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A RESEARCH PAPER ON REMOVAL OF FLUORIDE FROM DRINKING WATER USING VARIOUS CHEAP ADSORBENTS

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ABSTRACT

Excess availability of fluoride in drinking water is very common in India. For removal of fluoride from drinking water many adsorbents are using from the past but due to many demerits still we need a perfect method for this. In this research work we have been applied some cheap methods for the de fluoridation. The using adsorbents are Fly ash, red mud, marble powder and mixture of Fly ash and red mud. Here used fly ash, generated from Chula. Red mud was collected from Hanumangargh District. And pieces of marble collected from construction area and crushed for use in the laboratory. In this research work Ash, Red mud, Marble powder or Mixture of Ash and Red mud are mixed with fluoridated water after filtration the fluoride was analyzed by using ions selective electrode method. After the analysis we found all methods removes fluoride from drinking water but the results were found from Fly ash much satisfactory.

KEYWORDS: Adsorption, De fluoridation, Fluoride, Fly Ash, Marble Powder P^H, Red Mud

INTRODUCTION

Fluorine is an essential element for human beings, because it helps in growth and prevents the enamel of the teeth from dissolving under acidic conditions. Various dietary components influence the absorption of fluorides from gastrointestinal tract and the absorbed fluorides are distributed throughout the body. Drinking water and sea food are good sources of fluoride. Fluoride is beneficial to health if the concentration (CF) of the fluoride ion (F-) in drinking water is less than 1.5 mg/L (WHO 1994). A higher concentration causes serious health hazards. The disease caused manifests itself in three forms, namely, dental, skeletal, and non-skeletal fluorosis. Dental fluorosis produces widespread brown stains on teeth and may cause pitting (Bulusu and Nawlakhe, 1992). Skeletal fluorosis causes crippling and severe pain and stiffness of the backbone and joints (Bulusu and Nawlakhe, 1992). Even though extensive studies have been conducted, there seems to be no effective cure for these diseases. Therefore, it is desirable to drink water having a fluoride concentration less than certain value. Hence, drinking water with CF > 1.5 mg/L (1 mg /L in India) needs treatment (WHO1994).

Throughout many parts of the world, high concentrations of fluoride occurring naturally in groundwater and coal have caused widespread fluorosis - a serious bone disease - among local populations. A range of everyday products, notably toothpaste and drinking water, the fluoride in small doses has no adverse effects on health to offset its proven benefits in preventing dental decay. But more and more scientists are now seriously questioning the benefits of fluoride, even in small amounts (UNICEF Report, 1980). Since some fluoride compounds in the earth's upper crust are soluble in water, fluoride is found in both surface waters and groundwater. In surface freshwater, however, fluoride concentrations are usually low - 0.01 ppm to 0.3 ppm.

In groundwater, the natural concentration of fluoride depends on the geological, chemical and physical characteristics of the aquifer, the porosity and acidity of the soil and rocks, the temperature, the action of other chemical elements, and the depth of wells. Because of the large number of variables, the fluoride concentrations in groundwater can range from well under 1 ppm to more than 35 ppm. In Kenya and South Africa, the levels can exceed 25 ppm. In India, concentration up to 38.5 ppm has been reported in drinking water (UNICEF).

Table: 1 Permissible Limit of Fluoride in Drinking Water Prescribed by Various Organizations

Name of the Organization	Desirable Limit (Mg/L)
Bureau of Indian Standards (BIS)	0.6-1.2
Indian Council of Medical Research (ICMR)	1.0
The Committee on Public Health Engineering Manual and Code of Practice, Government of India	1.0
World Health Organization (International Standards for Drinking Water)	1.5

India is among the many countries in the world, where fluoride contaminated ground water is creating health problems. Safe drinking water in rural areas of India is predominantly dependent on groundwater sources, which are highly contaminated with fluoride. The concentrations in 17 States out of 32 are endemic for fluorosis being 1 to 48 mg/L. About 62 million people including 6 million children are affected with dental, skeletal and non-skeletal fluorosis.

In Rajasthan the existence of fluorides was first detected in 1964 when a survey was under taken by state PHED in collaboration with NEERI on the basis of reports of some peculiar diseases. Some villages were mainly in Nagour, Jaipur and Jhunjhnu district were traced later as endemic for fluorosis The concentration in ground water varied from as low as zero to 18.00ppm as maximum. Hence it becomes more necessary to fluoride concentration, exactly and maintains it in between 0.5mg/l to 1.5mg/l in water.

Due to the various health problems related to excess of fluoride in the drinking water, removal of fluoride is necessary. Defluoridation methods can be broadly divided into three categories according to the main removal mechanism:

- Chemical additive methods
- Contact precipitation
- Adsorption/ion exchange methods

METHODOLOGY

In this study we collected samples from various locations in the study area (Sitapura Industrial Area) in three phases at different time duration. Various physical and chemical analysis has been done in the Chemistry laboratory of the JaganNath University like $P^{H,}$ Total dissolve solids, Alkalinity, Hardness and Chloride. Some parameters like Fluoride, Nitrate and Heavy metals were analyzed by Team Test Lab. Sitapura Industrial area Jaipur.

DETAILS OF SAMPLES

Time of Sample Collection-

- Phase-I (Samples collection in August)
- Phase-II (Samples collection in December)

- Phase-III (Samples collection in March)

AREA OF SAMPLE COLLECTION-

•	Sample No. 1 Genus industries	Sample No. 6	JNIT College
•	Sample No. 2 Chevrolet industries	Sample No. 7	Residential Area
•	Sample No. 3 Ratan Textiles	Sample No. 8	Near Chokhi Dhani
•	Sample No. 4 Bharat patrol pump	Sample No. 9	Sachiwalaya Nagar
•	Sample No. 5 Hotel Amrapali	Sample No. 10	Laxhmipura

DETAILS OF DEFLUORIDATION METHODS

METHOD A: REMOVAL OF FLUORIDE BY FLY ASH (BASED ON ADSORPTION PROCESS): -The fly ash was an effective adsorbent especially at high concentration of fluoride. In this method we use fly ash, generate from Chula. The 100 gm ash is mixed with 1 liter fluoridated water and stirs 45 to 60 minutes then leave it for settle down. After 2 hour this solution filters with G-3 crucible in a filtration unit.

METHOD A1: PRE TREATMENT OF FLY ASH WITH DISTILLED WATER: Due to increase in some physico-chemical parameters during the research, it was observed that pre treated fly ash could address these problems without hindering the fluoride removal efficiency of fly ash therefore fly ash was pretreated before de fluoridation.

For the pre treatment of fly ash, it is washed by distilled water. For this 100 gm fly ash washed with 1 liter distilled water, washing it twice. For this process we were used an ordinary filter paper, funnel and beaker. Dried, Crushed and powered fly ash before use for fluoride removal.

METHOD B: REMOVAL OF FLUORIDE BY RED MUD (BASED ON ADSORPTION PROCESS):-The experimental red mud is collected basically from Hanumangargh district. The 100 gm red mud is mixed with 1 liter fluoridated water and stir 45 to 60 minutes then leave it for settle down. After 2 hour this solution filters with G-3 crucible in a filtration unit. The possibility of removal of fluoride ion by using red mud is explained on the basis of the chemical nature and specific interaction with metal oxide surfaces (Yunus *et a1*. 2002).

METHOD C: REMOVAL OF FLUORIDE BY MARBLE POWDER (BASED ON CHEMICAL TREATMENT PROCESS):- In various chemical treatment processes lime treatment is one of them. In this method, we collect marble stone and crushed into marble powder. Than it is used for removal of fluoride in place of lime.100 gm of marble powder mixed with1 liter fluoridated water and stirs 45 to 60 minutes then leaves it for settle down. After 2 hour this solution filters with G-3 crucible in a filtration unit.

METHOD D: REMOVAL OF FLUORIDE BY FLY ASH AND RED MUD MIX METHOD (BASED ON ADSORPTION PROCESS):- In this method we use the mixture of 50 gm of fly ash and 50 gm of red mud mixed with1 liter fluoridated water and stir 45 to 60 minutes then leave it for settle down. After 2 hour this solution filters with G-3 crucible in a filtration unit.

Table 2

S. No.	Phase I Concentration of F (mg/l.)						Phase II Concentration of F (mg/l.)						Phase III Concentration of F (mg/l.)					
	Before Treatment	A	Al	B	C	D	Before Treatment	A	Al	B	C	D	Before Treatment	A	Al	B	C	D
1	2.46	0.75	0.78	1.85	2.23	1.82	2.46	0.75	0.78	1.83	2.23	1.80	2.46	0.76	0.79	1.85	2.25	1.81
2	2.16	0.68	0.70	1.53	1.98	1.51	2.16	0.69	0.71	1.52	1.98	1.52	2.16	0.69	0.70	1.52	1.98	1.51
3	1.18	0.56	0.58	0.98	1.05	1.07	1.18	0.55	0.59	0.98	1.02	1.98	1.18	0.55	0.59	0.97	1.05	1.96
4	2.82	1.01	1.05	2.16	2.40	1.19	2.82	1.01	1.05	2.16	2.40	1.19	2.82	1.01	1.04	2.15	2.40	1.19
5	1.38	0.62	0.69	1.05	1.16	1.02	1.38	0.63	0.68	1.04	1.16	1.03	1.38	0.63	0.68	1.04	1.16	1.03
6	2.84	0.88	0.92	2.17	2.35	2.15	2.84	0.89	0.92	2.18	2.35	2.15	2.84	0.89	0.93	2.17	2.36	2.14
7	1.40	0.65	0.71	1.08	1.15	1.04	1.40	0.65	0.70	1.08	1.12	1.05	1.40	0.65	0.71	1.09	1.15	1.04
8	2.34	0.70	0.75	1.89	2.15	1.83	2.34	0.70	0.74	1.89	2.12	1.82	2.34	0.69	0.75	1.89	2.15	1.82
9	2.50	0.75	0.78	1.93	2.40	1.90	2.50	0.76	0.79	1.93	2.40	1.91	2.50	0.75	0.79	1.94	2.40	1.90
10	1.21	0.60	0.63	1.02	1.10	1.01	1.21	0.60	0.62	1.02	1.10	1.01	1.23	0.61	0.63	1.03	1.10	1.02

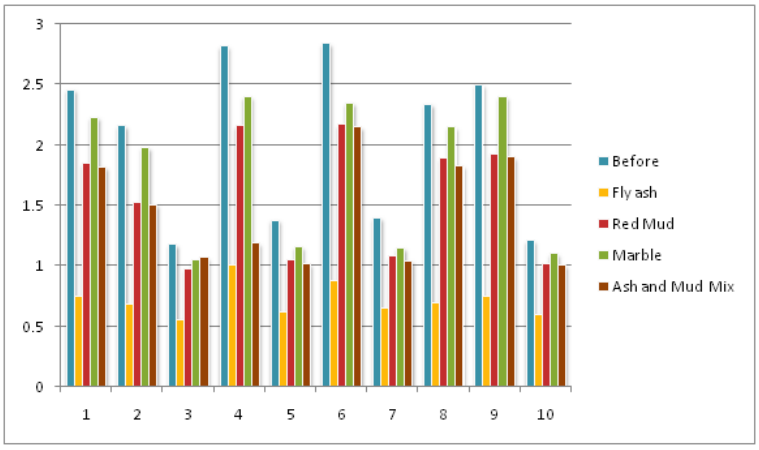

Figure 1: Comparative Fluoride Concentration before and after Using Adsorbents in Phase I

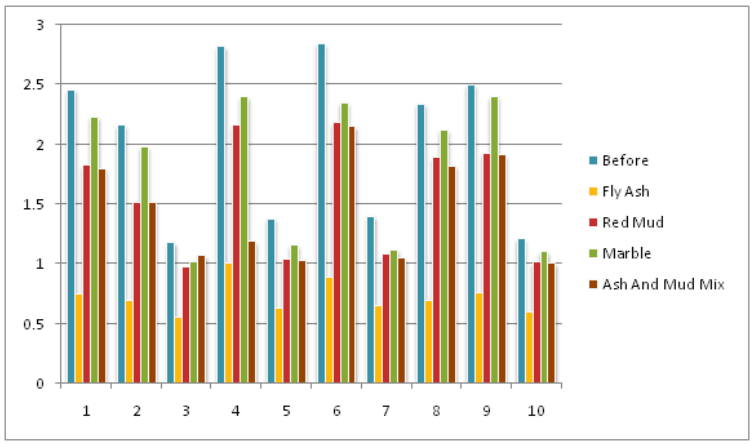

Figure 2: Comparative Fluoride Concentration before and after Using Adsorbents in Phase II

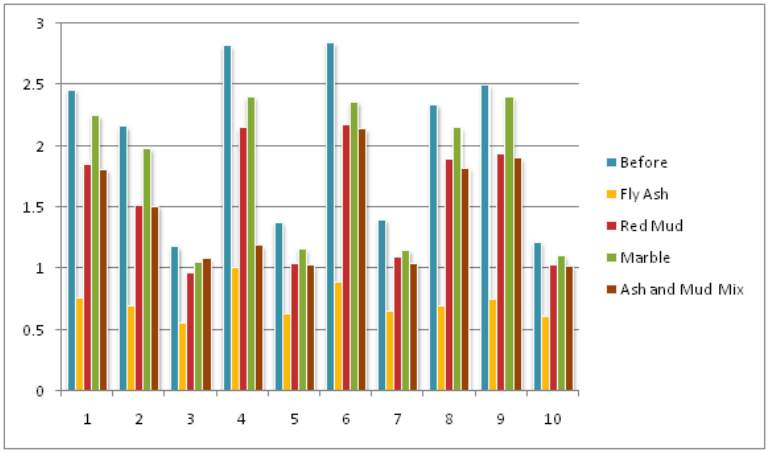

Figure 3: Comparative Fluoride Concentration before and after Using Adsorbents in Phase III

RESULTS AND DISCUSSIONS

It is found from above all observations that all four adsorbent from different methods removes fluoride from drinking water. But from the observation of all graphs shows the fly ash method is much effective and suitable method from the others. The fly ash is not only a good adsorbent for the removal of fluoride from drinking water but also it is a type of solid waste generated from many industries. In view of the demerits of various de fluoridation methods, we found that this method does not create so much variation in the other parameters and the concentration of those parameters can be reduced by the pretreatment of fly ash with distilled water. Results shows that fly ash can change the fluoride concentration satisfactory according to the permissible limit of WHO (1.15 mg/l.)

CONCLUSIONS

In this research work we have been used various cheap methods for fluoride removal which can apply easily for domestic purpose and this is the main aim of research work. It is concluded that the all raw material were used in research work are easily available, free of cost and none any other expenditure with these methods. The results of our experiments revealed satisfactory and that fly ash method is better method from the others for de fluoridation from drinking water.

We can easily apply this method for the domestic purpose because in rural areas, cooking is done by Chulhas and the fly ash is a waste after burning of fuel. By this method we can also show one of the reuse methods of fly ash. So this reuse helps us in solid waste management. This technology is very much cheap from the other de fluoridation methods.

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