

Evaluation of Quantity and Quality of Reject Water from Desalination Plants in Saveh City and Providing the Necessary Solutions

Mokhtar Mahdavi^{1,2}, Amir Hossein Mahvi³, Reza Nemati^{1,2}, Sajedah Saadati², Ali Fatehizadeh⁴, Ahmad Reza Yari⁵, Hamid Reza Tashauoei⁶, Reza Jalilzadeh Yengejeh⁷, Fazel Mohammadi-Moghadam⁸

¹Social Determinants of Health Research Center, Saveh University of Medical Sciences, Saveh, Iran, ²Student Research Committee, Saveh University of Medical Sciences, Saveh, Iran, ³Center for Solid Waste Research, Institute for Environmental Research, Tehran University of Medical Sciences, Tehran, Iran, ⁴Environment Research Center, Research Institute for Primordial Prevention of Non-Communicable Disease, Isfahan University of Medical Sciences, Isfahan, Iran, ⁵Research Center for Environmental Pollutants, Qom University of Medical Sciences, Qom, Iran, ⁶Department of Environmental Health Engineering, School of Health, Islamic Azad University Tehran Medical Branch, Tehran, Iran, ⁷Department of Environmental Engineering, Ahvaz Branch, Islamic Azad University, Ahvaz, Iran, ⁸Department of Environmental Health Engineering, School of Health, Shahrekord University of Medical Science, Shahrekord, Iran

Abstract

Aim: The concentrate stream or saline reject water from reverse osmosis plants with high dissolved solid provides an environmental problem. In the present work, the quantity and quality of saline reject water from desalination plants was evaluated and its effect on the wastewater treatment plant (WWTP) of Saveh city was assessed. **Methods:** The random sampling of raw feed water and reject water of desalination plant was conducted in duplicate and subjected to total dissolved solids (TDS), electrical conductivity, total hardness, pH, and residual chlorine analysis. **Results:** The results showed that the value of TDS in the raw feed water, municipal wastewater, reject water in the household treatment system, and centralized RO plant in Saveh was 1732 mg/L, 2220 mg/L, 2408 mg/L, and 3315 mg/L, respectively. The quantity of reject water was 2238.5 m³/day and when it was mixed by the feed wastewater to the WWTP with the capacity of 4000 m³/day, the TDS content reduced from 2220 to 2441 mg/L. By introducing saline wastewater into the Saveh WWTP, TDS increased by 1.6%. Overall, the TDS of effluent wastewater of the Saveh WWTP was reached 2257 mg/L with a total capacity of 35,000 m³/day. **Conclusion:** The amount of recoverable salt from saline wastewater is about 2.794 tons/ day. Transfer of saline reject water to Saveh WWTP or salt recovery to produce sandsalt can be proposed as an effective solution for the management of saline reject water.

Keywords: Brine wastewater, desalination, reverses osmosis, Saveh

INTRODUCTION

In recent years, as a matter of population growth, climate change, and the spread of various pollutants, water scarcity has attracted more attention in most countries.^[1] Today, special attention is paid to the recycling and reuse of wastewater in the management and conservation of water resources.^[2] However, some countries, especially Asian countries, are facing water shortages and have been forced to use saline and brackish water treatment by various desalination processes and harvesting water from air moisture^[3-7] and application of membrane processes such as nanofilter or reverse osmosis for desalination and water treatment.^[8-11] Estimates show that 40% of the world's

population is facing severe water shortages and will reach 60% by 2025. There are about 15,906 desalination plants around the world with a total capacity of about 95.37 million m³/day or 34.81 billion m³/year.^[12]

Address for correspondence: Dr. Ali Fatehizadeh, Environment Research Center, Research Institute for Primordial Prevention of Non-Communicable Disease, Isfahan University of Medical Sciences, Isfahan, Iran.
E-mail: fatehizadeh@gmail.com

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The capacity of desalination plants in Iran for reverse osmosis, multiphase distillation system, and multistage distillation system are 85,894 m³/day, 67,069 m³/day, and 51,270 m³/day, respectively.^[13] In some countries, reverse osmosis membrane systems have grown dramatically to provide potable water as household appliances.^[14] The basic philosophy of household water treatment plants or household reverse osmosis (HWTP/HRO) is to treat water in a remote or inaccessible area where heavy metal pollution or high salinity is present, but due to commercial advertising and profitability, many cities with no not need for water treatment have begun purchasing and installing these units in residential homes.

Saline wastewater or reject water is an important by product of the desalination process that is of great environmental concern.^[15] It contains high amounts of total dissolved solid (TDS) or salinity, and as well as some chemicals that being added during the desalination process in the form of pre-treatment and final treatment which can have direct and indirect effects on soil and water resources.^[16] Some studies showed that it increases the heavy metals in the soil^[17] or increasing soil and water salinity that finally reducing the area's agricultural production,^[18] so treatment and management of reject water are an important issues.

Currently, there are no specific standards or guidelines for the discharge of desalination plants reject water into surface water and into the environment. The best way is an environmental assessment and evaluation of the discharge impact on the environment. There are various methods for rejected brine recycling or treatment that include dilution, thermo-solar evaporation,^[19] salt production,^[20] forward osmosis,^[21] membrane separation,^[22] biological treatment, chemical precipitation,^[23] fish farming and irrigation,^[24] electrochemical oxidation,^[25] and zero-liquid discharge (ZLD) approach.^[26]

In Iran, there are cities in the southern part of Iran, several cities of Isfahan, Fars, Mashhad, Qom, and Saveh, where have brackish water sources and in these region either centralized (large desalination units) or decentralized (HWTP/HRO) desalination plants for drinking water supply should be used.^[27] Surface and groundwater resources in Saveh are brackish, therefore, potable water was produced via desalination processes by RO. These systems are used as centralized (5 semi-large desalination units) and decentralized (HWTP/HRO) throughout the city. At the present, saline reject water from these plants are discharged to the environment without any treatment. The aim of this study is to evaluate the quantity and quality of saline reject water and its effect on the quality of the Saveh wastewater treatment plant (WWTP) and finally providing appropriate solutions for the management of produced saline wastewater in Saveh city.

MATERIALS AND METHODS

Specifications of the study area

Saveh is the second-largest city in Markazi province with a population of over 250,000. The existence of numerous

factories has made Saveh one of the most migrant cities in Iran. The Saveh is characterized with a semi-arid climate with hot summers and slightly cold winters. The most important water source in Saveh is Gharehay river, Mazlaghan river, and Shur river, as well as al-Ghadir dam and 28 water wells. Saveh has brackish water and, due to the lack of freshwater resources, has to use desalination plants to supply potable water. One of the environmental issues of this city is the lack of treatment of saline wastewater from desalination plants, which is considered in this study.

Sampling and examination

The random sampling from raw feed water and saline reject water of household and centralized RO plants was conducted in duplicate in 2019. The sampling points are including five centralized RO plants in Saveh as station 1–5, thirteen household RO desalination systems under 4 districts as A, B, C, and D in the city [Figure 1], and Saveh WWTP. The collected samples are subjected for TDSs, electrical conductivity (EC), total hardness (TH), pH, and residual chlorine analysis. The examination of samples was conducted according to standard methods for water and wastewater examination.^[28] In this study, the quantities and quality of the saline reject water in Saveh and the status of treatment and disposal of saline wastewater, as well as the feasibility of its entry into the Saveh municipal WWTP, have also been evaluated.

RESULTS

Quality characteristics of saline reject water

The results of physicochemical quality of 13 decentralized household plants in Saveh city at zones A, B, C, and D are summarized in Table 1. As well as, the quality of the raw feed water and saline reject water from five centralized RO plants in Saveh as stations 1–5 are depicted in Table 2.

Quantity of produced saline reject water in Saveh

Table 3 shows the quantity of the produced saline rejects water from five centralized RO plants in Saveh.

The total water consumption per person was ranging from 75 to 150 lpcd excluding green space. From this consumption rate, about 2–5 L used for drinking, 5 to 10 L used for cooking, therefore, and

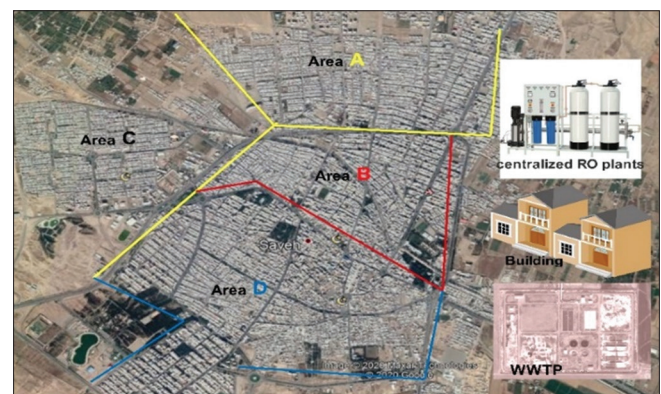


Figure 1: Sampling points of saline wastewater in Saveh city

Table 1: Physicochemical characteristics of feed and saline reject water of decentralized household plants

Samples	TDS (mg/L)	EC ($\mu\text{S}/\text{cm}$)	TH (mg/L as CaCO_3)	pH	Free Cl_2 mg/L
Area A					
RFW	1545±10.24	3360±30.8	470±15.1	8±0.3	0.6±0.2
SRW	2125±22.6	4450±33.6	728±21.4	8.11±0.35	0.1±0.05
Area B					
RFW	1554±9.4	3400±28.2	459±13.8	8.2±0.36	0.5±0.15
SRW	2510±16.84	4990±38.2	760±23.6	8.3±0.4	0.2±0.06
Area C					
RFW	1790±14.2	3500±31.3	585±18.1	8.2±0.39	0.5±0.18
SRW	2350±24.84	4600±34.11	770±25.4	8.35±0.41	0.15±0.02
Area D					
RFW	1882±18.4	3760±30.8	572±16.5	7.2±0.28	0.4±0.22
SRW	2650±22.6	5190±44.1	790±28.4	7.6±0.33	0.1±0.12
Average					
RFW	1693±12.44	3505±37.1	521±17.1	7.9±0.11	0.5±0.1
SRW	2408±21.8	4807±41.4	789±31.1	8±0.12	0.1±0.012
Increase in RW (%)	42	37	51	2.4	-72

RFW: Raw feed water, RW: Reject water, SRW: Saline RW, TDS: Total dissolved solids, EC: Electrical conductivity, TH: Total hardness

Table 2: Physicochemical characteristics of feed and saline reject water of centralized reverse osmosis plants

Samples	TDS (mg/L)	EC ($\mu\text{S}/\text{cm}$)	TH (mg/L as CaCO_3)	pH	Free Cl_2 mg/L
Station 1					
RFW	1865±14.2	3750±24.4	427.6±14.6	7.99±0.5	0.4±0.1
SRW	3460±22.5	6650±28.6	701±16.2	7.78±0.4	0.1±0.06
Increase (%)	85	77	64	2.62	-75
Station 2					
RFW	1869±14.4	3830±26.1	464±16.3	7.9±0.54	0.5±0.22
SRW	3020±18.8	6005±24.2	672±14.6	8±0.61	0.11±0.05
Increase (%)	61	56.7	45	1.26	-78
Station 3					
RFW	1840±13.5	3650±23.6	496±19.4	8.12±0.66	0.5±0.2
SRW	3485±23.5	8540±39.8	1240±29.7	8.15±0.7	0.15±0.055
Increase (%)	143	134	150	0.36	-70
Station 4					
RFW	1517±14.2	3100±28.2	468±22.1	7.7±0.26	0.7±0.15
SRW	2760±30.4	5600±33.4	832±29.2	7.8±0.32	0.2±0.1
Increase (%)	82	80	78	1.3	-71
Station 5					
RFW	1610±18.2	3220±31.4	445±24.5	7.75±0.15	0.6±0.12
SRW	2850±28.8	5710±35.4	740±29.4	7.9±0.2	0.25±0.1
Increase (%)	77	77	66	1.93	-58
Increase in RW (%)	89.6	86	80.6	1.49	-70.4

RFW: Raw feed water, RW: Reject water, SRW: Saline RW, TDS: Total dissolved solids, EC: Electrical conductivity, TH: Total hardness

Table 3: Quantitative characteristics of desalination plants. Data was collected from centralized desalination plants

Stations	RFW (m^3/days)	Produced water (m^3/days)	SRW (m^3/days)	Minimum SRW (m^3/year)	Minimum SRW ($\text{m}^3/25$ years)
1	20-30	10-15	10-15	3650	91,250
2	20-25	10-12.5	10-12.5	3650	91,250
3	60	30	30	10,950	273,750
4	1	0.5	0.5	182.5	4562.5
5	2000	1000	1000	365,000	9,125,000
Total produced saline wastewater			1058.5	386,170	9,654,250

RFW: Raw feed water, SRW: Saline reject water

overall, 5–15 L/day used for drinking and cooking by each person. In this study, for subsequent calculations, 10 lpcd was considered as an average of consumption rate. The current population of Saveh (without suburbs and the village) is about 254,166, so the estimated water requirement is around 2540 m³/day in Saveh.

Total dissolved solid concentration in the raw feed water, saline reject water, and municipal wastewater

The concentration of TDS in the raw feed water, municipal wastewater, household saline reject water, and saline reject water from the centralized RO plant in Saveh are shown in Figure 2. Furthermore, the average concentration of TDS parameter in different mixing modes with municipal wastewater in WWTP is illustrated in Figures 3 and 4.

Amount of recoverable salt

Figure 4 shows the amount of produced saline reject water and recoverable salt from saline reject water of five centralized desalination plants in Saveh with 80% recovery efficiency.

DISCUSSION

Quality of saline reject water

The average of TDS content in raw feed water to decentralized household plants was about 1732 mg/L [Table 1] and this value is higher than Iranian standard (No. 1053) for drinking water and causes an undesirable taste of water, so that citizens do not wish to use the water of the distribution network. In the mentioned standard, the permissible limit of TH is 500 mg/L as CaCO₃ and is lower than TH concentration in the Saveh

city water. Long-term consumption of water may pose a health threat for sensitive people in the community or increase the use of detergents, thereby bringing more phosphorus into the sewage, as well as precipitating and clogging up household appliances, thereby increasing household costs. The amount of TDS in raw feed water (1732 mg/L) indicated that Saveh has brackish water and application of desalination system for the preparation of potable water is necessary.^[29]

The residual chlorine in the saline reject water of RO systems can react with organic compounds and also microorganism’s growth as biofilms in the membrane system. It should be noted that the decentralized household plants are purified municipal brackish water, so there is no concern for microorganisms and organic matter. However, for another centralized desalination plant, the source of raw feed water was the untreated water from dam or groundwater.

The results showed that the average percent increase of parameters such as TDS, TH, and pH in saline reject water were 42%, 51%, and 2.4%, respectively, but, the free residual Cl₂ decreased by 72%. This decrease is due to the reaction of neutralization. Finally, the TDS value of saline reject water of decentralized household plants was about 2408 mg/L.

The sources of feed water to five centralized desalination plants in Saveh were the combination of treated water in the city and

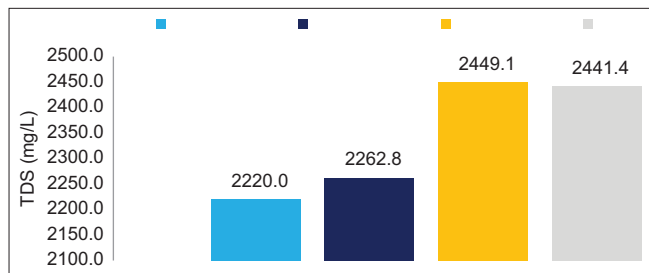


Figure 2: Total dissolved solids concentration of in the raw feed water, municipal wastewater, and saline reject water

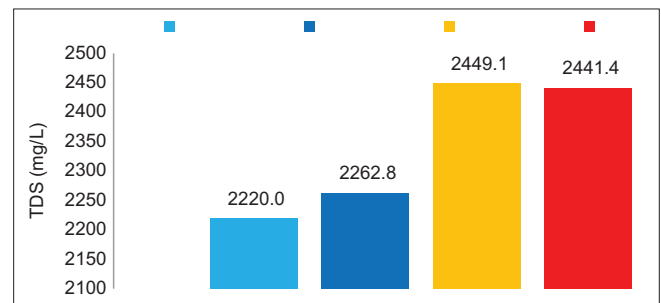


Figure 3: Total dissolved solids concentration after mixing of saline reject water from desalination units with municipal wastewater of Saveh city at current treatment capacity (4000 m³/day)

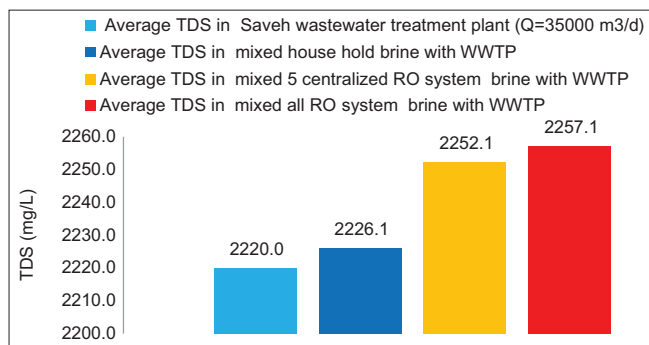


Figure 4: Total dissolved solids concentration after mixing of saline reject water from desalination units with municipal wastewater of Saveh city at final treatment capacity (35,000 m³/day)

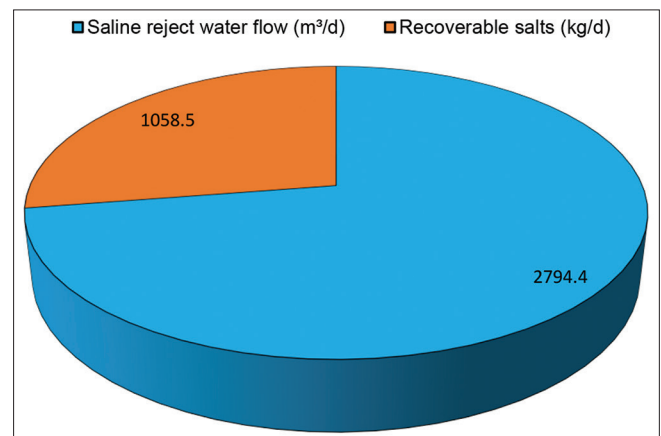


Figure 5: Amount of salt produced from the saline wastewater of Saveh

wells around the Saveh. The average value of TDS, EC, TH, pH, and free residual Cl_2 in saline reject water from station 1 were 3460 mg/L, 6650 $\mu\text{S}/\text{cm}$, 701 mg/L, 7.78, and 0.1 mg/L, respectively. Comparing to the raw feed water, the increasing percentage of mentioned parameters were 85%, 77%, 64%, 2.62%, respectively, and only 75% decrease in free residual Cl_2 .

In station 2, the average value of TDS, EC, TH, pH, and free residual Cl_2 in saline reject water was 3020 mg/L, 6005 $\mu\text{S}/\text{cm}$, 672 mg/L, 8 and 0.11 mg/L, respectively. In comparison with raw feed water, the percent increment of studied parameters in saline reject water were 61, 56.7, 45, 1.26%, respectively, and only 78% decrease in free residual Cl_2 was observed. According to field studies, the influent water to this station is from the Saveh surface water collection channel. The mean value of TDS, EC, TH, pH, and free residual Cl_2 in saline reject water of station 3 were 4485 mg/L, 8540 $\mu\text{S}/\text{cm}$, 1240 mg/L, 8.15, and 0.15 mg/L, respectively. However, the increasing percent in these parameters in the saline reject water were 143%, 134%, 150% and 0.36%, respectively and only 70% decrease in free residual Cl_2 as registered.

At station 4, the mean value of TDS, EC, TH, pH and free residual Cl_2 in the saline reject water were 2760 mg/L, 5600 $\mu\text{S}/\text{cm}$, 832 mg/L, 7.8 and 0.2 mg/L, respectively. The percent increment of these parameters in the saline reject water compared to the raw feed water were 82%, 80%, 78%, 1.3%, respectively and only 71% decrease in free residual Cl_2 was documented. Station No. 5 is the largest centralized desalination plant in Saveh. It has a 5,000 m^3 reservoir of raw feed water that is supplied from the 3 wells of Yahya Abad and Al-Ghadir dam. At present, the saline reject water from this desalination plant released to the environment without any treatment but is expected to enter the Saveh sewage collection network in the future. The mean value of TDS, EC, TH, pH, and free residual Cl_2 in the saline reject water of station 5 were 2850 mg/L, 5710 $\mu\text{S}/\text{cm}$, 740 mg/L, 7.9 and 0.25 mg/L, respectively. However, the percent of the increase in these parameters in the saline reject water compared to the raw feed water were 77%, 77%, 66%, 1.93%, respectively and only 58% decrease in free residual Cl_2 was observed. According to the standard of wastewater discharge,^[30] it is forbidden to discharge the wastewater to a receiving source that will increase the solubility of the solute in a 200 m radius by more than 10%. The average TDS increasing in the saline reject water of five stations in Saveh was 70%, so it is essential to take the risks associated with increasing this parameter in the receiving waters. Finally, the average value of TDS in saline reject water from all of the centralized desalination plants in Saveh was approximately 3315 mg/L. Considering the total quality of saline reject water in Saveh, it can be said that the average percent increasing of parameters such as TDS, TH, and pH in saline wastewater were 65.8%, 65.8%, and 1.94%, respectively. The residual chlorine also decreased by 71.2%.

Lozier *et al.* showed that the concentration of TDS at the feed water to RO system was 450 mg/L and reached to 2830 mg/L

in the saline reject water.^[31] Also, Pontius *et al.* demonstrated that the values of parameters such as TDS, TH, and alkalinity in the saline reject water of the RO system were significantly increased but the pH value slightly increased.^[32] Qurie *et al.* studied the treatment of saline water produced by RO units showed that pH and TDS values in saline water were 7.7 and 2250 mg/L, respectively.^[33] The conducted study in the Qom city showed that the average value of TDS, EC, TH, and pH of the influent water to the RO was 1872 mg/L, 2615 $\mu\text{S}/\text{cm}$, 615 mg/L, and 7.02, respectively.^[34] Study of Afonso *et al.* in Jordan on the treatment of brackish water illustrated that TDS was about 1000–2200 mg/L and pH was about 8.5.^[35]

Quantity of saline reject water produced in Saveh

The results show that five centralized desalination plants produced about 1058.5 m^3/day of saline reject water. The water recycling ratio (amount of produced water to feed water) in RO systems is estimated to be about 40–60% based on water quality and our results showed that the recycling ratio was about 50% as reported in the literature.^[36]

Overall, five centralized desalination plants produced about 1058.5 m^3/day of drinking water [Table 3]. By considering 10 L of water for drinking and cooking per capita, these plants provide water for 106,000 people in Saveh during a day. Therefore, it can be said indirectly that the rest of the population of Saveh city receives their needed drinking water from their household RO plant that installed in their homes. The total population of Saveh is 254,166 and by considering 106,000 people being served by 5 centralized desalination plants, 148,166 people do not get their drinking water from 5 centralized desalination plants in Saveh. The household dimension in Saveh city is 2.6 person. Consider this dimension to be 3 people, and by dividing 148,166 by 3, we reached to 49,388 households, not being served by RO plants in Saveh. If we consider 20% as error, it is estimated that 39,510 household RO plants are in Saveh. In fact, the saline reject water of these units does not enter the wastewater collection network and directly entered the household wastewater wells.

Overall, 148,166 people supply their water through household desalination units. By considering a 20% as error, the population reaches to 118,000. Considering the 10 L of drinking water for a person in a day, which will also produce 10 L of household saline reject water (because the efficiency of reverse osmosis systems is 40–60% as stated by the manufacturers, we also choose 50%) therefore, 1180 m^3/day of saline reject water will be produced by all household desalination systems in Saveh. Therefore, all the saline reject water produced in Saveh is about 2238.5 m^3/day . Currently, the influent flow rate to Saveh WWTP is about 4000 m^3/day and the final capacity of this plant is 35,000 m^3/day . About 25 percent of Saveh has connected to the wastewater collection system. Previous studies of the Gaza Strip desalination plants have shown that there are 6 large desalination plants in the region that produce 2260 m^3/day of water, with an average recovery rate of about 75%. Compared to the Saveh, it treated almost the same amount of water.^[37]

In another study, the results showed that this region's water was in the brackish range, with TDS ranging from 1400 to 3500 mg/L.^[38]

Total dissolved solid concentration in raw feed water, saline reject water, and municipal wastewater

As shown in Figure 2, the mean concentrations of TDS in the raw feed water of Saveh (purified municipal brackish water), municipal wastewater, saline reject water from 5 centralized desalination plants, and saline wastewater from household RO plants were 1732, 2220, 3315 and 2408 mg/L, respectively. Figure 3 shows the mixing of saline reject water with influent wastewater to Saveh WWTP which is currently operating at a capacity of 4000 m³/day. The results showed that in the case of mixing saline reject water from household RO plants with influent wastewater to the Saveh WWTP, the average TDS value in municipal WWTP reaches 2263 mg/L. Also, in the case of mixing saline reject water from 5 centralized desalination plants with influent wastewater to the Saveh WWTP, the average TDS value in the treatment plant reaches 2449 mg/L. By mixing all saline reject water from five centralized RO plants and household RO plants, the average TDS value in municipal WWTP reaches 2441 mg/L. That is, we will have a 1.9, 10, and 9.9% increase in TDS, respectively.

Figure 4 also shows the mixing of saline reject water with a WWTP with a maximum final capacity of 35,000 m³/day. In the case of mixing saline reject water from household RO plants with influent wastewater to the Saveh WWTP, the average TDS value in municipal WWTP reached 2226 mg/L. Also, in the case of mixing saline reject water from five centralized RO plants with influent wastewater to the Saveh WWTP, the average TDS value in treatment plant reaches 2252 mg/L. By mixing all produced saline reject water (five centralized RO plants and household RO plants) the average TDS value in influent wastewater to the Saveh WWTP increased to 2257 mg/L. That is, we will have a 0.27%, 1.44% and 1.6% increase in TDS, respectively.

One of the simplest ways to reduce the effects of direct discharge of saline reject water into the environment is its dilution with other water or wastewater with low concentration of TDS to minimize the risk to the environment.^[39] Therefore, transferring saline reject water to the influent wastewater to the Saveh WWTP could be an effective solution for management of saline reject water as it will not have a significant effect on increasing TDS of influent wastewater to the Saveh WWTP.

In some desalination plants, centralized RO plants that saline reject water does not enter directly into the sewage, the saline reject water was mixed with the effluent wastewater from WWTP at 1:50 ratio and released to the river.^[40] The problems encountered in the collection of saline reject water from household RO plants are including the low volume of reject water from residential units and the difficulty of centralized produced reject water.^[41]

Khudair *et al.* studied the environmental impacts of a RO plant in Basra with a TDS parameter and showed that while

the recovery rate of the RO system was 85% and 50%, the increasing TDS of receiving waters was about 5.9 and 2.7, respectively.^[42] This means that when the recovery rate is high, the TDS increase is higher than the 5%. A maximum of 5% increase in the amount of TDS is used as a standard criterion in some countries.^[43] But for the Iranian standard, this criterion is 10%. Lozier *et al.* studied the treatment of reject water from RO plants and demonstrated that the best way to solve the problem of RO reject water is its mixing with the effluent wastewater from the municipal WWTP. They stated that this condition leads to increasing TDS of the mixed stream to 424 mg/L and meets the TDS discharge standard of 650 mg/L.^[31] Nikhil *et al.* have used the RO process to purify the effluent from an anaerobic baffled reactor and illustrated that the TDS value in the effluent of the RO system increased from 2000 mg/L to 10,000 mg/L.^[44] Shahalam *et al.* evaluated the treatment of nutrients from RO reject water by activated sludge and revealed that the TDS and alkalinity content in the RO reject was 4600 mg/L and 361 mg/L, respectively.^[45]

One of the problems related to discharging saline reject water into water resources is the red tide phenomenon due to *Cochlodinium Polykrikoides* overgrowth, which poses many dangers to aquatic life as it is even referred to as harmful algal blooms. One of the main causes of this phenomenon is the presence of nutrients such as nitrogen and phosphorus, as well as some of the antifouling compounds used in the desalination process.^[40] Therefore, it is necessary to prevent unauthorized entry of reject water into the water resources. For example, in Bangalore, India, the effluent saline reject water from RO plant treated by a lime-soda process to precipitate calcium and magnesium, which are major contributors to TDS and indirectly reduce TDS in saline reject water.^[46]

Other possible options to reduce the amount of saline reject water produced in desalination plants is to mix part of the saline reject water with raw feed water entered to the treatment system, which usually mixes 20% saline reject water with 80% of the incoming raw feed water.^[47] This method can also be implemented in Saveh. Previous studies showed that increasing salinity in wastewater decreases the efficiency of biological WWTPs especially at the salt concentration above 1%. Because of the action of plasmolysis, microbial cell water is lost and cell cytoplasmic activity is reduced.^[48] One of the proposed solutions to overcome these conditions is the application of salt-resistant microorganisms.^[49] Since the TDS content of influent wastewater to the Saveh WWTP after mixing with saline reject water is below 5000 mg/L, it is not possible to interfere with the treatment process at present but if its value exceeds 10,000 mg/L, the performance of the treatment plant may have problems.

Amount of recoverable salt

The amount of saline reject water produced from five centralized RO plants is more feasible to collect separately. TDS concentration of saline reject water produced from five centralized RO plants is about 3.3 g/L. Considering 80%

recycling efficiency, about 2794 kg/day (2.794 tons/day) of salt can be recovered from centralized RO plants reject water [Figure 5]. Recovering this salt can help to reduce the consumption and purchase of salt for the production of salt-sand in the cold provinces. Of course, this requires further investigation into the presence or absence of heavy metals in recycled salt. Strict environmental laws and regulations as well as financial benefits in the discussion of the recycling of valuable materials in saline reject water have increased the approach to reduce wastewater generation and wastewater reuse. The most well-known of these approaches are ZLD and useful salt production.^[50] In this regard, due to some limitations and non-compliance of Saveh City with such advanced and cost-effective measures that require high cost and technology, simpler methods such as surface evaporation ponds can be addressed. Solar evaporation pond is one of the most common methods for producing salt from saline reject water, where products such as $MgCl_2$, $NaCl$, and $CaCO_3$ are produced by evaporating.^[51] Unfortunately, there are not any treatments for produced saline reject water in the Saveh, and saline reject water directly entered to the environment. Shi *et al.* studied the application of solar evaporation for the treatment of saline reject water and showed that about 1.26 kg/m²/h salt can be produced.^[52] Other saline wastewater treatment options include direct discharge to surface and groundwater, agricultural irrigation, and pisciculture. Due to the hazardous effects of direct discharge, this method is used with pre-treatment.^[24] Household applications of saline reject water also include phytoremediation and the use of saline reject water for aquariums because different animal species exist in saline or brackish waters.^[53]

CONCLUSION

In the present work, the quantity and quality of saline reject water from desalination plants was evaluated and its effect on WWTP of Saveh city assessed. It was concluded that the total volume of saline reject water produced in Saveh is being discharged to the environment without any treatment. Therefore, attention to saline reject water is one of the most important environmental issues that should be addressed by the city authorities and decision-makers. Although it is not possible to collect produced saline reject water by household desalination units but produced saline reject water by five centralized RO plants in Saveh (1058.5 m³/day) can be collected as separate wastewater collection with TDS concentration of about 3.3 g/L. By considering 80% salt recycling, the amount of recoverable salt from saline reject water is about 2794 kg/day and it can be used as ice defrizzing agent [Figure 5]. The mixing of produced saline reject water with influent wastewater to Saveh WWTP is an effective management way due to not significantly increasing TDS concentration of municipal wastewater (1.6% increasing). However, it is necessary to consider the mixing of saline reject water with raw wastewater or treated wastewater in the Saveh treatment plant and it needs more investigation in future.

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Conflicts of interest

There are no conflicts of interest.

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