International Journal of Scientific Engineering and Applied Science (IJSEAS) - Volume-1, Issue-7,October 2015
ISSN: 2395-3470
www.ijseas.com

Quantitative Study of Fluoride Content in Correlation with various Quality Parameters of Drinking Water

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Abstract

Water provides a unique medium to many physical, chemical and Biochemical Processes. Any minute change in water quality parameter may adversely and favorably affect the ecosystem as well as biological and industrial process. Fluoride in low concentration of 0.5 to 1.5ppm is beneficial for human health but its excess amount can cause serious health hazards and can interfere with various industrial synthetic pathway. In present study drinking water samples from various recourses of Punjab and northern Rajasthan have been analyzed in triplicate with respect to pH, alkalinity, Total hardness, turbidity, Cl^-, SO_4^{2-}, Ca^{2+}, Mg^{2+} and F^- content. The area under study is extension of peninsular block and mainly composed of quartzite, sandstone, micaschilt, phyllitis etc. which are responsible for high F^- content in area. In this study F^- content water sample is correlated with the depth, alkalinity, pH, total hardness and carbonate content. The study will be helpful to many water quality analysts, biologists, ecologists, environmentalists and industrialists.

Key words: Water quality parameters, fluoride content, correlation analysis

Introduction

Water is conceived to be the most precious natural resource on earth. Major part of Indian population is rural and agriculturally oriented, for whom the rivers and ground water are source of prosperity Due to increasing urbanization and Industrialization, contaminant factor in water is constantly increasing which may be inorganic organic, physical, microbial and radiological in nature. It not only creates anxiety to the soil health but also causes massive problems to the quality of ground water. Because of rise in the amount of dumping of municipal waste, industrial waste and heavy use of fertilizers, the properties of ground water have also been constantly

changing. Fluoride contamination of ground water has now become a major geo-environmental issue in many parts of world due to its toxic effects even if consumed in trace quantities.

The geological crust in India and especially in selected area for this study is very rich in fluoride bearing minerals such as sallaite, villianmite, fluorite (fluorospar), cryolite, bastnaesite, fluorapalite. Ground water and potable water is effected in its content due to sand and gravel aquifer, shallow bedrock aquifer as well as deepbed rock aquifer. The other important parameter controlling and influencing the occurrence and the movements of ground water are landforms and cover, slap, altitude vegetation and lithology beside the metrological parameter.

A high fluoride content in drinking water sources have been observed in 15 states of India. physico-chemical parameters of Indian water resources have been analysed by Kanwar *et al.* (1968), Trivedi (1988), Pallah, Bansal, Sahota (1991), Ozha *et al.* (1992), Choubisa *et al.* (1994), Aggerwal *et al.* (1997), Dahiya *et al.* (2000), S. Gupta, S. Banergee (2006) reported that fluoride concentration in ground water of India varies widely, ranging from 0.01ppm to 48ppm.

In the areas having sub optimal levels of fluoride fluoridation is a common practice as dietary requirement in infants, children and adult is 0.5mg, 1.0mg, and 4.0mg per day respectively. Since 1850 relationship between fluorides and teeth has been studied. In hyper fluoridated areas. Various health problems such as fluorosis and.osteosarcoma. Functions of kidney, thyroid gland and brain also highly affected by high F content. About 95% of the fluoride in the body is deposited in hard tissues and it continues to be deposited in calcified structures which is due to great affinity of fluorine for calcium phosphate. Disease onset is due to interference of fluoride with carbohydrates lipids, proteins, enzymes and mineral metabolism in body

The essentialities for monitoring involve survey and surveillance physico-chemical parametric analysis is to facilitate judicious and effective use of available water and gat a data documented for further references.

Experimental Methodology

Water samples were collected from different sub-divisions of districts Hanumangarh (Rajasthan) located between 29°5' to 30°6' N and 74°3' to 75°31' F with total area 9656.09 km^2 and Ferozpur (Punjab) located at 30°20' N and 74o25' F with total area 5303 km^2. Both districts have semi dry climate with extreme hot during summer and extremely cold during winter with min and max temp 1°C and 49°C respectively. Samples were taken from 22 states during January, June, October from different resources such as hand pumps, well, tube wells, DCB, diggi, tanka and water works supply and analysed in triplicate with respect to pH, alkalinity, turbidity, total hardness. Cl^-, CO_3^{2-}, Ca^{2+}, Mg^{2+}, and F^- content and average results are reported in table. Sample no. 1 to 12 are collected from Hanumangarh district and sample no. 13 to 22 from Ferozpur district and results are represented in tables with respect to increasing fluoride content.

Sample No.	F^- (ppm)	pH	Alkalinity (ppm)	Total hardness (ppm)	Ca^{2+} (ppm)	Mg^{2+} (ppm)	Cl^- (ppm)	CO_3^{2-} (ppm)
21	1.64	7.0	87	116	60	56	32	62
19	2.23	7.1	92	144	100	44	57	55
11	2.30	7.0	130	170	110	60	90	66
16	2.46	7.1	190	190	120	70	100	130
10	2.78	7.1	170	380	210	170	190	120
17	2.80	7.3	260	410	230	180	210	180
12	2.96	7.3	545	360	220	140	270	280
18	3.12	7.5	280	616	456	160	544	260
7	3.26	7.4	180	480	270	210	400	220
9	3.29	7.7	230	490	340	150	240	200
13	3.40	7.6	260	450	260	190	130	170
06	3.43	7.7	220	454	260	194	120	190
22	3.45	7.7	180	570	350	220	90	170

14	3.49	7.8	200	410	230	180	100	92
2	3.55	7.7	130	360	226	134	57	180
5	3.67	7.9	120	380	250	130	50	110
15	3.73	8.0	110	240	150	90	110	92
1	3.95	7.9	100	177	122	55	100	88
3	4.04	8.0	92	160	116	44	90	66
8	4.28	7.9	110	190	112	78	32	53
4	4.51	8.6	88	210	120	90	40	62
19	4.74	8.4	98	125	80	45	28	66

Results and Discussion

According to WHO, the acceptable limit for pH is 7.0 to 8.5, alkalinity- and total hardness is 200ppm, Turbidity is 1, Cl^- and SO_4^{2-} is 200ppm, Ca^{2+} is 75ppm, Mg^{2+} is < 30ppm and for F^- is 1.0ppm.

Majority of samples show, alkalinity and total hardness above the permissible limit. Very few samples have Cl^- at alarming level.

F^- distribution is associated with parameters like depth of water resource, pH, Hardness, alkalinity Ca^{2+}, $Mg^{2+}$and Cl^- content of water samples. F^- content in the present study ranges from 1.64 to 4.74ppm. Which is much above the permissible limits prescribed by ICMR, WHO,ISI. It is observed that F content is positively correlated with the depth of water resources pH is found to be within permissible limits. F^- content is positively correlated with the pH of water sample which may be due to high pH have a tendency to displace fluoride from mineral surface. Correlation Equation is $pH = 0.5407 F^- + 5.8267$.

Alkalinity and hardness is positively correlated with fluoride content upto a certain range but for hyper fluorinated water samples, negative correlation is observed upto F^- 2.96 ppm. Total alkalinity (TA) is correlated as $TA = 256\text{-}48F^-\text{-}418.53$ and above

3.12ppm the correlation is TA=108.99 $F^{-+566.12.}$ In case of Total Hardness (TH) the correlation upto 3.12ppm F^- content. The correlation is TH=317.28 F^- -506.46 and above TH=-274.73 F^- +1371.4 .For the F^- content upto 3.12ppm the correlation is Cl^-=285.23 F^- -536.79 and above 3.26ppm the correlation is Cl^-= 1.131 F^- +608.46 . Considering the correlation between F^- and CO_3^{2-} , it is observed that upto 2.96 ppm F^- content the correlation equation is CO_3^{2-}=141.09 F^- -218.51 and above 3.12ppm, it is correlated as CO_3^{2-} =-106F^-+525.35 .

The change in correlation may be due to the fact that high fluoride containing ground water is chemically distinctive in that, it is soft, has high pH and contains large amount of silica and natural ores of fluoride such as fluorapatite, cryolite and fluorspar.

The water is in study area is not suitable for domestic consumption without prior treatment. Environmental factors and human activities also have impact on water parameters. So Environmental awareness of health implication of fluoride should be emphasized through sustainable education and community participation.

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