CONCEPTUAL CONSIDERATIONS CONCERNING WATER QUALITY OF GEZEL-OZAN RIVER IN IRAN

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ABSTRACT

This research surveyed water quality of Ghezel-Ozan River that is one of the important rivers on North-West of Iran, for the evaluation of water corrosivity and sedimentation. A total of 16 samples were taken from various points of the Ghezel-Ozan for testing the specific parameters and calculation Langelier Index (LI), Ryznar (RI) and Puckorius Index (PI). According to equilibrium of chemical between salts exist on water on 2 half of a year, to reduce dangers of undesirable quality componentsof Ghezel-Ozan River water. The average of Langelier saturation Index for water of Ghezel-Ozan River, obtained equals 1.22, Ryznar saturation Index is 5.83 and Puckorius Index obtained is 4.66. Comparison of this index showed tendency on sedimentation that must be remedied in order to prevent the sediment and corrosion pipes in order to reduce costs of replacing pipes. Determination the kind of plantation on regions that has salty water is necessary, in order to prevent reducing crop efficiency in these regions. Therefore, in the present research, pay attention toward researching the quality of water samples of Ghezel-Ozan River and to make a comparison of water quality of this river with methods of plantation for using optimum use of the water of this river in order to increase the efficiency of water for irrigation systems.

Keywords: Ghezel-Ozan, Zanjan, Iran, corrosion, sediment, quality water, operation, efficiency, Ryznar, Langelier, Puckorius.

INTRODUCTION

Generally, the water in nature exists in pure form, and has some dissolved and suspense matter. But impurities in the water do not prevent using this water, as long as it is not harmful and more than allowed limits. Factors that closed the dropper are physically and biologically (Alizadeh and Khiabani, 1996). Corrosion is destruction of a matter such as metals in responses to reaction with environment. This environment can be a liquid media such as water flowing in pipes and solid media such as soil in

contact with buried pipes. Corrosion occurs due to various processes including physical, chemical, biological, and electrochemical reaction (Saatchi, 1993, Pishnamazi, 2005, Oram, 2007). At the present time, since metal pipes for water transmission are commonly used allover the world, so water have to consider effects of corrosion upon water quality and conversely (Dietrich, 2004). In Iran, limited studies were carried out in the field of corrosion, as a study on Zarrinshahr city (Iran) water distribution system showed that high concentration of lead, Cadmium and Zinc in drinking water relates to corrosion of internal walls in galvanized pipes (Shahmansori and Pormoghadas, 2004). Every year several billion dollars lost via corrosion. In Iran, especially in the past two decades which was in economic and scientific development stage, these problems exist as an economical challenge (Saatchi, 1993). For the best operation of boiler or cooling tower, the water quality control is considered an important factor (Log et al., 2004). A Ryznar Index number of less than about 6 is indicative primarily of the start of calcium carbonate (scale) deposition, which represents an Index number greater than 6 to 7. This is an indication of increasing water corrosivity (Pishnamazi, 2005; Salvato, 2003). One important target is securing the water for parts of drinking, agriculture and industrial, with suitable quality. According to ISO 8044 Standard, corrosivity is physical and chemical reaction on transfer line with sides' environment that due to changing on properties of transfer line (Horfar, 1996). Corrosivity is a reaction of physical and chemical quality due to several factors (Purzamani et al., 2005). These factors can endanger humans' health and invert difficulties in economic, engineering and technical (Hosseinian, 1998). Therefore, it is necessary to pay attention to the problem of water quality (Mahvi and Eslami, 2006). Chloration and flocculation on water treatment of Emamzade-Hashem, showed that the water quality and corrosivity of this region was changed (Ramezani, 2001). Study the corrosion and sediment in Iran is important, because country of Iran has a first place of sediment in the world with amount 10 ton/hec (Khodabakhshi et al., 2008). Also, study of water on Ahvaz indicated, corrosivity of this water is low (Savari et al., 2008). Whereas Karim et al. (2008) showed that the water of Ahvaz according to Ryznar Index is very corrosive. In another study, Nikpurr et al. (2006) indicated that water of springs, wells, and water tank Behshahr, are corrosive according to Ryznar and contain sedimentation according to Langelier. Puckorius and Brooke (1991) introduced the Puckorius Index for distinction corrosivity and contain sedimentation in waters. Also, Pakshir et al. (2004), according to guidance Puckorius and Brooke (1991) in Esfahan who described Puckorius Index for waters. Al-Rawajfeh and Al-Shamaileh (2007) applied CCPP Index on Tafelia–Ordon. Al-Rawajfeh et al. (2005) showed that it had suitable Ryznar and Langelier Index for assessment (Al-Rawajfeh et al, 2005). You et al. (2001) used Practical Scale Index for determinate of sedimentation. In agriculture, sediment of $CaCO_3$ is the most important factor in closing the system (Naderi, 2006), and droppers (Alizadeh and Khiabani, 1996). Results of the study of Zareei et al. (2006) in Iran showed that tubes of tape had a most sensibility to water quality. Dehganisanij et al. (2005) showed that efficiency of irrigation system was reduced in water quality. Nakayama and Bucks (1991) said that the sediment through tubes and water distribution systems is related to temperature of environment. Zehtabian (1997) said that sediments on tube could be washed out by strong acid. Among various index, Ryznar and Langelier Indexes used more than other

indexes (Pakshir et al., 2004). Researchers introduced various indexes about corrosivity and sedimentation (Al-Rawajfeh and Al-Shamaileh, 2007; Patzay et al., 1998; Puchorius and Broke, 1991). At present, Bromine element is necessary for growing the plants, but if it exceeds a permitted limit, it becomes a poison effect (Alizadeh, 1996). Study of corrosivity and sedimentation on water is necessary. So, in the present research, study of water quality of Ghezel-Ozan River which is considered one of the most important rivers on North-West of Iran, in point of view of corrosivity and sedimentation with Ryznar, Langelier and Puckorius Indexes.

MATERIAL AND METHOD

In order to do the present research a survey concerning water quality of Ghezel-Ozan River was carried out. Ghezel-Ozan River is one of the most important rivers on North-West of Iran (Figure 1). This river, originate from Chehel-Cheshme Mountains on Kordestan province and arrives to Zanjan province and then passing Mahneshan in Zanjan province, while it becomes a part of East the Zanjan. Then added Zanjanrood to it, and it arrive to Azarbayejan-sharghi province and after passing of this province, again return to Zanjan, and then by passing the Tarom on Zanjan, flowing toward Gilan province and finally merging with the other rivers, in the name of Sefid-rood till it arrives to Khazar Sea.

Fig. 1: Position of Ghezel-Ozan River

By attention to existing data concerning water quality, this river has changeable point of view in terms of time and location. In spite of these changes, lands of border river, irrigated with water of this river, and this subject is due to study water quality of this

river. Recognize the kind of this plantation on regions that has a salty water and non-favorable water in this region is becoming very important. Therefore, in the present research, the water quality of samples of Ghezel-Ozan River were considered, then a comparison of water quality of this river was carried out relevant to plantation methods.

Attention was considered towards the water quality of this river at various locations. 16 selected samples of water in 2 seasons of the year: summer and winter were done. Various methods exist for foresight of sediment or corrosion that based on chemical equilibrium and it can define incidents only and do not surveyed dynamic nature of sedimentation and corrosivity. The simplest methods for survey of these cases, is applying Ryznar, Langelier and Puckorius Indexes for determining sedimentation and corrosivity as follows:

$$LSI = pH - pH_c \quad (1)$$

$$RSI = 2(pH_C) - pH \quad (2)$$

$$pH_c = p(Ca+Mg+Na+k) + p(Ca+Mg) + p(CO_3+HCO_3) \quad (3)$$

in which LSI is Langelier Index, RSI is Ryznar Index, PH is the measured water PH, PH_c is the PH at saturation in calcite or calcium carbonate, P(Ca+Mg+Na+K) is Index of cations of water, P(Ca+Mg) is index Ca+Mg of water, $P(CO_3+HCO_3)$ is index of carbonate and bicarbonate on water. For calculating the factors that exist on relation of 3, by guidance tables, extracted the diagrams of reference on Excel software (Alizadeh, 2001) and obtained regression models that there has a R^2 with high amounts. For Index of water cations, Polynomical model with tourist class, for index of Ca+Mg on water and index of carbonate and bicarbonate is suitable Logarithm model. These steps were done for sampling and calculations and to increase the carefulness. In the next step, the calculation of the amount of index with relations 1 and 2 is done. In base of Langelier Index, if $PH<PH_c$, water has a negative Langelier Index and due to solution of calcium carbonate, that in this case, water is corrosivity. If $PH>PH_c$, Langelier Index is positive and water saturated of calcium carbonate, and this case, quality of water is the form of sedimentation. In Ryznar Index, if Ryznar Index is more than 6, water has a state of corrosivity, if Ryznar Index<6, the water is sedimentation (Pakshir et al., 2004). Tables 1, 2, 3 and 4 show the abstract of any index.

Table 1: Determination of the various classifications of sedimentation and corrosivity (Pakshir et al., 2004; and Kevin, 2000)

Ryznar Index		Langelier Index	
Description	Quantity	Description	Quantity
Sedimentation	< 7	Corrosivity	< 0
Corrosivity	> 7	Sedimentation	> 0

Table 2: Interpretation of the Langelier Saturation Index (Carrier, 1965)

Description	Quantity
Scale forming but non corrosive	> 2
Slightly scale forming and corrosive	0.5-2
Balanced but pitting corrosion possible	0.02-0.5
Slightly corrosive but non-scale forming	(-0.5)-0.02
Serious corrosion	(-0.5) to (-2)

Table 3: Interpretation of the Ryznar Stability Index (Carrier, 1965)

Description	Quantity
Scaling intolerable	< 4
Heavy scale	4-5
Light scale	5-6
Little scale or corrosion	6-7
Corrosion significant	7-7.5
Heavy corrosion	7.5-9
Corrosion intolerable	> 9

Table 4: Interpretation of the Puckorius Index

Description	Quantity
Scaling	> 6
Corrosion	< 6

This research is based on recognizing various classes of sediment and corrosion as studied by Kevin (2000). In order to survey the chemical situation of water, an attention is directed towards this index, using the relationships of 4, 5 and 6.

$$P(Cations)= -0.0003Cations^2 + 0.0189Cations + 2.1223 \quad R^2 = 0.99 \tag{4}$$

$$P\ (Ca+Mg)= -0.4347\ Ln\ (Ca+Mg) + 3.298 \quad R^2 = 1 \tag{5}$$

$$P(CO_3+HCO_3)= -0.4348\ Ln\ (CO_3+HCO_3) + 2.9982 \quad R^2 = 1 \tag{6}$$

Then, Ryznar and Langelier Indexes are calculated for water of this river and then Puckorius Index is calculated by relationship 7.

$$PSI= 2PH_c - (1.465(CO_3+HCO_3) + 4.54) \tag{7}$$

For studying water quality for irrigation, various methods can be carried out to study EC and Na in water. One of these methods is the method of American soil salty laboratory where irrigation water is classified into to 4 classes taking point of view the

limit of Na, and classification to 4 classes as point of view for the limit of salty index. In the present research, this method was used for analyzing the samples of water.

RESULTS AND DISCUSSION

The corrosion in tubes may be caused. This may happen also due to interring the polluters to irrigation systems, which expose healthy problems to human and consumers. Corrosivity due to pierced and depreciation of the tubes leads to changing the tubes, which cause high expenditure. Also, sediment reduces the section area of the tubes and increases the head loss along the tubes. Results of studies of analyzed data for water samples of Ghezel-Ozan River in the base of Ryznar, Langelier and Puckorius Indexes located on Figures 2 to 4. Results of twin of salty and Na by American soil salty laboratory are shown in Table 5.

Table 5: Survey of water quality of Ghezel-Ozan River according to twin effects of EC and SAR and classification this river by American soil salty laboratory

Row	River name	Sampling Place	Date of Sampling	EC	SAR	Class
1	Ghezel-Ozan	Mahneshan-Pol	First-half of year	2675	6.93	C_4S_2
2	Ghezel-Ozan	Mahneshan-Pol	Second-half of year	3488	6.41	C_4S_2
3	Ghezel-Ozan	Eili-Bolagh	First-half of year	2617	5.42	C_4S_2
4	Ghezel-Ozan	Eili-Bolagh	Second-half of year	5203	14.88	C_4S_4
5	Ghezel-Ozan	Mashampa	First-half of year	3836	6.49	C_4S_3
6	Ghezel-Ozan	Mashampa	Second-half of year	6316	46.57	C_4S_4
7	Ghezel-Ozan	Ebrahim-Abad	First-half of year	4904	8.65	C_4S_3
8	Ghezel-Ozan	Ebrahim-Abad	Second-half of year	7679	18.53	C_4S_4
9	Ghezel-Ozan	Gilvan-Pol	First-half of year	2096	6.3	C_3S_2
10	Ghezel-Ozan	Gilvan-Pol	Second-half of year	2061	5.93	C_3S_2
11	Ghezel-Ozan	Sofla-Kuhkan-Pol	First-half of year	2007	6.69	C_3S_2
12	Ghezel-Ozan	Sofla-Kuhkan-Pol	Second-half of year	1976	6.24	C_3S_2
13	Ghezel-Ozan	Deram	First-half of year	1967	6.68	C_3S_2
14	Ghezel-Ozan	Deram	Second-half of year	1726	7.88	C_3S_2
15	Ghezel-Ozan	Aslanlu	First-half of year	1413	2.44	C_3S_1
16	Ghezel-Ozan	Aslanlu	Second-half of year	5903	16.17	C_4S_4

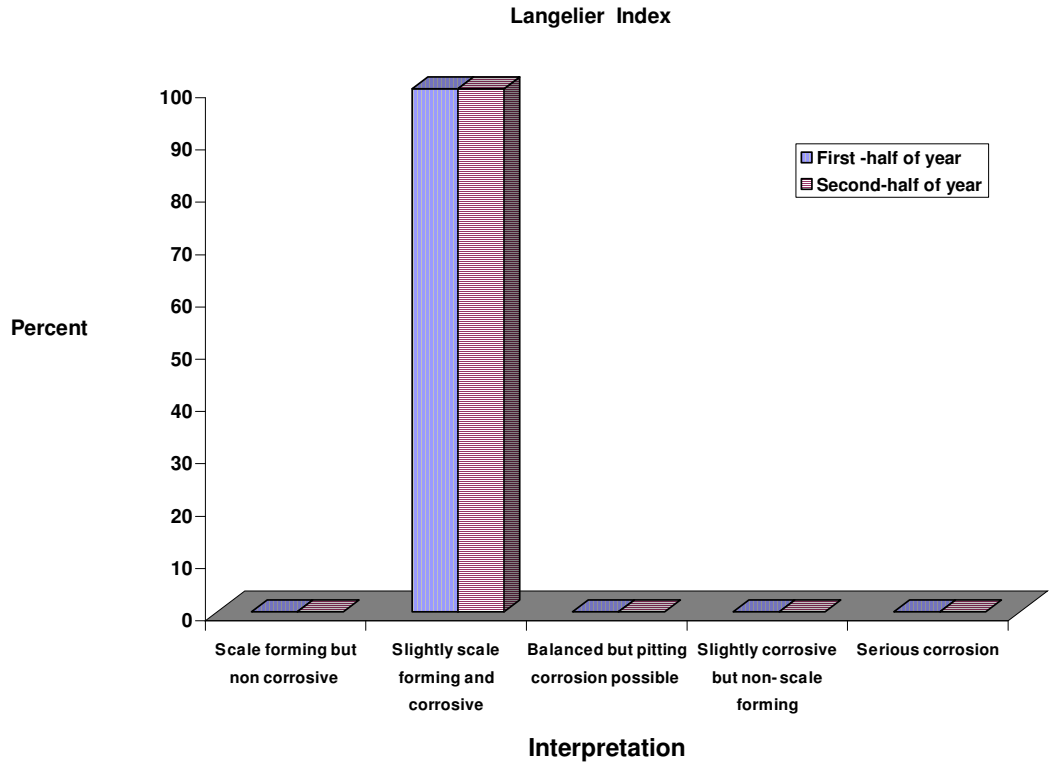

Fig. 2: Results of Langelier Index

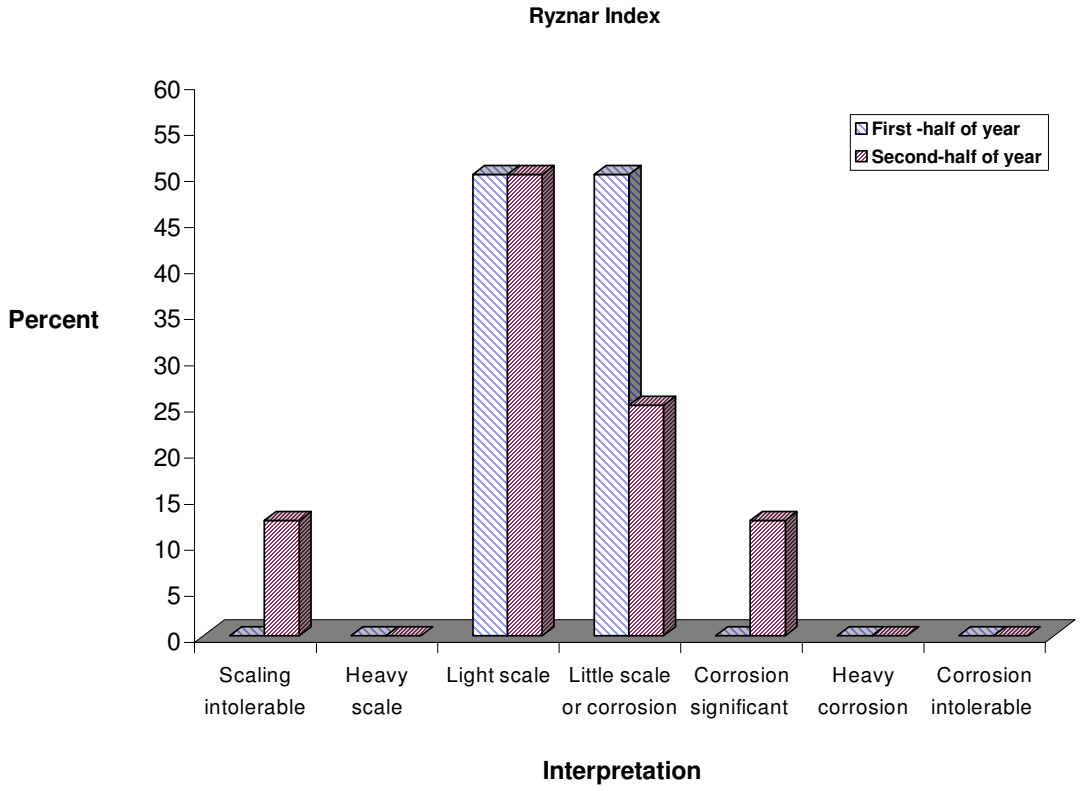

Fig. 3: Results of Ryznar Index

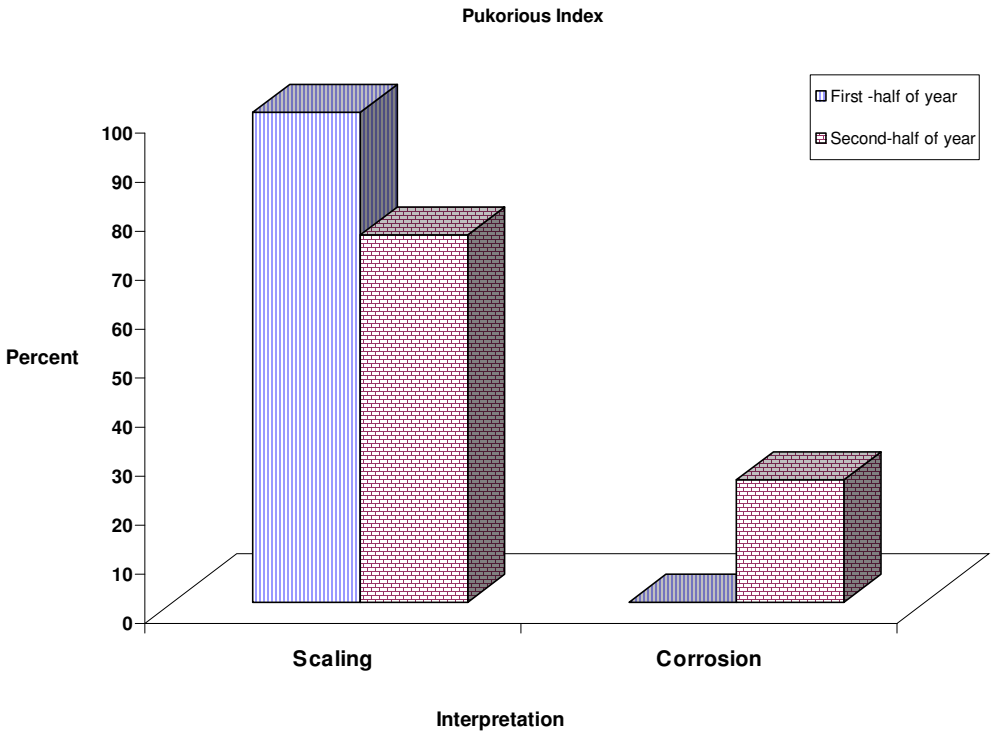

Fig. 4: Results of Puckorius Index

In the present research, salty water was classified into 4 classes and also SAR was classified into 4 classes and therefore by mixing these 2 indexes, there become 16 kinds of water. In order to survey corrosion and sediment, we used 3 indexes, Ryznar, Langelier and Puckorius. After the calculation and survey the results, the obtained Langelier saturation index for water of Ghezel-Ozan River is 1.22. It shows that this water has a property of slightly scale forming and corrosive. Also, arrange of Ryznar saturation index for Ghezel-Ozan River, calculated 5.83 which shows light scale. And arrange of Puckorius index calculated 4.66, which indicated that this water form the scale. Comparison between 3 indexes of Ryznar, Langelier and Puckorius, showed that the river had tendencies to sedimentation and corrosivity. According to Langelier index, for water of Ghezel-Ozan River allover the year (First-half of year and Second-half of year) 100% of the water was resource of Ghezel-Ozan River which had a property of slightly scale forming corrosive action. Surveying the results of Ryznar index has shown that, on the First-half of year, 50% had a light scale and 50% had little scale of corrosion. On the Second-half of the year by attention this index, 12.5% was corrosion intolerable, 50% was of little scale, 25% of little scale of corrosion and 12.5% was of heavy scale. Also, Puckorius index indicated during the First-half of the year, while 100% of scale forming while the Second-half of year was 75% scale forming and 25% was corrosivity.

Referring to the classification in Table 5 for various points one can say that water quality of this river on various locations and various times of year was not favorable quality due to difficulties in agricultural process with water of this river. In the

sampling place of Ebrahim-Abad there was high changing point of view concerning salt and on Eili-Bolagh place, because of receiving the Anguran-chai River, the water quality was changed and found salty and Alkality as located on C_4S_2 class. Water of this river on the sampling place Aslanlu had not a suitable quality and located on C_4S_4 class. It means that this water is not suitable for drinking and agricultural use. Salty water of this river after receiving Zanjan-Rood River and after mixing such river water reduced and located on C_3S_2 class. This position was constant concerning sampling place Gelivan and did not change. In the season when water is little, salty and alkality on sampling place Ebrahim-Abadwas found to have increasing values of C_4S_3, which was not suitable for agriculture. Water quality of Ghezel-Ozan River, after crossing Mahneshan lands, had reduced values of C_4S_2. Then salty and Alkality of this river, after receiving the Zanjan-rood, with mixing these rivers, reduction of sampling place of Deram showed excessive values of C_3S_2, which was suitable for agriculture. This quality was found constant to sampling place of Gilvan. Ghezel-Ozan River showed amount of Bromine on sampling places of Ebrahim-Abad and Eili-Bolagh which had a limitation for production of agriculture besides certain amount of Nitrate, between 1 to 4.4 ppm. Certain amount of pH was measured on the course of the river allover the year and covering all seasons which showed insignificant changes.

Water quality of Ghezel-Ozan River on the most part and allover sampling places, even on season of full-water, had difficulties concerning salt. Water quality on seasons of winter and summer was constant often, and sometimes during the winter time, quality of water was reduced and becoming worse.

REFERENCES

1. Alizadeh, A., 1996. Quality water on irrigation, Publication of Razavi, 95 pgs.
2. Alizadeh, A., 2001. Principles and practices of trickle irrigation, Publication of Razavi, 450 pgs.
3. Alizadeh, A., and Khiabani, H., 1996. Trickle irrigation, Publication of Razavi, 275 pgs.
4. Al-Rawajfeh, A.E. and Al-Shamaileh, E.M., 2007. Assessment of tap water resources quality and its potential of scale formation and corrosivity in Tafila Province, South Jordan. Desalination J. 206(1-3): 322-332.
5. Al-Rawajfeh, A.E., Glade, H. and Ulrich, J., 2005. Scaling in multiple-effect distillers: the role of CO_2 release. Desalination J. 182 (1-3): 209-219.
6. Carrier Air Conditioning Company, 1965. Handbook of Air Conditioning System Design. McGraw-Hill Books, New York.
7. Dehganisanij, H., Yamamoto, T., Ould Ahmad, B., Fujiyama, H. and Miyamoto, K., 2005. The effect of chlorine on emitter clogging induced by algae and protozoa and performance of drip irrigation. Transactions of the ASAE. 48(2): 519-527.
8. Dietrich, A.M., 2004. Health and aesthetic impacts of copper corrosion on drinking water .Water Sci. Technol., 49(2): 55-62.
9. Horfar, A., 1996. Principal of corrosion technology. Center of University Publication.

10. Hosseinian, M, 1998. Methods of determinate the quality of corrosivity and sedimentation. Tehran University, Iran.
11. Karim, M., Takdastan, A., Moslem, Z., and Jafarigol, F., 2008, Survey of corrosion and sedimentation the water of Ahvaz by Ryznar and Langelier index, Tehran University, Iran.
12. Kevin Rafferty, 2000, Scaling in geothermal heat pump systems, PP 11-15.
13. Khodabakhshi, B., and Shabihkhani, Z., 2008, Discharge of sediment on dam. Tabriz University, Iran.
14. Log, T. et al., 2004. Scale and corrosion control with combined dolomite / calcite filter. Water Sci Technol., 49(2): 137-144.
15. Mahvi, A.,and Eslami, A., 2006, Survey the quality of drinking water on Zanjan, point of view corrosion and sedimentation by Ryznar and Langelier index, Journal of Environment, 23: 90-95.
16. Naderi, N., 2006, Weighing the effect of water quality on efficiency of irrigation system.Tehran.
17. Nakayama, F.S. and Bucks, D.A., 1991. Water quality in drip, trickle irrigation: A review. J. Irri. Drain. Eng. 12(4): 187-192.
18. Nikpur, B., Noshadi, M. Mortazavi, M.S., and Usefi, Z., 2006, Survey the water quality of drinking water the Behshahr point of view corrosion and sediment index, Tehran University, Iran.
19. Oram, B., 2007. Corrosion, Saturation Index, Balanced Water in Drinking Water System. http://www.water-research.net/corrosion.htm.
20. Pakshir, M., A. Moalem, A.A. Nazarboland and S.H. Abbasi, 2004. Limitation of corrosion and scaling indexes in industrial systems. Water and Wastewater, 51: 60-66.
21. Patzay, G., Stahl, G., Karman, F.H. and Kalman, E., 1998. Modeling of scale formation and corrosion from geothermal water. Electrochimica Acta J. 43(1-2): 137-147.
22. Pishnamazi, S.A., 2005. Water Corrosion Control in Industry, Arkan Publication, Esfahan, Iran, pp: 242-251.
23. Puckorius, P.R. and Brooke, J.M., 1991. A new practical index for calcium carbonate scale prediction in cooling tower system. Corrosion. 47(4): 280-284.
24. Purzamani, H., et al. 2005. Survey the water source quality of Esfahan, point of view corrosion and sediment. Tehran University, Iran.
25. Ramezani, P., 2001. Survey the corrosion and sediment of Rasht. Water and Wastewater, 38: 41-45.
26. Saatchi, A., 1993. Corrosion engineering. Jahad Daneshgahi of Esfahan Technical University, Iran, pp: 1-25.
27. Salvato, J.A., 2003. Environmental Engineering. John Wiley and Sons Inc., New Jersey, pp: 310-465.
28. Savari, J., Jafarzadeh, N., Hasani, A.H., and Shams Khoram-Abadi, Gh., 2008. Compare of changing the Index of corrosion on Ahvaz, Tehran University, Iran.
29. Shahmansori, M. and H. Pormoghadas, 2004.Leaking of microelement due to internal corrosion. J. Res .Med. Sci., 8: 30-34.

30. You, S.H., Tseng, D.H. and Guo, G.L. 2001. A case study on the wastewater reclamation and reuse in the semiconductor industry Resources. Conservation and Recycling J. 32(1): 73-81.
31. Zareei, Gh., Nakhjavani moghadam, M.M., and Zolfagharan, A., 2006, Survey the reasons of closing the droppers on Iran. Tehran-Iran.
32. Zehtabian, Gh., 1997, Guidance the practice of irrigation, Published in Tehran University, Iran. 324 pgs.