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Study of Arsenic Adsorption Characteristics on Fuller's Earth

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Abstract

In this research, adsorption of Arsenic on fuller's earth has been studied through using batch adsorption techniques. Main objectives of this study are, to study the physical properties of Fuller's earth, detection of Arsenic removal by adsorbent as a function of contact time, adsorbent dosage and pH, to study sorption kinetics. The results of this study showed that the Optimum contact time, dosage and pH for adsorption of Arsenic on Fuller's earth reached to equilibrium after 110mins, with removal efficiency of (79.30%), 2000mg as optimum dosages. Higher adsorption of Arsenic was observed at higher pH, obtained at pH 8.0, the rate of adsorption of Arsenic obeys first order rate equation. The obtained results of the batch experiments are best fit to Langmuir and Freundlich adsorption isotherms. From the experimental analysis it is concluded that Fuller's earth shows good removal efficiency and hence can be used as adsorbents.

Keywords*: Fuller's Earth, Adsorption Characteristics, Arsenic*

INTRODUCTION

Arsenic [As] and other heavy metals occur naturally in geological structures or sometimes caused by mining, industrial and Agricultural activities[1]. This heavy metal can badly affect human health when they are consumed in large amount. The ground water at various locations in Bangladesh, States of West Bengal & Karnataka, has been noticed to be contaminated with Arsenic in excess of its permissible value. Recently 14 out of 20 villages at Surpur taluq of Yadgir district, Karnataka state (India) has been found to

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be affected by Arsenic content. The determination of Arsenic has been of importance to public health agencies for many years because of the toxicity of Arsenic compounds. Several incidents have demonstrated that Arsenic in water may be carcinogenic. Acute poisoning by Arsenic involves the central nervous system leading to coma and for doses of 70-80 mg to death.

The gastro-intestinal tract, nervous system, the respiratory tract, and the skin can be severely affected [2]. It is recommended that, when water is found to contain Arsenic in excess of 0.01 mg/L (W.H.O), the water is considered to be unfit for drinking. Arsenic can be removed by many conventional and non-conventional methods. Adsorption is used widely to remove Arsenic metal from water and industrial wastewater.

Adsorption offers significant advantages like low cost, availability, profitability, easy of operation and efficiency, in comparison with conventional methods (such as membrane filtration or ion exchange) especially from economical and environmental points of view. .

MATERIALS AND METHODOLOGY

Fuller's Earth

In this present study naturally available soil namely Fuller's earth which is abundantly available in kapnoor area Humanabad road Gulbarga is taken as a study material (adsorbent) for the removal of arsenic its synthetic sample. Soils are moderately Alkaline in nature.Fuller's earth is very fine grained naturally occurring earthy substance.

Characteristics of Fuller's earth:

Before using the Fuller's earth as an adsorbent, the physio-chemical characteristics such as moisture content, pH, decolorizing power, specific gravity and bulk density are studied. The results are shown in Table 1. All the methods of analysis are as per "Standard Methods for the Examination of Water and Wastewater", 21 edition. [3]

Table 1: Characteristics of Fuller's earth

Sl.no	Characteristics	Fuller's earth
1.	pH	8.2
2.	Specific gravity	2.4
3.	Moisture content	20%
4.	Decolorizing power	19.5
5.	Bulk Densitygm/cc	1.008

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METHODS

1. Batch Sorption Experiment

In batch sorption, a predetermined amount of adsorbent is mixed with the sample. The sample is shaking on a rotary shaker for a given contact period and subsequently separated by filtration. . Arsenic removal affinity of Fuller's earth was determined from batch experiments as a function of contact time, dose of the adsorbent, pH, kinetics of Arsenic removal were also studied.

2. Selection of Optimum Contact Time:

The adsorption is strongly influenced by the contact time, for the study of effect of contact time 100m1 of 10mg/L Arsenic solution was mixed with 50gm of soil sample and stirred for different period of contact time i.e. for 2hr and time interval varies as 10,20……120 min .This is filtered and analyzed for Arsenic concentration using spectrophotometer method.

3. Determination of Optimum Dosage of Adsorbent:

To determine the optimum dosage of adsorbent, adsorbents were added to the conical flask containing known concentration of Arsenic solution (10mg/L). The solution in the conical flask was subjected to stirring for optimum contact time and the dosage varies from 200,400,600…..2400mg/L. Filtered and analyzed for residual and removal of Arsenicchosen as optimum dosage.

4. Selection of Optimum pH:

To determine the optimum pH series of conical flasks were taken with 100 ml of 10 mg/L Arsenic solution. Optimum dosage of soil (10mg/100ml) is added the pHs of the flasks were adjusted ranging from 6.0 to 8.75. The flasks were shaken for optimum contact time. After stirring the samples are filtered and analyzed for the residual Arsenic concentration. The dosage which gives minimum residual concentration is. The flask which gives minimum residual concentration is selected as the optimum pH.

Adsorption Isotherms

The quantity of adsorbate that can be taken up by an adsorbent is a function of both the characteristic and concentration of adsorbate and the temperature. The characteristic of the adsorbate that are of importance include: solubility, molecular structure, molecular weight, polarity and hydrocarbon saturation. Generally the amount of adsorbate adsorbed by adsorbent is determined as the function of concentration at constant temperature, and the resulting function is called as the

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adsorption isotherm. Adsorption isotherms are developed by exposing a given amount of adsorbate in a fixed volume of liquid to varying amounts of adsorbate. Equations that are often used to describe the experimental isotherm data were developed by Freundlich and Langmuir.

RESULTS AND DISCUSSION

General

With the following Arsenic removal study gas been carried out with respect to the following parameters

1. Effect of contact time
2. Effect of dosage
3. Effect of pH

Effect of contact time

Contact time has greater influence in the adsorption process. The effect of contact time on removal of arsenic from synthetic sample's by using Fuller's earth. The resulting graph is plotted as shown in the below fig 1. From the graph it is evident that the extent of Arsenic adsorption increases with increase in time. After equilibrium further increase in time, adsorption is not changing. Hence, the removal efficiency on 'As' by using Fuller's earth was found to be 79.30% with an optimum contact time of 110 mins respectively.

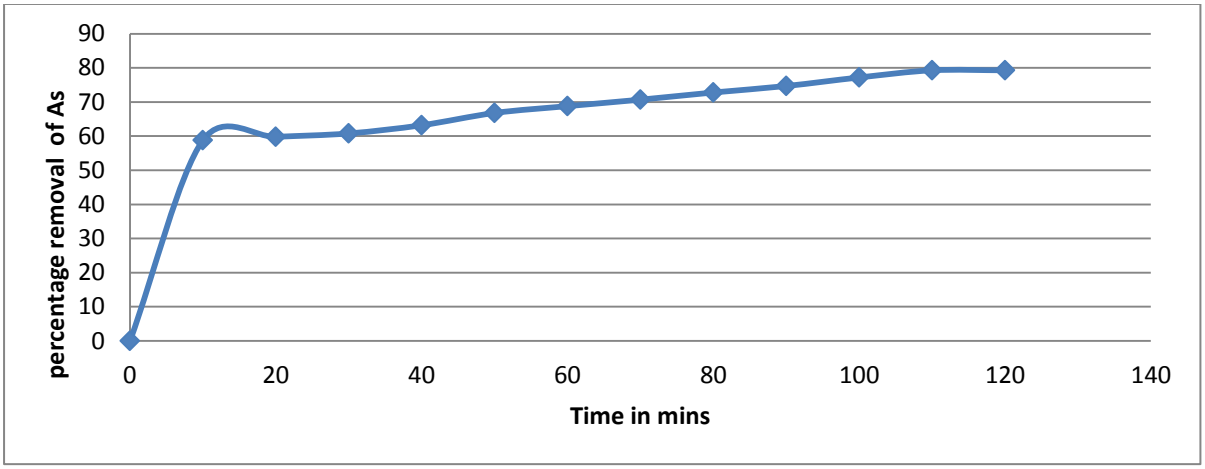


Fig.1 Effect of Contact time on Fuller's earth

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Effect of Adsorbent Dosage:

Adsorption is a process in which continuous transfer of solute from solution to adsorbent occur, until residual concentration of solution maintains an equilibrium with that adsorbed by the surface of adsorbent at constant contact time. Effect of adsorbent dosage is studied and graph of percentage of arsenic versus dosage is plotted as shown in fig.2. It is observed from the graph that as dosage increases amount of As increases, sharply in the beginning and attains maximum latter. The point where maximum is attained is taken as optimum dosage. After attending optimum dosage, change in Fuller's earth dosage alter much in the beginning and remain constant after attending optimum dosage. Hence, the removal efficiency on As by using Fuller's earth was found to 84.90 % with an Optimum dosage of 2000 mg respectively**.(See Figure: 2)**

Effect of pH

The impact of As removal mainly depends upon the pH of the medium. The graph of pH against As removal is plotted by not altering the optimum contact time and optimum dosage as shown in the fig 3. The amount of As not only depends on optimum time and optimum dosage but also depends on pH..From the graph it is evident that the As is removed more effectively in acidic range. As pH increases the removal efficiency of As increases appreciably. Hence, the removal efficiency on As by using Fuller's earth was found to be 75.10 % around pH 8.0 respectively (See figure3)

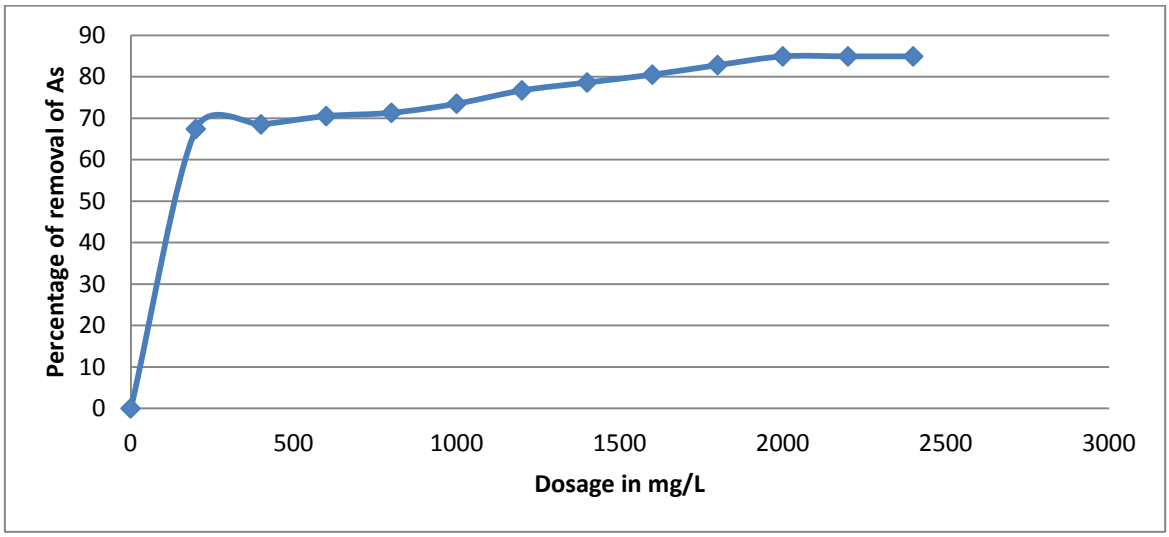


Fig.2 Effect of Adsorbant dosage on Fuller's earth

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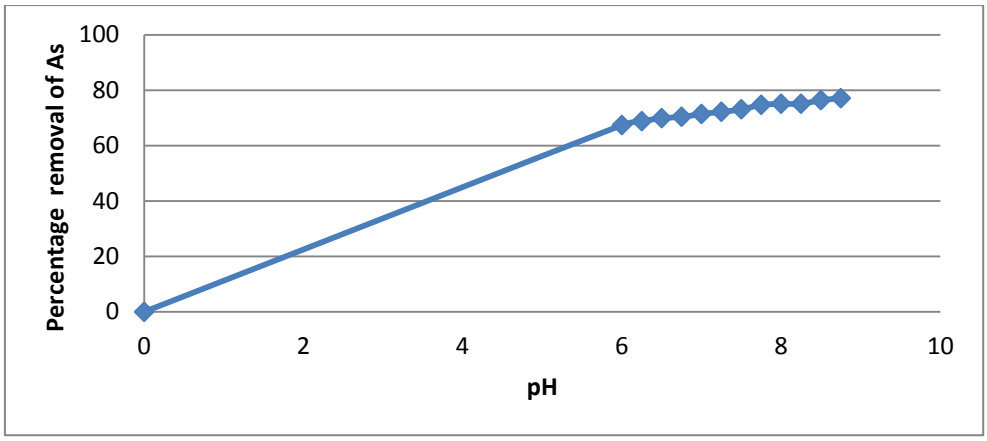


Fig.3 Effect of pH on Fuller's earth

4. SINGLE ADSORPTION OF NITRATE (BATCH EXPERIMENT)

4.1 Fuller's earth

Table 2 Single adsorption of Arsenic in Fuller's earth

cmg/L	q mg/kg	1/c l/mg	1/q kg/mg
5	35.20	0.2	0.0284
10	79.40	0.1	0.0125
15	108.20	0.066667	0.00924
20	142.40	0.05	0.00702

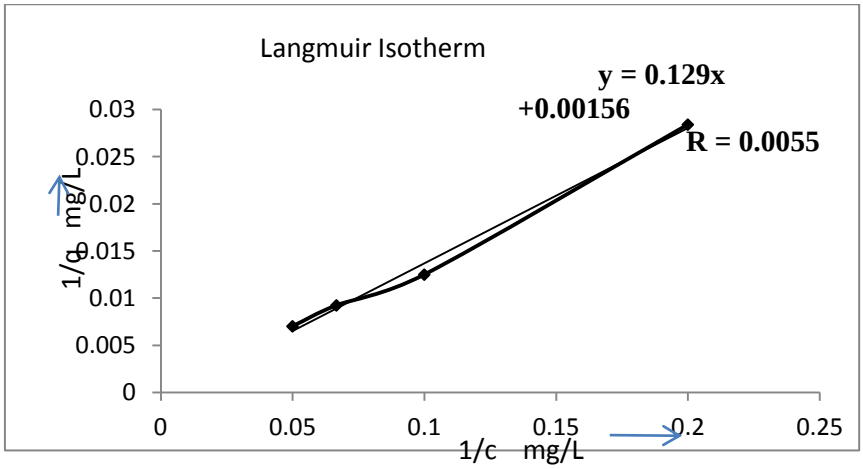


Fig. 4 Single adsorption of Arsenic in Fuller's earth

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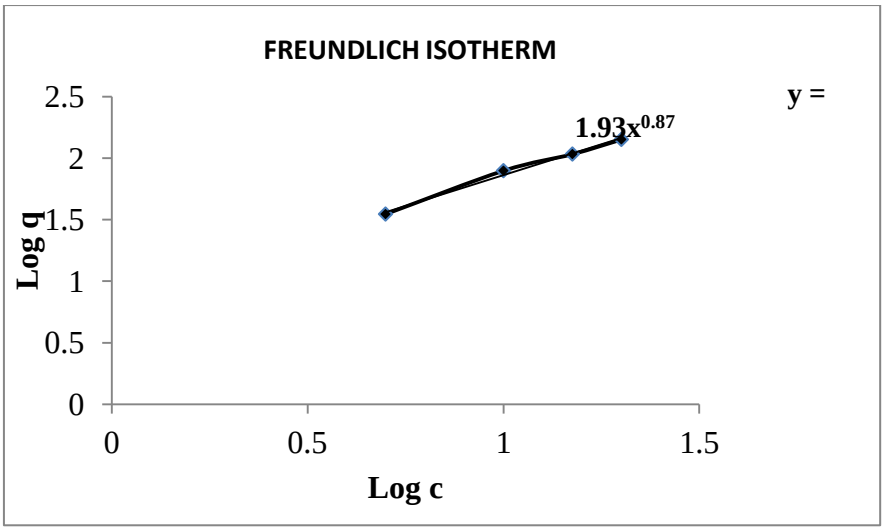


Fig. 5 Single adsorption of Arsenic in Fuller's earth

CONCLUSION

Based on the experimental study the following conclusions were drawn. The extent of Arsenic adsorption increases with increase in time and attain equilibrium. The result of experiment on optimization of dosage the adsorbent reveals that increase in amount of adsorbent added, increases the removal of Arsenic from the solution and almost becomes constant after saturation dose for different dosages. The adsorption of Arsenic is pH dependent. The removal efficiency of adsorbent increases with decrease in the pH value 8. In batch experiments studies the adsorption of Arsenic follows Freundlich and Langmuir isotherms indicating single adsorption of Arsenic and proves to be a favorable(R=0.0055) adsorption because when we fit the results to isotherms it gives equilibrium parameter or separation factor R<1.

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