

Defluoridation of Water by Various Technique- A Review

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ABSTRACT: The distribution of ionic form of fluoride is uneven in the environment. Fluorides can be present in sedimentary formations in minerals, rock, soil, clay, and anthropogenic activities. Higher level above (1.5 ppm) of fluoride in drinking water can affect the teeth and bones (dental and skeletal fluorosis). The problem due to fluoride affects not only the human but animals as well. This review paper is aimed at providing information for preventive method for excess fluoride removal from water i.e. defluoridation that is made by various researcher's. Although researcher's has reported various adsorbent techniques like alumina base, bio-adsorbent, natural, chemical and carbon base compounds.

KEYWORDS: Adsorption, Defluoridation, fluoride removal, Techniques, water.

I. INTRODUCTION

Fluoride is anionic form of fluorine. Geological formation is the main source of fluoride in the groundwater. It is well known that small supplies of F⁻ ion (1 ppm) are useful in preventing tooth decay and higher intakes (>1.5 ppm) can be injurious for human health (like mottled teeth, dental and bone fluorosis). As per EPA [1] at levels markedly over 1.5 mg/l an inverse effect occurs and mottling of teeth (or severe damage at gross levels) will arise. For this reason there is a constraint on fluoride levels, the effects of which vary with temperature. Although lot of methods have been developed to be removing fluoride from ground water the adsorption method is the most popular because of the simplicity of the adsorption units and availability of viable adsorbents locally. In present paper discussed various methods for de-fluoridation.

II. VARIOUS METHODS FOR DEFLUORIDATION

The removal of fluoride from ground water has been many attempts over the years, using a wide variety of material giving various efficiencies. Following are the various methods.

1. Nalgonda Technique
2. Activated Carbon
3. Sulphonated coal
4. Magnesium compound
5. Iron and aluminium salt
6. Alumina and Iron Oxide
7. Alumina and Calcium minerals
8. Red Mud
9. Clays and Soil
10. Bioadsorbent
11. Membrane bioreactor technology
12. Aluminium oxide coated bauxite (AOCB)

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- 13. Aluminum oxidecoated charcoal (AOCC)
- 14. Reverse Osmosis and Electro dialysis
- 15.Fill and draw technique for small communities
- 16. Bone char
- 17.Poly Aluminium Hydroxy Sulphate(PAHS)

The de-fluoridation methods are divided in to three basis types of mode of action

1. Base some kind of chemical reaction with fluoride – Nalgonda technique
2. Based on adsorption process- Bone Charcoal, Processed bone, tricalcium phosphate, activated carbon, activated magnesia, tamarind gel, serpentine, activated alumina, plant material, burnt clay.
3. Based on ion- exchange process- Anion/ Cation exchange resins

Brief discussion on above methods-

The Nalgonda technique employs flocculation principal. This technique is a combination of several unit operations and the process involves rapid mixing, chemical interaction, flocculation, sedimentation, filtration, disinfection and sludge concentration to recover water and aluminium salts. Hydrated aluminium salts a coagulant commonly used for water treatment is used to flocculate fluoride ions in the water. Since the processed best carried out under alkaline condition, lime is added. For the disinfection bleaching powder is added. After through stirring, the chemical elements coagulant in to flocs and settle down in the bottom.System are shown through flow diagram in fig.1.

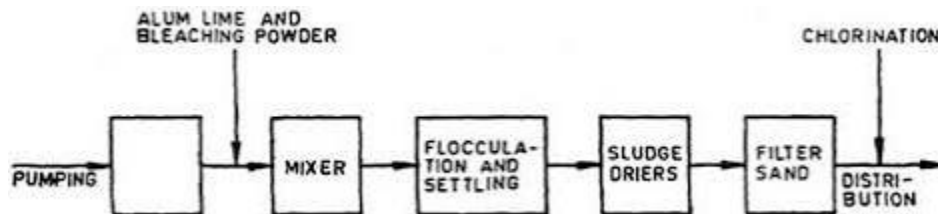


Fig.1.Flow diagram for Nalgonda Technique

Surface adsorption retains a major place in de-fluoridation research and practice because of its general greater accessibility and lower cost. The nature of adsorption of fluoride on some adsorbents especially clays which contain oxides of iron, aluminum and silicon has been reviewed by Puka (2004) a background for his own experimental studies to improve the understanding of fluoride-adsorbent interactions. Theoretically, the adsorption of fluoride on the solid particles normally takes three essential steps. When aluminium and iron (III) hydroxides are co-precipitated from chloride mixture in equal-molar quantities using ammonia, the resulting mixed hydroxide after aging and drying, is a better adsorbent for fluoride than either aluminum hydroxide or iron (III) hydroxide [2]

Several researcher groups have studied the adsorption of fluoride on soils investigated the effect of varying levels of exchangeable sodium on the adsorption of fluoride on to sonic- soils [3].

For Small communities (200 to 2000), a defluoridation plant of fill and drawtype is useful. The plant consists of a hopper-bottom cylindrical tank(Depth 2m). The diameterdepends upon how much water shouldtreat. In same vessel of mixing, flocculation andsedimentation are performed with stirring mechanism, which can be either hand operatedor power driven. Raw water is pumped to the unit and required quantity of alum; lime and bleaching powder areadded. The contents are stirred for 10 min and allowed to settle for 1-2 hours. The settled sludge is discardedand the defluoridated supernatant is filtered and supplied through stand posts [4].

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Activated alumina used in domestic defluoridation plant lunched by UNICEF in rural India [5]. Carbon-based biomolecules very effective in defluoridation like, *Phyllanthus Emblica* (Indian Gooseberry), active seeds and bark of trees and bone charcoal. Prepared adsorbent shows enchanted removal of fluoride by 82.1 % at equilibrium contact time of 15 min. As per http://www.appropedia.org/Water_defluoridation shown in fig.2.

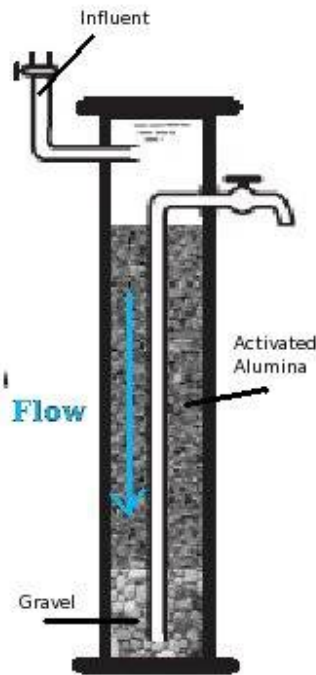


Fig.2. Column Filter Typical for use with Activated Alumina

Red mud (Iron and Aluminium oxides) with adsorbent has been extensively adsorbent. The raw pots are subjected to heat treatment as in the case of brick production. Hence the mud pot also will act as an adsorbent media.

A polymeric aluminum compound, poly-aluminium-hydroxy-sulphate (PAHS) is found to require less flocculation time and settling time. Detention time of 20 to 30 minutes will suffice for complete settlement of all flocks. Cost of PAHS is much less than the alum [5]. Precipitation methods are based on the addition of chemicals (coagulants and coagulant aids) and the subsequent precipitation of a sparingly soluble fluoride salt as insoluble fluorapatite [5]

Bone char (adding calcium chloride (CaCl_2) and monosodium phosphate (NaH_2PO_4) to the water the precipitates of fluorapatite and calcium fluoride) in defluoridation is the method of contact precipitation [7]. In bone char method the chemical added water pass through bone char and get defluorinated water shown in fig.3.

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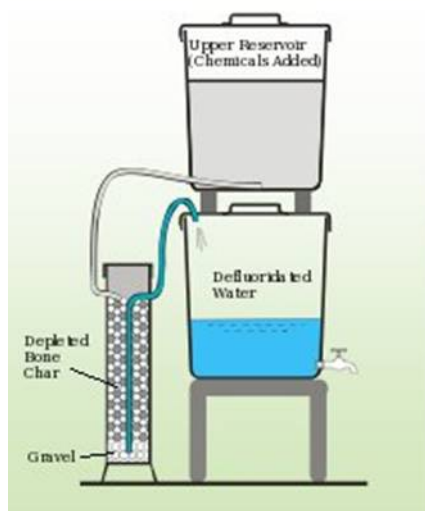


Fig. 3. Bone Char method for defluoridation

The membrane bioreactor (MBR), an innovative combination of membrane technology and biological process for wastewater treatment, has been exhibiting great advantages over the conventional activated sludge (CAS) process owing to its preponderantly higher efficiency for solid-liquid separation than that of a secondary sedimentation tank [6]. Aluminum oxide coated bauxite (AOCB) and aluminum oxide coated charcoal (AOCC) as versatile and potential fluoride adsorbents.

Table 1.
Different defluoridation techniques and the materials used [5]

Adsorption	Ion-exchange	Precipitation	Others
Carbon materials, Activated Alumina, Magnesia, Tricalcium phosphate, Calcite, Hydroxy apatite, Wood, Lignite, Activated char coal, Fish bone char, Processed bone, Nut shells, Avaram bark, Paddy husk, Coffee husk, Tea waste, Jute waste, Coir pitch, Fly ash, Bauxite, Serpentine	Anion exchange resins: NCL poly anion resin, Tulsion A27, Lewatit-MIH-59, Amberlite IRA-400, Deacedodite FF-IP, Waso resin-14, Polystyrene. Cation exchange resins: Defluoron-1, Defluoron- 2, Carbion.	Lime, Alum, Lime & Alum (Nalgonda technique), Alum flock blanket method, Poly Aluminium Chloride (PAC), Poly Aluminium Hydroxy Sulphate (PAHS), Brushite.	Electrochemical method (Aluminium electrode), Electro dialysis, Electrolysis, Reverse Osmosis.

The Fluoride concentration in water can determine by Ion-Selective Electrode Method (range 0.1 ppm to 10 ppm) and SPADNS (range 0.0 to 1.4 ppm) from APHA (8). Due to high level of fluoride vague aches, pain in the body restricted and painful movements of cervical, pelvic, leg joint, forearm in human are the symptoms (9). Guideline for drinking water quality can considered as per WHO (10). In buffalo hoof deformation, attrition and mottling can possible (11). Several factors including rainfall, soil salinity, etc., influence the form and availability of fluoride in water (12).

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III. CONCLUSION

Almost 19 states of India is affected due to the presence of fluoride in ground water. Due to fluoridotoxicity are mild to severe dental fluorosis, skeletal fluorosis, genu vulgum, crippling fluorosis in human body. Many cattle's are affected by fluoride. A mini review on defluoridation of water has been presented with variety of methods. Adsorption (Conventional technique) with different adsorbents in the fields of fluoride removal has been reviewed.

These techniques should also apply for cattle's water feeding. Nalgonda technique is the most suitable technique for Indian rural communities' so far.

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