In situ calibration of large water meters

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Abstract

The establishment of a flow reference standard for the cost-effective *in situ* calibration of large in-line water meters consists of the combined accuracy of point velocity measurements within pipes, a velocity-area method and a velocity-profile function.

Tests were carried out in compliance with the requirements of international standards relating to large water meters. Velocity profiles were measured within pipe sections of 250, 300, 400, 500, 600 and 800 mm dia. and compared to the flow measured by Eskom's Flow Laboratory. This flow laboratory has a best measurement capability of 0,1% uncertainty for the 95% confidence level as accredited by the National Laboratory Accreditation Service (NLA).

The physical dimensions of the pipes dictated at which position the turbine insertion meter should be placed within the pipe in accordance with the log-linear method adopted for this research. This resulted in the need to calculate the velocities near the pipe wall within pipes smaller than 700 mm dia. using a first approximation of the ratio of point velocity nearest the pipe wall to the maximum (centre line) velocity. Second approximations of these velocities were derived using the actual position of mean axial velocity and revised constants for the modified Pao equation for each profile, only if the first approximation indicated a positive error.

Flow tests carried out on the 800 mm dia. pipeline were used as a control because all the velocity measuring points dictated by the log-linear method could be reached with the turbine insertion meter. This control exercise was used to establish the meter's calibration factor (K) for the other tests on the 300, 400, 500 and 600 mm dia. pipelines. Another turbine insertion meter was used for flow tests on the 250 mm dia. pipeline and the manufacturer's calibration factor (K) was applied.

Results of this research indicate that the method for the *in situ* calibration of large water meters can achieve accuracies that comply with relevant standards; however, practical limitations of the meters' performance and the limitations of the hydraulic system in which they are installed could restrict the flow range over which they can be tested/calibrated.

The recommendation is that the flow reference standard consisting of insertion flow meter measurements, a velocity-area method and a velocity-profile function detailed in this report be adopted as an accepted test method for the *in situ* calibration of large water meters.

Introduction

The Water Research Commission (WRC) appointed Stewart Scott (CE) Inc. to undertake research to establish a flow reference standard for the cost effective *in situ* calibration of large water meters required for water audits and other test purposes. This flow reference standard can be used to establish the accuracy of permanently installed water meters by means of regular on-site comparisons to ensure that these meters remain within the limits of accuracy prescribed by local and international standards

This research established the accuracy of a flow reference standard consisting of the combined accuracy of insertion point velocity measurements, a velocity-area method and a velocity - profile function which can be effectively applied in the field through the insertion of a velocity probe into a common pipeline in which a permanent large water meter has been installed.

Flow tests were carried out in compliance with the requirements of the specifications relating to large water meters such as the International Standard ISO4064 (1993) and possible future parts of the South African Standard SABS 1529 (1994). Velocity profiles were measured within various pipe sections by means of a single traverse of an insertion flow meter at the depths determined by the relatively more accurate log-linear velocity-area method, with missing values (i.e. near the pipe wall) established with the aid of an iterative process that included the modified Pao equation and actual point velocity measurements.

Flows determined by means of these velocity profile measurements were compared to those established by Eskom's Flow Laboratory, which has been accredited by the National Laboratory Accreditation Service (NLA). Test sections varied in diameter from 250 mm to 800 mm in order to comply with the abovementioned standards. A comprehensive background to this research is provided in Johnson (1995). This research project is essentially as a result of the recommendations of that paper.

Flow laboratory

The Eskom Flow Laboratory used for this research project has been accredited to measure flow rates in closed conduits for a flow range of 20 to 1200 ℓ/s. The total accuracy of the installation is 0.1% of flow rate. This gravimetric flow laboratory can accommodate piping from 150 to 1 000 mm dia. A constant water flow rate is provided either from a constant-head tower (at lower flow rates) or by direct pumping from a constant-head reservoir (at higher flow rates). The flow passes through the meter under test and then through a control valve and into the diverter chute. The diverter changes the flow stream into the weigh tank in 0.1 s without causing any upstream disturbances. The weigh tank has a 200 t capacity and stands on four calibrated load cells. When sufficient water has been diverted to the tank, the flow stream is returned to the normal direction, where it discharges into an open channel and returns to a make-up

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