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Evaluation of Removal of Mercury (II) Using Bicarbonate Washed Cyprus Rotundus Carbon

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Abstract: Pyrolysis, chloride, carbonate, sulphate and acid process were used to prepare activated carbon which was prepared from the roots of Cyprus rotundus plants. The above activated carbon's Hg (II) removing capacity was found out by carrying out experiments. The above set of experiments were also done with commercially activated carbon and its ability for Hg (II) removal was also found. The results from the about experiments were tabulated and compared. By using different parameters like pH, carbon dosage and concentration, the above set of experiments were carried out and tabulated. Equilibrium isotherms were found using Langmuir and Freundlich isotherms and plotting graphs. The adsorption ability of carbon activated from the above processes were found out using Langmuir adsorption isotherms. The values were found to be 80.123 mg/g, 98.245 for Bicarbonate washed Cyprus rotundus Carbon (BCRC) using distilled and tap water respectively. For Commercially activated carbon, the data was found to be 218.162 mg/g and 53.24 mg/g for Carbon activated Commercially (CAC) using distilled and tap water respectively. In the above set of experiments the R^2 values found using both the isotherms are in (CAC) in distilled water and tap water respectively. It was found that the R^2 values obtained for both the isotherms are in good agreement. The above experiment can be used to determine the adsorbing ability of Bicarbonate washed Cyprus rotundus carbon and commercially activated carbon. The above experiment follows pseudo first order kinetics. From the above experiment, it is evident that Hg (II) obtained from industrial effluents can be effectively removed using Bicarbonate washed Cyprus rotundus carbon.

Keywords: Hg (II) Removal, Cyprus Rotundus Carbon, Bicarbonate Washed Cyprus Rotundus Carbon (BCRC), Commercially Activated Carbon (CAC), Langmuir And Freundlich Adsorption Isotherms, Kinetics, Toxic Hg (II) Waste From Industrial Effluents.

1. Introduction

Metallic Mercury (Hg), Mercurous mercury (Hg^+) and Mercuric mercury (Hg^{2+}) are toxic forms of mercury. Inorganic mercury has toxic and corrosive properties. Mercury accumulates in the kidney causing renal damage. Its poor solubility in lipids limits its Central Nervous system penetration. Mercury exposure dermally leads to toxicity. Excretion of mercury through urine is insufficient. It results in chronic exposure and accumulation within the brain causing effects in the Central nervous system. Lignocellulose waste carbonaceous adsorbents remove inorganic (Hg^{2+}) and organic ($MeHg^+$) mercury ions (Norasikin Saman et al., 2015). Bio-char based modified activated carbons remove mercury superior to commercial activated carbon (Mahuya De et al., 2013). Xanthoparmelia conspersa – lichen biomass removes Hg (II) from aqueous solutions (Mustafa Tuzenet al., 2009). Carbonaceous sorbent obtained using flax shive removes Hg(II) from aqueous solution (M Cox et al., 2000). Drepanocladus revolvens – moss biomass removes Hg (II) from aqueous solution (Ahmet Sari et al., 2009). Marine macroalga Cystoseira baccata biomass removes inorganic Hg from aqueous solutions (Roberto Herrero et al., 2005). Activated carbon prepared from sago waste adsorbs Hg (II) (K Kadirvelu et al., 2004). Peanut hull carbon that is treated with bicarbonate removes Hg (II) from aqueous solution (C. Namasivayam et al., 1993). Mercury (II) from aqueous solution is bisorbed using the biomass of Sargassum glaucescens and Gracilaria corticata (Akbar Esmaeili et al., 2017). Biochars obtained from bagasse and hickory chips remove Hg (II) (Xianoyun et al., 2016). Activated carbon obtained from Rosmarinus officinalis leaves removes Hg (II) (Mohamed Erhayem et al., 2014). Multi-walled carbon nanotube with amino and thiolated groups adsorbs Hg ions from synthetic and real waste water aqueous solution (Mojtaba Hadavifar et al., 2014). Mesosporous activated carbon obtained from Bambusa vugaris striata adsorbs Cd (II), Hg (II) and Zn (II) from aqueous solutions (P G Gonzalez et al., 2014). Modified Phoenix dactylifera biomass adsorbs mercury (Natarajan Rajamohan et al., 2014). Activated carbon of Palm oil Empty fruit Bunch removes Hg, Pb and Cu from aqueous solution (Rafeah Wahi et al., 2009). Camel bone charcoal removes Hg (II) from wastewater (Saad S M Hassan et al., 2007). Carbon sorbent obtained from the fruit shell of Terminalia catappa adsorbs Mercury (B Stephen

Inbaraj et al., 2005). Sugi wood carbonised at 1000 ° C adsorbs Hg (Lilibeth Pulido-Novico et al., 2001). 1-(2-thiazolylazo)-2-naphthol functionalised activated carbon removes and recovers Hg (II) from hazardous wastes (AM Starvin et al., 2004). The idea of this experiment is to estimate the adsorbing capacity of Bicarbonate washed Cyprus rotundus carbon (BCRC) for the removal of Hg (II) from industrial effluents and comparing the adsorption capacity of Commercially Activated Carbon. Various parameters like pH, concentration and carbon dosage were modified and the experiments were carried out. Adsorption isotherms were found and various kinetic data were obtained to provide a better understanding of the adsorption process.

2. Principles and Process Description

Pyrolysis and Activation Method for Cyprus Rotundus Carbon Preparation: 100 g of Cyprus rotundus roots were collected cleaned using water and grated into small pieces and dried in sunlight. The dry sample is then heated at 450 – 700 ° C. Volatile impurities go out. The sample chars and fumes are produced. Heating is continued until the fumes cease. Then the sample is subjected to pyrolysis under inert conditions at 850 -900 for an hour.

Chloride Process for Cyprus Rotundus Carbon Preparation: Roots obtained from Cyprus rotundus plants were immersed in solutions of Calcium chloride, Manganese chloride, Zinc chloride and Ammonium chloride for a day. The residue is filtered and the filtrate is removed. The moist residue is kept on plates and are dried. The dry residue it subjected to heating at 600 – 650 ° C. Then the substance is heated at 850 – 900 ° C to activate it for about 45 minutes in the absence of air. Then the sample is washed using excess of water and dilute HCl and then moisture is removed.

Sulphate Process for Cyprus Rotundus Carbon Preparation: Roots obtained from Cyprus rotundus plants were immersed in a 10% aqueous solution of ammonium or sodium sulphate for about a day. The solution is filtered and the filtrate is drained. The remaining substance as residue is placed on plates to dry them. The residue that is dry is subjected to heating at a temperature of about 600 – 650 ° C. Then the sample is subjected to further heating at 850 – 900 ° C for about an hour in the absence of air. Then the remaining residue is washed with excess water and dilute HCl. Any remaining traces of acid is removed by washing with water. It is then slowly dried.

Acid Process for Cyprus Rotundus Carbon Preparation: To the Roots obtained from Cyprus rotundus plants 200 ml of concentrated H_2SO_4. The sample is agitated by vigorous stirring. Gases are released and the sample chars. After the reaction stops, the remaining matter is kept in an oven and a temperature of 150 ° C is set and placed for about a day. Water is used to wash any traces of acid left in the residue. At 110 ° C, the sample is dried.

Carbonate Process for Cyprus Rotundus Carbon Preparation: To the Roots obtained from Cyprus rotundus plants water is added and washed. Then Manganous chloride is added and kept for a day. The resultant substance is kept in a solution of 10% Sodium bicarbonate for a day. The residue is filtered and the filtrate is disposed of. To dry the sample, it is heated upto 110 ° C. The sample is subjected to thermal decomposition at 700 ° C and then activation is done at 850 ° C for about an hour without air. 10% HCl is added to the sample and then water is added to it and it is subjected to heating at 110 ° C so as to remove traces of moisture.

Selection of Cyprus rotundus carbon: The components present in Cyprus rotundus carbon and their percentage are listed in the table given below:

Table 1: Components and their composition present in Cyprus rotundus carbon

S.No.	Constituent	Percentage
1	Moisture content	7.30
2	Essential oil	78.4
3	Cypere	9.76
4	Humulen	7.97
5	Selinene	7.88
6	Zierone	4.62
7	Campholenic aldehyde	3.83
8	Pinene	3.51

9	Longeverbenone	2.72
10	Vatirenene	2.32
11	Other organic compounds	14.65
12	Ash (Dry basis)	4.30
Ash Analysis		
1	Silica	55.00
2	K_2O	9.41
3	Na_2O	5.36
4	CaO	5.60
5	MgO	3.25
6	P_2O_5	0.20

Cyprus rotundus carbon that is prepared by the carbonate process is the best suitable for our adsorption studies. The parameters of CAC (Commercially activated carbon) that is obtained from various processes are tabulated below:

Table 2: Various Paramaters of CAC (Commercially activated carbon) obtained from different processes

S.No.	Parameters	CAC	Pyrolysis process	Chloride process	Sulphate process	Carbonate process	Acid process
1	Moisture %	7.20	3.01	8.17	7.10	9.27	11.30
2	Ash %	3.68	20.28	21.38	27.63	23.48	4.94
3	Bulk Density	0.61	0.23	0.26	0.25	0.23	0.45
4	Matter soluble in water %	1.69	5.60	8.32	10.00	7.43	2.50
5	Matter soluble in Acid%	1.75	9.64	9.45	11.30	8.32	2.12
6	Free Carbon%	85.68	61.46	52.68	70.97	74.76	80.0
7	Phenol number	20	68	78	70	74	67
8	Methylene Blue Value	78	28	50	56	60	42
9	Ion exchange capacity Meq/g	NIL	NIL	NIL	NIL	NIL	0.56
10	Surface area Sq.meters/g	563	235	216	200	210	40.32
11	pH	8.40	9.44	7.82	9.10	8.72	3.35
12	Iron %	0.005	0.063	0.063	0.07	0.065	0.015

Stock solution of Hg (II) preparation: A stock solution of Hg (II) which contains 40mg/L of Hg (II) is prepared by dissolving 0.0541 g of $HgCl_2$ is in a litre of distilled water.

Adsorption Studies: In the adsorption experiments, about 100 ml of Hg (II) of a desired concentration and varied pH are kept in 300 mL high density polythene (HDPE) and a desired amount of adsorbent is added. 0.1 M Nitric acid or KOH is used to modify the pH of the solution. The resultant solutions were vigorously agitated for various contact times at about 30 ° C. The solutions were centrifuged using a speed of 500 rpm and the carbon particles were removed and the resultant clear filtrate was tested for Hg (II) using Cold vapour Atomic Adsorption Spectra (CVAAS). To the resultant liquid $SnCl_2$ (25 % w/v) in HCl (20 % v/v) is added to reduce aqueous Hg^{2+} to Hg^0 which is able to produce a better analytical absorbance signal before the determination of Hg in the medium of adsorption. Blanks along with the solute which are adsorbent free are used as control in all the experiments. Equilibration is done to the solution for a day and isotherms of adsorption were calculated and kinetics of the reaction were studied for various concentrations of Hg (II), maintaining the same adsorbent dosage. Mercury vapours at a high pressure is kept in an inert atmosphere of Argon. The vapours of Mercury are placed into the optical path of the Atomic Absorption spectrophotometer apparatus. At a specific wavelength, Mercury absorbs light at room temperature. High concentration of the reducing agent and its flow rate will affect the analytical signal. The Argon flow rate should be 2 mL/min. An air-acetylene flame was utilized to estimate the amount of Hg (II) that remains unadsorbed in the supernatant liquid. The instrument contains a hollow cathode lamp that works at 15 mA. The operating wavelength is about 358 nm. The efficiency of removal for the adsorbents', (E) for Hg was determined using the equation: $E\ (\%) = C_0 - C_e/C_0 \times 100$ …….. (1)

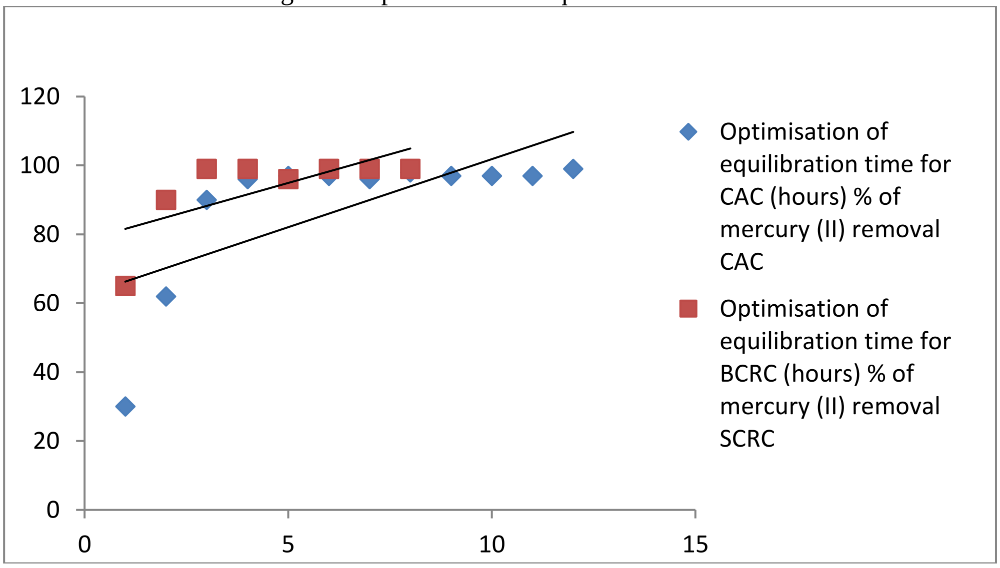
C_0 and C_e denote the initial concentration and equilibrium concentration in (mg/L) of Hg (II) (aqueous) respectively Where C_0 and C_e are the initial and equilibrium concentrations (mg/L) of Cr (VI) solutions, respectively.

3. Results and Discussion

Effect of contact time: In order to determine the effect of equilibration time on the removal of Hg (II), Hg (II) of concentration 10 mg/L at a pH of 5 was used. The solutions containing Hg (II) were equilibrated for an equilibration time ranging from 1 to 9 hours. After equilibrating the solutions for various times, they are subjected to centrifugation and the percentage of Hg (II) in the solutions were determined and a graph is plotted; which is given in the figure: was

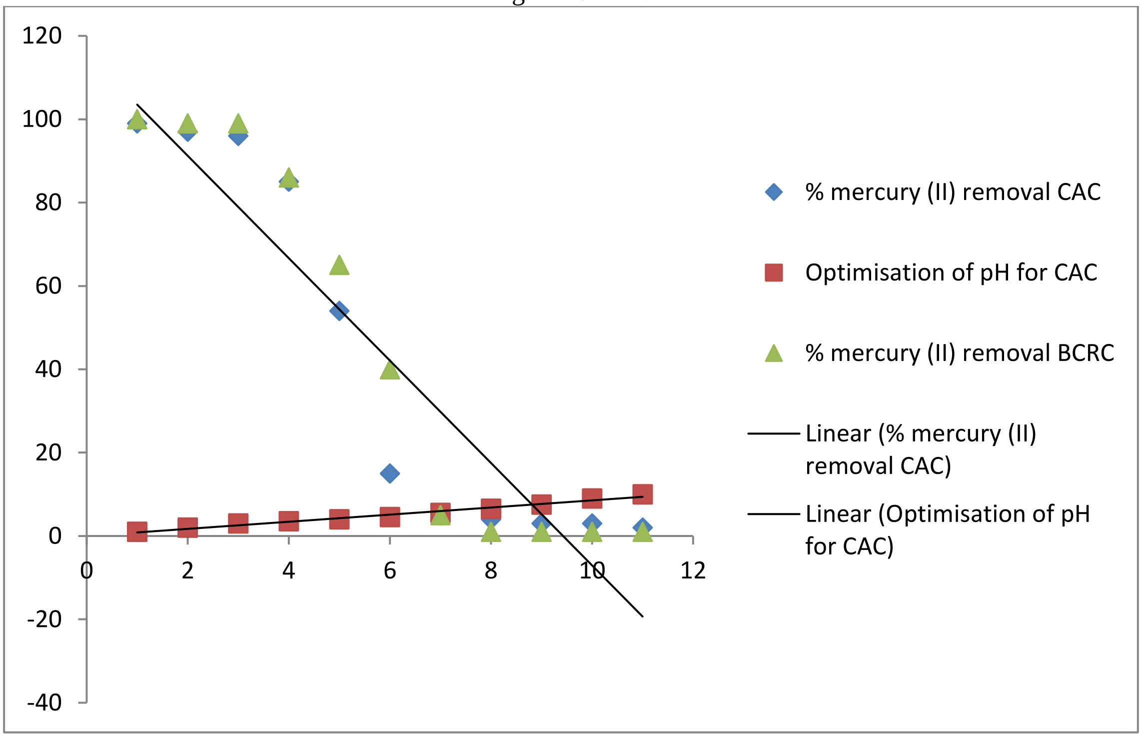
From the graph, it is clear that 5 hours and 7 hours were needed for the highest removal of 91.37% and 82% of Mercury (II) using commercially activated carbon and Bicarbonate washed Cyprus rotundus carbon respectively. We therefore conclude that Cyprus rotundus carbon is a better adsorbent when compared to CAC (commercially activated carbon) for the removal of Hg (II) from aqueous solutions

Figure 1: Optimization of Equilibration Time



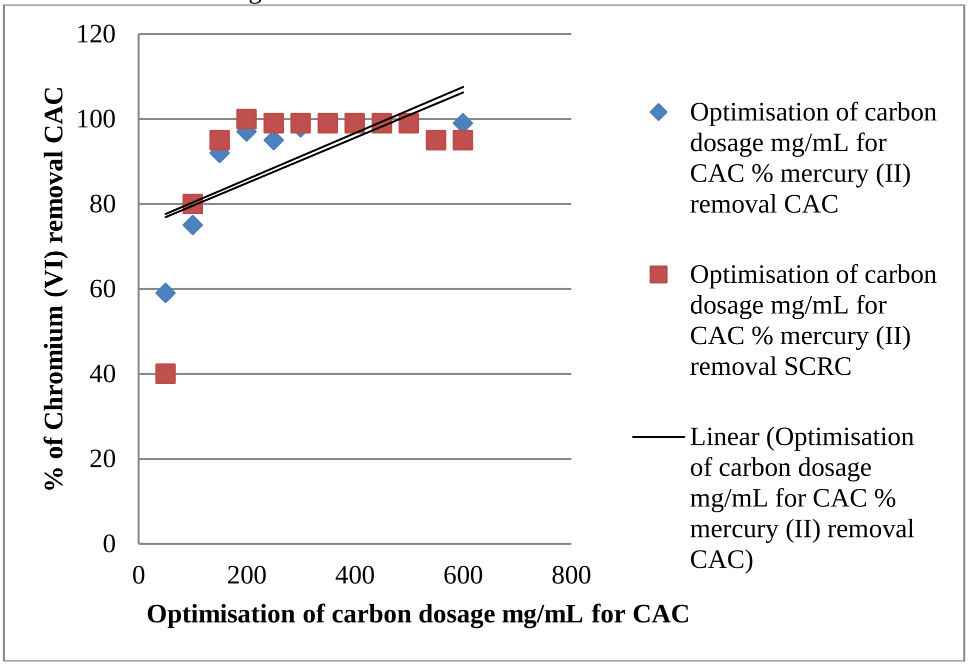
Effect of pH: In order to find out the apt pH for the maximum removal of Hg (II), different sets of experiments were done for different pH varying from 1 to 12. After the desired equilibration time, the solutions were subjected to analysis and the percentage of removal of Hg (II) were found and the results are given in the figure. We get varying results with varying pH values for Bicarbonate washed Cyprus rotundus Carbon (BCRC) and Commercially Activated Carbon (CAC). Bicarbonate washed Cyprus rotundus Carbon (BCRC) removes maximum Hg (II) at a pH of 8 and Commercially Activated Carbon (CAC) removes maximum Hg (II) at a pH of 7.5. When the pH value is increased the percentage removal of Hg (II) for both BCRC and CAC carbons steadily increases and then reaches a constant value after a pH of 4, then remains almost constant upto a pH of 8. Then it again decreases after a pH of 8. Hence a pH range of 4 to 8 remains the apt pH for the maximum removal of Hg (II) for both BCRC and CAC carbons. At a pH range that is slightly basic, maximum adsorption of Hg (II) occurs for both BCRC and CAC carbons. Hg (II) removal of Bicarbonate washed Cyprus rotundus carbon (BCRC) at pH 4, 5, 6, 7, 8, 9 are 89, 88.5, 90, 91.5, 92, and 75 respectively. Hence we conclude that Hg (II) removal is the highest at a pH of 7.5 for BCRC. Hg (II) removal for that of Commercially activated carbon (CAC) at pH 4, 5, 6, 7, 7.5, 8 are 81, 81, 80.5, 81, 82 and 75 respectively. Hence we decide that Hg (II) removal is highest at a pH of 8 for BCRC. Hence we conclude that BCRC removes Hg (II) more effectively than CAC from aqueous solutions.

Figure 2: Effect of Ph



Effect of Carbon dose: We have to find out the minimum amount of carbon that is needed for the maximum removal of Hg (II) for Bicarbonate washed Cyprus rotundus carbon (BCRC) and compare the same for commercially activated Carbon (CAC). We carry out experiments with 10mg/L of Hg (II) which contain varying amounts of carbon ranging from 50 to 600 mg/100mL at a desired pH of about 5 for Bicarbonate washed Cyprus rotundus carbon (BCRC) and commercially activated carbon (CAC). We have to maintain the required equilibration times for the removal of Hg (II) at every instance. The figure depicts the results of our experiments. A minimum of 200mg/100mL is desired for both Bicarbonate washed Cyprus rotundus carbon (BCRC) and commercially activated carbon (CAC) for the removal of 91 % and 81.5 % of Hg (II) removal respectively. From this we conclude that Bicarbonate washed Cyprus rotundus carbon (BCRC) is superior and most effective in the removal of Hg (II) when compared to commercially activated carbon (CAC). are depicted in the figure below. Therefore based on the above experiments and studies we conclude that Bicarbonate washed Cyprus rotundus carbon (BCRC) is a good adsorbent than commercially activated carbon (CAC) for the removal of Hg (II) from aqueous solutions.

Figure 3: Effect of Carbon Cac and Carbon Scrc



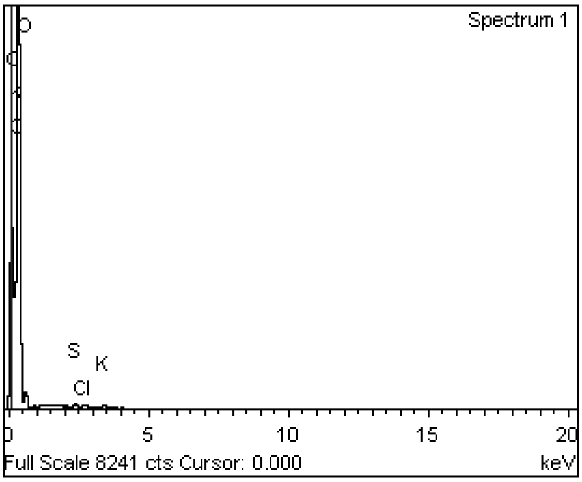


Figure 4 : Edax Cac Raw Material

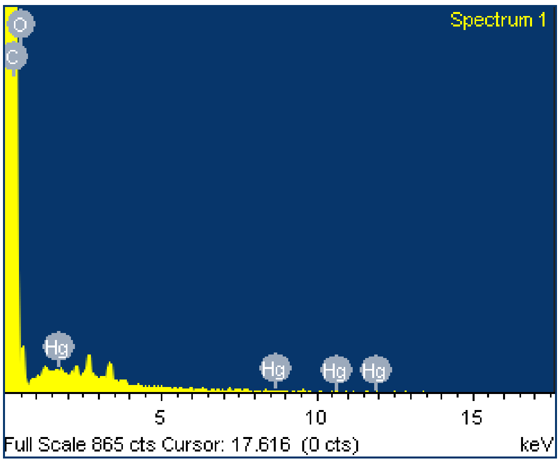


Figure 5: Edax Cac Hg (Ii) Adsorbed

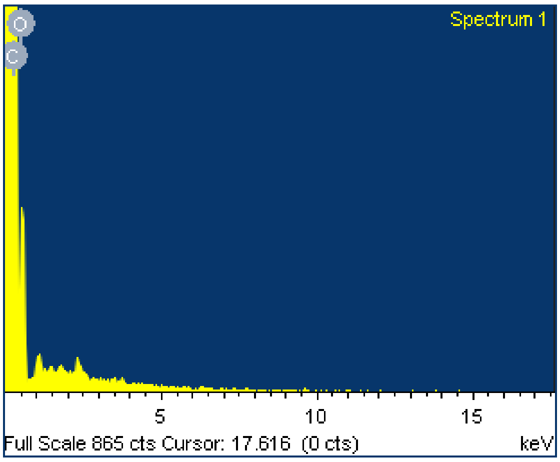


Figure 6 : Edax Bcrc Raw Material

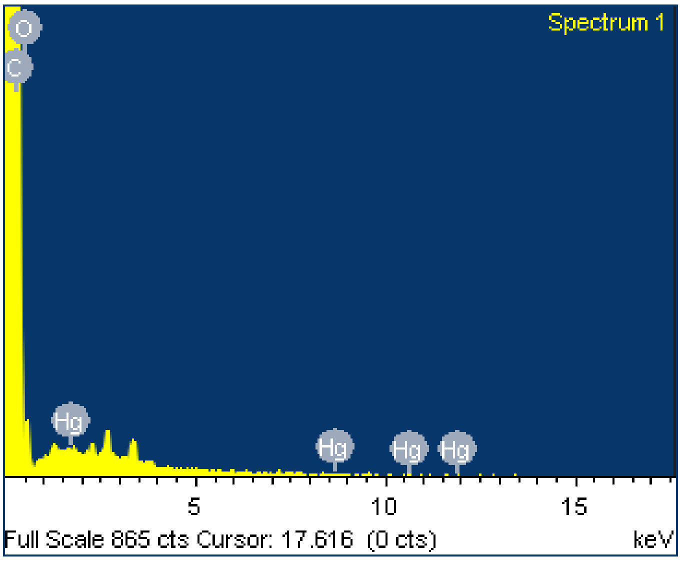


Figure 7: Edax Bcrc Hg (Ii) Adsorbed

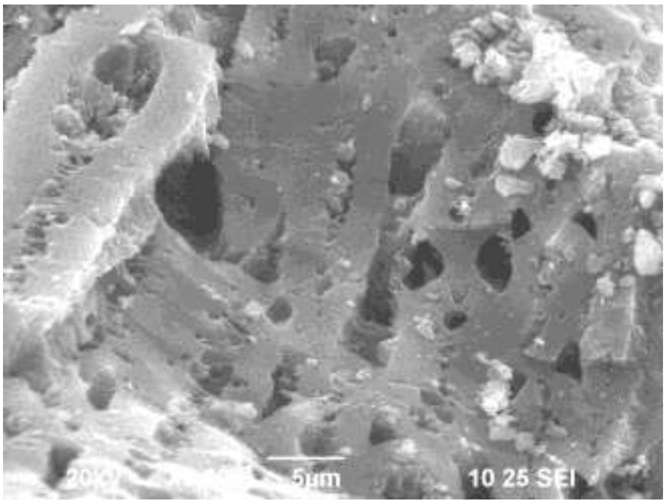


Figure 8 : Sem Images For Cac Raw Material

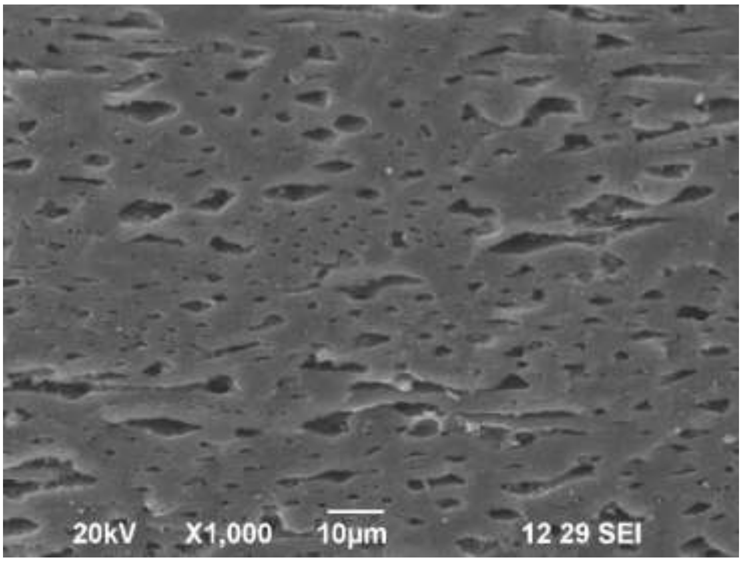


Figure 9: Sem Images For Cac Hg (Ii) Adsorbed

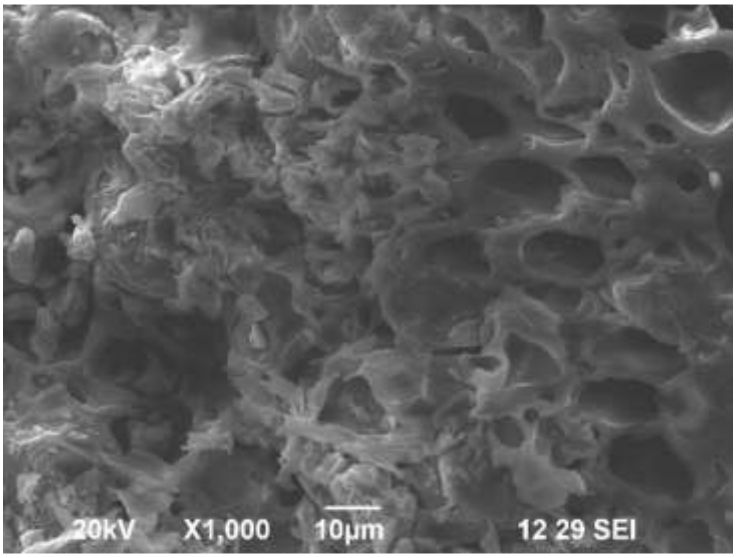


Figure 10: Sem Images For Bcrc Raw Material

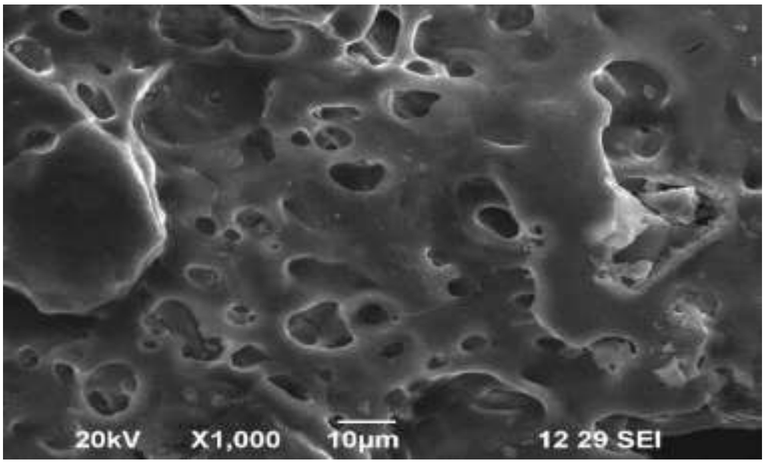


Figure 11: Sem Images For Bcrc Hg (Ii) Adsorbed

Isotherms of Adsorption: Isotherms measure rate of adsorption at a constant temperature. They are useful in understanding the interaction between the adsorbents and the solute. Isotherms are needed to optimize the using of adsorbents. The common isotherms that are used in adsorption study of adsorbents are Freundlich, Langmuir and Tempkin isotherms. The equation for Langmuir (1918) adsorption is given below:

$1/q_e = 1/b + 1/ab.C_e$ ……… (2)

The equilibrium concentration in mg/L is C_e, The amount of Hg (II) that remains adsorbed at equilibrium is denoted as q_e. Here 'a' and 'b' are the Langmuir constants for adsorption energy (L/mg) and adsorption capacity (mg/g) respectively. A plot of $1/q_e$ vs $1/C_e$ gives a straight line. The graph gives us the Langmuir adsorption isotherm for Hg (II) adsorption on the surface of adsorbents obtained for one day. The values of the constants 'a' and 'b' are found out from the slopes and intercepts of the graph and are tabulated

Langmuir adsorption isotherm produces the highest adsorption for adsorbents. For Bicarbonate washed Cyprus rotundus carbon (BCRC) the adsorption capacity levels for activated carbons were found by plotting graphs for their respective Langmuir adsorption isotherms and they were found to be mg/g and mg/g in distilled water and tap water respectively. For Commercially activated carbon (CAC), the adsorption capacity levels for activated carbons were found by plotting graphs for their respective Langmuir adsorption isotherms and they were found to be mg/g and mg/g in distilled water and tap water respectively. R_L denotes a dimensionless constant. It is a factor used to find out the favourable condition for a sorption system in an adsorption process. R_L values ranging from 0 to 1 favours adsorption. The Langmuir isotherm equation

$R_L = (1/1+aC_0)$……..(3)

is very useful in finding the value of R_L.

The concentration of Hg (II) at the initial stage is given by C_0 the constant that denotes adsorption energy is given by 'a'.

R_L predicts the nature of the adsorption process. For a favourable, irreversible, linear and unfavourable process, the R_L values are $0 < R_L < 1$, $R_L = 0$, $R_L = 1$ and $R_L > 1$, respectively. The values of R_L for Bicarbonate washed Cyprus rotundus carbon (BCRC) and Commercially Activated Carbon (CAC) range from 0 to 1 for any concentration. Thus BCRC and CAC can be used as favourable adsorbents. Freundlich adsorption isotherm can be calculated by using the equation (Freundlich and Helle, 1939):

$\log x/m = \log K_F + 1/n (\log C_e)$ ………… (4)

The equilibrium concentration in mg/L is given by C_e. The adsorbed amount for unit mass of the adsorbent in mg/g is given by x/m. We get a straight line which indicates that the adsorption is favourable. The graph gives us the Freundlich adsorption isotherms for the adsorption of Hg (II) using BCRC and CAC. The values of K_F and n were found out from the intercepts and slopes of the graph. The values of adsorption capacity, K_F, correlation coefficient (R^2) and adsorption intensity, n were found out and tabulated. When we plot log x/m vs log C_e, we get a straight line whose slope is 1/n and intercept of log x/m as log K_F at log $C_e = 0$ ($C_e = 1$). The linearity obtained in the graph proves that the adsorption process follows Freundlich adsorption type of adsorption. We calculate the Freundlich adsorption equation K_F values for Bicarbonate washed Cyprus rotundus carbon (BCRC) and Commercially Activated Carbon (CAC) from the intercept values of log x/m axes. '1/n, the intensities of sorption were found out from the slopes of the graph for both BCRC and CAC.

The values of intensity of adsorption ranging between 1 to 10 ($1 < n < 10$) show that the adsorption is favourable. The range of values for 'n' between 1 to 10 show that these adsorbents are most favourable on Hg (II) adsorption. The values of coefficient of correlation, (R), found from the graph for the two isotherm models are tabulated. From the values of R^2 obtained we conclude that both Freundlich and Langmuir adsorption iostherms are present simultaneously on the carbon adsorbent layers so as to completely eliminate Hg (II) form aqueous solutions.

Adsorption Kinetics: ToLangergren's pseudo- first order and second order kinetics was used to study the adsorption kinetics of Hg (II) for these adsorbents. Two of the kinetic models was used for this purpose. Lagergren (Lagergren 1998) pseudo-first order rate equation is:

$\ln (q_{e\,(exp)} - q_{t\,(exp)}) = \ln q_{e\,(theo)} - k_1 t$ .... (5)

here $q_{t\,(exp)}$ and $q_{e\,(exp)}$ give the time (min) and concentration in mg/g of metal ions at equilibrium. The rate constant for the pseudo-first order at equilibrium is given by k_1 in min^{-1}. A plot of $\ln (q_{e\,(exp)} - q_{t\,(exp)})$ vs t will give us a straight line with slope k_1 and intercept $q_{e\,(theo)}$. It is clearly evident that the adsorption follows pseudo-first order kinetics. The graphs show the pseudo-first order kinetics for the adsorption of Hg (II) for Bicarbonate washed Cyprus rotundus Carbon (BCRC) and Commercially Activated Carbon Pseudo-second order rate equation (Ho and McKay, 1999) is :

$t/ q_{t\,(exp)} = 1/k_2 q^2_{e(theo)} + 1/ q_{e\,(theo)}$ .... (6)

k_2 is the rate constant for pseudo-second order kinetics in g/mg, min. When we plot $(t/q_{t\,(exp)})$ vs 't', we obtain a straight line where $1/ q_{e\,(theo)}$ and $1/k_2 q^2_{e(theo)}$ are the slopes. This shows that the adsorption follows pseudo-second order model. We come to a conclusion from the graphs that pseudo-second order kinetics applies good for the adsorption of both Hg (II) for Bicarbonate washed Cyprus rotundus carbon (BCRC) and Commercially Activated Carbon.

The percentage of relative deviation , P is calculated from the below equation so as to compare the kinetic models apply to the data.

$P = 100/N \{\Sigma\, q_{e(exp)}\ q_{e(theo)} / q_{e(exp)}\}$ .... (7)

q_e (exp) is the experimentally calculated value of q_e for any value of C_e. $q_{e(theo)}$ is the theortically calculated value for q_e. N is the number of observations.When the percentage deviation values are less, the fit is found to be good. It is found to be excellent when $P<5$. The equations were utilized to check the results. The experimental values fit very well for both the equations. The theoretical values of $q_{e(theo)}$ were found from the models and are compared with the experimentally obtained values and are listed in the table. The q_e values, experimental ($q_{e(exp)}$) and theoretical($q_{e(theo)}$) values obtained using pseudo-second order kinetic model were in good agreement with each other. P, the relative deviation percent was found to be maximum and their values were in good agreement. The value (R^2) of is almost approaching unity. It is found clear from the above results that the adsorption of Hg (II) on BCRC and CAC follows pseudo-second order kinetics.

Figure 16: Kinetic Fit Curve For Bcrc

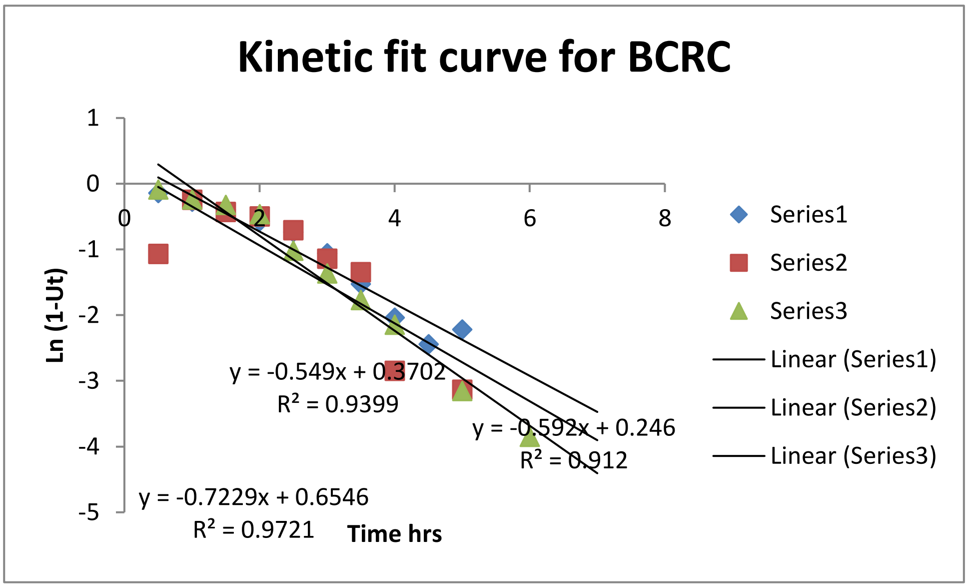
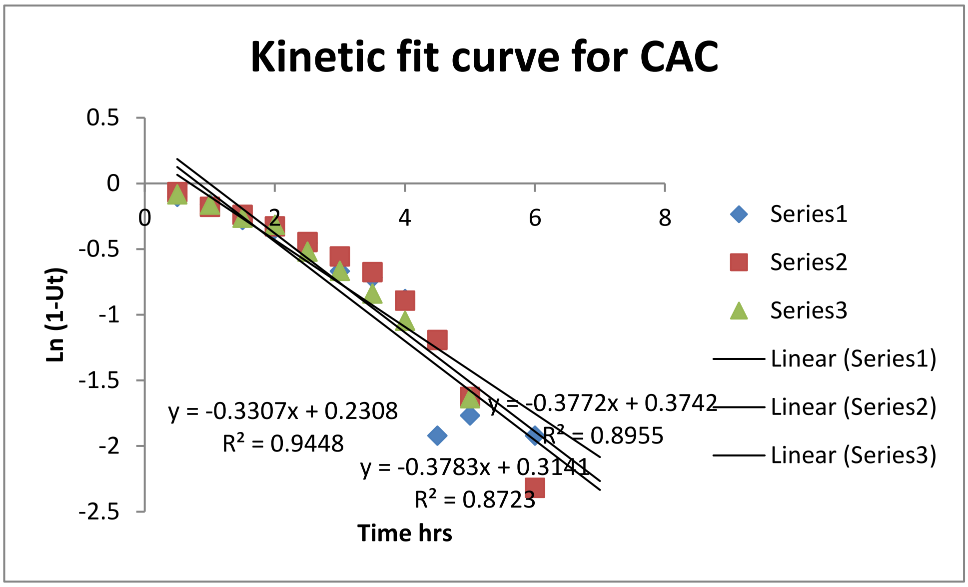


Figure 17: Kinetic Fit Curve For Cac



4. Application to wastewater

Mercury obtained from effluents of industries were collected and adsorption studies were carried out to find out the efficiency for the removal of Hg (II) for these adsorbents. The concentrations and composition of various substances obtained from the waste water effluents of industries are found out and tabulated. Generally the waste water contains 0.092g/L of Hg (II). The waste water was diluted to about 6 times before the adsorption was carried out using Bicarbonate washed Cyrus rotundus carbon (BCRC) and Commercially Activated Carbon (CAC).The pH of the water was adjusted to 5 for both Bicarbonate washed Cyrus rotundus carbon (BCRC) and Commercially Activated Carbon (CAC). For carbon doses ranging from 50 to 600 mg/L, the removal of Hg (II) for BCRC and CAC at a pH of 5 was found to be maximum at carbon dosage 200 mg/L. The percentage of removal of Hg (II) was found to be 82% and 92% for CAC and BCRC respectively. Hence we conclude that Bicarbonate washed Cyprus rotundus Carbon (BCRC) is superior over commercially activated Carbon (CAC) in the removal of Hg (II) from waste water. BCRC is a better adsorbent than CAC.

5. Conclusion

1. We find out that 90%, 89%, 90%, 91%, 92% of Hg (II) was removed at pH 4, 5, 6, 7 and 8 respectivley at a carbon dose of 100 mg/100 mL for Bicarbonate washed Cyprus rotundus Carbon (BCRC). 77%, 82%, 81%, 81%, 81% and 75% of Hg (II) was removed by Commercially Activated Carbon (CAC) at pH 4, 4.5, 6, 7, 7.6 and 8 respectively at a carbon dose of 100 mg/100 mL. A maximum of 92 % Hg (II) and 82% of Hg (II) was removed at pH 7 and pH 4.5 for Bicarbonate washed Cyprus rotundus carbon (BCRC) and commercially activated carbon (CAC) respectively. Hence we come to a conclusion that Bicarbonate washed Cyprus rotundus carbon (BCRC) is superior to commercially activated carbon (CAC) in the removal of Hg (II) from waste water.
2. Freundlich adsorption capacity of Bicarbonate washed Cyprus rotundus carbon (BCRC) is found to greater than that of commercially activated carbon (CAC).
3. We conclude that Hg (II) adsorption on Bicarbonate washed Cyprus rotundus carbon (BCRC) and commercially activated carbon (CAC) follows pseudo-first order kinetics.
4. It is found that Bicarbonate washed Cyprus rotundus carbon (BCRC) is superior to commercially activated carbon for the removal of Hg (II) obtained from waste water effluents from industries.
5. Hence it is concluded that Bicarbonate washed Cyprus rotundus carbon (BCRC) can be used as an adsorbent alternatively for the elimination of Hg (II) from aqueous solutions and waste water effluents from industries.

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6. References

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