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Adsorption Studies of Nitrate on Activated Carbon derived from Helianthus Annuus

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Abstract

The present study deals with removal of nitrate from aqueous solution using low cost activated carbon prepared from helianthus annuus cob. In adsorption solute present in dilute concentration in liquid or gas phase is removed by contacting with suitable solid adsorbent so that the transfer of component first takes place on the surface of the solid and then into pore of the solid. Batch adsorption study were conducted by varying the contact time, adsorbent dosage & pH were studied. For physically activated carbon the optimum contact time is 50min,45min and 40min for 300µ, 150µ and 75µ respectively and for chemically(NH_4Cl) activated carbon is 45min,40min and 35min for 0.25,0.5 and 0.75 IR respectively. And the optimum dosage for physically activated carbon is 1000mg, 900mg and 800mg for 300µ,150µ,and 75µ respectively and for chemically activated carbon is 700mg ,600mg and 400mg for 0.25,0.5 and 0.75IR respectively for 100mL of sample. And the optimum pH for physically activated carbon is 1.5,1.5,1.5 for 300µ,150µ,75µ respectively and optimum pH for chemically activated carbon is 1.5,1.5,1.5 for 0.25,.50,0.75IR respectively.

Keywords:*Activated Carbon, Adsorption, nitrate.Imprigation Ratio*.

Introduction

The scope of interest in this present study is to use Helianthus Annuus (sun flower cob) as an alternate low cost adsorbent in removal of nitrate. The sun flower cob is available locally and abundantly and the cob is Agricultural waste which is available at throw way cost. The interest in choosing this cob is that it has not being used as adsorbent for the removal of nitrate.

Nitrate is a common pollutant introduced into the water sources due to variety of waste materials from site used for disposal of human and animal wastes, industrial wastes related to food processing and fertilizers used by farmers in fields. According to ISO 10,500 drinking water guidelines, the maximum allowable limit for the nitrate is 45mg/L as Nitrate.

At the maximum contaminant level, nitrate causes methemoglobinemia, blue baby syndrome, stomach and gastrointestinal cancer

Materials and methods

Adsorbent

The material used in this research study is Helianthus Annuus as an adsorbent. For removal of nitrate from aqueous solution, adsorption technique was employed using activated carbon prepared from helianthus annuus. There are two methods to prepare activated carbon, namely

i. Physical activation (taking three sieve sizes 75,150,300 microns)
ii. Chemical activation, using ammonium chloride (NH_4Cl) as an activating agent (taking sieve size 150 microns).

Impregnation Ratio

In chemical activation the degree of I.R. play an important role. It is the ratio of weight of anhydrous activating salt to the dry carbonizing material. The effect of the degree of impregnation ratio on the porosity of the resulting product is apparent from the fact that volume of pores increases with I.R. When degree of impregnation is further raised the number of pores with large diameter increases and the volume of the smallest decreases. In this study 0.25, 0.50 and 0.75 I.R'S are used.

Batch Sorption Experiment

In batch sorption, a pre-determined amount of adsorbent is mixed with the sample, stirred for a given contact time and subsequently separated by filtration. Powdered adsorbent is more suitable for the batch type of adsorption.

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Selection of Optimum Contact Time

The adsorption is strongly influenced by the contact time. To study the effect of contact time, 100mL of 10mg/L nitrate of pH 2.0 ± 0.02, was mixed with 0.4g of activated carbon, stirred at different contact times varying from (5mins, 10mins, 15mins upto 60mins). Then the filtrate was analyzed for residual nitrate concentration using UV- spectrophotometer.

Determination of Optimum Dosage

To determine the optimum dosage of activated carbon, carbon was added to the conical flask in varying amount (100mg, 200mg, and 300mg upto 1200mg), containing 100mL concentration of nitrate solution (10mg/L) and adjusted pH 2.0±0.02. The solution in the conical flask was subjected to stirring for optimum contact time, filtered and analyzed for residual nitrate concentration. The dosage which gives minimum residual concentration is chosen as optimum dosage.

Selection of Optimum pH :

The extent of adsorption is strongly influenced by the pH at which adsorption is carried out. The effect of pH on nitrate adsorption was studied by performing equilibrium adsorption tests at varying pH values. i.e. from 1.25 to 3.0. The pH of solution was adjusted by using 0.1N H_2SO_4 and 0.1N NaOH .The pH at which maximum nitrate removal forms optimum pH.

Results and discussions

Efficiency of prepared carbon for removing Nitrate is studied with the:

a) Effect of contact time
b) Effect of dosage
c) Effect of pH

Effect of contact time:

Contact time has greater influence on the adsorption process. The effect of contact time on removal of nitrate from synthetic sample at pH 2.0 ±0.02 using physically and chemically activated carbons Ammonium Chloride (NH_4Cl)) prepared from Helianthus annuus cob powder.

Optimum contact time for physical activated carbon at different sizes 300µ,150 µ ,75 µ are 50min,45min,40min with removal efficiency of 55.4%,57.97%,62.92%.Similarly optimum contact time for chemically activated at different I.R.0.25,0.50,0.75 are 45min,40min,35min with removal efficiency of 80.13%,84.10%,88.13% as shown in fig 1and 2.

The result of optimization 0f contact time of adsorbent reveals that, removal of nitrate increases with increase in contact time and attains equilibrium at particular time. Hence optimum contact time for physically activated carbon of size 75 µ retained is 40min with removal efficiency of 62.92% which has higher removal efficiency with lower optimum contact time compare to other two carbons. optimum contact time for NH_4Cl activated carbon of I.R.- 0.75 is 35min with removal efficiency of 88.13% which has higher removal efficiency with lower optimum contact time compare to other two other carbons because surface area of this carbon is more than other two carbons.

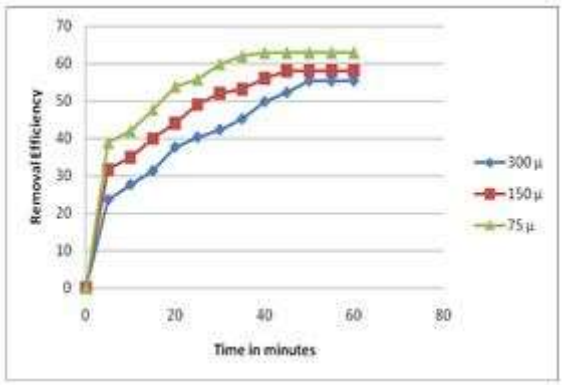

Fig. 1 Effect of Contact Time on Physically Activated Carbon

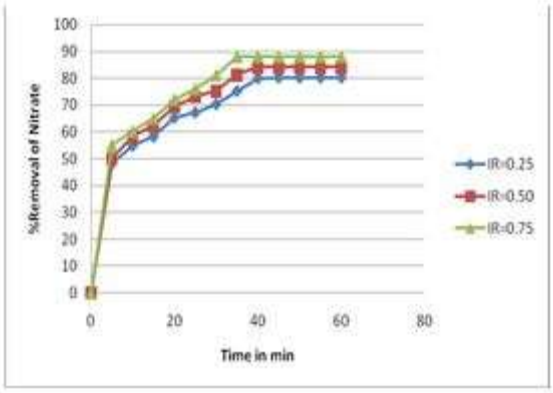

Fig.2 Effect of Contact Time on chemically activated Carbon

Effect of adsorbent dosage

Adsorption is a process in which continues transfer of solute from solution to adsorbent occurs, until residual concentration of solution maintains an equilibrium with what adsorbed by the surface of adsorbent at constant contact time.

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Optimum dosage for physical activated carbon at different sizes 300µ,150 µ ,75 µ are 1000mg, 900mg, 800mg with removal efficiency of 50.77%, 57.34%, 61.53%.Similarly optimum dosage for chemically activated at different I.Rs.0.25, 0.50,0.75 are 700mg, 600mg, 400mg with removal efficiency of 65.58%, 71.08%, 73.90% as shown in fig 3and 4.

The result of experiment on optimization of dosage of adsorbent reveals that, increase in amount of dosage added, increases the removal of nitrate from the solution. Hence Optimum dosage for physically activated carbon of size 75 µ retained is 800mg with removal efficiency 61.53% which has higher removal efficiency at lower optimum dosage compare to other two carbons respectively. Similarly 0ptimum dosage for NH4Cl activated carbon at I.R.- 0.75 is 400mg with removal efficiency of 73.90% which has higher removal efficiency with lower optimum dosage compare to other two carbons because surface area of this carbon is more than other carbons.

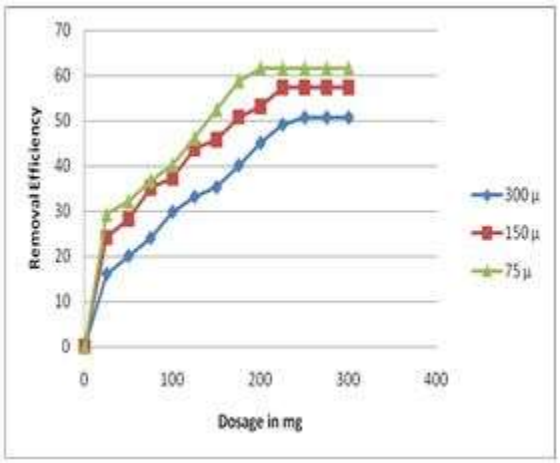

Fig.3 Effect of Adsorbent Dosage on physically Activated Carbon

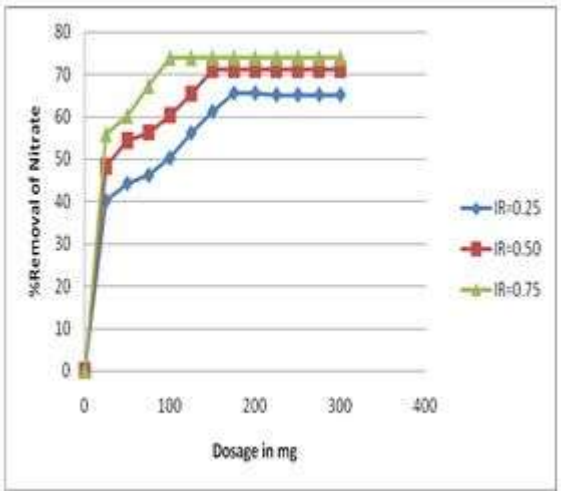

Fig.4 Effect of Adsorbent Dosage on NH_4Cl Activated Carbon

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Effect of pH on nitrate:

The pH of solution has influence on the extent of adsorption removal efficiencies of Nitrate by prepared activated carbon at different pH values 1.25 to 3. The amount of nitrate not only depends on the optimum time and optimum dosage but also depends on pH.

Optimum pH for physical activated carbon at different sizes 300µ,150 µ ,75 µ is 1.5 with removal efficiency of 68.72%, 69.98%, 72.76%. Similarly optimum pH for chemically activated carbon at different I.Rs.0.25,0.50,0.75 is also 1.5 with removal efficiency of 95.18%,96.16%,98.77% as shown in fig 5and 6.

The removal efficiency of adsorbent increases with decrease in pH value. It has been observed that maximum adsorption takes place in the acidic medium at pH-1.50. physically activated carbon of size 75 µ has got removal efficiency 0f 72.80% which has higher removal efficiency at optimum pH value compare to other carbons. Similarly Ammonium chloride (NH_4Cl) activated carbon of I.R.- 0.75 with removal efficiency of 98.80% which has higher removal efficiency at optimum pH value compare to other two carbons because surface area of this carbon is more than other two carbons.

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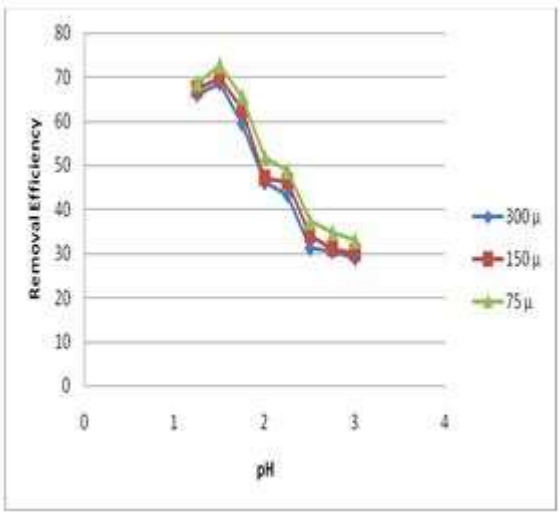

Fig5.Effect of pH on Physically Activated carbon

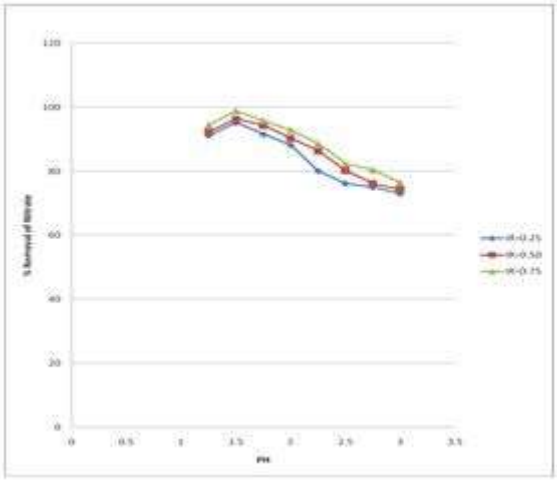

Fig.6 Effect of pH of on NH_4Cl Activated Carbon

Table-1: Optimum Contact time, Optimum Dosage and Optimum pH for Prepared Carbons

Type of Carbon	Size in micron	LR	Optimum Time (Min)	Optimum Dosage (mg)	Optimum pH	Surface Area m^2/gm
1.Physically activated	300	-	50	1000	1.50	581.32
	150	-	45	900	1.50	589.03
	75	-	40	800	1.50	601.97
2.Chemically activated (NH_4Cl)						
	150	0.25	45	700	1.50	670.28
	150	0.50	40	600	1.50	685.59
	150	0.75	35	400	1.50	704.37

Conclusion

1. The optimum contact time for physically avtivated carbon of different sizes 300µ,150µ,75µ are 50mins, 45mins, 40 mins and for NH4Cl activated carbon at different IRs 0.25, 0.50, 0.75 are 45mins,40mins,35mins respectively.
2. The optimum dosage for physically activated carbon of different sizes 300µ,150µ,75µ are 1000mg, 900mg, 800mg and for NH4Cl activated carbon for different IRs 0.25, 0.50, 0.75 are 700mg, 600mg, 400mg respectively.
3. The optimum pH for all physico-chemically activated carbon is 1.5 .

Scope for future study

1. Adsorption studies can be further continued on various other heavy metals like arsenic, lead, zinc etc.

Acknowledgements

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