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STUDY OF REMOVAL OF FLUORIDE FROM GROUND WATER OF HISAR CITY USING BRICK POWDER

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Abstract: *Water is essential component for survival of all form of life on Earth. Ground water is unsafe due to one or other reasons of excessive exploitation or contamination. One such contaminant is fluoride. Fluoride beyond the prescribed limit in drinking/ground water causes a lot of complication to human health. There is no cure of the disease, prevention is the only option. The present study focus on de-fluoridation of ground water using low cost brick powder as adsorbent. The sample was collected from Vegetable Market Location of Hisar City of Haryana State (INDIA). Batch adsorption studied carried out to analyze the effect of parameters contact time, adsorbent dose and initial concentration for de-fluoridation. The experiment studies shows that maximum removal of fluoride in ground water observed 53.48 % at 1.0 gm/100ml concentration and 120 minutes contact time.*

Keywords: *Fluoride, Ground water, Adsorbent, Brick Powder, De-fluoridation.*

1. INTRODUCTION

Fluoride is present in rocks, air, water, plants, food in natural form with varying concentration. In earth crust the presence of fluoride is 0.06-0.09%.Being highly electronegative it readily combines with other elements. In Indian sub-continent fluoride rich rocks are in abundance. Due to volcanic activities and chemical weathering of rocks fluoride ions runs off in the soil and groundwater therefore concentration of fluoride in the adjacent catchment area increases[2]. Small quantity of fluoride is an essential component for bones structure and formation of dental enamel, but its presence beyond the required amount (0.6 to 1.5 mg/L) in drinking water can cause harmful effects on human life. The prolonged excessive intake of it through drinking 4 water leads to dental, skeletal and non-skeletal fluorosis[3], whereas, long term use of fluoride can cause havoc with the kidneys. Fluorosis is an important public health problem in developing and densely populated countries like India, China, Japan, Iraq, Iran,Nigeria, Afghanistan, Kenya etc. Around 20 million people of 19 states of India are severely affected by fluorosis and more than 40 millions are exposed to its risk[1]. Due to scarcity, mismanagement of water distribution and contamination of drinking water, the most affected are the poor and weaker sections of the society. Therefore water should not only be conserved but be cleaned.

2. MAJOR SOURCES OF FLUORIDE FOR HUMAN:-

Water, air, medicine, cosmetics, coffee, beverages, toothpaste, etc are the major source of intake of fluoride in human body but approximately 60% of total intake comes through drinking water. Therefore it is necessary to ensure permissible limit of fluoride in drinking water to prevent the population from the disease fluorosis. Fluoride in soft water is less than hard water [4,6].

3. DE-FLUORIDATION METHODS: -

Several methods are available for removal of water pollutants[5,7] in ground water. De-fluoridation is the process of minimization of fluoride from ground water to optimum/permissible limit so that it

becomes suitable for drinking purposes. The desirable characteristics for the process are that it must be cost effective, easy to handle, free from presence of harmful elements and the taste of water must not change. It must also be odorless.

There are mainly two de-fluoridation methods: -

Additive Methods:-In such methods reagents/ chemicals are used under optimum conditions so that fluoride present in water reacts with the chemicals to form insoluble complex.

Adsorptive Methods:-In these methods suitable adsorbents are used and owing to surface activity fluoride ions get adsorbed when water passes through the bed. These methods are easy to operate, low cost and effective. The most commonly used adsorbents are activated alumina, activated carbon, charcoal, calcite, marble slurry, saw dust, activated coconut shell carbon, brick powder add red mud, bone char, magnesia, serpentine, tricalcium phosphate, bone charcoal etc.

4. DESCRIPTION OF THE STUDY AREA[8]

Water sampling

The groundwater sample was collected in cleaned, washed and sterilized polyethylene bottles of two-liter capacity from Vegetable Market location of Hisar City of Haryana (India). The sample was stored in an ice cooled box.

5. METHODOLOGY

The following physio-chemical properties of drinking water sample were determined before batch study:-

Table No.1:- Physio-Chemical Characterisitics of the Water Sample before Treatment in continuity in stead Table 1

Sr No	Parameters	Location (Vegetable Market)
1	pH	6.67
2	EC	0.77
3	TDS	967
4	Fluoride	2.58

Except pH & Conductivity all parameters are expressed in mg/L.

The study was carried out by using standard analytical grade chemicals and double glass distilled water was used for preparation of all the reagents. The physio-chemical properties of drinking water samples were determined before batch study according to standard method of APHA[9]. The fluoride concentration in samples was determined spectrophotometrically using Hatch Spectrophotometer. Standard SPADNS solution used during the Experiment to find fluoride content in the samples.

Preparation of Adsorbent[10-11] (Brick powder)-

Haryana (India) is hub of brick-kiln. Bricks were collected from Brick Kiln located near Hisar City of Haryana State (India) and washed with distilled water, suitably dried and then grinded properly to convert into fine brick powder. Distilled water used to wash the powder many times till water becomes clear and then kept for 12 hours in oven at 105^0 C. The dried powder now sieved to separate less than 300 micro meter size of particles for the experiment work.

6. RESULT AND DISCUSSION

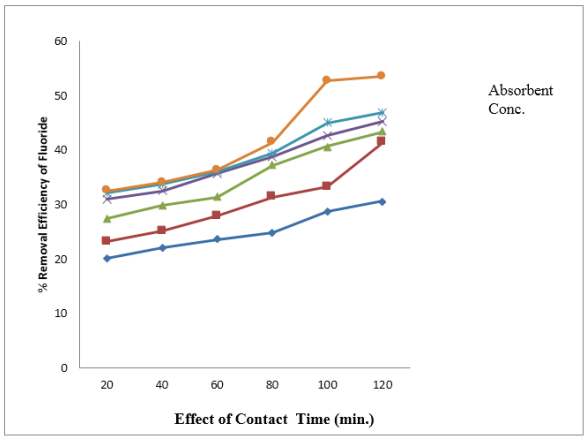
Batch adsorption method used to study the effect of parameters initial concentration, contact time, adsorbent dose, and temperature by using brick powder as adsorbent for fluoride ion removal from the collected sample of groundwater. The effect of these parameters are discussed below:-

a. **Effect of contact time:-** By using brick powder as adsorbent the effect of contact times 20, 40, 60, 80,100 and 120 minutes studied with varying dose of adsorbent between 0.1 to1.0 gm./100ml. Results show that the removal of fluoride ion percentage increased with increase in contact time. Maximum percentage removal of fluoride ion observed at120 minute contact time. The results are presented in the table below:-

Table No.2:- Effect of contact time on percentage removal of fluoride ion by Brick Powder.

Effect of Contact Time						
Location – Vegetable Market						
(a)						
Sr. No.	Dose gm/100ml	Contact time (min)	Initial Fluoride conc. (mg/l)	Final Fluoride conc.(mg/l)	Removal of Fluoride (mg/l)	% Removal efficiency
1.	0.1	20	2.58	2.06	0.52	20.15
2.	0.1	40	2.58	2.01	0.57	22.09
3.	0.1	60	2.58	1.97	0.61	23.64
4.	0.1	80	2.58	1.94	0.64	24.80
5.	0.1	100	2.58	1.84	0.74	28.68
6.	0.1	120	2.58	1.79	0.79	30.62

(b)						
Sr. No.	Dose gm/100ml	Contact time (min)	Initial Fluoride conc. (mg/l))	Final Fluoride conc.(mg/l)	Removal of Fluoride (mg/l)	% Removal efficiency
1.	0.2	20	2.58	1.98	0.60	23.25
2.	0.2	40	2.58	1.93	0.65	25.19
3.	0.2	60	2.58	1.86	0.72	27.90
4.	0.2	80	2.58	1.77	0.81	31.39
5.	0.2	100	2.58	1.72	0.86	33.33
6.	0.2	120	2.58	1.51	1.07	41.47
(c)						
Sr. No.	Dose gm/100ml	Contact time (min)	Initial Fluoride conc. (mg/l)	Final Fluoride conc.(mg/l)	Removal of Fluoride (mg/l)	% Removal efficiency
1.	0.4	20	2.58	1.87	0.71	27.51
2.	0.4	40	2.58	1.81	0.77	29.84
3.	0.4	60	2.58	1.77	0.81	31.39
4.	0.4	80	2.58	1.62	0.96	37.20
5.	0.4	100	2.58	1.53	1.05	40.69
6.	0.4	120	2.58	1.46	1.12	43.41
(d)						
Sr. No.	Dose gm/100ml	Contact time (min)	Initial Fluoride conc. (mg/l)	Final Fluoride conc.(mg/l)	Removal of Fluoride (mg/l)	% Removal efficiency
1.	0.6	20	2.58	1.78	0.80	31.00
2.	0.6	40	2.58	1.74.	0.84	32.55
3.	0.6	60	2.58	1.66	0.92	35.65
4.	0.6	80	2.58	1.58	1.00	38.75
5.	0.6	100	2.58	1.48	1.10	42.63
6.	0.6	120	2.58	1.41	1.17	45.34
(e)						
Sr. No.	Dose gm/100ml	Contact time (min)	Initial Fluoride conc. (mg/l)	Final Fluoride conc.(mg/l)	Removal of Fluoride (mg/l)	% Removal efficiency
1.	0.8	20	2.58	1.75	0.83	32.17
2.	0.8	40	2.58	1.71	0.87	33.72
3.	0.8	60	2.58	1.65	0.93	36.04
4.	0.8	80	2.58	1.56	1.02	39.53
5.	0.8	100	2.58	1.42	1.16	44.96
6.	0.8	120	2.58	1.37	1.21	46.89
(f)						
Sr. No.	Dose gm/100ml	Contact time (min)	Initial Fluoride conc. (mg/l)	Final Fluoride conc.(mg/l)	Removal of Fluoride (mg/l)	% Removal efficiency
1.	1.0	20	2.58	1.74	0.84	32.55
2.	1.0	40	2.58	1.70	0.88	34.10
3.	1.0	60	2.58	1.64	0.94	36.43
4.	1.0	80	2.58	1.51	1.07	41.47
5.	1.0	100	2.58	1.22	1.36	52.71
6.	1.0	120	2.58	1.20	1.38	53.48

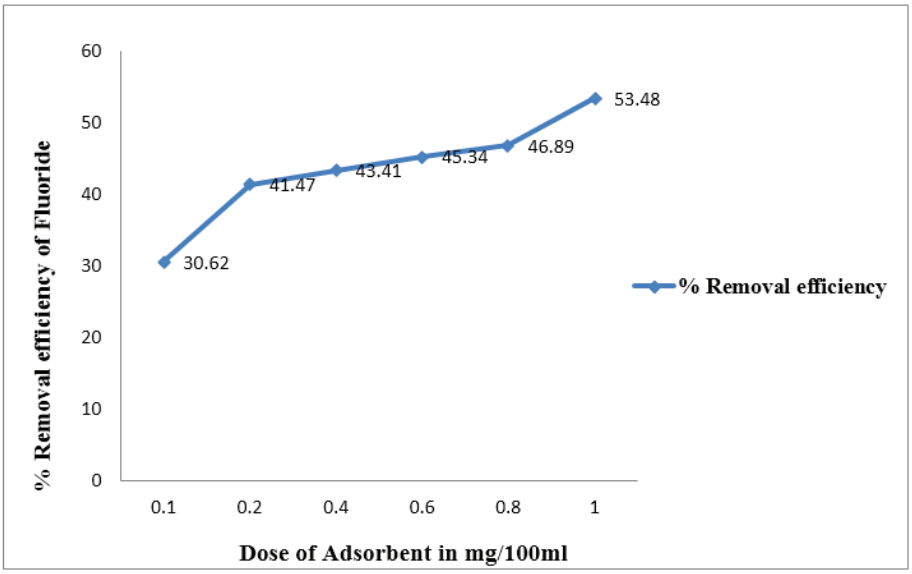


Graph 1:- Effect of Contact Time on % removal of Fluoride ion by Brick Powder

b. Effect of adsorbent dose: - The results for adsorptive removal of fluoride ion with respect to adsorbent dose are shown in Table No. 3 and Graph No. 2. Studies on effect of adsorbent doses are conducted by varying adsorbent doses between 0.1 g to 1 g/100 ml. Contact time is kept 120 minutes. With Increase the adsorbent dose the removal efficiency also increased due to increase in surface area, as more active sites are available for the adsorption of fluoride. Studies shows maximum 53.48% removal of fluoride ion occurs at 1.0 gm/100 ml. concentration and 120 minutes contact time for the location.

Table No.3:- Effect of Adsorbent Dose on % removal of Fluoride ion by Brick Powder.

Dose of Adsorbent(Brick Powder)						
Sr. No.	Wt of adsorbent in mg/100ml	**Amount of water**	**Initial concentration of Fluoride (mg/l)**	**Final conc. of Fluoride after 120 minutes**	**Removal of Fluoride (mg/l)**	**% Removal efficiency**
1	0.1	100ml	2.58	1.79	0.79	30.62
2	0.2	100ml	2.58	1.51	1.07	41.47
3	0.4	100ml	2.58	1.46	1.12	43.41
4	0.6	100ml	2.58	1.41	1.17	45.34
5	0.8	100ml	2.58	1.37	1.21	46.89
6	1.0	100ml	2.58	1.20	1.38	53.48

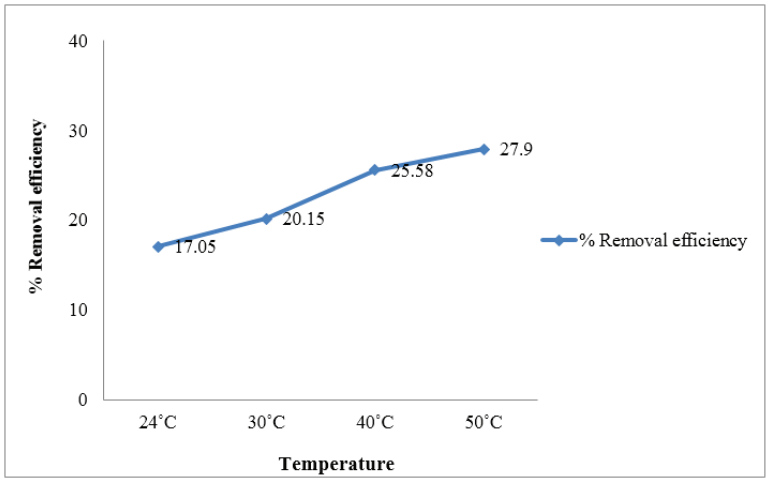


Graph 2:- Effect of dose of Adsorbent on % removal of fluoride ion by Brick Powder

c. Effect of temperature:-Effect of temperature was studied at various temperature range and adsorbent concentration 0.2mg/100 ml. and 6 pH of the solutions. Results shown in Table No.4 and Graph No.3 reveal that with increase of temperature there is increase in % removal in fluoride concentration from the ground water sample. The maximum %removal of fluoride was observed at 50°C.

Table No.4:- Effect of Temperature on % removal of Fluoride ions by Brick Powder

Effect of Temperature (Brick Powder)					
Dose gm/100ml	**Temperature (in ^{0}C)**	**Initial conc. of Fluoride (mg/l)**	**Final conc. of Fluoride (mg/l)**	**Removal of Fluoride(mg/l)**	**%Removal efficiency**
0.2	24	2.58	2.14	0.44	17.05
0.2	30	2.58	2.06	0.52	20.15
0.2	40	2.58	1.92	0.66	25.58
0.2	50	2.58	1.86	0.72	27.90



Graph 3: Effect of Temperature on % removal of Fluoride ions by Brick Powder

7. CONCLUSION

The results demonstrate that brick powder has economical and effective adsorbents in removing fluoride from water to permissible range. The study also concludes that the optimum condition for removal of fluoride are found to be 120 minutes contact time, 1.0 gm adsorbent dose. Maximum 53.48% removal of fluoride was found at initial 1.0 gm/litre concentration. The study also reveals that with increase of temperature de-fluoridation enhances. The experimental investigations show that use of in place of by using low cost adsorbents for de-fluoridation would be useful in rural areas for domestic purpose.

References

Arlappa N, Qureshi Aatif I, Srinivas R. Fluorosis in India: an overview, *Int. J Res Dev Health.*; 1(2):97-102.

Feenstra L.V., Griffioen J., "Fluoride in groundwater: Overview and evaluation of removal methods. Utrecht", **The Netherlands, International Groundwater Resources Assessment Centre**, 25, (2007).

"Fluorine and Fluorides (Environmental Health Criteria-36)", **WHO Geneva**, 93 (1984)

WHO. World Health Organization, Guidelines for drinking water quality, Drinking water quality control in small community supplies, Geneva. 1985; 8:121.

Manjeet B.P., Sharma J.K. Assessment of quality of ground water in some villages of Gurgaon District, Haryana (India): Focus on fluoride. *Int J Innov Res in Sci, Eng and Technol.* 2014;3(4)

Meenakshi, V.K. Garg, K. Ground water quality in some villages in Haryana, India: Focus on fluoride and fluorosis**.** *J Haz Mat.* 2004; 106:85-97.

Palishajee Godboley B.J., Sudame A.M. Removal of fluoride from aqueous solution by using low cost adsorbent, *International Journal of Innovative Research in Science, Engineering and Technology.* 2013; 2(7):2721-2725

http://haryana.gov.in/hargovt/misc/location.html.

Standard Methods for the Examination of Water and Wastewater, **APHA**, American Public Health Association (APHA), Washington, DC (1995).

Rani Bina, Maheshwari Raaz A.K. Chauhan, Bhaskar N.S. De-fluoridation of contaminated water employing brick powder as an adsorbent**,** *I.J.S.N.* 2012; 3(1):78-82.

Manjunath S, Santhosh R, Raja S, Jemish Kumar, V Modi. Low cost de-flouridation of water using brick pieces, *International Scientific Journal on Science Engineering & Technology*. 2014; 17(05):354-363.