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Non-Accounted Water Assessment at the Level of Water Distribution Networks in Isfahan's Small Communities, Isfahan, Iran

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Abstract

In our country, in addition to economically significant costs of wasting water, which the government should pay, and our country has limited water resources. Therefore, identifying ways of occurrence of water losses and providing solutions to these problems will be a great challenge for the newly created water and wastewater industry in the country. The main objective of this review is to prove the high-water waste in Isfahan water distribution networks and to obtain its amount and provide methods for identifying and reduction its bad effects. In this review, the annual water balance method has been used to calculate non-accounted water, it means the difference between water production and consumption. Finally, the most important reasons for water loss at pilot points are the failure plan and the inaccuracy of subscribers' water meters, burnout of pipes, installations, faucets and the lack of proper design of the water distribution network and unauthorized branching. According to the research carried out in this research project, the amount of not considered water in the scope of the project was approximately (33.6%) and in the villages of Senete complexes, Yazebolaghi, Ghamlu and Alyverdi were 33.8%, 33.7%, 33.9%, and 33.9% respectively.

Keywords: Non-accounted water; Water utilities; Water distribution network; Meter; Wastewater

Introduction

From the 21st century it is called the century of water crisis. At present, water needs are increasing rapidly due to demographic and industrial development, while climate change, droughts and pollution have caused more limited human water availability, especially for drinking [1,2]. Therefore, supplying water with quantity and quality is considered as the main concern of policy makers at different levels of management. In the meantime, the supply of drinking water to human societies is of high importance and because of its high quality, there is a need for special installations, resulting in considerable time and cost [3-7].

Reducing the amount of water not considered in addition to reducing the cost of investment and operation and maintenance of the water system, increasing the life of water facilities, including water purification equipment, pumping and improving the quality of water supply will increase the economic efficiency, technical and improve the satisfaction of rural subscribers of Water and Wastewater companies [7-12].

Literature Review

The concept of non-accounted water and non-revenue water

According to the definition given by the World Bank, the Non-accounted water is the difference between the pure productions of water (the volume of water entering the network from the refinery or main reservoir) minus consumption [18]. Since 2000, the concept of non-revenue water 1 (NRW) has been proposed by the World Water

Institute (IWA) as the basic concept used by most countries in the world, which includes two parts:

- Allowed consumptions without paying costs, which usually form a small part of consumption [13,14].
- Water losses includes two types. Actual and apparent losses (illegal consumption and caused by measurement errors) [15,16].

Measured amount of consumed water- Amount of generated water=Non-accounted water

The objectives of the non-accounted water project

- Reduced the amount of the non-accounted water up to 50% of the existing situation in urban and rural systems [17].
- Audit on identification subscribers and their costs and determining non-physical casualties (losses) [18].
- Identification of the system of guidance and determination of physical losses [19].
- Determine the strengths and weaknesses of the leadership [20].
- Determine the strengths and weaknesses of the subscriber affairs system [21-23].
- Determine the long-term executive plan to improve the status quo [24].
- Provide solutions to reduce water leakage and provide relevant instructions [25].

Causes of the occurrence of non-accounted water

- Expired (finished) the useful life of the facility [26].
- Failure to comply with all executive standards, especially monitoring implementation [27].
- Failure to exploitation and maintain the facilities properly [28].
- Not having a proper program in exploitation, especially in the leak detection area [29].
- Failure to measure inputs and outputs at installations [30].
- Management errors in exploitation affairs - affairs of subscribers [31-33].
- Poor quality of consumable (used materials) [34-36].
- imprecise measuring instruments [37].
- Failure to establish measuring instruments on main pipes or key points of the facility [38-41].
- Lack of technical and experienced staff and lack of opportunities for retraining them in different job categories [42-46].

Reasons for leakage in pipes

- High system pressure [47].
- Inaccurate soil around the pipe [48].
- Archaism pipes of network and burnout of them [49].
- The inappropriate pipe materials and its appurtenance [50].
- Failure to observe the technical test points of pipe at the workshop [51].
- Use of inappropriate materials for pipe coating and subs ruction [52-54].
- Non-standard pipe putting by unprofessional workers [55-58].

Components of non-accounted water

Non-accounted water consists of two major parts:

Non-physical or apparent losses of non-accounted water: This portion of the water is not considered to be consumed by subscribers, but because of the human error, the measurement tool or the management and leadership errors of the system are not measured and its costs does not take by the water and wastewater company [59-64].

Physical or actual water losses of non-accounted water: This part is due to the physical evasion of the water from the distribution network and the subscribers' branches, not received by the consumer and the cost is not taken by the water and wastewater company [65-68]. The losses' amount is significantly depending on specifications of the network pipes and the leak detection and repair policy [69-74].

Methods for analyzing and calculating non-accounted water in water networks

- Annual water balance method [75].
- The method of estimating the leakage components **(Tables 1 and 2)** [76-79].
- Night Stream Analysis Method [80].

Table 1 Required information for calculating leakage components.

Network components	Field losses	Reported Fractures	Unreported Fractures
Main lines	Length	Number per year	Number per year
	Pressure	pressure	pressure
	Losses rate per kilometer	average output flow rate average duration	average output flow rate average duration

Joints and branches from main line up to subscription	Number	Number per year	Number per year
	pressure	pressure	pressure
	losses rate in branches	average output flow rate average duration	average output flow rate average duration
Joints	Length	Number per year	Number per year
Branches	Pressure	pressure	pressure
Joint building	losses rate per kilometer	average output flow rate	average output flow rate average duration
		average duration	

Table 2 Recommended values for field leakage rate at standard pressure of 50 m.

Components of field losses	Unit	Bad instruction	Moderate instruction	Good instruction
		Conditions	Conditions	Conditions
Field losses in the main pipe distribution	Liter per kilometer per hour	60	40	20
Field losses in subscriber lines(branch)	Liter per branch per hour	4.5	3	1.5
Field losses in pipe inside Substations	Liter per subscriber Per hour	1.5	1	0.5

Table 3 Proposed values for calculating the amount of waste water losses due to fractures.

Details	Reported fractures		Unreported fractures	
	Occurrence frequency	Discharge flow (cubic meter per hour)	Occurrence frequency	Discharge flow (cubic meter per hour)
Main transmission lines	0.03 km/ year	30	0.006	0.12
The main distribution lines	0.15 km/ year	12	0.008 km/ year	0.6
Branches	2.5 per 1,000 branches per year	01-06	0.825 per 1000 branches in year	1.6
Pipes inside the subscription	2.5 in 1000 branches per year	1.6	0.825 per 1000 branches in year	1.6

Method for calculating the non-accounted water in six villages of Pilot

The following three steps have been taken to calculate non-accounted water in rural areas:

- Determine the total volume of water generated or imported into the distribution system [81-85].
- Determine the total volume of water measured by subscriber meters [86-90].
- The final step of the task of determining the amount of non- accounted water equal to difference between the losses amount of water generated and the amount of water consumed **(Table 3)** [91-95].

Suggested approach of water losses controls

In most cases, including the research project in the villages of Isfahan province the expired useful life of the installations and the giving of new offshoots are causes of incident and events in the water supply system, which requires a complied program divided into following cases:

- Teaching and creation the culture of informing the incident in villagers [96-102].
- Correct and timely encounter with the accident and the full identification of the causes of its creation [103-107].
- Provide optimal services to subscribers to reduce wastes and prevent escalation of accidents [108-112].
- Prevent the undesirable development of water supply facilities by planning to reduce the amount of losses in the distribution system [113-116].
- Identify the weaknesses of the distribution system and the principled program for correcting faulty networks [117-120].
- Reduction of hydraulic phenomena including ram blows with proper network design and increasing the efficiency of the available facets in the network [121-126].
- Use of the minimum time in repairs [127].
- Compile a map of the density of incidents [128-132].
- Explore the causes of the incidents [133-138].
- Removing non-standard networks and replacing modern and advanced networks with the appropriate tools [139-145].
- Optimal use of the private sector in the reconstruction of incidents' recovery, along with precise monitoring levers on the contractor's work [146-152].

Suggestions

- As we know, research and investigation are the method of proved accountability to questions and finding the unknowns [153-156]. The proved message of this study is to identify ways to reduce water losses and provide

solutions to it as a result of reducing water losses factors and to rise the life of existing installations, as well as adequate use of facets and obviates a lot of problems of the water and wastewater industry in the country [157-162].

- Using the methods and solutions presented in this plan or other plans to reduce water losses should be implemented as soon as possible by the water and Wastewater Company of Isfahan province to prevent the most losses of water resources and its harvesting [163-167].
- Implementing practices for reducing non- accounted water through the province's ABFAR Company, according to past experiences, has a lot of economic benefits for the company [168-174]. Therefore, it is recommended that, despite the high cost of reduction of water losses strategies, the company will take steps to implement these methods and approaches [175-180].

Method of calculation the exact amount of water production at pilot points

In order to calculate the exact amount of water production in pilot villages, in this plan, one of the most popular and most efficient methods available in the country is used, that due to limited financial, installations and instructions facilities, we used the water balancing method to calculate non-accounted water [181]. According to the balance of water method, the amount of waste water is obtained from the actual difference between the amount of consumption and production of input water [182-186]. It was necessary to measure the exact amount of water production at the wells through volumetric meters, but due to some of the installation problems, the financial and non-availability of such meters at the design area or their failure if they were existed, use of this method was impossible so to calculate the approximate amount of produced water We used from the outlet flow rate of the wells [187].

Discussion

Therefore, in order to calculate the waste of water at the mentioned points, the plan required amount of flow rate needed by the well, the average hours of the pump work in different time period, the number of working days in the considered period and for the non-automatic pumps (precise information collected from the water collectors), and considered the possible errors in the rate of water output from the well, changes in pressure and flow, and so on [188]. Due to the lack of facilities needed for the operation of pressure gauge and the lack of precision to carry out the work in this plan, considering the available facilities and equipment, it was virtually impossible to examine these cases [189].

Conclusion

The important thing to pay attention to is that, in order to be equally accurate in the calculation of sales and production of water, according to the principle of the theory of errors, some of the above errors can be eliminated, and in some cases, such as the accuracy error of the meters and pumps in different conditions equal ± 1% of the total, so you can discard it [190]. Of course, the above method used to calculate the water production due to non- automatic pumping machines has problems with low accuracy, which in some points of the plan scope, the average of the operation of pumps at night and during different periods which collected through collectors have been used [191]. In order to collect the water production information in each complex, at first, the proposed pump flow rate was calculated from the catalog on the pump and obtained the average value of the pump operating hours at different time periods (daily, ...) by the same catalog. In case of unavailability of access to the information in most of cases, the information was collected through water users and accorded with the information in Abfar of province and suspicious data was identified and modified as follows.

Therefore, by calculating the amount of production and sale of water over a given period and dividing this amount of production within this specific period, the amount of water or water losses during the specified time for the intended place non-calculated (UFW) is obtained [192].

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