NOVEMBER 2024 - SCIENCE BRIEF

SIMPLE AND COST EFFECTIVE INNOVATION TO MEASURE EFFICIENCY/ACCURACY OF BULK WATER METERS

Water utilities in developing countries face significant challenges, with high levels of water losses posing a threat to financial sustainability. These losses, categorised as real and apparent, are exacerbated by metering inefficiencies and other factors like leakage and billing errors. Despite the adoption of universal and sub-metering systems, the benefits remain elusive due to meter inaccuracies, particularly in developing countries with poorly managed networks. The urgency to control water losses is driven by recent droughts and increasing demand, necessitating effective distribution system management. Reservoirs, key components in water distribution, experience losses due to leakages and overflows, highlighting the need for quantification and remedial methods to address unaccounted-for-water (UFW) or non-revenue water (NRW).

Meter calibration and verification is crucial to minimise inaccuracies and optimise revenue collection. However, calibration procedures are often costly and disruptive, necessitating a strategic approach to determine calibration needs and intervals.

A Water Research Commission (WRC) funded study sought to address these challenges by identifying optimal methods for determining reservoir volumetric characteristics, quantifying water losses, developing an innovative testing method for bulk water meters, and raising awareness about water loss issues. The literature review underscores the importance of accurate metering in managing water resources, identifying losses, and making informed decisions.

Challenges in water loss reduction programmes include poor design, incomplete implementation, and underestimation of difficulties. Successful interventions require a systematic approach tailored to the specific problems of each water-supply system, emphasising the importance of quantifying water loss to guide remedial actions. Water metering is crucial for measuring water usage accurately. Meters come in various types, including mechanical (volumetric, inferential, and combination meters), electromagnetic, and ultrasonic, each with distinct features and applications. Each meter type has advantages and limitations, making them suitable for different applications based on factors such as accuracy requirements, flow conditions, and water quality. Understanding these distinctions is essential for selecting the appropriate meter for specific water management needs.

Meter applications in water utilities are vital for accurate billing and monitoring. They are strategically placed throughout the supply and distribution infrastructure to measure various points such as raw water withdrawals, clean water production, connection points, and consumer usage. Installation considerations include complying with manufacturer recommendations, ensuring proper flow direction, and maintaining water supply.

Meter calibration is crucial for confirming performance, quality control, and compliance with legal requirements. Various methods such as gravimetric, volumetric and master meters are used for calibration. Testing methods include laboratory and in-situ verification. In-situ methods like master or reference meters, tracer methods, and on-site volumetric or gravimetric methods offer practical solutions for verifying meter accuracy in the field. Despite limitations in field testing accuracy compared to laboratory calibration, in-situ verification remains an important aspect of water meter management and maintenance.

The Water Meter Calibration Using Reservoir Volumetric Characteristics (WMCURVC) procedure was developed and tested, which follows defined steps like defining reservoir volumetric characteristics, installing measuring devices, conducting a step-by-step method to test flow through the meter and analysing the data. The process involves systematically filling or emptying the reservoir, for specific time periods, at different flow rates and measuring the volumetric change and comparing this with the flow meter readings for these periods.

The Volumetric Evaluation Tool offers a systematic approach for assessing the accuracy of in-situ flow meters using various measuring instruments. It guides users through a step-by-step process, starting with project definition, site selection, defining key parameters such as reservoir characteristics, site accessibility, flow meter functionality, and storage structures to ensure accurate verification. Reservoir volumetric characterisation involves inputting parameters such as capacity, diameter, internal columns, and minimum operating and full supply level to calculate net volume at incremental heights. Flow meter characterization follows SANS 1529-4:2004 guidelines, determining error envelopes based on meter description, diameter, number, and class.

The financial model assesses the economic impact of inaccurate flow meters, allowing users to define revenue generation parameters and potential revenue loss due to meter inaccuracies. Remedial action costs and payback periods are calculated, aiding utilities in decision-making. It is important to highlight that the testing procedure determines the potential error that results from the meter and meter installation configuration. As many meters are not installed according to the manufacturers or local authorities' specifications the error in measurement can only be attributed to the system and not necessarily directly to the meter inaccuracy.

Case study

The Pierre van Ryneveld Reservoir complex in the City of Tshwane served as a case study, highlighting the importance of functional water meters, the installation configuration, reservoir storage characteristics, and appropriate testing equipment installation. The analyses indicated a possible 2.99% to 4.22% difference in measured inflow depending on the flow rate in which the existing flow meter overestimated the actual volume. Based on the average supply to this reservoir complex of R4.1 million litres per annum and a typical tariff of R14.58/m^3 the inaccuracy of on average 4.22% (high flow rate range) could equate to an amount of R2.54 million/annum. This potential saving in expenditure could be achieved if the installation configuration is optimised and a more accurate flow meter is utilised.

In conclusion, effective metering, quantification of losses, and strategic interventions are essential to mitigate water losses, enhance revenue collection, and ensure sustainable water management in developing countries like South Africa. The WMCURVC procedure simplifies the process although providing a comprehensive approach that could be used to test an installation and assess flow meter installation accuracy. Using the Volumetric Evaluation Tool offers a systematic approach for assessing the accuracy of in-situ flow meter installations and determining the potential economic impact. This study contributes to knowledge gaps in sustainable water management, particularly in quantifying reservoir losses and in-situ verification of water meter installations, thereby enhancing water resource accountability.

For more information, email WRC senior research manager,
Jay Bhagwan, at email: jayb@wrc.org.za