ABSTRACT

Nowadays, large expenditures are spent on maintenance and rehabilitation of water distribution systems due to lack of performance. Low performance problems, also, cause environmental issues as a result of exhausting more power and resources while heavily burdening the environment with huge quantities of waste produced. However in the stage of initial design, more attention is given for determining the size of elements than for achieving high performance.

This research work is concerned with assessing the performance of water distribution systems. It presents a new methodology to assess its performance. Three indices were selected to express the performance considering both ordinary and unusual conditions namely; efficiency, adequacy, and equity. The real conditions are emulated by employing the concept of segment isolation. Following determining the values of the indicators, the fuzzy set approach is applied to combine them into a zero to one *Overall Design Performance Index*. This methodology can simply be applied by the practice engineer to help in designing high performance systems. Moreover, it can assist in decision making process to select the best design alternative from several available options or identifying the weakness of an existing network and laying out a plan to boost the service level.

The procedure is employed on twenty alternate designs for a certain distribution system while applying the pressure-dependent hydraulic analysis to find that there is a firm positive correlation between the overall design performance index and the adequacy and equity of a water distribution system. However, an inverse proportion exists between the overall performance index and the efficiency of water delivery. This is to say that designs with the maximum adequacy and equity would cause, on one side, more uniform water distribution among the end consumers and, on the other side, would lead to a high amount of water leakage i.e. lowest efficiency.

Moreover, It is also found that increasing the number of pipes, sum of paths' length, and number of available paths in a system would result in improved distribution of water throughout the network (i.e. better adequacy and equity), but in the same time, it would cause more leakage problems and subsequently lower efficiency.

Another point was concluded is that the weight assessment of the three indices has a critical impact on the final value of the performance index. Increasing the weight of the equity index with respect to the other indicators, would result in the lowest measurements of the overall performance index. While, increasing the weights of the efficiency and the adequacy would lead to almost similar effect on the overall index, but in general, the overall index in these cases would possess a higher value than in case of choosing the same value for each index.

Furthermore, determining the most influential node in distribution networks is an essential step during the design to help the management planning the protection strategy and selecting which nodes need more protection activities.

Finally, there is not direct relationship between the cost of a design and its overall performance index and employing the cost effectively on the elements of the system is the best matter to do in order that the highest performance is achieved.

Keywords: Water distribution system; performance evaluation; performance indices; segment isolation; pressure-dependent demand analysis; fuzzy set approach; overall performance index.