Sequential optimization for pressure management in water distribution networks

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Abstract

Most distributed water is not used effectively due to water loss occurring in pipe networks. These water losses are caused by leakage, typically due to high water pressure to ensure adequate water supply. High water pressure can cause the pipe to burst or develop leaks over time, particularly in an aging network. In order to reduce the amount of leakage and ensure proper water distribution, it is important to apply pressure management. Pressure management aims to maintain a steady and uniform pressure level throughout the network, which can be achieved through various operational schemes. The schemes include: (1) installing a variable speed pump (VSP), (2) introducing district metered area (DMA), and (3) operating pressure-reducing valves (PRV). Applying these approaches requires consideration of various hydraulic, economic, and environmental aspects. Due to the different functions of these approaches and related components, an all-together optimization of these schemes is a complicated task. In order to reduce the optimization complexity, this study recommends a sequential optimization method. With three network operation schemes considered (i.e., VSP, DMA, and PRV), the method explores all the possible combinations of pressure management paths. Through sequential optimization, the best pressure management path can be determined using a multiple-criteria decision analysis (MCDA) to weigh in factors of cost savings, investment, pressure uniformity, and CO_2 emissions. Additionally, the contribution of each scheme to pressure management was also described in the application results.

Keywords: Leakage, Optimization, Pressure management, Water distribution networks

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