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Review on Different Defluoridation Techniques

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Abstract: ***Water is basic need for life. It is used in every household activity. With increasing population, the demand of water is increased. In addition to problem of limited quantity of water, its quality is also main concern. One of main concern is about fluoride present in water. Defluoridation involves removal of fluoride present in water. Consuming fluoride has both advantageous and disadvantageous effects on human body and animals that is why it is known as 'double -edged sword '. Excessive consumption of fluoride causes fluorosis. It is major health problem in India. Various techniques are studied to remove fluoride bur still the problem is not been solved. The purpose of this paper is to review the techniques or methods available for fluoride removal from water.***
Keywords: Fluoride, Defluoridation, Groundwater, Water treatment, Adsorption, Human Health.

I. INTRODUCTION

Fluoride is an ion of element fluorine. It belongs to halogen group. Fluoride observed in ground water is due to natural and anthropogenic influences its formation. Use of phosphatic fertilizers in agriculture and industrial activities like clay used in ceramic industries, burning of coals also increase the fluoride in groundwater. Fluoride gets leached out and get dissolved in ground water during the movement of water is soil substrata.

A. Factors Affecting the Natural Fluoride Concentrations Are as Follows

1) *Geology:* Most common fluorine bearing minerals are fluorite, apatite and micas. Ground water from crystalline rocks like granites are sensitive to high fluoride concentrations. Igneous and volcanic rocks have fluorine concentration from 100ppm to 1000ppm. Sedimentary rocks contain fluorine concentration from 200ppm up to 1000ppm. Metamorphic rocks contain fluorine from 100ppm to more than 5000 ppm.
2) *Contact Time:* Concentration of fluoride in ground water depends on reactive time with aquifer minerals.
3) *Climate:* Arid regions have high fluoride concentrations because ground water flow is slow and contact time with rocks is long. In humid tropics fluoride is less because of high rainfall and their diluting effect on ground water chemical compositions.
4) *PH of Ground Water:* Water having high sodium bicarbonate and low calcium, magnesium concentrations have high fluoride concentrations. These waters have high pH values.

According to WHO (World Health Organization) guidelines the maximum acceptable concentrations is 1.5mg/l. greater than 6mg/l people and animals suffers from skeletal fluorosis. Chronic fluorosis is caused due to high levels of fluoride through water and food. Fluoride adversely affects teeth, bones Ans other organs. Its excess leads to diabetes, obesity, hypothyroidism and cardiovascular diseases.

Fluoride in India: In several regions of Karnataka, Tamil Nadu, Uttar Pradesh have fluoride more than 1.5mg/l. 200 districts in 15 states are affected due to excess fluoride concentration.

The Range Varies From 1.0 To 48mg/Fluoride Affected States Are Andhra Pradesh, Delhi, Gujarat, Bihar, Karnataka, Haryana, Kerala, Jammu and Kashmir, Maharashtra, Madhya Pradesh, Orissa, Tamil Nadu, Rajasthan And Uttar Pradesh.

II. DIFFERENT METHODS USED FOR DEFLUORIDATION ARE

A. Adsorption Techniques

Adsorption is mostly used method in defluoridation. This includes absorption of fluoride ions on the surface of active agent. Adsorbing agents like activated alumina, bone char, activated carbon are highly used. It is a process that transfer ions from solution to the solid state by using different process. It consists of physical absorption by different methods like chelation, complexation exchange etc. Extreme porous materials are used. These is most suitable for small communities and also for household application. Its efficiency depends on properties of adsorbed and its dose, initial fluoride concentration and biding capacity. Over the time fluoride removal capacity reduces.

Nanoparticles like catalytic surface, high reactivity, many active sites, ease of separation are excellent adsorbents of fluoride. Adsorbents are categorized as oxides and Hydroxides, biosorbents materials, carbonaceous materials, industrial products and by products. Activated alumina and activated carbon are commonly used adsorbing agents. If activated alumina is used then hardness and ratio of total fluoride concentration to activated alumina dosage affects the fluoride removing efficiency. The pH. should be between 5.0 -6.0. Activated alumina technique is provided in number of villages by UNICEF to provided them clean drinking water.

➢ *Advantages*
- Efficiency to remove fluoride is up to 90%.
- This method is economical.
- It takes minimum contact time.

➢ *Disadvantages*
- This process only works if pH. is between 5-6.
- It requires pre-treatment.
- It has low absorption capacity and poor integrity.
- The regeneration should be carried out after every 4 Months.
- Skilled person is required to carry out plant operation.Not suitable if TDS is greater than 1500mg/L.

1) Activated Alumina

Highly porous material made from aluminium Hydroxides by dehydroxylating. This is used to keep things dry by absorbing water from arsenic selenium in drinking water. It can reduce fluoride from 10mg/L to less than 1mg/Required pH for defluoridation is 5.5. Its efficiency is 95%. Water having higher temperature and acidic water are filtered easily. Its FUC is up to 5000mg/kg. It can be determined by V.K. Chhabra's method. Aluminium Hydroxides which does not fulfilled the specifications can be used un this technique. It requires pre and post adjustment of pH.

➢ *Advantages*
- It adsorbs high amount of moisture.
- Its nontoxic.

➢ *Disadvantages*
- Its efficiency decreases with increasing time of usage.
- It is an expensive technique.
- It causes disposal problem of concentrated solution.
- It is only possible at specific pH. range.

2) Bone char

Produced by charring animal bones. It is a porous, black, granular material. It is composed of tricalcium phosphate (57-80%), calcium carbonate (6-10%) and carbon (7-10%). It is also used for decolourisation and also known as bone charcoal. Its density is 0.7 -0.8 g/cubic centimetre. It is used to remove fluoride as well as metal ions. It is an oldest agent for defluoridation. Toxic metal ions like arsenic and lead can also be removed. The electrostatic interaction between the bone char surface and fluoride plays important role in defluoridation. M.S. Nutthomon Fangsrekam observed the process by bone char and found that maximum amount of fluoride adsorbed per gram of bone char at 25°,35°,45°C are 21.1,22.4,25.7 mol respectively. The pH. of water should be between 7.0 -7.5. Efficiency of bone char can be improvised by pre-treatment of raw water using Brushite and Calcium. If it i.e., treated with Calcium it precipitates out the fluoride.

➢ *Advantages*
- It is highly economic technique.
- It has defluoridation percentage of 62-65%.

➢ *Disadvantages*

- Harbors bacteria which is unhygienic.
- It is a sensitive procedure.
- It can invite cultural and religious objections.

3) Brick Pieces Column

Basic function of brick piece is same like activated alumina. Soil used for making bricks composed of aluminium oxide that is why it is also known as brick pieces alumina. During the burning in the kiln, aluminium oxide gets activated and adsorbs excess fluoride when water is passed through it. Its replacement is required one time in three months if fluoride in water is 2.50 mg /L. Places where high alumina soil is present can use brick bat filter. Modi Jemish Kumar studied about brick pieces and found that it has good absorption capacity. They used 6.3 - 4.75 mm and 16 -12 mm size of brick pieces. In both cases the fluoride was decreasing as time was increasing.

➢ *Advantages*

- Capital investment is low and can be affordable.
- Maintenance cost is low.
- It is simple method and doesn't require skilled person.

➢ *Disadvantages*

1. It only removes fluoride from water having low concentration of fluoride.

4) Mud Pot

Heat treatment is given to raw pots like bricks production. That's why it also works as adsorbent media. As per various studies it is shown that the reduction of fluoride level from 1.8 ppm to 1.5ppm and 1.4ppm at end to 2 and 4 dates respectively. It is beyond the acceptable limits of alkalinity. Fluoride removal capacity depends on alumina content present in soil used for making pots.

➢ *Advantages*

- They are economical.
- Readily available for rural communities.

➢ *Disadvantages*

- Alumina content is beyond the control.
- It's not a promising method.

5) Natural Adsorbents

Different naturally available, low-cost adsorbents are horse gram powder, rice husk, ragi powder, Multani Miti, red mud, calcined clay, concrete, pineapple peel powder, chalk powder, orange peel powder, coffee husk etc. McKee and Johnston studied about removal of fluoride using activated carbon which was made from rice husk and wheat husk. They observed that this is effective at pH.<3.0 and very less removal at neutral pH.83%of efficiency was achieved by rice husk in 180min (3hours).Removal of fluoride was decreasing as the pH. was increasing. Mohammed and Majumder studied banana peel, groundnut shell, sweet lemon peel for industrial waste water defluoridation at neutral pH. range .They observed that banana peel ,groundnut shell and sweet lemon peel removed 94.34% ,89.9 % and 59.9% of fluoride respectively and contact time for them was 60,75,40 minutes respectively. Gandhi et al studied adsorbents like concrete, ragi seed powder, red soil, horse gram seed powder, orange peel powder, chalk powder, pineapple peel powder and Multani Miti. It shows the 86% of efficiency for chalk powder and pineapple peel powder .75% for horse gram seed powder, 65% for ragi seed and 71%for red mud. It was less for Multani Miti and concrete i.e., 56% and 53% respectively.

➢ *Advantages*

- Naturally available adsorbents
- It is highly efficient for removal of fluoride.
- It is economical.

➢ *Disadvantages*

- It requires huge quantity of adsorbents.

B. Precipitation Technique

1) Nalgonda Technique

Nalgonda technique helps to remove a fluoride or defluoridation together with the removal of colour, turbidity, bacteria and odour from raw supplies.in this method Alum with prior mixing of lime (Cao) and sodium carbonate (Na2CO3) is used.it is used in agricultural area and rural areas, where ground water containing overconsumption fluoride. The main objective of the fluoride is removed along with the flocs. This technique has been applied in India at different different levels. This method of removal, is until now not understand properly, retains some authors been depute as a co- precipitation.

➢ *Advantages*

- No handling of sarcastic acid and alkalise.
- Renewal of media is not required.
- The chemical required for test is easily available.

➢ *Dis-advantages*

- The great amount of alum is need to remove fluoride.
- Strictly PH controlled treated water is required.

C. Ion – Exchange Technique:

In ion – exchange method artificial chemicals use like; anion and cation exchange resins are used for removal of fluoride. A few are polyanion (Ncl), tulsion a-27, diacetate ff (ip) and amberlite xe-75. These methods depend upon the ratio of fluoride to total anions in groundwater. When total ratio of anion is 0.05 the approximate capacity of amberlite xe 75 was found to be 88 g/m3. The capacity will increase with the increasing ratio. This method study is also carried out by Mohan Rao and Baskaran in Andhra Pradesh. He experimented some materials including lime, aluminium salts, magnesium, activated carbon and ion exchange resins have been partition for their usefulness defluoridation of water. In this study, 5mg/1 to 1.5mg/1 fluoride. While burning in the kiln, aluminium oxides present in it gets activated and when water is passed it adsorbs excess fluoride.

➢ *Advantages*

- It remove fluoride up to range of 90-95%.
- It helps in the maintenance of taste and colour of water intact.

➢ *Dis-advantages*

- In the presence of other ions like sulphate, phosphate, carbonate and alkalinity its efficiency get reduce.
- Expensive technique because of the high cost of resins.
- High level of chloride is present in water.
- Treated water have very low ph than other methods.
- Fluoride is treated separately before the final disposal.

D. Miscellaneous Technique

➢ *Reverse Osmos Technique and Electro Dialysis*

In reverse osmosis method, the hydraulic pressure is applied on one side of the partially permeable membrane which force the water across the membrane leaving the salts behind. The removal of fluoride in this technique procedure has been report to range from 45-90% as the pH. of the water is uplift from 5.5-7. In this pH. and temperature is very reactive to membranes. The elements are also based on chemical attack, fouling by particulate matter and plugging and large quantity of waste. In this method waste quantity is even larger than ion exchange method. Occasionally, the pre-treatment required.

➢ *Advantages*

- The process is efficient for removal of fluoride.
- Its work under broad PH range.
- It certify the sustained water quality.
- No use of any chemical.
- Low maintenance is needed.

➢ *Dis-advantages*

- It take out all the ions particle present in water.
- Lots of water gets wasted.
- Problem of discarding of brine.

E. Electrolysis Technique

In this method of defluoridation technique water purified system is only suitable for fluoride affected area where they containing excess fluoride. This process of defluoridation is based on the principle of electrolysis. It removes fluoride by active species of hydroxide of aluminium manufacture by passing dc power between aluminium electrode. It is simple to construct and easy to operate with low maintenance.in this fluoride concentration up to 10mg/l for a treatment of raw water. The quantity of sludge produce by these is 60-70%.

➢ *Advantages*

- Does not required any additional chemicals.
- No need to pre and post treatments.
- Low volume of sludge produce.

➢ *Dis-advantages*

- Waste produce is large.

III. CONCLUSION

Fluoride concentration is high in water is where the geological settings contain high levels of fluoride and deficiency in competing ions like calcium. Fluoride consumption has both adverse and beneficial effects on human health especially in young age. defluorination should be carried out where there's no alternate source of safe drinking water. It's observed that numerous styles are used for junking of excess of fluoride in the drinking water but every system have their benefits and limitations. Some particular procedure, which is suitable at a individual region, may not meet the demands at some different place. Therefore, any technology to be applied should be acted before enactment in the field. Priority should be given to methods, which use locally obtainable materials as defluorination mediums. Regular force of the materials and equipment should be secured by means of ways resembling as social marketing. administrations should establish the community defluorination workshops and granting sufficient finances for their upkeep.

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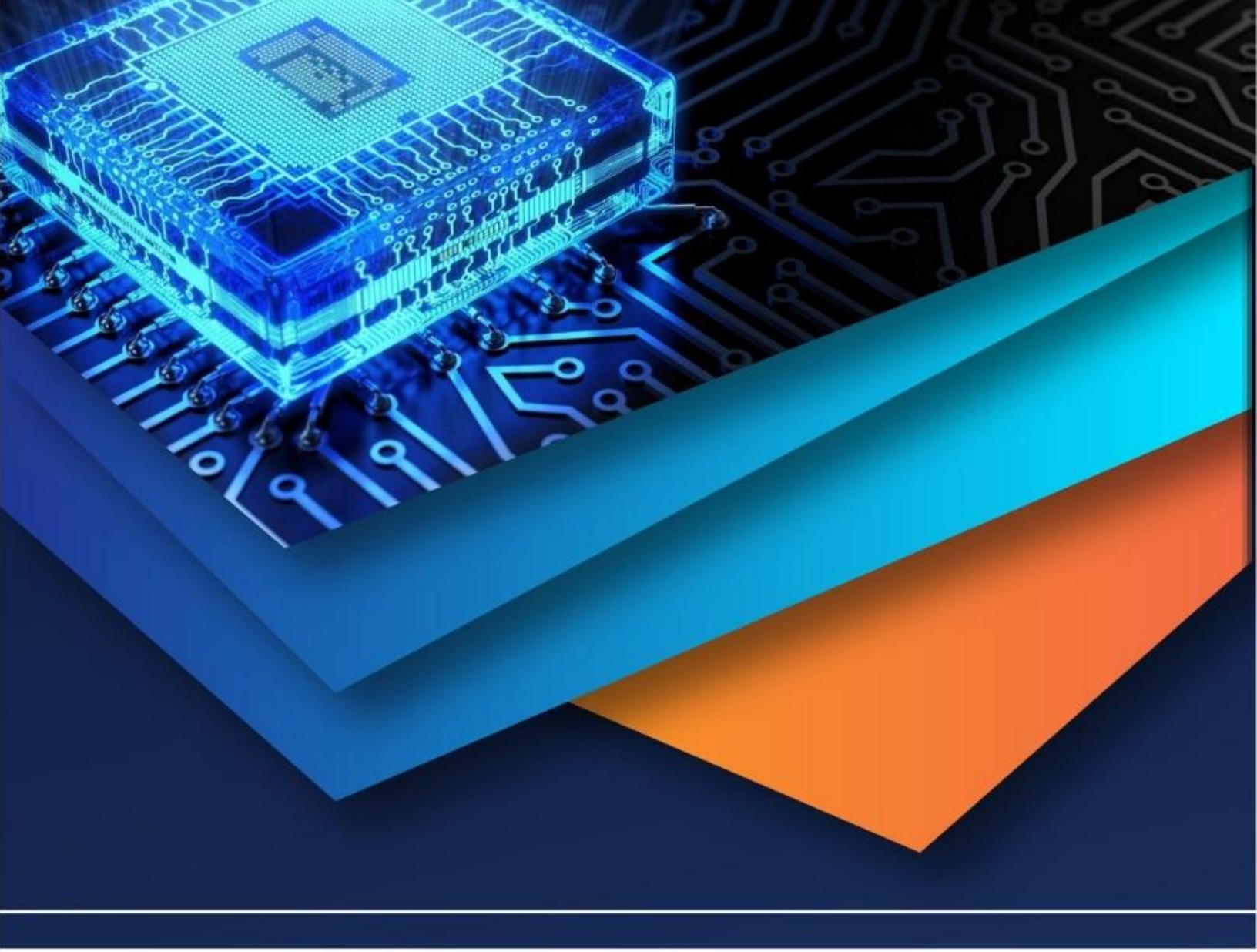

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