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Robustness of parameter-less remote real-time pressure control in water distribution systems

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ABSTRACT:

One way of reducing water leakage, pipe bursts and water consumption in a water distribution system (WDS) is to manage the pressure to be as low as possible. This can be done by adjusting a pressure control valve (PCV) in real-time in order to keep the pressure low and constant at a remote consumer location, by using a controller. When such smart infrastructure is implemented in a WDS, the choice of controller is important. Recently proposed controllers which use the flow rate in the PCV are more resilient to different WDS conditions than conventional proportional control. Here the former controllers which adjust the head-loss coefficient of the PCV are considered; either with a tunable parameter, or parameter-less. For two parameter-less controllers new mathematical expressions are derived for the deviation of the pressure from constant pressure in a WDS with one PCV. The deviation is proportional to the head-loss over the PCV, which varies for different WDSs. Also, the deviation is proportional to the time-step between successive controller iterations. Hence the time-step can be chosen to reduce the deviation to a pre-selected level. Moreover, the deviation is proportional to the scale-independent rate of change of flow rate in the PCV. In addition, it is shown that for the two “constant flow” controllers, the flow does not have to be known accurately. Hence, although the flow needs to be known, it can be known with significant uncertainty, enhancing the practical use of these controllers.