Water Quality and Corrosion Potential in Water Distribution System of Shadegan City, Khuzestan, Iran

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Abstract

Introduction: Shadegan is a city and the capital of Shadegan County in Khuzestan Province, Iran. It has an area of 3197 m^2 and located 84 km south of Ahvaz. Water distribution system serves 70,000 people in the city and the total consumed drinking water is 28525 m^3per day (3,4).
This descriptive, cross sectional study examined water quality of Shadegan distribution system and its corrosion potential.

Methods and Materials: In this study, eight water distribution stations were selected and samples were taken and examined in a five-year period from 2007 to 2011. Standard methods were performed to examine all the parameters. Sculler classification method was used to classify chemical water quality. All the water quality parameters were compared with the Iranian national standards for drinking water.

Results: The results indicated that the highest level of pollution occurred in autumn. Residual in 97% of samples were 0.2 to 0.8 mg/l. Wilcox water quality classification was C2S4. Electrical Conductivity (EC) was 3019 µs/cm, and 2.9% of all the samples for fecal coliforms were positive.

Conclusion: Based on Langelier, corrosion index of water in the distribution system was balanced.

Keywords: Water quality, Shadegan, distribution system, corrosion.

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Introduction

Shadegan County is located in Khuzestan province southwest of Iran. The County is bordered by Ahvaz in north, Mahshahr in east, Khoramshahr in west, and Abadan in south. Shadegan city is the capital of Shadegan County. Its latitude is 30°, 39", longitude, 48°, 40" and altitude 5 meter. Its climate is hot and dry. Average Annual precipitation is 203 mm. Rain falls mostly in November to January. Average annual temperature is 24.2 Celsius degree. Water distribution system of Shadegan city covers 5.6 square kilometers and serves around 70,000 people and supplies 29527m^3 drinking water. (4)The main source of the drinking water is Karun River (2). Karun is the biggest and longest river in Iran. The river supplies domestic and industrial water needs for the Shadegan Water Treatment Plant, after the uptake and treatment, it is pumped to the distribution system. The type pipes used in Shadegan Water Distribution system is Asbestos (78%) and PVC (12%). The distribution system is 40 years old (3, 5, 6). The current study aims to determine physicochemical and microbiological quality and corrosion and precipitation potential of Shadegan drinking water. The reasons to do this study were unsatisfactory consumers and possibility of water pollution due to failures in water distribution system. In general, water leakage originated by corrosion in distribution system causes odor and taste due to biofilm inside the distribution pipes. Corrosion of distribution pipes can dissolve heavy metals like iron and copper.

Methods and Materials

The study was conducted in a 5-year period from 2006 to 2011.Among all the samples, 192 were taken for physicochemical analysis and 208 for microbiological analysis (10, 15, 16).

Sampling and analysis methods for all physicochemical and microbiological parameters were based on 20th edition of Standard Methods for the Examination of Water and Wastewater (2005). Measuring parameters included pH, E.C, Turbidity, TDS, Total hardness, magnesium, sodium alkalinity, and other related parameters. In addition, total coliform bacteria and fecal coliforms were analyzed. Results obtained from the above parameters were compared with the Iranian standards for drinking water quality and World Health Organization guidelines for drinking water quality. Furthermore, corrosion and precipitation indices were calculated.

Study Area:

Water Uptake point in Karun River and the pipeline from the river to Shadegan city is demonstrated in figure 1.

The study area and Shadegan Water Distribution system are shown in figure 2.Schaech map of sampling points is depicted in figure 2.

Figure 1: Water uptake point in Karun River and the pipeline from the river to Shadegan city

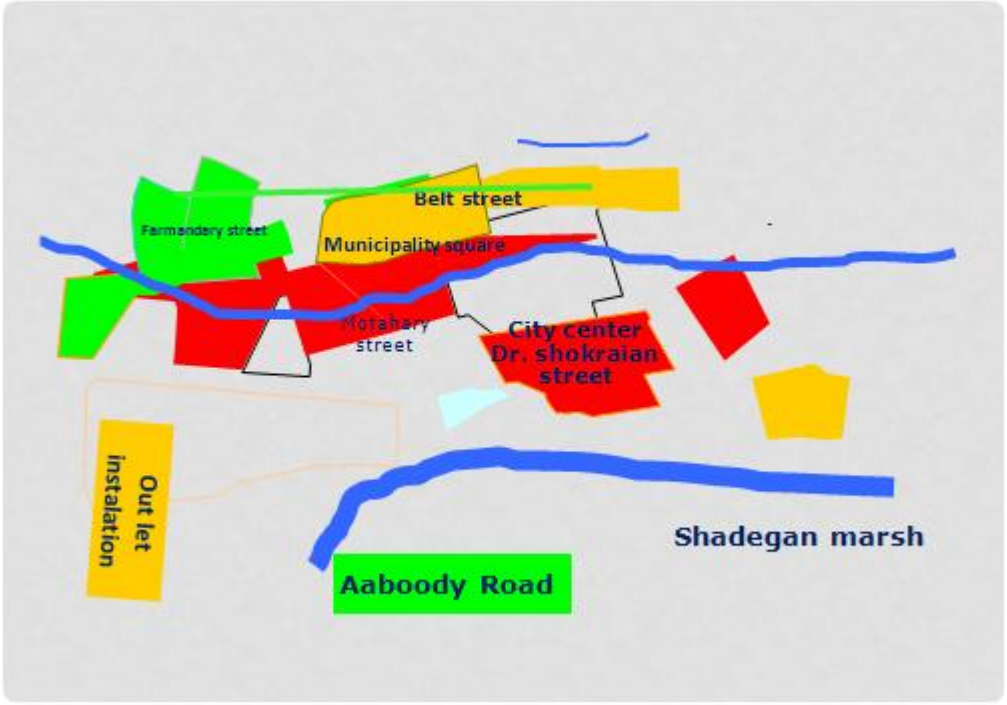

Figure2: Study area and Shadegan Water Distribution system

Results

Water quality parameters results are compared with the Iranian Drinking water quality standards and WHO guidelines.

According to Table1, data (PH and alkalinity), Langelier and Ryznar indices were calculated. The results of this calculation are shown in Tables 2 and 3.

Physicochemical and microbiological parameters (including Residual chlorine,Turbidity, coliform Bacteria) of water quality in Shadegan Water Distribution system are shown in Table 1.

Table1: Physicochemical and microbiological parameters of Shadegan Water Distribution system in different seasons from 2006 to 2011

Quality Parameters	دما (c)	pH	کدورت (NTU)	TDS (mg/l)	EC (µs/cm)	TH (mg/l)	Cl (mg/l)	SO4 (mg/l)	CO3 (mg/l)	HCO3 (mg/l)	NO3 (mg/l)	قلیائیت mg/l)	F (mg/l)	Ca (mg/l)	NH3 (mg/l)	Mg (mg/l)	Na (mg/l)	Fe (mg/l)	Mn (mg/l)	Cfu/ml HPC
Min	2.8	7.5	1	550	930	245	20.76	139.9	0	55.77	0	0	0.03	72.91	0	0.41	100	0	0	10
Average	22	8.01	3.66	1288.3	2151.8	417.64	387.32	284.87	0.57	139.48	4.01	0.09	0.57	102.73	0.18	39.7	252.9	0.11	1.72	38
Max	35	8.6	14	2368	3210	551.6	601.9	440.76	10.6	165.4	9.82	4.52	0.98	135.5	80.68	290	390	2.5	2.8	350
S.D	6.51	0.25	1.77	290.7	472.7	67.27	91.86	65.63	1.334	12.91	1.62	0.39	0.15	12.96	0.16	21.18	56.17	0.19	0.86	0.25
Rang	26.8	1.1	13	1818	2280	306.6	581.13	309.86	10.6	109.62	9.82	4.52	0.95	26.6	0.69	289.6	290	2.5	2.8	340
C.V	0.3	0.03	0.48	0.23	0.22	0.16	0.24	0.23	2.36	0.09	0.4	4.51	0.26	0.13	0.85	0.53	0.22	1.7	0.5	0.22
Iran standardNO,1053	-	-8.57	≤1	1500	-	500	400	400	-	-	50	-	-10.6	250	1.5	50	200	0.3	0.5	150
***WHO**	-	5.8-5.6	≤1	1500	-	-	250	400	-	-	44	-	-	250	-	50	200	-	-	100

Table 2: Langelier and Ryznar indices for Shadegan Water Distribution system based on sampling areas

Index / Locations		Langelier*	Ryznar**
Farmandari street	max	0.54	8.67
	min	1.26	6.06
Municipal street	max	0.51	8.62
	min	1.22	6.14
City center	max	0.54	8.57
	min	1.05	6.3
Abbodi Road	max	0.37	8.34
	min	1.2	6.25
Motahari street	max	0.8	9.19
	min	1.24	6.12
Kamarbandistreet	max	0.61	8.72
	min	1.47	5.56

Acceptable level for Langelier index is 0.2-0.8

Acceptable level for Ryznar index is 6-6.5

Table 3: Langelier Index and Ryznar Index Shadegan Water Distribution system based on seasons

Index / Seasons		Langelier*	Ryznar**
Spring	min	0.65	8.9
	max	1.26	6.08
Summer	min	0.28	8.17
	max	1.13	6.24
Autumn	min	0.65	8.8
	max	0.95	6.5
Winter	min	0.43	5.55
	max	0.75	6.81

Discussion

As shown in Table1, minimum values for all the parameters do not meet the quality standards for drinking water in Iran. In addition, the average values of all parameter were below the standards except Turbidity (3.66 N.T.U), manganese (39.7 mg/l), and Sodium (252.9 mg/l) which were above the standards and WHO drinking water guidelines (2, 3, 5).

Turbidity:

The main reason of high Turbidity in water distribution system was high Turbidity in the water in the Karun River. Average Turbidity of the Karun River water in uptake point located near Hydrometery station of Darkhovein (reported by Khuzestan Water and Power Organization) were 280, 126.5, 636.7 and 176NTU in spring, summer, autumn and winter, respectively. Maximum value was 5200 NTU (3, 5).

Sodium:

High concentration of sodium in water distribution system was because of high level of EC, T.D.S and sodium in the Karun water.

Khuzestan Water and Power Organization reports show that there was high level of EC with maximum 2491 µs/cm and T.D.S with 2852 mg/l. sodium in uptake point of the Karun water. The highest level of EC, T.D.S and Na. was reported to be in spring and summer (3, 5).

Manganese:

High concentration of manganese was possibly due to the high hold of water distribution system and corrosion of distribution system. In addition, according to the parameters shown in Table 1, the maximum values of T.D.S and total hardness (TH) were above the Iranian standards (3, 5).

The main reasons for this were high T.D.S and TH in the Karun River. High T.D.S and TH in Karun water were due to agriculture drainage of sugar agro industrial zones adjacent to the river, and especially the drought in the recent years (2009) (2,3,5).

Residual chlorine:

Residual chlorine average in Shadegan Water Distribution system was 0.5 mg/l, but minimum residual chlorine in 2.9% of samples was zero. Fecal coliform bacteria analysis in the distribution system showed that 2.9% of all the samples were positive. The positive samples might be due to a very old distribution system and fractures and leakage in Shadegan Water Distribution system. The distribution

system is more than 40 years old. This can affect microbiological quality in the distribution system (3).

Statistical Analysis:

There was no significant difference in different areas of Shadegan distribution system, using ANOVA test, with α=0.05 and P-value less than 0.0 50.

Statistical analysis (t-students) showed no significant difference between average of measured parameters with the Iranian drinking water quality standards and WHO guidelines (α =0.05).

Corrosion Indices discussion:

As shown in Tables 2 and 3, Ryznar and Langelier indices indicate that Shadegan water was in balance in all the seasons, however but it is less corrosive in winter.

Discussion:

Savari et al., conducted a study in (2002) on Ahvaz water distribution system, the results of that study showed that due to corrosiveness of water, there was heavy metals (Iron and lead) in Ahvaz water, but in our study, Shadegan water was corrosive only in winter (17).

Also Banisaed et al. carried out a study in Ahvaz city to determine physicochemical parameters of water quality. The results showed that all the water quality parameters were below the Iranian standards except T.D.S and TH, consistent to the results of our study. The reason is that the same river water is used in both Ahvaz and Shadegan. (18)

Aiman E. Alrawafeha et al. reported that the water in the southern region of Gordon was corrosive due to the hot climate and the high evaporation in the region. These results are inconsistent to our study results, because this study examined the river as the source of water but the other study considered the underground water. (19)

Patzaya G. et al. reported that the water in Budapest (Hungary) was not corrosive, but precipitant because of high TH in most seasons. (20)

Liontal etal. Concluded that precipitation and corrosion were related to water quality (specialty PH Calcium carbonate) and pipes type.

Recommendations:

Based on the results of this study, the followings are recommended:

1) Improving the Karun water quality by treating municipal, agricultural and industrial wastewater discharges into the river and increasing the flow of the river by opening Dams drain valves,

2) Replacing asbestos, ductile and steel pipes with poly Ethylene pipes,

3) Analyzing the potentials of the distribution system through other methods such as Copen.

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