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Aluminium Impregnated Orange Peel Activated Charcoal used for Fluoride Remediation from Synthetic Fluoride Solution

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Abstract: ***Fluoride is very found and common contaminant in ground water. Due to the excess contamination of fluoride in drinking water it cause of fluorosis. The World Health Organization (WHO) guidelines give the permissible limit of fluoride in drinking water is 1.5gm/l. There are various methods for elimination of fluoride as Electrocoagulation, Ion exchange, Membrane process, Adsorption etc. Adsorption is widely explored because of its simplicity and easy processing. There are using agro wastes orange peel charcoal which is impregnated by aluminium, for fluoride removal. This adsorbent efficiency studied at different parameters such as adsorbent dose, agitation time, pH, initial concentration of fluoride and temperature. The adsorption of fluoride from ground water with aluminium impregnated orange peels gives 96% fluoride leaching at pH 6.***
Keywords: Adsorption, Aluminium Impregnated Orange peel, Charcoal, Fluoride Removal.

I. INTRODUCTION

There are many natural resources of water among of them resources the water is one of the important resource for pants, animals and human beings. There are various contaminant substances which directly affect the health of human being. Fluoride is such type of contaminator that directly affects the human beings health after its consumption throughout the food and drinks [1, 2]. Fluoride in gaseous form is the very strong oxidizing agent and it is also a powerful electronegative element [3]. Through the guideline of WHO (World Health Organization) the permissible limit of fluoride is 1.5mg/l in drinking water [4].

Fluoride comes in water due to weathering of fluoride containing rocks and soils and leaching from the soil into ground water. Fluoride enters into ground water due to dissolution from minerals/rocks like topaz, fluorite, fluorspar, cryolite, fluorapatite etc [5]. Fluoride is more toxic than lead but less toxic than arsenic.

Fluoride has influenced on human being because of its dual nature, it's inefficiency is harmful for bones and tooth on the other hand it's high concentration is causes of fluorosis, brittling of bones, curvature of bones, mental disorders etc. that's why fluoride is known as two edges sword.

In small doses of fluoride, it prevents the tooth decay but in high doses it causes of fluorosis. So many treatment methods were followed as coagulation/precipitation, electrochemical, electrodialysis, invert assimilation, adsorption and ion-exchange but adsorption was found to be more suitable and efficient method for defluoridation .In adsorption process many natural/agriculture waste and low cost adsorbents such as coconut shell fiber carbon, coconut shell carbon, rice husk ash, nirmali seeds, powdered and granular red mud, clays, cashew nut shell carbon were studied [6, 7].

The idea of generation of adsorbent with agro wastes came due to its easily availability and low cost. It has been reported that hydroxyl, carbonyl, amine, amide, carboxyl, sulfhydryl, imidazole, phosphonate, and phosphodiesters functional groups are present on the surface of biosorbents and allows to biosorption [8, 9]. To removal of fluoride from water there are required for a cheap process for remediation.

Adsorption is found the cheap process for fluoride removal and then required for a cheap adsorbent. In recent days removal of fluoride from drinking water is a big challenge for human health. Removal of fluoride from drinking water especially in fluoride affected areas at low cost there are used orange peels. Most of the adsorption studies were done with modification of the natural activated carbon by doping or impregnation/mixing with other chemicals to increase the surface area for higher removal efficiency, which has a longer procedure. Orange peels can be easily collected from local market of fruit shops. With this point of view, present work was undertaken to investigate the potentiality of aluminium impregnated orange peel charcoal for removal of fluoride from synthetic fluoride solution.

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II. MATERIAL AND METHOD

A. *Collection of Adsorbent*

The orange peels are collected from the HBTU Kanpur hostels and also from the fruit shops of local market. After collecting the peels cut them into small pieces and washed them with distilled water then dried it into the sunlight. After drying the peels into the sunlight for 3-4 hr, dried it into the hot air oven at 353K around 60 minutes. Then grind them with the help of grinder and sieved through mesh size 150m. The grinded powder was burnt into the muffle furnace at 427 K for 45 minutes. The ash was removed by washing with distilled water and further dried in oven at 353 K for overnight. Throughout the whole process the material was found known as charcoal.

B. *Preparation Of Aluminium Coated Orange Peel Charcoal*

With the guidelines of Ganvir and Das [10] for the aluminium impregnation there are used a stirrer tank reactor with stirring, vacuume pressure filter and oven drier. Firstly100gm of orange peel charcoal was taken into the stirrer tank reactor further 0.6M aluminium sulphate solution with the 500ml volume was added and stirred the mixture. There were required to control its pH, the pH remains 5-7 for controlling its pH 1.0M sodium hydroxide solution was used. When the pH reaches upto 5-7 stopped to add sodium hydroxide solution the reaction had completed. The whole slurry was filtered and got desired adsorbent at 400K. For the further used of the impregnated charcoal double distilled water was used to removal of sodium sulphate and dried it at 370K.

C. *Adsorption Experiment*

A synthetic fluoride solution was prepared by dissolving 2.21 g sodium fluoride solid granules in 1 L of deionised water and subsequently diluted to the required concentrations for the adsorption experiments. pH control was occuring with HCl or NaOH. The percentage of fluoride removal (% F) and the amount of F^- adsorbed per unit weight of adsorbent at time t (q_t, mg g^{-1}) and at equilibrium (q_e, mg g^{-1}) were calculated using the following equation, respectively:

$$\%F = \frac{(C_0 - C_e)}{C_0} * 100$$

$$q_t = \frac{(C_0 - C_t)v}{m}$$

$$q_e = \frac{(C_0 - C_e)v}{m}$$

Where v (L) is the volume of fluoride solution, and C0 (mg L^{-1}) is the initial concentration of F. Ct (mg L^{-1}) is the concentration of F at a given time t, Ce (mg L^{-1}) is the concentration of F^- at equilibrium and m (g) is the dry weight of the adsorbents.

III. RESULTS AND DISCUSSION

A. *Effect of pH*

pH gives the sharp effect on fluoride removal the fig. 3.1 shows that at 6 pH the removal of fluoride is maximum 92% and the initial fluoride concentration 20mg/l, 45 minute contact time of adsorbent dose, 25˚C temperature and 1 gm/l adsorbent dose were operating conditions.

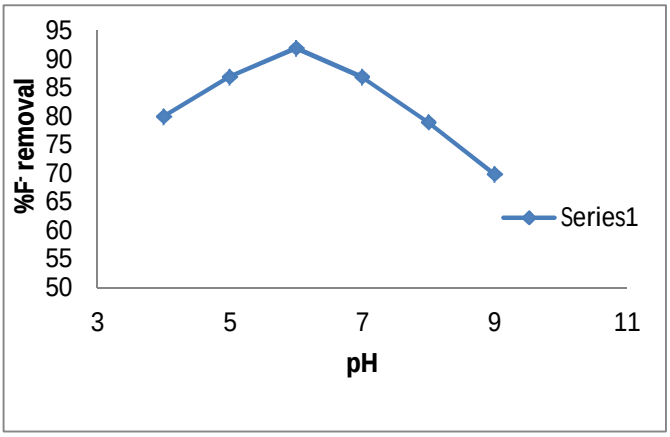

Fig. 3.1 Percentage F^- removal vs. pH

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B. Effect Of Agitation Time

Fig. 3.2 shows that as time increases the removal of fluoride increases and after 45 minute the removal of fluoride was 78% and then further increases the time, removal of fluoride decreases. The initial concentration of fluoride was 20 mg/l, temperature was 25 ˚C, pH=6, adsorbent dose 1 gm/l.

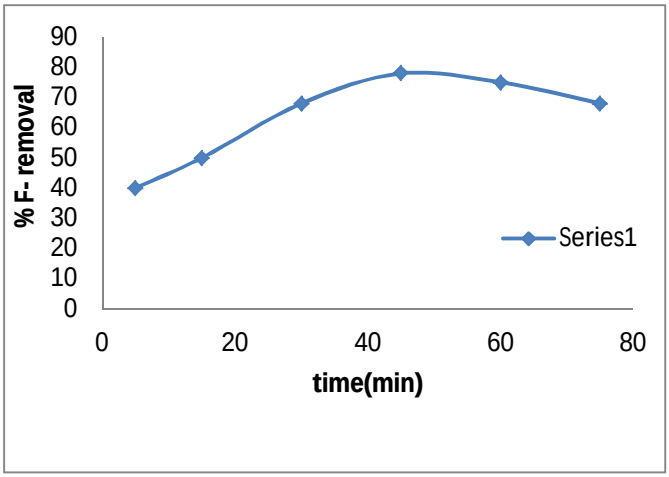

Fig. 3.2 Percentage F¯removal vs. time

C. Effect of Temperature

The fig. 3.3 explains the effect of temperature, as temperature increases the percentage of fluoride removal increases upto the optimum temperature after that increases the temperature slightly decreases because the adsorption process is an exothermic process the removal of fluoride to find this effect of temperature keep the initial concentration of fluoride 15 mg/l, pH=6, contact time 45 minute and the adsorbent dose was 1 gm/l.

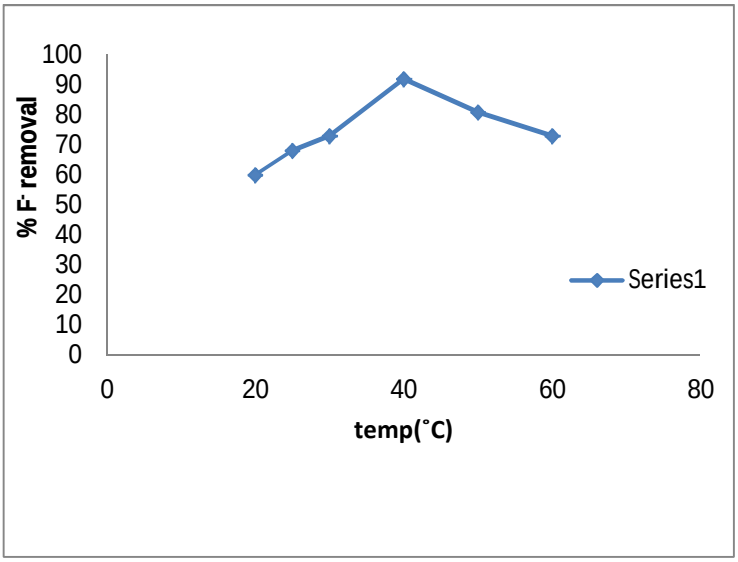

Fig. 3.3 Percent F¯ removal vs. temperature

IV. CONCLUSION

Following conclusions given below are found with this experiment:

For pH study, using aluminium impregnated orange peel charcoal adsorbent the percentage of fluoride removal increase as pH increase from 2 to 6, the maximum was obtained 92% at pH 6.

For Contact agitation time study, using aluminium impregnated orange peel charcoal adsorbent the percentage of fluoride removal increase with increase in time from 5-45 min, the maximum was obtained 78% at time 45 min.

For adsorbent compatible temperature study, using aluminium impregnated orange peel charcoal adsorbent the percentage of fluoride removal was obtained 96% at 40˚C because adsorption is an exothermic reaction.

V. ACKNOWLEDGMENT

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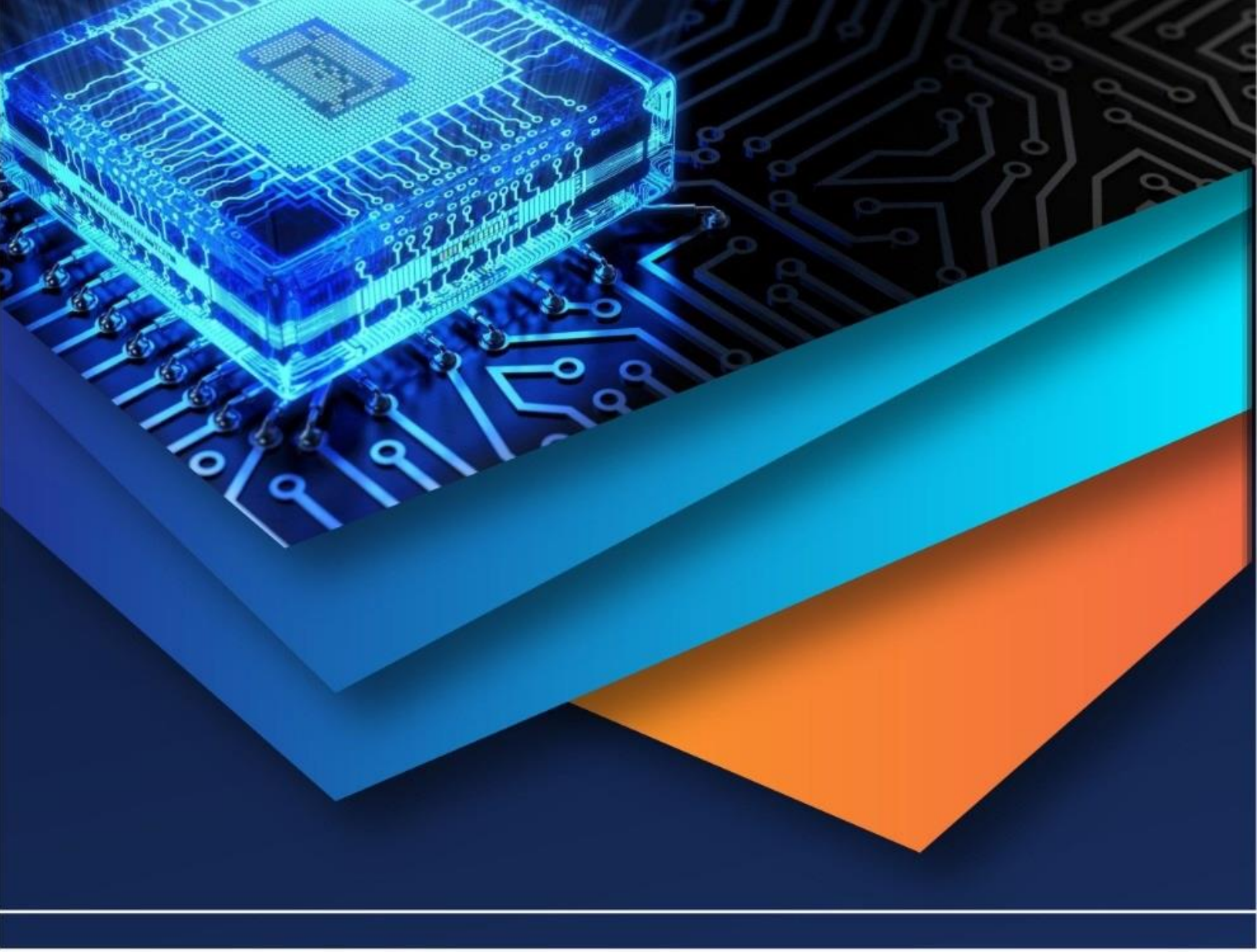

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