Mercury(Ii) Ions Removal by Adsorption

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ABSTRACT

Mercury is a hazardous element and hence its removal from the eco system is essential to prevent the associated environmental health risk. There are many techniques available for the removal of Mercury (II) ions from the effluent stream; most of them are costly. By using a low cost and easily available adsorbent - a tamarind bark powder, the removal of Mercury (II) ions was carried out in this project work. The scope of this project work is to study of adsorption of Mercury (II) from effluent by varying the amount of adsorbent, size of adsorbent, concentration of Mercury (II) solution, contact time and nature of tamarind bark powder. The removal of Mercury (II) was studied in the laboratory shaker by batch process. The mercury concentration in the effluent was determined using spectrophotometric method, before and after adsorption. The adsorption of Mercury (II) using the tamarind powder is found to have an efficiency of around 40%. The efficiency increases up to 50 % for the reduced size adsorbent and it improves further up to 60% for the chemically activated wood powder.

1.Introduction

Water pollution is a major concern for the living environment as most of the chemical industries produce waste water containing colored and solid substance. Out of solid pollutants, metals like mercury, chromium cadmium and lead are the most dangerous one[1,2,3]. Even their trace presence will lead to fatal death, so the removal of these solid pollutants is the most need one in the field of environmental study. Adsorption process is the most widely used process for the removal of coloring materials and solid pollutants[6].The various adsorbents include activated carbon, wood powder, saw dust, and charcoal.

Toxic substances in wastewater have been causing environmental pollution, and their removal is an important problem in the field of water purification[7,8,9]. Municipal wastes, urban and agricultural runoff, and industrial wastes are principal pollutants in water systems[22,23,24]. The pollutants of special importance are the residues of toxic and hazardous materials, mostly metallic compounds that seep into the surface and ground water systems. In particular, mercury (Hg), which is toxic, quite mobile, and active in biochemical metabolism, is still spreading in the environment. Removal of toxic material especially Hg (II) in wastewater, is significant for environmental protection purposes[25].

Mercury is a hazardous element and hence its removal from the eco system is essential to prevent the associated environmental health risk. The industries which discharge mercury with their effluents are: chlorine and caustic soda manufacturers, laboratories, paints, pigments, pharmaceuticals, plastics paper and pulp, insecticides, fungicides, fulminates, lubricating oils, electric lighting, wiring devices & switches, batteries, measuring and control equipment, dental equipment and supplies.

Specific treatment methods to reduce mercury concentrations in wastewater are reduction process, sulphide treatment, ferrous chloride treatment, magnetic ferrite, and ion exchange followed by chelating resin but these treatments are cost incentive. Removal of mercury by inexpensive natural products like modified peanut skin, walnut expeller meal, redwood bark, western hemlock bark, wool, chicken feathers, Soya flour, silk, wheat gluten, acacia bark, and bituminous coal were also found in practice.

2. Experimental Work

2.1. Solution Preparation

2.1.1 Preparation of mercury (II) solution:

0.3385 g of mercury chloride is weighed, dissolved in 250ml of distilled water. This is about 1000ppm of Mercury (II) solution containing 0.25 g of mercury. From this 1000ppm solution various concentration of mercury (II) solution like 1,2,3,4,5,6,7,8,10 and 15ppm were prepared.

2.1.2 Preparation of buffered potassium iodide solution:

5 g of potassium iodide and 5 g of potassium hydrogen phthalate are dissolved in water. Few crystals of sodium thiosulphate is added and diluted to 250 ml.

2.1.3 Preparation of Rhodamine 6G solution (0.005 %):

0.0125 g of coloring reagent Rhodamine 6G is dissolved in water and diluted to 250ml.

2.1.4 Preparation of gelatin solution (1%):

1 g of gelatin powder is dissolved in 100ml of water and gently heated.

2.2 ADSORBENT PREPARATION

2.2.1 Adsorbent 1: Preparation of raw tamarind powder:

1 Kg of tamarind wood chips was crushed in the roll crusher and then grounded to 32/80- mesh, which was washed with 0.1 N of hydrochloric acid solution, followed by distilled water washing. Then it is dried in the oven at 50° C. after drying it was closely packed.

2.2.2 Adsorbent 2: Preparation of tamarind powder of smaller size:

The wood powder was again finely grained in the ball mill to < 80 mesh size and washed with 0.1 N of hydrochloric acid solution, followed by distilled water washing to remove

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excess HCl acid. Then it is dried in the oven at 50º C. after drying it was closely packed.

2.2.3 Adsorbent 3: Preparation of chemically activated tamarind powder

a) Preparation of sulphuric acid:

0.2 N sulphuric acid is prepared by dissolving 6.25 ml of concentrated (98%) sulphuric acid in 1 liter of distilled water.

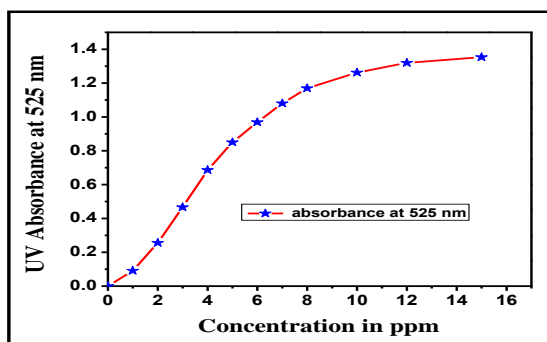**b)Preparation procedure for chemically activated tamarind powder:**

100 grams of prepared raw wood powder of < 80 mesh size was transferred to 500 ml of prepared 0.2 N solution of concentrated sulfuric acid and heated to 100º C for 1 hour in the microwave oven. After that it was washed with distilled water 3-4 times to remove excess acid present in the wood powder and then dried at 50º C in the same oven then it was closely packed.

3. Experimental Procedure

1 gram of adsorbent was taken in a 100 ml conical flask to which 50 ml of synthetically prepared effluent water of 1000 ppm Mercury II solution is added. Four flasks of same solution were placed in a rotary shaker at 120 rpm. Every flasks were taken from the shaker for every 15 min and filtered and 10 ml of filtrate was taken to which 5 ml of buffer solution, 5 ml of rhodamine solution and freshly prepared gelatin solution are added and mixed well. From which 3.5 ml of sample was taken for UV spectrophotometer and absorbance at 525 nanometer was measured and noted. This procedure was followed for 10 ppm of mercury II solution with different dosage of adsorbents like 2 g, 3g, 4g, and 5g for half an hour. The same procedure was repeated for the adsorbent 2 and adsorbent 3 also. The concentration of mercury II in the solution was calculated from the calibration chart.

Table.1 Adsorbence for various concentration of mercury II solution at 525 nm in UV.

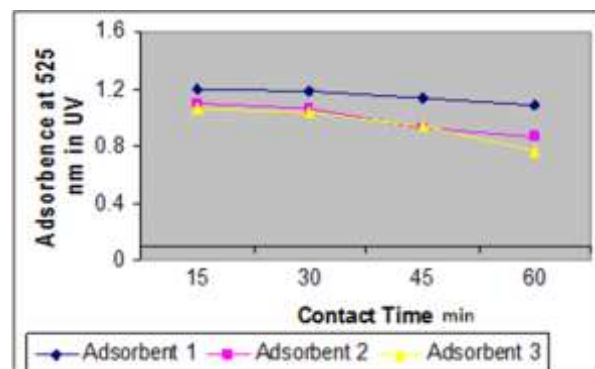| Concentration of mercury in ppm	Absorbance in UV Spectrophotometer
0	0
1	0.091
2	0.256
3	0.466
4	0.686
5	0.850
6	0.969
7	1.080
8	1.170
10	1.262
12	1.320
15	1.353

Figure 1. Absorption Spectra for Various Concentration of Mercury (II).

**4. Result and Discussion**

Table 2. Effect of adsorbents

Concentration of mercury II in 10 ppm	Absorbance at 525 nm			
	15	30	45	60
Adsorbent 1	1.2	1.18	1.13	1.08
Adsorbent 2	1.09	1.06	0.92	0.86
Adsorbent 3	1.06	1.03	0.93	0.76

Figure 2 . Effects of adsorbents in various contact time (min)

Table 3. Effect of adsorbents in varying amount in grams.

Concentration of mercury II in 10 ppm	Absorbance at 525 nm				
	1	2	3	4	5
Adsorbent 1	1.18	1.15	1.09	1.04	0.96
Adsorbent 2	1.06	0.99	0.91	0.87	0.83
Adsorbent 3	1.03	0.95	0.86	0.75	0.64
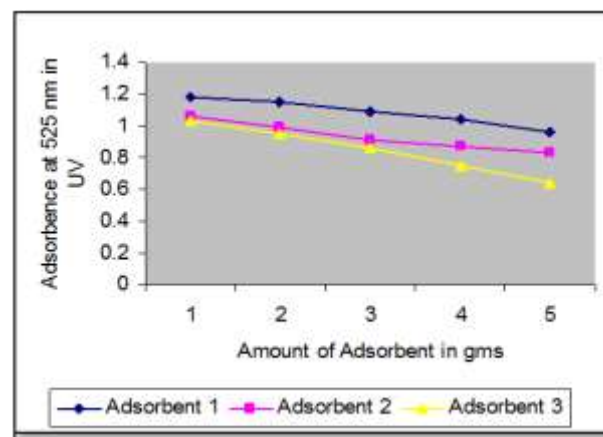
Figure 3. Effect weight Vs absorbance

Result

The efficiency of the adsorbent 3 was slightly higher compared to the others, shows that adsorption increases with the increase in contact time as well as increase in amount of adsorbent used.

4.1 Effect of Concentration of Mercury (II) for Adsorbent 3

Table 4. Effect of Concentration of Mercury (II) in varying Contact time in minutes:

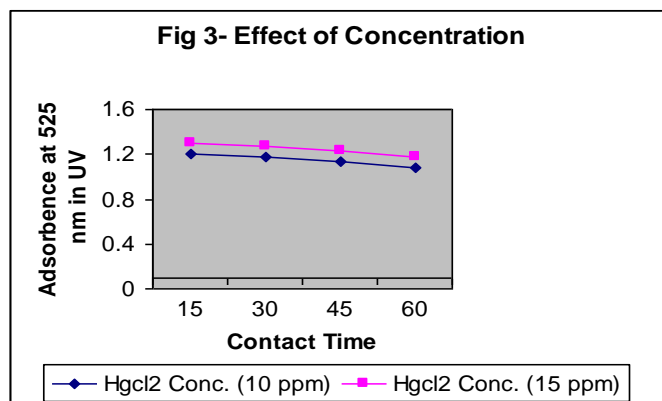| Adsorbent 3 Contact Time	Absorbance at 525 nm				
	1	2	3	4	5
Concentration of mercury II in 10 ppm	1.03	0.95	0.86	0.75	0.64
Concentration of mercury II in 15 ppm	1.22	1.06	0.95	0.84	0.78

Figure 4. Effect of concentration Vs Absorbance.

Table 5. Effect of Concentration of Mercury(II) in varying amount in grams.

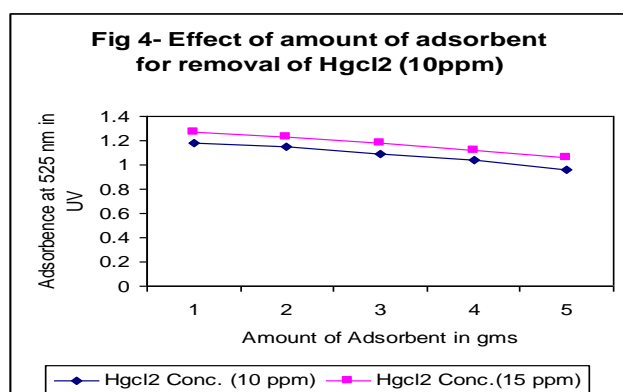| Adsorbent 3 Contact Time	Absorbance at 525 nm				
	1	2	3	4	5
Concentration of mercury II in 10 ppm	1.03	0.95	0.86	0.75	0.64
Concentration of mercury II in 15 ppm	1.22	1.06	0.95	0.84	0.78

Figure 5. Effect weight Vs absorbance.

Result

The adsorption efficiency decreases with the increase in concentration of the solution when the contact time increases and also increases in amount.

5 Conclusions

Adsorption of mercury was studied using the novel bark powder. And the result shown that the removal of mercury increases when the contact time increases and also when the amount of adsorbent increases.

When comparing the size of the adsorbent, the smaller size NBP shows higher adsorption rate then the larger one.

The efficiency of the adsorption is higher for the chemically activated adsorbent than the non-activated adsorbent.

The adsorption efficiency decreases with the increase in concentration of the solution.

It is concluded that the adsorption of the NBP is medium, an average efficiency is around 40%, and the efficiency increases up to 50 % for the reduced size adsorbent and it is still increased up to 60% for the chemically activated wood powder.

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