Methodology for generic water pipe model: Hydraulic simulation and failure risks due to polluting threats

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Both water supply systems as district heating grids or even drain or sewer systems exist out of complex networks of water pipes and channels. Pipe failure or local pollution often threatens the functionality of the complete system and/or causes failures at other locations in the system. Different types of threats or water pollution can be distinguished on system level, such as corrosion, water hammer, bacterial growth and calcification. These threats are often strongly linked to each other, as there is a clear correlation between some threats regarding growth and propagation in networks.

This paper proposes a generic modelling approach to describe the growth and propagation of these common time-dependent polluting threats in water networks. The model is based on a two control volumes approach for each threat, namely a flow conducting volume and a layer volume. The latter can be different for each kind of threat, but the flow conducting volume is based on a hydraulic pipe model. This hydraulic model pipe is able to evaluate water hammer and back flow.

The double control volume approach allows to include the specific behavior in biofilm, convection layer, pipe surface, … with respect to growth, diffusion and decline of each threat. This occurs at different speed compared to the main water volume. By including an exchange between both layers within the water pipe model, the model can take this into account and still be easily incorporated in large system assemblies. The result is a better understanding of the failures or a comprehensive base for data interpretation, which is a first step adopting machine-learning techniques in this field for predictive maintenance.