Optimisation procedure for pipe-sizing with break-repair and replacement economics

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Abstract

The importance of incorporating break-repair costs and pipe-replacement costs in optimal design of a water distribution network is highlighted and demonstrated with a hypothetical network. Deterioration due to ageing of pipes requires expensive maintenance and causes inconvenience. The number of breaks generally increases exponentially with pipe age and small-diameter pipes are more likely to break than large-diameter pipes. After a certain age, it would be more cost-effective to replace the pipes than to repair them. The optimisation models which do not consider the maintenance costs tend to result in smaller pipe sizes. The proposed model incorporates both the repair cost and the replacement cost in addition to initial cost. The proposed model is demonstrated by applying it to a 2-loop network. Incorporating pipe-break and replacement economics into optimisation leads to slightly larger diameter pipes. The analysis also reveals that consideration of repair/replacement is essential if the pipe breaks cause high economic impact, the pipe-break growth rate increases fast and discount rate is low. For the example network considered, for a typical set of values, the cost benefit is as much as 12.92%. For cases with low breakage rates, incorporating repair/replacement has been found to make no practical difference. The results show that considering pipe break and pipe replacement in optimisation is important as this could save considerable amounts of money over the lifetime.

Keywords: water distribution network, pipe-break analysis, optimisation, network design, economics