

## Research Article

## Removal of Fluoride from Drinking Water using Pretreated Fly Ash

Ranjeeta Soni\*

Environmental Engineering, Jagannath University, Chaksu, Jaipur, Rajasthan, India

**Abstract**

Fly ash is cheap adsorbent for removal of fluoride from drinking water. Due to the presence of unburnt carbon particles and the other components like silica, alumina, iron oxides, calcium oxide and residual carbon make effective adsorbent of fly ash. Especially at high concentration of fluoride and surface area of ash make it a good candidate for utilization as an inexpensive adsorbent. In this work used fly ash, generated from household Chula. For the removal of fluoride from drinking water fly ash dissolved in fluoridated water for few times and after that the solution of ash and water filters. After this the fluoride was analyzed by using ions selective electrode method.

If we used pretreated fly ash in place of without any treatment of fly ash then the results of other parameters are found much satisfactory. For the pre-treatment of fly ash the fly ash washed with distilled water. So the results were found very much satisfactory after this pretreatment.

**Keywords:** Drinking water, Fluoride, Defluoridation, Fly ash, Adsorption

**\*Correspondence**

Author: Dr. Ranjeeta Soni

Email: ranjeetasoni@gmail.com

**Introduction**

Fluoride exists fairly abundantly in the earth's crust and can enter groundwater by natural processes; the soil at the foot of mountains is particularly likely to be high in fluoride from the weathering and leaching of bedrock with high fluoride content.

According to 1984 guidelines published by the World Health Organization (WHO) fluoride is an effective agent for preventing dental caries if taken in 'optimal' amounts. But a single 'optimal' level for daily intake cannot be agreed because the nutritional status of individuals, which varies greatly, influences the rate at which fluoride is absorbed by the body. A diet poor in calcium, for example, increases the body's retention of fluoride. Fluoride is essential element for the human body but when its concentration is high in the drinking water it causes serious health hazards for humans. It is beneficial when its concentration is less than 1.5 mg/L (WHO1994). Fluoride being an electronegative element and having a negative charge is attracted by positively charged ions like calcium ( $\text{Ca}^{++}$ ). Bone and tooth having highest amount of calcium in the body attracts the maximum amount of fluoride and is deposited as Calcium Fluorapatite crystals. Intake of fluoride above 1.5 mg/L may lead to serious manifestations.

Due to the geochemical deposits in the water and various dietary sources it increases in the body and caused various diseases like dental, skeletal and non skeletal fluorosis.

In Rajasthan the existence of fluorides was first detected in 1964 when a survey was under taken by state PHED in collaboration with NEERI on the basis of reports of some peculiar diseases. The concentration in ground water varied from as low as zero to 18.00ppm as maximum. It is already clear from the previous studies that all 32 districts of Rajasthan are affected from the excess concentration of fluoride and facing severe problem related health.

***Changing the Dietary Habits***

People living in high fluoride zone can make certain changes in their diet; it may help them to keep away the problem of fluorosis. Vitamin C inhibits the progress of fluorosis (P. Singh et.al. 2011). Thus people should be directed to add items like awla, lemon, oranges, tomato, sprouted cereals/pulses and dhaniya leaves in their food. Clinical data indicate that adequate calcium intake is clearly associated with a reduced risk of dental fluorosis. So it is recommended to consume calcium rich food in endemic zones. It includes milk, yoghurt, leafy vegetables, drumstick leaves and sesame seed. Foods containing anti-oxidants help in preventing fluorosis. These foods include garlic,

ginger, carrot, papaya, pumpkin white onion and green leafy vegetables. Vitamin E also has a prophylactic role. Its sources include whole grain cereals, vegetable oils, green vegetables and dried beans. Avoid the use of Tobacco and beetle nut.

### **Defluoridation Methods of Drinking Water**

The removal of excess concentration of fluoride from drinking water is called defluoridation. The technique of defluoridation is not a new technique because from the previous year's many method and technologies have been used for this. NEERI (National Environmental Engineering Research Institute), Nagpur, India has been used a method for removal of fluoride from drinking water. After this UNICEF also has been work for this with NEERI. The name of this technique is known as Nalgonda technique because it was first started from the district Nalgonda from Madhya Pradesh (India). In this method aluminum salts was used for coagulation. After the Nalgonda method many methods were used for defluoridation but still no one method is found adequate due to some demerits. Defluoridation methods can be broadly divided into three categories:

#### ***Chemical additive methods***

Chemicals like lime used alone or with magnesium or aluminum salts along with coagulant aid in this method (Nalgonda technique).

#### ***Contact precipitation***

In this method fluoride is removed from water through the addition of calcium and phosphate compounds. Adsorption/ion exchange methods: In this method fluoridated water is passed through a bed containing defluoridating material. These materials are Fly ash bone char, activated alumina and clays have been successfully used in the field.

#### ***Time of sample collection***

All Samples were collected in three phase in the different seasons and months like August, December and March.

#### ***Details of samples***

All drinking water samples collected from Sitapura Industrial Area, Jaipur (Rajasthan). These areas given in following table:

S.No	Sample No.	Area
1.	1	Genus industries
2.	2	Chevrolet industries
3.	3	Ratan Textiles
4.	4	Bharat patrol pump
5.	5	Hotel Amrapali
6.	6	JNIT College
7.	7	Residential Area
8.	8	Near Chokhi Dhani
9.	9	Sachiwalaya Nagar
10.	10	Laxhmipura

### **Materials and Methodology**

The fly ash is much suitable adsorbent media for suitable for fluoride removal. In this research work we have used fly ash, generated from household cooking Chulas. Due to increase in some physico-chemical parameters during the research, it was observed that pre treated fly ash could address these problems without hindering the fluoride removal efficiency of fly ash therefore fly ash was pretreated before defluoridation.

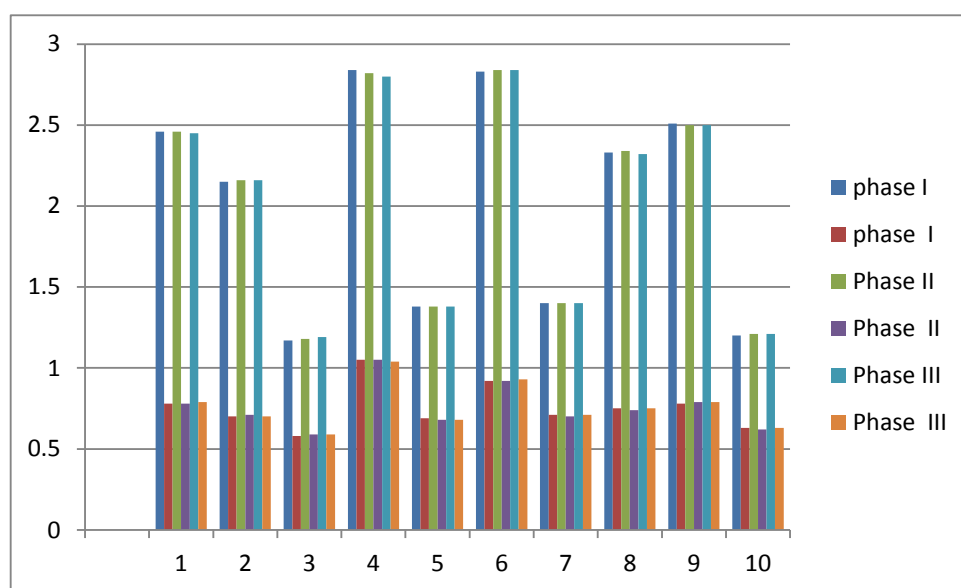
For the pre treatment of fly ash, it is washed by distilled water. For this 100 g fly ash washed with 1 liter distilled water, washing it twice. For this process we were used an ordinary filter paper, funnel and beaker. Dried, Crushed and powered fly ash before use for fluoride removal. After the pre treatment dissolved 100 g fly ash in 1 liter fluoride contained water. The solution left for 5-10 minutes for settle down. After 2 hours the solution of ash and water filtered by the help of filtration unit (G-3 crucible).

## Results and Discussion

As per given in the observation **Table 1**, all samples were collected in the three different season (August, December and March). So from the above observation we are found that the concentration of fluoride before defluoridation is higher (2.84mg/L.) according to the WHO prescribed standards. But when we applied the fluoride removal method by using pre treated fly ash we found the fluoride concentration goes down. Similarly we can see these results in the **Figure 1**, where in all water samples fluoride shows in higher concentration. But after defluoridation it reduced satisfactory according to the WHO standards. So after viewing table and figure we can say the fly ash can reduce the fluoride concentration satisfactory according to the permissible limit of WHO (1.15 mg/l.) because the fly ash is good adsorbent for the removal of fluoride from drinking water.

**Table 1** Concentration of Fluoride (mg/L.) in different Phases before and after Defluoridation

S.No	Fluoride Concentration (mg/L.)					
	Phase I		Phase II		Phase III	
	Defluoridation		Defluoridation		Defluoridation	
	Before	After	Before	After	Before	After
1	2.46	0.78	2.46	0.78	2.45	0.79
2	2.15	0.70	2.16	0.71	2.16	0.70
3	1.17	0.58	1.18	0.59	1.19	0.59
4	2.84	1.05	2.82	1.05	2.80	1.04
5	1.38	0.69	1.38	0.68	1.38	0.68
6	2.83	0.92	2.84	0.92	2.84	0.93
7	1.40	0.71	1.40	0.70	1.40	0.71
8	2.33	0.75	2.34	0.74	2.32	0.75
9	2.51	0.78	2.50	0.79	2.50	0.79
10	1.20	0.63	1.21	0.62	1.21	0.63



**Figure 1** Concentration of Fluoride (mg/L.) in different Phases before and after Defluoridation

## Conclusion

After the observation we can concluded that fly ash is good source of fluoride removal. The raw material are easily available, free of cost and none any other expenditure with this method. For Rural areas, this method can easily use because cooking is done by Chulhas in villages and the fly ash is a waste after burning of fuel .By this method we can also show one of the reuse of fly ash. This technology is very much cheapest from the other defluoridation methods. But due to some side effects of fly ash on water parameters we applying the pre treatment of fly ash before it use for fluoride removal.

## References

- [1] G. Karthikeyan, A. Shunmuga Sundarraj, "Defluoridation Processes", (1999)
- [2] Rakshit, Pranab Kumar "A report on Studies on estimation of fluoride and defluoridation of drinking water" (2004)
- [3] Daw, Raj Kumar "Experiences with domestic defluoridation in India", 30th WEDC International Conference, (2004)
- [4] Jamode, A. V. Sapkal, V. S. Jamode, V. S "Defluoridation of water using inexpensive adsorbents", (2004)
- [5] Vaish A. K. & Vaish, P "A Case Study of Fluorosis Mitigation in Dungarpur District, Rajasthan, India" (2001)
- [6] Dahi Eli, Mtalo Felix, Balthazar Njau, Henrik Bregnhj " Defluoridation using Nalgonda Technique in Tanzania" , 22nd WEDC Conference, New Delhi, India,266-268, (1996)
- [7] Yunus Ç engelo lu, Esengü l Kir and Mustafa Ersö z "Removal of fluoride from aqueous solution by using red mud, Separation and Purification Technology", 28 (1), 81 86, (2002)
- [8] Goswami .Debasis and Das Arabinda " Removal of fluoride from drinking water using modified fly ash adsorbent" , Journal of Scientific and Industrial Research, Vol.65, pp.-77-79, (2006)
- [9] Patil S. Shrikant Ingole W. Nitin, Bhakumi T.S. And Sharma N.N., "Studies on Defluoridation-A Critical Review" Studies on defluoridation Bulletin, 07:77-80, (1970)
- [10] Vaish A.K. and Gyani K.C. " Management of fluoride contaminated drinking water – A successful approach of defluoridated at domestic level in Dungarpur District of Rajasthan" Proceeding of Int. workshop on "Fluoride in drinking water" organized by Govt. of Madhya Pradesh at Bhopal, 22-24 , p 71-74 (2001)
- [11] Susheela A.K. "Defluoridation of drinking water merits of alternative technologies", 1992
- [12] Rani, Bina, "Fluoride and fluorosis in Rajasthan: An Overview, A project Report" [IGNOU], ND, DNHE, 2006
- [13] Singh P et.al. "Fluoride contamination in groundwater of Rajasthan and its mitigation strategies" Journal of Pharmaceutical and Biomedical Sciences, 6(09), 2001
- [14] Lela Iyenger, Defluoridation of water using activated alumina technology, Studies carried out at IIT Kanpur, A report prepared in March 2005 for UNICEF, New Delhi, Pages1-9, (Accessed on 2011 Jan. 4th).
- [15] Bulusu, Fluorides in water-defluoridation methods and their limitations, J. Inst. Egg, 60, 2-6, 1979.
- [16] Anurag Tiwari, Ashutosh Dubey, "Defluoridation of Drinking Water: Efficacy and Need", Journal of Chemical and Pharmaceutical Research 2009, 1 (1): 31-37.
- [17] J.D Sharma, M.K. Sharma, P. Jain and D. Sohu, Quality Status of Potable Water of Tehsil- Sanganer, District- Jaipur, Rajasthan, Asian Journal of Experimental Science, 2005, 19(2), 113-118
- [18] Soni R and Modi S, Removal of Fluoride from drinking water using fly ash of chulhas, Indian journal of science, vol.11, November 28, December 10, 2014, ISSN 2319-7730 , EISSN 2319-7749.
- [19] Soni, Ranjeeta and Modi, Shikha, Removal of fluoride from drinking water using red mud, International journal of Scientific and Technology Research volume2, ISSUE10, October2013, ISSN 2277-8616.

© 2015, by the Authors. The articles published from this journal are distributed to the public under "Creative Commons Attribution License" (<http://creativecommons.org/licenses/by/3.0/>). Therefore, upon proper citation of the original work, all the articles can be used without any restriction or can be distributed in any medium in any form.

### Publication History

Received	08 <sup>th</sup> Oct 2015
Revised	16 <sup>th</sup> Nov 2015
Accepted	09 <sup>th</sup> Dec 2015
Online	30 <sup>th</sup> Dec 2015