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Activated Carbon Derived from *Peltophorum pterocarpum* (Copper Pod) Seeds and *Phoenix dactylifera* (Date Plam) Seeds in Batch Comparative Adsorption Studies of Fluoride

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ABSTRACT

A synthesis of two forms of activated carbons is included in this paper. Because of its capacity to remove contaminants from both air and water, activated carbon (AC) is commonly employed for purification. Its porous structure allows it to trap impurities, and it is frequently suggested for a variety of water and wastewater treatment applications. However, due to the high expense of filing an AC application, the number of applications that can be filed is limited. AC was made using locally accessible *Peltophorum pterocarpum* (Copper Pod) and *Phoenix dactylifera* (Date Plam) seeds in this study. Fluoride adsorption on physical activated carbon from a synthetic sample made from *Peltophorum pterocarpum* (Copper Pod) and *Phoenix dactylife*. To remove fluorine from the body physically activated carbon, adsorption in batches methods were completed in order to find the best time, dose, pH sorption kinetics, and sorption equilibrium. The ideal contact duration, dosage of adsorbent and carbon pH were found to be 30 minutes, 140 mg, and 8.00, and 50 minutes, 225 mg, and 9.00, with fluoride removal efficiency of 77.5 percent, 79.33 percent, 82.6 percent, and 72.63 percent, 75.8%, 76.5 percent, respectively. Changes in process factors such as adsorption time and dosage were recycled to inspect adsorption kinetics and sorption isotherm models. The isotherms of Langmuir, Freundlich, and Temkin are three scientists investigated using This experimental data has been determined to be accurate.

Key words : *Seeds of Peltophorum Pterocarpum (copper pod), Seeds of Phoenix Dactylifera (Date Plam), Fluoride, Carbon activated, Adsorption isotherms models, Contact time, Dosage, pH, Kinetics*

Introduction

Water is life, but we are still unable to provide everyone with safe drinking water that is both accessible and inexpensive. Water is an essential component of life for all living things. However, only a small percentage of the population has access to potable drinking water anymore. Others drink polluted water to varying degrees. The topic of providing clean water to drink is causing a lot of anxiety around the globe, especially in emerging and poor countries. Because India is a developing country with a large population living in villages with limited infrastructure, a high rate of illiteracy and a deficiency of sanitation and sterility awareness, the model of clean drinking water is a foreign concept to many people takes on more importance. However, the majority of the inhabitants in rural areas relies on contaminated Drinking water from the ground, It has a mix of minerals and salts in it. One of them is an overabundance of fluoride in the water, which has a negative impact on people's health. Fluoride is a necessary component for Depending on the situation, humans and animals overall amount consumed or the concentration in the water we drink. Fluoride in the water supply is useful for the formation and the preservation of strong bones and teeth within permitted ranges of 0.5-1.0 mg/l, but excessive fluoride intake Fluorosis of the teeth and skeleton. Fluoride is a hazardous substance that is It is a toxin that is more hazardous than lead but less dangerous than arsenic, and it accumulates in the body. Fluorosis of the teeth and skeleton is caused by drinking dirty water on a regular basis, as well as a variety of other health problems such as gastrointestinal issues. Because "Fluorosis" is an incurable condition, the only way to solve the problem is to prevent it. As a result, investigations on the defluoridation of water utilising a range of adsorbents have become increasingly important in recent years. Defluoridation can be accomplished using a variety of ways, including Ion exchange, reverse osmosis, besides electrodialysis, NEERI's Defluoridation in Nalgonda process has recently gained popularity, however it has its own set of limitations. Defluoridation activity is also tested with a variety of adsorbents. Defluoridation capacity of activated alumina is said to be high. However, the majority of these strategies and methodologies have been found to be costly. Carbonaceous materials, such as activated carbon (AC), are a form of carbonaceous material. Carbon atoms are oxidized found arranged the inner and outer surfaces distinguishes it from elemental carbon (Falah *et al*., 2015). Due to their exceptional qualities, these materials have recently become a popular research topic. This is due to their enormous nontoxicity, excellent porosity, and particular locations capacity to contain diverse functional groups on their tunable surface. Adsorbent materials of the AC type have been widely utilised for a long time variety of applications due to these features (Falah *et al*., 2015). They have the potential to be utilised to absorb large amounts of high-capacity compounds from both There are two phases of matter: gas and liquid. AC is utilised in the dealing of wastewater, drinking water purification, air pollution adsorption in the gaseous phase and adsorption in the liquid phase. Because of its high porosity, fast adsorption, and thermal constancy, AC offers a wide range of applications in adsorption. AC that has been synthesised has been very expensive until recently, therefore the development of a relatively inexpensive and AC that is commercially available and may remain used in a inclusive range of uses appears to be an intriguing task (Falah *et al*., 2015). This goal can be achieved by utilising low-cost, readily available raw materials (Monal Dutta *et al.*, 2012). Agricultural wastes are used as low-cost carbon-rich source minerals with little inorganic content in these AC raw precursors. The removal of contaminated colours from industrial effluent is currently a prominent use of AC. Industrial effluents, which are wastes produced by various industrial and human activities, are widely known for causing high amounts of pollution in the environment. Around the world, more than 7105 tonnes of Dye and pigment-containing effluent is created each year (Falah *et al*., 2015). The discharge of this coloured contamination occurs when water is released into the environment of the soil and/or water by these polluting materials. Dyes and pigments are a significant class of contaminated elements in industrial wastewaters. For both toxicological and environmental grounds, this substance may have an impact on the environment (Falah *et al*., 2015). These colours, on the other hand, are non-biodegradable and expensive. Physical and chemical processes for colour removal, on the other hand, are more effective than biodegradable methods, but they are very expensive and cannot be employed in large-scale applications. As a result, adsorption techniques appear to be the most effective methods for dye removal. Activated carbons appear to be the most promising of the various adsorbents. AC, on the other hand, is broadly utilised as a common adsorbent for removing an inclusive spectrum of contaminated dyes from coloured wastewaters. Because of its high microporosity, exterior area, and lack of injuriousness, activated carbon has recently been deemed an essential type of adsorbent (Falah *et al*., 2015). As a result, it can be utilised to adsorb a wide spectrum of adsorbates. AC can be used for this, both powder and granular phases are required process. As a result, numerous scientists have been working on developing adsorption materials at a cheap cost Sugarcane, bagasse, rice straw, and flay ash are some of the materials used are among the adsorbents (Falah *et al*., 2015).

Objectives

1. The first step is to make physical activated carbons.
2. To determine the physical properties of the carbons that have been prepared.
3. To determine how much fluoride an adsorbent can remove as a utility of adsorbent dosage, contact phase, and pH
4. To look at the sorption kinetics and isothermal patterns.

Literature Review

Graphite (Karthikeyan and Elango, 2008), Gulmohar fruit shell (Pallavi Vijyakumar and Mise, 2008-09), *Cynodon dactylon* (Alagumuthu *et al*., 2010), *Phyllanthus emblica* (Veeraputhiran and Alagumuthu, 2011; Dutta *et al.*, 2012), possotia (*Vitex negundo*) leaf (Pranjal Saikia *et al.*, 2017), commercial and natural adsorption by (Das Kumar *et al.*, 2011), mango seeds (Salwa A Ahmed *et al.*, 2015) As adsorbents, they have been used. Activated made carbon from a variety of basic materials is effective in removing fluoride from drinking water. There have been no reports of defluoridation using *Phoenix dactylifera* (Date Plam) seeds.

As a result, the goal of this research is to see if carbon made from *Peltophorum pterocarpum* (copper pod) seeds and Seeds of *Phoenix dactylifera* (Date Plam) can be utilised in the capacity of an adsorbent to remove fluorides from water to drink.

Materials and Methods

Materials

The fruit of *Peltophorum pterocarpum* (Copper Pod) seeds and *Phoenix dactylifera* (Date Plam) seeds were utilised to make carbons. Physical properties of carbon, are all important factors to consider, were measured and are listed in Table 1 below.

Table 1. Characteristics of Primed Activated Carbons

Sl. No.	Characteristics	Physical Activated Carbon	
		Date Palm Seeds	Copper Pod Seeds
1	Moisture level (percent)	4.01	5.01
2	Content of ash (%)	11.77	16.63
3	Decolorizing power (mg/g)	30.0	116.7
4	Surface area (m^2/g)	503.31	596.90
5	pH	9.50	9.01
6	Specific gravity	1.218	1.5
7	Density of Bulk (g/cm^3)	0.45	0.240

Characteristics of Activated Carbons

It is necessary to understand some of the characteristics of *Peltophorum pterocarpum* (Copper Pod) seeds and *Phoenix dactylifera* (Date Palm) seed carbon before using and of the produced carbons are all factors to consider when using it as an adsorbent. Table 1 displays the results.

Methods

Preparation of Physical Activated carbon

The seeds of *Peltophorum pterocarpum* (Copper Pod) and *Phoenix dactylifera* (Date Palm) were cleaned and broken into bits, then washed 8 to 9 times in distilled water. The powder stood formerly withered in the oven for 24 hours at 105 °C. The oven dried powder was compacted in three layers in a small container, keeping no air space between each layer to stay away from powder a weight loss; otherwise, the material will burn instantly, leaving just the ash. After that, the container was placed inside a larger container, with the lid of the larger container snugly fitted, such that sand completely encircled the small container. The setup was then placed in a heated in a muffle furnace a constant rate until it reached 800 °C. The furnace was let to cool for a while roughly 10 hours after reaching the 800 °C temperature, then the container was removed. Activated carbon was used then sieved to a size of 300 microns, wrapped and kept in polythene bags as dessicator.

Optimal contact time determination

The contact time has a significant impact on adsorption. To investigate 100 ml of 5 mg/l fluoride results was diverse with 100 mg of activated carbon to see what effect contact time had. and swirled at various contact times ranging from 10 minutes to 24 hours (10 mins, 20 mins, 30 mins up to 120 mins). The fluoride concentration in the filtrate was then determined using a Spectrophotometer that measures UV and visible light.

Optimal adsorbent dose determination

To figure out how much activated carbon to use, from *Peltophorum pterocarpum* (Copper Pod) seeds and *Phoenix dactylifera* (Date Palm) seeds, it was additional to a bottle with a conical shape that contains a known a high concentration fluoride solution of 5 mg/l in 100mL in diversed dosages ranging derived (20 mg, 40 mg, 60 mg, up to 180 mg). The filtrate was tested for residual fluoride content using a spectrophotometer after In the conical flasks, the solution was stirred for the optimum contact period.

Calculation of Fluoride's Optimal pH

The pH at which adsorption occurs has a significant impact on the amount of adsorption that occurs. Equilibrium adsorption studies at numerous beginning pH values, extending from 2.0 to 9.0, were used to examine the effect of pH on fluoride adsorption. 0.1N H_2SO_4 or 0.1N NaOH were used to alter the pH of the solution. *Peltophorum pterocarpum* (Copper Pod) seeds and *Phoenix dactylifera* (Date Palm) seeds were varied and agitated to achieve optimal contact duration, and the filtrate was tested for fluoride residue content. The pH by which fluoride levels are at their highest elimination occurs is referred to as the optimal pH.

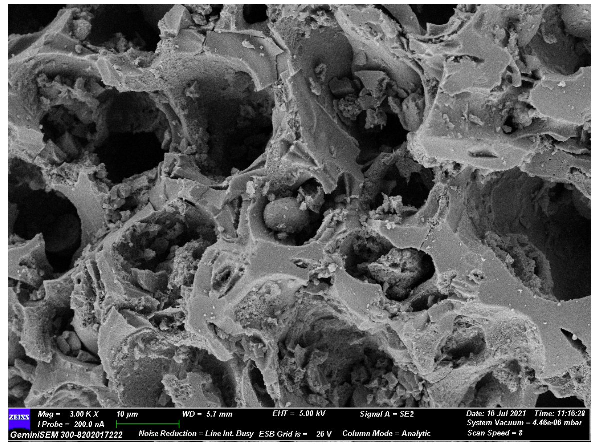
Perusing Electron Microscopy(sem)

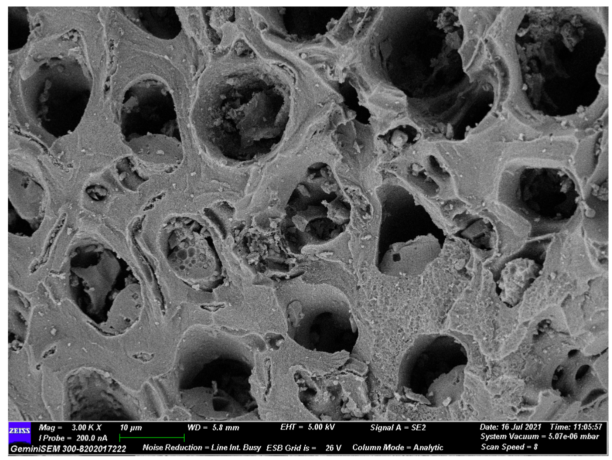
SEM was used to examine the morphology of the produced activated carbon. SEM scans of these materials revealed an uneven distribution and a surface with a heterogeneous shape. For all activated carbon samples, these pictures revealed the pores and cavities are present. Samples of activated carbon 1 2 and 3 have a lot of porosity and irregularity. These materials' increased porosity and cavities increases their adsorption capacity, allowing them to adsorb significant concentrations of adsorbates. As a result, They have a high efficiency as adsorbent materials and can be used in a variety of applications used in a variety Environmental and industrial applications are both possible. Those types of morphological pictures AC Figure 1 shows some examples.

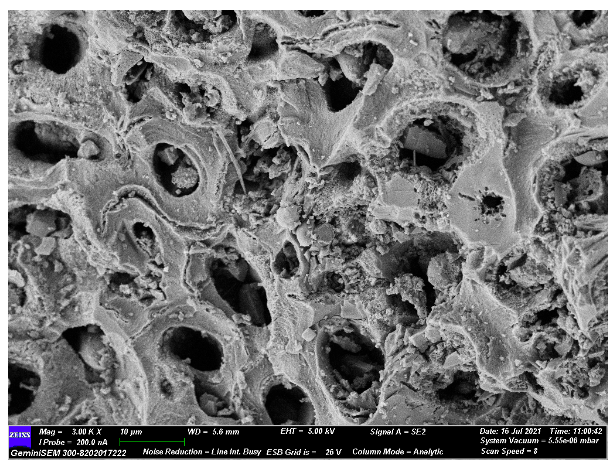
Results and Discussion

The effectiveness of fluoride reduction is measured in relations of –

The contact time
The dosage
The pH
Kinetics of Sorption
Equilibrium of Sorption







Contact Time Effect

The adsorption process is a complex one mostly contact time has an impact. Figure 1 depicts the influence of time spent in contact on the elimination of fluoride from a synthetic sample. It has been discovered that the fluoride adsorption extent grows with time and reaches equilibrium at a specific time. As a

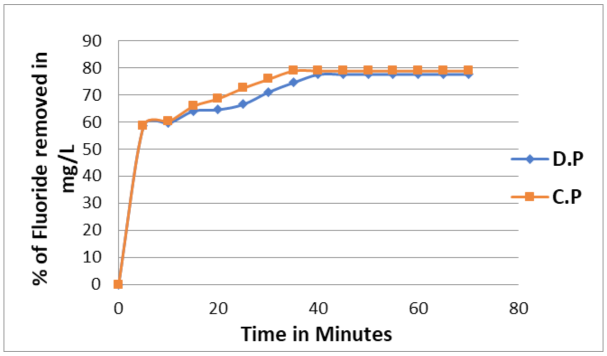


Fig. 1. The effect of contact time on the elimination of fluoride by Physically Carbon Activated

result, Table 2 lists the best time to call for all prepared carbons.

Dosage of adsorbent has the following outcome

The quantity of the adsorbent is investigated, and a graph of Fluoride elimination percentage vs dosage is presented in Figure 2. As the carbon increasing dosage, the residual quantity fluoride reduces dramatically and reaches equilibrium, as seen in the graph. The dosage that achieves maximum removal is referred to as the optimum dosage. As a result, Table 2 lists the optimum dosages for every prepared carbon.

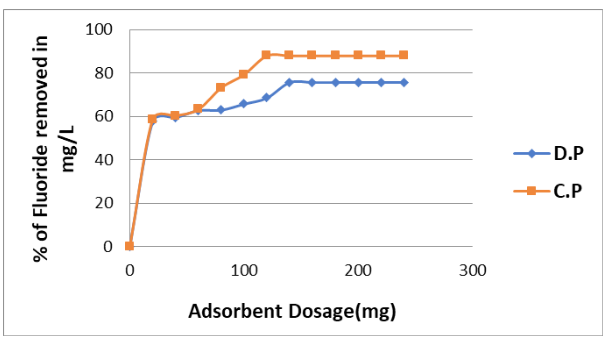


Fig. 2. Effect of contact dosage on fluoride elimination by Physically Activated Carbon

The impact of pH on Fluoride Removal

The pH at which adsorption occurs has a significant impact on the amount of adsorption that occurs. The degree of Fluoride adsorption removal efficiencies by produced activated carbon was impacted by the pH of the solution Figure 3 and Table 2 illustrate the results at various pH levels.

Sorption Kinetics

At room temperature, the kinetics of fluoride removal were studied at varied time intervals of adsorption. Table 3 shows the values of the model the constant reaction rate for various carbons, with the plots as a result given in Figure 4. Table 3 shows the calculated and graphical values of 'K' for prepared carbon. The first order reaction was tested using batch kinetic data for fluoride adsorption. The first order reaction's rate equation is provided as levelspiel.

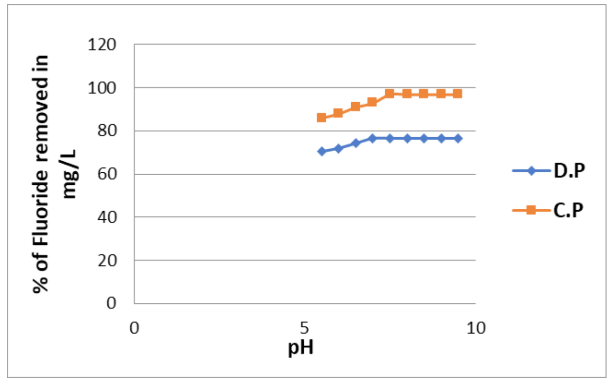


Fig. 3. Outcome of pH on fluoride elimination by Physically Activated Carbon

Table 2. Optimal time, dosage and pH for prepared carbons

S. No.	Type of carbon (Phyically Activated Carbons)	Optimal time (min)	Optimal dosage in (mg)	Optimal pH
1	Date Palm seeds	50	225	9.00
2	Copper Pod seeds	30	140	8.00

L_{n-} Ca / Co = K*T

2.303 log10 a / (a – x) = K * t i.e., log10 a / (a – x) = (k / 2.303) t i.e., k = 2.303 / t x log10 a / (a – x) = K * t i.e., log10 a / (a – x) = (k / 2.303) t

Where an is the preliminary fluoride concentration and x is the quantity of fluoride absorbed at any given time't'

an x = remaining fluoride quantity K = rate constant

Y = mx is the type of equation (5).

Where Y = log10 a / (a x) and x = t are the variables. m = k / 2.303

Substituting the values in equation (5) we get

y = mx

As a result, there is a conventional line graph per slope = k / 2.303 produced. It can be seen from the graphical and computed "K" values that fluoride adsorption follows first order rate equations. As demonstrated in Fig 4 and Table 3, the rate of

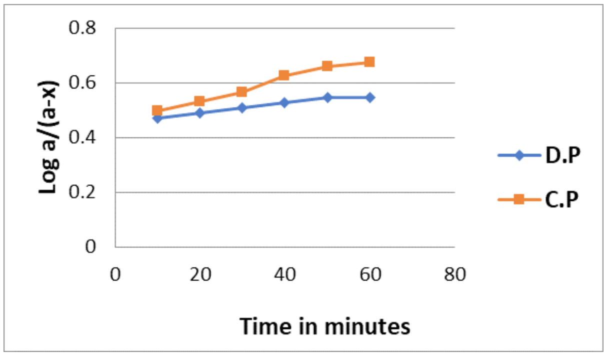


Fig. 4. Plot of Physically Activated Carbon Reaction Rate Constant

change for each carbon becomes constant, and "K" values increase as the Impregnation ratio increases, and graphical values are somewhat lower than calculated values for physical activated carbons.

f3.2.1) Pore Diffusion

C / C0 = KP x t12 = C / C0 = KP x t12 = C / C0 = KP x t12 = C / C0 = KP x t12 = C / C0 = K Where C is the sorbate attentiveness in mg/L at any time "t" (hr). t = time taken for sorption. C0 = initial sorbate concentration in mg/l. KP = pore diffusion rate

A straight line graph of C / C0 Vs t1/2 for fluoride is given. The C/Co and t1/2 model values are shown. For prepared carbon, the computed and graphical values of KP are shown. As demonstrated in Fig 5 and Table 3, the graphical values of KP values are bigger than the theoretical values. It demonstrates that pore diffusion reduces with time, resulting in an increase in adsorption. Data on pore diffusion confirms the rise in adsorption with time.

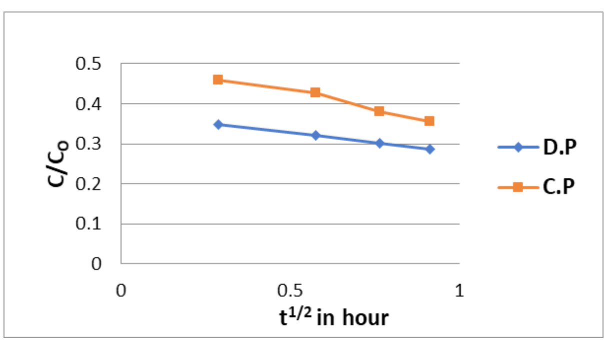


Fig. 5. Webber and Morris Plot for Physically Activated Carbon

Sorption Isotherm Model

Sorption equilibrium isotherms can be used to calculate the amount of sorbate necessary to sorb a specified amount of sorbate from solution. Freundlich, Langmuir, and Temkin isotherms are the most commonly used equations for presenting adsorption data. For all three isotherms, the sorption equilibrium data is filled.

Freundlich Isotherm

The Freundlich isotherm has a linear form.

Taking both sides of the log

Log10 = log10 K + 1 / n log10 log10 log10 log10 log10 log10 log10 log C At equilibrium, X/M = Amount of sorbate adsorbed per unit weight of adsorbent. X is the amount of adsorbate extracted in milligrammes per litre (mg/l). M is the adsorbent's mass or weight. C = Adsorbate equilibrium concentration in solution K is a sorption capacity-related empirical constant. n = A sorption intensity-related empirical constant.

The kind of equation (4.2) is y = c + m x.

Where c = log10 K is the constant.

Y = log10 X / M, X = log10 C, and m = 1/n are the equations.

Knowing the slope and intercept "1/n" and "K," the plot of log10 X/M vs log10 C yields a conservative contour with a slope of 1/n and a point of intersection = log10 K. As illustrated in Fig. 6 and Table 4, This is a common technique of presenting experimental results as a convenient means of identifying

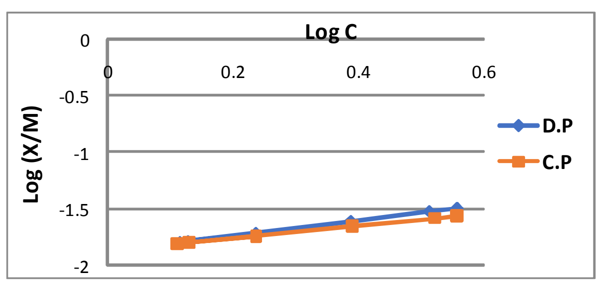


Fig. 6. Plot of Freundlich Isotherm for Physically Activated Carbon

Table 3. Sorption Kinetics

Sl. No.	Carbon Species (Physically AC)	Calculation's K Values	The graph's K values	Kp values from calculation	Kp values from graph
1	Date palm seeds	0.0647	0.0041	0.323	0.301
2	Copper Pod seeds	0.287	0.036	0.558	0.436

if materials are removed from solution by adsorption and calculating the constants "K" and "n."

Langmuir's Isotherm

The Langmuir isotherm is applied to represent single-layer adsorption, and its line form is:

X/M = (a + bc) / abc 1/ab + c / a = C / (X/M) Where X/M is the amount of adsorbate adsorbed per unit of adsorbent weight. C= after adsorption, equilibrium or saturated concentration of adsorbent in solution. The emperical constants 'a' and 'b' are used in this example.

y = c+mx, where c = 1/ab and m=1/a, and x = c the C/(X/M) plot Unlike C, a straight-line graph is generated. The intercept and slope are used to derive the value of the constants 1/b and 1/ab. 1 / ab = intercept; 1/a = slope 1/b X slope Equals intercept; b = slope / intercept

Table 4 displays the model data that was calculated. Figure 7 and Table 4 show the for many adsorbents, the linearised Langmuir isotherm (C / X/M against C) was displayed.. The slope and intercept of the above graphs are used to evaluate 'a' and 'b.' Least square analysis can be used to verify this, and graphical values are shown. On the basis of the results, the succeeding equations for various carbons are presented.

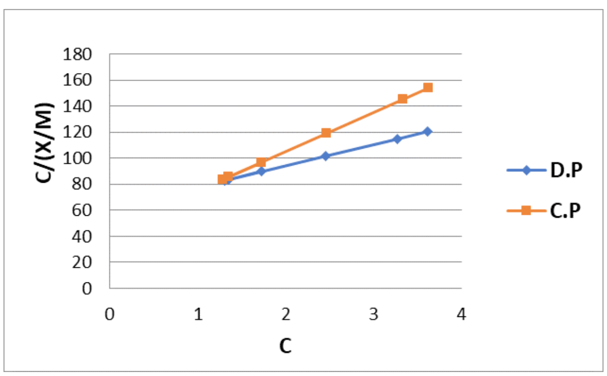


Fig. 7. The Langmuir Isotherm for Physically Activated Carbon is plotted on a graph

Webber defines the main properties of the R = 1 / [(1 + a) Co] is the Langmuir isotherm conveyed in terms of a dimensionless continual unique equilibrium parameter. The Langmuir constant is an, and C0 is the solute's preliminary concentration. Webber has offered the succeeding parameter identifying the kind of the isotherm from the preceding equation:

Values of R	Type of Isotherm
R > 1	unfavorable
R = 1	Linear
0 < R < 1	Favorable
R = 0	Irreversible

Temkin Isotherm

The adsorption isotherm typical, which was created to account for the chemisorption of an adsorbate against the adsorbent, is written as X = a + b ln C in its simplest form.

Where C is the adsorbate attentiveness in result at equilibrium (mg/l).

X represents the metal quantity absorbed per gramme of adsorbent (mg/g).

a = An adsorption capacity-related empirical continual.

b = An experimental constant connected to adsorption intensity.

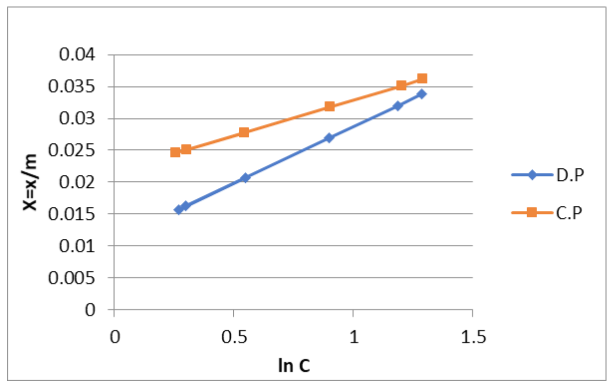


Fig. 8. Physically Activated Carbon Temkin Isotherm Plot

In the Temkin front equation, adsorption energy is a linear utility of surface coverage. The Temkin isotherm is only effective for an in-between variety of ion concentrations. You can draw a conventional line with slope and intercept using the slope and intercept of ln C vs X..

Conclusion

1. For physical activated carbon, the optimum contact time is 30 minutes and 50 minutes, with removal efficiency of 77.50 percent and 72.63 percent, respectively.
2. The results of an experiment on adsorbent dose optimization shows that increasing the adsorbent quantity supplied increases fluoride removing it self from the solution. Physical activated carbon dosages of 140 mg and 225 mg were shown to be

Table 4. Sorption Isotherm Model

S. No	Type of Carbons (Physically Activated)	Freundlich Isotherm		Langmuir Isotherm			Temkin Isotherm	
		Const '1/n'	Const 'k'	Const 'a'	Const 'b'	'R'	Const 'a'	Const 'b'
1	Date Palm Seeds	0.6952	0.0133	0.0654	0.2367	0.208	0.0109	0.0178
2	Copper Pod Seeds	0.5564	0.0135	0.033	0.672	0.2151	0.0128	0.0110

optimal, with elimination efficiencies of 79.33 percent and 75.80 percent, respectively.

3. Fluoride adsorption is primarily pH dependant. With a lower pH value, the adsorbent's removal effectiveness improves. For physical activated carbons, maximal adsorption occurred around pH 8.00 and 9.00, with removal effectiveness of 82.6 percent and 76.5 percent, respectively..
4. The rate of fluoride adsorption follows a first order rate equation. For pore diffusion, it also follows the Webber and Morris equation.
5. The results of the isotherm models that follow the Langmuir, Temkin, and Freundlich isotherms show that adsorption is favourable.

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