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Ways of Preventing Water Losses in Real Water Installations

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Abstract
The paper intends to present different ways in which one can prevent losses of water volume in real water installations. The study is performed on real data obtained by recording the water consumption in each apartment from a block of flats, during several months, and also, by considering the total volume of water indicated by the branch water meter, the one indicating the water consumption for the entire block of flats. The number of persons living in each apartment is considered. The paper contains a study on the ways in which errors in metering the consumed water volume are produced, due to the sensitivity of the water meters mounted in the apartments from the block of flats considered. Data analysis was performed on data collected from the water meters considered, in order to establish the water loss volume and to obtain instruments which can help in identifying any water leakage in any apartment, such as to be able to sense any modification drift from the medium consumption such as to analyse the water loss estimated for a month for each type of water meter considered. In this way, it is possible to estimate the water loss volume for a certain period of time for the block of flats considered and, by that, to find ways to prevent losses in the potable water supply system.

Keywords
water flow, water meter, water loss volume

1. Introduction

In present, a great interest is being shown to conservation of the quality of the environment, to the rational utilization of all natural resources. Water resources are one of the most important, so that elimination of water losses should be priority objectives for water companies. In this case, water companies should monitor their water meter performance and establish their leakage levels [1 - 3]. Large quantities of the same type of water meters are purchased and installed by the water companies and their performance is assessed by a type evaluation and verification/calibration. As to the leakage, it occurs in all distribution networks [3]. There is a difference between total water loss and leakage. Figure 1 presents the components of the total water loss in a network/installation.

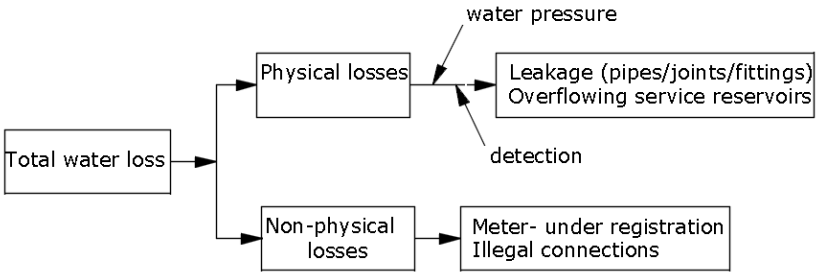

Fig. 1. Components of the total water loss in a network

Total water loss represents the difference between the amount of water which is provided and the amount of water which is billed or consumed. Leakage is one of the components of the total water loss in a network, and contains the physical losses from pipes, joints and fittings, and also from overflowing service reservoirs. These losses can be severe, and may be undetected for months or even years. The other components of total water loss are non-physical losses, e.g. meter under-registration, illegal

connections, and illegal or unknown use. The volume of the water loss depends on the pressure in the system, and on how fast the loss is noticed and solved, depending on the leak detection and repair policy of the water supply company [3].

A large interest is shown for detecting and reducing the water losses where the water consumption is greater than normal; this fact might be possible due to watering, open taps, gasket injuries, but also to a leakage in the system. For solving this problem, one needs to use accurate water meters and leakage detecting equipment [1 - 3]. Using accurate water meters would help consumers pay exactly the volume of the water used and would help in this way to reduce water consumption and to detect a possible leakage.

The paper presents a study on the water loss volume in a real installation and on methods to detect and prevent water losses. The analysis is performed on data obtained by recording the water consumption in each apartment from a block of flats, during a year, and also, by considering the total volume of water indicated by the branch water meter, the one indicating the water consumption for the entire block of flats (24 apartments). The medium consumption per person per apartment is considered. The paper contains also a study on the sensitivity of the type of water meters which are mounted in the respective apartments from the block of flats considered and on the volume of the water loss in the respective water supply branch, corresponding to the block of flats. Data collected from the experimental installation was used for determining the water loss volume corresponding to a month, for each apartment, in the case a leakage difficult to sense is occurring. By considering the water loss volume corresponding to this leakage difficult to detect and the medium consumption per person per apartment, it is possible to detect a more serious leakage which is not that obvious.

2. Experimental Installation Used for Determining the Sensitivity of the Water Meters

The experimental installation used in the research is presented in Figure 2.

It consists of five water meters of the type mounted in all apartments from the block of flat considered, and are connected in series arrangement [4, 5]. They are apartment water meters for cold water or hot water, with an accessible price, of precision class B (mediate precision). The branching water meter for the block of flats is of precision class C (high precision). Water meters of precision class B are designed such as to start the correct registration of the water consumption from the minimum starting flow *Qmin* = 30 l/h, while in case of the water meters of precision class C, the minimum starting flow is *Qmin* = 15 l/h [6].

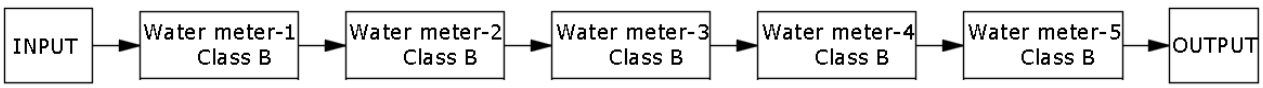

Fig. 2. Block scheme of the experimental installation

The apartment water meters do not register correctly the water consumption in case the water flow is less than the minimum starting flow in the apartment installation, but the correct water consumption will be registered by the branching water meter which is the general water meter for the block of flats. Using the experimental installation described in Figure 1, it was considered the case of a leakage difficult to detect by the consumer, when the tap is not properly closed and a small drop of water falls from the tap from time to time [4, 5].

The volume of the water loss depends on the water flow in the installation. There were considered three cases in which the water flow is less than the minimum starting flow for the water meters considered. In each case it was collected, drop by drop, in a certain time *t*, a volume of water *V* =2 l.

The water flow *Q* is calculated for the corresponding period of time *t*, with the formula below:

$$Q = \frac{V}{t}. \tag{1}$$

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

Table 1. Water loss for different values of the water flow *Q* for the type of water meters considered

Mean of the measured water volume	Water loss volume (l), corresponding to time t	Water loss volume (l), corresponding to one hour (1h)	Water loss volume (l), corresponding to 24 hours	Water loss volume (m^3) in 30 days
Time T_1 = 32'53" Actual water volume (l) = 2l Flow rate $Q_1 = 3.649 \cdot 10^{-3}$ m^3/h				
The measured water volumes (l): 0.07, 0.06, 0.06, 0.05, 0.06				
0.06	1.94	3.539	84.936	2.548
Time T_1 = 44'05" Actual water volume (l) = 2l Flow rate $Q_1 = 2.722 \cdot 10^{-3}$ m^3/h				
The measured water volumes (l): 0.03, 0.02, 0.02, 0.01, 0.02				
0.02	1.98	2.695	64.68	1.94
Time T_1 = 61'52" Actual water volume (l) = 2l Flow rate $Q_1 = 1.939 \cdot 10^{-3}$ m^3/h				
The measured water volumes (l): 0, 0.01, 0, 0.01, 0.01				
0.006	1.994	1.933	46.412	1.392

3. Ways to Prevent Water Losses in a Real Water Installation

Table 2 presents the experimental data which consists of medium consumption per person per apartment calculated during six months, by taking into account the consumption per month and the number of persons. In this table are also presented the consumptions per apartment during other six months. There are calculated the total volume (m^3), recorded by the apartment water meters every month, the volume (m^3) recorded by the branch water meter every month. The total water loss volume represents the difference between the amount of water which is provided and the amount of water which is billed or consumed and is calculated for each of the six months, for the block of flats considered; water loss volume is calculated as the difference between the volume of the consumption recorded by the branch water meter and the total volume recorded by the apartment water meters. This difference is usually divided to the number of apartments, each part being added to the amount of consumed water for each apartment.

Since the total water loss volume is paid for by all the apartments from the block of flat, and the appropriate value is not one to be neglected, it is not fair for all the consumers to support the water loss, irrespective of their attitude. In this case one needs to find ways to prevent water leakage. It is possible to create a data basis with the medium consumption per person per apartment per month and in this way it would be possible to point out any awkward case in terms of consumption.

Part of the total water loss volume could be due to the fact that apartment water meters do not register correctly the water consumption in case the water flow is less than the minimum starting flow, but it is not possible to detect where is happening this situation, in which apartment. Also, it is possible for a leakage to be produced in an apartment installation and this can be detected due to the outlier values of the water consumption. It is the case of the apartments which are marked (*) in Table 2, where were discovered problems in the water installation, responsible for the water loss.

4. Conclusions

The paper tends to present ways in which water losses may be prevented. It is possible to create a data basis with the medium consumption per person per month and in this way it would be possible to discover a possible hidden leakage. As to the sensitivity of the water meters, it is important to use accurate water meters which would enable a more responsible attitude of the consumers towards water consumption, creating the conditions in which each consumer pays correctly for the appropriate volume of water, reducing the financial losses of the water supply company and also reducing the irrational water losses.

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Table 2. Experimental Data

Apartment/No. of persons	Medium consumption/ person	Month No.1	Month No.2	Month No.3	Month No.4	Month No.5	Month No.6
1/2	0.9	0	1.8	2.8	2.8	3.8	4.9
2/2	0.7	1.1	0.9	1.1	1.2	1.1	1.2
3/2	1	1.8	1.8	1.5	1.8	1.5	2.4
4/2	2.6	6.4	6.6	7.5*	7.3*	7.5*	13.3*
5/2	1.1	2.1	1.3	2	2.3	2	2
6/3	1.8	2.9	5.7*	7.7*	8.1*	7.9*	12.2*
7/2	2.2	7	2.2	4.2	4.1	4.2	4.3
8/2	2.1	3.7	4.7	4.6	4.6	4.6	6
9/2	1.35	3.5	1.2	2.2	2.1	2.2	2.7
10/3	1.65	5.4	5	4.6	4.9	4.6	4.8
11/2	1.3	5.8	1.1	2.7	3	2.7	2.8
12/2	2.5	9.2*	5.9	5.9	5.2	5.9	5.9
13/2	2.4	8.5	7.5	5.4	6.2	5.4	8.3
14/3	2.4	9.2	7.2	6.8	7	6.8	8.5
15/2	2	10.2*	11.3*	5.9	6	5.9	7.4
16/2	0.8	1.3	1.3	1.8	1.9	1.8	1.8
17/2	1.5	3	2	3	3.1	3	3
18/2	1.3	4.2	2.2	2.5	3	2.5	1.6
19/2	3.5	11.2*	8.8*	10.8*	9.8*	10.8*	11.3*
20/2	1.7	6	3.4	1.5	4	4.2	7.8
21/2	1.4	4.5	1.3	2.3	2.8	2.3	2.8
22/2	2.6	4	4.7	5.3	5.4	5.3	5.3
23/2	1	2	2	2	2	2	1
24/2	1.3	4.6	1.2	1.5	2.5	1.5	2.6
Total volume (m^3), recorded by the apartment water meters		117.6	91.1	95.6	101.1	99.5	123.9
Volume (m^3) recorded by the branch water meter		137.1	107.8	113.7	118.6	116.9	145.3
Water loss volume (m^3)		19.5	16.7	18.1	17.5	17.4	21.4
Water loss volume (m^3)/apartment		0.8125	0.695	0.754	0.729	0.725	0.891

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