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A Study On Corrosion Indices Of Secondary Treated Wastewater Used In Hanumangarh (Raj.)

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ABSTRACT

Water quality is important from health, environment as well as economic point of view. Treated water reuse is associated with some potential risks especially when the treatment is not adequate. The present study aims to determine the corrosive and scaling potential of secondary treated wastewater used in Hanumangarh. In this study, secondary treated water from SARAS dairy and GB sewage treatment plant, Hanumangarh was collected for a period of one year. Langelier Saturation Index (LSI) and Aggressive Index (AI) were calculated using various water quality parameters. It was found that nature of treated water was from slight corrosion to slight scale with overall faint scale coating. The concordance between the analysis of chemical water quality and national standards could not be sufficient to confirm the water quality balance in terms of corrosion and scaling potential.

KEY WORDS

secondary treated wastewater, corrosion indices, scaling potential, LSI, AI.

INTRODUCTION

Water treatment process produces clean reusable water and ensures reliable and cheaper water supply. Wastewater needs to be adequately treated prior to its disposal or reuse in order to protect receiving water bodies from contamination. The discharge of poorly treated wastewater usually affects water users downstream and contaminates groundwater [1]. As well it may affect water distribution network through corrosion and scale formation. Pipe corrosion and scale formation may cause unwanted alterations in water quality. It may cause health issues like gastrointestinal infections and skin problems. Corroded pipes can lead to leakage problems resulting in costly repairs and disrupt the water distribution system. The Corrosion in water distribution systems involves the electrochemical or physicochemical interaction between the pipe and the water. Electrons move through the corroding metal and separate locations at the metal-water interface that act as anode and cathode where oxidation and reduction half-cell reactions occur.

High mineral content in water like calcium and magnesium leads to scale deposition. When water is heated, the dissolved minerals precipitate out and form hard deposits on surface. Excess scaling can affect water flow and damage the pipes or other equipment using highly aggressive water while slight scaling acts as barrier between the conductive water and metal surface thereby preventing corrosion [2,3]. The corrosion and scaling potential of drinking water system in Tabriz, Iran was studied by [4] and the results revealed the water corrosion. Corrosion and scaling rate were evaluated by [5] using LSI and RSI for the groundwaters of K.R. Puram area in Bangalore, India. This study investigated 66.67% of the samples as intolerable corrosion. Scaling and corrosion potential of water can be controlled by pH and water speed adjustment, proper cleaning and using corrosion inhibitors [6]. The present study aims to examine corrosion and scaling potential of secondary treated wastewater used in Hanumangarh using the corrosion and scaling indices.

MATERIALS AND METHODS

To examine the intended goals of present study, SARAS dairy ETP, Hanumangarh was selected as first site. The second site selected for the study is GB (Ghaghar Bridge) STP, Hanumangarh with capacity of 5.0 MLD. SARAS is famous and leading milk and milk product brand in Rajasthan. The ETP of SARAS dairy, Sri Ganganagar Zila Dugdh Utpadak Sehkari Sangh Ltd. Hanumangarh is having capacity to treat 500 m^3 per day of effluent. To assess the level of treatment, sampling of secondary treated water as per standard procedure was done from both sites. Composite method of sampling was adopted for the research work. Sampling was done in the morning and evening time. Temp., pH, DO were noted in the field at the time of sampling. For other parameters, the samples were refrigerated immediately and then mixed together. The samples were collected for one year at an interval of fifteen days to record the data of all the seasons. The detailed analysis of all the composite samples was carried out using standard methods given in 'Standard Methods for the Examination of Water and Wastewater' 23rd Edition- 2017 prepared and published jointly by American Public Health Association (APHA) [7], American Water Works Association (AWWA) and Water Environment Federation (WEF) for following physicochemical parameters (Table 1).

Table 1 - Standard methods adopted for analysis

S. No.	Parameter	Method	Page No.
1	pH	Electrometric method	4500-H^+ B4-95
2	Total Hardness (TH)	EDTA Titrimetric method	2340 C2-48
3	Total Alkalinity (TA)	Titration method	2320 B2-36
4	Total Dissolved Solids (TDS)	Dried at 180^oC	2540 C2-69

Corrosive indices - To determine corrosion potential of treated water, corrosive indices LSI and AI are calculated.

***Aggressive Index (AI)* –** Aggressive Index is computed from the actual pH, TH in mg/l as $CaCO_3$ and TA of the water using the formula

AI = pH + log (TH * TA)

AI values less than 10.0 indicate highly aggressive nature of water, values between 10.0 and 12.0 indicate moderately aggressive nature and values greater than 12.0 are indication of non-aggressive water.

***Langellier Saturation Index (LSI)* –** The Langellier Saturation Index (LSI), a measure of a solution's ability to dissolve or deposit calcium carbonate is used to indicate corrosivity of water. It is purely an equilibrium index and denotes only the thermodynamic driving force for calcium carbonate scale formation and growth. It simply indicates the driving force for scale formation and growth in terms of pH as a master variable. It gives no indication of how much scale or calcium carbonate will actually precipitate to bring water to equilibrium.

Table 2 – Physical Parameters of Study Sites

Sample	ETP SARAS					GB STP				
	Temp.	pH	TH	TA	TDS	Temp.	pH	TH	TA	TDS
1	17.7	8.3	94	126	246	17.2	7.1	294	262	634
2	18.2	8.4	90	128	218	18.5	7.1	280	238	612
3	20.8	8.5	87	132	254	20.6	7.3	275	243	654
4	22.0	8.6	102	144	286	21.9	7.5	310	282	728
5	25.6	8.7	116	148	342	25.3	7.8	334	302	782
6	27.8	8.8	110	140	316	27.5	7.4	320	290	744
7	28.4	8.5	108	136	354	28.2	7.2	316	287	730
8	27.5	8.3	96	132	328	27.6	7.1	296	268	708
9	26.4	7.9	90	128	282	26.5	7.0	287	260	678
10	25.0	8.0	88	122	268	25.1	7.1	284	256	570
11	24.8	8.1	92	128	295	25.0	7.1	298	270	511
12	24.2	8.2	94	123	272	24.0	7.2	304	275	480
13	23.2	8.3	97	130	250	23.4	7.3	310	280	496
14	22.5	8.3	104	126	234	22.0	7.5	316	286	540
15	22.0	8.4	100	135	276	22.1	7.4	300	272	562
16	20.3	8.2	96	121	294	20.0	7.4	292	278	584
17	18.7	8.1	92	128	268	18.4	7.3	285	282	617
18	17.0	8.3	88	131	282	16.7	7.2	278	263	627
19	16.4	8.4	97	134	236	16.2	7.2	297	270	680
20	14.4	8.3	90	126	218	14.4	7.1	280	264	704
21	15.5	8.2	86	122	210	15.3	7.2	288	276	672

If LSI is negative, water is not scale forming (aggressive) i.e. the water will dissolve $CaCO_3$.

If LSI is positive, water is scale forming (non-aggressive) and $CaCO_3$precipitation may occur.

If LSI is zero, water is balanced [4].

LSI is defined as:

$LSI = pH - pH_s$…… (1)

pH is the measured water pH.

pH_s is the pH at saturation in calcite or calcium carbonate and is defined as:

$pH_s = (9.3+A+B) – (C+D)$ …… (2)

where:-

$A = (\log_{10}[TDS] – 1)/10$ …… (3)

$B = -13.12 * \log_{10} (+273) + 34.55$ ….. (4)

$C = \log_{10} [TH \text{ as } CaCO_3] – 0.4$ …… (5)

$D = \log_{10} [TA \text{ as } CaCO_3]$ …… (6)

Table 3 – Corrosive Indices of Study Sites

Sample No.	ETP Saras, HMH		GB STP, HMH	
	LSI	AI	LSI	AI
1	0.30	12.37	-0.13	11.99
2	0.41	12.46	-0.17	11.92
3	0.55	12.56	0.07	12.12
4	0.78	12.77	0.41	12.44
5	1.00	12.93	0.83	12.80
6	1.10	12.99	0.44	12.37
7	0.79	12.67	0.24	12.16
8	0.51	12.40	0.08	12.00
9	0.05	11.96	-0.07	11.87
10	0.10	12.03	0.00	11.96
11	0.23	12.17	0.05	12.01
12	0.32	12.26	0.15	12.12
13	0.44	12.40	0.25	12.24
14	0.44	12.42	0.44	12.46
15	0.54	12.53	0.29	12.31
16	0.24	12.27	0.25	12.31

17	0.12	12.17	0.11	12.21
18	0.27	12.36	-0.06	12.06
19	0.42	12.51	-0.04	12.10
20	0.23	12.35	-0.21	11.97
21	0.12	12.22	-0.06	12.10
Average	0.43	12.42	0.14	12.17

RESULTS and DISCUSSIONS

Langelier Saturation Index (LSI) – Calculated values of LSI were found to vary from -0.21 to 0.83 for GB and from 0.05 to 1.10 for SARAS. The negative LSI value indicates under-saturated water with respect to calcium carbonate. Such water has a tendency to remove existing calcium carbonate protective coating in pipelines and equipment. The positive LSI value indicates super-saturated water with respect to calcium carbonate and scale forming may occur. Data revealed nature of treated water from slight corrosion to slight scale with overall faint scale coating [4].

Aggressive Index (AI) - Calculated values of AI were found to vary from 12.80 to 11.87 for GB STP and from 12.99 to 11.96 for SARAS ETP. Data reveals non-aggressive nature of corrosivity for all the treated waters [6].

Although information obtained from LSI and AI is not quantitative, it can be useful in estimating treatment requirements for low pressure boilers, cooling towers and waste treatment plants.

CONCLUSION

The present study aimed to examine corrosion and scaling potential of secondary treated wastewater used in Hanumangarh. LSI and AI were calculated and used as the corrosion and scaling indices. Corrosion and scaling are important water quality indicators to maintain the integrity of drinking water distribution system. Deterioration of water distribution system materials may add lead and other heavy metals in water and necessitate huge maintenance expenditure. The results of present study indicate slight under-saturated to low super-saturated nature of water that may lead to slight scale formation. Scaling and corrosion potential should be managed by pH control and water flow speed of the distribution system.

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