iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 7 **Issue:** VIII **Month of publication:** August 2019

DOI: http://doi.org/10.22214/ijraset.2019.8028

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.177
Volume 7 Issue VIII, Aug 2019- Available at www.ijraset.com

A Comparative Study of Removing Fluoride from Drinking Water using Agro-Industrial Waste & PAC

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Abstract: ***This paper presents a complete study package to remove fluoride from drinking water using Low-cost adsorbents like Agro-Industrial Waste and Packaged Activated Carbon (PAC). A large number of individual depends on drinking water that contains excess of fluoride. Rather than using costly setups to remove fluoride, this study presents the use of a very low cost material for defluoridation. The efficacy of different parameters like initial concentration of fluoride, final concentration of fluoride, optimum dose of adsorbent, effective contact time, effect of pH. The fluoride removal efficiency seems to be 70% using Agro-Industrial Waste as adsorbent, 2gm /100ml in 5 min @ 7 pH and optimum fluoride removal using PAC is 68% at the same dose, same time and same pH level. All the experimental studies conducted are batch studies. A comparative study it is found to that the performance of Agro-Industrial Waste and packaged activated carbon as an adsorbent.***

Keywords: Defluoridation, Agro-Industrial Waste, Packaged Activated Carbon (PAC), Adsorbent, Batch study, Contact time, optimum dosage, pH

I. INTRODUCTION

Fluoride is a universal element present in the earth's crust naturally and it is also being added to the natural environment by human. Fluoride is the world's 13th most abundant element and constitutes 0.08% of the earth's crust and the lightest member of the halogen family. Fluoride is even described as a 'Double-edged sword' as inadequate ingestion is associated with dental caries whereas excessive intake leads to dental and soft tissue fluorosis which has no cure considering the fact i.e. fluorosis is an irreversible condition that has no cure thus prevention can be the only solution to this problem.

It is estimated that around 260 million people worldwide (in 30 countries) are drinking water with fluoride content more than 1.0 mg/L. In India alone, endemic Fluorosis is thought to affect around one million people and is a major problem in 17 of the 29 states, especially Rajasthan, Andhra Pradesh, Tamil Nadu, Gujarat, and Uttar Pradesh etc.

According to WHO standards, the fluoride in drinking water should be within a range that slightly varies above and below 1 mg/L. In temperate regions, where water intake is low, fluoride level up to 1.5 mg/L is acceptable. The BIS has prescribed a desirable and permissible limit of fluoride in drinking water as 1.0 and 1.5 mg/l respectively. Removal of fluoride from drinking water, is normally accomplished by precipitation, membrane separation, ion exchange and electrolytic deposition but these are expensive and non-suitable methods in developing countries. National Environmental Engineering Research Institute (NEERI), Nagpur, India, developed a method known as the Nalgonda Technique which involves the addition in sequence of an alkali, chlorine and aluminum sulphate or aluminum chloride or both; it is cheap and is used extensively in India in rural area. Though lime softening accomplishes fluoride. Adsorption is a method used for removal of fluoride in which materials like activated carbon, activated alumina, bone char or ion-exchange resins are used as adsorbents. Activated carbon, prepared from various raw materials, exhibits a good capacity of fluoride removal from drinking water. This method is mainly used because it is cost-effective, easy to operate and eco-friendly in nature. The technique is also popular due to availability of a wide range of adsorbents. This study is an attempt to explore a possibility of utilizing waste materials as adsorbents to remove fluoride from aqueous solution.

II. OBJECTIVES OF THE STUDY

The objectives of this study were

A. To identify and estimate efficiency of Agro-Industrial Waste & PAC in removal of fluoride from drinking water.
B. To compare the superiority between two adsorbents.

III. MATERIALS AND METHODS

Adsorption is defined as the change in concentration at the interfacial layer between the two phases of a system due to surface forces. Adsorption is mass transfer operation in that a constituent in the liquid phase is transferred to a solid phase. The adsorbate is a substance that is being removed from the liquid phase and transferred to the solid phase. The Agro-Industrial Waste used in present study is rice husk which is the end product of PADDY. When rice is extracted out from the paddy the bulk amount of the remaining part is Agro-Industrial Waste which is useless. It can be easily available at any nearby rice mill. The PAC (Packaged activated carbon) is also easily available at water purifier's stores in the market. The experiments was conducted at room temperature. Synthetic sample is prepared and used for the experimental purpose of defluoridation of water.

A. Experimental work

1) Material Required

a) Air drying oven
b) Muffle furnace
c) pH meter
d) AU-2701 UV-VIS Double Beam Spectrophotometer
e) Rotary Shaker & Magnetic stirrer
f) Nitric Acid, NaOH, SPANDS REAGENT A&B, H_2SO_4, NaF
g) Sieve 2mm size
h) AGRO-INDUSTRIAL WASTE
i) Packaged Activated Carbon
j) Round shaped filter papers
k) Distilled water and Borosil Glassware and laboratory equipment.

B. Activation of Agro-Industrial Waste

Agro-Industrial Waste was purchased from Shankar rice mill Lashkar, Gwalior (M.P) at a reasonable cost of 5 Rs per kg. The purchased Agro-Industrial Waste is washed with tap water to remove dust and physical impurities. Then it was spreaded on a ceramic tile and was kept into the oven for drying period of 24 hours at 100 degree Celsius after which it was sieved with 2 mm sieve. The retained Agro-Industrial Waste on the sieve was used for further study and filtered part was discarded. The sieved Agro-Industrial Waste was filled in five crucibles and placed into the muffle furnace for thirty minutes at 350 degree Celsius to convert it into carbon. For conversion of whole waste into carbon several batches of five crucible needs to put into furnace to obtain sufficient amount of carbon. 30-minute later, crucibles were taken out from the furnace and cooled down to room temperature. 32ml volume of nitric acid was mixed with 468ml of distilled water to make 500ml of 1 Normality of nitric acid solution. This was followed by soaking of carbonized Agro-Industrial Waste with nitic acid solution in 1:1 v/v proportion in a plastic container for half an hour. 30 minute later, nitric acid was rinsed out by using a sieve. After spilling out the nitric acid, the carbonized Agro-Industrial Waste again put into the muffle furnace at 350 degree Celsius for 30 minutes. After half an hour the sample collected from the furnace was put into the plastic tumbler soaked in distilled water and provided several washings by distilled water after which residual water was checked for having any color by naked eyes and pH by pH meter. 8 to 10 washings were needed to get neutral pH of water. For drying of this processed Agro-Industrial Waste, it was kept in air drying oven at 100 degree Celsius for 24 hours. The above explained process bestowed us a product, known as Activated Agro-Industrial Waste.

C. Packaged Activated Carbon

This adsorbent was purchased from water purifier store local market Gwalior. This adsorbent is sold in the market as in 100 gm packet named as KENT ACTIVATED CARBON @ a price of 90 Rs per packet. It was used directly in study no pretreatment required for this adsorbent.

D. Preparation of 5ppm fluoride solution

To make working fluoride solution of 5 ppm, 1.5gm by weight sodium fluoride is taken and put it into the air drying oven for 2 hours at 100 degree Celsius to remove the excess moisture. After removal of moisture weight the sodium fluoride exactly 1.105gm. Take 1L volumetric flask and rinse it with distilled water then fill it with distilled water up to the mark and mix weighed sodium fluoride in that flask and shake it thoroughly. Now, this solution is of 500ppm from this solution take 10ml of the solution and mix

with another 990ml of distilled water this solution is known to be our working solution of 5ppm fluoride concentration. After all this preparation Agitated, non-flow batch sorption studies were conducted to study the effect of controlling parameters like contact time, sorbent dosage, solution pH, etc. The practical availability of Activated Agro-Industrial Waste and PAC for removal of fluoride from water. Taking 12 conical flask and rinse it with distilled water and after that fill it with 100ml of 5ppm fluoride water and name it as sample A,B,C,D,E,F & A',B',C',D', E',F' out of all these samples A and A' was taken as control sample and other samples were dosed with Activated Agro-Industrial Waste and PAC of dosing (0.2,0.4,0.6,0.8,1.0) gm . Sample B, C, D, E, F were having activated Agro-Industrial Waste as an adsorbent and sample B', C', D', E', F' were having PAC as an adsorbent. All these samples having a neutral pH. After making of all samples put all these samples to rotary shaker for 120 Minutes at 150 rpm speed. After two hours samples were taken out from shaker and filtrate. By using of filter paper and vacuum filter apparatus and samples were tested in AU-2701 UV-VIS Double Beam Spectrophotometer for finding the fluoride concentration in samples. The test of finding the concentration of fluoride is done on the basis of APHA MANUAL 4500-F. After the above steps, the optimum dose of Agro-Industrial Waste and PAC were obtained at maximum removal. Now taking optimum dose and pH as constants variation of contact time for all the samples were taken at 1, 2, 3, 4, 5, 10, 15, 30, 60, 90, 120 minutes to find the contact time on which higher amount of fluoride was being removed. Fluoride is measured by the same APHA Manual of prescribed method. After getting optimum dose and fixing contact time for activated Agro-Industrial Waste and PAC the effect of pH were seen in the study. For study of pH effect take 10 BOROSIL beakers of 250ml and fill 100 ml of 5ppm fluoride solution and then take 0.5 N of NaOH and 0.5 N of HCL to set the pH level of working solution. By use of a magnetic stirrer, NaOH & HCL working solution were made of (2, 4, 6, 8, 10) pH in two sets one for activated Agro-Industrial Waste & other for PAC. The naming of the sample was given as same as above. The optimum dose of adsorbent was mixed with the sample and placed on the rotary shaker for 5 min. After five minutes all the samples were filtrated by filter paper and further fluoride concentration is checked by spectrophotometer by using SPANDS method.

All the experiments were performed thrice to compensate the errors. All the data present as results are average values.

IV. RESULTS AND DISCUSSION

A. Removal of fluoride by Agro-Industrial Waste & PAC

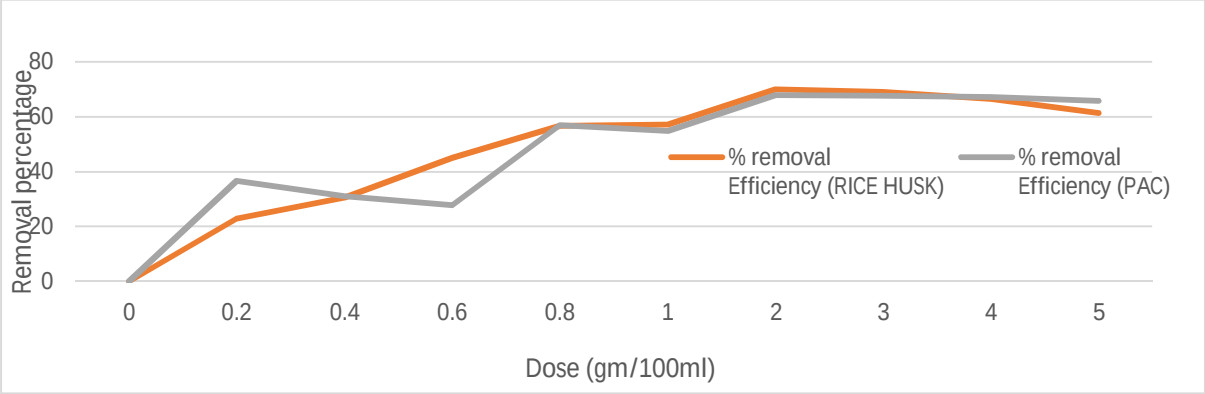
Execution of experiments on lab-scale for the removal of fluoride through the batch process by adsorption. Various dosage of adsorbent made from Agro-Industrial Waste and PAC were added in the 5ppm fluoride solution. To avoid the interference of any other salts or impurities in experiment distilled water was used as a solvent for preparing synthetic fluoride solution. Since the pH level of the solution was also neutral. The experiments was performed at room temperature.

B. Determination Of Optimum Dosage

The effect of various dosage on removal of fluoride using Agro-Industrial Waste and PAC is presented in TABLE 1 as shown below and represented in the GRAPH 1 as percentage fluoride removal at different dosage It is clearly observed from the table and graph that if dose was increased percentage removal also increased. Initially after 2gm/100ml percent removal is decreased. A maximum percent removal by Agro-Industrial Waste at 2gm/100ml is 70.00% .whereas PAC is concerned the maximum removal efficiency is 67.92% at the dosing of 2gm/100ml. the contact time is kept for 120 minutes and pH level is neutral .

Table 1:- Fluoride Removal Efficiency At Various Adsorption Dosage

Dose(g/100ml)	pH	Contact time (min)	Initial fluoride (mg/l)	% removal Efficiency (PAC)	% removal Efficiency (AGRO-INDUSTRIAL WASTE)
0	7.0	120	5	NO ADSORBENT	NO ADSORBENT
0.2	7.0	120	5	36.63	22.96
0.4	7.0	120	5	31.02	30.46
0.6	7.0	120	5	27.79	45.12
0.8	7.0	120	5	56.84	56.77
1.0	7.0	120	5	54.80	57.04
2.0	7.0	120	5	67.92	70.00
3.0	7.0	120	5	67.69	69.02
4.0	7.0	120	5	67.26	66.43
5.0	7.0	120	5	65.74	61.31



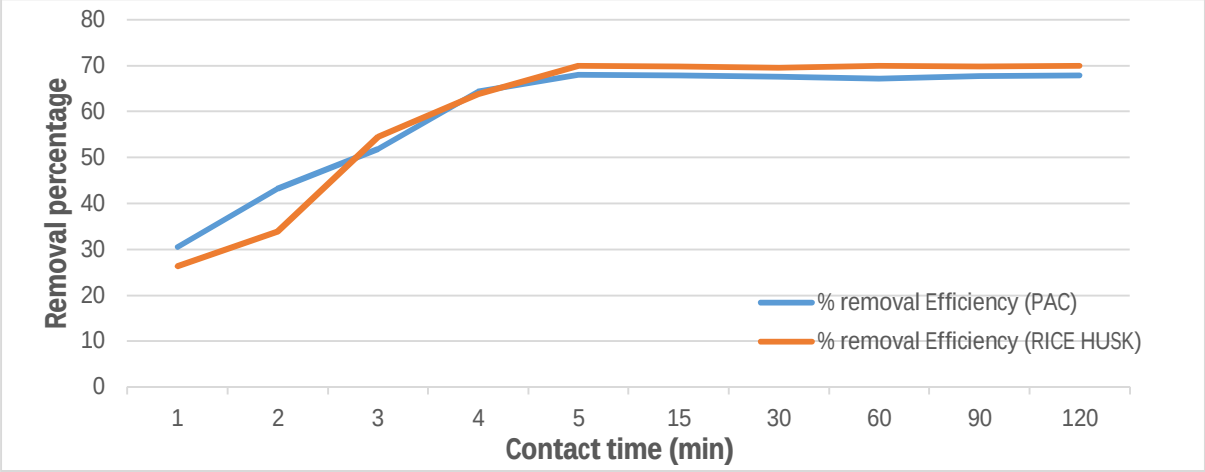
Graph-01

C. Effect Of Various Contact Time At Optimum Dose

The effect of contact time on the adsorption of fluoride on Agro-Industrial Waste and PAC was observed by the TABLE 2 and GRAPH 02 below rapid uptake of fluoride was observed during the initial stage of contact from 1 minute to 5 minute after 5 minute the removal percentage is uniform throughout the graph. For both adsorbent the contact time of maximum removal efficiency is same. The rapid uptake of fluoride was observed was found during the initial stage of contact. The dose of adsorbent is fixed at 2gm/100ml and pH is also set as neutral for this batch study

Table 2:- Fluoride Removal Efficiency At 2gm Of Dosing With Varrying Contact Time

SDDXZCose(g/100ml	pH	Contact time (min)	Initial fluoride (mg/l)	% removal Efficiency (PAC)	% removal Efficiency (AGRO-INDUSTRIAL WASTE)
2.0	7.0	1	5	30.56	26.42
2.0	7.0	2	5	43.26	33.84
2.0	7.0	3	5	51.91	54.56
2.0	7.0	4	5	64.37	63.81
2.0	7.0	5	5	68.00	70.00
2.0	7.0	15	5	67.83	69.80
2.0	7.0	30	5	67.54	69.52
2.0	7.0	60	5	67.12	70.01
2.0	7.0	90	5	67.68	69.76
2.0	7.0	120	5	67.92	70.00



Graph-02

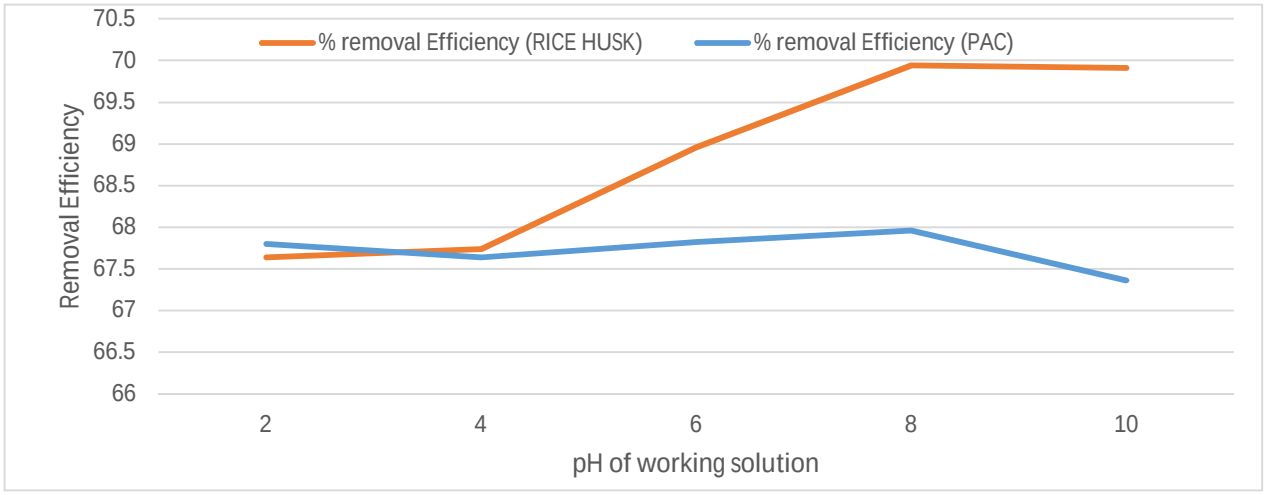
D. Effect OF pH ON Defluoridation

The effect of pH on removal of fluoride was conducted employing test solution adjusted the pH ranging between 2 to 10. As the TABLE 03 & GRAPH 03 indicate the result that the pH of the solution is little bit increased in between 6 to 8. Percentage of removal is approximately same in acidic solution to alkaline solution. The dose of adsorbents was fixed to 2gm/100ml and contact was also fixed at 5 min for this batch.

The whole experiments was conducted several times and the results are on the averagely form.

Table 03:- Fluoride Removal Efficiency At Varying Ph Levels

Dose(g/100ml)	pH	Contact time (min)	Initial fluoride (mg/l)	% removal Efficiency (PAC)	% removal Efficiency (AGRO-INDUSTRIAL WASTE)
2.0	2.0	5	5	67.80	67.64
2.0	4.0	5	5	67.64	67.74
2.0	6.0	5	5	67.82	68.96
2.0	8.0	5	5	67.96	69.94
2.0	10.0	5	5	67.36	69.91



Graph-03

V. CONCLUSION

Based on the Results and Discussions following conclusions can be drawn:

A. Maximum fluoride removal from synthetic solution is found to be 70% using ACTIVATED AGRO-INDUSTRIAL WASTE at the dose of 2gm/100ml. The contact time was 5 minutes at 7 pH.

B. Maximum fluoride removal from synthetic solution is found to be 68% using PAKAGED ACTIVATED CARBON at the dose of 2gm/100ml. The contact time was 5 minutes at 7 pH.

C. It is feasible to use AGRO INDUSTRIAL WASTE (Rice Husk) to manage the excess fluoride present in the water as compare to PAKAGED ACTIVATED CARBON.

D. The material chosen for adsorption is Agro-Industrial Waste and is easily available at every place in Gwalior city and it is the cheapest method to remove fluoride.

E. As in NALGONDA TECHNIQUE some precipitation were formed, but using Agro-Industrial Waste after filtration no precipitation seen in study.

F. The literature survey and the laboratory experiments have indicated that each of the discussed technique can remove fluoride under specified conditions.

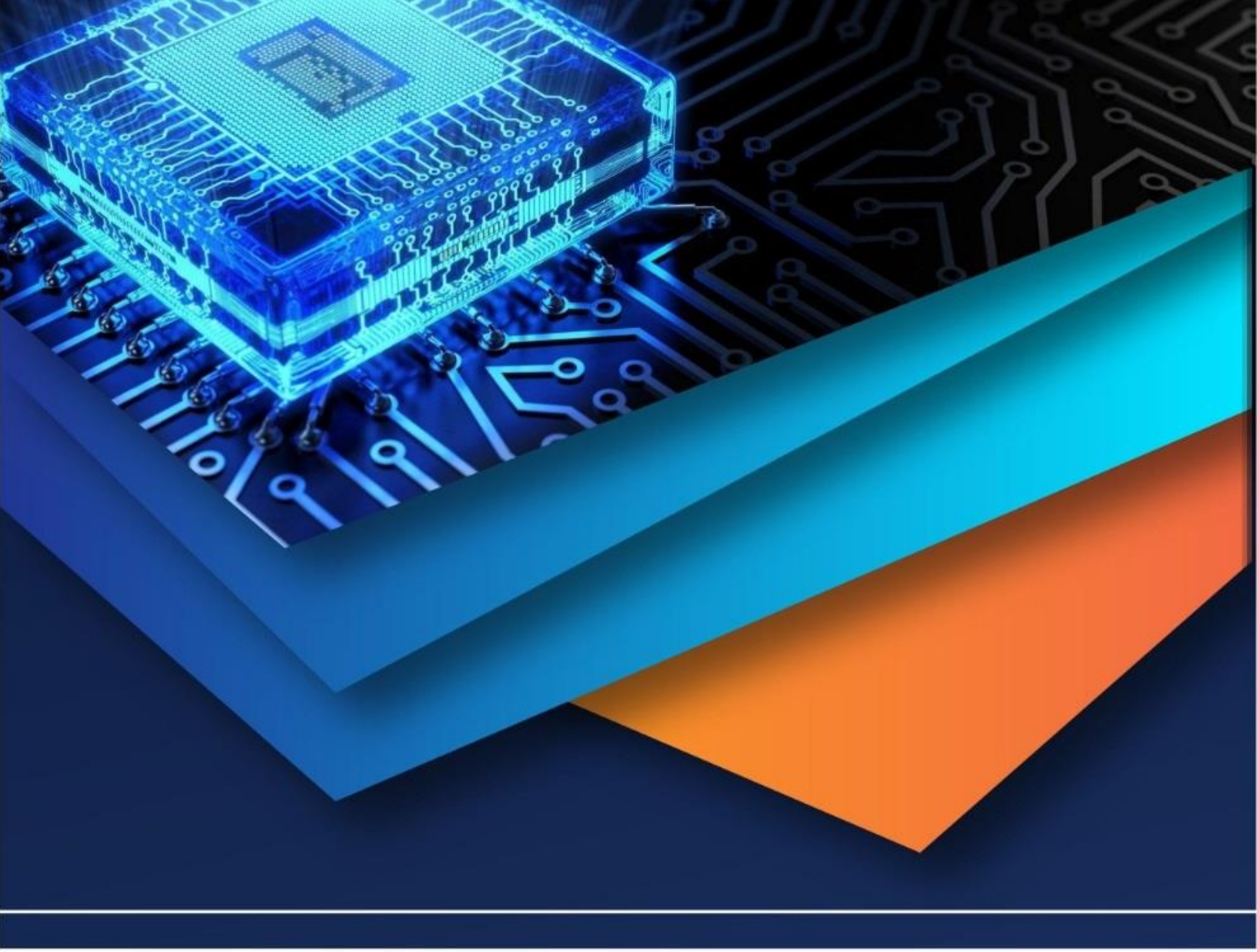
G. Above study were conducted on the synthetic solution hence applying on ground water or surface water the results may differ.

VI. FURTHER SCOPE OF WORK

A. Continuous flow type study can be done with these adsorbents
B. Different models can be used to calculate the efficiency of adsorbent.
C. Cost benefit analysis can be performed to know which of these are economical and can be used easily in rural area.

REFERENCES

[1] APHA-1995 Standard Methods for the Examination of Water and Wastewater (19th Edition), American Public Health Association, New York.
[2] WHO, International Standards for Drinking Water, 3rd Ed., Geneva (2008) pp. 375-377.
[3] BIS 10500, Indian Standard Drinking Water Specification, Bureau of Indian Standards, New Delhi (1991).
[4] Bulusu, K.R. and Nawalakhe, W.G. (1988) Defluoridation of water with activated alumina: batch operations. Indian J. Environ. Health. 30, 262-299
[5] M. Srimurali et al. A study on removal of fluorides from drinking water by adsorption onto low-cost materials Environmental Pollution 99 (1998) 285-289.
[6] C.M.Vivek Vardhan and J.Karthikeyan REMOVAL OF FLUORIDE FROM WATER USING LOW-COST MATERIALS International Water Technology Journal, IWTJ Vol. I - Issue 2, September 2011.
[7] Sheetal Bandewar, S. J. Mane, S. N. Tirthakar REMOVAL OF FLUORIDE FROM DRINKING WATER BY USING LOW COST ADSORBENT IJRET Volume: 04 Issue: 04 | Apr-2015
[8] Islamuddin, Rajneesh K Gautam, Shaista Fatima REMOVAL OF FLUORIDE FROM DRINKING WATER BY COCONUT HUSK AS NATURAL ADSORBENT IJESRT October, 2016
[9] Aleena R Haneef and Nithya Kurup Comparative Study of Fluoride Removal from Water by Using Muringa Oleifera and Thulsi (Ocimum Sanctum) International Journal of Scientific & Engineering Research, Volume 7, Issue 4, April-2016 .
[10] Pranab kumar rakshit studies on estimation of fluoride and defluoridation of drinking water July, 2004
[11] M. Mohapatra et al. Review of fluoride removal from drinking water Journal of Environmental Management 91 (2009) 67–77
[12] S. R. Saranya and N. Anu Comparative Study of Fluoride Removal from Synthetic Wastewater by using Bio-adsorbents International Journal of Scientific & Engineering Research, Volume 7, Issue 4, April-2016.
[13] ANIL K. SHRIVASTAVA and MANOJ K. SHARMA AN INNOVATIVE TECHNIQUE FOR REMOVAL OF FLUORIDE FROM DRINKING WATER Sci. Revs. Chem. Commun.: 2(2), 2012, 133-140
[14] Mr. N. M. Gajjar A Comparative Study on Removal of Fluoride from Water Using GSAC, PAC & GAC December 2013 IJIRS



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