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ORGANOLEPTIC AND PHYSICO-CHEMICAL PROPERTIES OF UNDER GROUND AND REVERSE OSMOSIS WATER USED IN V.V. NAGAR AND NEARBY PLACES OF DIST. ANAND (GUJARAT)

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ABSTRACT

A report of organoleptic and physico-chemical study of the water samples taken from the region nearby Anand district of central Gujarat is presented here. Twenty five water samples are subjected to analysis like odour, taste, transparency, pH, TDS, hardness, and conductivity. The calcium, magnesium, potassium and sodium count obtained from the study of these samples has given the information regarding the suitability of the water for drinking purpose. The drop in mineral contents after reverse osmosis treatment is critically examined and the pros and cons are identified. While the pros are appreciated, remedies to cons are also suggested wherever possible.

Key words: Organoleptic, Reverse osmosis, Water, TDS.

INTRODUCTION

Water plays a vital role in human life. It is known to provide significant amount (~7%) of essential nutrients to the human body. During last decade, it has been observed that the ground water is getting drastically polluted due to increased human activities[1,2]. Consequently, number of cases of water borne diseases has been seen which a cause of health hazards[3-5]. So basic monitoring on water quality has been necessitated to observe the demand and pollution level of ground water[6]. A good number of water analysis experiments are regularly conducted by different groups of chemists and biologists across the country[7-10]. Various methods for improving the potability of water are gaining grounds these days.

Reverse Osmosis (RO) is one of the most popular methods amongst this. Osmosis is a phenomenon in which water moves from dilute salt solution to a concentrated salt solution through a semi-permeable membrane whereas in reverse osmosis, an external force is applied to the water to move from a concentrated salt solution through a semi-permeable membrane. On this basis, the commercial RO plants work. Thus, RO treatment removes almost all the salts from the water.

EXPERIMENTAL

The present work is an extension to our earlier work and an attempt to examine the composition of RO water vis-à-vis the ground water of various water sources[11,12]. Five water samples from each of the

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places viz. GIDC, Vallabh Vidyanagar, Bakrol village, Karamsad village and Anand city were collected. Since, there was considerable proximity in the water composition of all the five samples collected from same place, an average result for all the five places mentioned above are reported.

Material and methods

All the samples were collected in the months of June and July 2011. The locations selected for the investigation are GIDC, Vallabh Vidyanagar, Bakrol village, Karamsad village and Anand city. The samples are collected in sterilized and phosphate free bottles. The collected samples were analyzed on various organoleptic and physico-chemical parameters. The procedure for analysis followed "Standard Methods of Analysis of Water and Wastewater[13]" (APHA). All the measurements were carried out in the vicinity of temperature 30^{o}C.

The various parameters included analysis of organoleptic properties, pH, TDS and conductivity, sodium, calcium and potassium contents were measured by flame photometry. Calcium & magnesium hardness, total hardness, chloride, sulphate and nitrate contents were also determined by suitable methods[14]. All the reagents used for the analysis were of analytical grade and the instruments were of required precision and accuracy.

RESULTS AND DISCUSSION

Many of the parameters exhibited considerable variations from sample to sample. While all the samples were found to be transparent and odourless, the tap water samples in each of the cases showed salty taste. This is attributed to a very high TDS in tap water. The observations are summarized in the Table 1.

Table 1: Measured values of various parameters of water samples

Parameters	GIDC		Anand		Vallabh Vidya Nagar		Bakrol		Karamsad	
	Tap Water	RO Water	Tap Water	RO Water	Tap Water	RO Water	Tap Water	RO Water	Tap Water	RO Water
pH	7.21	7.10	7.07	6.27	7.65	6.23	7.50	6.70	7.43	7.07
TDS	810.00	77.00	621.00	37.00	1180.00	90.00	1050.00	33.00	1390.00	130.00
Conductivity	131.00	13.00	115.00	8.00	210.00	15.00	178.00	5.00	230.00	22.00
Total hardness	405.00	16.00	372.00	15.00	424.00	18.00	414.00	23.00	490.00	24.00
Magnesium	93.00	11.00	116.00	12.00	105.00	13.00	88.00	14.00	112.00	15.00
Calcium	312.00	23.00	256.00	24.00	319.00	25.00	326.00	24.00	378.00	29.00
Sodium	270.00	12.00	254.00	17.00	280.00	22.00	280.00	21.00	288.00	15.00
Potassium	4.00	0.20	11.00	0.80	7.00	0.40	4.00	0.30	6.00	0.20
Chloride	78.00	3.00	74.00	3.00	85.00	9.00	77.00	4.00	89.00	11.00
Nitrate	30.44	0.20	15.36	0.20	40.55	0.30	33.08	0.20	35.56	0.30
Sulphate	31.00	0.20	30.00	0.10	32.00	0.10	31.00	0.20	35.00	0.10

[1] All the values other than that for pH and conductivity are in mg/L or ppm.

[2] The conductivity is measured in mili Siemens.

[3] Calcium, sodium and potassium are measured by flame photometry

It is observed that the pH of the water was slightly alkaline (7.21 to 7.65) and only minor decrease in pH was recorded in the RO water. The pH levels were within the limits set for domestic use as prescribed by APHA[13].

The WHO has suggested a limiting value of 500 ppm of TDS for potable water. While the minimum TDS for the tap water samples under present investigation is 621 ppm whereas the highest value of TDS has risen to 1390 ppm. Such high values of TDS must be reduced by suitable method to reinstate the potability of water. An overwhelming value of TDS has also increased the conductivity values of all the tap water samples as shown in the Table 1.

The summation of calcium hardness and magnesium hardness is regarded as the total hardness of water. In the present investigation, it has been observed that the calcium concentration is at least two to three folds greater than that of magnesium. Each of the samples has registered a high value of calcium hardness (256-378 ppm), magnesium hardness (88-116 ppm) and in turn, the total hardness (372-490 ppm). The limiting values prescribed by ISI are much less than reported ones. Potassium content of all the tap water samples is much low. It is reported in the range of 4 to 11 ppm. The sodium content of water samples is almost found to be constant in the vicinity of 250 ppm, which probably contributes significantly to the salty taste of water.

A significant presence of anions like chloride, nitrate and sulphate is also observed in the water samples under investigation. It has been observed that greater amount of sulphate in drinking water causes diarrhea. The chloride and sulphate amounts in the samples range from 74-89 ppm and 31-35 ppm, respectively. The nitrate ion contents in the samples vary in the range of 15 to 40 ppm. Here, it is observed that the sulphate concentration in the samples fall well within the prescribed limit but the chloride content is much higher than the permitted values of WHO and ISI.

Table 2: Percentage reductions of various ions of water upon RO treatment

Ion	Ionic radii (pm)	Name of the water sample				
		GIDC	Anand	Vallabh Vidya Nagar	Bakrol	Karamsad
Magnesium	72	88.17	89.66	87.62	84.09	86.61
Calcium	100	92.63	90.63	92.16	92.64	92.33
Sodium	102	95.56	93.31	92.14	92.50	94.79
Potassium	138	95.00	92.73	94.29	92.50	96.67
Chloride	181	96.15	95.95	89.41	94.81	87.64
Nitrate	V.High	99.34	98.70	99.26	99.39	99.16
Sulphate	V.High	99.35	99.67	99.69	99.35	99.71

Table 2 shows the ionic radii and percentage reductions of some important ions present in water. Here, it is clearly seen that there is a linear relation between the size of the ion and the rejection by the membrane of the RO system. About 84 to 88% of small ion like magnesium is rejected in the RO treatment. While calcium and sodium ions with almost same ionic radii are rejected to an extent of 92 to 95%. This high rejection value is attributed to the larger size of the latter ions. The next larger sized ions viz. potassium and chloride are rejected to an extent of 93 to 95%. Some irregularities are observed in the rejection

percentage of the above two ions. No simple explanation has been found for the same. The polyatomic anions like nitrate and sulphate have a relatively very large size. As expected, these ions are quantitatively rejected by the RO membrane in each of the cases.

The said observations are visualized in Fig. 1.

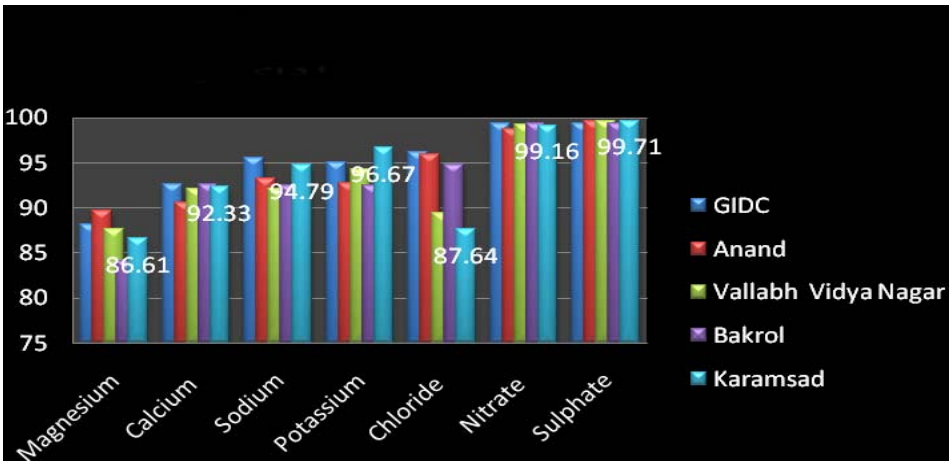

Fig. 1: Percentage reductions of various ions of water upon RO treatment

Table 3 compares the levels of essential minerals in the RO treated water as compared to the desired levels as per WHO norms for drinking water. TDS is an important indicator of the chemical contents of the water. While there is no strict adherence on the desired TDS value of drinking water, 350 ppm is a commonly accepted value for the same. The TDS value in the RO treated water is observed in the range of 33- 130 ppm. This is an important indicator for predicting the essential mineral content in RO treated water.

Table 3: Desired level of essential minerals vs. levels found in RO treated water

Mineral	Desired level	GIDC	Anand	Vallabh Vidya Nagar	Bakrol	Karamsad
TDS	350	77.00	37.00	90.00	33.00	130.00
Magnesium	30	11.00	12.00	13.00	14.00	15.00
Calcium	75	23.00	24.00	25.00	24.00	29.00
Sodium	150	12.00	17.00	22.00	21.00	15.00
Potassium	100	0.20	0.80	0.40	0.30	0.20

Magnesium plays some very important role in the functioning of the human body. Almost all the cells in the human body contain magnesium. Moreover it plays a vital role in muscle contraction and transmission of nerve impulses. It also activates energy producing enzymes and expands blood vessels which reduces the blood pressure and in turn reduces the risk of heart attacks. Deficiency of magnesium can cause nervousness, lack of concentration, dizziness, headaches and migraines. Since the magnesium levels found in the RO treated water in each case is almost 60% less than the desired levels, the user must input the balance amount of magnesium through alternate source[15-17].

Calcium is an important intake for human beings of all the age. The need of calcium is much high during the fetal growth, child hood and lactation. Calcium deficiency is known to cause several diseases related to teeth and bones. Osteoporosis is commonly observed in calcium deficient people. It also helps in

preventing blood clotting. Around 70% of deficiency of calcium observed in RO treated water can cause above mentioned disease if it is not properly supplemented through calcium rich diet[18,19].

Alkali metals like sodium and potassium also play vital role functioning of the human body. While excess of sodium is found to increase the blood pressure, a level of 100 ppm is recommended for drinking water. Since sodium is readily available from the common salt which is used extensively, sodium deficiency is a very rare situation in human beings. Potassium is essential for the smooth functioning of muscles. The deficiency of potassium is capable of malfunctioning of heart impulse and weakening of skeletal muscles. While the desired potassium level in drinking water is about 100 ppm, the RO treated water in present samples show almost negligible concentration. Such low concentration of potassium must be supplemented through alternated sources[20-22].

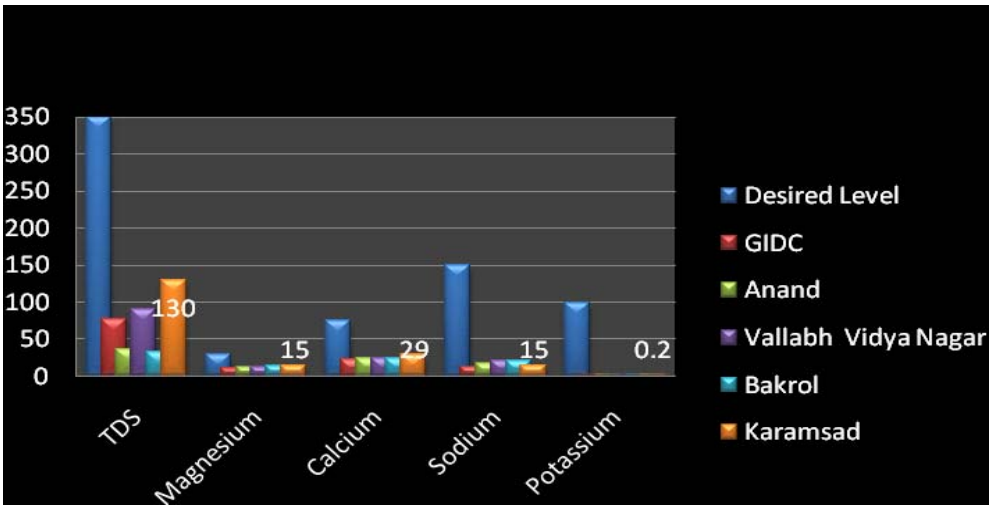

Fig. 2: Desired level of essential minerals vs levels found in RO treated water

CONCLUSION

The present investigation has led us to conclude that the quality of water samples subjected to study was unacceptable from majority of physico-chemical parameters. While, RO treatment is an interesting option for making these waters potable, it imposes a few threats also. The said treatment quantitatively removes the undesired anions. However, the rejection of certain essential cations causes lowering of these ions which may lead to their deficiency in the user. Finally, it is concluded that either the RO plant or the end user must adjust the essential nutrients before drinking such water. Cognizant people may also increase the intake of the said essential nutrients via alternate sources. The possibility of ion leaching by RO treated water must also be studied by the researchers. *In vivo* and *in vitro* studies can be helpful for understanding this.

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