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DEVELOPMENT OF OPEN CHANNEL METER CALIBRATION FACILITY

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Abstract. To overcome the disadvantage of building weirs and flumes, recently velocity-area meters have been developed, using that electromagnetic or ultra-sound Doppler effect principle. In these meters the wet area is evaluated using liquid column pressure or ultra-sound.

The importance of flow rate measurement of open channels is growing as a result of environmental impacts caused by the wastewater produced in metropolitan areas. This brings up the need of wastewater collection and treatment, where flow rate is a very important parameter.

This paper describes a prototype of a facility for the calibration of these new types of meters. This paper also describes the results of calibrations of one Ultra-Sonic Doppler meter and one electromagnetic meter.

Keywords: calibration, open channel flow, flow measurement, wastewater.

1. INTRODUCTION

The environmental impact caused by the wastewater produced has become an important problem in metropolitan areas, bringing up the need of wastewater collection and treatment. To manage these complex system an indispensable parameter is the flow rate.

The most known flow meters of open channel are weirs and flumes, but they have a great disadvantage: they need a construction and for this reason they are not frequently used to measure the flow rate of wastewater in sewers. To overcome this disadvantage, velocity-area meters that use electromagnetic or ultra-sound Doppler phenomena to measure flow rate have been developed. These velocity-area meters use the continuity equation, where the flow rate is equal to the mean velocity times the cross sectional area. The height of the cross sectional area is measured using liquid column pressure or ultra-sound. To obtain the mean velocity it is used the electromagnetic phenomena or the ultra-sound Doppler.

As these meters were only recently developed, their calibration not yet standardized. The standardization of the calibration is very important because these meters have been used for billing, an application where the knowledge of the uncertainty of the measurement indispensable. This article proposes a prototype of a facility and a method for the calibration of these types of meters and presents the calibration results of two different meters.

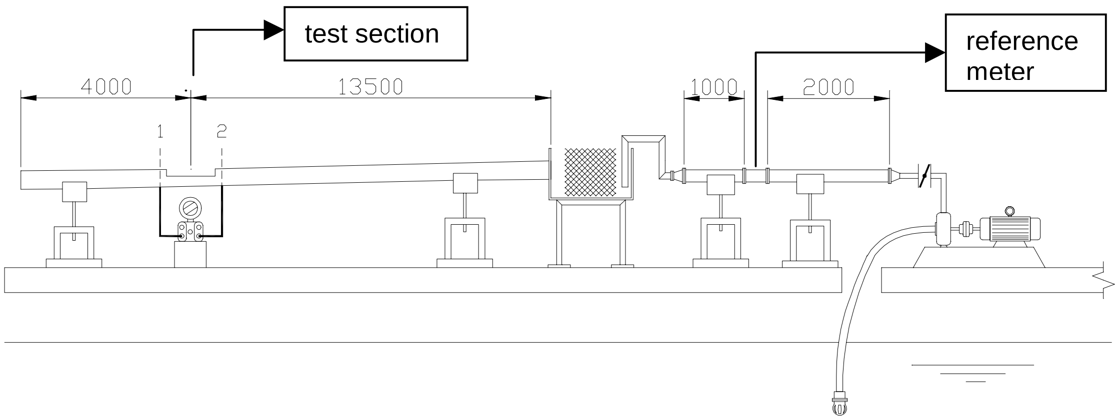
2. THE TEST FACILITY

Fig.1 shows a sketch of the proposed prototype of the calibration facility. In this installation, the water from a reservoir in the underground is pumped through a reference meter (for example an electromagnetic full bore meter) in a running full pipe and discharged into a open tank. Water flow rate is adjusted by a butterfly valve. In order to achieve uniform flow condition in the test section, a flow straightner was provided in the open tank ,so was a straight upstream length greater than 46 diameters for the open channel and more than 13 diameters for the downstream test section.

The mean feature of the uniform flow is that the water surface and channel bottom are parallel. To check the uniform flow condition in the test section, a differential pressure transducer, connected to points 1 and 2, was used to measure depth variation of the water surface, and no variation was found other than the characteristic fluctuations usually found in open channel flow.

Calibration of the test meter is carried throughout the comparison of the performance the test meter against the reference meter. After established steady flow condition, the flow rate passing through the test meter is the same flow rate has passed in the reference meter. To minimize the level fluctuation effects into the tank, the comparison between meters is done using the mean flow rate measured. Figure 1shows the test facility.

Figure 1 Test facility



The reference meter, an electromagnetic flow meter for running full pipes, was calibrated in a Laboratory accredited by PTB – Physikalisch Technische Bundesanstalt. The uncertainty is ±0,31%.

3. CALIBRATION PROCEDURES

Two meters were calibrated in this bench. One uses the electromagnetic principle and the other uses an ultra sonic Doppler effect principle to determine the mean velocity of the flow. Both use velocity sensors, level sensors and a processing unity that makes the data acquisition and treatment of data.

Figure 2 shows a scheme of the calibrated meters.

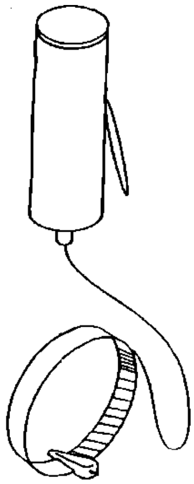


Figure 2 Tested meter

Before the installation the level sensors were configured: with the equipment operating, the level sensor was installed at the plane bottom of a water reservoir and the level measured precisely. This measure was inserted in the program to make the adjustment of the level.

After the meter installation the maximum flow rate was adjusted and new measurements of the water column was again checked.

The electromagnetic meter needed to be configured with the information of the mean velocity corresponding to a certain flow rate. This information was obtained with the measurement of flow rate at the maximum flow rate of the bench. The Doppler meter does not need this previous test.

The time bases (clock) of the meters and of the benches were synchronized and configured to make an acquisition every one minute. Every flow rate value tested was tested at least 30 times, with three repetitions for every flow rate.

Tests were made for five different flow rates: 28,5; 26,1; 22,8; 16,2 e 8,4 l/s.

Fluid was always clean water.

4. RESULTS

The error for every flow rate, repeated three times, was calculated according to the expression:

$$\text{Error} = 100 \times \frac{\text{average of flow rate} - \text{“true” flow rate}}{\text{“true” flow rate}}$$

where the “average flow rate” is the average of 30 instantaneous measurements and the “true flow rate” is the average of 30 measurements of the reference meter. Measurements of both meters were made simultaneously.

Figures 3 and 4 show the error curves for both meters.

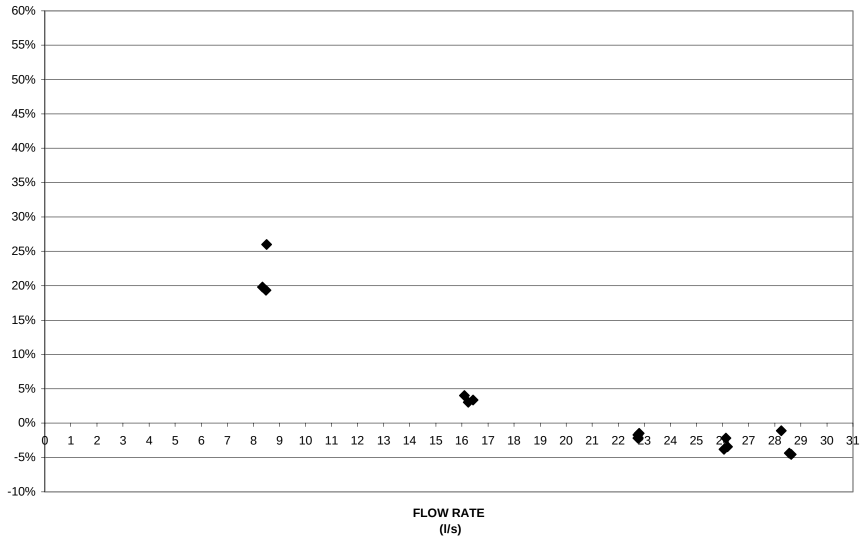


Figure 3 Electromagnetic flow meter error curve.

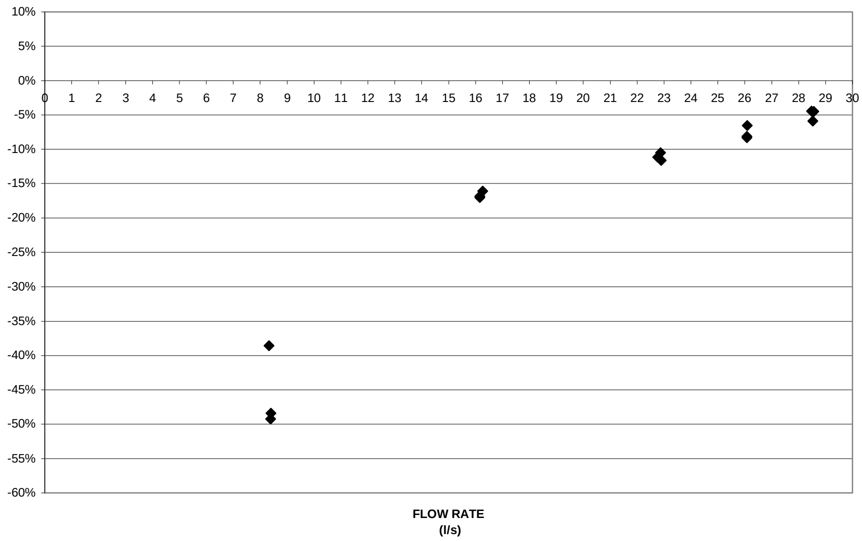


Figure 3 Ultra sonic flowmeter error curve.

5. CONCLUSIONS

It was developed a prototype of a calibration bench for channel flow meters, using as a reference an electromagnetic flowmeter in a pipe running full.

The results obtained in the calibrations showed that the meters have good repeatability, with large errors in the calibration range. It should be pointed out that the maximum height of the water column in the test section was around 30% of the diameter of the test section.

Next steps will be the analysis of the extrapolation of these data to actual flow of sewage water.

REFERENCE

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