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Estimating the Water Loss Volume in an Experimental Installation

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Abstract
The paper presents a study on the sensitivity of the water meters and on the volume of the water loss in a water supply branch, corresponding to a block of flats, aiming to emphasize ways in which errors in metering the consumed water are produced. It is presented also the experimental installation used in the research, which consists of several water meters of different types, used as apartment water meters and branching water meters. The water meters analysed are of three types, belonging to two different precision classes. Data analysis was performed on data collected from the water meters considered. The experimental installation is used for collecting experimental data, for determining the water loss volume; it also analyses the water loss estimated for a month for each water meter considered, creating the premises for estimating the water loss volume during a certain period of time for a block of flats consisting of a certain number of apartments, assuming that there are the same type of water meters mounted in each apartment. In this way it is possible to determine the losses in a potable water supply system.

Keywords
water flow, water meter, water loss volume

1. Introduction

Rational utilization of all natural resources, including water resources represents a major problem. There are multiple efforts for finding ways in which water losses are detected and reduced and it is very important to use accurate water meters and leakage detecting equipment [1-3].

Leakage occurs in all distribution networks [3]. It is important to distinguish between total water loss and leakage. Total water loss represents the difference between the amount of water produced and the amount which is billed or consumed; it depends on the pressure in the system, and on how quickly the loss is noticed and solved. Leakage represents a part of the total water loss in a network, and consists of the physical losses from the elements of the water installation – pipes, joints and fittings, and also from overflowing service reservoirs; these losses can be severe, and may be undetected for long periods of time. Other parts of total water loss are non-physical losses: meter under-registration, illegal connections, and illegal or unknown use [3].

A very important issue in a water supply system is represented by creating the appropriate conditions in which each consumer pays correctly for the consumed quantity of water; in these conditions, the use of water meter helps promote a more responsible attitude of the consumer towards water consumption, and so it helps to reduce the irrational water losses. Reducing water consumption generates lower costs for obtaining the potable water, for maintaining the whole water feed, which produces a good impact on the rational exploitation of water resources [1-3].

The paper presents an experimental installation which was used for collecting experimental data, for determining the water loss volume; it also analyses the water loss estimated for a month for each water meter considered, as well as that estimated for a month for the entire block of flats considered (40 apartments), assuming that there are the same type of water meters mounted in each apartment.

2. Experimental Installation

The experimental installation used in the research is presented in Fig 1. It consists of 9 water meters of three types, belonging to two different precision classes: three water meters of type I (precision class

B), three water meters of type II (precision class B), three water meters of type III (precision class C), connected in series arrangement [4, 5]. For water meters, class C means high precision and they are in general branching water meters, and class B means mediate precision and they are apartment water meters, with a more accessible price, but with a lower precision [6].


Fig. 1. Experimental installation

Water meters of type I are apartment water meters for cold water or hot water, of precision class B, with nominal diameter Dn15 and minimum starting flow 30 l/h. Water meters of type II are apartment water meters for cold water, of precision class B, with nominal diameter Dn15 and minimum starting flow 30 l/h. Water meters of type III are single-jet water meters, of precision class C, with nominal diameter Dn15 and minimum starting flow 15 l/h.

Water meters of precision class C are designed such as to start the correct registration of the water consumption from the minimum starting flow $Qmin$ = 15 l/h, while in case of the water meters of precision class B, the minimum starting flow is $Qmin$ = 30 l/h. As a consequence, since water meters of precision class B are apartment water meters, it results that any water consumption which is less than 30 l/h will not be correctly registered by the apartment water meter. In case of a block of flats, although apartment water meters might not register correctly the water consumption due to a reduced flow in the apartment installation, the proper consumption will be correctly registered by the branching water meter which is the general water meter for the block of flats. Thus, the water losses are not registered by the apartment water meters and the water consumption is not paid correctly, so that the water company may have financial losses.

3. Estimation of the Water Loss Volume in a Water Supply Installation

A study was conducted using the water meters in the experimental installation described in Fig. 1, for determining the volume of the water loss in case the flow is less than $Qmin$=15 l/h. It was considered the case of a leakage which is difficult to detect by the consumer, when, from time to time, a very small drop of water appears and falls from the tap. It might be the case in which the tap is not completely closed and water pours drop by drop from time to time, without this fact to be detected by the consumer [4, 5].

The volume of the water loss depends on the water flow in the installation. The three cases presented below prove this fact. Each of the three water flows is less than the minimum starting flow for the water meters considered.

In each case it was registered the period of time t in which a water loss has occurred, the size of the actual water volume collected drop by drop being V =2 l. Table 1 presents, for each case, the water flow Q, calculated for the corresponding period of time t, with the formula below:

$$Q = \frac{V}{t} . \quad (1)$$

Table 1 presents the volume of the water loss, volume which is not measured by the water meters considered and the volume of the water loss corresponding to one hour, for each value of the water flow Q.

Table 1. Water loss registered for different values of the water flow Q

Water flow Q (m³/h) Time t	Type of water meter	Volume of water, recorded (l)	Mean of the volume of water (l) recorded	Actual volume of water (l), corresponding to time t	Volume of water loss (l), corresponding to time t	Volume of water loss (l), corresponding to one hour
$Q_1 = 3.649\times10^{-3}$ m³/h t_1 = 32’53”	I	0.05/0.04/0	0.03	2	1.97	3.594
	II	0.03/0.01/0.02	0.02	2	1.98	3.612
	III	0.17/0.15/0.13	0.15	2	1.85	3.375
$Q_2 = 2.628\times10^{-3}$ m³/h t_2 = 45’40”	I	0.01/0/0	0.003	2	1.997	2.623
	II	0.02/0.01/0	0.01	2	1.99	2.614
	III	0.08/0.06/0.05	0.063	2	1.937	2.544
$Q_3 = 1.921\times10^{-3}$ m³/h t_3 = 62’30”	I	0/0/0	0	2	2	1.92
	II	0/0/0	0	2	2	1.92
	III	0.02/0.01/0	0.01	2	1.99	1.91

Table 2 presents the volume of the water loss estimated for a month for each water meter considered, as well as that estimated for a month for the entire block of flats considered (40 apartments), assuming that there are the same type of water meters mounted in each apartment, values which correspond to a certain value of the water flow Q.

Table 2. Water loss estimated for the entire block of flats

Water flow Q (m³/h) Time t	Type of water meter	Volume of water loss (l), corresponding to one hour (1h)	Volume of water loss (l), corresponding to one day (24 h)	Volume of water loss (m³), corresponding to one month (30 days)	Volume of water loss (m³)/mean – corresponding to one month for 40 apartments considered	
$Q_1 = 3.649\times10^{-3}$ m³/h t_1 = 32’53”	I	3.594	86.256	2.587	103.48	101.56
	II	3.612	86.68	2.6	104	
	III	3.375	81	2.43	97.2	
$Q_2 = 2.628\times10^{-3}$ m³/h t_2 = 45’40”	I	2.623	62.952	1.888	75.52	69.65
	II	2.614	62.736	1.505	60.2	
	III	2.544	61.056	1.831	73.24	
$Q_3 = 1.921\times10^{-3}$ m³/h t_3 = 62’30”	I	1.92	46.08	1.382	55.28	55.18
	II	1.92	46.08	1.382	55.28	
	III	1.91	45.84	1.375	55	

In order to establish the function describing the variation of water loss volume as a function of the water flow Q, regression analysis was performed [7]. Figure 2 presents the regression line which indicates the variation of water loss volume as a function of the water flow Q. By considering the limit for the registration as being the minimum starting flow Q_{min} = 15 l/h, one obtains a water loss volume of 408.514×10^{-3} m³ during a month, for the entire block of flats.

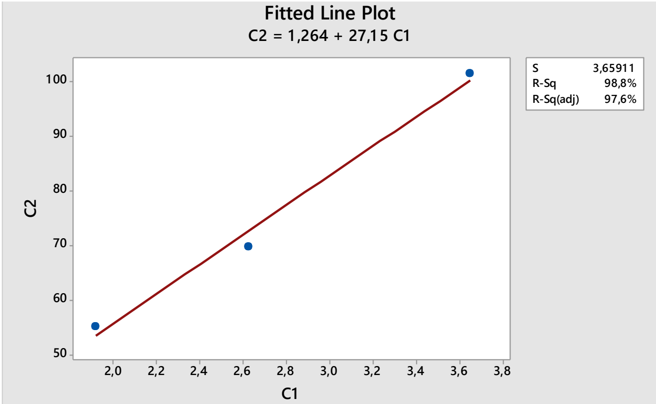

Fig. 2. Regression line – volume of the water loss vs water flow

4. Conclusions

The paper emphasises the fact that the volume of the water in a water supply installation depends on the water flow in the installation. In case of water flows less than the minimum starting flow for the appropriate water meters, the water losses are not registered by the apartment water meters and the water consumption is not paid correctly, so that the water company has financial losses. In these conditions, the use of accurate water meters will help to induce a more responsible attitude of the consumer towards water consumption, and by that it will help to reduce the irrational water losses. Reducing water consumption generates lower costs for the water supply company and will lead to rational exploitation of water resources.

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