Optimal water meter selection system

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Abstract

The comparison of the particular accuracy envelope of a water meter with a consumer's diurnal demand pattern by means of a common reference facilitates the optimal selection of water meters.

The accuracy curve and envelope of a new water meter is governed by the type of water meter and relevant standards. Water demand patterns vary with time, period, seasons, consumers and combinations of these factors. The classical accuracy envelope and demand pattern are not directly comparable, and require a common comparison reference. The relative frequency of the volume of water passing through a meter at various flow rates and the weighted accuracies of these measured volumes play a pivotal role in establishing a common comparison reference.

The time unit selected to calculate the volume of water passing through the meter is guided by the type of water reticulation infrastructure within which the meter is installed. However, experience and literature show that a flow interval of less than 1 min would result in the application of unrealistic high flow rates.

A simplified example for the determination of the weighted accuracy of a water meter monitoring a theoretical demand pattern illustrates the methodology used to establish the common comparison reference.

Economic/financial analysis based on an income statement together with capital budgeting techniques assist with the determination of the financial suitability of investing in a new replacement water meter. This financial analysis includes various potential income and expenditure components that will result from the installation of a new water meter. Sensitivity analysis facilitates the decision-making process.

The analysis of flow data by a computer program developed in context with the described methodology illustrates that the savings achieved by the improved accuracy of matching the optimally selected meter and a particular demand profile can finance the costs of such an investment.

Introduction

The selection of a water meter for a required duty is complex and the consequences of an incorrect selection are loss of performance, time and money (British Standard BS 7405, 1991). A study undertaken in the United States found that generally water meters were oversized by some 50% when they were first installed (American Water Works Association, 1975) and a study for a South African coastal city found that nearly 65% of the water meters were oversized (Wild, 1997). Under-registration and a consequent loss of revenue are the result of poorly selected or improperly installed water meters (Jeffcoate and Pond, 1989).

The matching of theoretical water demand with the performance specification of a water meter is generally a common approach used by practitioners in the selection and sizing of a new water meter installation. Various codes or standards are used to establish these water demands in Britain (British Standard BS 6700, 1987), Germany (Coe, 1978) and South Africa (SABS 0252, 1994).

Water demands estimated by guidelines in South Africa such as the "Blue Book" (Department of Community Development, 1983) and "Red Book" (Department of Planning, Provincial Affairs and Housing, 1991) appear to over-estimate these water demands (Turner et al, 1997). Recent research has also identified that these South African guidelines over-estimate peak flows (Booyens, 2000).

This paper describes the theory used in the development and application of a module of a computerised optimal water meter selection system that utilises the actual water demand pattern recorded by an existing water meter for comparison with various water meter performance specifications. The selection of a water meter that best "fits" the particular demand pattern is undertaken through a ranking process that considers the greatest weighted accuracy gain by the proposed meter, the minimum energy (head) loss and the lowest purchase price of the new meter. The final selection of the new meter is facilitated through the application of financial analysis techniques such as payback period, net present value (NPV) and internal rate of return (IRR).

Accuracy curve and envelope

Accuracy is the closeness of the actual reading to the true value and it includes the effect of both precision and bias error. Accuracy is greater when the indications are closer to the true value. Therefore, an accuracy of 99% is an inaccuracy of 1%. However, inaccuracy (or error) is sometimes referred to as "accuracy" (Miller, 1989).

Accuracy envelopes are used to define the accuracy band within which the meter's accuracy curve is expected to be situated as well as its specified flow range.

The South African Standard Specification SABS 1529-1 (1994) as well as the International Standards ISO 4064 (1993) provide a generic definition of this accuracy envelope from the minimum flow rate (q_{min}) up to their maximum or overload flow rate (q_s) as follows:

- q_{min} is the lowest flow rate at which the meter is required to give indications within the permissible tolerance and is specified as a ratio of the permanent flow rate (q_p) for various metrological classes of water meters.
- q_p is the flow rate for which the meter is designed and at which the meter is required to give indications within the permissible tolerance under normal conditions of use.

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