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The Evaluation of Water Leakage in the Irrigation Channels of Kazeroon Plain Using the Input Method of Discharge and Experimental Formulas

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Abstract

Water scarcity is one of the most important problems encountered in arid and semi-arid areas, and as a limiting factor, the growth and development of vegetation in these areas is limited. Considering that Iran is a country of low water and dryness, using solutions to reduce water consumption and optimal use of available water amounts to a solution to many problems. One of the best practices is the optimal utilization of soil and water resources. With the increasing population of the world and the limited supply of water and food, many experts have sought to limit the use of this water for optimal use. One of these existing strategies is to evaluate the effect of coating on irrigation canals to reduce leakage. The results of the research carried out in Kazerun plain in Fars province, which was carried out by the Input flow method, showed that in the case of coated walls of the Arab irrigation canals, Shah Paradise and Khaje bagheri, from dirt to coated, decreased by 57.78, 78.73, and 89.4% in water leakage. The statistical analysis showed that the difference between the amount of water leakage in the Arab soil and coated channel at the level of 5% was significant in the soil and coated channel of the Shah landscape at a level of approximately 1% and in the Khaje bagheri canal at this significant level are not. Also, the results of comparing this method with empirical formulas showed that the maximum leakage value is represented by the Davis and Wilson formulas in the Khaje Bagheri channel and the lowest leakage rate is the Indian Punjab formula in the Arab canal.

Keywords: Irrigation; Water; Canals; Leakage

Introduction

In many agricultural plots, the distance between the water supply to the farm is high, which increases the water loss in irrigation canals. Unfortunately, most of the irrigation channels are traditional sources, with a significant amount of water leakage. One of the ways to reduce water leakage in soil or traditional irrigation canals is to coated the canal body with materials such as cement, stone, bricks, asphalt, and plastics and petroleum products that are more common than conventional cement coatings. Due to the traditional nature of the channels, water losses in the water conduits are higher through leakage. To solve this problem, the authorities are planning to coated and modernize the channels. One of the causes of waste water on the path to the farm is the leakage from the canal, which is considered as one of the most important factors in water waste in some irrigation areas.

According to the data provided by the Ministry of Jihad-e-Agriculture and the Ministry of Energy (Iran), the irrigation efficiency of arable land is 31% and is estimated at 34.5% for the current conditions, although this is a bit far from reality, but it reflects the fact that the high irrigation efficiency. And the need to implement research projects to improve efficiency and save water consumption is felt more and more. This is especially important in dry and semi-arid areas and therefore the need for quantitative and qualitative water leakage from the canals is considered. Therefore, in irrigation schemes, minimizing water losses to the minimum required is an urgent need, and will draw the attention of the experts to the leakage current of the channels and related issues. One of the ways to save water is to prevent leakage losses from irrigation canals. The significance of these casualties is so much that the country's water industry standard plan to prevent water losses is recommended by networks of irrigation canals of grades 1 and 2 in all coated Iran's projects.

The use of open channels for carrying water is the most commonly used method in the state of Washington, USA. Today, much water is lost by leaking from the floor and the walls of these canals. The leakage of canals in a kilometer and places is causing water loss. The control of leakage from the channels leads to waste of water and the creation of new water sources [1].

Alam and Bhutta [2] obtained leakage during one day in cm, with a leakage rate of 6 cm/day for Ponding, but in the Input -output flow of 16 cm/day. The Ponding method was more accurate than the Input-output flow method.

Soltani and Maroufi's [3] showed that in the Khuzestan region, the drop in a number of soil channels in the irrigation network of this region was measured by the Input-output flow method. The transmission efficiency in the channels of this network varied from 34 to 83 percent. On average, it is about 60%; as well, the results showed that the casualties in the transmission channels of this network varied from 0.75 to 18.66 liters per second at 100 meters. The air phenomenon changes from channel length to an average of 17.7 liters per second per hundred meters from the length of the channel. In the course of the research, the Input -output flow method was used to calculate the amount of water leakage. In this method, the amount of inlet and outlet water and the length of the intervals are measured, to measure the flow velocity of the mole. Measurements are made in three sections and three replications. The operation of measuring speed in high-vegetation vegetation channels was problematic, so sections of the channel were selected that allowed the Molina readings with the minimum of personal and machine errors. In this method, the flow of Input and

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output from the product of the speed of flow at the cross-section of the Input/output is obtained. Kinzli et al. [4] estimated leakage losses in Colorado's earthly canals at 15 to 45 percent of the total water volume in the irrigation canal. Swamee et al. [5] reported in an article that water drops in the canal is estimated to be about 45 percent of the water in the irrigation channel when the water reaches the farm.

The World Standard Organization has outlined some considerations for the selection of cross sections in channels in 2007 as follows:

1. The channel should be flat and aligned.
2. Distribution of speeds (both vertical and horizontal) should be regular.
3. Swelling should occur in the upper reaches of any obstruction and significant incidence at the cross-section [6].

Salemi and Sepaskhah [7] measured the water leakage in several Ruddasht channels of Isfahan by Input-output flow method and calibrated the leakage equations for that area. The results showed that experimental leakage estimation methods estimated the leakage rate less than the reality and introduced the best method for their study area, the Ingham and Moritz methods.

Materials and Methods

This research has been carried out in Dadin from Kazeroun city in Fars province in the years 90-91. Unfortunately, in recent years due to reduced rainfall reduction and indiscriminate withdrawal of groundwater resources, water resources in the region is declining, so in recent years the authorities, several measures have done, one of which coated the channels of traditional irrigation area, in order to reduce The amount of water leakage is wasted. In this research, determination of water leakage in Arab irrigation canals, Shahmanzar, Khaje Bagheri was considered and in each channel three replications were considered. The method was to use Input-output flow to measure leakage. Measurements were performed at three points on each channel.

Two methods of Input-output and Ponding were used to measure leakage. Also compared experimental equations with Ponding methods and these are calibration and noticeable the most equation than there. Measurements were performed at three points on each channel. Leakage values were compared in uncoated channels and coated channel in each method. Leakage measurements were also compared. T-test was used for this comparison. Considering that in most scientific sources the use of anchoring method was used as the basis of comparison, this study was also considered as a control and the Input -output flow method was compared with it.

The characteristics of the channels evaluated and studied are as follows.

1. Arab Dadin water supply channel, made of stone and cement, is a rectangular or box shape, 0.5 m channel width, 0.45 m high, longitudinal slope of 0.002 m, wall width 0.45 m, and channel of canal Designed for 200 liters per second.
2. Channel of Shah Parasite aqueduct, made of stone and cement, is a rectangular or box shape, channel width 0.65 m, height of 0.6 m, longitudinal slope of 0.001 m, wall width of 0.45 m and channel of the channel designed for 250 liters per second.
3. Khaje Bagheri water supply channel is made of rock and cement, is a rectangular or box shape, 1 meter wide channel, 0.8 meter height, longitudinal slope of 0.002 meters and channel flow rate of 500 liters per second.

Input-output method

At first, the cross-sectional area of the channel (both earthy and concrete) is obtained, and then the channel is marked in two to three parts with a length of approximately 100 meters. (In this method it is not necessary to block the channel). As it was mentioned above, the cross-section of the channel in this method is obtained at the beginning and end of the desired length, then in the same places where the cross-section was taken, at the first point (start) of the micro-Molinas. At the beginning of the water channel, the depth of water and then the number of permits and times are recorded, so in a few points of the channel (transversally) immersed the impeller in water and in accordance with the depth of water, the number of times and time. It is recorded here that the time (40 s) is constant; at the 100 m second point (the end), the starting point should be the depth of the water at the beginning of the channel and the other point gained the channel (cross section) along with the number of rounds of the butterfly. The flow velocity was measured and multiplied by the cross section, flow rate was calculated on both sides of each interval and the difference is equal to leakage rate. The longer the channel is to be considered, the more accurate the data and measurements (with the help of professors and resources). In this method, uniform flow is required in the measurement [2] (Figure 1).

The following formula is used to obtain the results of the Input-output (Micro-Molina).

$V=N/T \times 0.2625+0.0055$

Where V: Speed, N: Number of rounds, T: Time (S) and the rest of the numbers are related to the calibration coefficients of the device.

If the number of rounds in a second exceeds 0.58, then the mean velocity of the formula (0.008+Rounds per second × 0.2665) is used.

And if the number of rounds in one second does not exceed 0.58, then the average speed of the formula (0.015+rounds per second × 0.2445) is used.

The Excel software was used to enter data into the computer and plot the graphs and analyze the data, and Autocad software was used to calculate the leakage and drawing of the cross-sectional area of the channel (Figure 2).

Discussion and Conclusion

Table 1 shows the average amount of water leakage in the canal (coated and uncoated) Arab using the flow-through-flow method. Also, the percentage of water leakage reduction due to the coating has been calculated and arranged. It is observed that the average water leakage in the Arab canal (coated and uncoated) is 0.036 and 0.17 cubic meters per day per square meter, due to the coated of the channel to about 78.57% of the leak rate water has been lost.

Table 2 shows the average water leakage in the channel (coated and uncoated) of the particle shade using the flow-through-flow method.

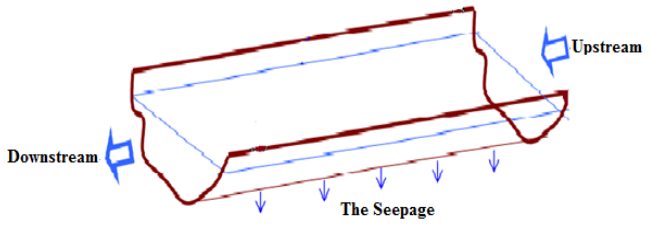

Figure 1: The openings of the test channel using the Input -output flow method.

Also, the percentage of water leakage reduction due to the coating has been calculated and arranged. It is observed that the average water leakage in the Shah'Canal was (0.036 and 0.226 $m^3/day.m^2$) which, due to the coated of the canal, were about 83.78% water leakages has been reduced.

Table 3 shows the average water leakage in the channel (coated and uncoated) of Khaje Bagheri using the Input-output flow method. Also, the percentage of water leakage reduction due to the coating has been calculated and arranged. It is observed that the average water leakage in the Khaje Bagheri channel (coated and uncoated) was 0.032 and 0.308. Due to the coated of the canal, about 89.4% of the water leakage rate has been reduced.

Tables 4 and 5, respectively show a mean leakage and statistical analysis of different leakage rates in different ways in the Arab canal. In Table 4, the statistical analysis shows the Input-output flow method in the coated and non-coated Arab channel, in which the average leakage in each of the three repetitions, the number of repetitions, standard deviation and standard error is calculated. The statistical analysis showed that the difference between the water leakage rate and the Input-output flow rate in the coated and non-coated Arab channel was significant at 5% level.

Figure 2: Molinas devices.

Tables 6 and 7 show the mean leakage and statistical analysis of the difference in leakage rates with different methods in the Shah manzar canal. In Table 6, the statistical analysis of the Input-output flow method is calculated in the channel coated and uncoated by the Shah manzar. In this table, the average leakage is given in all three repetitions, number of repetitions, standard deviation and standard error. The statistical analysis showed that the difference between the amount of water leakage and the Input-output flow in the Shahmanzar and coated channel of the shah manzar was significant at 1% level.

Tables 8 and 9 show respectively the average leakage and statistical analysis of the difference in leakage rates in different ways in Khaje bagheri canal. In Table 9, the analysis of the Input-output flow method in a coated and non-coated channel of Khaje Bagheri is calculated separately.

Statistical analysis showed that the difference between the amount of water leakage in the Input and output discharge method was not significant.

In general, it can be concluded that empirical formulas that are not significant at a significant level are more accurate. Formulas that

Period Repeat	Leakage channels are not coated (m^3/day.m^2)	Leakage in the Channel has coated age(m^3/day.m^2)	Reduction of leakage in the coated
1	0.21	0.03	85.71
2	0.156	0.048	69.23
3	0.144	0.03	79.16
Average	0.17	0.036	78.57

Table 1: Percent reduction of water leakage in the Arab irrigation channel by Input-output flow method (coated and uncoated).

Period Repeat	Leakage channels are not coated (m^3/day.m^2)	Leakage in the Channel has coated age(m^3/day.m^2)	Reduction of leakage in the coated
1	0.228	0.03	86.84
2	0.294	0.048	83.67
3	0.156	0.03	83.78
Average	0.226	0.036	83.78

Table 2: Percentage of water leakage in the shaft irrigation channel with Input-output flow method (coated and uncoated).

Period Repeat	Leakage channels are not coated (m^3/day.m^2)	Leakage in the Channel has coated age(m^3/day.m^2)	Reduction of leakage in the coated
1	0.198	0.036	81.81
2	0.408	0.03	92.3
3	0.318	0.03	90.56
Average	0.308	0.032	89.4

Table 3: Percentage of water leakage in Khaje Bagheri irrigation channel with Input -output flow method (coated and uncoated).

Chanel irrigation Arab	Method	Average leakage	The number of repetitions	Standard deviation	Standard error
Arab channel have been coated	Inflow-Outflow	0.036	3	0.011	0.006
Arab channel non coated	Inflow-Outflow	0.17	3	0.036	0.021

Table 4: Water leakage rate in the Arab canal.

Chanel irrigation Arab	Method	The difference between average	Standard deviation	Standard error	Degrees of freedom	The significant level
Channel Coated	Inflow-Outflow	0.025	0.012	0.006	2	0.053
Uncoated channel	Inflow-Outflow	-0.176 ns	0.134	0.077	2	0.152

Table 5: Analysis of water leakage in the Arab canal.

Chanel irrigation Shahmanzar	Method	Average leakage	The number of repetitions	Standard deviation	Standard error
Shahmanzar channel have been coated	Inflow-Outflow	0.036	3	0.011	0.006
Shah manzar channel non coated	Inflow-Outflow	0.226	3	0.069	0.039

Table 6: Level of water leakage in the Shah manzar Channel.

Chanel irrigation Shahmanzar	Method	The difference between average	Standard deviation	Standard error	Degrees of freedom	The significant level
Channel coated	Inflow-Outflow	0.01700 ns	0.01127	0.00651	2	0.121
Uncoated channel	Inflow-Outflow	-0.09367 ns	0.09042	0.05221	2	0.215

Table 7: Analysis of the rate of water leakage in the Shah manzar channel.

Chanel irrigation Shahmanzar	Method	Average leakage	The number of repetitions	Standard deviation	Standard error
Khajeh Bagheri channel have been coated	Inflow-Outflow	0.032	3	0.0035	0.002
Khajeh Bagheri channel non coated	Inflow-Outflow	0.308	3	0.105	0.061

Table 8: Water leakage rate in Khaje Bagheri channel.

Chanel irrigation Shahmanzar	Method	The difference between average	Standard deviation	Standard error	Degrees of freedom	The significant level
Channel Coated	Inflow-Outflow	0.01233 ns	0.00651	0.00376	2	0.082
Uncoated channel	Inflow-Outflow	-0.05267 ns	0.13931	0.08043	2	0.580

Table 9: Analysis of water leakage in Khaje Bagheri channel.

are meaningful are less accurate than other methods and should be calibrated for the tested channel.

Calibrated experimental formulas

Ingham equation: The difference in the leakage of the non-calibrated Angah equation is 23% Ponding and the calibrated formulation is reduced to 4% (approximated by leakage calculated by the Ponding method).

$q = 0.55CPL\ (10^{-6})(H^{0.5})$

Where, C=5.5

Moles Worth and Yenniduniya equation: The difference between the leakage rate of the non-calibrated Moles Worth and Yenniduniya equation is 35% by Ponding, and the calibrated formulation has decreased by 20% (approximated by leakage calculated by the Ponding method).

$q=(86.4).C.\ (R^{0.5})$

Where, C=0.027

Davis and Wilson equation: The difference between the leakage rate of the non-calibrated Davis and Wilson equation is 68%, and the calibrated formula has been reduced to 26% (approximated by leakage calculated by the Ponding method).

$$q = 0.45 \times C \times \frac{Pw \times L}{4 \times 10^6 + 3650V^{0.5}} \times H^{1/3}$$

Where, C=0.7

Moritz equation: The difference between the leakage rate of the Mauritius calibrated non-calibrated equation is 60% off, and the calibrated formula has decreased by 25% (approximated to the leakage calculated by the Ponding method).

$$q = 0.0186.C.(Q/V)\hat{}\ 0.5$$

C=0.99

Punjab India equation: The difference in the leakage of the non-calibrated experimental equation of Punjab in India is 85%, and the calibrated equation has decreased by 49% (approximated leakage rate by approaching the Ponding method).

q=(C).(a).(d)

C=5

In this chart, the amount of leakage obtained in the non-coated channel is compared with the Input-output flow method, the Moles Worth and Yenniduniya experimental formula, the Moritz experimental formula, the Punjab India experimental formula, the Ingham experimental formula, and the Davis and Wilson experimental formula (Figure 3). Taken together, for comparison, the maximum leakage value is represented by the Davis and Wilson formula in the Khaje Bagheri channel and the lowest leakage rate is the Indian Punjab formula in the Arab canal.

In this diagram the leakage calculated the methods of Input-Output and Ponding channels coated are compared and analyzed. The greatest amount of leakage in the Input-Output channel view Shah Manzar and the lowest leakage rate of Input-output channel of Khaje bagheri,

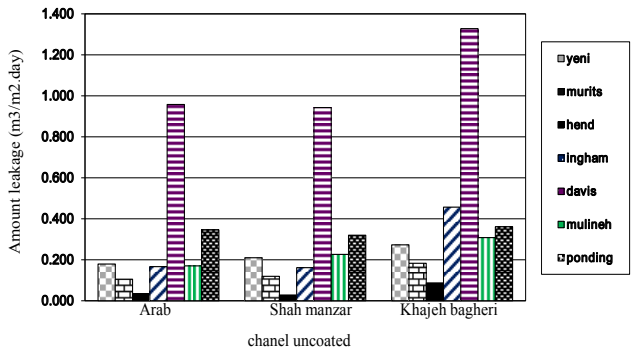

Figure 3: Comparison diagram of statistical analysis of leakage amount in soil canals with experimental formulas and Input-output flow methods.

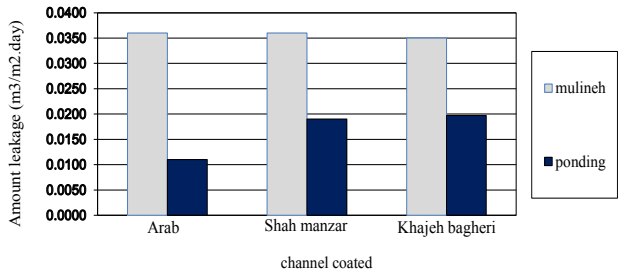

Figure 4: Compares the leakage channels coated with the methods of Input-Output and ponding.

similarly, most leakage using the method of Ponding Khajebagheri channel and the lowest leakage in the method of Ponding Arab channel (Figure 4).

Also, the statistical analysis performed on the data of the Input-output outflow discharge method showed that the amount of leakage in uncoated irrigation channels was much higher than the leakage level in the irrigation channels coated.

Pounding method was also the best method for measuring leakage rate.

According to the results, it is concluded that the leakage rate in the ducts coated by the Arab Ponding method is 0.010 $m^3/day.m^2$, Shahmanzar 0.020 $m^3/day.m^2$, Khaje Baqeri 0.020 $m^3/day.m^2$and the leakage rate in non-coated channels by Ponding, Arab 0.170 $m^3/day.m^2$, Shahmanzar 0.320 $m^3/day.m^2$, Khaje Bagheri is 0.36 $m^3/day.m^2$. Therefore, the average percentage of leakage losses due to coating in the Arab canal, about 97%, in the Shahmanzar, is about 94%, and in the Khaje Bagheri channel, about 95%, the leakage rate in the coated channels has decreased.

Similarly, the leakage rate was calculated using the Input -output method in Arab coated channels 0.036 $m^3/day.m^2$, Shahmanzar 0.036 $m^3/day.m^2$, Khaje Bagheri 0.032 $m^3/day.m^2$. Similarly, leakage rates in non-coated channels by Moline, Arab were 0.170 $m^3/day.m^2$, Shahmanzar 0.226 $m^3/day.m^2$, Khaje Bagheri 0.308 $m^3/day.m^2$. Therefore, the average percentage of leakage losses due to coating in the Arab canal, about 79%, in the Shahmanzar, is about 84%, and in the Khaje Bagheri channel, about 89%, the leakage rate in the coated channels has decreased. Statistical analysis showed that the difference between water leakage rates in all three soil and coated channels and using Input-output discharge method was significant at 1% level. Also, the comparison between two methods of intake and discharge/intake showed that the difference between the two methods in the soil channel is 5% and in the coated channel at 1% level. It is recommended that studies be carried out on the other irrigation channels implemented, and it is proposed to consider the economic coated of the channels.

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