

Review On Fluoride Removal Techniques from Groundwater

Md Nematulain Nazri¹ Sana Karim Subha²

^{1,2}M.Tech Scholar

^{1,2}Department of Civil Engineering

^{1,2}Maharishi University of Information Technology, Sitapur Road Lucknow Uttar Pradesh, India

Abstract— Groundwater is the major source of drinking water in most places of the earth's surface. Fluoride levels in water beyond desirable/ permissible limits are typically found in Groundwater. Fluoride has a dual significance, at low levels range from (0.5-1 mg/L) protect against dental caries and high levels of fluoride in drinking water above 1.5mg/L will lead to adverse health impacts such as dental fluorosis and skeletal fluorosis. This review article discusses the various methods for the removal of fluoride from Groundwater such as precipitation methods, ion exchange process, membrane filtration process, nano-filtration, electro-coagulation, and adsorption in which adsorption method proved better than other fluoride removal techniques because of the availability of adsorbent and its removal efficiency. The adsorption technique is more suitable for rural areas on the small scale.

Keywords: Natural Adsorbent, Groundwater, Removal Techniques, Fluorosis, Estimation, Defluoridation

I. INTRODUCTION

Groundwater is the water that is found in aquifers below the earth's surface. according to WHO the permissible limit of fluoride in potable water is 1-1.5mg/ L.

Fluorine is one of the elements essential for humans it is a member of the halogen family with an atomic weight of 19 and an atomic number of 9. it is driven from the Latin word "fluere" meaning " to flow" it is most electronegative and reactive of all elements. In 1984 WHO guidelines suggested that in areas with warm climate the optimal fluoride concentration in drinking water should remain below 1mg/L while in cooler climates it could go up to 1.2mg/L.

II. HISTORY OF FLUORIDE

The history of fluoride is more than 100 years old the first hint of the possible connection of fluoride and dental health was given by sir JAMES CRICHTON BROWNE in 1802.

Composition of fluoride: fluoride may occur in combined form in a wide variety of minerals

- 1) Fluospar- 49%
- 2) Fluorapatite-3.4%
- 3) Cryolite- 54%

III. ESTIMATION OF FLUORIDE CONCENTRATION IN WATER

Several methods were reported for analyzing the total concentration of fluoride in water in which a few analytical methods were determined as follows.

- 1) Colorimetric; SPANDS method (standard methods 4500f-c).
- 2) Ion selective electrode method (ASTMD1179-93B).
- 3) Ion chromatography (IC) chemical suppression of Eluent conductivity method (EPA 300.0, ASTMD 4327-91, and standard methods 4110E, ISO1035-1).

IV. AVAILABLE FLUORIDE REMOVAL TECHNIQUES

Several defluoridation technologies have been developed in many places around the world. The common fluoride removal technologies include.

A. Precipitation Methods:

It is based on the addition of chemicals (coagulants and coagulant aids) and the subsequent precipitation of sparingly soluble fluoride salt as insoluble fluorapatite.

The best example of this technique is the ferrous Nalgonda technique of defluoridation. Limitations: time-consuming, requires more diligence, a large dosage of aluminum sulfate sludge transfer issue.

B. Ion- Exchange Process-

Synthetic chemicals namely anion and cation exchange resins have been used for fluoride removal.

These are commercially produced resins which are expensive and uneconomical in most circumstances.

1) Materials used:

- 1) Bone- exchange of carbonate radicals with fluoride.
- 2) Bone char- consists of calcium phosphate and carbonate.
- 3) Activated alumina- consists of aluminum oxide.
- 4) Ion exchange resins: anion exchangers- Eg. Polyanion (NCL), cation exchangers- Eg- carbon, polystyrene.

2) Limitation:

C. Membrane Filtration Process:

1) Reverse Osmosis (RO):

The pressure is exerted on one side of the semi-permeable membranes leaving the pollutants behind.

2) Electrodialysis:

The membranes allow the ions to pass but not the water .the driving force is an electric current which carries the ion through the membrane.

3) Limitation:

Electrodialysis is highly energy-intensive and expensive. Both processes are very complicated.

D. Nanofiltration:

Nanofiltration membranes have a high retention of charged particles that require less pressure. Limitation: very expensive and complicated.

E. Electro-Coagulation:

Utilizes electricity and sacrificial anodes to form the active coagulants. Advantages- less space, no chemical storage, no PH adjustments.

1) Disadvantages –

Expensive and complicated.

2) Limitations:

High operational and maintenance costs. Low fluoride removal capacities and generate a large volume of sludge.

F. Adsorption:

This technique functions on the adsorption of fluoride ions onto the surface of an active agent such as Activated Alumina, activated carbon, bone char, brick pieces column, and mud pot were the highly tasted adsorbing agents.

1) Natural Adsorbents:

Many natural adsorbents from various trees were tried as removal agents such as seeds of drumstick tree, neem stem, Maize husk, fly ash, Rice husk, tea ash, Tamarind seeds were few among them.

Researchers at "M.S. Swaminathan Research Foundation" (MSSRF) had shown drumstick seeds to have remarkable fluoride removal efficiency which was higher than that of activated alumina

2) Adsorption Technique:

Adsorption is the bond of molecules species from bulk solution for a surface of a solid by physical or chemical forces.

Three phases of adsorption of fluoride;

- 1) Diffusion or transport of fluoride ion to the external surface of the adsorbent.
- 2) Adsorption of fluoride ions on to particle surfaces.
- 3) The adsorbed fluoride ions probably exchange with the structural elements inside adsorbent particles.

3) Advantages of Adsorption:

- 1) Adsorption units are simple in their operation and design.
- 2) Eco-friendly in nature.
- 3) Lack of sludge production.
- 4) Offers 50-95 % efficiency.
- 5) Cheap and easily available compared to conventional adsorbents.
- 6) Need less maintenance and supervision.
- 7) It is applicable in the removal of fluoride even at low concentrations.
- 8) Used adsorbents can be used as filler material thus disposed of easily and safely.

V. CONCLUSION

Adsorption technique by natural adsorbents is the most suitable, eco-friendly, and low-cost technique at a small scale for rural areas in India. Fluorosis is a serious public health problem in India. groundwater is the main source of the ingestion of fluoride. there is no cure to the fluorosis only prevention is a solution.

REFERENCE

- [1] S Awasthi, S.K. Gupta and S.K. Awasthi, Indian j. Environ. protect, 22,228 (2002).
- [2] K.R. Bulusu and W.G. Nawalkhe, Indian. J. Environ. Health, 32, 107 (1998).
- [3] Soben peter; preventive and community dentistry; 3rd edition, 2008.
- [4] Fluorosis in India Int J RES DEV Health April 2013 voll (2).
- [5] Shorbha tendon; Textbook of pedodontics.
- [6] WHO Committee on oral Health status and fluoride use Geneva, 1993.
- [7] Hiremath SS. Textbook of preventative and community Dentistry. 2nd edition Elsevier publications India 2011.

- [8] Morya CM. A Textbook of Public Health Dentistry, Jaypee Brothers New Delhi. 2011.
- [9] Peter S. Essentials of preventive and community Dentistry 2nd edition Aryan publishing house, New Delhi 2003 p. 364-6.
- [10] Defluoridation of an update 2010 page 1-26.
- [11] Susheela AK. A treatise on fluorosis edition AK Susheela.
- [12] Srimurali M et al activated alumina for Defluoridation of water and household application 2008 1-13,
- [13] Iyengar Defluoridation of water using activated alumina technology, A report by UNICEF, New Delhi. 2005.
- [14] Eswar p, Deraj CJ Water defluoridation field studies in India. Indian Journal Dental Advancements 2011.3 (2) 526-33.
- [15] M. Murugan and E. Subramanian Defluoridation of water by tamarind seed Journal of Water and Health 04-4/ 2006.
- [16] WHO Drinking water quality control in small community supplies Guidelines for Drinking-water Quality. Vol.8 Geneva: WHO; 1985.
- [17] Boruffcs. Removal of fluorides from drinking water. Ind Chem. 1934; 26 (1); 69-71.
- [18] Piddennavar R, Krishnappa p. Review on defluoridation technologies of water Ind J Eng Sci 2013; 2(3); 86-94.
- [19] Delhi E contact precipitation for Defluoridation of water. Paper presented at 22nd WEDC Conference, New Delhi 9-13 Sept 1996.
- [20] IRC.2007. Household water treatment FAQ sheet. <http://www.irc.nl/page/8028>. cited October 2009.
- [21] BGS. 2009 Water quality fact sheet; fluoride, British geological survey.
- [22] UNICEF, 2009. Water, sanitation, and hygiene. <http://www.unicef.org/wash>. cited August. 2009.
- [23] Harder, R 2008 fluoride. Toxin or medicine department of the water management Delft University of Technology, Delft, Netherland.
- [24] Whit ford, G.M 1996. The metabolism and toxicity of fluoride, Karger, Switzerland. (25). C M Vivek Vardhan and J Karthikeyan Removal of fluoride from water using low cost