THESIS

USE OF MODIFIED PITOT TUBE FOR MEASURING FLOW OF FULL AND PARTIALLY FLOWING PIPES OF DIFFERENT DIAMETERS

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ABSTRACT

This study was conducted to test the use of various diameters of the Pitot tube for flow measurement both in fully flowing and partially flowing pipes. Three sizes of the Pitot tubes (i.e. 2, 3 and 5 mm) were used for flow measurements from five sizes of the delivery pipes (i.e. 8.165 cm (3.22- inch), 10.16 cm (4.0-inch), 13.0 cm (5.12-inch), 15.495 cm (6.1-inch) and 20.48 cm (8.06-inch)).

The Pitot tube is simply a 'L'-shaped metal tube which is placed in front of the delivery pipes from tubewells. The rise of water in the Pitot tube represents the velocity head. The Pitot tube was used to measure the velocity near the wall, at one-half of the radius, and in the center of the delivery pipe. Discharge at every point was calculated by multiplying the velocity with the flow cross-sectional area of the delivery pipe. V-notch and rectangular sharp-crested weirs were used to test the proposed technique. Discharge measured by the Pitot tube was compared with the flow measured by a sharp-crested rectangular weir, V-notch weir, and the trajectory method.

Discharges measured by the Pitot tube were analysed by using a Two-Point technique (average of velocity head at the center and near the wall of pipe) and Darcy averaging technique (mean of velocity head at the center and near the wall of pipe). To measure the average discharge at these points, regression analysis was used and equations

were developed for three sizes of the Pitot tube for fully flowing pipes. To estimate the average discharge of a delivery pipe from a tubewell, a factor equal to 1/1.05 times the discharge measured at a quarter of the pipe diameter was developed for the three sizes of the Pitot tubes. To estimate the average discharge, a factor equal to 1/1.12 times the discharge measured at the center of the delivery pipe was developed for the three sizes of the Pitot tubes. This technique is most suitable for measuring the discharge from fully flowing pipes and the resulting error was found to be less than 2 percent.

Results of the three Pitot tube sizes (2, 3 and 5 mm) were almost the same. But it was observed that in smaller sized Pitot tubes of 2 and 3 mm, air becomes entrapped, thus making their use quite difficult. The Pitot tube of 5 mm diameter is recommended for discharge measurements in fully flowing pipes.

For the partially flowing pipes, the velocity head was measured at four points (i.e. at 30%, 60%, 80% and 90% of the water depth in the pipe). The discharge was calculated by multiplying the area of water-filled pipe with the velocity measured at each point. Again average discharge equations at selected points were developed for partially filled pipes. In general, for the average discharge equation of partially filled pipes, a factor equal to 1/1.2 times the discharge$^{1.05}$ measured at all four points of the delivery pipe was developed. An important observation was that flow measurement by the Pitot tube give unsatisfactory results if the velocity is less than 1.5 m/sec (5 ft/sec). The

resulting error of measurement was observed upto 3 percent. The conclusion is that the Pitot tube can be used for estimation of discharge for partially filled pipes if the velocity condition is met.

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