Determining chlorine injection intensity in water distribution networks: a comparison of backtracking and water age approaches

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Abstract

Providing safe and readily available water is vital to maintain public health. One of the most prevalent methods to prevent the spread of waterborne diseases is applying chlorine injection to the treated water before distribution. During the water transmission and distribution, the chlorine will experience a reduction, which can imply potential risks for human health if it falls below the minimum threshold. The ability to determine the appropriate initial intensity of chlorine at the source would be significant to prevent such problems.

This study proposes two methods that integrate hydraulic and water quality modeling to determine the suitable intensity of chlorine to be injected into the source water to maintain the minimum chlorine concentration (e.g., 0.2 mg/l) at each demand node. The water quality modeling employs the first-order decay to estimate the rate of chlorine reduction in the water. The first method utilizes a backtracking algorithm to trace the path of water from the demand node to the source during each time step, which helps to accurately determine the travel time through each pipe and node and facilitate the computation of time-dependent chlorine decay in the water delivery process. However, as a backtracking algorithm is computationally intensive, this study also explores an alternative approach using a water age. This approach estimates the elapsed time of water delivery from the source to the demand node and calculate the time-dependent reduction of chlorine in the water. Finally, this study compares the outcomes of two approaches and determines the suitable and effective method for calculating the chlorine intensity at the source to maintain the minimum chlorine level at demand nodes.

Keywords: Backtrack, Chlorine concentration, Water age, Water quality simulation

Acknowledgment

This study is supported by the Korea Institute of Energy Technology Evaluation and Planning (KETEP) and the Ministry of Trade, Industry & Energy (MOTIE) of the Republic of Korea (20224000000260).

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