A Review on Calibration of Cup-Type Current Meter

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Abstract- *This paper represents the study and review of calibration of cup-type current meter. We studied the one case study which is related to calibration of cup-type current meter. The main purpose of cup-type current meter calibration is to determine the relationship between velocity and the rate of revolutions of the rotating element. The current meter are attached to the carriage and moved through still water in the tank at various constant speeds of the trolley during calibration. The speed of the trolley and the rate of revolution of the rotor of the current meter are measured simultaneously. In a calibration analysis, the accuracy of an instrument is shown. A measurement uncertainty ratio is included in a calibration report to assist identify if an instrument is drifting.*

I. INTRODUCTION

The velocity distribution in conduits and open ducts is measured using current metres. The towing method is used to calibrate them, which involves hauling them along a rating channel at a constant speed with the water at rest. Depending on the rotational velocity value, the same propeller can have different calibration equations. The fitted constant, represents the minimum velocity required to overcome hydraulic and mechanical frictions. Two experimental velocities were compared to the velocity produced by the pre-existing manufacturer's calibration curve, which was obtained using the standard calibration process by towing tank. One obtained from an electromagnetic flow metre discharge calculation v_{magn}, and the other obtained by executing the Torricelli formula between the two reservoirs v_{torr}. R. Woltmann invented the first current metre in 1787.

II. CURRENT METER

Current meter is basically an oceanic device which is used to check the acceleration or force of current in the waters like a river, sea, canal or tunnels. The current meter operates with a wading rod and current meter processor which helps monitor the velocity of flow of current in various depths and streams of water. This method is necessary to observe the flow velocities at various depths around the waters. The current meter can also be used to measure flow of current in contaminated waters. The metre can be used in polluted water flows as well.

III. CURRENT METER WORKING PRINCIPAL

The pulse signal emitted per revolution is used to calculate water flow. An encapsulated reed switch located inside the current meter body produces this signal.

IV. ADVANTAGES & DISADVANTAGES OF CURRENT METER

- **The advantages of current meter are as under:**

i. Low cost of maintenance
ii. It measures both reverse as well as forward flow of water accurately
iii. The smallest obstacle in the flow path results in the slightest pressure drop.
iv. It is corrosive or slurry fluid flow.

- **The disadvantages of current meter are as under:**

i. It is dependent on electricity for conduction.

V. PROPELLER CURRENT METER

The propeller current meter fitted with two or three bladed propellers that are parallel to the stream's flow direction. A contact and hence audible signals are produced by a worm and worm wheel system. A fine cable suspends the current meter, which is then lowered to the required depth. The current meter is move freely across its horizontal and vertical axes, allowing it to adjust to the direction of the water flow.

Fig 5.1 – Propeller current meter

VI. CUP-TYPE CURRENT METER

The Cup Type Water Current Meter is used to accurately measure the velocity of running water in open waterways, lakes, canals, and rivers. It was designed in accordance with I.S.3910 specifications. Velocity measurement ranges from 0.3 to 1 m/sec.

The cup type current meter is made up of six cups which are aligned and mounted on a vertical shaft in a yoke shaped frame on two axis points. The yoke frame protects the cups from damage that can be caused by any floating bodies or particles in the water.

Fig. 6.1 - Cup Type Current Meter

Velocity area principal is used to calculate the discharge from current meter data.

The cups move in circular motion which generates a signal per revolution with the help of magnet in the magnetic chamber. And these signals can be recorded by the external sensor.

The Cup type Current Meter is designed in accordance with IS standards. Current meters are point-of-sample velocity measurement instruments. After that, each point velocity calculation is assigned to a significant portion of the entire cross section moving flow. A wireless meter or a headset may be used to monitor revolutions.

VII. COMPARISON BETWEEN CUP-TYPE CURRENT METER AND PROPELLER CURRENT METER

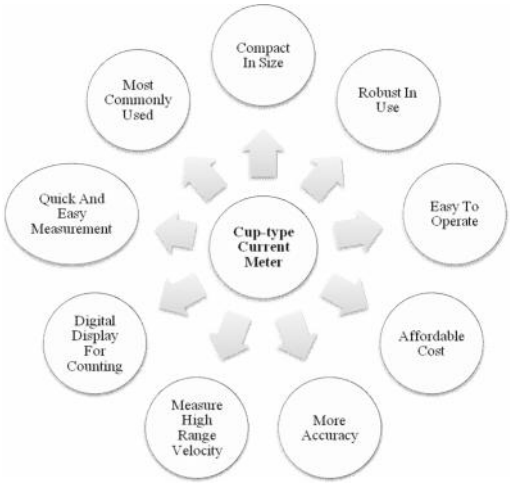
The basic difference between the cup-type current meter and propeller current meter is that the propeller type current meter only registers velocity in a direction parallel to the propeller's axis, while the cup-type current meter registers velocity in any direction in a horizontal plane. Propeller current meters are more sensitive than cup current meters because they produce higher R.P.M. for the same flow velocity.

VIII. WHY CUP-TYPE CURRENT METER IS WIDELY USED?

Cup-type current meter is widely used due to their various features. Some of the reasons of it's widely use are as follows:

Cup-type current meter is comparatively compact than the other current meter such as Propeller current meter and therefore it can be easily carried from one place to another. It is robust in use, hence it is more durable and simultaneously the life of cup-type current meter increases. They are easy to operate. It has affordable cost. The main feature of cup-type current meter is that it accommodates the digital display for counting.

The accuracy of measurement of velocity is increased by using cup-type current meter. It can also measure the high range velocity than the others. The required discharge can also be calculated using the measured velocity. As a cup-type current meter has a chain it can be immersed in lower depths of streams. With the help of cup-type current meter, it is possible to take quick and easy measurement.



IX. CALIBRATION

The calibration is the process of comparing the actual measurements on your instrument with standard measurement. The standard's precision should generally be ten times that of the measuring device being analyzed. Most of the standards organizations consider a 3:1 accuracy ratio is appropriate.

The calibration is the method which based on determining the flow through a submerged outflow. The Bernoulli's theorem states that, a current meter mounted in front of a submerged outflow is subjected to a known constant velocity due to a uniform velocity at a given cross section.

X. OBJECTIVE OF CALIBRATION FOR CUP-TYPE CURRENT METER

The main objective of calibration of cup-type current meter is to state the relation between velocity and the rate of revolutions of the rotating element.

XI. NEED OF CALIBRATION FOR CUP TYPE CURRENT METER:

Calibration ensures the measurements taken by a system are precise and of high quality. Since the results are analyzed using technology, there is a possibility that they will vary over time, and it is difficult to provide precise results for humidity and temperature because they change excessively.

Hence, to be sure about the measurements recorded and their results it is very important to maintain calibration using equipment throughout lifetime for accurate and reliable repeatable measurements.

Calibration's main goal is to provide precise measurements using a piece of equipment or instrument without creating any uncertainty, by quantifying and controlling the variability in the measuring process to an acceptable level.

Periodic calibration ensures the current meter's quality, since its usage will change the calibration equations with time. As a result, the new meter can be checked after 100 hours of operation, or at least once a year.

All equipment's accuracy reduces with time due to natural wear and tear. It can degrade quickly or gradually over time. Electrical or mechanical shock, as well as any unsafe manufacturing environment, can impact accuracy, depending on the type of instrument and the environment in which it is used.

Calibration is necessary because it ensures correct and high-quality measurements, which are the basis for the creativity, protection, and quality of most devices we use and rely on every day.

Periodic current meter calibrations are necessary to ensure accurate readings, but the appropriate testing facilities are extremely complicated and only accessible in a few institutions. Advanced electronics and automations, on the other hand, facilitate the development of efficient and quick calibration systems.

XII. PROCEDURE OF CALIBRATION OF CUP-TYPE CURRENT METER

Calibration of cup-type current meter is standard practice to calibrate current meters in a straight open tank (rating tank). Periodic calibration is required for older current meters to account for probable wear and tear of some components. According to IS 13371, current meters must be recalibrated every year or after 300 hours of use. To create a relationship between the rotational speed and the velocity of flow of a new current meter, it must be Calibrated

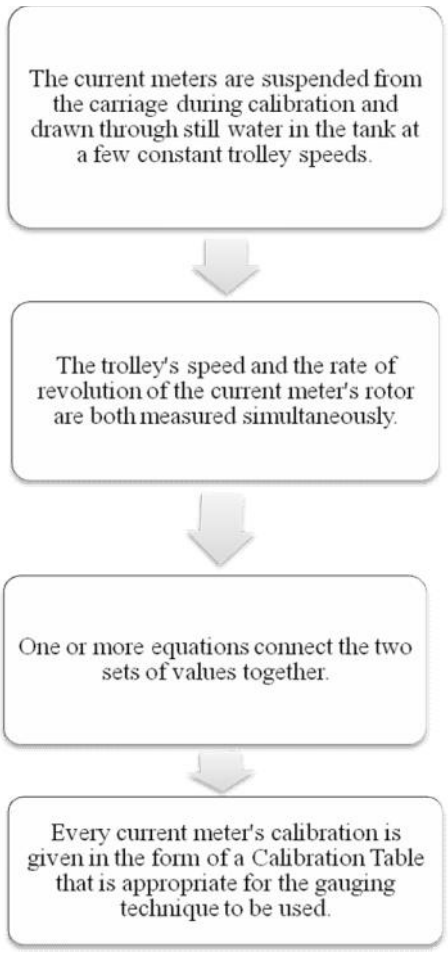


Fig .12.1 – Current Meter Rating Trolley

XIII. RESULT OF CALIBRATION

1. The accuracy of an instrument is shown in a calibration analysis.
2. The accuracy of an instrument is determined by the calibration report's results.
3. A calibration report includes a measurement uncertainty ratio which helps to indicate if an instrument is drifting.
4. As shown in Graph (Trolley velocity Vs Current meter revolutions per second), Trolley velocity is directly proportional to Current meter revolutions per second.
5. As shown in the Graph, the nature of graph is straight line.

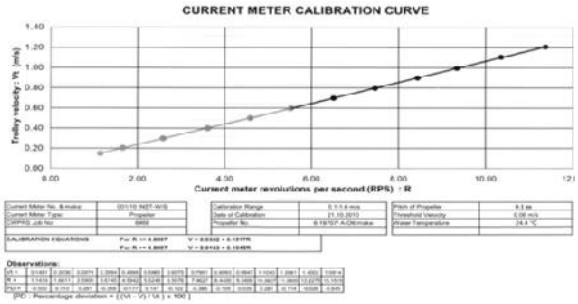


Fig.13.1 Current meter calibration curve

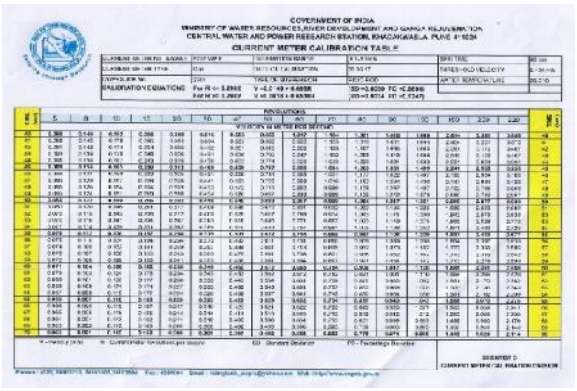


Fig.13.2 Result of calibration of cup-type current meter

XIV. CONCLUSION

1) The conclusions of the calibration method revealed a strong correlation between the velocity estimated by the two calibration lines produced by fitting experimental data v_{torr} and v_{magn}.
2) To increase the accuracy of the current meter it must be calibrated periodically.
3) Due to the calibration, the durability of current meter is increases.

XV. ACKNOWLEDGEMENT

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FIGURE REFERENCES

[1] Fig 5.1 – Propeller current meter from Central Water and Power Research station, Pune.
[2] Fig. 6.1 - Cup Type Current Meter from Central Water and Power Research station, Pune.
[3] Fig .12.1 – Current Meter Rating Trolley from Central Water and Power Research station, Pune.
[4] Fig.13.1 Current meter calibration curve (Trolley velocity Vs Current meter revolutions per second) from Central Water and Power Research station, Pune.
[5] Fig.13.2 Result of calibration of cup-type current meter from Central Water and Power Research station, Pune.

NOTATION

[1] V_{magn} = flow velocity obtained by the calibration line fitting v_{magn} experimental points
[2] V_{torr} = flow velocity obtained by the calibration line fitting v_{torr} experimental points
[3] IS = Indian Standard
[4] RPM = Revolutions Per Minute