Evaluation of Groundwater Quality of Tubinakere Industrial Area, MandyaCity, Karnataka, India

Pushpavathi. C[1] Dr. B C Nagendra Prasad[2]

[1,] **Research Scholars, Department of Civil Engineering, MIT, Mysore.**

[2], **Professor and Head, Department of Civil Engineering, MIT, Thandavapura, Mysore.**

***Abstract*:** Due to human and industrial activities the ground water is contaminated. This is becoming serious problem now a day. Thus the analysis of the water quality is very important to preserve and protect the natural eco system. The assessment of the ground water quality was carried out in the Tubinakere industrial area, Mandya City. The present work is aimed at assessing the water quality using Langlier's Index or Calcium Carbonate ($CaCO_3$) Saturation Index for the ground water of Tubinakere industrial area. The ground water samples of all the selected stations from the wards were collected for a physiochemical analysis. For calculating present water quality status 16 parameters have been considered. The obtained results are compared with Indian Standard Drinking Water specification IS: 10500-2012. The study of physico-chemical and biological characteristics of this ground water sample suggests that the evaluation of water quality parameters as well as water quality management practices should be carried out periodically to protect the water resources.

Keywords: water quality index; ground water; relative weight; physico chemical analysis; ground water quality.

1. Introduction

Groundwater is water located beneath the ground surface in soil pores and in the fractures of lithological formations. A unit of rock or an unconsolidated deposit is called an aquifer when it can yield a usable quantity of water. The depth at which soil pores or fractures and voids in rock become completely saturated with water is called the water table. Groundwater is recharged from, and eventually flows to, the surface naturally; natural discharge often occurs at springs and seeps, streams and can form oases or wetlands. Groundwater is also often withdrawn for agricultural, municipal and industrial use by constructing and operating extraction wells. The study of the distribution and movement of groundwater is hydrogeology, also called groundwater hydrology. Rainwater percolating into the ground and reaching permeable layers (aquifers) in the zone of saturation constitutes ground water source. It is the underground water that occurs in the saturated zone of variable thickness and depth, below the earth's surface. Cracks and pores in the existing rocks and unconsolidated crystal layers, make up a large underground reservoir, where part of the precipitation is stored.

Generally, ground water is clear and colorless but harder than the surface waters of the region in which they occur. In limestone formations, ground waters is very hard, tend to form deposits in pipes and are relatively non-corrosive. Water deficient in oxygen and high in carbon dioxide dissolves iron and manganese compounds in the soil. Hydrogen sulphide also occurs some times in ground water and is associated with the absence of oxygen, the decomposition of organic matter of the reduction of sulphates. Percolation into the sub-soil also results in the filtering out of bacteria and other living organisms. In fissured and creviced rock formation such as limestone surface pollution can be carried long distances without material change. Tubinakere is a part of Mandya city, which is having residential area, where thousands of civilians spend their livelihood. Here there is a major industrial area, which haves a continuous flow of industrial wastes and effluents to the soil. Hence, the soil gets contaminated and resulting in soil pollution and henceforth the ground water pollution. The industrial waste which flows on the soil will filter into the subsurface of the soil and reaches the water bodies inside the earth.

1.1 Objectives

- To determine the ground water quality to assess the suitability for domestic use from the ten selected bore wells in Tubinakere industrial area of Mandya city.
- To determine the Langlier's Index or Calcium Carbonate ($CaCO_3$) Saturation index to evaluate the scale forming and scale dissolving tendencies of water.
- To identify the default sampling points and to give possible suggestions to improve the ground water quality.

1.2. Study area

The district lies between 76° to 19° and 77° 20° East longitude and 12°13° and 13°14° North latitude. 4961 Sq.Kms, constituting 2.59% of the total area of the State. Total geographical area of the district is 4961 Sqkms. The city is situated at an elevation of 669.47 m above MSL. It covers crystalline and high grade rocks occurring as huge enclaves within hornblende- gneiss, quartzite and granite.

The research work was conducted in Tubinakere industrial area which is located around 10Km away from Mandya city and being located between Bangalore and Mysore. There are nearly 65 industries are located in the area. There are 18 red category, 13 orange category and 33 green category industries in the vicinity. Also it consists of 13 chemical industries, 1 hazardous waste Reprocessing industry, 1 Re-cycling/ Reprocessing used oil industry, 1 lead acid storage batteries industry, 3 granite cutting and polishing industries, 3 animal feeds industries and some other agro based industries. With this regards present study is a taken assessment of groundwater, in the region of Tubinakere Industrial Area, Mandya.

Figure 1: Layout of Tubunakeri Industrial area, Mandya.

2. Methodology

.2.1 Sampling Technique:

In sampling of ground water for quality analyses polythene bottles was used. A volume of five liters of water was collected for analyses. After rinsing the cans with the water being sampled, the sample was then collected and securely sealed. The samples were taken after pumping of water for about two or three minutes otherwise non-representative samples of stagnant or polluted water may be obtained.

During sampling the water was removed from the natural environment. Due this change chemical composition of water may not remain same. The physico chemical changes possible, where large amounts of organic materials are present and the conditions are suitable for the growth of microorganisms, the water contents changes in a very short time. Preservations are highly recommended in such cases. The samples must be examined at the earliest possible time. Cooling to 4^{0}C is generally suitable for storage condition. The soil samples are preserved in desiccators. Sampling was carried out using glass-stopper bottles of capacity 300ml. The bottles were properly sterilized before sampling. The samples were examined immediately at laboratory using membrane filter technique.

2.2 Langlier's Index

The Langlier's Saturation Index (sometimes Langlier's Stability Index) is a calculated number used to predict the calcium carbonate stability of water. It indicates whether the water will precipitate, dissolve, or be in equilibrium with calcium carbonate.

Langlier's Index or Calcium Carbonate ($CaCO_3$) Saturation Index is commonly used to evaluate the scale forming and scale dissolving tendencies of water. Assessing these tendencies is useful in corrosion control programme and in preventing$CaCO_3$ scaling in piping and equipment such as industrial heat exchanges or domestic water heaters. Index that indicates $CaCO_3$precipitatedefines whether water is over saturated with respect $CaCO_3$. Water, over saturation with respect to $CaCO_3$tends to dissolve calcium carbonate. Saturated water, i.e., water in equilibrium with $CaCO_3$ have either$CaCO_3$ precipitating nor $CaCO_3$ dissolve in tendencies,, saturation represents the dividing line between precipitation likely and precipitation not likely. When the water is in equilibrium, it is possible to express its scale forming at corrosive tendency.

The saturation Index was calculated by +ve (positive) and –ve (Negative). Positive value indicated over saturation with calcium has got a scale forming property. While negative values indicate under saturated with calcium and in fact corrosion is to be protected by deposition of a thin film of $CaCO_3$ in the pipes when the tendency of the water were calculated by the saturation index value. It is also worth noting that the Langlier's saturation Index is temperature sensitive. The Langlier's saturation Index becomes more positive as the water temperature increases. This has particular implications in situations where well water is used. According to Langlier's Saturation Index, the following saturation value shows different tendency of water.

Table 1. Determination of Tendency of Water.

Saturation Index	Tendency of Water

+2 and Higher	Heavy Scale
+2	Heavy Scale
+0.05	Light Scale
-1.0	Significant Corrosion
-2.0	Heavy Corrosion
-2.0 and below	Intolerable Corrosion

The effect predicated by the index does not always confirm to the expectation. The relation between rates at a point $CaCO_3$ is believed to inhibit by clogging reactive factors. The methods involve the calculation using various bases on temperature (^{0} C), total dissolved solids (mgL^{-1}), Calcium ions (mgL^{-1}), and total alkalinity (mgL^{-1}), of the water.

- First the initial p^H of water is noted.
- The water sample estimated for temperature, total dissolved solids, calcium hardness, and total alkalinity in the water bodies.

The table shows that the value of factors A,B,C and D depending upon the values temperature (^{0}C), TDS (mgL^{-1}), Calcium Ions (mgL^{-1}), total alkalinity (mgL^{-1}) respectively are used for the calculations forLanglier's Index.On the basis of these values, we can find out the values of Langlier's Index –

Table 2 Values of Langlier's Index for the samples.

pHs= (A+B) – (C+D)

The value of these factors A, B, C and D can be obtained from Langlier's Index table.

Sampling Station Number	pH_s = (A+B) – (C+D)
Cottage Waste industry	7.77
Gericke vacuum pumps	7.67
Preethi granite industry	7.76
Jungle dhaba	7.88
Sharadadhaba	7.84
J,K.Tyres	7.79
Mangalore Ganesh Beedi works	7.27
Vintech precision	7.59
Kapila aqua	7.37
Srinidhi industries	7.78

Saturation Index is determined from the equation,

SI = pH - pHs

pH = Measured pH

pHs = Calculated using temperature, total dissolved solids, Calcium Hardness, Total Hardness, Total Alkalinity.

3 Results and Discussions

The study was conducted in Tubinakere industrial area of Mandya city, Grab sample were collected and analyzed in the laboratory according to the methods depicted in the standard methods. Sixteen water quality parameters were analyzed and results of each set of samples are depicted in**ta**ble 4.

Table 3 Valuesof Table for Tendency of Water

Sampling Station	Saturation Index Value	Tendency of Water
Cottage Waste industry	-0.603	Significant Corrosion
Gericke vacuum pumps	0.1	Light Scale
Preethi granite industry	0.16	Light Scale
Jungle dhaba	-0.06	Significant Corrosion
Sharadadhaba	-0.2	Significant Corrosion
J,K.Tyres	0.54	Light Scale
Mangalore Ganesh Beedi works	0.13	Light Scale
Vintech precision	-0.055	Significant Corrosion
Kapila aqua	0.067	Light Scale
Srinidhi industries	-0.815	Significant Corrosion

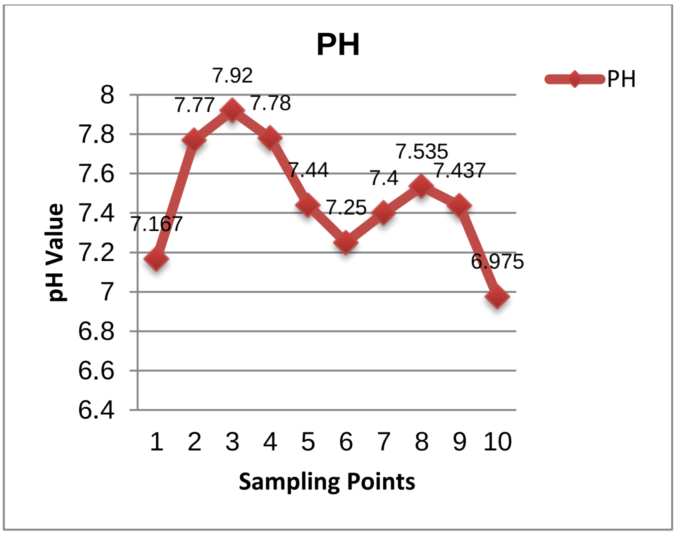

Fig1. Variation of pH of the Ground water for the respective sampling station over different periods of time.

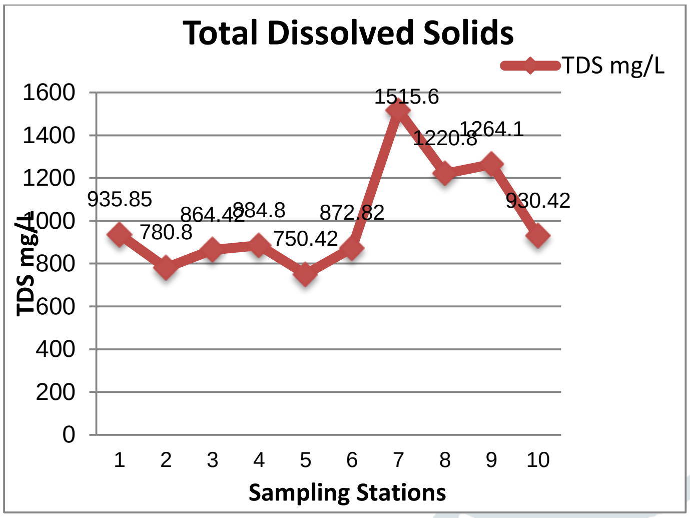

Fig 2.Variation of TDS mg/L of the Ground water for the respective sampling station over different periods of time.

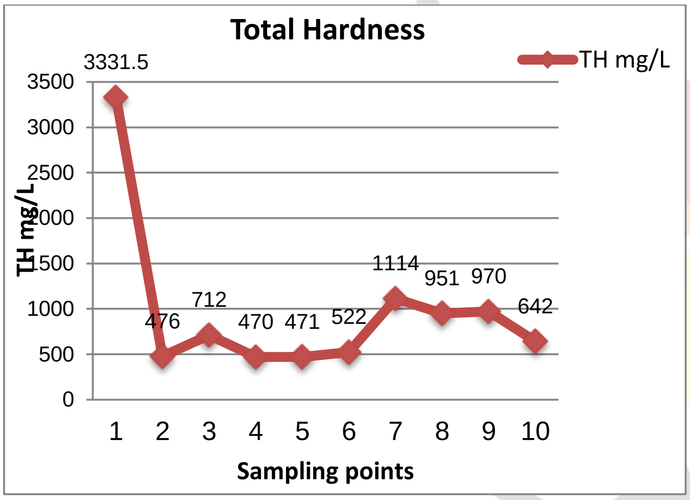

Fig 3.Variation of Total Hardness of the Ground water for the respective sampling station over different periods of time.

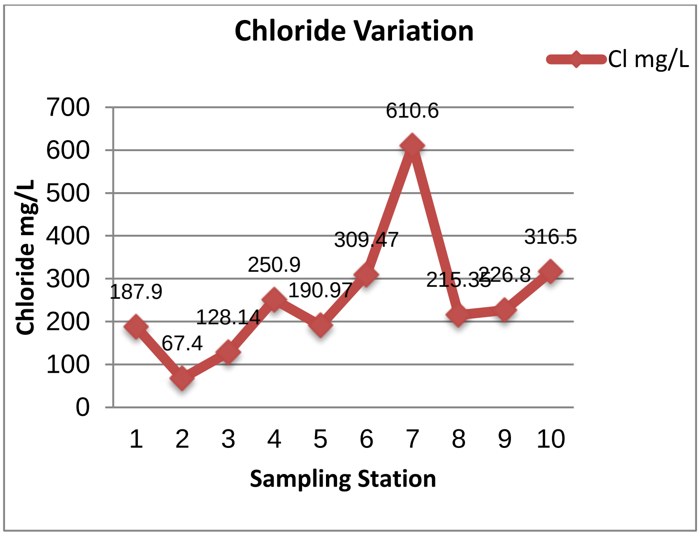

Fig 4.Variation of Chloride Content of the Ground water for the respective sampling station over different periods of time.

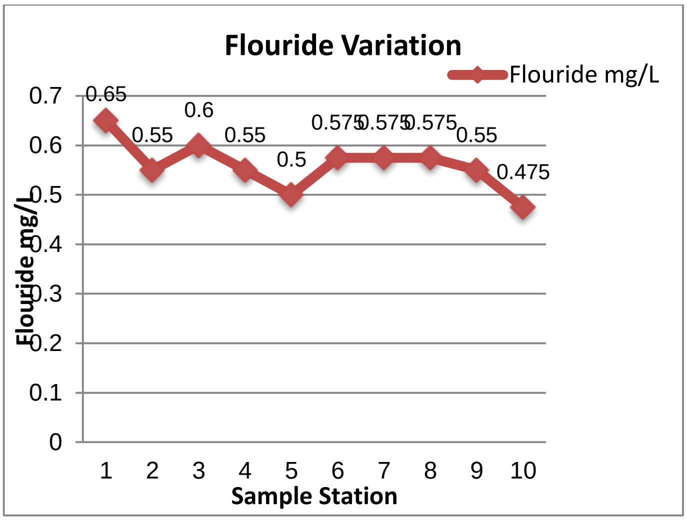

Fig 5.Variation of Fluoride mg/L of the Ground water for the respective sampling station over different periods of time

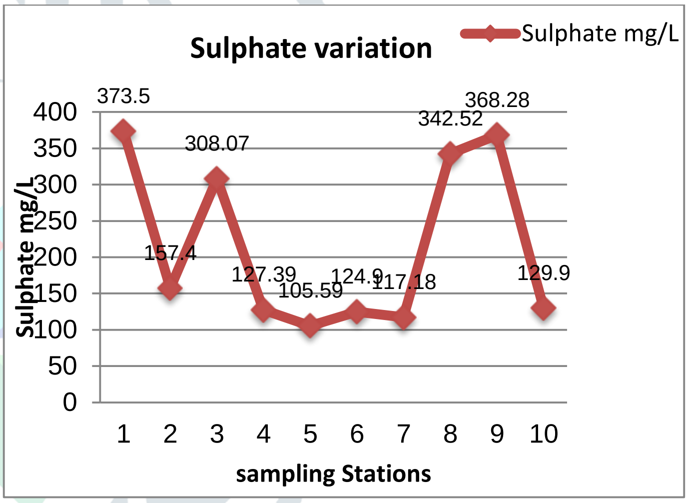

Fig 6. Variation of Sulphate of the Ground water for the respective sampling station over different periods of time.

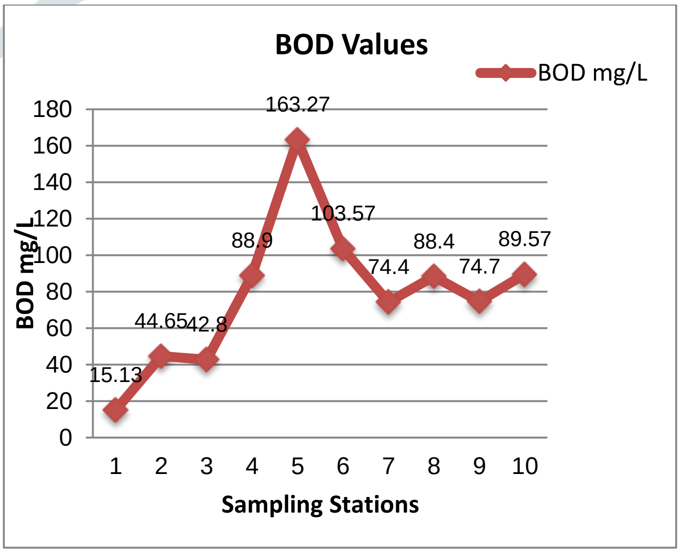

Fig 6. Variation of BOD mg/L of the Ground water for the respective sampling station over different periods of time.

Table 4. The average ground water quality parameters

Sampling station no.	1	2	3	4	5	6	7	8	9	10
PH	7.167	7.770	7.920	7.780	7.440	7.250	7.400	7.535	7.437	6.975
EC	1560	1301	1440.7	1474.7	1250.7	1454.7	2526	2034.7	2106.7	1500.7
BOD	15.13	44.65	42.8	88.9	163.27	103.57	74.4	88.4	74.7	89.57
COD	37.42	89.55	134.07	194.6	326.12	209.3	148.8	178.95	149.15	178.2
Iron	0.041	0.066	0.078	0.057	0.0825	0.504	0.027	0.055	0.067	0.711
TDS	935.85	780.8	864.42	884.8	750.42	872.82	1515.6	1220.8	1264.1	930.42
Mg	733.18	46.05	67.1025	27.12	47.63	40.165	83.305	105.75	108.61	65.848
Ca	124.3	107.5	167	137	117.6	141	305.9	207.6	214.9	160
TH	3331.5	476	712	470	471	522	1114	951	970	642
Cl	187.9	67.4	128.14	250.9	190.97	309.47	610.6	215.35	226.8	316.5
Turbidity	0.933	0.255	1.475	0.137	1.505	0.178	6.225	1.787	0.687	13.625
Flouride	0.65	0.55	0.6	0.55	0.5	0.575	0.575	0.575	0.55	0.475
Nitrate	11.28	11.31	10.99	4.288	5.38	4.05	11.67	11.01	11.67	11.17
Sulphate	373.5	157.4	308.07	127.39	105.59	124.90	117.18	342.52	368.28	129.9
Total Alkalinity	248.7	319.2	278.5	252.25	245.75	263	337.25	311.25	351.5	256.5
E-coli	2.5	2.75	2.75	2.27	1.75	3	2.75	2.5	2.5	2.25

All values are in mg/l, Turbidity in NTU except PH, EC

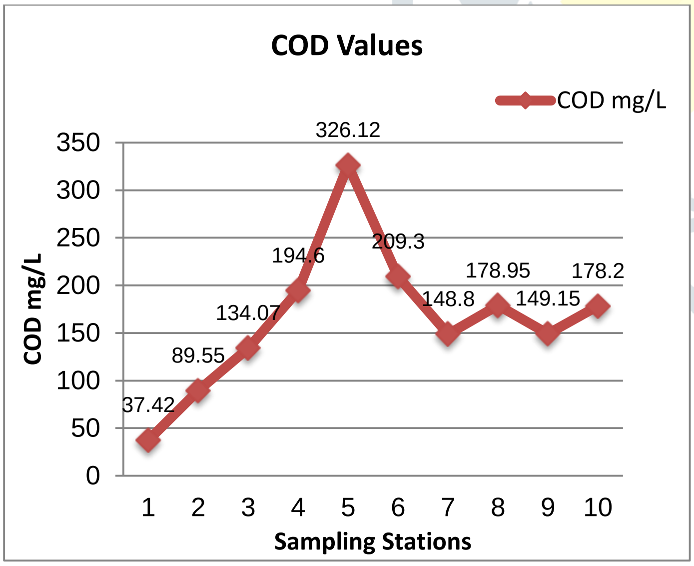

Fig 7. Variation of Iron mg/L of the Ground water for the respective sampling station over different periods of time

Conclusions

The chemical aspects of the groundwater has been determined in Tubinakere industrial area, the results obtained shows the alkaline nature of water. Most of the sampling points have a fluoride concentration of less than 0.65 mg/L. The TDS present in water shows that the samples are suitable for drinking and irrigation purposes after taking some remedial measures. It is advisable to avoid soils having excessive alkalinity and low calcium and magnesium contents while digging wells in search of potable waters. The determination of alkalinity and hardness of existing waters can be expected to be helpful which reflects the geochemical character of groundwater and nature of the rocks in which it occurs.

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