PhD THESIS

# DESARROLLO E IMPLEMENTACIÓN DE UN MODELO REALISTA DE DEMANDAS Y FUGAS DEPENDIENTES DE LA PRESIÓN PARA REDES DE DISTRIBUCIÓN DE AGUA URBANA

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## Abstract

In urban water supply networks, the demanded flow and the latent leakage flow depend on the available pressure on the user's node. So when due to different circumstances (pipe breakage, pumps detention...) a pressure reduction occurs in the network, the real consumed flow can decrease considerably because the pressure may be insufficient to fully meet the users' demand. In this case it is said that the network is working under insufficient pressure conditions. Otherwise, in normal conditions, when the demand is fully satisfied, if pressure increases in the sevice conection, consume will slightly increase. Similarly, the latent leakage flow of the network will be higher as the pressure increases and vice versa.

Traditional simulation models do not take into account this circumstance and suppose that demand is constant and independent of pressure, which represents an important limitation thereof. Due to this fact, it is necessary to have more realistic hydraulic simulation models that are able to model the behavior of urban distribution water networks under any operation and supply pressure conditions.

Till the date, many authors have proposed different methods to model the behavior of urban water supply networks considering that the user's demand and/or leakages depend on pressure. In most of them it is needed a law that correlates the leakage flow with pressure and, additionally, a function that correlates the user's demand depending on the available pressure in the user's node (PDD curve). Several approaches and real assays have been done in order to establish that relation for leakages, being the potential law set according to the discharge theory of fixed and variable area (FVDA), the most used and proven till the date. However, there aren´t many approaches that correlate the user's demand with pressure, especially from a practical point of view in urban water distribution networks.

In this work there have been reviewed the proposed PDD functions so far by various authors, it has been analyzed the behavior of demand as a function of pressure, from the theoretical and experimental point of view on a real network, and have been proposed some new functions that fit the analyzed behavior and also has the necessary mathematical properties to be integrated in a model.

The proposed function has adjustment parameters that make it able to be adapted to different housing typologies, according to the heights, existence of pump or not, etc. In the work there have been tabulated the adjustment parameters for different housing typologies, so that they can be used without real information.

This PDD function has been adjusted to the particular case of the network of Valencia, where during four months there have been made assays in a sector of the distribution network. After establishing a modification of pressure program its influence on the user's demand has been analyzed, for what the information given by the telemetry counters installed in this sector has been very important. Also, the pressure has been correlated with the leakage flow and the exponent of the potential law has been adjusted.

Finally, it has been proposed a practical methodology to implement an integrated model of demands and leakages dependent of pressure from practical information available in any supply network.

This model is able to provide, in every node of the network and under any regulation condition, the value of the pressure and the consumed flow, moreover, this last one is dissected in the terms that compose it (leakages, registered demand and non-registered demand). An additional data that the model provides is the deficit or surplus of the users' demand.

The simulation of the network has been made under any operation circumstance, so the model is also valid in situations as transport pipe breakage, to analyze its impact in the demand fulfilling grade or analyzing the repercussion of a leakage management policy in both leakage and demand levels. Simulations that can't be done with a traditional model of fixed demands.