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Evaluation of water resources in terms of corrosion and deposition potential on the aqueous structures by five common indicators (Case of study: Bahmanshir River)

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Abstract: Water is the source and the origin of life and plenty of good quality is essential for human survival. Qualitative assessment of water resources, including surface water is one of the most important issues in water resources development plans of the country. Corrosion and fouling of water quality are the problems of management and management of water distribution network. Corrosion is causing progressive destruction of the metal or material in contact with water and sediment deposition in pipes leads to reduce its carrying capacity. This study aimed to determine the potential for corrosion and fouling water of Bhmnshyr by using index was performed. In this study, the five indicators which are Langelier, Ryzener, Porkorios, aggressive and Larsen by sampled parameters temperature, calcium hardness, alkalinity, total dissolved solids, and pH ranged "between" (2005 - 2014) was used for evaluation. These indexes were calculated monthly seasonal and annually.The highest values obtained by the method corrosively indices, including the Langelier (o.44) in 2007, Ryzener (7.68) in 1387 Porkorios (8.13) in 1380 Aggressive (9.16) in2007 and Larsen (7.71) in 2013Corrosion. Bahmanshir River tends to be that the corrosion rate is higher in cold months and also cold seasons. Also assessing changes the rate of corrosion indicators show that the annual general corrosive water has risen. Therefore, careful planning is necessary for corrosion and fouling water quality that should be considered.

Key words: *Larsen index; Pokoriuss index; Aggressive Index; Bahmanshir River; Corrosion of hydraulic structures*

1. Introduction

One of important factors in the discussion of the chemical quality of drinking water supplies is a potential corrosion and deposition. Currently, issues of corrosion and fouling, can be accounted a significant percentage of capita income across countries for these issues. Corrosion is one of the most important problems for industrial water and the general health, change quality and high cost of the distribution system will create a lot of economic, aesthetic and health problems. Today, the problems caused by corrosion and as one of inevitable fact of life reveals itself. Each year over a hundred million dollars in damages due to corrosion in water distribution systems is entered to communities.

In the world, multi-billion dollars every year is lost due to corrosion issues in the water sector in industrial activity. In the world of multi-billion dollars every year due to corrosion issues in the water sector in industrial activity. In 2002 it was announced that corrosion costs in Australia, Great Britain, Japan and several other countries is several times more than gross domestic product. In Iran during the past two decades, particularly in the scientific and economic development, this issue has emerged as an economic competition. In past research, has focused on the spill and economic damage which were resulting from corrosion, but now higher quality of health and aesthetic aspects are considered. Due to the wide use of metal pipes in municipal and domestic water systems, it is necessary to check the corrosive effects on water quality regularly. Also Water that is corrosion and have high deposition potential can dissolve raw materials metal pipes and fittings and create healthy problems .The effective factors that creating the phenomenon of corrosion and deposition by water is including physical, chemical and biological factors. Physical factors are include the current and temperature and chemical factors affecting in the rate of corrosion are including alkalinity, hardness, conductivity, dissolved oxygen, sulfate and chloride ions. Corrosion from point of biologically view usually affected by iron bacteria and sulfate that reeducates bacteria .These bacteria are resistant to high levels of chlorine in the distribution system.

Corrosion can cause a metallic smell and sometimes the smell of water is decay that is one of the problems which is caused by these bacteria. One of the indirect methods to determine the potential for corrosion and fouling drinking water is corrosion and fouling indices. This index can indicate water quality. Accurately assess corrosion and

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fouling indices are on the base of their ability to determine the state of saturation, saturated or supersaturated calcium carbonate and water, according to the prophecy of the stored water capacity and create precipitated calcium carbonate.

This study aims to determine the extent of corrosion and fouling water sources of Bahmanshir were performed by using corrosion and fouling indices.

2. Materials and Methods

2.1. The area of studying

Bahmanshir River with approximately 70 kilometers Length has been located in south of Khuzestan province that has been split from Karoon River in a pace which has named HEFAR in KHORAMSHAHAR and after passing through the Abadan and CHUEBDEH cities is connected to the Persian Gulf.

This river is affected by tides of Persian Gulf. The resulting wave of this phenomena will continue to move to the farthest point on the Bahmanshir River.

In this phenomenon salty water of the sea and river's water meet and mixing takes place.

Some of the used water in Abadan is providing from station 11 which has located beside Bahmanshir river .The coordinates of the mentioned station are 88 degrees, 49 minutes and 50 seconds is the length and 30 degrees, 22 minutes and 40 seconds width. The satellite images of Project's location and the location of 11th station has shown in Fig.1.

Fig.1: Location The studied area (station 11 in Abadan)

The analysis of seasonal changes in parameters of quality of water

In this study, the water quality data that has used, collected by the Water and Power organization of Khuzestan which is related to energy department .these data in a period of years from 2005 to 2014 are available. These data are including temperature, pH, calcium concentration, bicarbonate concentration, total dissolved solids (TDS) and electrical conductivity (EC), total anions and captions, carbonate.

2.2. Methods of corrosively or fouling

There are different methods to predict that water is corrosive or tend to create sediment. It should be noted that these methods are usually based on chemical equilibrium and can only determine what will happen, but it would not check the dynamics. The easiest way to check it is using a tendency to sedimentation or corrosive water analysis to determine the relationships of corrosive or sedimentation of it. These relationships involving Langelier, Ryzener, Porkorios, aggressive and Larsen indexes are defined as follows and can be calculated. Firstly by using the values of alkalinity, calcium hardness, temperature, total dissolved solids and pH, the pHs (pH of saturated calcium carbonate) was calculated by using the following equation.

$$pH_s = (9.3 + A + B) - (C + D) \quad (1)$$

$$A = (\mathrm{Log}_{10}(\mathrm{TDS}) - 1)/10$$

$$B = -13.12 Log_{10}({}^{0}\mathrm{C} + 273) + 34.5$$

$$C = Log_{10}(\mathrm{Ca}^{+2} \text{ as } \mathrm{CaCO_3}) - 0.4$$

$$D = Log_{10}(\text{Total Alkalinity as } \mathrm{CaCO_3})/10$$

To calculate the Langelier and Ryzener indexes, relations (2) and (3) is used:

$$LI = pH_s - pH \quad (2) \qquad RI = 2pH_s - pH \quad (3)$$

Table 1: Interpretation of Langelier index

Description of Mood	The subscript
Super saturated water has a tendency to sedimentation $CaCO_3$ There	$LI > 0$
Water $CaCO_3$ saturation and tend not to make or $CaCO_3$ analyze	$LI = 0$
Saturated with water and analyze $CaCO_3$ the expected	$LI < 0$

Table 2: Interpretation of Ryzener index

Description of Mood	Index RI
Water deposition has many	$RI \leq 4$
Precipitation is relatively little water and corrosive	$5 \leq RI \leq 6$
It is both corrosive and not deposition.	$6 \leq RI \leq 6.5$
Water is corrosive precipitation is low.	$6.5 \leq RI \leq 7$
Water is highly corrosive.	$RI \geq 8$

Equation 4 is used to calculate the index of aggression (16-1)

$$Al = pH - Log_{10}(\mathrm{A.H}) \quad (4)$$

Table 3: Interpretation of aggressive index [10]

Index	Description of Mood AI
So much water is very corrosive.	$AI \leq 10$
Water is very corrosive average	$10 \leq AI \leq 12$
Water is non-corrosive.	$AI \geq 12$

Equation 5 is used to calculate the index of Porkorios (17-1)

(5)

$$PI = 2pH_s - pH_{eq}$$

Water saturated with calcium carbonate, and water at equilibrium is obtained by the following equation.

(6)

$$pH_{eq} = 1.465 Log(\mathrm{T} - \mathrm{AlK}) + 4.54$$

In this regard, total alkalinity is milligrams per liter.

Table 4: Interpretation of Porkorios index [10]

Description of Mood	Amount PI
Corrosive the water	$PI \succ 6$
The water is sedimentation	$PI \prec 6$

Equation 7 is used to calculate the index of Larson (17-1)

$$LR = \frac{(\sum Cl^- + \sum SO_4^{-2})}{(\sum HCO_3^- + \sum CO_3^{-2})} \qquad (7)$$

Table 5: Interpretation of Larsen index [10]

Description of Mood	Amount LR
Water is highly corrosive.	$LR \succ 1.2$
Water is corrosive.	$.8 \prec LR \prec 1.2$
Sedimentation and water quality.	$0.8 \succ LR$

3. Discussion and conclusions

The following table shows the average results of the analysis of Bahmanshir river water samples corrosively index that these parameters are presented on the base of annual average of 10-year period. The quality tests have been performed on the base of Iran and international standards.

Table 6: Calculation of annual water corrosively index

LR	PI	Al	RI	LI	Index's / Year
Amount	Amount	Amount	Amount	Amount	
4.07	8.12	9/04	7/64	*0.16*	2005
3.50	7.43	9.10	7.18	0.40	2006
3.04	7.22	9.16	7.06	0.44	2007
3.05	7.09	9.11	7.06	0.38	2008
2.91	7.07	9.05	7.11	0.32	2009
3.02	7.39	9.09	7.21	0.35	2010
2.97	7.32	8.90	7.37	0.18	2011
5.95	7.19	8.68	7.68	-0.13	2012
7.71	7.11	8.78	7.53	0.09	2013
7.36	7.03	8.81	7.31	0.09	2014

Results of water quality parameters and corrosion indices in Table 6 and Figures 1 to 16 in the following are presenting the percentage of fouling and corrosion. As it can be seen in Figure 1, the Langelier Index in different months of the year is between 0 and 0.5 and on the base of Table 1, the water is deposited.

Langelier index in October and the lowest occurred in December. According to diagram 2 Ryzener index is between 85/6 to 58/7, which is based on Table 2, therefore the water is corrosive, and a little precipitation. Most Ryzener index in December and the lowest occurred in September. As it was observed in Langelier index indicates the deposition of the water situation While Rayznz index shows that the water is in corrosive conditions and is little precipitation. This paradox is because Langelier index is valid when water is Static or its speed be up to 6/0 meters per second. According to Porkorios 4diagram in different months of the year is between 27/9 and 084/10 that shows water is corrosive and the most index in February and the lowest occurred in September. Diagram 3 represents the offensive index that the maximum amount in August (85/8) and lowest in October (2/9) occurred. According to this index the water is corrosive. According to diagram 5 Larsen index value is between 97/1 and 65/3 and according to Table 5, the water is corrosive.

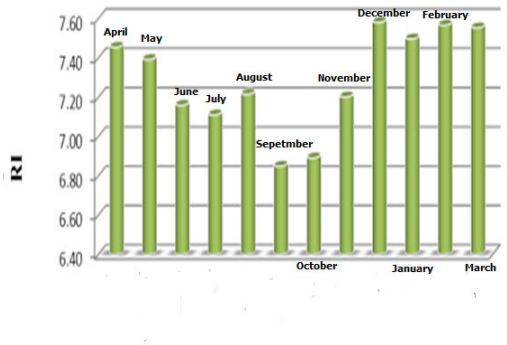

Chart 2: The Ryznar index in different months

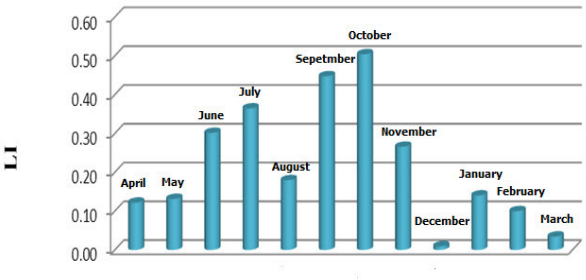

Chart 1: Langelier index indifferent months

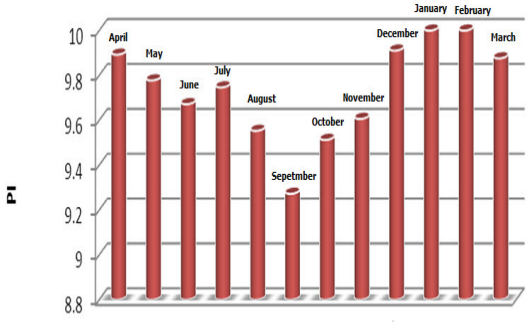

Chart 4: Pokurious index in different months

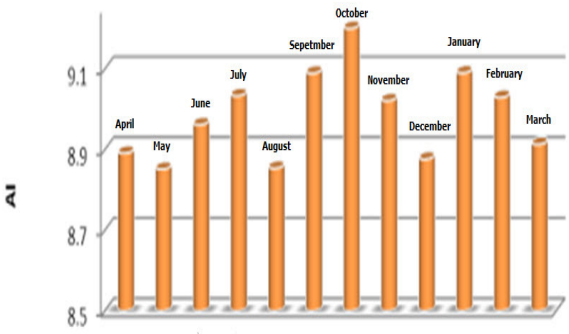

Chart 3: The invasive index in different months

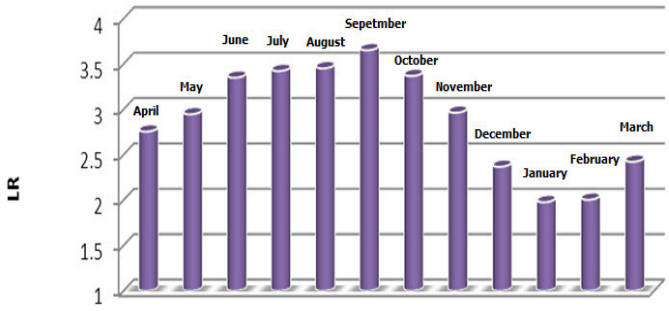

Diagram 5: Larsen index in different months

As it can be seen in different seasons Langelier index values is between 0 to 5/0, Ryzener index values is between 7 to 54 or 7, Parkorios index values is between 51/9 to 98/9, Larsen index values is between 36/3 to 38 / 4, the aggressive index values is between 89/8 to 38/9 and according to table 2, the water is corrosive and a little precipitation.

.The maximum Langelier Index in summer and lowest in winter has occurred

The maximum Ryzener and Parkorios Indexes in winter and lowest in summer has occurred. The maximum Larsen Index in summer and lowest in spring has occurred. The maximum aggressive Index in autumn and lowest in spring has occurred. Annual Average of Ryzener and Langelier index was calculated results are presented in diagram 7 and 8.

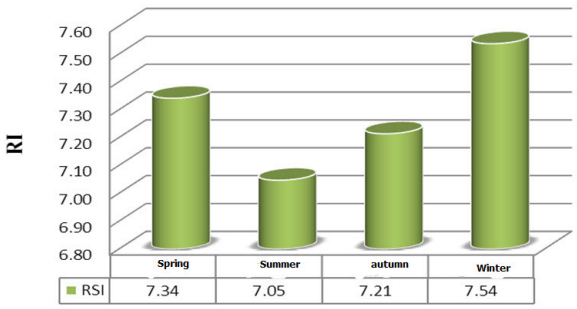

Chart 8: The index of the seasons Reisner

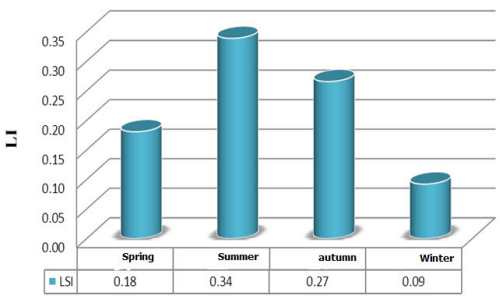

Chart 7: Langelier index in different seasons

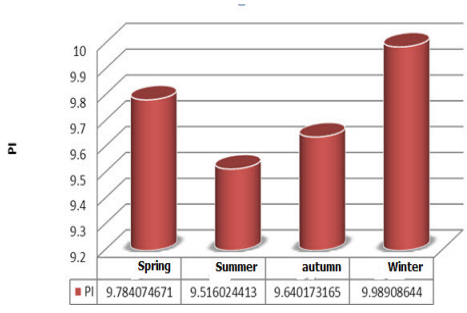

Chart 10: The index of through the seasons Pokurious

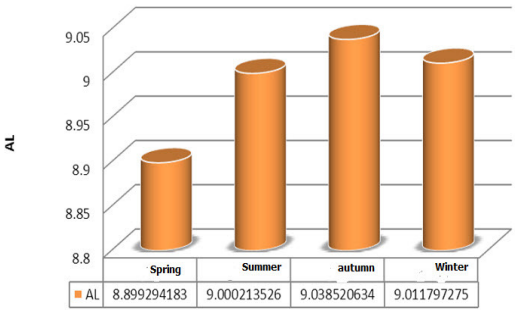

Chart 9: The invasive index of through the seasons

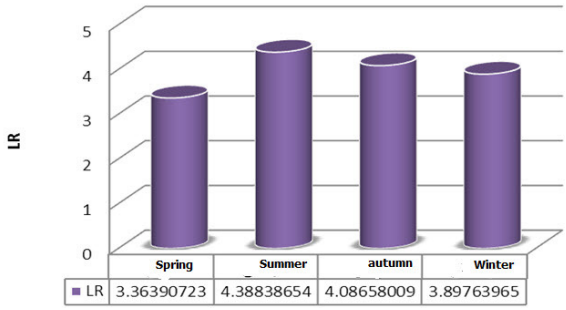

Chart 11: Larsen index in different seasons

As it can be seen on the Langelier index the water in 2005 and 2011 is sedimentation, in the years 2012 and 2013 corrosive and in 2014 the water is fouling. The values of Ryzener index for the years 2005 to 2014 is between 06/7 to 64/7, which is corrosive and a little precipitation on the base of Table 3. According to figures 14, 15,16 respectively aggressive index is between 69/8to 11/9, Parkorios index is between 034/7 to 12/8, Larsen index is between 91/2 to 71/7 which is showing that the water is a corrosive.

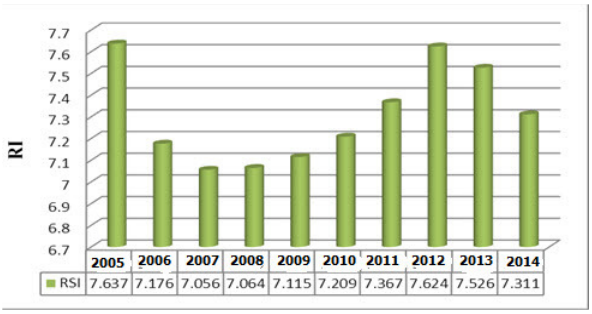

Chart 13: The Ryznar index in different

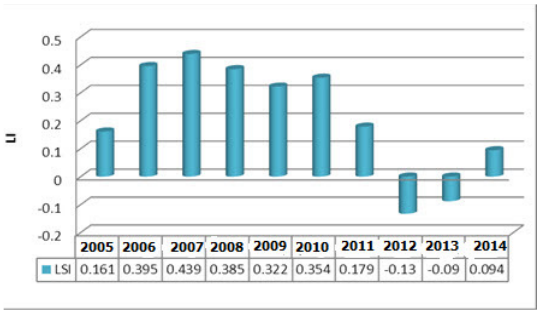

Chart 12: Lanzhnyh index in different years

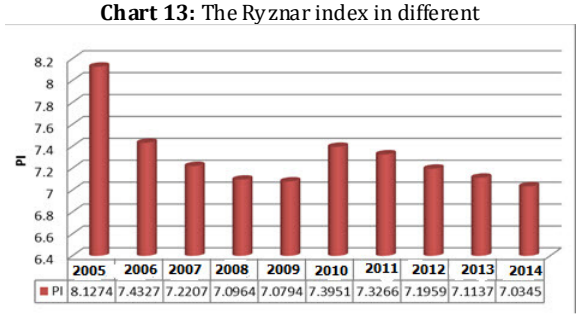

Chart 15: Pokurious index in different

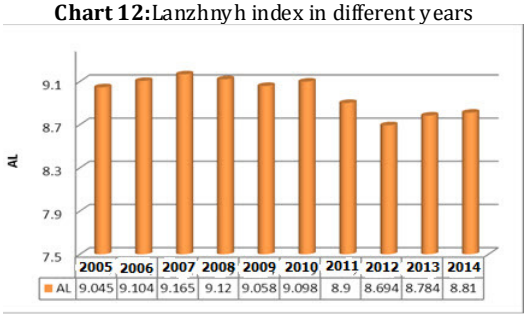

Chart 14: The invasive index in different

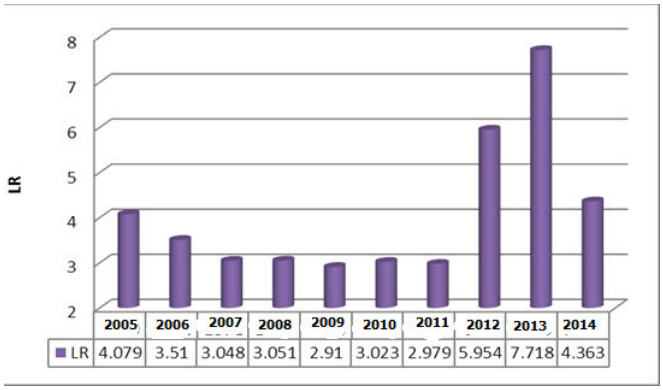

Chart 16: Larsen index in different

3. Conclusions and recommendations

According to conducted surveys studies on the hydraulic structures on Bahmanshir river, The amount of ions changes indicate that we are going towards the end of river, the amount of anions and cations are added to the river which stems from urban wastewater, agricultural and industrial pollutants as well as sea water entering from Persian gulf to Bahmanshir river . The situation of water is slightly corrosive and fouling in different months. While in the cold months is more corrosive and during the hot months corrosion is reduced.

4. Suggestions

Different strategies can be used to control water corrosively which are depend on the Engineering and economic policies operator that the decision to use those methods shall be taken according to local conditions and facilities.

Protection and control techniques can be named as follows:

Water treatment, Colors and polished coatings, Cathodic protection, cement Coatings, Galvanized coatings, Tin coating, cadmium coating and stainless coating.

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