Importance of pressure reducing valves (PRVs) in water supply networks.

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Abstract. Challenged with the high rate of leakage from water supply systems, these managers are committed to identify control mechanisms. In order to standardize and control the pressure Pressure Reducing Valves (VRP) are installed in the supply network, shown to be more effective and provide a faster return for the actual loss control measures. It is known that the control pressure is while controlling the occurrence of leakage. Usually the network is sectored in areas defined by pressure levels according to its topography, once inserted the VRP in the same system will limit the downstream pressure. This work aims to show the importance of VRP as loss reduction for tool.

1. Introduction

Recognizing the importance of water as a limited natural resource and considering the prospect of growth of urban populations, it is necessary an investigation of the distribution of water supply systems for addressing up common basic infrastructure to big centers around the world [1]. Basically the goal of a design of water distribution networks was not only to provide water to consumers, but in recent decades, in addition to providing water to consumers in satisfactory condition, researchers have concentrated efforts to reduce network costs, losses, among others, which can often represent amounts of million.

For a good operation of a water supply system, it is essential that put together the concern for water availability in quantity and its quality for human consumption. However, many water supply networks have presented operational deficiencies, causing losses. Given the scarcity of water that Brazil has faced in recent years, water losses in the supply network have become major problems, and should be treated and managed with preventive measures.

In particular the reduction of physical or actual losses allows reduce operating costs and maintenance. These also optimize the use of existing facilities providing an increase in treated water supply without expanding the production system [2]. So, among the actions recommended as best operational practices to optimize the operation of the distribution systems there is the pressure of managing the network. This management pressures have been reflected in the aspect of reducing excessive or unnecessary pressures, resulting in the installation of pressure reducing valves (PRVs). This paper discusses the use of PRVs as loss reduction tool.

2. The water supply system and losses

An efficient urban water supply system must be operated in the daily horizon with the lowest cost of electricity and maintenance providing each network node consumer demands with desired pressure. Furthermore, the delivery system must be reliable in enabling the water supply under abnormal conditions caused by faults in its elements [3].

All the networks parts are local sections subject to losses, mainly in distribution. These losses can occur by deterioration in infrastructure and/or by the user for processing by unlawful means [4]. In this context, studies are conducted to improve operational practices to better performance of the systems such as pressure management in reducing network losses [5].

In a water supply system, the variation of the internal pressure level is linked to human consumption: nighttime with low consumption and daytime use with high [15]. It is in this period of lower consumption, night and early morning hours, that occurs leaks, when the static pressure is high and the low dynamic and reservoirs tend to reach their maximum level, which further raises pressures occurring disruptions in the system [17].

The pressure is the force that the water must have to go through the different elements of the distribution network and reach the consumer. When high, increases the frequency of breaks, reducing the lifetime of the pipes and the flow of leaks is also much higher [16].

By definition, we can say that losses supply systems is nothing more than the volume of water at the input of the system minus the authorized consumption, and thus, losses are grouped in physical losses and either (not consumed) and non-physical losses and either apparent (consumed, but not billed). These losses can determine the increase in running cost taking in to account if it is in capture, adduction, treatment and final distribution, so that there is an increase in the cost of operating revenue [6]. Through Figure 1, it can be seen that water losses are, mostly associated with the actual losses in the systems.

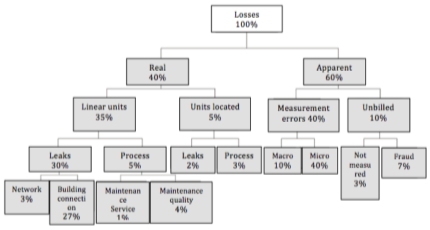

Figure 1. Hypothesis distribution losses in the water supply system [7].

The water losses are measured using established performance indicators characterizing as a strategic indicator, given its strong ties with many organizational processes (Main, Support and, Management) [8]. Many are the metrics that characterize the loss of water: one to measure in% other in liters / active connection.day, others in% or liters / connection.day but separating real loss, apparent loss, or encompassing both [9].

It is believed that by controlling the pressure it is possible to reduce the amount of losses from leakage, the occurrence of internal damage to the premises and fuel consumption related to the high-pressure network, providing the end user a service with more stabilized pressures [4]. Thus, the Pressure Reducing Valves (PRVs) are recommended to reduce excessive pressures, adapting them as far as possible. They make possible an improvement in losses combat management, allowing not only the management of pressures as well as the knowledge of the flow through the system and monitoring control points of the area enabling more accurate corrective actions [10].

3. The importance of PRVs

The main feature in a system that has PRVs is that its controlled area is bounded by closing border records ensuring not only the control pressures as well as knowledge of how to flow monitored and enabling continuous improvement management combat losses [10]. The PRVs are installed at specific points to thereby provide a reduced pressure downstream avoiding excessive pressures that can damage the system in certain parts of the network and ensuring an adequate level of service [5].

Therefore, a water supply network that controls the pressure automatically controls the occurrence of leaks, since these are a function dependent on the pressure occurring in the system. Thus, PRVs as dissipative structures are used in hydraulic systems as a way to standardize and control the pressures giving rise to localized head loss through dissipation of hydraulic energy by lowering the pressure values downstream.

PRVs can be controlled mechanically or electronically, working not only to a single pressure value but, for various pressure levels defined as a function of variations in water demand, allowing a more efficient service levels management and better hydraulic performance of the system [11].

This type of device has been installed on a large scale in various water systems. These valves ensure the minimum and maximum pressures, ie, static and dynamic pressures for the end consumer following the fixed limits. According to NBR No. 12,218 / 1994 the maximum static pressure in the distribution pipes should be 500 kPa and, the minimum dynamic pressure of 100 kPa [12]. Therefore, this valve is recommended in supply systems and reservoirs reducing the pressure and thus, maintaining an active leakage control with an economically viable cost-effective.

While experts recommend its use some sectors within the companies of operating systems suspect that the pressure reduction caused by PRVs may be causing the reduction in revenues of these companies with consequent reduction in the overall consumption of water connections in areas controlled with the device [5].

There are different VRPs and the most common are: controlled by spring (Figure 2), controlled by piston (Figure 3) and, controlled by diaphragm (Figure 4). The main function is to limit downstream pressure when it exceeds a certain value.

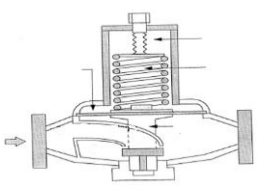

Figure 2. Pressure Reducing Valves - Controlled by spring [11].

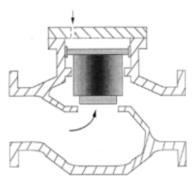

Figure 3. Pressure Reducing Valves - Controlled by piston [11].

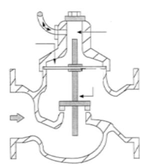

Figure 4. Pressure Reducing Valves - Controlled by diaphragm [11].

There are three operating states for PRVs: active, passive open and passive closed. The active state occurs when the valve downstream pressure is too high closing the valve, which increases the localized load loss and reduces the value of the downstream pressure to the desired value of the PRVs. The passive open state occurs when the upstream pressure is insufficient and less than that presented in the PRVs configuration. In these conditions the valve opens fully keeping the upstream and downstream the same pressure and introducing only the pressure drop in the open valve. The passive closed state is the total closure of the PRVs in the flow reversal conditions, i.e. when for some reason the downstream pressure results higher than the upstream pressure, in this case the valve behaves like a check valve [7].

The problem of inclusion of valves, for practical purposes, can be addressed as a pseudo device simulating the effects as incremental roughness in the pipe [13].

4. Conclusion

It can be seen that leaks produce negative effects both operationally and economically for companies. Systems with leaks need more energy pumping to compensate pressure losses and increase the risk of intrusion of contaminants compromising the water distribution quality [14]. These lead to high capital investments for system rehabilitation or combat the deterioration of structures. Currently, companies operate networks that were designed under conventional criteria of satisfaction and represent a large portion of aged components.

Thus losses are becoming increasingly larger these days when taking into account the progressive reduction of the sources of water and energy supply. Loss reduction policies structured on successful experiences are needed. After valves analysis we can notice they are now one of the fundamental elements for regulation and operation of pressurized hydraulic systems. Without them much of the facilities could hardly operate in the current conditions, which would require investments and higher operating costs.

The identification and use of different PRVs types of behaviors and influence on hydraulic systems (either for supply, distribution and irrigation) for the control pressures and reduction of leakage can be a strategy for loss reduction program. Therefore, optimizations of a supply system using PRVs (oriented by control pressures) can result in effectively reduce in loss in the system thereby improve the service. However, it is clear that the use of PRVs is extremely effective for controlling water losses and reduction of leakage but, should be understood as an accessory for specific situations and their indiscriminate use is not a recommended practice.

Acknowledgment
The authors would like to thank the institutions where they conduct their research for supporting this project and also the financial support provided by CNPq and PRP/UNICAMP.

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