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An Appraisal of Water Quality of Selected Areas in Pimpri Chinchwad Municipal Corporation, Pune District, Maharashtra, India

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Abstract: ***Analysis of water quality is of prime importance in environmental pollution monitoring. Bad quality of water poses a great threat not only to living organism, but to surrounding ecosystem as well. Due to ever-increasing urbanization of Pimpri Chinchwad Municipal Corporation (PCMC) area in Pune, a systematic physicochemical analysis of water quality was needed. In the present study, 26 water samples (S1 To S26) have been collected from areas in and around PCMC limit during February to March 2019. Collected water samples belong to surface water, groundwater, Corporation treated water and purified water categories. Physicochemical analysis of the sample included determination of pH, Conductivity, Total hardness (in terms of $CaCO_3$ mg/liter or ppm) and alkalinities (in terms of $CaCO_3$ mg/liter or ppm). The analysis of 2 samples belonging to the surface water such as river or lake and 5 samples of borewell (underground) the water exhibited exceptionally high total hardness (from 200-450 ppm) with high Bi-carbonate alkalinity (100 – 300 ppm). The pH of these samples was in the range from 6.3 to 7.8 and conductivity was as low as 0.14 mS and as high as 0.95 mS which is indicative of moderate conductivities due to high salt concentration. Analysis of rest of the samples showed total hardness and alkalinities within BIS (IS-10500) limits. Also, few municipal corporation treated water samples quality lingers on borderline which remains to be investigated***
Keywords of the abstract: BIS, pH, total hardness, total alkalinity, electrical conductivity, PCMC.

I. INTRODUCTION

Water is an essential part of our life and without good quality water sources survival of human life and industries is crucial. Chemical contaminants from nature or human interference render water unsafe for human consumption and also prove detrimental to industries using raw water.

Typically the water quality is determined by comparing the physical and chemical parameters of water bodies with standard guidelines set by *Bureau of Indian standard (BIS)* in our case. Providing safe drinking water to the common man is an priority of government. In that direction municipal corporation setup has state of the art water treatment plant to cater to the needs of safe water of its people. Due to ever-increasing demand for potable water, ground water sources have been exploited by citizens throughout the year for many purposes like household, industrial, agricultural usage etc. More stress on groundwater coupled with high population and disproportionate demand, urbanization, and industrialization have put considerable stress on water management[1,2]. This has led to the depletion of water level in India in underground continuously and its purity being degraded due to large-scale discharge of industrial and agricultural contaminants and toxic metals[3].Pimpri Chinchwad is one of the fastest-growing suburb in Pune district and is rightly called as abode for automobile and IT industries in recent years. Growth rate of Pune for the last 40 years has been at least 40% and it's estimated that population will hit 5.6 million by 2031 if this trend continues. The migration of skilled labours from other states could be one of the important reason. However due to increased urbanization of Pimpri Chinchwad area in past couple of years, it has been a real challenge for the corporation to deliver clean and sufficient amount of water to all the people of its jurisdiction. The use of pesticides in Maharashtra is on higher side as compared to other states[4] which is prevailing cause of pollution of underground and surface water sources. The main goal of the study was to access the quality of underground (borewell) water, surface water and corporation treated water from different areas of PCMC. Few earlier reports are have been published on water quality study of PCMC[5] however on a few water samples only. We have investigated 26 water samples which has covered almost all wards of PCMC.

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II. MATERIALS AND METHODS

A. Study Area

Pimpri Chinchwad is an extension of Pune and rapidly grown into a giant industrial hub post independence. It is home for automobile industries, many medium and small-scale industries and IT hub in recent years. It is located at 53m (1,740ft) above sea level, about 15km from Pune center in northwest direction.[6] The city is situated approximately at 18° 37' North latitude and 73° 48' East longitude.Three rivers Pavana, Mula and Indrayani flow through this area. The base rock found throughout the city is a Deccan trap basalt. Building stone is the only commercially important mineral found in the area[7,8] . The summer season soars the city temperature from 35°C to 42°C. The Average rain fall is 722mm in monsoon season from June to september. Winter season comprises of October to January where temperature lies between 12°C (min) to 30°C (max).

The Pimpri Chinchwad urban area Development Authority (PCNTDA) is that the urban planning authority. Pawana dam located at 35 km distance is currently the only water supplying body. Pavana dam has capacity of 241milion cubic meters. The water after initial screening is pumped in from pawana river at Ravet pumping station and then transported to Water Treatment Plant (WTP) at Appu Ghar Nigdi PCMC for treatment and then distributed to the entire PCMC area from there. There are two plants at WTP Nigdi PCMC with capacity of 114 mld each and phase III and IV of 100 mld each[9]. Approximately 420 MLD (million liters per day) is purified, disinfected and distributed to the entire PCMC area on daily basis.The city is divided into 32 electorial wards and 47 ESR (elevated service reservoir) zones for water suppy.[10]

B. Sample Collection and Method

26 samples were collected from different parts of PCMC during February and March 2019. (*see Fig. 1*). The samples were collected in PET bottles which were cleaned with double distilled water and air-dried. The analysis of these samples included determination of pH, electrical conductivity (EC), Total hardness ($CaCO_3$ equivalent in mg/liter or ppm) and total alkalinity ($CaCO_3$ equivalent in mg/liter or ppm). pH of 26 water samples were determined on digital display with electrode equiptronics EQ 610) pH Range 0 to 14, electrical conductivity (EC) were determined on (digital display with conductivity cells make Equiptronics and displayed in mS (milliSiemens) per cm. Total hardness of samples were found out by titration against standardized Na_2-EDTA using EBT (Erichrome Black-T) as indicator in basic pH maintained by using NH_4OH-NH_4Cl buffer. Total alkalinities were determined by performing neutralization titration of samples against standard 2N HCl using phenolphthalein and methyl orange as indicators.

III. RESULTS

The results of various physico-chemical parameters recorded during analysis is given in *Table 1*. This study suggests that the samples (S1-S5) collected from river, lake or underground are of bad quality. Extreme high hardness (approx. 500ppm) is on the higher side of the permissible limit set by Bureau of Indian Standards; (BIS) which is between 200-600 ppm (*IS-10500 2012*) . While most of the samples of corporation treated water from various locations of PCMC are well within permissible limit still few samples (S4 & S6)) of them show erratic readings. Possible reasons could be poor sanitation and mixing of underground water with treated water sources. These anomalies remain yet to be investigated in further study.

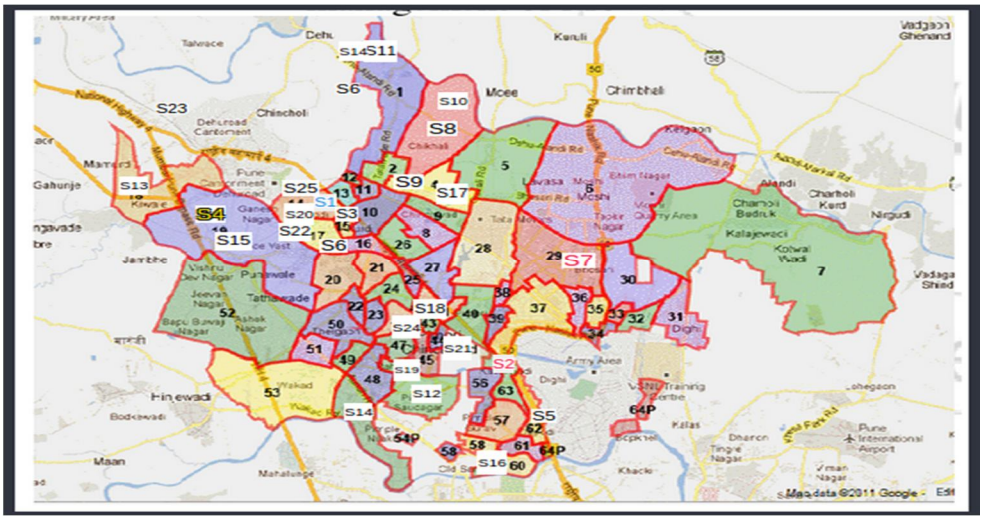

Fig. 1: Location of all the sampling points

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S.No.	Sample ID	pH	EC (mS/cm)	Total Hardness (ppm)	Total Alkalinity (HCO^{-1} only ppm)
1	Sample 1	7.08	0.95	450	280
2	Sample 2	6.47	0.86	450	40
3	Sample 3	6.5	0.71	400	273
4	Sample 4	7.1	0.34	350	47.5
5	Sample 5	7.02	0.46	320	80
6	Sample 6	6.85	0.657	300	220
7	Sample 7	7.05	0.86	282	52
8	Sample 8	7.86	0.5	230	48
9	Sample 9	7.22	0.11	196	66
10	Sample 10	6.45	0.07	186	42
11	Sample 11	7.03	0.26	180	70
12	Sample 12	7.14	0.285	160	110
13	Sample 13	7.3	0.79	160	93
14	Sample 14	7.6	0.16	158	74
15	Sample 15	7.27	0.23	155	75
16	Sample 16	7	0.32	150	110
17	Sample 17	6.95	0.189	140	90
18	Sample 18	7.22	0.17	110	36
19	Sample 19	7.55	0.1	110	90
20	Sample 20	7.22	0.28	100	71
21	Sample 21	8.6	0.2	97	38
22	Sample 22	7.03	0.16	95	33
23	Sample 23	7.38	0.15	90	47
24	Sample 24	6.98	0.29	80	18
25	Sample 25	7.04	0.21	70	58
26	Sample 26	7.01	0.13	28.5	198

Table 1: Different parameters for samples

IV. DISCUSSION

A. pH

pH can be defined as number of hydrogen ion concentration in given solution. pH scale is a measure to detect nature of solution whether acidic, basic or neutral. According to scale acidic range is less than 7, basic solution has range more than 7 and neutral solution has pH 7. Apart from pH scale nature of solution can also be determined by litmus paper. pH is very useful for determining concentration of acids and alkalies in water sample. pH is a measure of alkalinity and hardness of water sample.[11]

Boiler feed water has great effect on pH of water. In industries water is taken into steel tank and heating is carried out for steam generation. If boiler feed water is acidic in nature it promotes corrosion reaction and forms corrosive products.

Oxidation reaction:- $2Fe + O_2 + 2H_2O \rightarrow 2Fe(OH)_2$

$2Fe(OH)_2 + 1/2O_2 + H_2O \rightarrow 2Fe(OH)_3$

Effect of pH of water supplied to agriculture is of prime importance. The pH of rain water is in the range of 5 to 6 which tends to be acidic in nature. River water pH is in the alkaline range between 6.5 and 8.5. pH of underground water drifts towards alkaline levels with in the range of 7 to 8.5. In rainy seasons, the alkalinity of river water decreases slightly.[12] In India, only 40% of the cultivation depends on rain water, while the remaining is supplied either from rivers by canal system or from underground through submersible pumps.

If the land having soil pH more acidic and if furnished with water more acidic or the other way around, then extreme acidity oralkalinity will have adverse effect on overall growth of crops. Therefore pH monitoring of water supplied for cultivation is mandatory. pH usually found out by using pH meter. Initially standardization of electrode is important . The standardization of a pHmeter is vital to make sure that the readings returned from that meter are accurate. Digital & analog pH meters offer calibration buttons or dials that are required to adjust the sensitivity of the meter.

B. Conductivity

Conductance is defined as the ease with which current flows. Conductivity is the measure how well water can transmit electric current. When water containing salts like Ca, Mg and other metal ions present in water, it shows conductance. Organic and inorganic salts like chlorine, sulfate, nitrate present in excess amount shows high conductivity. Conductivity increases as the concentration of salts in water increases.[13]

Conductivity measurements are rapid and non-destructive way to measure salt content in the sample. The conductivity measurement is determined with an electronic sensor or meter and displays the result in micro/milli-Siemens per centimeter. Conductivity increases with increasing salt concentration, which means that in most it is an indicative of the total TDS contect approximately . Conductivity is temperature sensitive and is usually standardized at 25°C. The presence of hardness in water is conveniently suggested by high conductance. But it does have the disadvantage of combining all ions in the measurement, including those that do not contribute to the water's hardness.

C. Alkalinity

Alkalinity is because of presence of high concentration of alkaline salts like hydroxide (OH^-), carbonate (CO_3^{2-}) and bicarbonate (HCO_3^-). These salts make water highly alkaline which further imparts caustic embrittlement.[14] Alkaline salts may present individually or in combined form. If alkaline water is feed to the boiler it leads to caustic embrittlement. It is a type of corrosion which deteriorates boiler slowly by formation of sodium hydroxide followed by sodium ferroate.[15]

$$Na_2CO_3 + H_2O \rightarrow 2NaOH + CO_2$$

$$Fe + 2NaOH \rightarrow Na_2FeO_2 + H_2$$

In caustic embrittlement metal becomes brittle. In agricultural field, alkalinity leads to kill many useful microbes. Underground water has natural filter process as it passes through layers of rocks containing salts which results in eutrophication.[16]

Alkaline water is not good for drinking purpose, cooking purpose due to high concentration of salts in it. In thermal power plant maintenance cost increases due to use of highly alkaline water sample.[17] Alkalinity can be determined using neutralization titration where it is treated with hydrochloric acid, where amount of basic salts can be determined. Phenolphthalein and methyl orange are two indicators used for titration respectively.

D. Hardness

The net amount of impurities present in water sample is known as hardness. These impurities are of different types like suspended, biological, colloidal etc. Hardness in water affects quality and applications of water. If hard water is feed to the boiler for steam generation it causes corrosion of metal, scale, sludge formation which are bad conductors of heat. Boiler corrosion is the destruction of metal by forming pitting (holes) corrosion.[17]

In industrial field, underground pipes, cable lines corrodes due to impurities present in water. In rainy season rate of corrosion increases as increase in the concentration of humidity can be observed.[18] Acidic water is not safe for drinking purpose as it contains many pollutants in it. Acidic water also not safe for cultivation as high concentration of salts adversly affect proper growth of plants.[19] Hardness can be determined by complexometric titration using Disodium salt of Ethylene Diamine Tetraacetic acid (Na_2-EDTA). It forms a complex with salts causing hardness and thereby removes them from water by giving soft water. Erichrome Black T indicator is used for this titration.

V. CONCLUSIONS

An analysis of 26 samples from river, lake, treated drinking and underground water of Pimpri Chinchwad Muncipal Corporation (PCMC) was carried for the assessment of water quality. The results from this study indicate that Samples Ids S1, S2, S3 and S5 which were mainly surface water and underground water sources have very high content of hardness and bi-carbonate alkalinities backed by moderately high electrical conductivities though pH of these sample is inclined towards very mild acidities. Sample S4 & S6 though belonged to Municipal treated water sources yet had water qualities compromised which remains to be investigated further. Rest Sample Ids S8-S19 had water quality parameters within BIS standards. Few water samples from Commercial water purifier like *RO filter* (S20), *Bisleri mineral water* (S21) and *Aqua-guard compact classic model* (S22) had all physical and chemical parameters within permissible limit.

VI. ACKNOWLEDGMENTS

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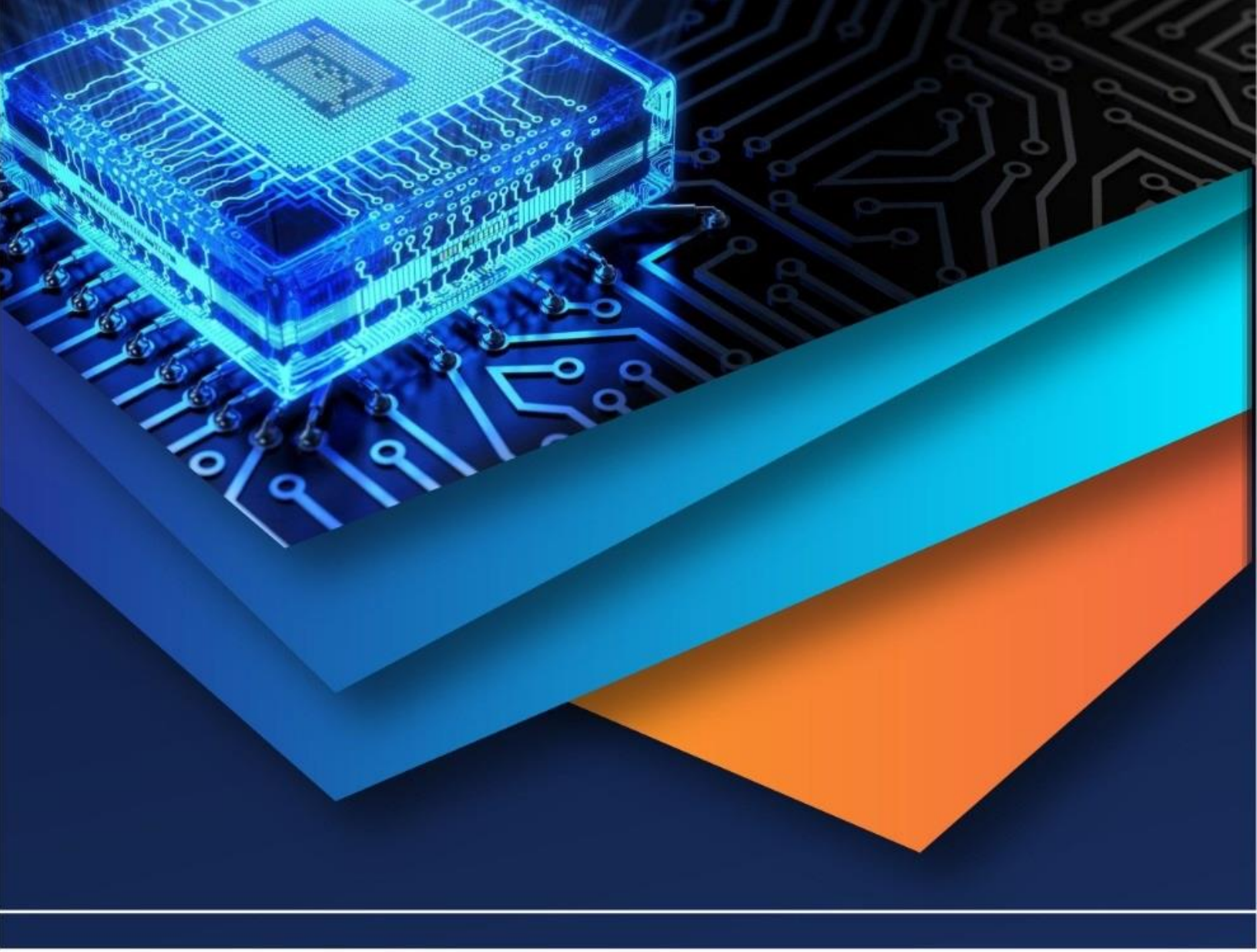

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