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Comparative Analysis On Groundwater and Defluoridation Using Natural Adsorbents

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***Abstract*: Fluoride is the one of the very few chemicals that has been shown to cause significant effect in people through drinking water which is found in excess in surface or ground water because of geochemical reactions are authropogenic activities various methodology used for defluoridation of water such as coagulation, precipitation membrane processes, electrolysis treatment, ion exchange process among these methods adsorption widely used because of cost effectiveness simplicity of design and operation. An attempt is made in this study with special reference to different natural absorbent such as ACTIVATED CHARCOAL, FlyASH, WOODEN ASH, RIVER SAND for defluoridation. The result obtained for these studies are the ash absorbent showed maximum adsorption significant reduction in turbidity, ph hardness, chloride, dissolved oxygen and fluoride with in the standard limit.**

***Keywords*: Charcoal, Fly ash, Wooden ash, River sand.**

1. Introduction

Excess of fluoride in groundwater has become a threat in recent days due to the lesser availability of potable groundwater resource. Fluoride is known to be a natural contaminant for ground water resources globally. Fluorine, a fairly common element of earth crust, is present in the form of fluorides in a number of minerals and in many rocks. The ingestion of excess fluoride can cause fluorosis which affects the teeth and bones. Moderate amounts lead to dental effects, but long-term ingestion of large amounts can lead to potentially severe skeletal problems. Paradoxically, low levels of fluoride intake help to prevent dental caries. Research of several researchers during the last 5-6 years has proved that life-long impact and accumulation of fluorides cause not only human skeletal and teeth damage, but also changes in the DNA-structure, paralysis of volition, cancer, etc.

Mainly two factors are responsible for contamination of ground water with fluoride: one is geological and second is anthropogenic. Although both geological and manmade sources contribute to the occurrence of fluoride in water, the major contribution comes from geological resources. In the 3rd edition of the World Health Organization (WHO) guidelines on drinking water, it maintains its guideline on the appropriate fluoride concentration at 1.5 mg/L (WHO 2008).

It is estimated that around 260 million people worldwide (in 30 countries) are drinking water with Fluoride content more than 1.0 mg/L. In India alone, endemic Fluorosis is thought to affect around one million people and is a major problem in 17 of the 25states, especially Rajasthan, Andhra Pradesh, Tamil Nadu, Gujarat, and Uttar Pradesh. So Fluoride removal from water is an important mission of Environmental Engineers.

There are different methods of defluoridation methods like ion exchange, precipitation and adsorption. Among these methods, adsorption is widely used method for defluoridation of water because of its easy method of operation and cost effectiveness. Some of the adsorption materials broadly used for defluoridation are; physico-chemically treated sand microwave assisted activated carbon, aluminium sulphate treatment, pumice and raw Bauxite, an extensive survey on the removal of excess fluoride in water shows that different techniques have been attempted by several authors, using natural and synthetic material. This review of the literature shows that the study of fluoride removal by natural materials/soil is less.

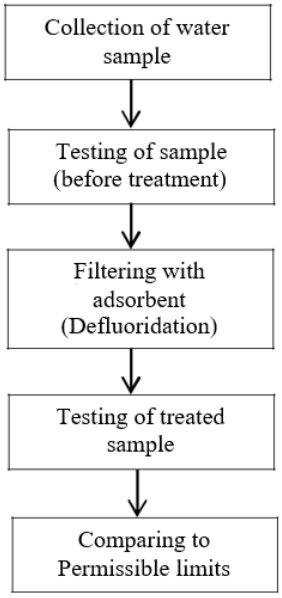

Fig. 1. Methodology

The column study thus reveals that the quantity of materials used were according to their effective fluoride removal capacity. But this study lacks detailed monitoring of data over a periodic time interval, where sequential changes can occur

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rapidly: further, the materials were not examined studied before and after the treatment. Keeping these factors in mind, red soil which is an effective fluoride remover was used in this study to understand the fluoride removal capacity over time. They are also studied for their change in their bonding nature before and after the treatment. Further an attempt was also made to understand their regeneration property/capacity after this experiment.

2. Methodology

A. General

The removal methodology of fluoride in groundwater is shown in fig. 1.

3. Filter Bed Preparation

Four different types of filter bed are prepared, first one is filled with charcoal, second is filled with fly ash, third filled with combination of charcoal and fly ash brick, fourth is filled with wooden ash. These entire filters are supported at bottom of the filter bed using fine sand and cotton. The filtering media and sand washed with distilled water for cleaning and removing the impurities. The filter media is washed with water after washing completed the washed medium is dried with help of sun light. After completion of cleaning the filter media is prepared. The bottom most portion of the bed filled with cotton over the fine sand at considerable depth. The filtering media filled over the sand, each layer of the filter media is compacted well by using hand.

Filter 1: cotton + fine sand + charcoal + fine aggregate.
Filter 2: cotton + fine sand + fly ash + fine aggregate.
Filter 3: cotton + fine sand + charcoal + fly ash + fine aggregate.
Filter 4: cotton + fine sand + wooden ash + fine aggregate.

4. Treatment Methodology

In this study the treatment is fully based on the charcoal, wooden ash, Fly ash brick. The Charcoal, wooden ash, Fly ash was used as an adsorbent. The plastic container should have a capacity of not less than 2 litres. The container is provided with a hole of 1 cm diameter at the bottom. The hole is used to collect the treated water. The plastic container is easily available in market or either used as waste PET bottles. The bottom of the container filled with cotton for sufficient depth, over the cotton layer backed with fine sand, after filled with filtering media. The various types of filtering media used for filtering.

Charcoal, wooden ash, fly ash is filled with different container with help of sand and cotton. The sample water passed through the filter media and collect at the bottom of the container. After filtering, the samples were tested for their physical, chemical characteristics. The results were compared with the collected water characteristics before and after filtering with their permissible limits.

5. Defluoridation

The sorption studies are carried out in a plastic column of 2.5 cm diameter and bed height of 25 cm. Four sets of column study are performed A cotton plug is used in the bottom of the column to support the adsorbent bed and prevent the outflow of particles. In each set, for a given initial fluoride a concentration is 2.5 mg/L. The charcoal filled with 43 cm height, the wooden ash filled with 23 cm, and the charcoal and fly ash brick filled with 20 cm height. Fly ash brick is filled with 20 cm height. The effluent is collected and analyzed for fluoride concentration. Packed bed experiments are carried out at room temperature.

Filter 1: cotton + fine sand + charcoal + fine aggregate

Fig. 2. Filter 1

Filter 2: cotton + fine sand + fly ash + fine aggregate

Fig. 3. Filter 2

Filter 3: filled with Cotton + Fine sand + Charcoal + Fly ash.

Fig. 4. Filter 3

Filter 4: filled with Cotton + Fine sand + Wooden ash.

Fig. 5. Filter 4

6. Results

Table 1
Test results for treated water samples with filter 1

S.No.	Parameter	Unit	Sample 1	Sample 2	Permissible Limit
1	Turbidty	NTU	15	12	5
2	pH	-	7.23	7.52	6.5-8.5
3	Hardness	mg/l	240	280	300
4	Chloride	mg/l	360	370	250
5	Dissolved Oxygen	mg/l	18.2	18.6	6
6	Fluoride	mg/l	1.4	1.4	1.5

Table 2
Test results for treated water samples with filter 1

S.No.	Parameter	Unit	Sample 3	Sample 4	Permissible Limit
1	Turbidty	NTU	15	13	5
2	pH	-	7.1	7.3	6.5-8.5
3	Hardness	mg/l	250	240	300
4	Chloride	mg/l	380	360	250
5	Dissolved Oxygen	mg/l	18.4	18.6	6
6	Fluoride	mg/l	1.4	1.4	1.5

Table 3
Test results for treated water samples with filter 1

S.No.	Parameter	Unit	Sample 5	Sample 6	Permissible Limit
1	Turbidty	NTU	14	11	5
2	pH	-	7.26	7.48	6.5-8.5
3	Hardness	mg/l	250	280	300
4	Chloride	mg/l	350	390	250
5	Dissolved	mg/l	18.2	18.6	6
	Oxygen				
6	Fluoride	mg/l	1.4	1.4	1.5

Table 4
Test results for treated water samples with filter 2

S.No.	Parameter	Unit	Sample 1	Sample 2	Permissible Limit
1	Turbidty	NTU	10	8	5
2	pH	-	7.53	7.27	6.5-8.5
3	Hardness	mg/l	300	260	300
4	Chloride	mg/l	370	360	250
5	Dissolved Oxygen	mg/l	19	20	6
6	Fluoride	mg/l	1.5	1.5	1.5

Table 5
Test results for treated water samples with filter 2

S.No.	Parameter	Unit	Sample 3	Sample 4	Permissible Limit
1	Turbidty	NTU	9	10	5
2	pH	-	7.24	7.62	6.5-8.5
3	Hardness	mg/l	260	280	300
4	Chloride	mg/l	360	380	250
5	Dissolved Oxygen	mg/l	18.6	19.4	6
6	Fluoride	mg/l	1.5	1.5	1.5

Table 6
Test results for treated water samples with filter 2

S.No.	Parameter	Unit	Sample 5	Sample 6	Permissible Limit
1	Turbidty	NTU	10	11	5
2	pH	-	7.59	7.63	6.5-8.5
3	Hardness	mg/l	300	270	300
4	Chloride	mg/l	340	350	250
5	Dissolved Oxygen	mg/l	20	18.2	6
6	Fluoride	mg/l	1.5	1.5	1.5

Table 7
Test results for treated water samples with filter 3

S.No.	Parameter	Unit	Sample 1	Sample 2	Permissible Limit
1	Turbidty	NTU	5	6	5
2	pH	-	7.46	7.59	6.5-8.5
3	Hardness	mg/l	280	260	300
4	Chloride	mg/l	360	360	250
5	Dissolved Oxygen	mg/l	15.5	16.2	6
6	Fluoride	mg/l	1.45	1.45	1.5

Table 8
Test results for treated water samples with filter 3

S.No.	Parameter	Unit	Sample 3	Sample 4	Permissible Limit
1	Turbidty	NTU	6	7	5
2	pH	-	7.4	7.38	6.5-8.5
3	Hardness	mg/l	300	300	300
4	Chloride	mg/l	340	360	250
5	Dissolved Oxygen	mg/l	16.4	15.6	6
6	Fluoride	mg/l	1.45	1.45	1.5

Table 9
Test results for treated water samples with filter 3

S.No.	Parameter	Unit	Sample 5	Sample 6	Permissible Limit
1	Turbidty	NTU	5	8	5
2	pH	-	7.45	7.23	6.5-8.5
3	Hardness	mg/l	250	270	300
4	Chloride	mg/l	380	350	250
5	Dissolved Oxygen	mg/l	15.8	15.6	6
6	Fluoride	mg/l	1.45	1.45	1.5

Table 10
Test results for treated water samples with filter 4

S.No.	Parameter	Unit	Sample 1	Sample 2	Permissible Limit
1	Turbidty	NTU	0	1	5
2	pH	-	7.1	7.15	6.5-8.5
3	Hardness	mg/l	250	240	300
4	Chloride	mg/l	320	340	250
5	Dissolved Oxygen	mg/l	20	20.6	6
6	Fluoride	mg/l	1.3	1.3	1.5

Table 11
Test results for treated water samples with filter 4

S.No.	Parameter	Unit	Sample 3	Sample 4	Permissible Limit
1	Turbidty	NTU	2	1	5
2	pH	-	7.22	7.17	6.5-8.5
3	Hardness	mg/l	240	250	300
4	Chloride	mg/l	300	320	250
5	Dissolved Oxygen	mg/l	19.8	21.4	6
6	Fluoride	mg/l	1.3	1.3	1.5

Table 12
Test results for treated water samples with filter 4

S.No.	Parameter	Unit	Sample 5	Sample 6	Permissible Limit
1	Turbidty	NTU	1	1	5
2	pH	-	7.11	7.19	6.5-8.5
3	Hardness	mg/l	220	250	300
4	Chloride	mg/l	320	340	250
5	Dissolved Oxygen	mg/l	20.6	19.8	6
6	Fluoride	mg/l	1.3	1.3	1.5

Fluoride content of the raw sample exceeding the permissible limit. The permissible limit of the drinking water is 0.6 to 1.5 ppm. The raw sample fluoride content is 2.5 ppm. The fluoride content of the water not exceeding 1.5 and not less than 0.6. The filtered water gives the fluoride content value less than permissible value. The filter 1, 2, 3 gives the good result and filter 4 is reducing the fluoride more effectively.

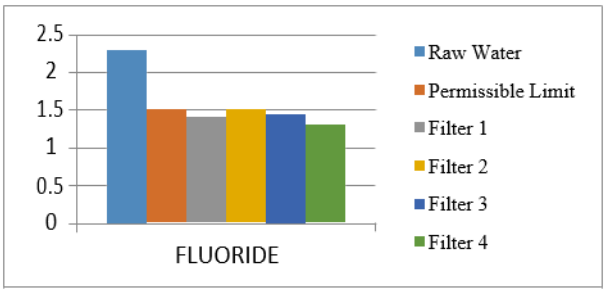

Fig. 6. Fluoride content in water sample after defuoridation

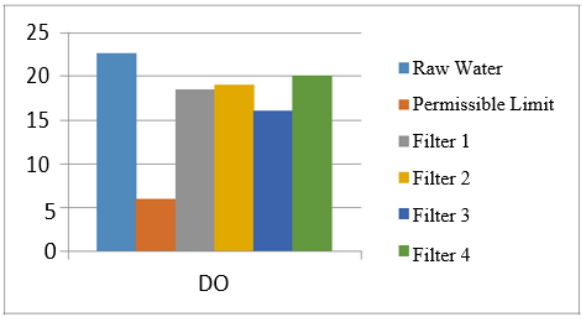

Fig. 7. DO content in water sample after defuoridation

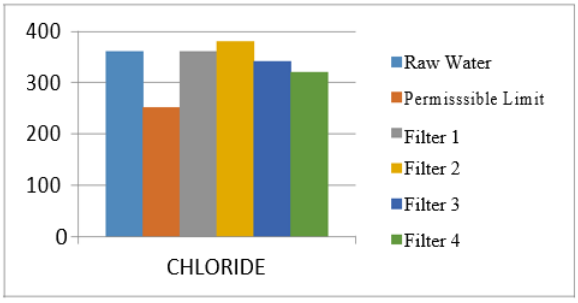

Fig. 8. Chloride content in water sample after defuoridation

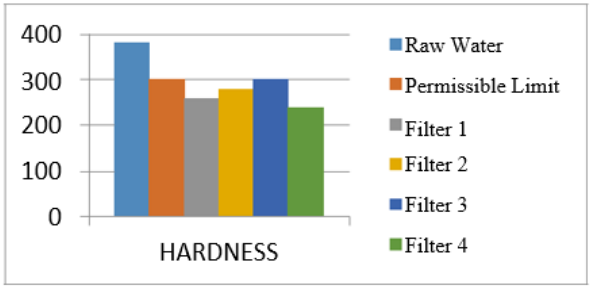

Fig. 9. Hardness in water sample after defuoridation

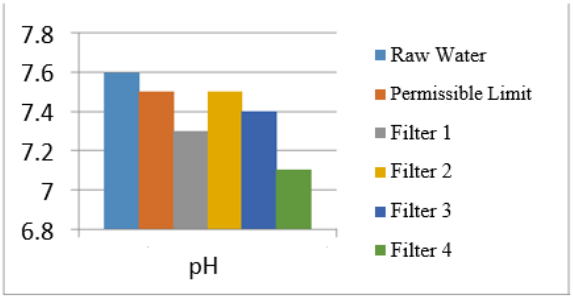

Fig. 10. pH in water sample after defuoridation

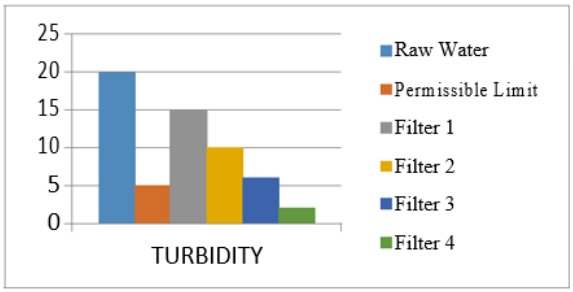

Fig. 11. Turbidity in water sample after defuoridation

7. Conclusion

- The test result of the treated water sample shows that their fluoride characteristics are well within the permissible limits.
- Whereas in case of raw water samples, some of the parameters like fluoride are just exceeding their permissible limits.
- The various types of filter media used in different filters like charcoal, fly ash and wooden ash these all are the waste material in the environment.
- So the disposal of the waste material is also reduced by using it in the filter media.
- The filter media is prepared by a waste material from the locality, so it is a cost effective method.
- It reduces the waste from the environment, so it is an ecofriendly process.
- The fluoride free water is served for the people with eco-friendly and cost effective method.
- The materials for preparing filter media is easily available, so this method can be adopted anywhere.

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