Adsorption of Cadmium(II) from Polluted Water by Engineered Carbon (EC)

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Abstract

Today, Cadmium pollution is a matter of grave concern for environmentalists all over the world, due to its toxic effects on flora, fauna and human beings. It is emitted from natural and industrial sources, causes contamination of aqueous environment. It causes 'ouch-ouch' disease in human beings.

In the present paper, the adsorbent Engineered Carbon(EC) was used for removal of cadmium from water using adsorption technology. The parameters like pH, contact time, concentration etc. studied to know the % sorption of the effective adsorbent – EC.

Key words: *Adsorption, Cadmium(II), Engineered Carbon(EC)*

1. Introduction

Cadmium is ubiquitous in the environment. It is a toxic metal, which causes 'ouch-ouch' disease and harmful biochemical effects in human beings. It has various uses in different industries like various alloy manufacturing, electroplating, paint – pigments, plastics, Nickel-cadmium storage batteries, amalgam in dentistry. Cadmium bromide and iodide are used in photography, process engraving and lithography. Cadmium oxide is used in glass manufacture in ceramic glazes, in electroplating, and in the manufacture of ceramic alloys. Cadmium selenide is used in photoelectric cells, photoconductor, rectifiers and in phosphorescence. Cadmium sulphide used as pigment to boost glaze in colouring glass, soaps, textile, paper rubber, printing inks, ceramic glazes and fire works. Cadmium storages are used as stabilizers in the manufacture of PVC. Cadmium released from various sources causes pollution of the aquatic environment.

The permissible limit for Cd is 0.01mg/l for drinking water as per IS:10500(1983) and 1mg/l for public sewer as per IS:2490-1982 standards in India. It causes 'ouch-ouch' disease, cyanosis, hypertension, anemia, weakening of bones etc. cadmium acts inhibitor of sulphydryl enzymes which interacts or competes with other heavy metals such as Cu, Fe and Zn which induces the deficiency symptoms of these essential metals.

Various adsorbents such as starch xanthate, activated carbon minerals, china clay, low grade manganese ore, hematite, various biomaterial products like bark, peat-moss, strew, water hyacinth [1,2], Treated PUF [3] and Mineral adsorbent [4] have been reported for removal of Cadmium(II) from aqueous system. I have selected good and innovative sorbent material- Engineered Carbon (EC) for remediation of cadmium from water/waste water.

The present study was undertaken to assess the adsorption capacity of the smart adsorbing material Engineered Carbon(EC).

2. Materials and methods

The batch mode laboratory experiment was done using adsorption technology. Here Engineered Carbon(EC) was used for the removal of cadmium from water/waste water. It is effective adsorbent because of high degree of porosity and large surface area.

Chemicals:

All chemicals used were of analytical grade. Cadmium solution was prepared by dissolving the required quantity of cadmium nitrate of analar grade.

Engineered Carbon:

Smart adsorbing material Engineered Carbon was prepared by Chemical oxidation, heat treatment and degassing processes of Junk Carbonaceous materials like tyres.

Adsorption experiments:

The batch experiments were conducted at room temperature were conducted at room temperature in a rotatory shaker. 0.2 gram of engineered carbon was agitated with 20ml of aqueous solution of cadmium at desired concentration, pH, contact time and temperature using the shaking machine for different retention time. At the end of pre-determined time intervals the adsorbent was centrifuged then filtered. The supernatant liquid was analyzed for the remaining cadmium concentration using AAS. The adsorption isotherms were determined at 30^0C.

3. Results and Discussion

3.1 Effect of pH on adsorption of cadmium (II)

The effect of pH on the adsorption of Cd^{++} using Engineered Carbon has been given in Table-1.

0.2 gram of engineered carbon was agitated with 20ml of cadmium solution. The pH of the initial concentration varied between 2.0 to 10.

Table-1: Effect of pH

Initial concentration of Cd(II) = 50mg/l

Sl. No.	pH	Cd(II) in filtrate mg/l	Cd(II) adsorbed in mg/l	% removal
1	2.0	3.9	1.1	22
2	4.0	2.9	2.1	42
3	6.0	1.7	3.3	66
4	8.0	0.9	4.1	82
5	9.0	0.6	4.4	88
6	10.0	0.6	4.4	88

Table-2: Effect of Contact Time

Initial concentration of Cd(II) = 50mg/l

pH = 9.0

Sl. No.	Time in minutes	Cd(II) in filtrate mg/l	Cd(II) adsorbed in mg/l	% removal
1	15	3.8	1.2	24
2	30	3.3	1.7	34
3	60	2.7	2.22	44.4
4	2x60	0.8	4.2	84.0
5	3x60	0.25	4.75	95
6	4x60	0.25	4.75	95

Table-3: Effect of Temperature

Initial concentration of Cd(II) = 50mg/l, pH = 9.0

Contact time = 3 hours

Sl. No.	Temp ^{0}C	Concentration of Cd(II) in filtrate mg/l	Cd(II) adsorbed in mg/l	% removal
1	20	0.38	4.62	92.4

2	30	0.125	4.875	97.5
3	40	0.17	4.83	96.6

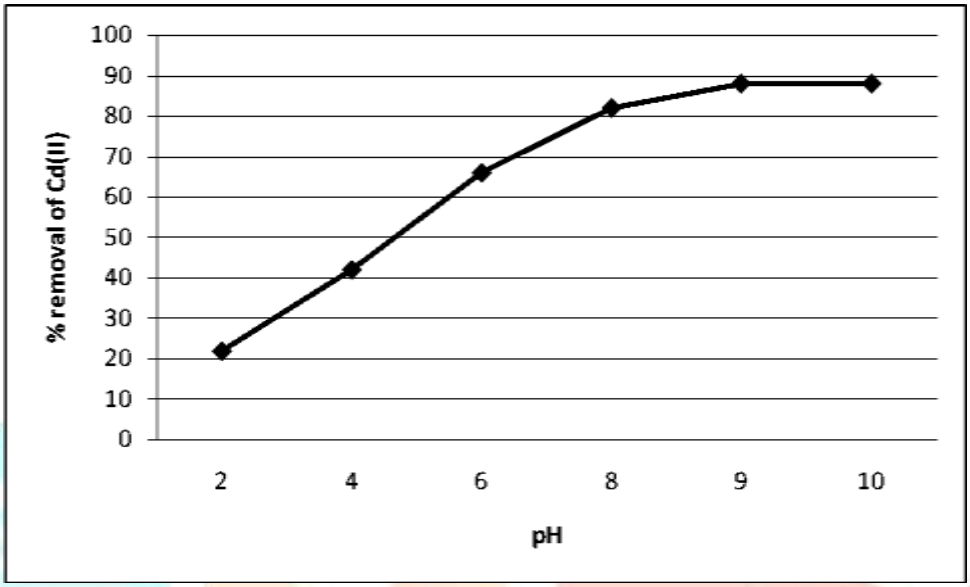

Fig.1: Effect of pH on adsorption of Cd(II)

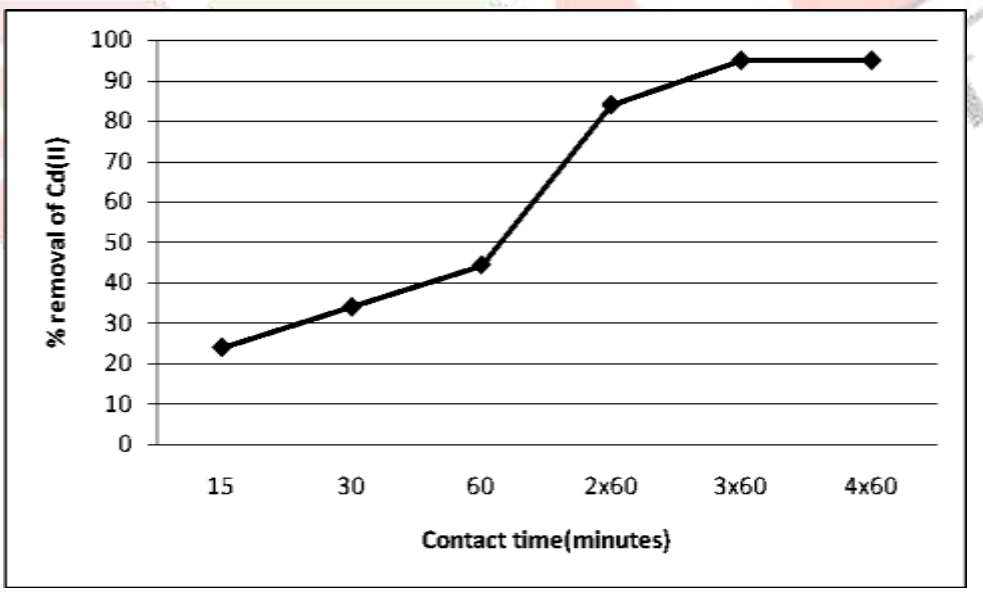

Fig.2: Effect of contact time

The results are shown in the Table-1 and figure-1, that as pH increased, adsorption of cadmium increased, which achieved optimum value of pH of 9.0. Hence for all further experiments, the pH of the solution is maintained at 9.0.

3.2 Effect of contact time on the adsorption of Cadmium (II):

The effect of contact time on the adsorption of Cd(II) on engineered carbon is given in Table-2.

It is obvious from Table-2 and figure-2, that adsorption of Cd(II) on EC increases with contact time. It is observed that %removal of Cd(II) reaches to 95%, when contact time is 3 hours.

3.3 Effect of Temperature:

The effect of temperature on the removal of Cd(II) from water/waste water by Engineered Carbon (EC) is shown in Table-3. It is clear from Table-3 that increase of temperature from 20^0C to 40^0C increases the adsorption of Cd(II). Optimum temperature investigated in this adsorption studies was 30^0C. the increase in uptake of Cd(II) with temperature may be due to desolvation of adsorbing species, the change in size of pores and enhanced rate of intraparticle diffusion of adsorbate as diffusion is endothermic process. The adsorption isotherms follow Langmuirian model.

Conclusion

It is concluded from the above experimental studies that a good amount of Cd(II) i.e.=95% is removed by adsorption on Engineered carbon, at pH =9.0 and contact time of 3 hours. It is effective technology for remediation of cadmium rich water. It may be useful in development of prototype Effluent Treatment Plant (ETP) or periodical and continuous removal Batch Reactor for treatment of Cadmium and polluted water.

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