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ANALYSIS OF FLUORIDE CONTENT OF GROUND WATER IN AND AROUND INDUSTRIAL AREAS OF NAGPUR

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ABSTRACT:

Nagpur is one of the major cities of central India and the second capital of Maharashtra. Natural water bodies such as river Kanhan, Ambajhari and Gorewada tank are the ready sources to meet the water demands of the city. The requirement of water has been rising due to growth in population, migration and commercial activities. Groundwater remains the only option to rely on for such a growing urban population.

Anthropogenic activities cause pollution of the surface and groundwater. Quality of water for public health is a major concern need to be examined.

In the present study, critical analysis and assessment of the groundwater in and around the industrial areas of Nagpur have been taken up to evaluate its suitability for domestic purpose. Twelve groundwater samples were collected during pre and post monsoon season in three consecutive years from 2010 to 2012 from industrial areas of Kalmeshwar, Butibori and Hingna covering open wells and tube wells. The obtained results were compared with the Drinking Water Standards to know the potability of water.

In certain areas it was observed that the fluoride levels of groundwater are much higher than the normal standards. The present study reveals that the highest value of fluoride content was found to be 7.42 mg/l in summer 2011 near Ankush industry at Kalmeshwar and the lowest was noted 0.51 mg/l in winter 2011 at Digdoh, Hingna.

Keywords: Assessment, fluoride, groundwater, industrial areas, Nagpur.

INTRODUCTION:

Ground water is an important source of water supply to much of the global population. Due to its relatively low susceptibility to pollution in compared to surface water and its large storage capacity it is widely used for agriculture drinking water and industrial purposes.[1-3] Movement of ground water through soil and sediments naturally filters it and makes it free from organic impurities. Ground water quality and quantity is deteriorating at an alarming rate due to anthropogenic activities. As ground water percolates through the ground, metals such as Iron and Manganese are dissolved and may later be found in high concentrations in the water.[4-8] Industrial discharges, agriculture, groundwater pumpage and disposal of wastes can affect the groundwater quality. Pesticides, fertilizer and leakage from septic tanks seeps into soil and eventually ends up in ground water. Fluoride is one of the critical parameter that influences the quality of ground water. Fluoride concentration above the permissible limit (1.5mg/l) in drinking water leads to human health hazards, such as dental and skeletal fluorosis.[9-12]

Fluoride is a non-degradable and relatively persistent pollutant, which at high and even in low concentration causes serious health problems. High concentration (above 1.5mg/l) causes dental and skeletal fluorosis whereas below 1mg/l it causes dental caries and osteoporosis. More than half a million people are affected by fluorosis, which is due to intake of excess fluoride.[3,7,12] The present study was undertaken to assess the fluoride content of

ground water in the industrial areas of Nagpur city.

Sources of Fluoride

The concentration of fluoride in water is highly variable and is often dependent on the types of rocks and minerals present there. The most common fluoride-bearing minerals are fluorite, apatite and micas. Fluoride ions from these minerals leach into the ground and hence contribute to high fluoride concentrations. In general, ground water tends to have more fluoride than the surface water because of its maximum interaction with the fluoride-bearing minerals in rocks.[2-6]

The Study area

Currently significant numbers of industries are located within the vicinity of Nagpur city. The Butibori area is the largest in all of Asia in terms of area. The largest unit is the Indo Rama Synthetics which manufactures synthetic polyester yarn. The estate also has a number of other textile units, a washing machine plant belonging to Videocon group, besides several medium-sized units that manufacture a variety of products.

On the western fringes of the city is the Hingna industrial estate which comprises of around 900 small and medium industrial units. Mahindra and Mahindra, casting units of NECO Ltd. (the country's largest casting ground), Bajaj Auto group, Candico (the second largest confectionary manufacturing plant in India), Ajanta toothbrushes, Sanvijay Group (largest steel rolling group of companies for long products in Central India) are some of the major units in this area.

Kalmeshwar industrial area has almost 150 industrial plots, namely KTM textiles, ESAB India Ltd, Purohit Textile and ISPAT industry. ISPAT industry was ranked 5th among major next to Tata steel and JSW steel companies in India for the year 2008 by Business world. JSW steel after merger of ISPAT steel in 2013 has become India's second largest private sector steel company.

MATERIAL & METHODS:

Butibori industrial area (Zone 1) was divided as Dormitory, Temri Gao, Zone C and Outer MIDC. Kalmeshwar industrial area (Zone 2) was divided as Residential area, Area opposite to ISPAT, Ankush fertilizer industry, Bambal layout and Outer Kalmeshwar and Hingna industrial area (Zone 3) was divided into Opposite to Bombay O^2 Corporation, Digdoh and Durga nagar.

Sampling is an important part of any analysis. The ground water samples were collected from different zones of each industrial area. The samples were collected from open wells and tube wells. The ground water samples were collected from open wells by dip (or grab) sampling method during pre-monsoon and post-monsoon seasons. Twelve ground water samples were collected in polythene bottles. Fluoride ions were determined by SPADNS method described in NEERI Manual of Water and Waste Water Analysis. All the reagents used were of AR grade. The reagents used were SPADNS solution, zirconyl acid reagent, reference solution and stock fluoride solution.[8]

RESULTS & DISCUSSION:

In the industrial area of Butibori, during summer the minimum and the maximum was noted at Zone C i.e. 1.20 mg/l and 6.14 mg/l respectively. During winter at Zone C, the concentration was 5.53 mg/l in the year 2010 (Table 1., Figure 1.)

At Kalmeshwar, in the year 2010 almost all the samples were found having concentration above 5mg/l. The maximum was found in the year 2011 in summer at Ankush industry i.e. 7.42 mg/l and in winter it was noted 6.6 mg/l (Table 2, Figure 2). The reason for high fluoride concentration at this site may be the fertilizers industry near the sampling site. High amount of fluoride present in phosphatic fertilizer effluent enrich the fluoride content of the receiving water.

The lowest concentration was noted in the year 2011 in winter at outer MIDC i.e. 0.44 mg/l. In the industrial area of Hingna, in summer the maximum value noted was at Digdoh in the year 2010 i.e. 5.35 mg/l and minimum was 0.64 mg/l in 2011. In the winter the range was found between 0.51 mg/l to 5.40 mg/l, the minimum was noted at Digdoh and maximum at Durga nagar (Table 3, Figure 3).

The possible reason for contamination of fluoride in this area may be due to the pollutants released by industries or by natural weathering of fluoride minerals.

Fluorite, fluorapatite, mica, hornblende and various other minerals take part during rock-water interaction and liberate fluoride into the groundwater.

High concentration of fluoride in observed in ground water where the temperature

is high and rainfall is low. Soil porosity and permeability has a major role in building up the concentration of fluoride in ground water. It can make the water unsafe for drinking or livestock watering. High concentration can be observed in waters near sewage, irrigational drains and waste outlets. This high value of fluoride content indicates the intense chemical weathering of the parent granite rock. Fluoride from those weathered rock minerals like fluoroapatite, fluorite and fluoride replaceable hydroxyl ion in ferromagnesian silicates leach into the ground water and contribute to the high fluoride concentration. Solubility of fluoride from fluoride bearing minerals is relatively low under normal conditions but slow process of dissolution enhances leaching and fluoride enrichment in ground water.

CONCLUSION:

Ground water in and around industrial areas is contaminated with fluoride containing minerals as one or other by-product of industrial waste. Industries either to be banned which produces fluoride containing salts in high content or they must acquire and accept proper disposal methods to save the environment at large. Government should take strict actions against companies not following the norms. Necessary steps should be undertaken to curb the unplanned disposal of hazardous byproduct waste from industries.

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Table 1. Values of fluoride of ground water samples from Butibori MIDC area.

Area	Year 2010		Year 2011		Year 2012	
	S	W	S	W	S	W
Dormitory	3.86	4.91	3.71	4.27	3.79	4.59
Temri gao	3.33	4.45	3.53	4.50	3.43	4.48
Zone C	6.14	5.53	1.20	0.54	3.67	3.03
Outer MIDC	5.53	4.96	1.20	0.44	3.37	2.70

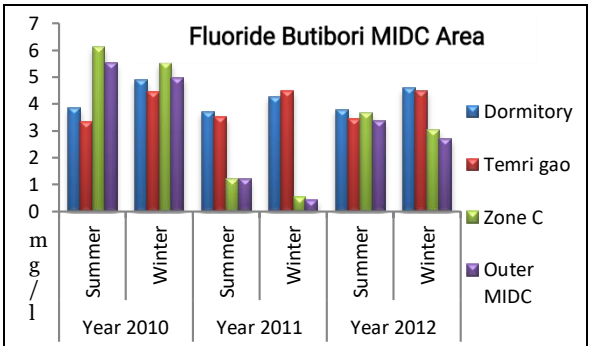

Figure 1. Values of fluoride of ground water samples from Butibori MIDC area.

Table 2. Values of fluoride of ground water samples from Kalmeshwar MIDC area.

Area	Year 2010		Year 2011		Year 2012	
	S	W	S	W	S	W
Residential Area	6.12	5.30	0.90	1.38	3.51	3.34
Opposite to Ispat	5.02	5.35	0.97	2.46	2.99	3.90
Ankush industry	4.45	4.02	7.42	6.65	5.94	5.34
Bambal Layout	5.40	5.48	0.92	1.38	3.16	3.43
Outer Kalmeshwar	6.01	5.30	0.77	1.05	3.39	3.17

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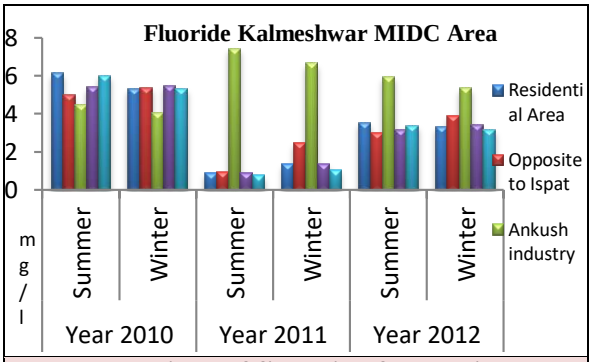

Figure 2. Values of fluoride of ground water samples from Kalmeshwar MIDC area.

Table 3. Values of fluoride of ground water samples from Hingna MIDC area.

Area	Year 2010		Year 2011		Year 2012	
	S	W	S	W	S	W
Opp. Bombay o^2 corp.	1.54	Dry	Dry	Dry	Dry	Dry
Digdoh	5.35	5.12	0.64	0.51	2.99	2.81
Durga nagar	5.91	5.40	1.74	1.48	3.83	3.44

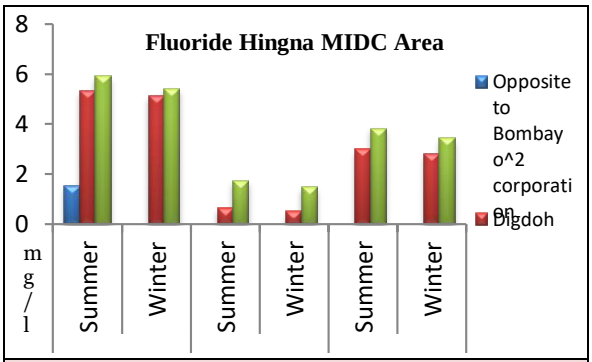

Figure 3. Values of fluoride of ground water samples from Hingna MIDC area.