2] &1056cm^{-1} [-CO stretching vibration in -COH]

The peaks at these wave notes were infect, indicating that the functional groups were not attributed during the process and are available for interaction with the metal ion. The intensities of transmittance of peaks were relatively more in the case of Ni adsorption compared with the raw sorbent. The fundamental groups were not disturbed during the process and are available for interaction with the metal ion. This is due to the interaction between the fundamental groups in Ni (II) ions during the adsorption process. Some shifting indicates in loading and unloading the adsorption of metal ion by the sorbent. The presence of FT-IR peak 670cm^{-1} in the Nickel loaded sorbent suggest the bonding between the Ni and sorbent.

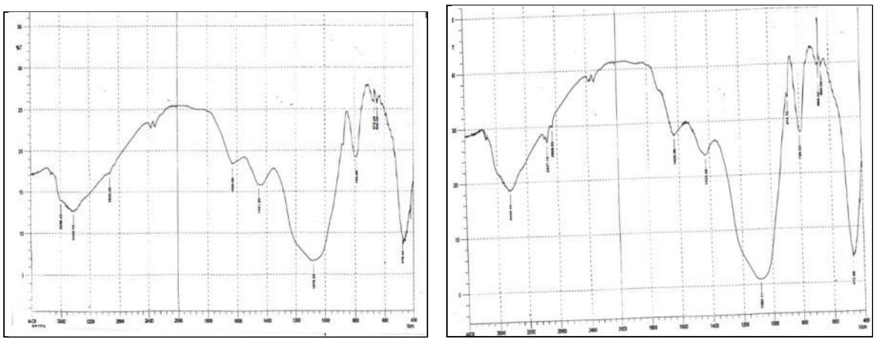

Fig. 4. SA before Ni (II) ion adsorption and SA after Ni (II) ion adsorption

4. CONCLUSION

From the above comparative learning of removal of Nickel by adsorption on Corn Ash (CA) and Straw Ash (SA), the activated carbon (AC) prepared from the Straw ash is very effective. The sorption capacity of Straw ash is 4400mg/kg at 30min. At P^{H} level, the maximum sorption capacity was found and a slight declaim in sorption capacity at both acidic and alkaline medium. The activated carbon prepared from the straw ash is low cost, environmental friendly and economic substance. While using straw ash as an adsorbent, there is a remarkable decrease in Nickel adsorption. The results obtained from the FTIR prove that the sorption capacity of the straw ash is very effective. The presence of FT-IR peak is 670cm^{-1}. FTIR study confers an idea about the chemical structure of adsorbent. The greater porosity of the adsorbent leads to the greater adsorption of heavy metals. The Nickel loaded sorbent suggest the bonding between the Ni and sorbent. This is very useful in the waste water treatment plants which contains Nickel ion.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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