Physico-Chemical Characterisation of Well Water and Their Significance with Special Reference to Public Health in Ambarnath M.I.D.C. Area, Maharashtra

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The MIDC area of Ambarnath is one of the highly polluted industrial belts. The paper presents results of physico-chemical studies of well water samples in order to discuss the effect of pollution on the ground water quality and the possible magnitude of health problems în Ambarnath MIDC area. The water quality parameters like colour, odour, pH, total dissolved solids, total hardness (TH), sulphates (SO_4^{2-}), chlorides (Cl^-), phosphates (PO_4^{3-}), total iron (Fe), calcium (Ca) and magnesium (Mg) were studied. The findings revealed that the contents of some well samples were above WHO and ISI permissible limits for drinking water. The results were discussed in the light of pollution status of the area and literature on public health aspects.

INTRODUCTION

The well is considered to be the most ancient artificial source of water. It is one of the major sources of drinking water in the villages and rural areas. It also provides the essential source of water for irrigation and small scale industries.

The water is the most essential thing in living systems. In last few years, the water pollution problem has reached a crisis point. The term pollution is defined as the deterioration in chemical, physical and biological properties of water by human and industrial activity. The industrial wastes, sewages and agricultural run off can overload ground water with chemical wastes and nutrients and make water supply toxic[1].

In view of this, it is essential to monitor the physico-chemical characters of certain well water samples in the industrial area under study. Ambarnath is a town at a distance of 67 km from Mumbai towards East. Since 1960's Ambarnath MIDC (Maharashtra Industrial Development Corporation) area is in existence. Today more than 300 industral units are there in the area. The area possesses industries like chemical manufacturing, glass, rubber processing units, engineering units, ink manufacturers, pharmaceutical industries, stone-crushers etc. The untreated/partially treated effluents are discharged to Waldhuni nallah through small streams or gutters. In these processes there is every chance that waste water may percolate in the soil and contaminate the well water in the nearby area. In the present study three wells were monitored periodically for measuring the

parameters like colour, odour, pH, total dissolved solids (TDS), total hardness (TH), chlorides (Cl^-), sulphates (SO_4^{2-}), phosphates (PO_4^{3-}), total iron (Fe), calcium (Ca) and magnesium (Mg).

EXPERIMENTAL

The collection of samples carried out from different sampling stations as follows:

W.1 Near fly over bridge, Bhendi Pada, Kansai Block (Open well)

W.2 Near Mandir at Morivali, Morivali Block (Bore Well)

W.3 Morivali Pada, Morivali Block (Open Well)

The standard methods of collection, preservation and analysis of water were adopted[2]. The samples were collected once in three months from January 1999 to December 1999. The samples were collected in wide-mouth plastic bottles. Prior to use the bottles were cleaned sequentially as follows: a detergent wash, tap water rinse, soaking in 1% nitric acid for 24 h and high purity water rinse. The reagents used were of AR grade while double distilled water was used whenever required. ELICO-Li-120 model of pH meter and Shimadzu model of spectrophotometer were used for pH and spectrophotometric determinations respectively.

RESULTS AND DISCUSSION

The results obtained are presented in Tables 1–4. Each result reported is the mean of three independent determinations. Colour and odour are very primary tests for discussing the pollution status of water. All the samples collected from wells over a period of one year were observed to be colourless and odourless. But, from this, any direct conclusion about the quality of water cannot be derived.

TABLE-1

PHYSICO-CHEMICAL CHARACTERISTICS OF WELL WATER SAMPLES
COLLECTED IN THE MONTHS JANUARY–MARCH 1999

	W.1	W.2	W.3
Colour	Nil	Nil	Nil
Odour	Nil	Nil	Nil
pH	6.6	5.8	6.4
TDS	780	1215	546
TH	128	252	90
Ca	72	64	65
Mg	14	18	10
Fe	5.5	9.2	8.7
Cl	139	145	210
SO_4^{2-}	36	214	133
PO_4^{3-}	0.3	0.01	0.03

Except colour, odour and pH all values are expressed in mg/L.

TABLE-2
PHYSICO-CHEMICAL CHARACTERISTICS OF WELL WATER SAMPLES
COLLECTED IN THE MONTHS APRIL–JUNE 1999

	W.1	W.2	W.3
Colour	Nil	Nil	Nil
Odour	Nil	Nil	Nil
pH	6.3	5.9	6.2
TDS	945	1021	653
TH	165	242	98
Ca	78	58	68
Mg	18	14	10
Fe	5.8	10.1	8.2
Cl	174	108	184
SO_4^{2-}	48	192	104
PO_4^{3-}	0.2	0.02	0.03

Except colour, odour and pH all values are expressed in mg/L.

TABLE-3
PHYSICO-CHEMICAL CHARACTERISTICS OF WELL WATER SAMPLES COLLECTED
IN THE MONTHS JULY–SEPTEMBER 1999

	W.1	W.2	W.3
Colour	Nil	Nil	Nil
Odour	Nil	Nil	Nil
pH	6.9	6.1	6.7
TDS	648	980	482
TH	110	228	84
Ca	60	62	58
Mg	10	18	12
Fe	4.8	8.7	7.5
Cl	145	135	192
SO_4^{2-}	32	198	102
PO_4^{3-}	0.1	Nil	0.01

Except colour, odour and pH all values are expressed in mg/L.

pH is observed to be slightly acidic in all the samples. The pH of samples from W.2 are observed to be low as compared to other samples. Hence, special consideration from public health point of view is needed.

According to WHO and Indian standards, TDS values should be less than 500 mg/L for drinkng water[3]. The sample W.2 in July-September 1991 is observed to give TDS 482 mg/L while all other samples showed TDS value above the limit. This may be attributed to the solid waste disposed around the wells. The TDS may affect water quality adversely in a number of ways. It is generally inferior to palatability and may induce unfavourable physiological reactions in the consumer. The water with high TDS indicates that water is highly mineralised.

Hence, it is not only unsuitable for drinking purpose but also for some industrial operations. If the amount of dissolved solids exceeds 2000 mg/L, it produces laxative effect.

TABLE-4
PHYSICO-CHEMICAL CHARACTERISTICS OF WELL WATER SAMPLES
COLLECTED IN THE MONTHS OF OCTOBER–DECEMBER 1999

	W.1	W.2	W.3
Colour	Nil	Nil	Nil
Odour	Nil	Nil	Nil
pH	6.7	5.6	6.3
TDS	874	1134	589
TH	138	246	92
Ca	74	246	92
Mg	14	18	14
Fe	5.8	7.4	8.4
Cl	152	128	244
SO_4^{2-}	38	208	98
PO_4^{3-}	0.1	Nil	0.01

Except colour, odour and pH, all values are expressed in mg/L.

Total hardness is the sum of polyvalent cations present in water. It varies from 89 mg/L in January-March 1999. Total hardness values are observed to be less than the Indian Standards throughout the study period.

The limits of calcium (Ca) and magnessium (Mg) have been fixed at 75 mg/L and 50 mg/L respectively. Ca and Mg contents in all samples collected fall within the limits prescribed. Calcium is needed for the body in small quantities, though water provides only a part of total requirement. High concentration of magnesium has a laxative effect specially on new users of supply, and hence water becomes unpalatable before toxic concentrations at magnesium are reached[4].

The iron is one of the most abundant elements in the earth's crust. It is used in many industries. Iron deficiency in human body causes anaemia. The iron content in the samples is ranging between 4.8 mg/L to 10.1 mg/L. The samples from W.1 are always showing the lowest iron content as compared to others. A very high dosage of iron may prove fatal as it may lead to respiratory failure. Clinical signs preceding death are anorexia, oligodiapdia, oliguria, alkalosis, diarrhoea, loss of body weight, hypotheromia, irritability and depression. Biochemical consequences of acute iron intoxication include metabolic acidosis, due to the accumulation of lactic acids and hypoglycemia[5]. In general, typical daily intake of iron by human beings is 10–18 mg per day.

The chloride content in the samples is in between 108 to 244 mg/L. Natural water contains low chloride ions. The findings indicate that all are below the permissible limits of chloride in drinking water prescribed by WHO and ISI. These limiting values are based on taste factor only and sometimes the water with less than 250 mg/L may produce laxative effect. Deleterious effects on metallic

pipes, effects on agricultural plants and salty taste are observed in case of high chloride concentrations.

The concentration of sulphates in water samples is observed to be within the limits prescribed for sulphate content and it varies from 32 mg/L to 214 mg/L. The high concentrations of SO_4^{2-} may induce diarrhoea.

Phosphate is essential for bones and some enzyme systems. Phosphate contents in ground water are contributed by numerous ways. Besides atmospheric phosphorus, combustion of organic materials, industrial waste gases, fossil fuel burning are some of the sources of phosphates in water. The WHO and Indian Standard is 0.01 mg/L for phosphate. In this study it is observed that in two samples from W.2 phosphate is undetectable. The phosphate content in W.1 is ranging between 0.1 to 0.3 mg/L. This may be attributed to the dyes and paint industries in nearby area (near flyover bridge); as phosphorus is major component of some dyes, detergents etc. The phosphate in low concentrations may not cause any harm to man and animal. But, if phosphate is consumed in excess phosphene gas is produced in gastrointestinal tract on reaction with gastric juice. This could even lead to the death of consumer[6].

Another interesting fact is observed that in July-Aug-September 1999, the concentration of different parameters is quite low as compared to concentrations at another time which may be attributed to dilution effect because of rain. Also, it is observed that in W.2 the extent of such reduction in concentration is less; this may be because W.2 is closed well (bore well).

The wells under investigation are generally used for domestic purpose and only sometimes for drinking purpose. But looking at the results obtained, it can be concluded that the well water is contaminated and should not be used for drinking purpose. Hence, it is necessary to develop a suitable technology to protect water resources from contamination as a national concern.

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