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REMOVAL OF CADMIUM FROM INDUSTRIAL WASTE WATER USING CILANTRO (*Coriandrum Sativum*) AS ADSORBENT

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Abstract – *The Laundry that produce waste water that contain cadmium which is a heavy metal and which contributes to pollution. This study investigates the adsorption of cadmium from the waste water by using cilantro as an adsorbent. The efficiency of the plant is tested by using batch study and column study. Study will research the effect of some primary operating parameters such as Adsorbent dosage, contact time and pH on the adsorption capacity of the plant. The column studies was performed by passing the waste water through a column setup having a diameter of 5cm and length 45 cm. The water sample will pass through the filter media through the column and the water was tested at different time interval and the removal efficiency of cadmium was calculated. Flow rate and bed depth are the two parameters used in column studies. The cadmium removal by the dry cilantro leaves was 69.3%.And the adsorption capacity of cadmium by the cilantro plant is 65 to 75% respectively.*

Key Words: **Cadmium, Cilantro plant, Batch study, Column Study, Adsorption capacity**

1.INTRODUCTION

Cadmium is an extremely toxic industrial and environmental pollutant classified as a human carcinogen. The textile wastewater contributes heavy metals like cadmium to the environment. This leads to the ability of the environment to foster life being reduced as human, animal, and plant health become threatened. This occurs due to bioaccumulation in the food chains as a result of the non-degradable state of the heavy metals. Remediation of heavy metals requires special attention to protect soil quality, air quality, water quality, human health, animal health, and all spheres as a collection. Developed physical and chemical heavy metal remediation technologies are demanding costs which are not feasible, time-consuming, and release additional waste to the environment.

Heavy metals and dye pigments used in the production in the textile industries can exist in the structures of textile fabrics and can penetrate into fibers and these can be transferred to the environment which are high in toxic and can bioaccumulate in the water life, water bodies and also traps in the soil. Developing research on a different treatment methods for example; membrane processes, coagulation, precipitation, sedimentation, filtration, flotation, biological methods, chemical processes, electrochemical method ion exchange and adsorption; with various degree of successes leads to elevated dramatic outcomes in the scientific world. Adsorption is a surface process in which multi-component fluids are attached to the surface of a solid adsorbent, forming chemical or physical bonds. It is being recognized as one of the widely applied and most efficient fundamental approach in contaminated water treatment methods which mainly revolves on its technical feasibility, economical viability, socially acceptable and simplicity. Although, many more techniques can be used in treatment of inorganic wastes, the best method should not only be appropriate, suitable and applicable locally, but also be of the maximum contaminant standards. Activated carbon, an adsorbent with controllable pore structure, thermally stable, low base/acid reactivity, large and porous surface area use has been witnessed, in terms of its applicability in eliminating of different types of chemical waste dissolved in water and in gaseous products. Despite the prolific application in adsorption processes, the major disadvantage of its use in the industries lies in the high cost and difficulties related on how to regenerate it. As a result of the above complications, more research to evaluate suitable and feasible renewable low cost natural materials like peat, bamboo waste, fungi, lignite, bark, moss, husks, coir piths, tea leaves, maize cobs, rice husks, and sago wastes as an alternative adsorbents for heavy metals decontamination has been intensified.

Adsorption utilizes nonliving biomasses to eliminate heavy metals ions from water, is a biological phenomenon that can be explained by different types of physical and chemical relations among the heavy metals ions and different functional groups that are on the cellular wall. The active sites on cell wall can vary according to the type of the biosorbent material. This study investigated cilantro plant as potential adsorbent to eliminate cadmium and lead ions from simulated contaminated water.

1.1 Objective of study

(1) To study and analyses the difference between adsorption capacity of fresh and dry cilantro leaves.

(2) To find out the optimum eff1iciency of the plant.

2. METHODOLOGY

2.1 Sample collection

The waste water is collected from the laundry situated near Eranhipalam bypass junction Calicut. Five liters of waste water sample was collected for the project. The waste water is collected from huge washing machine used for the dry cleaning processes. Mainly detergents and chemical that are used for cleaning purpose present in the wastewater. While there are numerous other domestic sources of heavy metals in waste water, detergents are the major source of cadmium. Therefore the presence of cadmium from detergents is particularly undesirable, so there is a need for constant monitoring and re-evaluation of metals concentration in all detergents, including those used in dishwasher.

2.2 Initial parameters of wastewater

The initial parameters such as pH, Turbidity, TSS, BOD, Alkalinity, Chloride, Hardness and Cadmium were determined bt standard method procedures.

Table -1: Initial characteristics of waste water

Parameters	Laundry wastewater	General standards
pH	9.31	6.5-9.0
Turbidity	10.42 NTU	≤5
Total suspended solids	290	≤100
BOD	440mg/l	Nil
Alkalinity	672mg/l	<250mg/l
Chloride	269.91mg/l	500mg/l
Hardness	72mg/l	0-75 soft
Cadmium	0.32mg/l	0.05mg/l

2.3 Adsorbent Preparation

The cilantro plant was collected and washed properly for removing the soil from the root of the plant. The plant was then separated as leaf and stem and a section was dried in sunlight for removing the excess moisture content.

Fresh cilantro stems and leaves were sun dried and then covert to fine powder using a mixer. Fresh plants leaf and stem were chopped to 1 cm and then grounded to increase the surface area for the adsorption The cilantro plant is nowadays cultivated widely in most parts of the world as a spices, for essential oils production and production of seeds.

2.4 Batch Study

Batch study is conducted in order to study the effects of various parameters like adsorbent dosage, contact time and variation in pH on the removal capacity of cilantro plant. The batch experiments were conducted using 100 ml of waste water sample for each adsorption run having an initial concentration of 0.32 mg/ltr of cadmium.

Fig -1: Samples of Batch Experiment

Various studies were conducted using dry leaf, dry stem, fresh leaf, fresh stem. The four adsorbent such as dry leaf, dry stem, fresh leaf and fresh stem was taken as 0.5, 1, 1.5,2 and 2.5 grams respectively. And five different contact time was selected as 30, 60, 90,120 and 150 minutes and pH values from 5 to 9 was considered. Here we have to find the maximum removal efficiency of the different adsorbent and choosing the best adsorbent from the plant having the highest removal efficiency among them. And removes cadmium in higher level from the waste water.

2.5 Column Study

Column experiments on laboratory scales were carried out at steady state in a duplicate sets of column with the dimensions and arrangements given in the figure 3.9. From the batch study we get the optimum value that the dry leaf powder has the highest removal efficiency than the other adsorbent. So that the column study chosen the dry leaf adsorbent and the parameters taken from the batch study. Since the highest optimum value obtained

from 1.5 gram of the adsorbent for 100 ml of waste water sample and here taking 15 grams of adsorbent for one liter of waste water sample and considering the bed depth for the experiment . About 15 grams 30 grams and 45 grams of cilantro dry leafs are taken for the experiment by choosing the bed depth of 2.5cm ,5cm and 7.5 cm was packed separately and bed was covered by pebbles. After

Filling the column by the waste water by maintaining the head.The water was flow through the column continuously and by changing the flow rate of 2 ml/min, 4 ml/min, 6 ml/min. The water was collected by an interval of 30 minute, 60 minute, 90 minute, 120 minute and 180 minute and the removal efficiency were detected.

Fig -2: Column setup

Here in figure shows the column set carried out for the study. Here the waste water sample was placed at the top portion of the column for the easy flow of water and a pipe was connected from the beaker to the column for the passage water.

3. RESULTS AND DISCUSSION

This section deals with the batch study done by using DL, DS, FL and FS by using adsorbent dosage, contact time and pH as initial parameters

3.1 Effect of adsorbent dosage

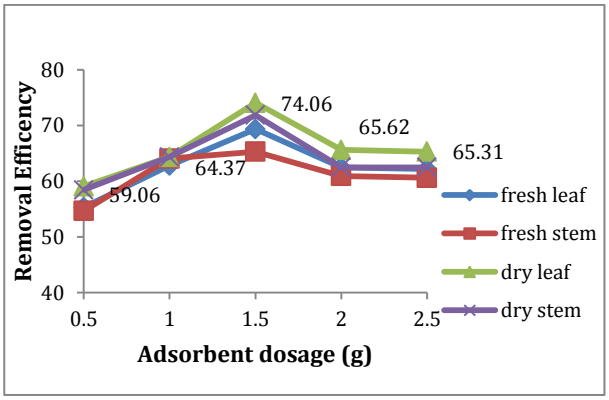

Chart -1: Effect on adsorbent dosage for DL, DS, FL and FS

The removal efficiency of cadmium for the adsorbent dosage of 1.5gram are 69.37%, 65.31%, 74.06% and 71.87% Figure 5.1 shows the effect of adsorbent dosage on the removal of cadmium by different adsorbent. Here we can see that the value increases gradually when weight of the adsorbent increases and decreases when reached at 2 grams. The 1.5 gram of dry leafs having an optimum removal efficiency of 74.06% than the other adsorbents. And then decreases to 62.62% by adding 2 grams of adsorbent and also decreases to 65.31% when adding of 2.5 grams of adsorbent. Dry stem has a removal efficiency of 71 % fresh leaf having 69% and fresh stem 65.3%. From these it is clear that dry leafs having the highest removal efficiency than the other adsorbents.

3.2 Effect of contact time

The study of contact time was conducted such as taking 1.5 gram of each adsorbent and the contact time was taken as 30 minutes, 60 minutes, 120 minutes and 150 minutes at an initial concentration of 0.32mg/l.

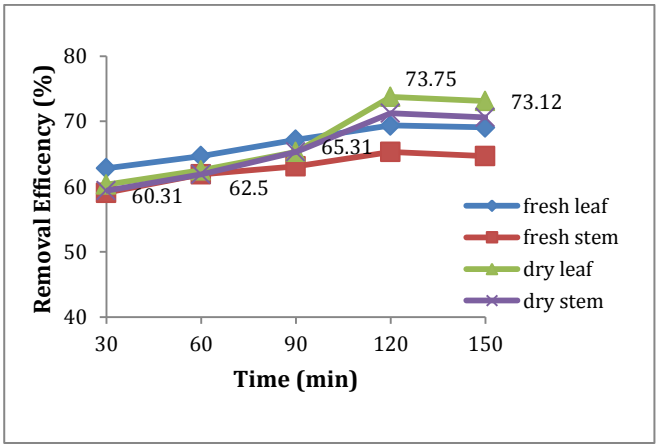

Chart -2: Effect on contact time for DL, DS, FL and FS

Here the value gradually increasing when contact time increases and the optimum value are obtained at 120 minutes and gradually decreases. Figure shows the effect of contact time of various adsorbent such as fresh leaf, fresh stem, dry leaf and dry stem. The time of 120 minutes having a optimum value of the removal efficiency and also dry leaf has higher value than the other adsorbent. The graph it is clear that when time increases the removal efficiency also increases. At last when the contact time increase up to 120 minutes the removal efficiency is optimum and decreases.

3.3 Effect of pH

The effect of pH was determined by taking 100 ml of solution of pH 5,6,7,8 and 9 by keeping other factors such as adsorbent dosage, initial concentration as constant. Providing the adsorbent dosage of 1.5 gram and a contact time of 120 minutes.

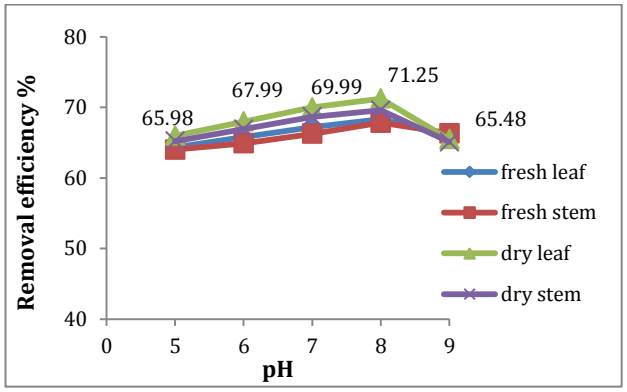

Chart -3: Effect on contact time for DL, DS, FL and FS

Here the removal efficiency gradually increases when pH varies up to 8 dry leaves. And then gradually deceases Figure shows the effect of pH of various adsorbent such as dry leaf, dry stem, fresh leaf and fresh stem. Dry leaf has higher removal efficiency when pH 8. The efficiency gradually increases when pH increases. The optimum value shows in pH-8 in adsorbents. The variation in pH shows a gradually increases in the value of removal capacity of adsorbent from the waste water. The dry leaf has the highest of 71.25 % at pH 8 and deceases to 65.48% at pH 9.

3. 5 Effect on bed depth

For this experimental setup the bed depth were taken as 2.5 cm, 5 cm and 7.5 cm.1 liter of waste water is pass though the column and head is maintained. Samples was collected at an interval of 30 min, 60 min, 120 min and 150 min.With a rate of flow of 2ml/min, 4ml/min and 6ml/min. We get the optimum removal efficiency at the adsorbent dosage 1.5 grams for 100 ml of water so taking 15 grams of dry leaf powder for one liter of waste water sample. It has a length of 2.5cm so choosing the bed depth as 2.5 cm .15 grams of dry leaf powder was packed in 2.5 cm height, 30 g were packed as 5 cm height and 45 g were packed as 7.5 cm height .and efficiency were calculated in various flow rate. The optimum time obtained from the batch study was 120 minutes so here taking the constant. From this the maximum removal efficiency of cadmium from the waste water is about 5cm bed depth at the flow rate of 2ml/min and contact time 120 minutes.

3.6 Effect on flow rate

Here three flow rates are considered, 2ml/min, 4ml/min and 6ml/min. when flow rate decreases the removal capacity of the adsorbent increases.

From this analysis it is clear that removal efficiency increases when flow rate decreases. Figure shows the effect on bed depth of 2.5 cm of flow rate 2ml/min, 4ml/min and 6ml/min and effluent are collect at three different time interval 30min, 60 min, 120 min and 150 minutes.

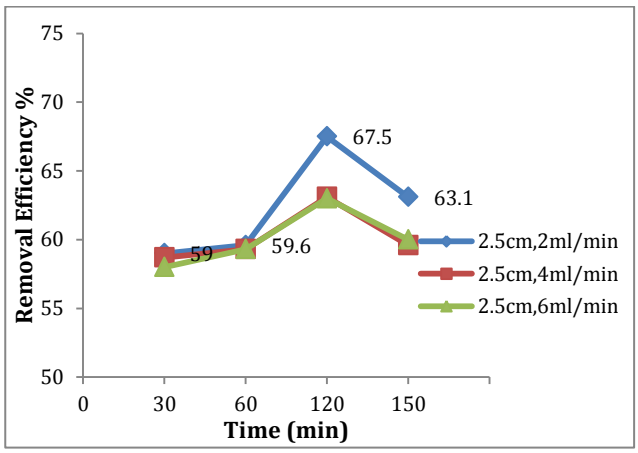

Chart -4: Effect on bed depth 2.5 cm on 2ml,4ml and 6ml

Here we can see that the removal capacity increases when the time increases to 60 minutes and the optimum value obtained at the sample collected at 120 minutes. The maximum removal capacity was 67.5 at the flow rate of 2 ml/min and decreases when sample tested after 150 minutes. Flow rate on 4ml and 6ml has almost the same removal efficiency when sample tested at 120 minutes is 63%. And decreases to 60% when tested at 150 minutes.

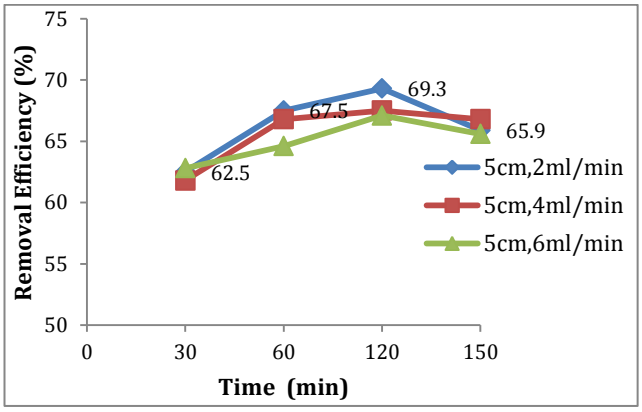

Chart -5: Effect on bed depth 5 cm on 2ml,4ml and 6ml

The removal efficiency of water sample at three different flow rate such as 2ml/min, 4ml/min and 6ml/min. on bed depth of 7.5 cm. The removal efficiency increases when flow deceases. The optimum value is at 2ml/min having a removal capacity of 69.3% when is at 120 minutes, and then decreases gradually.

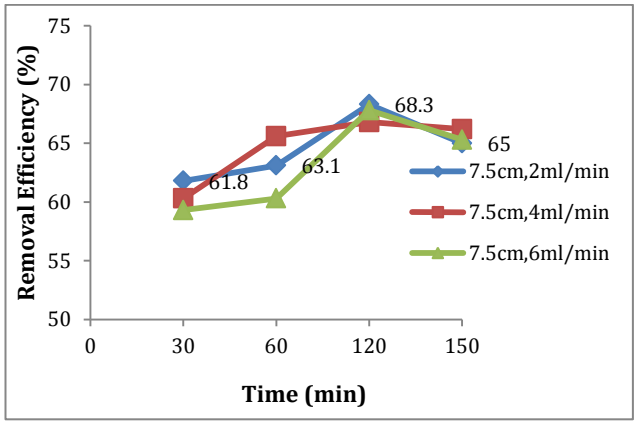

Chart -6: Effect on bed depth 5 cm on 2ml,4ml and 6ml

The removal efficiency of water sample at three different flow rates such as 2ml/min, 4ml/min and 6ml/min. on bed depth of 7.5 cm. The removal efficiency increases when flow deceases. The optimum value is at 2ml/min having a removal capacity of 68.3% when is at 120 minutes, and then decreases to 65 % gradually. The optimum value is obtained at 5cm bed depth on 2 ml/min. In this study the removal efficiency obtained from 58 to 69 %.

4. CONCLUSIONS

This study leads to prove the removal efficiency of the cilantro plant with different adsorbents prepared from the plant and the optimum value obtained from the dry leaf. Study conducted with a batch study and column study. In batch considered parameters such as adsorbent dosage as 0.5g, 1.5g, 2g and 2.5g. Contact time as 30min,60 min, 90 min,120 min and 150 min. and pH varies 5-9 . And taken different adsorbents as dry leaf, dry stem, fresh leaf and fresh stem. The percentage removal efficiency of the fresh adsorbents gives about 60%. The maximum removal efficiency was obtained in dry leaf as 73% at 1.5 g of adsorbent in 120 mints contact time in batch study.

Column experiments was performed using 5.5cm diameter and 35 cm height pipe is used for the experiments. In column study taking two parameters such as bed depth and flow rate. In the previous batch study we get the optimum removal efficiency for 100 ml of sample is 1.5grams of dry leaf as adsorbent Dry leaf which is grounded is taken for the study. Choosing three different bed depth as 2.5cm, 5 cm and 7.5 cm and three different flow as 2 ml/min, 4ml/min and 6ml/min.15 grams of dry leaf powder is taken for one liter of water. Removal efficiency is 67.5% at the flow rate of 2ml/min, 63.1 % at the flow rate of 4ml/min and 63% at the flow rate 6ml/min at the bed depth of 2.5cm bed depth. Removal efficiency at 5 cm bed depth is 69.35% at 2ml/min, 67.5% at 4ml/min and 67.1% at 6ml/min as flow rate. And the removal efficiency at 7.5 cm bed depth is 68.3% at the flow rate of 2ml/min, 66.8% at the flow rate of 4ml/min and 67.8% at the flow rate of 6ml/min. The maximum removal efficiency obtained in the column experiments is 69.3% at a bed depth of 5 cm of flow rate 2ml/min.

Here we can conclude that cilantro plant has about 60% of removal efficiency of cadmium from the waste water. The cilantro plant can used as a organic adsorbent for the removal of cadmium from the waste water is naturally occurring material easily available is possesses some medical value and moreover with high cadmium removal.

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