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Water distribution system calibration: Manual versus optimization-based approach

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Abstract

The water distribution system hydraulic model for an Ontario, Canada town has been calibrated by engineers familiar with the system. Their calibration procedure was mainly an expert-based approach using judgment and trial-and-error and did not rely on optimization. The purpose of this study is to resolve the corresponding calibration problem with optimization tools and compare the calibration solutions in terms of quality (closeness to measured data) and calibration parameter values. The calibration problem is posed as a multi-objective optimization problem and solved with the PA-DDS algorithm described in [1]. The precise calibration objectives are roughly matched to the manual calibration objectives specified by the engineers who calibrated the model. Multi-objective optimization results are compared with the current solution to determine if the current solution is non-dominated.

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1. Introduction

Hydraulic models are essential tools for planning, operation and maintenance of water distribution systems. However the use of these models is limited by the proper calibration of model parameters. A model is considered well calibrated if the discrepancies between model results and field data are minimized. Thus, a well calibrated model is essential for any useful results to be obtained. While automated calibration processes are widely available, the use of these processes has been limited in practice, with most practitioners preferring engineering judgment and a trial and error approach to model calibration [2]. In an effort to validate and quantify the benefits of automated calibration methods to practitioners, this paper directly compares the results of one such trial and error method to an optimization approach using PADDS.

The municipality of a Canadian city (City X) of population ~115,000 commissioned a local consulting company (Company Y) to complete a calibration study of the City's hydraulic model of their existing water distribution network. The goal of the calibration was to update the existing network to include newly built areas, update system demands and demand patterns, pump information, pipe roughness coefficients, and update controls accordingly to match observed field conditions. The model, depicted in Figure 1, consists of two distinct pressure zones, each with their own demand pattern, 3611 nodes, 4661 pipes, 19 active wells, 3 elevated storage tanks, 5 in ground storage reservoirs, and 3 zonal booster stations. The model was built and calibrated to supervisory control and data acquisition (SCADA) data and field data collected on August 26, 2010. It was manually calibrated using InfoWater by Innovyze software (http://www.innovyze.com/products/infowater/). The same network calibration problem was posed as a multi-objective optimization problem and solved using PADDS. Calibration results of both methods are presented and compared.

Figure 1 - City Network with pressure zones delineated