Water Age Computation for Distribution Networks

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ABSTRACT

As you start reading these lines, you may have already taken a shower, drank tap water, started a washing machine, or any of these small daily miracles that a water distribution system offers us. The omnipresence of water distribution networks (WDNs) in our daily life may lead us to reduce WDNs to simple and well-understood systems, which they are not. Among many concerns for WDNs, a major and essential one is to ensure to every customer good water quality. A well-known technique to easily assess water quality is to evaluate the water age ([1], [3], [5]).

In this work, two existing methods to evaluate the water age in WDNs have been reviewed and implemented: the flow weighted method from the software Epanet [7], and the bins method introduced by Machel et al. [4]. First, assuming steady-state, a method with a new representation of the age distribution has been implemented. This last method is shown to be more accurate and more computationally efficient. It has been successfully applied on a full-scale network. Some models to extends this new method to unsteady-state have been reviewed and implemented. The new method is shown to not include any further complication compared to the already existing methods.

All the previously cited methods make two common assumptions: the complete mixing at the junctions and the plug flow assumption. These two hypotheses have been shown to be inaccurate by several authors ([6], [8], [2]). In the second part of this work, numerical techniques are developed to model more complex phenomena on academic networks. Some non-homogeneous mixing models are reviewed and implemented with the newly developed method. Dispersion effects are modelled thanks to an approximate analytical solution and a finite volume scheme to go beyond the plug flow assumption. The optimal model to consider the dispersion effects is shown to depend on the Peclet number in each pipe of the network.

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