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ADSORPTION EFFICIENCY OF COCONUT HUSK, SUGARCANE BAGASSE AND ORANGE PEEL IN THEREMOVAL OF SELECTED HEAVYMETALS IN WASTEWATER

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Abstract: Coconut husk, sugarcane bagasse, and orange peels are examples of agricultural waste products that can be used as biosorbent materials. In this work, coconut husk, sugarcane bagasse, and orange peels were employed as adsorbents to explore their potential to adsorb zinc, nickel, and chromium. Zinc, nickel, and chromium ions were adsorbed in a batch adsorption experiment employing various parameters, including contact duration (30, 60, 90) minutes, pH (5, 6, 7, 8) and adsorbent dosage (5, 10, 15) g. Adsorption of zinc, nickel, and chromium will be optimized using raw coconut husk, sugarcane bagasse, and orange peels at various contact times, pH levels, and adsorbent dosages. In general Orange peel showed greater adsorption efficiencies than Coconut husk and Sugarcane bagasse. Adsorption of Chromium on Orange peel, Coconut husk and Sugarcane bagasse was very fast and more efficient than Zinc and Nickel. The maximum adsorption efficiencies for Zinc, Nickel and Chromium on Coconut husk, Sugarcane bagasse and Orange peel are found to be 59.33% for Orange peel, 57.17% for Coconut husk and 69.02% for Orange Peel In conclusion, raw coconut husk, Sugarcane bagasse and orange peels can adsorb zinc, nickel and chromium ions from aqueous solutions.

Index Terms– heavy metals, adsorption, coconut husk, sugarcane bagasse, orange peel, zinc, nickel, chromium, adsorbate, adsorbent

I. INTRODUCTION

Wastewater is a combination of liquid or water-borne waste from residential, commercial, and industrial properties, as well as groundwater, surface water, and rainwater. Because of the diverse variety of inputs into sewers, it contains some undesired elements such as organic, inorganic, and poisonous compounds, as well as pathogenic or disease-causing microorganisms. Several contaminants from natural and manmade sources have been found to pollute both surface water and groundwater globally. Metals such as cadmium (Cd), chromium (Cr), copper (Cu), mercury (Hg), nickel (Ni), lead (Pb), and zinc (Zn) are commonly related with pollution and toxicity issues.

Excessive disposal of Radioactive Metals to water bodies in recent years is a major issue for the environment due to an increasing industrialization. In view of the insufficient treatment techniques for Industrial Wastes, many rivers and streams act as a dumping ground for dangerous materials and metals. Heavy metals have a tremendous negative effect on river water quality and marine life, because they are very soluble. These heavy metals include cadmium, chromium, copper, mercury, nickel, lead and zinc whichare highly toxic when taken into the body from the food web.

A major source of heavy metal pollution in our environment comes from wastewater generated by the electroplating industry. Heavy metals are the world's most important contaminants, and their economic importance is significant for industrial use. In the ecosystem, environmental contamination of heavy metals has become a major threat to living organisms.

Heavy metal bearing sectors are the most hazardous in chemical intensive industries, since much of polluted water is discharged with metals. Because of their solubility in marine waters, strong metals can be consumed by live organisms. Once they get into the food chain large concentrations of heavy metals may build up in a person's body. These metals may have serious health effects if they are ingested at a higher concentration than is allowed.

Heavy metals levels in household waste are, on average, lower than industries. Hazardous metals can be found in municipal wastewater due to large urbanization and the development of untreated industrial waste into municipal sewage systems; On the basis of similar toxicity for plants and animals, two classes of metals may be classified. First class that consists of the following: Chromium, cadmium, mercury and lead have very high toxicity for both humans and animals but are less toxic to plants. The second class, which contains zinc, nickel and copper when present in excess concentrations, can harm plants more than humans or animal species.

II. LITERATURE REVIEW

2.1Adsorption process

A component is moved from the liquid phase to the solid phase through the mass transfer process known as adsorption. It is the process by which substances in solution accumulate on the proper interface. The substance that is separated from the liquid phase at the interface is known as the adsorbate. The layer of solid, liquid, or gas that the adsorbent accumulates on is known as the adsorbent. The two types of contact forces between the adsorbent and the adsorbate are frequently referred to as adsorption. These forces of interaction are referred to as physisorption (physical adsorption) and chemisorption (chemical adsorption). Adsorption is a simple, affordable, and adaptable method for removing heavy metals from wastewater. Low capital costs, suitability at very low concentrations, low sludge output, ease of operation, and sorbent regeneration through a successful desorption process due to potential process reversal are some of its benefits. sorbents can be easily added to waste management systems and are suitable for both batch and continuous processes. An adsorbent is considered "good" if it has a porous structure that results in a significant surface area and quick adsorption kinetics.

There are numerous instances that show how a solid's surface has a propensity to draw in and hold onto the molecules of the phase it comes into contact with. These molecules don't penetrate further into the bulk; they only stay on the surface. Adsorption is the term used to describe the accumulation of molecular species at the surface as opposed to the interior of a solid or liquid. Adsorbent refers to the material on which adsorption occurs, and adsorbate refers to the molecular species or substance that concentrates or accumulates at the surface. Adsorption is primarily a phenomenon of surfaces. Because solids, especially those that are finely divided, have a large surface area, they make effective adsorbents like charcoal, silica gel, alumina gel, clay, colloids, finely divided metals, etc.

2.2Adsorption studies

Batch adsorption experiments were carried out by mixing adsorbents with 500 mL of wastewater in a conical flask. The effect of the pH of the solution on the Zn, Ni and Cr equilibrium adsorption was investigated between 5 and 8. The adsorption time ranged from 30 to 90 min and 5 g to 15g of adsorbent mass were used in adsorption studies. After the specified contact time was reached, the samples were extracted and analyzed using flame atomic absorption spectrophotometry for the concentration of the residual ions. The selected heavy metal ions removal was calculated by the following equation:

$$R = Co - Ce / Co \times 100 \qquad \ldots\ldots (1)$$

The amount of metal ions adsorbed onto CH, SB and OP, Qe (mg/g) was calculated by the following equation:

$$Qe = (Co - Ce) v / m \qquad \ldots\ldots (2)$$

Where R is the adsorption efficiency of metal ions adsorbed by adsorbent,
Co and Ce are the initial and final concentration of metal ions (mg L-1).
V is the volume of metal ions solution (L) and m is the mass of adsorbent used (g).

2.2.1 Effect of adsorbent mass

The effect of adsorbent mass in the removal of the selected heavy metals was investigated for different masses ranging from 5g, 10g and 15g. Solutions of the same initial concentration, the same contact time and temperature at the selected optimum pH were used. The samples were filtered using 150 mm filter paper and the filtrate was analyzed for the metals of interest.

2.2.2 Effect of contact time

The effect of contact time was investigated at optimum adsorbent mass, pH, concentration, and temperature for varying contact times between 30, 60 and 90 min. The samples were filtered using 150 mm filter paper and the filtrate was analyzed for the metals of interest.

2.2.3 Effect of pH

The study of the effect of pH on adsorption was performed in the pH range of 5 - 8. The pH was adjusted using 0.1 M NaOH and 0.1 M HCl solutions using a pH meter. The samples were filtered using 150 mm filter paper and the filtrate was analyzed for the metals of interest.

III. MATERIALSAND METHODS

3.1Wastewater collection

Sample of wastewater was collected from local electroplating industry located at Uppalwadi, Nagpur. The color of the wastewater was grey, green and yellow, while it had pH value of 7.65 ± 0.13. The wastewater was taken from three times which is before treatment. The wastewater was mixed well to make it homogenized and filled in plastic containers

Figure 1 waste water collection

3.2Collection of Adsorbents

Coconut husk, sugarcane bagasse and orange peel were purchased from the local market in Nagpur. The adsorbents from the different places were mixed well to homogenize adsorbent samples. Samples from different areas may have different adsorption abilities, therefore, mixing samples from different areas will help to homogenize this ability.

Figure 2 Collection of Adsorbent sample

3.3Preparation of Adsorbents

Coconut husk (CH), Sugarcane Bagasse (SB) and orange peel (OP) were used as the raw material for the preparation of the adsorbents. The GS, LH and OP which were prepared from the items purchased from local markets, were washed with distilled water several times to remove dust, adsorbed impurities and other contaminants. Then they were washed with distilled water and were dried in sunlight for two weeks. The GS, LH and OP were dried at 177 ℃, 70 ℃ and 93 ℃ respectively inside a convection oven for 25 - 30 min to remove any moisture left. The dried CH, SB and OP were crushed and sieved with 0.30 mm sieve to obtain smaller particles and were kept in plastics.

Figure 3 Collection of Adsorbent samples

3.4Construction of Adsorption tank

An adsorption tank of size 15x15x30 cm is prepared using glass having an inlet and outlet valve to pass and collect the effluent. A perforated plate is provided at a depth of 15cm from the top of the tank above which the sieve is placed. The effluent after passing through the adsorption bed is collected from the outlet valve which is provided at the bottom.

Figure3 Construction of Batch Adsorption tank

3.5Adsorption tank during treatment period

Figure 4 Adsorption tank during treatment period

The electroplating industry waste water effluent was passed through the bed of adsorbents like coconut husk powder, sugarcane bagasse powder and orange peels powder placed in adsorption tank as shown in the figure 4 with three different parameters which are effect of adsorbent mass ranging from 5g ,10g and 15g , effect of contact time 30 min, 60 min and 90 min and effect of pH ranging from 5,6,7, and 8.

3.6Characteristics of sample

The electroplating waste water effluent was treated with adsorbents, sample concentration test before and after adsorption treatment were carried out. Initial and final concentration test readings were recorded to calculate the adsorption efficiency of adsorbents. Concentration test of the sample was done by flame atomic absorption spectrophotometer.

IV. RESULTS AND DISCUSSIONS

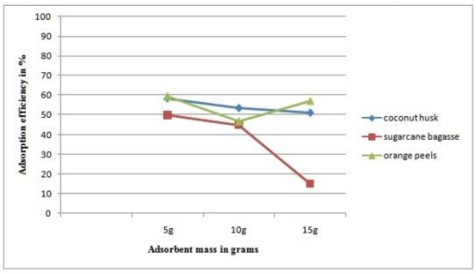
Adsorbent	Metals	Initial Conc. (ppm)	After Adsorption (ppm)	Optimum pH	Adsorbent mass (g)	Contact Time (min)	Adsorbed amount (mg g -1)	Adsorption efficiencies (%)
Sugarcane bagasse	Zn	3170	1590	7	5 gm	30 min	158	49.84%
	Ni	4960	2776	7	15 gm	90 min	72.8	44.03%
	Cr	4665	1675	7	10 gm	60 min	149.5	64.09%
Coconut husk	Zn	3170	1320	7	5 gm	30 min	185	58.35%
	Ni	4960	2124	7	15 gm	90 min	94.53	57.17%
	Cr	4665	1567	7	10 gm	60 min	154.9	66.40%
Orange peel	Zn	3170	1289	7	5 gm	30 min	188.1	59.33%
	Ni	4960	3316	7	15 gm	90 min	54.8	33.14%
	Cr	4665	1445	7	10 gm	60 min	161	69.02%

Table 1 Level of selected heavy metals in wastewater before and after adsorption with optimization

It is observed that the adsorption performance of Zn, Ni and Cr are significantly affected by adsorbent mass, contact time and pH.

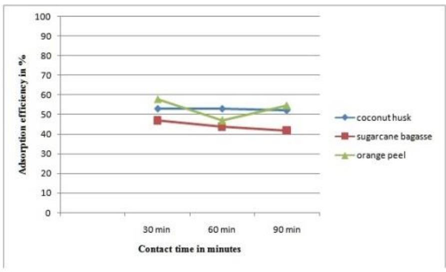
- **Effect of adsorbent mass**

Figure 4.1.1: Effect of adsorbent mass on the adsorption efficiency of CH, SB and OP for zinc Zn



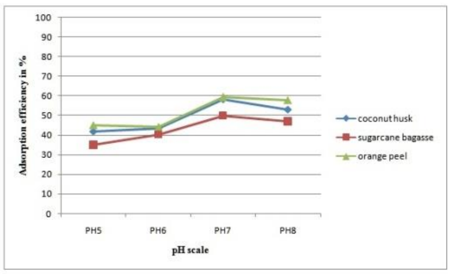
- **Effect of Contact time**

Figure 4.1.2 Effect of contact time on the adsorption efficiency of CH, SB and OP for Zinc Zn



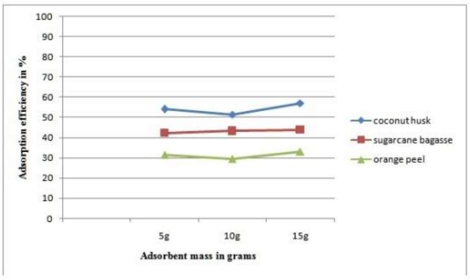
- **Effect of PH**

Figure 4.1.3: Adsorption efficiency of Zinc Zn on CH, SB and OP as a function of pH



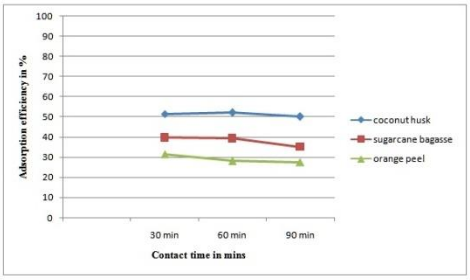
- **Effect of adsorbent mass**

Figure 4.2.1: Effect of adsorbent mass on the adsorption efficiency of CH, SB and OP for Nickel Ni



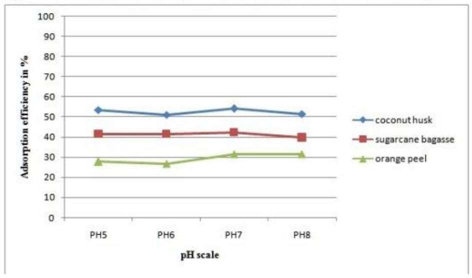
- **Effect of Contact time**

Figure 4.2.2: Effect of contact time on the adsorption efficiency of CH, SB and OP for Nickel Ni



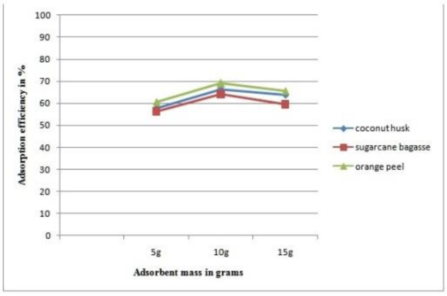
- **Effect of PH**

Figure 4.2.3: Adsorption efficiency of Nickel Ni on CH, SB and OP as a function of pH



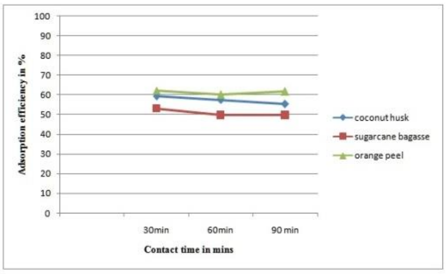
- **Effect of adsorbent mass**

Figure 4.3.1: Effect of adsorbent mass on the adsorption efficiency of CH, SB and OP for Chromium Cr



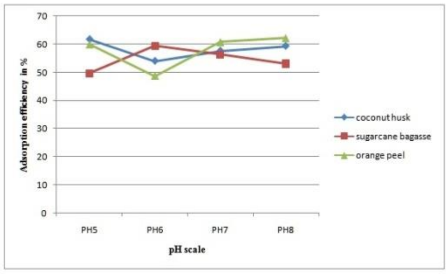
- **Effect of Contact time**

Figure 4.3.2: Effect of contact time on the adsorption efficiency of CH, SB and OP for Chromium Cr



- **Effect of PH**

Figure 4.3.3: Adsorption efficiency of Chromium Cr on CH, SB and OP as a function of pH



V. CONCLUSIONS

In this study, CH, SB and OP were used for the removal of Zn, Ni and Cr from wastewater. The adsorption performance of Zn, Ni and Cr are significantly affected by adsorbent mass, contact time and pH. In general Orange Peels showed greater adsorption efficiencies than Coconut husk and sugarcane bagasse.

The maximum adsorption efficiencies for Zn, Ni and Cr on CH, SB and OP are found to be 59.33% (OP), 57.17% (CH), and 69.02% (OP) respectively.

The level of adsorption efficiencies in this study are in the following order Cr(OP)>Cr(CH)>Cr(SB)>Zn(OP)>Zn(CH)>Ni(CH)>Zn(SB)>Ni(SB)>Ni(OP). Adsorption of Cr on OP, CH and SB was very fast and more efficient than Zn and Ni.

This study showed high adsorption efficiency of the heavy metals using easy and simple water treatment process by utilizing inexpensive adsorbents. However, since this is a preliminary work further systematic study is required. The method developed has shown the application of Coconut husk, Sugarcane bagasse and orange peel for the removal of Zn, Ni and Cr from water.

However further study is required with respect to the effect of initial metal ion concentration and specific site sampling and investigation**.**

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