

Correlation study on physico-chemical parameters and quality assessment of ground water of Thane region, Maharashtra

MIRGANE SUNIL RAMARAO¹ and BHAGURE GANESH RAMDAS²

¹Department of Chemistry, J.E.S.College Jalna, Maharashtra (India).

²Department of Chemistry, Dnyanasadhana College, Thane - 400 604 (India).

(Received: May 12, 2008; Accepted: August 17, 2008)

ABSTRACT

Thane is the third most industrialized district in the Maharashtra state. The area is characterized by hard water and high salinity hazard due to its proximity and hydraulic connection with the sea. Therefore an Attempt has been made to assess the physico-chemical Parameters of ground waters of Thane Region, Maharashtra during Oct. Nov. 2008. Statistical studies have been carried out by calculating correlation coefficient between different pairs of parameters and t-test applied for checking significance. The observed values of physico-chemical parameters of ground water samples were compared with standard values recommended by WHO. It is found that an appreciable significant positive correlation holds for electrical conductivity with Na, Cl⁻ and T.D.S. total hardness with Ca and Mg, pH with C.O.D.T.D.S. with Na, Cl⁻. Negative correlation was found between electrical conductivity and nitrate, with SO₄²⁻ and nitrate, Total hardness with C.O.D. All the physico-chemical parameters of ground water of Thane region are within the highest desirable limit or maximum permissible limit set by WHO, except chemical oxygen demand, total hardness and alkalinity values for most the ground water samples.

Key words: Ground water pollution, correlation coefficient, t-test, potability.

INTRODUCTION

Water is one of the materials required to sustain life. In India ponds, river water and ground water are used for domestic and agricultural purposes. Ground water is the major source of drinking water in both urban and rural areas. Ground water pollution is not due to natural factors but it has been caused by human actions. The quality of ground water may be described according to their physico chemical and micro biological characteristics. In recent years along with physico chemical characteristics of water an alternative approach based on statistical correlation has been used to develop mathematical relationship for comparison of physico chemical parameters¹.

The present study deals with the study of physico chemical parameters of ground water in

Thane region of Maharashtra. The analyzed data were compared with standard values recommended by WHO. Systematic calculation of correlation Coefficient between water quality parameters has been done with the objective of minimizing the complexity and dimensionality of large set of data. The significant correlation has been further verified by using 't' test.

EXPERIMENTAL

All the chemicals used were A. R. Grade and were purchased from S. D. fine chemicals Ltd. PH and electrical conductivity were measured by using PH meter and conductivity meter (Model Equiptronics). Dissolved oxygen, Chemical oxygen demand, total hardness, total alkalinity chloride, sulphate, phosphate nitrates calcium, magnesium, potassium and sodium were determined as per the

standard procedure of APHA AWWA². Flame photometer [Model Elico CL-178] was used for determination of metal ions Na⁺ and K⁺.

The statistical analysis has been performed using standard methods³. Karl Pearson correlation coefficient (r) was calculated and correlation for significance has also been trusted by applying t-test.

22 bore wells and dug wells were selected as sampling stations from Thane Region for sampling of ground water. Each locality of ground water was sampled once in the month of Oct.-Nov. 2008. The sampling locations, source and corresponding habitats are shown in Table 1

RESULTS AND DISCUSSION

The standard and observed values of physico chemical parameters of ground water

samples are presented in Table-2 & 3. The observed values of pH ranging from 7.48 to 8.52 shows that ground water samples are slightly alkaline except G14 samples (PH 5.93).

Ground water samples G6, G10, G16, G19 contain T.D.S. more than maximum permissible limit set by WHO. Ground water samples except G6, G10, G16, & G17, G19 contain T.D.S. are within the highest desirable limit or maximum permissible limit set by WHO. Whereas G6, G10, G16, G17, & G19 shows T.D.S. more than maximum permissible limit. These samples are located in industrial area which shows direct impact on these samples. Since no standard is suggested by WHO for Dissolved oxygen, electrical conductivity, sodium and potassium content for drinking water so no comparison can be made from observed values. The chemical oxygen demands values of water samples G1, G3, G4, G5 & G8 are within the maximum permissible limit whereas remaining

Table 1: Sampling Stations with location

Sample Source of Ground water	Habitat	Sampling Location
G ₁	Borewell	Dnyanasadhana College, Thane.
G ₂	Borewell	Kishna Nagar, Thane.
G ₃	Borewell	Near TMT Workshop, Thane.
G ₄	Dug well	Lokmanya Nagar Pada No. 3, Thane.
G ₅	Dugwell	Near N.G.Vihar Complex, Thane
G ₆	Borewell	Near Vrundavan Soc. Bus Stop, Thane
G ₇	Borewell	Green acres phase-II, Ghodbundar.
G ₈	Borewell	Kopri, Thane east.
G ₉	Borewell	Kalwa Naka, Pandurang Chowk, Kalwa.
G ₁₀	Borewell	Divegaon, Belapur road.
G ₁₁	Dugwell	Saipetrol Pump, Kausa, Pune Highway.
G ₁₂	Dugwell	Divajunction.
G ₁₃	Borewell	Gandhinagar, Dombivali (East)
G ₁₄	Borewell	Near Autokripa Garage, Dombivali (East)
G ₁₅	Borewell	Usma Automobiles, MIDC Dombivali.
G ₁₆	Dugwell	Bailbazar Kalyan.
G ₁₇	Borewell	Near Kala Talav, Kalyan.
G ₁₈	Borewell	Om water supplier's ULNGR, No.3.
G ₁₉	Borewell	CHM College Campus, Ulhasnagar.
G ₂₀	Borewell	Nehru Garden, Ambernath.
G ₂₁	Dugwell Water,	Morivali Ambernath.
G ₂₂	Dugwell water,	Jambivali Ambernath

ground water samples shows chemical oxygen demand values more than maximum permissible limits. The high values of C.O.D. may be due to contamination of well water and bore well water due to domestic and industrial waste⁵.

Total Hardness (30-770 mg/lit) values of ground water samples are within the maximum permit set by WHO except Sample No. G7, G17, G18, G19. The abnormal value of Total Hardness in there sample is due to discharge of domestic sewage, paper, textile and chemical waste⁶. Ground water samples nearby creak G3, G5, G7 shows high value of hardness this may be due to proximity and hydraulic connection to the creak⁷.

The mean value of alkalinity in the ground water of Thane Region was 300 mg/lit (Table 2) which exceeded the highest derivable limit. The value of alkalinity in water provides an idea of natural salts present in water. The alkalinity in water is due to dissolution of mineral in water from soil. The various ionic species that contribute to the alkalinity includes bicarbonate, hydroxide, phosphate and organic acids. These factors are characteristics of the source of water and processes taking place at any given time⁸.

Chloride

The ground water samples G6, G10, G14,

Table 2: Physico-chemical parameters of water studied

Station	pH	Elec. Cond.	TDS	D.O .	C.O.D.	T.H.	T.A .	Cl ⁻
G1	7.48	1311	0853	4.63	236	432	210	240
G2	7.51	0754	0490	4.02	1326	286	270	199
G3	7.15	1134	0737	1.83	0195	430	262	154
G4	7.43	0671	0436	5.60	0074	300	497	146
G5	7.31	1247	0811	4.25	0056	488	510	170
G6	8.47	2123	1381	3.53	0805	270	393	574
G7	7.02	1320	0858	3.44	0429	566.0	262	122
G8	7.43	1190	0775	4.10	0117	160	250	270
G9	7.80	0616	0400	2.83	0332	130	183	115
G10	7.8	2230	1450	4.38	0351	386	220	719
G11	7.94	0669	0435	4.53	0213	230	287	087
G12	7.91	0903	0587	3.70	0732	276	327	141
G13	7.94	0724	0471	4.81	0383	322	327	070
G14	5.93	1022	0665	4.20	0315	320	092.0	387
G15	9.30	0704	0458	3.92	2453	312	490	216
G16	8.52	1920	1248	3.73	1170	624	580	576
G17	7.89	1610	1045	2.73	0897	770	520	387
G18	7.53	1671	1086	4.38	1166.1	620	220	288
G19	8.10	1940	1261	4.10	0538	736	150	672
G20	7.89	0764	0497	3.64	1587	308	250	080
G21	8.45	0704	0458	4.38	1306	222	230	076
G22	7.95	0358	0234	4.14	1377	030	070	064
Average	8.08	1162	0887	4.20	0730	078	030	262
WHO	Standard							
HDL	7-8.5	-	500	-	-	100	-	200
MPL	6.5-9.5	-	1000	-	255	500	120	600

Except PH, and electrical conductivity(micro Simenscm-1)all values are expressed in mg/lit.

T.D.S.-Total Dissolved Solids, D.O.-Dissolved oxygen,C.O.D. Chemical Oxygen Demand

T.H.-Total Hardness,T.A.-Total alkalinity.

G16, G17, G18 & G19 contain high value of chloride which is above the maximum permissible limit as set by WHO. High amount of chloride in these water samples may be due to natural processes such as passage of water through natural salt formation in earth or it may be an indication of pollution from industrial or domestic waste.

Remaining ground water sample shows chloride values with in the maximum permissible limit as set by WHO. Sulphate (70-148 mg/L) Nitrate (0.021-1.760 mg/L) Phosphate (0.018-2.341 mg/L) Calcium (32-176 mg/lit) and Magnesium (12-60 mg/L). Values of ground water samples are with in the highest desirable limit or maximum permissible limit set by WHO.

Statistical Analysis

The correlation coefficient 'r' was calculated using the equation.

$$r = \frac{\sum xy}{\sqrt{\sum x^2 \sum y^2}}$$

Where $x = x - \bar{x}$ and $y = y - \bar{y}$, X and Y represent two different parameters. \bar{x} = mean value of X = \bar{y} mean value of Y

The correlation coefficient (r) amongst various water quality parameters are given in Table 4 and 5. The significance of the observed correlation coefficient have been tested by using 't' test. Out of

Table 3: Concentration of ions at various sampling stations

Station	SO ₄ ²⁻	NO ₃ ⁻	PO ₄ ³⁻	Ca ²⁺	Mg ²⁺	Na ⁺	K ⁺	I.S.I.
G1	21.2	0.045	0.370	252	44	98	39	+0.63
G2	028	0.398	0.120	058	35	81	02	+0.65
G3	147.2	1.760	0.0025	081 _x	56	50	0.7	+0.41
G4	023	0.021	0.018	064	34	42	9.5	+0.87
G5	041.0	0.024	0.033	166	46	98	6.0	+0.90
G6	064.0	0.425	0.175	095	8.0	223	6.0	+1.62
G7	148	0.042	0.0077	125	60	43.2	Zero	+0.37
G8	020	0.446	0.69	020.0	27	104	16.0	+0.23
G9	050	0.540	1.33	028	15	75	14.0	+0.45
G10	89	0.376	0.23	092	30	290	15.0	+0.85
G11	16.5	0.083	0.68	059.0	21.0	49.0	2.3	+1.03
G12	40.2	1.048	0.253	053	35	69	4.5	+1.1
G13	12.0	0.052	0.0764	061	42	24.6	0.2	+1.22
G14	18.16	0.173	0.809	081	29.0	66.5	7.4	-1.38.
G15	42.24	0.242	0.088	064.	37	30	1.0	+2.72
G16	36.0	0.189	2.341	154	58.5	179	34	+2.21
G17	30.0	0.1813	0.335	116	117	48.5	2.0	+1.66
G18	150	0.102	0.040	176	44	81	2.0	+0.82
G19	130	0.0933	0.0585	176	72	130	4.0	+1.24
G20	019.0	0.170	0.064	074	30.0	56	2.0	+1.01
G21	016.4	0.376	0.0573	056.0	20	73	19	+1.42
G22	014.0	0.001	0.059	032	12.2	7.0	3.6	-0.24
Average	053	0.30	0.340	095	40	93	95	
WHO Standard								
HDL	200	0.0	-	75	30	-	-	
MPL	400	45	-	200	150	200	-	

All values are expressed in mg/lit., L.S.I.-Langelier Saturation Index.

63 correlations found between two parameters. 17 were found to have significant at 5% level ($t > 2.086$). The positive correlations were found in 47 cases and negative correlation in 16 cases. The significant positive correlations was found between electrical conductivity and Na ($r = 0.7672$, $t = 5.349$), Chloride ($r = 0.8873$, $t = 8.6073$), Total Hardness ($r = 0.6618$, $t = 3.9481$), Sulphate ($r = 0.5109$, $t = 2.6578$),

Calcium ($r = 0.5864$, $t = 3.2374$), So with the increase or decreases in the values of Sodium, Chloride, Total hardness, Sulphate and Calcium the electrical conductivity increases or decreases. Positive correlation was found between electrical conductivity and Mg ($r = 0.38372$, $t = 1.8582$), K ($r = 0.2456$, $t = 1.1329$), PO ($r = 0.1585$, $t = 0.7179$), Total alkalinity ($r = 0.1859$, $t = 0.8461$), PH ($r =$

Table 4: Correlation matrix for the water quality parameter. N = 22

Parameters	Parameters	r	t
Electrical Conductivity	Na	0.7672	5.349
	Cl-	0.8873	8.6073
	T.H.	0.6618	3.9481
	SO ₄ ²⁻	0.5109	2.6578
	Ca	0.5864	3.2374
	Mg	0.38372	1.8582
	K	0.2456	1.1329
	No ₃ ⁻	-0.02995	0.1339
	PO ₄ ³⁻	0.1585	0.7179
	T.A.	0.1859	0.8461
Total dissolved Solids	PH	0.08167	0.3664
	Na	0.7672	5.349
	Cl-	0.8873	8.6073
	T.H.	0.6618	3.9481
	SO	0.5109	2.6578
	Ca	0.5864	3.2374
	Mg	0.3838	1.8582
	K	0.2456	1.1329
	No	-0.02995	0.1339
	PO	0.1585	0.7179
Na	T.A.	0.1859	0.8461
	PH	0.0817	0.3664
	Cl-	0.8288	6.6254
	SO	0.2053	0.9381
K	PO	0.2655	1.2315
	No	0.0432	0.1936
	Cl-	0.2663	1.2355
	SO	-0.2716	1.2620
Ca	PO	0.5803	2.9855
	No	-0.1216	0.5478
	Cl-	0.3944	1.9134
	SO	0.3677	1.7680
	PO	-0.2924	1.3674
	No	0.2628	1.3312

Note: Significant if $t_{0.05} > 2.086$

0.08167, $t = 0.3664$). Negative correlation was found between electrical conductivity and NO ion. Total dissolved solids shows significant positive correlation with Na ($r = 0.7672$, $t = 5.349$), Cl⁻ ($r = 0.8873$, $t = 8.603$), T.H ($r = 0.6618$, $t = 3.941$), SO ($r = 0.5109$, $t = 2.6578$), Ca ($r = 0.5864$, $t = 3.2374$) positive correlation was found between T.D.S. and Mg ($r = 0.3838$, $t = 1.8582$), K ($r = 0.2456$, $t = 1.1329$), PO ($r = 0.1585$, $t = 0.7179$), Total alkalinity ($r = t = 0.1859$, $t = 0.8461$), PH ($r = 0.08167$, $t = 0.3664$).

Sodium shows significant positive

correlation with chloride ion ($r = 0.8288$, $t = 6.6254$). Positive correlation was found between sodium & SO ($r = 0.2053$, $t = 0.9381$), PO ($r = 0.2655$, $t = 1.3215$), Na ($r = 0.0432$, $t = 0.1936$) Significant positive correlation was found between K and Chloride ($r = 0.2663$, $t = 1.2355$), PO ($r = 0.5803$, $t = 2.9855$). Negative correlation was found between K and SO ($r = -0.2716$, $t = 1.2620$), Na ($r = -0.1216$, $t = 0.5478$).

Calcium shows positive correlation with Chloride ($r = 0.3944$, $t = 1.9134$) and SO ($r = 0.3677$, $t = 1.7680$), PO ($r = 0.2628$, $t = 1.3312$). It's

Table 5: Relation of parameters with correlation coefficient (r) & (t)

Parameter	Parameters	r	t	
Mg	Cl ²⁻	0.2661	1.2345	
	SO ₄	0.3079	1.4473	
	NO ₃ ⁻	-0.0239	0.1068	
Total Hardness	Ca ⁺⁺	0.7405	4.9278	
	Mg ⁺⁺	0.6025	3.3756	
	Cl ⁻	0.4967	2.5595	
	SO	0.5309	2.8023	
	T.A.	0.3468	1.6554	
	NO	-0.1726	0.7836	
	PO	0.2095	0.9580	
	C.O.D.	-0.05039	0.2256	
	Na ⁺	0.1908	0.8693	
	Total Alkalinity	Ca ⁺⁺	0.1335	0.6024
Mg ⁺⁺		-0.0396	0.1771	
K ⁺		0.0677	0.3033	
Na ⁺		0.0838	0.4562	
Cl ⁻		0.0969	0.4353	
SO		-0.1670	0.7577	
NO		-0.0638	0.2859	
PO		0.2095	0.9580	
C.O.D.		D.O.	-0.09069	0.4072
		Cl ⁻	-0.05995	0.2685
PH	Na ⁺	0.3403	1.6179	
	K ⁺	-0.0616	0.2689	
	Ca ⁺⁺	0.1432	0.6470	
	Mg ⁺⁺	-0.0616	0.2756	
	Cl ⁻	0.2961	1.3863	
	C.O.D.	0.6287	3.6156	
	T.H.	-0.1486	0.6721	

Note: Significant if $t_{0.05} > 2.086$

suggested that Chloride is present in the form NaCl in maximum amount, it's also present in form of KCl, CaCl₂ & Cl₂.

Phosphate may be present in the form of potassium salt of phosphate. Negative correlation was found between Ca and Na ($r = -0.2934$, $t = 1.3674$) between Mg and Na ($r = -0.0239$, $t = 0.1068$). No correlation found between Mg and PO.

Total hardness shows significant positive correlation between Ca ($r = 0.7405$, $t = 4.9278$), Mg ($r = 0.6025$, $t = 3.3756$) Cl⁻ ($r = 0.4967$, $t = 2.5595$) and SO ($r = 0.5309$, $t = 2.8023$). positive correlation was found between Total Hardness and T.A. ($r = 0.3468$, $t = 1.6554$), PO ($r = 0.2095$, $t = 0.9580$), Na ($r = 0.1908$, $t = 0.8693$). Negative correlation was found between Total hardness and NO ($r = -0.1726$, $t = 0.7836$), COD ($r = -0.05039$, $t = 0.2256$). As Hardness shows positive correlations with Ca, Mg, Cl⁻, and SO. Therefore, it is suggested that hardness of water samples is mainly due to presense of CaCl₂, CaSO₄, MgCl₂ and MgSO₄⁹.

Total alkalinity shows positive correlation between Ca ($r = 0.1335$, $t = 0.6024$), K ($r = 0.0677$, $t = 0.3033$), Phosphate ($r = 0.2095$, $t = 0.9580$). Negative correlation were found between Mg ($r = -0.0396$, $t = 0.1771$), SO ($r = 0.1670$, $t = 0.7577$), Na ($r = -0.0638$, $t = 0.2859$). Chemical oxygen demand shows Negative correlation between D.O. ($r = -0.0969$, $t = 0.4072$), Cl⁻ ($r = -0.05995$, $t =$

0.2685). PH shows significant positive correlation with C.O.D. ($r = 0.6287$, $t = 3.6156$) positive correlation between Cl ($r = 0.2961$, $t = 1.3863$) Ca ($r = 0.1432$, $t = 0.6470$), Na ($r = 0.3403$, $t = 1.6179$). PH shows negative correlation with K ($r = 0.0616$, $t = 0.2689$), T.H. ($r = -0.1486$, $t = 0.6721$), T.A. ($r = -0.1973$, $t = 0.7122$)

CONCLUSION

All the physico-chemical parameters of ground water of Thane Region are within the highest desirable limit or maximum permissible limit set by WHO, except chemical oxygen demand values for most the ground water samples recorded high values. Ground water of Thane region recorded higher values of Na, Cl, Ca and Mg. This may be due to proximity of ground water sampling stations to the creek. A large number of factors and geological conditions affect the correlations between different pairs directly or indirectly. An appreciable significant positive correlations have been recorded for electrical conductivity with Na and Cl⁻. Na with Cl⁻, Total hardness with calcium.

ACKNOWLEDGEMENTS

Author is grateful to Prin. Dr. G. B. Vishe for providing Administrative support, Mr. D. S. Patil Chemist I. T. L; Thane and Mr. N. Kalyan M. D. Elca lab, Thane for providing laboratory facility.

REFERENCES

1. N. Janardhan Raju, *Current Science*, **91**(6): (2006).
2. APHA-AWWA, Standard methods for the examination of water and waste water 20th edition, sec. 3120 (1998).
3. S. P. Gupta, statistical methods sultan chand & sons, 28th edition (1999).
4. World health organization, Guidelines for drinking water quality-I, Recommendations, 2nd Edition Genera WHO (1993).
5. Madhavi A. Rao, Acharya N. G. Ranga J. *Environmental Biology* **24**(2): 187-92 (2003).
6. Maharashtra pollution control board report, Environmental status of Thane Region, (2005).
7. Naik P. K. Dehury B. N; Tiwari A. N; *J. Environ. Monit. Asses.* **132**(1-3): 207-33 (2007).
8. Sharma M. R. *J. pollution Res;* **23**(1): 131-134 (2004).
9. Manish I. Shrivastava Environmental chemistry. Shree publishers and Distributors, New Delhi Ed (2004).