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# DEFLUORIDATION BY DOMESTIC METHODS: A REVIEW ARTICLE

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## ABSTRACT

Fluorine is the 13th most abundant and lightest member of the halogens. It is highly electronegative, and reactive of all the elements that is why it is not found as elemental fluorine. Double-edged sword is the name given to fluorine because inadequate intake causes dental caries while as excess causes fluorosis. Fluorosis is condition that cannot be reverted back, the only solution is the prevention and that is done by defluoridation. Defluoridation methods are broadly divided into coprecipitation, adsorption ion exchange, contact precipitation, electro-coagulation and membrane process. Activated Aluminum is found efficacious for defluoridation processes by domestic methods. This paper is a review on defluoridation studies of conventional materials by using methodologies such as ion exchange, precipitation and adsorption

**KEYWORDS:** Fluoride, Defluoridation, Activated Alumina; Domestic Defluoridation.

## INTRODUCTION

Defluoridation of drinking water is necessary to be done, whenever ground water have fluoride level above the proposed upper limit. For simplification defluoridation has been broadly classified into two categories one is precipitation method and other is adsorption. Precipitation methods are carried out by addition of chemicals to the raw water, resulting fluoride precipitates, lime, alum are most commonly used chemicals. Most popular defluoridation technique i.e. Nalgonda Technique came into existence in India in 1975, chemicals used in this technique are alum and lime. This technique can be used in domestic as well as at community levels.

Major drawback of this technique was regular addition of chemicals on daily basis, big amount of sludge production; effectiveness of this technique decreases as the total dissolved solids (TDS) and hardness increases. In comparison to the precipitation techniques adsorption one involves adsorption of fluoride on the adsorbent by physical, chemical or ion exchange interactions. Various adsorbent materials for defluoridation are used worldwide, among them Activated alumina (AA) as an absorbent is the method of choice in developed countries. Together work of UNICEF and Government in Defluoridation process was done for the areas of India where excessive fluoride was present in the groundwater. It was year 1980s, when UNICEF and Government's Technology Mission together work to rule out the problems of fluoride.

The present study was meant for development of defluoridation unit that can be used at the domestic level especially in the rural areas of India.

## MATERIALS AND METHOD

Activated alumina is among the one of the phases of aluminum oxide (Al2O3), it is made by dehydration process(at low temperature i.e. 600C) It has been excellently used as an absorbent material for removal of fluoride from water and lowering the fluoride level to <1mg/1 i.e. an acceptable level for drinking water. If the concentration of fluorides in the water to be treated is less then 20mg/l, adsorption efficiency by activated alumina is enhanced, but when bicarbonate and silica are not present.

Two researchers namely Balusu & Nawalakhe (1988), worked on kinetics of water defluoridation by using activated alumina powder. Findings of their work are as follows:

- Initially rate with which the fluoride was adsorbed decreases till 30 minutes.

- At PH of 9 to 4 relation between adsorption and square root of time was a straight line.
- More dilute the solution more rapidly fluoride is adsorbed from the water.
- It was found that effectiveness of adsorption of fluoride by activated alumina depends on the potential capacity i.e. rate with which fluoride is adsorbed depends on the diffusion of solute within the micro pores of activated alumina.

In Kanpur (1996) under the guidance of UNICEF domestic defluoridation unit using activated alumina was developed by I.I.T.This unit was meant for individual family use. After 3-4 months Activated alumina needs to be regenerated and that was done by local communities. There are about 400 activated alumina filters used.

**Domestic defluoridation unit (DDU)**

It is a double chambered unit made up of stainless steel (SS), copolymer plastic etc. Upper chamber with a microfilter having an opening at its bottom so as to give a 12 L/h flow rate. Upper chamber was charged with 3 kg of AA and the depth was 17 cm.There was a perforated plate over the AA bed so that raw water containing fluoride is equally distributed onto the bed. Upper chamber contains lid while as lower was fitted with a tap for withdrawal of water.

**APPLICATION**

In domestic defluoridation unit raw water was filled in the upper chamber. Water circulates through activated alumina (AA) bed, where fluoride was adsorbed. From the tap of the lower chamber treated water was collected when needed.

Intermittently (three to four times a day) raw water was filled in the upper chamber and the fluoride concentration in treated water was periodically determined. AA gets exhausted also and that was determined when the F- concentration of the treated water exceeded 1.5 mg/L.

Methods used for regeneration of activated alumina are by using NaOH and H2SO4 till the pH rises to 6-7 that makes the AA ready for the next defluoridation cycle, and this is done at regular intervals of 4–5 months.

Activated alumina, activated carbon, activated alumina coated silica gel, calcite, activated saw dust, activated coconut shell powder, activated fly ash, groundnut shell, coffee husk, rice husk, magnesia, serpentine, tri-calcium phosphate, bone charcoal, activated soil sorbent, defluoron-1, defluoron-2 etc are the numerous materials used as absorbent materials. Among these all activated alumina as an adsorbent material is widely used and is as effective as it can remove 90% of fluoride.

Bioscience Department at Satya Sai University for Higher Learning at Prasanti Nilayam at Anantpur District in Andhra Pradesh Research and development uses Prasanti technology for fluoride removal. Herschel S. Horowitz and Stanley B. Helfetz, in 1972 worked on success of activated alumina for community defluoridation plant that was granted in Bartlet, Texas, USA in the year 1952. That plant was very much effective for decreasing prevalence and severity of dental fluorosis.

**RESULTS**

With the help of UNICEF and voluntary organizations Activated alumina method for defluoridation has been prolifereated in Sarita Sansthan, Udaypur, and Rajasthan etc.

**TABLE 4.** Performance of DDU Treating Natural Waters from Rajasthan and Uttan Pradesh

| Site No | Place of sample collection | Raw water parameters | | | | | Vol.of Treated Water (L) |
|---|---|---|---|---|---|---|---|
| | | F conc (mg/L) | alkalinity (mg/L $CaCO_3$) | TDS (mg/L) | $SO_4^{2-}$ (mg/L) | pH | |
| 1 | Belsi, Unnao, UP | 3.3 | 580 | 780 | 38 | 8.37 | 1300 |
| 2 | Nainpura, Jaipur, Rajasthan | 3.7 | 1225 | 5880 | 1300 | 7.47 | 470 |
| 3 | Prahladpura, Jaipur, Rajasthan | 4.4 | 1320 | 3080 | 168 | 7.17 | 540 |
| 4 | Padampura,Jaipur, Dungarpur | 5.0 | 1100 | 1960 | 85 | 8.34 | 580 |
| 5 | Dungapura, Jaipur, Rajasthan | 5.0 | 634 | 2100 | - | 7.50 | 590 |
| 6 | Padampura, Jaipur, Rajasthan | 5.1 | 1100 | 2210 | 250 | 7.50 | 660 |
| 7 | Dungarpur, Rajasthan | 6.0 | 350 | 1050 | - | 7.91 | 820 |
| 8 | Makkar, Unnao, UP | 6.5 | 500 | 990 | 150 | 7.60 | 810 |
| 9 | Jaipur, Rajasthan | 7.0 | 475 | 1200 | 24 | 8.09 | 460 |
| 10 | Maharajpura, Jaipur | 8.3 | 775 | 3080 | 730 | 7.29 | 330 |
| 11 | Sivadaspura, Jaipur | 9.7 | 1025 | 2310 | 16 | 7.36 | 300 |
| 12 | Sivadaspura, Jaipur | 9.8 | 900 | 1610 | 37 | 8.46 | 310 |
| 13 | Padampura, Jaipur | 17.0 | 990 | 1368 | 28 | 7.89 | 185 |

- Not Determined

**- Field Evaluation.** The main findings of the field performance monitoring of about 388 domestic defluoridation units (DDUs) till June 1997 are:

1. Households are using domestic defluoridation unit (DDU) regularly and they are fully satisfied;
2. There was no operational problem found except leakage from micro-filter joint due to improper tightening of wing nut;
3. Almost in all the cases, treated water has a fluoride concentration of was 1.5 mg/L;
4. Activated alumina (AA) was regenerated at the village level accurately
5. About 25-30 liters of water was used daily for household means.
6. A survey was done and it was found that out of 179 respondents in Rayana and Kankri villages, 178 where having increased appetite, 116 having decrease in gas formation, 158 found relief in joint pain, 14 respondents feel decrease in thirst for water and 28 cases where reporting decrease in the tiredness. That is by one way or the other way respondents reported symptomatic relief.

## CONCLUSION

This review covered the procedure for the removal of fluoride from the drinking water at the domestic level. Other methods are liming and precipitation Th. Main drawback of these techniques are high economic value and contamination like production of toxic sludge. From this study it is clear that Defluoridation by domestic method unit is simple to use and its acceptability is excellent. Limitations of this technique at the level of rural areas are low socioeconomic status. Hence it is essential that people should be made aware of the use of domestic defluoridation unit and the benefits obtained from it. Awareness can be made with the help of NGOs and private sector. Finally by conclusion activated alumina (AA) is perfectly suitable for fluoride removal from drinking water in domestic defluoridation units.

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