Int. J. Chem. Sci.: 7(1), 2009, 147-154

AN ASSESSMENT OF FLUORIDE CONCENTRATIONS IN DIFFERENT DISTRICTS OF MADHYA PRADESH, INDIA

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ABSTRACT

Fluoride is most electronegative and most reactive halogen. Fluoride in the form of fluorine is 17th most common element on earth crust[1]. Concentration of fluoride below 1 ppm are believed beneficial in the prevention of dental carries or tooth decay, but above 1.5 ppm, it increases the severity of the deadly diseases fluorosis, which is incurable in India[2].

This paper alarm the latest scenario of fluorosis pollution in fifteen district of Madhya Pradesh, India. All water samples were taken for study from hydrograph stations in Madhya Pradesh. Fluoride in groundwater samples was found to range between nil to 14.20 ppm, while 33 % of water samples are within permissible limit of 1.5 ppm prescribed by BIS (1991). The highest value of fluoride (14.20 ppm) has been recorded at Seoni district in southern part of state. In western part, 13.86 ppm fluoride has been found in Jhabua district. In northern part, the high range of fluoride affects Gwalior and Shivpuri district. In central part of the province, 4.43 ppm concentration of fluoride was found at Vidisha district. This study was done in year 2006 and the maximum and minimum concentrations of fluoride are shown in different districts. The conclusion of this work is to give information about the deleterious changes of fluoride concentration in groundwater of the state.

Key words: Electronegative, Carcinogen, Crippling, Groundwater, Fluoride

INTRODUCTION

Fluorosis, in drinking water is beneficial, when it is present in low concentration (0.8 to 1.0 ppm) however; excessive intake of it causes dental, skeletal and non-skeletal fluorosis[3]. According to guidelines for drinking water quality of WHO, the permissible limit is 1.5 ppm (WHO, 1984)[4]. Excessive fluoride occurrence in drinking water is a problem in many countries[5]. In India, 65 million people in and around 8700 villages are

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estimated to be suffering from fluorosis[6].

Small quantity of fluorides is a vital necessity for man and animals. Fluorine is the component part of the bone and teeth. Tooth tissue contains about 0.02% of fluorine; its major part being in tooth enamel, whose composition is to close to the formula $Ca_5F(PO_4)_3$.

Fluoride is added to many drinking water supplies to reduce dental carries. On the other hand, fluoride is a carcinogen, a bone seeker and is linked to hip fractures and brittle bones[7]. In high concentration above 1.5 ppm, it is responsible for dental and skeletal fluorosis, where people are facing mobility difficulties. Recent investigations; however, show that even soft tissues of human body are affected, leading to non-skeletal fluorosis. The fluoride research in the past decade also proved that life long impact and accumulation of fluoride causes not only dental and skeletal damages but also changes in the DNA structure, paralysis of volition, cancer etc.[2].

Excess fluorine in water or air (as dust) is poisonous since all fluorine compounds are poisons. Chronic poisoning with fluorine manifest in the loss of appetite, cochexia, structural changes in the bone tissue and teeth. It affects the joints, kidneys liver, heart, adrenal glands, testis, and thyroid gland. So many experiments are also performed about effect of fluoride contaminated drinking water in Albino rat species that shows fluoride affects not only humans but also on animal species[8]. Subsoil water from artesian and other wells and also from springs, which are used for local water supply contains increased doses of fluorine. Its concentration rises as high as to 6-10 ppm. Fluoride enters the human and animal body mainly with water. But the vast investigations show that absence of fluorine in water causes the carries of the teeth[9].

Occurrence

The main natural source of inorganic fluoride in the parent rock itself. The major fluoride bearing minerals are Sellatite (MgF_2), Fluorspar (CaF_2), Cryolite (Na_3AlF_6), Fluorapetite $Ca_3(PO_4)F$ etc. Fluoride is a high electronegative and reactive and it combines with number of elements to form ionic and covalent fluorides. Fluorspar is the principal bearer of fluoride and it is found in granite, granite gneisses and pegmatite (WHO 2002)[10].

EXPERIMENTAL

Methods and materials

The study area selected was 15 districts of the Madhya Pradesh, India. All water

samples were collected from bore wells (Hydrograph stations) in clean polyethylene container from different districts in Madhya Pradesh were analyzed specially for fluoride by calorimetric method (UV Spectrophotometer) by using zirconium oxychloride method and absorption was measured at 570 nm (APHA)[11].

RESULTS AND DISCUSSION

Mainly the four parts of the state are considered in our analysis work that is central, northern, southern and western part.

Northern part: It comprises Shivpuri and Gwalior districts. The fluoride concentration was found to range from 0.21 to 6.20 ppm.

Southern part: It comprises of Khandwa, Khargone Betul, Seoni, and Mandla districts. The fluoride concentration was found to range from nil to 14.20 ppm. The highest value is recorded in Seoni district (14.20 ppm).

Central part: It comprises Bhopal, Raisen, Sehore, Vidisha and Jabalpur districts. The fluoride concentration was found to range from nil to 5.00 ppm. The higher values in this part are recorded in Jabalpur and Vidisha districts.

Western part: It comprises the Dhar, Jhabua and Shajapur districts. The fluoride concentration was found to range from nil to 13.86 ppm. In this part, some areas of the Jhabua, were not found to have any fluoride, while in some areas, it was found up to 13.86 ppm.

Table 1. Hot spots in different areas of Madhya Pradesh

S. No.	Districts	Fluoride range (ppm)	
		Maximum	Minimum
1	Shivpuri	0.21	3.89
2	Gwalior	0.21	6.20
3	Khandwa	0.00	0.65
4	Khargone	0.10	1.58
5	Betul	0.28	0.68

Cont…

S. No.	Districts	Fluoride range (ppm)	
		Maximum	Minimum
6	Seoni	0.21	14.20
7	Mandla	0.89	3.30
8	Bhopal	0.19	2.69
9	Raisen	0.00	1.25
10	Sehore	0.26	1.25
11	Vidisha	0.36	4.43
12	Jabalpur	0.00	5.00
13	Dhar	0.78	4.07
14	Jhabua	0.00	13.86
15	Shajapur	0.12	0.46

Table 2 : Technologies available for defluoridation

Name of technology	Developer and process	Advantages	Disadvantages
Nalgonda technology	NEERI, Nagpur in 1975. In this process, alum and lime is added to raw water and stirred for 10 minutes. Alum adsorbs fluoride and flocs are formed. These flocs are allowed to settle down for 90 minutes after which, water is filtered.	Useful at community and household level. Cost effective Indigenous technology Low capital cost	Technical expertise required Time consuming process Disposal of flocs is problem Alum does need regular calculation.
Activated alumina (A A) Commonly	Satya Sai University for higher learning, Andhra Pradesh. Cost Rs 35,000 at comm-	Useful at community and house hold level. Filters can be attached with hand pumps or	Cost is inhibiting for villagers. Regeneration of AA

Name of technology	Developer and process	Advantages	Disadvantages
known as Prashanti techno	unity level and Rs. 1300 - 1300-1700 at house hold level. Recurring cost of AA replenishment. In this process raw water is passed through AA, which adsorbs fluoride, passing out defluoridated water.	stand posts Low sludge formation	is problem. Poor after sales service in villages
Reverse osmosis	In this process water is passed through a membrane which blocks fluoride flow, allowing only defluoridated water to pass. 60 liter per day filter cost Rs 20,000 Annual maintenance Rs 3,000	Different kinds of membrane are available No chemicals added High fluoride removal efficiency	Cost is inhibitive for villagers Poor after sales service in villages
Ion exchange	Ion Exchange (India) Ltd. In this process resin is used to adsorb fluoride from water. Capacity ranges from 500 liters per hour to 5000 liters per hour.	Useful at community and household level High fluoride removal efficiency.	Regular replacement of resin Large amount of salts are involved in regeneration. Poor after sales service in villages.

Source: Cover story, The Dark Zone, April, 15th, 2003 Down to Earth page 41 (6).

Several defluoridation methods e.g. Ion exchange, adsorption, precipitation, electrodylysis and reverse osmosis have been developed. Numerous materials including alum and lime[12]. Activated alumina[13,14], bone char[15] and granulated activated charcoal[16] have been tested for defluoridation.

In India, defluoridation teachiques based on fluoride precipitation by alum and lime referred to as Nalgonda technique is widely used for domestic and community water supply[17-19]. However, its use is limited up to fluoride concentration of 10 ppm.

In India, mainly four techniques are mostly used for defluoridation. These are Nalgonda technique, activated alumina technique, reverse osmosis technique and ion exchange technique, but every technique have some advantages and some disadvantages (Table 2).

The presence of fluoride in groundwater and soil is manmade because before three decades, we used to drink water from open well and lakes and there was no problem of fluoride, but in last 2 to 3 decades, Population of the country has rapidly increased and the necessity of water is also increased. To fulfill this need, we have gone deeper and deeper into the ground and are extracting water with the help of pump sets and tube well motors. Groundwater cannot lead to introduction of fluoride but leads to tapping of high fluoride aquifers. We have over extracted groundwater and have tapped aquifers with high fluoride concentrations. Fluoride is endemic in 19 states of India. 65 Million people including 6 million children are today affected. Fluoride level in India groundwater is varying from 1 ppm to 48 ppm[20]. The WHO guideline for maximum permissible levels of fluoride in drinking water is 1.5 ppm.

CONCLUSION

If the excess fluoride is present in water, then the next step is to defluoridate the water. The technology that is used for defluoridation depends on the fluoride level in water and the quantity of fluoride to be defluoridated.

ACKNOWLEDGEMENT

We are very grateful to Shri S. G. C. Somnath, Shri S. S. Roy, AGC, Dr. M. R. Khan, AGC water quality Lab level II + WRD for their encouragement and permission to publish this paper. Authors are also thankful to Shri Hemant Sharma, RA, who helped us to perform this work.

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Accepted : 01.11.2008