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Physico-Chemical Characteristics and Analysis of Fe and Zn in Tubewell Water and Sewage Water of Bikaner City

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In Bikaner, all domestic and sewage wastes are poured into Sursagar, near Junagarh Fort. This water also becomes contaminated with industrial wastes when it passes through the industrial area of Bikaner. Lastly, this waste water reaches into Vallabh Garden and Madhosingh Bari. In these regions this waste water is used for irrigation along with tubewell water. To study the impact of this polluted water on tubewell water, it was necessary to examine the physico-chemical characteristics of sewage water. For this purpose, 15 sewage water samples and 6 tubewell water samples were collected and the value of some parameters such as pH, conductivity, total dissolved solids, total hardness, alkalinity, chloride, sodium, potassium, zinc and iron, were determined. This paper presents the results of analysis of sewage water and tubewell water.

Key Words: Analysis, Fe, Zn, Tubewell water, Sewage water, Bikaner City

INTRODUCTION

Water is a liquid of life as it is the most essential component to sustain life on earth. There are two sources of drinking water. One is surface water sources and other is ground water sources. Ground water comes mainly from the seepage of surface water and is held in the subsoil and in pervious rocks[1]. The use of water is for domestic purposes, for industrial applications, as well as for agricultural purposes[2]. Industrialization and urbanization affects physico-chemical quality of water. On the other hand, microbiological quality changes due to improper sewage and sanitary system as well as illiteracy. The industrial and domestic wastes not only affect the water bodies of the area but also exert an impact on physico-chemistry of ground water; therefore continuous periodical monitoring of water quality is necessary, particularly in the areas of industrial settlement[3].

During the last 15 years, many towns of Rajasthan have grown up as industrial cities. Various studies carried out[4–6] have shown that ground water is being contaminated with hazardous substances, particularly in industrial zones. Waters of arid areas of Rajasthan are brackish but also have alarmingly high concentrations of health affecting constituents, *viz.*, nitrate and fluoride. Heavy metals are also present in high concentration level in industrial effluents[7, 8]. Tannery effluents contribute the highest amount of solids to the streams[9].

The aim of this study is firstly to analyze the physico-chemical characteristics of sewage water and tubewell water; secondly, to find out the concentration of Zn and Fe in sewage water and tube well water.

EXPERIMENTAL

Standard procedures were adopted for the determination of physico-chemical parameters[10, 11]. Physical parameters include colour, odour and conductivity. Chemical parameters such as pH, TDS, alkalinity, anions (carbonates, bicarbonates, chlorides), cations (calcium, magnesium, sodium and potassium) and heavy metals were also determined.

Sampling: All water samples (tubewell and sewage water) were collected from and near the belt of sewage waste from Sursagar to Vallabh and Madhosingh Bari. The samples were collected in non-metallic equipment (polyethylene bottles) to ensure that they may not get contaminated with heavy metals from the sampling and storage equipment.

Processing of Samples: Tubewell water samples were analyzed as such and sewage water samples were analyzed after filtration.

RESULTS AND DISCUSSION

Results of chemical parameters are tabulated in Tables 1 and 2 respectively.

Colour and Odour: All sewage water samples had very foul smell and black brownish colour, whereas tubewell water samples were odourless and colourless.

Hydrogen ion concentration (pH): A perusal of Table-1 shows that tube well water samples have the pH value from 8.01 to 8.44, whereas sewage water samples have the pH value from 7.45 to 8.06 (Table-2). Variation in pH is due to different concentrations of cations and anions present in excess.

Electrical Conductivity (EC): The conductivity of distilled water ranges between 0.001 to 0.003 mS and for domestic water USPH and ISI standard is 0.3 mS. Suitable limit for irrigation water is less than 2.25 mS. In tube well water samples EC values range from 1.80 to 3.08 mS. A perusal of Table-1 shows that 100% tube well water samples have much higher EC values than standard values given by USPH and ISI (0.3 mS). Electrical conductivity in sewage water samples studied ranges from 2.10 to 2.76 mS. A perusal of Table-2 shows that except one water sample all samples have higher EC values. According to conductivity classes described by Thorne and Thorne (1954) and Christiansen (1942) it comes under C_4 category. of irrigation water. Therefore this water under investigation is suitable for irrigation only for soil of good permeability and typical leaching should be provided for removal of excess salts and only salt tolerant crops can be grown with this water. Otherwise higher amount of salts will deteriorate the soil texture, and will accumulate on the surface of soil and thus reduce the permeability of the soil.

Therefore, it is concluded that tubewell water contains high concentration of dissolved ionizable solids and is unsuitable for drinking but suitable for irrigation, whereas sewage water contains high concentration of dissolved ionisable solids and is not fit for irrigation.

TABLE-1
PHYSICO-CHEMICAL PARAMETERS AND ANALYSIS OF Zn AND Fe IN TUBE WELL WATER SAMPLES*

S.No.	Conductivity	pH	TDS	$Ca^{2+} + Mg^{2+}$	Hardness	CO_3^{2-}	HCO_3^-	P.A.	T.A.	Sodium	Potassium	Chlorides	Fe	Zn
T-1	1.87	8.45	1176.8	1.40	140	3.0	30.00	20	90	24.75	2.05	10.50	0.38	0.13
TW-2	2.45	8.26	1568.0	6.90	690	1.0	5.10	10	112	19.00	0.40	17.00	0.23	0.12
TW-3	2.89	8.01	1849.6	4.90	490	—	10.50	—	210	23.00	1.60	17.00	0.29	0.14
TW-4	2.80	8.29	1792.0	4.20	420	—	6.00	—	120	21.25	0.80	13.50	0.29	0.10
TW-5	1.80	8.44	1152.0	5.10	510	—	5.50	—	110	14.00	0.20	5.50	0.16	0.13
TW-6	3.08	8.15	1971.2	5.60	560	—	9.50	—	190	24.75	0.40	20.50	0.26	0.15

*All water samples are colourless and odourless.

TABLE-2
PHYSICO-CHEMICAL PARAMETERS AND ANALYSIS OF Zn AND Fe IN SEWAGE WATER SAMPLES

S.No.	Colour	Odour	Conductivity	pH	TDS	$Ca^{2+} + Mg^{2+}$	Hardness	CO_3^{2-}	HCO_3^-	P.A.	T.A.	Sodium	Potassium	Chlorides	Fe	Zn
W1	Grey brown	Foul smell	2.56	7.74	1638.4	6.90	690	4.0	11.00	40	260	17.50	1.80	10.00	0.34	0.21
W2	,,	,,	2.59	7.64	1657.6	6.90	690	2.0	11.50	20	250	17.50	1.60	11.50	0.19	0.28
W3	,,	,,	2.58	7.65	1651.2	6.90	690	3.0	12.00	30	270	17.50	1.40	12.50	0.12	0.15
W4	,,	,,	2.57	7.76	1644.8	7.10	710	3.0	11.50	30	340	16.50	1.40	11.00	0.20	0.16
W5	Brown black	Bad smell	2.52	7.75	1612.8	7.60	760	2.0	13.00	20	280	16.50	1.20	11.50	0.14	0.18
W6	,,	,,	2.55	8.06	1632.0	7.20	720	3.0	9.50	30	220	16.50	1.30	1.00	0.18	0.24
W7	,,	,,	2.57	7.45	1644.8	7.00	700	2.0	12.50	20	270	16.50	1.20	13.00	0.15	0.16
W8	,,	,,	2.67	7.76	1708.8	7.50	750	3.0	10.00	30	230	17.50	1.20	12.00	0.18	0.16
W9	,,	,,	2.10	7.46	1344.0	6.90	690	—	14.00	—	280	12.25	1.30	8.00	0.17	0.32
W10	Black brown	,,	2.76	7.68	1728.0	8.10	810	4.0	11.50	40	270	19.00	1.40	13.50	0.40	0.10
W11	Black	,,	2.54	7.84	1625.6	6.70	670	—	11.00	—	300	16.50	1.80	13.50	0.43	0.15
W12	Grey	,,	2.60	7.61	1664.0	7.90	790	2.0	11.50	20	250	18.25	4.40	15.00	0.53	0.19
W13	Brown	,,	2.65	8.04	1696.0	7.80	780	4.0	8.50	40	210	18.25	1.20	12.50	0.47	0.16
W14	Brownish	,,	2.71	7.77	1734.4	7.70	770	4.0	10.50	40	250	18.25	4.40	13.50	0.39	0.15
W15	Brown	,,	2.59	7.76	1657.6	7.80	780	2.0	10.90	20	238	17.50	5.20	13.00	0.18	0.13

Total Dissolved Solids (TDS): Total dissolved solids present in tube well water samples were found in the range from 1152.00 ppm to 1917.2 ppm and in sewage water samples TDS were found in the range of 1612.8 to 1734.4 ppm as per Tables 1 and 2. Therefore it is concluded that tubewell water is unsuitable for drinking purposes. It is also concluded that tube well and sewage water is suitable for irrigation purpose, because the tolerance limit for effluent to be discharged on the land for irrigation is 2100 mg/L for dissolved solids.

Total Hardness (TH): Table-1 shows the concentration of Ca^{2+} and Mg^{2+} ranges from 4.20 to 6.90 meq/L in tube well water; in sewage water it ranges from 6.70 to 8.10 meq/L (Table-2). Table-1 shows the value of total hardness in tube well water samples to range between 420 meq/L to 690 meq/L. Hardness in sewage water samples ranges between 670 meq/L to 810 meq/L (Table-2). Total hardness was observed in acceptable range, because over the standard limits (> 1300 mg/L) of hardness, water is unsuitable for irrigation as it will render the soil very alkaline.

Alkalinity: Alkalinity of water is its quantitative capacity to react with a strong acid to a predesigned pH. Alkalinity of irrigation water is detemnined by CO_3^{2-} and HCO_3^- concentrations. In tube well water samples only one water sample has CO_3^{2-} ion. Its concentration was observed 1.0 meq/L (Table-1), whereas HCO_3^- varied between 5.1 to 10.5 meq/L. Carbonate and bicarbonate ions range from 2.0 to 4.0 meq/L and 8.5 to 15 meq/L respectively in sewage water samples (Table-2). Alkalinity due to CO_3^{2-} ions is measured as residual sodium carbonate (RSC) and alkalinity due to HCO_3^- ions is measured as residual sodium bicarbonate (RSBC). The tolerance limit for RSC is 5 meq/L and for RSBC is 10 meq/L under favourable conditions (according to ISI 1981 and BIS 1988). It has been reported that water with RSC more than 2.5 meq/L is not suitable for irrigation[12]. Phenolphthalein alkalinity due to CO_3^{2-} ions was observed only in one tube well water sample and its value was 10 meq/L as $CaCO_3$ (Table-1). Phenolphthalein alkalinity due to CO_3^{2-} ions ranged from 20 meq/L to 40 meq/L as $CaCO_3$ in sewage water samples (Table-2). In tube well and sewage water samples alkalinity was above the permissible limits, therefore unsuitable for irrigation. Total alkalinity (due to HCO_3^-, CO_3^{2-} and OH^- ions) ranges from 110 to 210 meq/L as $CaCO_3$ in tube well water samples (Table-1) and 220 to 340 meq/L as $CaCO_3$ in sewage water samples (Table-2).

Sodium: If sodium content of an irrigation water is high compared to the calcium and magnesium content, the sodium will be absorbed by the soil and will replace the calcium and magnesium. As the exchangeable sodium increases in the soil, the soil becomes more alkaline and adverse physical and chemical conditions develop that limit or prevent plant growth. Sodium content of tube well water and sewage water under study ranges from 14 meq/L to 24.75 meq/L and 12.50 meq/L to 19.0 meq/L respectively (Tables 1 and 2 respectively). Sodium content of tubewell water and sewage water under study is very high. Excess of sodium also leads to rise in pH to unfavourable levels.

Potassium: In tube well water samples potassium ranges from 0.2 meq/L to 1.60 meq/L (Table-1). Potassium content in sewage water samples studied ranges from 1.30 meq/L to 5.20 meq/L (Table-2). Potassium content was significantly

higher in tube well water and sewage water samples. Potassium excess may induce iron chlorosis (Walsh and Clark, 1942) and magnesium deficiency[13] (Borynton and Burrel, 1944).

Chloride (Cl^-): Table-1 shows the concentration of chloride ranges from 5.50 to 20.50 meq/L in tube well water samples. It is found that chloride ion concentration is higher in tube well water samples and hence the taste should be salty. In one tube well water sample concentration of chloride was above the permissible limit. According to ISI, tolerance limit for irrigation water is 17 meq/L or 600 mg/L. In sewage water samples studied chloride content ranges from 8.0 meq/L to 15 meq/L (Table-2). Concentration of chloride ion was observed in acceptable range. Therefore it is concluded that chloride ion concentration of sewage water will not induce adverse effect if used for irrigation purpose.

Iron: In tubewell waters concentration of iron ranges between 0.16 to 0.29 ppm (Table-1), which was in the permissible range (0.3 mg/L). In sewage water concentration of iron ranges from 0.12 to 0.53 ppm (Table-2) which was in the permissible range.

Zinc: In tube well water zinc ranges under investigation between 0.10 to 0.15 ppm (Table-1) which was much below the permissible limit of 5 mg/L (given by EPA and WHO). Zinc concentration in different sewage water samples studied ranges from 0.10 to 0.32 ppm (Table-2) which was below the permissible limits.

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