



Optimum Reliable Operation of Water Distribution Network Considering Pumping Station and Tank

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Abstract

This research aims to optimize the operation of pumping stations in water distribution networks (WDNs). Two main objectives are considered: minimizing the pumping energy costs through the scheduling of pumping stations by means of variable-speed pumps and, maximizing the reliability of pumping stations or storage tanks. Accordingly, a multi-objective ant colony optimization is developed in Visual Studio C ++. This optimization algorithm is directly linked to EPANET2.0 for two case studies including Anytown and two loops WDNs. This study reveals that there is a strong correlation between the number of nodes and pumps, and the range of the hydraulic reliability in the solutions of pareto-optimal front. In scheduling of pumping station operation, a wider range of reliability can be provided in storage tanks compared to pumping stations. Based on WDN's requirements, decision makers can choose a solution with the desired reliability of pumping stations and storage tanks and the relevant pumping energy costs.

Keywords Multi-objective optimization · Pareto-optimal front · Pumping energy costs · Reliability · VSP

1 Introduction

Water distribution networks (WDNs) are considered as one of the main infrastructures in urban communities. Therefore, a proper design, operation and also rehabilitation of WDNs are essential to provide an appropriate service for consumers. In this respect, optimization of WDNs is necessary in the design, operation and also rehabilitation phases. Although the optimum design leads to the more

appropriate operation of WDNs, the optimum operation requires an accurate analysis of systems and their operating elements such as pumps and tanks during their life cycle. Performance of WDNs is analysed by means of reliability index. Reliability is the capability of WDN to satisfy required water demands under sufficient pressure in normal and also abnormal conditions (Tabesh and Zia 2003). Tabesh (1998) stated that a system is reliable when it is able to provide enough water to consumers with an adequate pressure. According to Gupta and Bhawe (1994), the reliability calculation of WDNs is very important; however, there is no globally accepted definition for reliability calculation. Analysing the reliability of WDNs is too complicated, due to dependency of reliability to various parameters.

Different reliability indicators were proposed by Cullinane et al. (1992). These indicators were linked to the system components, namely pipes, pumps, tanks, and valves through different equations. They assessed the mechanical reliability of pipes which were connected to pumps, tanks and valves, as a function of the design discharge of pumps, the capacity of tanks, and the diameter of the related pipes, respectively. In order to calculate these indicators, information about the failure of each component

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