Int. J. Chem. Sci. : 2 (3), 2004, 337–344

POTABLE WATER CHARACTERISTICS OF PATAN (WEST) REGION

J. D. JOSHI[1], JABALI VORA[2], SANGITA SHARMA[2], NAVIN PATEL[2], OJAS KOTHARI[2] and KRUTIKA SALVI[2]

[1] Department of Chemistry, Sardar Patel University, VALLABH VIDYANAGAR – 388 120 (Gujarat), India
[2] Department of Chemistry, Hemchandracharya North Gujarat University, PATAN – 384 265 (Gujarat) INDIA

ABSTRACT

The physicochemical characteristics of the ground water samples from different places of Patan (West) region have been analyzed. The samples were collected during April 2003 to July 2003. Most of samples in this area have fluoride, TDS, etc. more than the limits suggested by WHO and ISI. In all, 45 samples from this region have been analysed.

Key words : Potable water, Patan (West) region, Fluoride, TDS

INTRODUCTION

Patan (West) is located in North Gujarat and is facing the problem of potable ground water due to increasing sources of pollutants through industrial and urban effluents, which are directly released without any proper treatment. Extensive use of chemical fertilizers for better crop yields and weathering products contribute a lot to degrade the quality of ground water. The ground water is generally contaminated in shallow aquifers, which have direct or indirect hydraulic continuity with the ground surface[1]. The ground water gets lots of mineral nutrients and organic compounds from the soil layers and the underlying rocks. The complexing agents present in such contaminated waters tend to form complexes with majority of cations present in water. Such water is known to be injurious to human beings, as it does not satisfy the drinking water standards prescribed. Permissible limit for drinking water quality parameters have been recommended by United States Public Health (USPH), World Health Organization (WHO), Indian Standards Institution (ISI) and Indian Council for Medical Research (ICMR) etc. The parameters studied are pH, conductivity, total dissolved solid (TDS), D.O., B.O.D., C.O.D., Ca^{2+}, Mg^{2+}, Na^{+}, Al^{3+}, Fe^{2+}, CO_3^{2-}, HCO_3^{-}, Cl^{-}, SO_4^{2-}, NO_3^{-}, PO_4^{3-}, SiO_3^{2-} and F^{-}. These parameters were compared with standard values prescribed by different agencies.

EXPERIMENTAL

In present work, the samples from different sources were collected from west areas located in Patan Talukas, North Gujarat, in brown glass bottles without adding any preservatives.

Samples were collected with necessary precautions[2] during April 2003 to June 2003. All the chemicals used were of Analytical Grade. 45 samples were collected of this region. The estimation of anions like bicarbonate, carbonate, sulphate, nitrate, phosphate, chloride, silicate and fluoride, were carried out within 48 hours of the sample collection following standard methodology[3]. Calcium and magnesium were determined by EDTA titration method. Carbonate and bicarbonate were determined by acid–base titration method, chloride by argentometric titration method, D.O. and B.O.D. by the Winkler's modified method. The pH was measured with Systronics μ pH system Model 361 and conductance was measured with conductometer (EQUIPTRONICS Model EQ 665). Fluoride concentration was determined by ion selective electrode No. ORION 9409 B.N., Reference electrode No. 900100 and THERMO ORION No. 920 A^+ ion meter.

Phosphate, silicate, nitrate, iron, aluminium etc. were measured by spectrophotometry (Spectronic Model, $20D^+$), sulphate by nephelometry, sodium by flame photometer (Systronics Model 129). All results are presented in terms of mg/L.

RESULTS AND DISCUSSION

The physicochemical data of the bore well water samples collected in the period April–June 2003 are presented in Table 1 and 2. The depths of various bore wells varied from 300 ft. to 1000 ft. The different factors like different depths, different lands, under ground water conditions, rain condition, etc. also affect the concentration of different species in the different samples.

The pH values of the samples varied between 7.29 to 8.88. The pH values of drinking water is an important factor. The total or phenolphthalein acidity exhibited a wide range of variation. Acidity is of little concern from sanitary public health view point. Acid waters are of concern to industries because of their corrosive characteristics and expenses involved in removing or containing the corrosion producing substances[4]. The prescribed limiting value of pH suggested by WHO and ICMR ranges between 6 and 8.5.

In the present study, dissolved oxygen ranges from 0.885 mg/L to 3.76 mg/L depletion of dissolved oxygen in water supplies can encourage microbial reduction of nitrate to nitrite and sulphate to sulphide giving rise to odour problems. B.O.D. ranges from 0.221 mg/L to 2.35 mg/L C.O.D. ranges from 0.0 mg/L to 48 mg/L Conductance ranges from 0.7 mhos/cm to 5.8 mhos/cm.

TDS can have an important effect on the taste of drinking water. The palatability of water with a TDS level of less than 600 mg/L is generally considered to be good. Extremely low concentrations of TDS may be unacceptable because of its flat, insipid taste. The presence of high level of TDS may also be objectionable to cosnumers owing to excessive scaling in water pipes, heaters, boilers and household appliances[5]. According to WHO and Indian Standards, the TDS values should be less than 1500 mg/L for drinking water. In the present study, TDS ranged from 406 mg/L to 2984 mg/L.

Table 1

S.No.	Name of the Village/Farm	Depth (feet)	pH	Condu. mhos/cm	T.D.S. mg/L	D.O. mg/L	B.O.D. mg/L	C.O.D. mg/L
1.	Chandrumana	900	7.53	4.1×10^{-3}	2087	2.48	0.80	4
2.	Khanpur	1300	7.37	3.4×10^{-3}	1767	2.62	1.10	0
3.	Manpur	950	7.6	3.35×10^{-3}	1774	2.61	0.43	0
4.	Kunger	1250	7.56	3.65×10^{-3}	1943	2.66	0.29	0
5.	Khari vavdi	850	7.36	3.55×10^{-3}	1956	2.46	1.60	2
6.	Sariyad	700	7.6	3.1×10^{-3}	1724	2.75	1.34	0
7.	Undra	750	7.6	1×10^{-3}	584	2.14	0.48	0
8.	Sampara	830	7.81	1.7×10^{-3}	1024	2.85	1.25	0
9.	Bepadar	750	7.3	5.8×10^{-3}	2901	2.48	1.15	0
10.	Vareda	700	7.29	5.3×10^{-3}	2625	2.29	1.73	0.8
11.	Khanpurda	700	7.58	5.55×10^{-3}	2870	2.82	1.39	2.4
12.	Pt–Kalikapump	600	8.03	3.4×10^{-3}	1938	2.87	0.37	13
13.	Pt–Damaji 1	1200	7.61	3.3×10^{-3}	1752	2.52	0.24	15
14.	Pt–Damaji 2	700	7.86	3.2×10^{-3}	1759	2.52	0.28	15
15.	Pt–Ghandhi bag 1	Dharoi	8.16	0.7×10^{-3}	406	3.76	0.28	0.3
16.	Pt–Ghandhi bag 2	700	8	1.65×10^{-3}	887	2.68	0.39	7
17.	Pt–Kajiwada	500	8.35	2.7×10^{-3}	1505	2.98	0.63	15
18.	Pt–Bokarwada	800	8.11	2.3×10^{-3}	1341	1.61	0.51	14
19.	Pt–Laxmipura	1200	7.6	2.3×10^{-3}	1376	1.28	0.46	18
20.	Pt–Sardarbag	1200	7.44	2.45×10^{-3}	1388	1.23	0.39	15
21.	Dudharampura	800	7.32	3.05×10^{-3}	1638	2.34	0.48	0.8
22.	Audhav	910	7.8	3.4×10^{-3}	1803	3.46	1.90	0
23.	Vadli	1200	7.42	2.75×10^{-3}	1492	2.66	0.74	0
24.	Anawada	600	7.78	2.65×10^{-3}	1592	2.74	1.39	0
25.	Vayad	450	7.79	3.5×10^{-3}	1898	3.36	2.35	0
26.	Ghacheli	900	7.92	2.35×10^{-3}	1403	3.22	1.93	0.5
27.	Dharusan	830	7.56	5.4×10^{-3}	2915	3.12	2.29	0
28.	Melosan	830	7.74	4.75×10^{-3}	2470	2.75	1.00	3
29.	Veloda	750	7.64	2.55×10^{-3}	1469	2.78	0.87	0
30.	Nayta	800	7.65	5.7×10^{-3}	2984	3.01	1.00	48
31.	Balva	850	7.46	4.4×10^{-3}	2191	2.51	0.88	0
32.	Pt–B.Ed. Collage	800	7.97	3.4×10^{-3}	1850	2.88	0.40	1.6
33.	Sujanpur	1100	7.82	3.85×10^{-3}	1936	2.76	0.74	2
34.	Pt–Ghemariyavir	1200	7.47	3.75×10^{-3}	1906	1.98	0.30	0

S.No.	Name of the Village/Farm	Depth (feet)	pH	Condu. mhos/cm	T.D.S. mg/L	D.O. mg/L	B.O.D. mg/L	C.O.D. mg/L
35.	Pt–G.E.B.	1200	7.94	2.05×10^{-3}	1187	1.78	0.26	0
36.	Pt–Politeqniq	400	8.32	1.65×10^{-3}	1188	3.17	1.25	0
37.	Rajpur F22	635	7.93	4.9×10^{-3}	2508	3.14	0.63	16
38.	Golapur F23–3	720	7.86	2.6×10^{-3}	1449	3.47	0.96	0
39.	Pt–Uni. Qua.	600	8.88	1.7×10^{-3}	1028	2.12	0.54	0
40.	Pt–Police Qua 1	550	8.44	1.95×10^{-3}	1189	2.05	0.43	0
41.	Pt–Police Qua 2	550	8.66	2.1×10^{-3}	1226	2.78	0.48	0
42.	Pt–Railway sta.	750	8.3	1.8×10^{-3}	1114	0.89	0.36	0
43.	Pt–Navagunj	800	8.6	1.65×10^{-3}	982	2.75	0.44	0
44.	Pt–Adarsh High Sc.	600	8.49	2.35×10^{-3}	1392	2.91	0.41	0
45.	Pt–University	600	7.81	3×10^{-3}	1706	1.20	0.22	0
Desi. by WHO			7.0 to 8.5	–	500	–	–	–
Max. by WHO			6.5 to 9.2	–	1500	–	–	–
Desi. by ISI			6.5 to 8.5	–	500	–	–	–
Max. by ISI			–	–	2000	–	–	–

Desi. = Minimum desirable limit   Max. = Maximum permissible limit

Table 2

S.No.	Ca^{2+} mg/L	Mg^{2+} mg/L	Na^{+} mg/L	CO_3^{2-} mg/L	HCO_3^{-} mg/L	SO_4^{2-} mg/L	Cl^{-} mg/L	SiO_3^{2-} mg/L	PO_4^{3-} mg/L	NO_3^{-} mg/L	F^{-} mg/L
1.	78.4	78.72	518	14.1	315.1	278	712.77	27.1	25.29	3.4	0.653
2.	85.6	49.92	450	21.13	307.9	202	556	29.15	39.41	3.1	0.867
3.	60	50	470	21.13	329.42	225	540	25.95	27.65	3.8	0.66
4.	50	55	520	10.57	408.2	162	630	25.95	33.53	26.8	1.35
5.	40.8	40	560	35.22	515.62	125	560	23.24	34.71	8.9	1.75
6.	36	42	350	42	400	126	515	28.5	53	19.4	1.04
7.	20	18	135	17	225	22	80	19	32	7.4	1.17
8.	28	18	265	14	308	102	182	27	46	4.6	1.11
9.	104	93	800	17.6	387	147	1260	27.5	35	17.5	0.61
10.	80	90	730	17.6	380	150	1090	27	37	15	1.43
11.	50	70	860	31.66	458	212	1094	18.5	36	4.5	0.52
12.	41.6	37.44	541	21.23	494	105	577	24	33	27	2.05
13.	68.8	61.44	435	21.13	344	132	596	29	30	4	0.82
14.	32	39.36	498	24.65	451	135	500	25.6	27.6	13.5	2.72
15.	20.6	12.3	90	7.04	151	42	49	7.4	12.6	3	1.75

S.No.	Ca^{2+} mg/L	Mg^{2+} mg/L	Na^{+} mg/L	CO_3^{2-} mg/L	HCO_3^{-} mg/L	SO_4^{2-} mg/L	Cl^{-} mg/L	SiO_3^{2-} mg/L	PO_4^{3-} mg/L	NO_3^{-} mg/L	F^{-} mg/L
16.	17.6	23.04	260	7.04	329	101	195	15	19	8.1	2.96
17.	16	20.64	445	21.13	408	60	420	19	24.4	59.5	2.97
18.	12.8	18.24	385	14.09	367	82.47	335	18	24.4	68.2	2.75
19.	19.2	32.16	382	3.52	437	121	294.7	30	35	5	1.38
20.	60.8	34.56	331	14.09	387	119	355	31.4	38	0	1.19
21.	66	46	420	28	340	176	470	30	44	3	0.94
22.	77	44.16	490	24	344	200	535	30	40	5	0.71
23.	52	50	370	24	360	128	415	31	41	4.7	0.5
24.	19.2	22.08	470	50.87	560	108	278	20	30	6	3.52
25.	35.2	30.72	580	28.16	415	98	618	23.4	18.25	30.7	3.6
26.	24.8	20.64	400	21.12	455	101	316	24.35	2.25	31.3	3.61
27.	63.2	48.96	830	35.2	587	176	1075	25.83	31.25	26.3	2.54
28.	71.2	40.8	688	36	470	175	880	26.5	33	23.7	2.48
29.	35.2	26.4	403	24	405	93	372	27.73	46.5	19.6	3.63
30.	99.2	74.88	820	24.64	501	139	1160	24.84	33.5	30.7	2.27
31.	70.4	60.96	600	17.6	370	116	858	25	36.5	19.7	2.3
32.	22.4	39.36	556	24.65	436	82	6.16	17.16	29.85	5.9	5.98
33.	51	64.32	535	28.2	247	244	700	28	23.63	2.37	1.89
34.	110.4	54.72	472	17.42	278	168	702.1	25	46.4	2.65	3.01
35.	18.4	14.9	356	23.23	341	64	292.6	25.25	23.75	5.59	6.55
36.	8	3.84	370	20.33	391	46	259	14.25	22.5	11.5	6.48
37.	66.4	62.88	726.5	20.33	357.8	112	1057.9	22.67	17.41	19.55	8.02
38.	26	28.32	403.8	23.23	426.29	103	362.1	23.37	26.11	9.63	3.7
39.	8	8.64	298.77	29.04	362.19	62	166.9	12.81	47.8	6.28	10.5
40.	12	10.56	361.9	20.33	409.8	60	237.4	17.62	34.2	6.28	10.2
41.	11.2	7.68	386.86	26.14	304.6	62	309.6	19.25	57.21	6.24	10.4
42.	3.2	11.52	343.39	17.42	362.5	54	263.05	19.47	6.22	10.61	10.1
43.	11.2	6.72	298.3	23.23	305.1	48	192.5	19.02	35.45	6	9.58
44.	9.6	9.12	440.22	17.42	411.38	70	371.75	18.79	9.95	12.85	8.74
45.	15.2	13.8	534.06	26.51	491.18	26	510.72	14.83	29.85	29.85	11.4
Desi. by WHO	75	–	–	–	–	200	200	–	–	45	0.7
Max. by WHO	200	–	200	–	–	400	600	–	–	–	1.5
Desi. by ISI	75	–	–	–	–	200	250	–	–	45	1
Max. by ISI	200	–	175	–	–	400	1000	–	–	100	1.5

Desi. = Minimum desirable limit, Max. = Maximum permissible limit

Carbonate and bicarbonate ranged from 3.52 mg/L to 50.87 mg/L from 151 mg/L to 587 mg/L, respectively. The chloride content in the samples is in the range from 49 mg/L to 1260 mg/L. Limits for maximum concentration of chloride have been set on the basis of taste preferences. However, large amounts of chloride, when calcium and magnesium are also present lead to increase in water's corrosiveness and may adversely affect water quality by corroding metallic pipes through which it is be transported for use. The importance of chloride as an indicator of sewage pollution has been emphasized[6].

The presence of sulphate in drinking water can cause noticeable taste. Taste impairment varies with the nature of the associated cation. It is generally considered that taste impairment is minimum at levels below 250 mg/L. In the present study, sulphate concentration varies from 22 mg/L to 278 mg/L.

Phosphate ranges from 2.25 mg/L to 57.21 mg/L. The obtained values of phosphate concentration in the present study are higher than prescribed values. The higher values of phosphate concentration is mainly due to the extensive use of fertilizers and pesticides by the people residing in this area. If phosphate is consumed in excess, phosphine gas is produced in gastro–intestinal tract on reaction with gastric juice. This could even lead to the death of the consumer. In present study, silicate ranged from 7.4 mg/L to 31.4 mg/L.

The high levels of nitrates in drinking water is responsible for methemoglobinemia, where headache, tachycardia, dizziness, weakness, dyspnes, bradycardis, hypoxia metablic acidosis, seizures, coma and cardiac arrhythmias may occur[8]. The prescribed value of nitrate suggested by WHO is 45 mg/L. In this area, the range of nitrate from 0.0 mg/L to 68.2 mg/L was observed.

The excessive amount of fluoride in drinking water and environment is poisonous[9]. High levels of fluoride leads to dental and/or skeletal fluorosis. In dental fluorosis, the common symptoms observed are discoloration of the teeth, which may start with white or yellow and become brown to black. Dental fluorosis is usually reversible if no permanent damage is done[10]. In skeletal fluorosis, high dose of fluoride replaces bone calcium by calcium fluoride and as a consequence, bones become soft, crumble and chalky white. Maximum effect of fluoride is detected in the neck, spine, knee, pelvic, shoulder joints, small joints of the hands and feet. The observed value of fluoride content in this area varied from 0.5 mg/L to 11.4 mg/L.

The maximum permissible limit of calcium is 200 mg/L by IS and the observed range of calcium is from 3.2 mg/L to 110.4 mg/L. Magnesium enters in the drinking water system from natural geological sources. Excess magnesium causes nausea, muscular weakness and paralysis in human body when it reaches up to the level of about 400 mg/L. In this area, magnesium concentration ranged from 3.84 mg/L to 93 mg/L i.e. it is below the permissible level.

With an excess sodium concentration, when present with carbonate and bicarbonate as predominant anion, the water is called alkaline while when it is present with chloride and sulphate as predominant anions, water is called saline[12]. The maximum permissible limit of sodium in drinking water is 175 mg/L. The concentration of sodium was found in the range from 90 mg/L to 860 mg/L.

Excess amount of iron (more than 10 mg/kg) causes rapid increases in respiration, pulse–rate and coagulation of blood vessels, hypertension and drowsiness[11]. In this area, the concentration of iron was below detectable level (BDL) by spectrophotometer. The concentration of aluminium was also found to be BDL by spectrophotometry.

CONCLUSION

The whole West Patan region depends on ground water expect a few places where surface water (in the form of Dharoj water) is available. West Patan region has 29 samples having excess fluoride concentration, 2 samples having excess nitrate concentration and 26 samples having excess (more than 1500 mg/L) of TDS. In all, 12 water samples were found to be proper for drinking purpose, whereas 25 samples badly require proper chemical treatment to reduce the toxin levels and 8 samples require chemical treatment as after several months, the situation may aggravate.

REFERENCES

1. J. Behnke, A Summary of the Biochemistry of N Compounds in Ground Water, J. Hydrol. (AMST), **27(112)**, 155 (1975).
2. W. Freenius, E. K. Quentin and W. Schneider, Water Analysis in Practical Guide to Physico–chemical and Micro Biochemical Water Examination and Quality Assurance, Springer Verlag. (1998) p. 804.
3. A.I. Vogel, Vogel's Text book of Quantitative Chemical Analysis (Fifth Edition) by ELBS (1991).
4. P. M. Gopalswami., P. E. Kumar and A. R. Kulandaivelu, Study on the Quality of Water in the Bhavani River, Asian J. Chem., **15**, 306 (2003).
5. K. Park, Park's Text Book of Preventine and Social Medicine. (1997).
6. I. C. Thresh, E.Y. Suckling and J.E. Beale. The Examination of Water and Water Supplies London (1944).
7. APSFSL, Andra Pradesh State Forensic Science Laboratories Annual Report (1988).
8. C. H. Linden, M. J. Burns, Texton Viewer Harison Principal of Internal Medicine, C.D. Rome 15th Edition, Part. 15, Sec. 2, p. 396.
9. National Environmental Engineering Research Institute, Defluoridation (Revised), Nagpur, Sept. (1987).

10. Sangita Sharma, Jabali J. Vora and J. D. Joshi, Status of Fluoride and Fluorosis in Patan Emerging Scenario, Proceedings of the National Seminar Environ and Health, SARITA, Udaipur p. 143, (1999).

11. Assessment of the Water Quality in Rajganpur Industrial Complexes II: Metallic Parameters by Adak Mahuyadas Gupta and K.M. Purohit, Pool RS. **20(4)**, 575, (2001).

12. J. Hussain, I. Hussain and K. G. Ojha, Study of Ground Water Quality for Irrigation in Near Industrial Area of Bhilwara, Rajasthan, (India)., Asian J. Chem. **13**, 1114, (2001).

Accepted : 21.6.04