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Treatability Study and Heavy Metal Removal from Electroplating Effluent Using Low Cost Adsorbent

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Abstract:

The effective removal of heavy metals from Electroplating Effluent is among the most important issues for many industrialized countries. Pulses Peels were used to produce adsorbent through environment friendly process Pulses Peels were crushed, washed and dried and used for Chromium and Iron removal. Chromium and Iron adsorption onto Pulses Peels was depended upon the controlling parameters such as mesh size and types of pulses peel. The objective of this study is to contribute in the search for less expensive adsorbents and their utilization. Batch studies showed that 32.11%, 47.062%, 13.97%, 28.23% of Cr ions and73.56%, 54.02%, 66.09%, 4.59% of Fe ions were removed from aqueous solution by pulses peels.

Keywords: Pulses peel, Adsorption, Heavy metals, Chromium, Iron

1. Introduction

The presence of heavy metals in the environment is major concern because of their toxicity and threat to plant and animal life**.** VaniSatya*et al*.(2012) investigated that waste aqueous effluent containing heavy metals causes serious environmental problems. Many industries are responsible for the release of heavy metals into the environment through their wastewaters. These include pigment manufacturing, iron and steel production, mining and mineral processing, the non-ferrous metal industry, battery manufacture, the printing and photographic industries and metal-working and finishing processes (electroplating). In addition, considerable quantities of heavy metals may be released into the environment through routes other than in aqueous form in wastewaters. The main way of contamination by these industries is the emission of liquid effluents with relatively low, but harmful metal concentrations (up to some hundreds of mg L^{-1}), among these metals Cr, Ni, Zn, Cu and Cd are usually the most abundant ones. Gupta *et al.*(2001) studied and found the release of heavy metals into our environment is still large. In certain areas of the world it is even increasing. The pollution of water resources due to the disposal of heavy metals has been an increasing worldwide concern for the last few decades.

In the current scenario, electroplating is widely used in industries for coating metal objects with a thin layer of different metals. The layer of metal deposited has some desired properties, which metal of the object lacks. From these industries heavy metals are released in the environment or in water. These heavy metals are very harmful to our environment and cannot be considered above the permissible limit. There are several methods used for the removal of heavy metals in the wastewater such as chemical precipitation, ion exchange, reverse osmosis, electro dialysis, ultra filtration and phytoremediation. But these methods are either expensive or inefficient for the removal when the metals are at high concentration. The search for new technologies involving the removal of toxic metals from wastewaters has attracted attention to adsorption (Saseendran and Swarnalatha (2009)**.** So as to remove the heavy metals there are many conventional methods but some of them are too costly and some of them are non-eco-friendly. For this reason we are concentrating on the removal of the heavy metals by the use of low cost adsorbents. Hossain*et al*. (2012) examined that Banana peel, a fruit waste were used to produce bio adsorbent through environment friendly process. Many of the adsorbents like bagasse, banana peel, orange peel etc. are used.

2. Method and Materials

2.1 Sample Collection

Waste water of Electroplating Industry is the major source of heavy metals like Zn, Cr,Fe,Pb,Cu,and As.We collected waste water from local electroplating industry of Indore. In Indore there are several electroplating industries. About 600 plants are present in India which produces Electroplating waste water. In Indore there are 20 electroplating industries. Namely, Quality Electroplaters Indore, Vidyut Electroplaters Indore, Sony Electroplaters Indore, Tomar Electroplaters Indore etc. From one of the local industries of Indore we had collected the waste water sample by making a hypothesis that sample contains large amount of heavy metals.

2.2 Adsorbent Selection

Mazumder Debabrata*et al*. (2011)investigated the wastewater treatment process in an electroplating unit that practiced chrome and bronze plating with a view to recycle and reuse the wastewater, adsorption process was adopted as single stage treatment instead of the existing chemical methods. We select adsorbent from the various researches.Yusufu*et al.* (2012) examined quality indices of activated carbons from cattle bone (CB), coconut-shell (CS) and wood carbon (WC) as influenced by mode of activation (heat and acid) by using the non-activated carbon samples as control. Waste water from Electroplating Industry are toxic, hazardous, non- ecofriendly. Our first step was to minimize the waste by removal of heavy metals from waste water .The cost of process also recommended that we chose the cheapest, very different and easily available waste and eco-friendly i.e., Pulses Peels. In India there is huge number of pulses mills are present and they produce about 6, 72,000 tons pulses peels as a waste.In Indore about 30 pulses mills present and each pulses mill produce about 20 ton pulses peels per month as a waste. So, we chose pulses peels as our adsorbent for removal of heavy metals from waste water of electroplating industry. We had collected pulses peels from Palda Mill Indore.

2.3 Preparation of Adsorbent

Pretreatment of adsorbent- The basic steps of preparation of adsorbent are crushing, washing and drying.

Crushing- Pulses Peels are crushed initially by using crushing machine in very small size.

Washing- After crushing pulses peels are washed by using zinc chloride solution.

Drying- After washing pulses peels are dried by using sunlight.

After these basic pretreatments screening process is done by using 44 and 52 BSS mesh size screens to collect the pulses peels samples. The pulses peels Adsorbent was produced through chemical activation processes by using zinc chloride ($ZnCl_2$)**,** Onyejiand Aboje(2011).

3. Result and Discussion:

Waste water from electroplating Industry contains heavy metals which is toxic and have harmful effect on plants ,animals and as well as on humans. Generally, effluent of electroplating industry contains Cr, Fe, Ni, Zn, Cu and Cd.

These metals are very harmful to our environment and cannot be considered above the permissible limit .There are many methods through which we can remove these heavy metals but they are very costly. So as to remove these heavy metals we had done experiment by using low cost adsorbent such as pulses peels in the form of activated carbon. Since, heavy metals are those metals which are highly toxic and have eco-toxic properties and they are very cryogenic in nature.

We performed the experiment with the aim to remove heavy metals from waste water of Electroplating industry. So, we had used pulses peels as in the form of activated carbon. We had prepared activated carbon beds of pulses peels of Masoor and Moong of 52 BSS and 44 BSS mesh size by using $ZnCl_2$. For experiment, initially we measured the concentration of Cr and Fe in waste water of Electroplating industry shown in **Table1.** We had done batch process of sample waste water with pulses peels (Masoor and Moong) carbon bed for 2 hour and got the results over the concentration of water sample . The results for the effect of 44 & 52 BSS mesh size on adsorption of Cr & Fe removal are shown in **Table 1** and **Figure a,b,c** and **d.**

Table 1: Concentration of Cr and Fe for Pretreatment and after treatment

Particulars	Chromium Conc.(ppm)		Iron Conc.(ppm)	
	Initial	Final	Initial	Final
Masoor of 44 BSS mesh size	302.242	205.2	17.4	4.6
Masoor of 52 BSS mesh size	302.242	160	17.4	9.4
Moong of 44 BSS mesh size	302.242	260	17.4	11.5
Moong of 52 BSS mesh size	302.242	216.9	17.4	16.6

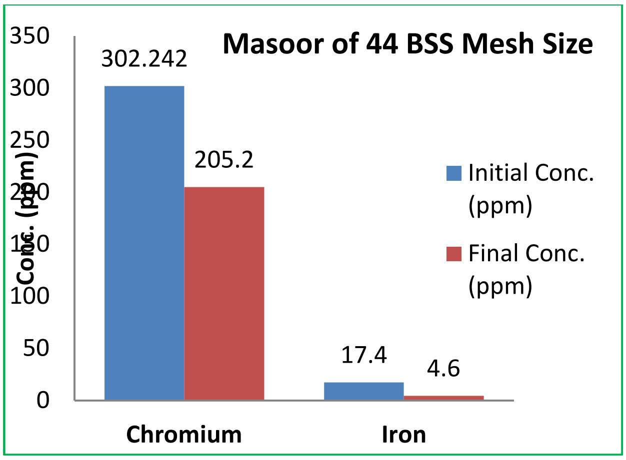

Figure a. Effect of 44 BSS mesh size on adsorption of Cr & Fe by Masoor.

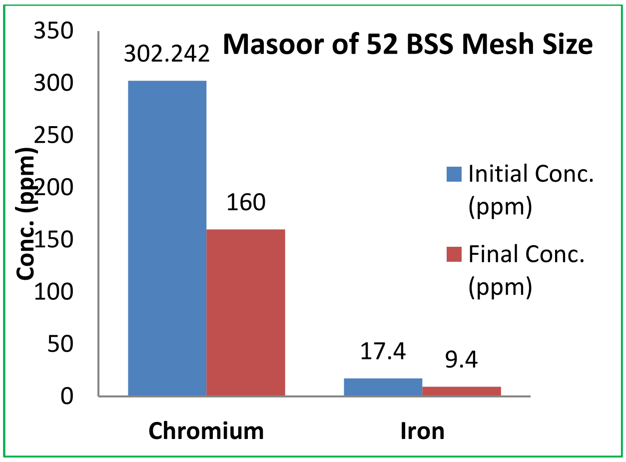

Figure b. Effect of 52 BSS mesh size on adsorption of Cr & Fe by Masoor.

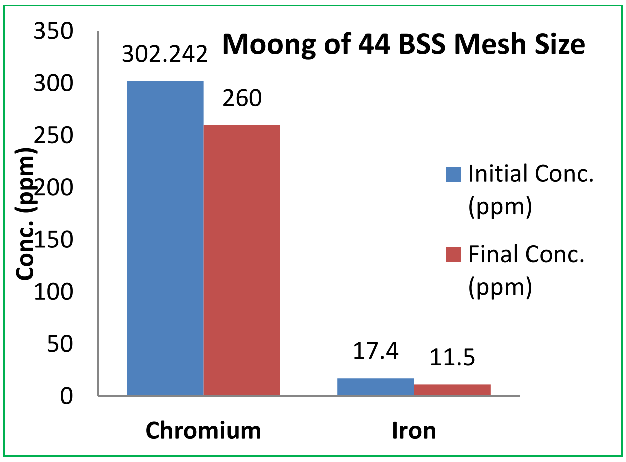

Figure c. Effect of 44 BSS mesh size on adsorption of Cr & Fe by Moong

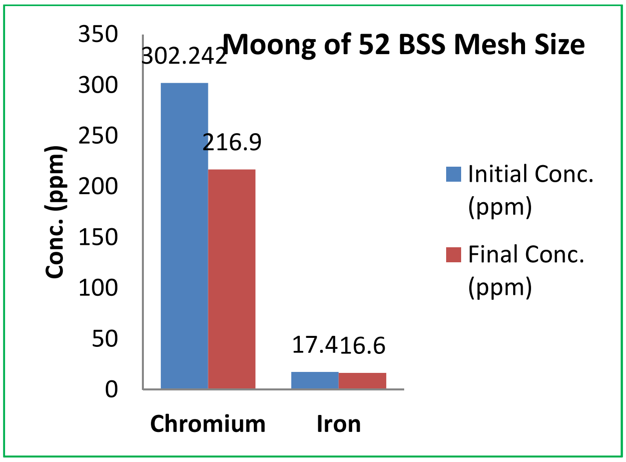

Figure d. Effect of 52 BSS mesh size on adsorption of Cr & Fe by Moong

The experimental results of physical & chemical parameters before & after treatment process of Electroplating Effluent are shown in **Table 2, 3,4and 5**.

Table 2. Masoor of 44 BSS mesh size

Particulars	Pre Treatment Data	Post Treatment Data	%Recovery
pH	7.4	6.9	6.76%
Alkanility(mg/L)	9000.0	7500.0	16.66%
Turbidity			%
Dissolved Oxygen (mg/L)	9.4	4.4	53.19%
Biological Oxygen Demand (mg/L)	6528.0	1224.0	81.25%
Chemical Oxygen Demand (mg/L)	192.0	157.6	17.92%
Total Solids (mg/L)	811460.0	179900.0	74.82%
Total Dissolved Solids (mg/L)	714600.0	266000.0	62.77%
Total Suspended Solids (mg/L)	143.1	71.5	50.03%

Table 3.Masoor of 52 BSS mesh size

Particulars	Pre Treatment Data	Post Treatment Data	%Recovery
pH	7.4	6.2	16.20%
Alkanility(mg/L)	9000.0	8250	8.33%
Turbidity			%
Dissolved Oxygen (mg/L)	9.4	6.9	26.59%
Biological Oxygen Demand (mg/L)	6528.0	780.0	88.05%
Chemical Oxygen Demand (mg/L)	192.0	161.6	15.83%
Total Solids (mg/L)	811460.0	201700.0	71.77%
Total Dissolved Solids (mg/L)	714600.0	236080.0	66.96%
Total Suspended Solids (mg/L)	143.1	87.5	51.14%

Table 4.Moong of 44 BSS mesh size

Particulars	Pre Treatment Data	Post Treatment Data	%Recovery
Ph	7.4	6.5	6.79%
Alkanility(mg/L)	9000.0	7500.0	16.66%
Turbidity			%
Dissolved Oxygen (mg/L)	9.4	4.1	56.38%
Biological Oxygen Demand (mg/L)	6528.0	2448.0	62.50%
Chemical Oxygen Demand (mg/L)	192.0	145.6	24.16%
Total Solids (mg/L)	811460.0	176900.0	78.19%
Total Dissolved Solids (mg/L)	714600.0	206800.0	71.06%
Total Suspended Solids (mg/L)	143.1	100.5	29.76%

Table 5.Moong of 52 BSS mesh size

Particulars	Pre Treatment Data	Post Treatment Data	%Recovery
Ph	7.4	6.8	8.11%
Alkanility(mg/L)	9000.0	8250	8.33%
Turbidity			%
Dissolved Oxygen (mg/L)	9.4	7.3	22.34%
Biological Oxygen Demand (mg/L)	6528.0	6120.0	6.25%
Chemical Oxygen Demand (mg/L)	192.0	153.6	20.00%
Total Solids (mg/L)	811460.0	240100.0	70.41%
Total Dissolved Solids (mg/L)	714600.0	145900	79.58%
Total Suspended Solids (mg/L)	143.1	100.3	29.90%

Batch studies showed that 32.11%, 47.062%, 13.97%, 28.23% of Cr ions were removed from aqueous solution by pulses peels of Masoor and Moong of 44 BSS Mesh size and 52 BSS size respectively.Dosing of adsorbents was 25 gm per 250 ml and it was kept for 2 hour. From these results it is clear that Masoor of 52 BSS Mesh size is able to remove more Cr ions from aqueous solution than that of other adsorbents.Batch studies showed that 73.56%, 54.02%, 66.09%, 4.59% of Fe ions were removed from aqueous solution by pulses peels of ofMasoor and Moong of 44 BSS Mesh size and 52 BSS size respectively.Dosing of adsorbents was 25 gm per 250 ml and it was kept for 2 hour. From these results it is clear that Masoor of 44 BSS Mesh size is able remove more Fe ions from aqueous solution than that of other adsorbents .Therefore, it may be concluded from the present studies that carbon derived from Pulses Peels should be used as an adsorbent for the removal of Cr and Fe from aqueous solution and electroplating plating industry waste water.

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