Standards on Water Meters

Conference Paper · February 2018

2 authors:

Gopan C K
Fluid Control Research Institute

Jacob Chandapillai
Fluid Control Research Institute

Standards on Water Meters

Gopan C K, Jacob Chandapillai, U Muthukumar*
Fluid Control Research Institute,Palakkad, Kerala, India.
**e-mail: gopan.c.k@fcriindia.com*

Abstract

Selection and testing of water meters are performed based on Indian and international standards like IS 779, IS 2373, ISO 4064 and OIML R 49. Recently the international standards have been revised by including different types of meters. More flexibility in specification is given to incorporate water meters based on various working principles as well as operating conditions. These additions are not adopted in the Indian standards. In this situation how to frame a suitable specification for Indian scenario to get good quality meters for minimum price is discussed in this paper. The importance of meter testing and standard quality assurance practices are also discussed in detail.

Keywords: Water meter, testing, quality assurance, sampling, certification

Introduction

Water meters play a vital role in accounting water distribution and usage. Since water meters are mainly used for billing it is considered as the "cash box" of water utility. Water metering has become inevitable for creating awareness on the water conservation and detecting leakage in the water distribution system. Millions of litres of water, wasted by leaks and over usage, can be saved if proper metering and billing is implemented in the system. Different types of water meters have evolved which serves the water utilities and consumers in many ways. It is very important that the quality of meters is ensured during procurement. Poor quality meters are posing a serious challenge to water utilities in their mission of efficient and accurate billing based on water consumption. Several quality assurance methods are adopted by different water utilities for selecting good quality water meters.

The metrological and technical requirement of water meters and test methods are described in international and Indian standards. The international standard ISO 4064 and the Indian standard IS 779 are widely used by water utilities for preparing the meter specifications and the qualification criteria. Even after revision of ISO standard in the year 2005 and 2014, the previous versions, ISO 4064 -1: 1993, ISO 4064-2:2001 and ISO 4064-3:1999 are widely used by many water utilities. IS 779: 1994 which is broadly in line with ISO 4064-1: 1993, is also referred in many tenders in India for domestic meters.

IS 779:1994 standard covers terminology, construction, technical characteristics, metrological characteristics and other requirements of water meters with threaded end connections of size up to and including 50 mm, having nominal flow rates in the range of 1.5 to 15 kl/h, suitable for measuring the flow of cold potable water at a nominal pressure of 1 MPa and ambient temperature.

ISO 4064: 2014 is identical to the corresponding edition of OIML R 49, which has been issued concurrently. In addition to water meters based on mechanical principles, ISO 4064 & OIML R 49 applies to devices based on electrical or electronic principles, and mechanical principles incorporating electronic devices, used to measure the volume of cold potable water and hot water. OIML Recommendation, R 49, is a publication of International Organisation of Legal Metrology which OIML Member States are morally obliged to implement as far as possible. The content of OIML R49 is the same in substance as that of ISO 4064-1:2014. Similar is the case of MID approval. Measuring Instruments Directive (MID) for water meters was adopted by the European Parliament and Council for application by EU Member States from 30 October 2006. The Directive is designed to harmonize the requirements for new measuring instruments placed on the market or put into use in Europe by eliminating the regulatory differences at national level which hinder trade. Certificates of conformity to the MID Directive are valid throughout Europe. MID reinforces European standards and OIML recommendations. In 2014 European standards for water meters, EN 14154 was withdrawn and was replaced by ISO 4064:2014. OIML R 49 is also completely in line with ISO 4064:2014. Hence a meter confirming to any one of these standard automatically confirms to the others also.

Classification of meters as per IS 779 and ISO 4064.

In India IS 779 standard is widely followed for selection and testing of domestic water meters. The meter specification as per IS779 is almost identical as in international standard ISO4064:1993. Meters are classified as Class A and Class B based on the minimum flow rate, transitional flow rate and the verification scale interval. Class B meters are generally used for domestic connections in India. The nominal flow rate of 15 mm class B meter is 1.5 kl/h and the minimum flow rate is 0.030 kl/h.

As given in table 1, various flow rates like Qmin, Qt, Qn and Qmax are fixed for different sizes of meters. This concept has been changed completely in the international standard when revised in 2005 and 2014. The new standard gives complete freedom to the meter manufacturers to choose any flow range, from the standard, for any sizes of meters. In ISO 4064: 2014, the critical flow rates are Q1, Q2, Q3 and Q4 compared to Qmin, Qt, Qn and Qmax in the older version and in IS 779. Different values of Q3 and R ratio (Q3/Q1) are given in the standard, which the meter manufacturer can choose from. Q3, the permanent flow rate, is the highest flow rate at which the meter is to operate within the maximum permissible errors (MPE). R or Q3/Q1 is the ratio of permanent flow rate to minimum flow rate. 2 is the transitional flow rate and Q4, the maximum flow rate.

TABLE 1: Flow rate specification of class A and class B domestic meters.

Meter Size (mm)	Minimum flow rate (lph)		Transitional flow rate (lph)		Nominal Flow rate (kl/h)
	Class A	Class B	Class A	Class B	Class A & B
15	60	30	150	120	3
20	100	50	250	200	5
25	140	70	350	280	7
40	400	200	1000	800	20
50	600	300	1500	1200	30

As per ISO 4064:2014 a water meter is designated by the numerical value of permanent flow rate, Q3, and R. A series of values of Q3 ranging from 1 m^3/h to 6300 m^3/h is given in the standard. The list may be extended to higher or lower values in the series. Similarly the values of Q3/Q1, ranging from 40 to 1000 is also presented. The ratio of transitional flow rate to minimum flow rate, Q2/Q1, is 1.6 and the ratio of maximum flow rate to permanent flow rate, Q4/Q3, is 1.25. Thus on selecting R and Q3 all other flow rates can be calculated. The introduction of R ratio is to have flexibility in choosing minimum flow rate for the meters based on the sensor type. While selecting water meters the utilities have to specify the expected maximum and minimum flow rate in the water distribution lines so that a suitable meter specification can be framed. Q3/Q1 ratio of 80 is nearly equivalent to class B meters as per IS 779 and ISO 4064:1993. Q3 of 2.5 m^3/h and R 80 has Q1 0.031 m^3/h and Q4 3.125 m^3/h which is very much close to the flow range of 15 mm Class B water meter.

ISO 4064:2014 classify the meters as class 1 and class 2 based on maximum permissible error (MPE). For class 1 meters the MPE for the upper flow rate zone (Q2 ≤ Q ≤ Q4) is ±1 %, for water temperature from 0.1 °C to 30 °C, and ±2 % for temperatures greater than 30 °C. The MPE for the lower flow rate zone (Q1 ≤ Q < Q2) is ±3 % regardless of the temperature range. For accuracy class 2 water meters the MPE for the upper flow rate zone (Q2 ≤ Q ≤ Q4) is ±2 %, for temperatures from 0.1°C to 30 °C, and ±3 % for temperatures greater than 30 °C. The MPE for the lower flow rate zone (Q1 ≤ Q < Q2) is ±5 % regardless of the temperature range. Table 2 shows the MPE with respect to temperature range for different accuracy classes.

TABLE 2: MPE for different accuracy classes.

Flow zone	**Maximum Permissible Error (MPE)**	
	Class 1	**Class 2**
Q2 ≤ Q ≤ Q4 (Upper zone)		
(a) for water temperature 0.1°C to 30 °C	±1 %	±2 %
(b) for water temperature greater than 30 °C	±2 %	±3 %
Q1 ≤ Q < Q2 (Lower zone) (for all temperature range)	±3 %	±5 %

Classification based on the MPE and water temperature is a new concept adopted in the revised ISO 4064 standard. For Indian condition it is difficult to choose a temperature range adopted here, which is 0.1 °C to 30 °C and above 30 °C. This classification based on water temperature was not there in the previous standards as well as in Indian standard. In many places the temperature varies from less than 10 °C to few degrees above 45 °C in a year. Class 1 meters for water temperature above 30 °C will have identical MPE as that of Class B meters as per IS 779 standard, except at the minimum flow rate at which the criteria will be more stringent. When following ISO standard, choosing class 1 meters for water temperature above 30 °C can be selected for any regions in India.

The maximum allowable pressure loss across the meter as per IS 779 standard is 0.25 bar at Qn and 1 bar at Qmax. ISO 4064:2014 allows a maximum pressure loss of 0.63 bar between Q1 and Q3. This comes under Δp 63 pressure loss class. The manufacturer can select any pressure loss class from Δp 63 to Δp 10, for the meters, from the values given in table 3.

TABLE 3: Pressure loss classes as per ISO 4064:2014

Class	Δp 63	Δp 40	Δp 25	Δp 16	Δp 10
Maximum Pressure loss (bar)	0.63	0.40	0.25	0.16	0.10

It may be noted that the maximum pressure loss specified is not for the maximum flow rate, but at Q3. When comparing with Class B meters this flow range falls between Qn and Qmax and the pressure loss class Δp 63 matches the pressure loss requirement of class B meters. Hence water meter with Δp 63 pressure loss class can be adopted when specifications are formulated with respect to ISO standard.

In the latest version of ISO 4064, the meter specification and test methods are framed by considering the operating conditions of European countries. The water temperature and ambient temperature to be maintained during testing is 25 ±5 °C and 15 °C to 25 °C respectively. It is evident that these conditions are irrelevant for Indian conditions and testing at normal ambient conditions will be more appropriate.

The water distribution system, including the infrastructure, water quality and price of water in India is not as in many developed countries. In this scenario what we need is simple, robust and low cost meters. Experience shows that class B meters as per IS 779 which qualifies life cycle testing has proved its reliability in many water utilities in India.

Meter specification

Many utilities have taken constructive steps to achieve efficient and cost effective metering. Usually, procurement of meters is carried out through tendering process and the tender document should convey the strategy adopted for meter selection and the specification of the meter. The meter specification shall be formulated purely based on the requirements of water utilities and shall be in such a way that maximum number of bidders can participate in the tender. Specifying insignificant requirements which are not appropriate for the application will eliminate good quality meters and thus reduce competition among bidders.

Apart from standard specifications and selection criteria some utilities are also demanding certain international certifications for meters. Depending upon the country of origin of meters different manufacturers has different product certifications. Those countries have a well defined quality control or quality assurance plan for ensuring the continued compliance of certified meters, which cannot be practiced in India. There are many good quality water meters available in India which does not have any foreign certifications. The quality of these meters can be very well evaluated by performing acceptance test and if required endurance testing. So in India foreign certification like MID can only become a criterion for eliminating many Indian bidders or many good quality meters which does not have these certifications. Testing is the best way of getting good quality meters rather than selection based on product certification.

As stated in the introduction of this paper the criteria for MID approval, OIML requirements and ISO 4064 are all the same. In addition to this there is a tendency to add several specifications as well as conditions in tender document, which are not having any practical significance. Sometimes the availability of meters in the market itself is not considered while framing meter specification. Because of this practice, several utilities are forced to cancel their purchase actions in a later stage. In fact, water utilities are expected to evaluate the importance of these specifications and conditions relating to Indian conditions.

In general utilities should try to reduce the additional specifications or conditions in order to get sufficient quotations for attaining good competition among the bidders. Nowadays several brands of meters from various countries with wide variation in quality and price are available in India. Good and poor quality meters are produced in India and abroad. Hence there is no need of making a distinction between Indian and imported meters. It is also true that a costly meter need not be superior in quality. Hence quality of water meters shall be ensured through proper quality assurance practices like endurance testing and acceptance testing by random sampling.

Quality Assurance

Proper testing is the only way to evaluate the quality of meters. Endurance test or “Pattern approval test” mentioned in IS 779 standard are generally considered as the minimum qualifying criteria for selection of the supplier. Endurance testing involves testing the meter at specific conditions over a significant period of time, to discover how the meter behaves under sustained use. This helps to assess the operational life span of the meter. Passing endurance testing is an effective pre bid qualification criteria and it ensures that utilities are not forced to go for a poor quality meters based on their lowest price bid. Endurance test allows only good quality meters to go to the next stage of the tender, ie; selection based on price bid.

Endurance tests are conducted on the samples provided by the manufacturer at their discretion. These limited tests on the “Golden samples” do not reflect the quality of particular brand but this procedure is highly suitable for eliminating sub-standard brands. Tests conducted at FCRI in the past show that many brands available in the market do not conform to the standard requirements. Even though endurance test helps to select a durable model of meter, the quality of lot supplied can be ensured only through acceptance test. Acceptance test by random sampling shall not be replaced with endurance testing.

Acceptance test is usually conducted on samples selected at random, from the lot supplied, to ensure that the meters supplied are also having sufficient quality similar to the meters submitted for endurance test during selection of supplier. During the supply of each lot of meters, samples are obtained by random sampling basis. The sampling plan for testing of meters for acceptance of lot can be based on the standard IS 2500 (Part 1) – “Sampling procedure for inspection by attributes” and ISO 2859 – “Sampling procedures for inspection by attributes”. This procedure is used universally for lot acceptance test of any products. A sampling plan, based on these standards, for AQL of 2.5 % is given in IS 779:1994 and is given in Table 4.

TABLE 4. Sampling plan and criteria of acceptance

Size of the Lot	Size of first sample	Acceptance Number	Rejection number	Size of second sample	Cumulative sample size	Cumulative acceptance no
Up to 50	5	0	1	-	-	-
51 to 150	13	0	2	13	26	1
151 to 280	20	0	3	20	40	3
281 to 500	32	1	3	32	64	4
501 to 1200	50	2	5	50	100	6
1201 to 3200	80	3	6	80	160	9
3201 to 10000	125	5	9	125	250	12
10001 to 35000	200	7	11	200	400	18
> 35000	315	11	16	315	630	26

Here is an example of lot acceptance procedure based on random sampling. If the lot size is 10,000 meters, 125 samples are selected from the lot for routine testing. The acceptance number is 5 or less (number of failure) and the rejection number is 9 or more. If the number of failed meters is between 5 and 9, second sample of 125 meters shall be obtained from the same lot for testing. The cumulative acceptance number is then 12. This is a general method for inspection by attributes. This practice is followed by several utilities for quality assurance of meters procured. It is evident that the number of permitted failures is quite low compared to the total number of meters in a lot. For meeting these criteria the manufacturers need to follow rigid quality control norms during the manufacture of the meters.

This procedure for meter selection has been found very effective during bulk purchases and many utilities have followed this procedure for selection of good quality meters. In bulk purchases the cost involved in testing is only 2% to 3% of the cost of meter. If the requirement is larger, this expense will come down further. The reliability of third party testing laboratories is very crucial in adopting this method of quality assurance. NABL accreditation ensures the competency of a laboratory for performing certain tests for which they are accredited.

Conclusion

Metrological characteristics of meters as per different International and national standards have been discussed in detail. The international standards have been revised by including many latest developments in metering and also by considering operational needs and inputs from manufacturers. ISO standards may be followed for meter selection by adopting the required specifications suitable for our requirements. Poor quality meters can be eliminated through the quality control practices discussed above. It has been proved that life cycle testing and lot acceptance testing is very effective in selecting good quality meters though tenders. The sampling plan and lot acceptance test as per IS 779 is formulated based on ISO and IS standards on random sampling and may be adopted irrespective of the water meter standard. While framing meter specification, irrelevant specifications such as international certifications shall be avoided and quality of water meters shall be ensured through proper quality assurance practices like endurance testing and acceptance testing by random sampling.

Reference

1. Chandapillai J, Gopan C K, (2017). Quality assurance practices in water meters in India, Everything About Water,-April 2017, p58-61.
2. Chandapillai J, Saseendran S, (2012). Emerging trends in quality assurance of Water meters.
3. IS 779: 1994 Water meters (Domestic Type) Specification
4. IS 6784: 1996 Methods of performance testing of water meters (domestic type)
5. ISO 4064: 2014 Water meters for cold potable water and hot water – Part 1 to 5.
6. ISO 4064: 2005 Measurement of water flow in fully charged closed conduits — Meters for cold potable water and hot water, Part 1 to 3.
7. ISO 4064: 1993 Measurement of water flow in closed conduits – Meters for cold potable water – Part 1 Specifications
8. ISO 4064: 2001 Measurement of water flow in closed conduits – Meters for cold potable water – Part 2 Installation requirements and selection
9. ISO 4064: 1999 Measurement of water flow in closed conduits – Meters for cold potable water – Part 3 Test methods and equipment.
10. OIML R49: 2013 Water meters for cold potable water and hot water – Part 1 to 3.