International Standard ISO 4064/3

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Measurement of water flow in closed conduits — Meters for cold potable water — Part 3: Test methods and equipment

Mesurage de débit d'eau dans les conduites fermées — Compteurs d'eau potable froide — Partie 3: Méthodes et matériels d'essais

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Foreword

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Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council.

International Standard ISO 4064/3 was developed by Technical Committee ISO/TC 30, *Measurement of fluid flow in closed conduits*, and was circulated to the member bodies in June 1982.

It has been approved by the member bodies of the following countries:

Australia	Korea, Rep. of	Sweden
Belgium	Netherlands	Switzerland
Czechoslovakia	Norway	United Kingdom
Egypt, Arab Rep. of	Poland	USA
France	Romania	USSR

The member body of the following country expressed disapproval of the document on technical grounds:

Japan

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0 Introduction

This International Standard is applicable to meters for cold potable water, as defined in clause 1 of ISO 4064/1.

ISO 4064/1 deals with terminology, technical and dimensional characteristics, metrological characteristics and pressure loss.

ISO 4064/2 deals with installation requirements.

1 Scope

This part of ISO 4064 specifies the test methods and means to be employed in determining the principal characteristics of water meters.

2 Field of application

Legal requirements take precedence over the specifications of this part of ISO 4064. In particular, it should be noted that in countries where legal requirements specify that the tests are to be carried out in accordance with the rules of the International Organization of Legal Metrology, for example for pattern approval and initial verification of water meters, OIML Recommendation 49 shall be followed.

3 References

ISO 228/1, *Pipe threads where pressure-tight joints are not made on the threads — Part 1 : Designation, dimensions and tolerances.*

ISO 2084, *Pipeline flanges for general use — Metric series — Mating dimensions.*

ISO 4006, *Measurement of fluid flow in closed conduits — Vocabulary and symbols.*

ISO 4064/1, *Measurement of water flow in closed conduits — Meters for cold potable water — Part 1 : Specification.*

ISO 4064/2, *Measurement of water flow in closed conduits — Meters for cold potable water — Part 2 : Installation requirements.*

OIML, *Vocabulary of legal metrology.*

OIML/SP 5/SR 16 Doc. 79[1)], *Installation and storage conditions for cold water meters.*

OIML/SP 5/SR 16 Doc. 91[1)], *The evaluation of flow standards and facilities used for testing water meters.*

4 Requirements common to all tests

4.1 Preliminary requirements

Before starting testing, a written test programme shall be compiled, and shall include, for example, a description of the tests for the determination of measurement error, pressure loss and wear resistance. The programme may also define the necessary levels of acceptability and stipulate how the test results should be interpreted.

Two of the most common forms of test programme, that is pattern approval and initial verification, are given in clause 10 by way of example.

1) At present at the stage of draft.

4.2 Water quality

Water meter tests shall be made with water. The water shall be that of the public potable water supply or shall meet the same requirements. If water is being recycled, measures shall be taken to prevent residual water in the meter from becoming harmful to human beings.

The water shall not contain anything capable of damaging the meter or adversely affecting its operation.

It shall not contain air bubbles.

4.3 General rules concerning the test installation and its location

4.3.1 Freedom from spurious influences

Test rigs shall be so designed, constructed and used that the performance of the rig itself shall not contribute significantly to test error. To this end, high standards of rig maintenance and adequate supports and fittings, preventing vibration of the meter, the test rig and its accessories, are necessary.

It shall be possible to carry out test readings rapidly and easily.

4.3.2 Group testing of meters

Meters are tested individually or in groups. In the latter case the individual characteristics shall be precisely determined. Interaction between meters, and between test rigs, shall be eliminated.

When meters are tested in series, the pressure at the exit of each shall be sufficient to prevent cavitation.

4.3.3 Temperature of the water during the tests

The results of the tests are acceptable without temperature correction provided that the water temperature in the meter is between 0 and 30 °C during the tests.

In no part of the test rig shall the temperature fall below 0 °C.

4.3.4 Location

During the tests, the location chosen for them shall be isolated from any other activity (for example, manufacture, repairs etc.) or disturbing influences (for example, ambient temperature, vibration).

5 Measurement error tests

The method described in this part of ISO 4064 to determine measurement errors is the so-called "collection" method in which the quantity of water passed through the water meter is collected in one or more collecting vessels and the quantity determined volumetrically or by weighing. Other methods may be used, provided the accuracy levels stated in this part of ISO 4064 are attained.

5.1 Principle

5.1.1 Nature of checks

The checking of the measurement error consists in comparing the indications given by the meter under test against a calibrated reference device.

5.1.2 Definitions

For the purpose of this part of ISO 4064, the following definitions apply.

5.1.2.1 measurement errors : Conventionally expressed as relative errors, calculated as a percentage, and equal to

$$\frac{V_i - V_c}{V_c} \times 100$$

where

V_c is the value accepted as true of the volume passed;

V_i is the volume indicated by the water meter at the time of measurement of the same volume, both expressed in the same units.

NOTE — ISO 4064/1 gives the maximum permissible errors.

5.1.2.2 test flowrate : The mean flowrate calculated from the indication of the calibrated reference device.

5.2 Description of the test rig

The test rig consists of

a) a water supply (mains, non-pressurized tank, pressurized tank, pump, etc.);

b) pipework;

c) a calibrated reference device (calibrated tank, reference meter, etc.);

d) means for measuring the time of the test.

Devices for automating the testing of water meters are permissible.

5.3 Pipework

5.3.1 Description

Pipework shall include

a) a test section in which the meter(s) is (are) placed;

b) means to establish the desired flowrate;

c) one or two isolating devices;

d) means for determining the flowrate;

and if necessary

e) one or more air bleeds;

f) a non-return device;

g) an air separator;

h) a filter.

During the test, flow leakage, flow input and flow drainage shall be permitted neither between the meter(s) and the reference device nor from the reference device.

The pipework shall be such that in the upper part of the meter a positive pressure exists of at least 0,05 bar (5 kPa) even at zero flowrate.

5.3.2 Test section

The test section includes, in addition to the meter(s)

a) one or more pressure tappings for the measurement of pressure, of which one pressure tapping is situated upstream of, and close to, the (first) meter;

b) if necessary, means for measuring the temperature of the water at the entry to the (first) meter.

The different devices placed in the measuring section shall not cause cavitation or flow disturbances capable of altering the performance of the meters or causing measurement errors.

5.3.3 Precautions to be taken during tests

The operation of the test rig shall be such that the quantity of water which has flowed through the meter(s) equals that measured by the reference device.

It shall be checked that pipes (for example the swan neck in the outlet pipe) are filled to the same extent at the beginning and at the end of the test.

Air shall be bled from the interconnecting pipework and the meter(s).

All precautions shall be taken to avoid the effects of vibration and shock.

5.3.4 Special arrangements for the installation of certain types of meter

5.3.4.1 Principles

The following reminder of the most frequent causes of error and the necessary precautions for the installation of water meters on the test bench is prompted by the recommendations of OIML Document 79, which aims to help achieve a test installation where

a) the hydrodynamic flow characteristics cause no discernible difference to the meter functioning when compared with hydrodynamic flow characteristics which are undisturbed;

b) the overall error of the method employed does not exceed the stipulated value (see 5.4.1).

5.3.4.2 Need for straight lengths of pipe or a flow straightener

The accuracy of the water meter can be affected by upstream disturbance caused for example by the presence of bends, tees, valves or pumps.

In order to counteract these effects, the meter shall be installed for test in a straight length. The connecting pipework shall have the same internal diameter as the hole in the connection of the meter. It may, moreover, be necessary to put a flow straightener upstream of the straight length.

5.3.4.3 Common causes of flow disturbance

A flow can be subject to two types of disturbance : velocity profile distortion and swirl, both of which affect the accuracy of the water meter.

Velocity profile distortion is typically caused by an obstruction partially blocking the pipe, for instance the presence of a partly closed valve or a misaligned flange joint. This can easily be eliminated.

Swirl is caused mainly by two or more bends in different planes. This effect can be controlled either by ensuring an adequate length of straight pipe upstream of the water meter, or by installing a straightening device, or by a combination of the two.

5.3.4.4 Volumetric water meters

Volumetric water meters (that is, involving measuring chambers with mobile walls), such as oscillating piston meters, are considered insensitive to upstream installation conditions; hence no special recommendations are required.

5.3.4.5 Velocity type water meters

Certain velocity type water meters are sensitive to flow disturbance which can cause significant errors, but the way installation conditions affect their accuracy has not yet been clearly determined. It is simply recommended to avoid, as far as possible, the presence of bends, pumps, taper pieces and changes in the diameter of pipework immediately upstream and to position the meter to afford the maximum possible straight length of pipe upstream and downstream.

5.3.5 Test commencement and termination errors

5.3.5.1 Principles

Adequate precautions shall be taken to reduce the uncertainties resulting from the operation of the test rig components during the test.

Details of the precautions to be taken are given in 5.3.5.2 and 5.3.5.3 for two cases encountered in the "collection" method.

5.3.5.2 Tests with readings taken with the meter at rest

The flow is established by opening a valve preferably situated downstream of the meter, and it is stopped by the closure of this valve. The meter is read whilst completely stationary.

Time is measured between the beginning of the movement of the valve at opening and at the beginning of closure.

Whilst flow is beginning and during the period of running at the specified constant flowrate, the measurement error of the meter varies as a function of the changes in flowrate (measurement error curve).

Whilst the flow is being stopped, the combination of the inertia of the moving parts of the meter and the rotational movement of the water inside the meter may cause an appreciable error to be introduced in certain types of meter and for certain test flowrates.

It has not been possible, in this case, to determine a simple empirical rule which lays down conditions so that this error may always be discounted as negligible.

Certain types of meter are particularly sensitive to such error.

In case of doubt, it is advisable

a) to increase the volume and duration of the test;

b) to compare the results with those obtained by one or more other methods, and in particular the method described in 5.3.5.3, which eliminates the causes of uncertainty given above.

5.3.5.3 Tests with the readings taken in stable flow conditions and diversion of flow

The measurement is carried out when the flow conditions have stabilized.

A switch diverts the flow into a calibrated vessel at the beginning of the measurement and diverts it away at the end. The meter is read in motion.

The reading of the meter is synchronized with the movement of the flow switch.

The volume collected in the vessel is the volume passed.

The uncertainty introduced into the volume measured may be considered negligible if the time of motion of the flow switch in each direction is identical within 5 % and if it is less than 1/50 of the total time of the test.

5.4 Calibrated reference device

5.4.1 Overall error of the method employed

For pattern approval and initial verification, the total error in the method used for the determination of the volume of water passed through the water meter shall not exceed 1/10 of the relevant maximum permissible error.

5.4.2 Minimum volume (volume of the calibrated vessel if this method is used)

The minimum volume permitted depends on requirements determined by the test start and end effects and the design of the indicating device (verification scale division) (see ISO 4064/1).

5.5 Meter reading

It is accepted that the maximum interpolation error for the scale does not exceed half a scale division per observation. Thus in the measurement of a volume of flow delivered by the water meter (consisting of two observations of the water meter) the total interpolation error can reach one scale division.

In the absence of other requirements the maximum error in the reading of the volume indicated by the meter shall not exceed 0,5 %.

NOTE — The stipulation above conforms to the requirements of ISO 4064/1; nevertheless, it should be noted that OIML Recommendation 49 allows the following : 1,25 % between q_{min} and q_t and 0,5 % between q_t and q_{max}.

The effects of a possible cyclic distortion on the reading of the meter (visual or automatic) shall be negligible.

5.6 Major factors affecting measurement error checks

Variations in the pressure, flowrate, and temperature in the test rig, and uncertainties in the precision of measurement of these physical quantities, are the principal factors affecting the measurement error test results.

5.6.1 Pressure

The pressure shall be maintained at a constant value throughout the test at the chosen flowrate.

For testing water meters having $q_n < 10\ m^3/h$ at test flowrates $< 0{,}10\ q_n$, the constancy of pressure at the inlet of the meter (or at the inlet of the first meter of a series being tested) is achieved if the test rig is supplied through a pipe from a constant head tank. This ensures an undisturbed flow.

Any other methods of supply shown not to cause pressure pulsations exceeding those of a constant head tank may be used.

For all other tests the pressure upstream of the meter shall not vary by more than 10 %.

The maximum uncertainty in the measurement of pressure shall be 5 % of the measured value. Pressure at the entrance to the meter shall not exceed the nominal pressure for the meter.

5.6.2 Flowrate

The flowrate shall be maintained constant throughout the test at the chosen value.

The relative variation in the flowrate during each test (not including starting and stopping) shall not exceed

$\pm$ 2,5 % from q_{min} to q_t (not inclusive);

$\pm$ 5,0 % from q_t (inclusive) to q_{max}.

The flowrate value used in plotting the error curve is the volume passed during the test divided by the time.

This flowrate variation condition is acceptable if the relative pressure variation (in flow to free air) or the relative variation in pressure loss (in closed circuits) does not exceed

± 5 % from q_{min} to q_t (not inclusive);

± 10 % from q_t (inclusive) to q_{max}.

5.6.3 Temperature

During a test the temperature of the water shall not change by more than 5 °C.

The maximum uncertainty in the measurement of temperature shall not exceed 1 °C.

5.7 Interpretation of results

5.7.1 Single test

Where the test programme specifies a single test, the meter shall pass this test if the measured error does not exceed the maximum permissible error at the chosen flowrate.

5.7.2 Duplicated test

Where the test programme specifies that the test may be repeated, the programme shall specify the rules to be applied for combining the errors obtained.

The meter shall pass this test if the error resulting from this combination does not exceed the maximum permissible error at the chosen flowrate.

6 Pressure tests

6.1 Principle

The water meter shall withstand a specified hydraulic test pressure for a specified time without leakage or damage.

6.2 Precautions to be taken during the tests

The test rig and the meter shall be adequately cleared of air by bleeding.

The test rig shall be leakproof.

Pressurizing shall be carried out gradually without pressure surges.

7 Pressure loss tests

The pressure loss of a water meter as defined in 4064/1 is obtained by the method specified below.

This method of pressure loss testing is a reference method. Other methods may be used on condition that the values of the pressure loss obtained are equal to those obtained by the reference method.

7.1 Principle

The pressure loss of the water meter may be determined from measurements of the static differential pressure across the water meter at the stipulated flowrate.

Pressure tappings situated in the walls of the pipe fitted up- and downstream of the water meter are used for the measurement of the static differential pressure.

The pressure loss tests shall take into account any pressure recovery downstream of the meter by suitably locating the downstream pressure tapping (see 7.2.1.2). The results of the tests shall take account of the pressure recovery, and shall also compensate as necessary for the lengths of pipe between the pressure tappings (see 7.3).

7.2 Pressure loss test equipment

The equipment needed to carry out pressure loss tests consists of a measuring section of pipework containing the water meter under test and means for producing the stipulated constant flowrate through the meter. The same constant flowrate means as that employed for the measurement error tests described in clause 5 is generally used for the pressure loss tests.

7.2.1 Measuring section

The up- and downstream pipe lengths, with their end connections and pressure tappings, plus the water meter on test, constitute the measuring section.

7.2.1.1 Internal diameter of measuring section

The up- and downstream pipe lengths in contact with the water meter shall have the same internal diameter as the meter connection so as to avoid hydraulic discontinuities. The pipe internal diameters shall be specified by the meter manufacturer.

A difference in the diameter of the connecting pipework and that of the meter may result in a measurement uncertainty incompatible with the precision desired.

7.2.1.2 Measuring section straight lengths

Up- and downstream of the meter, and up- and downstream of the pressure tappings, straight lengths of pipe shall be provided in accordance with the provision of figure 1, where D is the internal diameter of the pipework of the measuring section.

7.2.1.3 Design of measuring section pressure tappings

Pressure tappings of similar design and dimension shall be fitted to the inlet and outlet pipes of the measuring section.

Pressure tappings may consist of holes drilled through the wall of the pipe or be in the form of an annular slit in the pipe wall, in either case perpendicular to the pipe axis. There should be at least four such pressure tapping holes, equally spaced in one plane around the pipe circumference. Examples of both types of pressure tapping as described in 7.2.1.4 are shown in figures 2, 3 and 4.

Four or more pressure tapping holes may be interconnected by means of tee-shaped connectors which connect up the pressure tappings, forming an annulus to give a true mean static pressure at the pipe cross section. Other means such as a ring or balance chamber may also be used.

7.2.1.4 Pressure tappings, hole and slit details

Holes drilled through the wall of the pipe (see figures 2 and 4) shall be perpendicular to the pipe axis, and the diameter of the holes shall not exceed 0,08 D and shall preferably be less than 4 mm. The diameter of the holes shall remain constant for a distance of not less than two diameters before breaking into the pipe. The holes drilled through the pipe wall shall be free from burrs at the edges where they break through into the inlet and outlet pipe bores. Edges shall be sharp, that is, neither radiussed nor chamfered.

Slits shall be perpendicular to the pipe axis and shall have dimensions as follows (see figure 3)

Width i equal to or less than 0,08 D and less than 4 mm;

Depth k greater than $2i$.

7.2.1.5 Measurement of static differential pressure

Each group of pressure tappings in the same plane shall be connected by a leak-free tube to one limb of a differential pressure measuring device, for example, a manometer. Provision shall be made for clearing air from the installation.

7.3 Test procedure

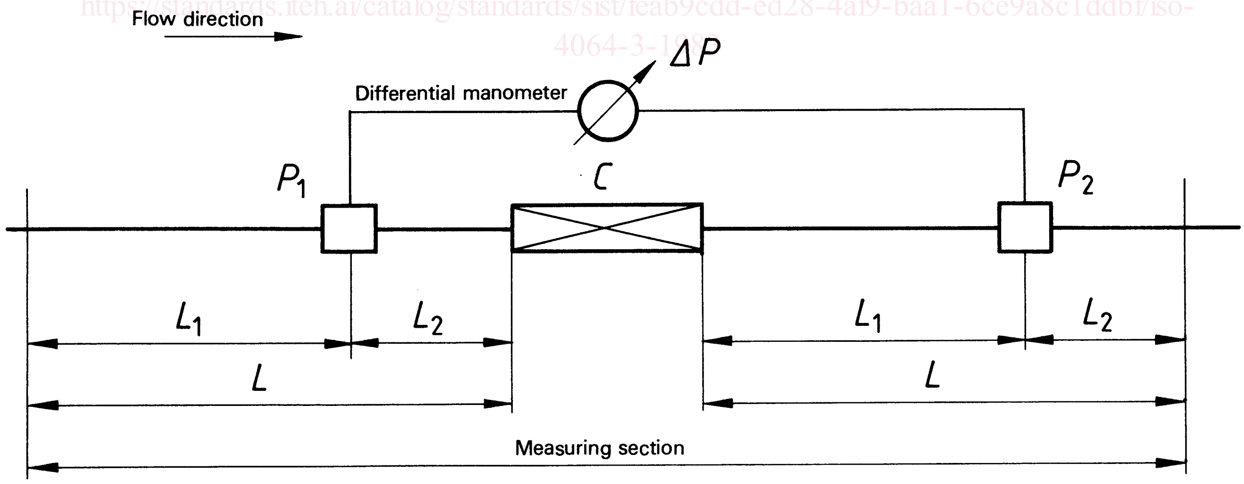
7.3.1 Principle of the method (see figure 5)

The method consists in measuring the static differential pressure (ΔP_2) between the pressure tappings of the measuring section with the meter present, and deducting from it the pressure loss (ΔP_1) of the up- and downstream pipe lengths measured at the same flowrate in the absence of the meter.

7.3.2 Determination of the pressure loss attributable to the pipe lengths (measurement 1)

The pressure loss of the up- and downstream pipe lengths (ΔP_1) may be determined prior to the tests proper, and checked periodically. This is done by joining the up- and downstream pipe faces together in the absence of the meter (carefully avoiding joint protrusion into the pipe bore or misalignment of the two faces), and measuring the pipe pressure loss of the measuring section for each test flowrate.

The absence of the flowmeter will shorten the measuring section. If telescopic sections are not fitted on the test rig, the gap may be filled by inserting, at the downstream end of the measuring section, either a temporary pipe of the same length and internal diameter as the pipe lengths, or the water meter itself.



NOTE — P_1 and P_2 are the planes of pressure tapping and C is the water meter.

$L > 15\,D$
$L_1 > 10\,D$
$L_2 > 5\,D$

Figure 1 — Layout of the measuring section

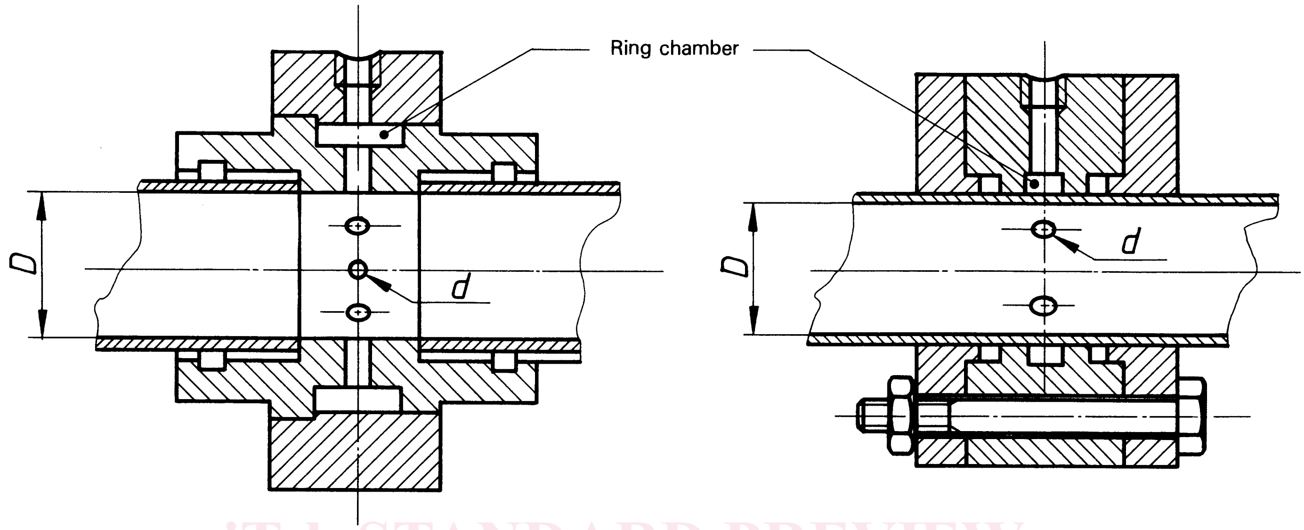


Figure 2 — Example of drilled hole type of pressure tapping with ring chamber, suitable for small/medium diameter test sections

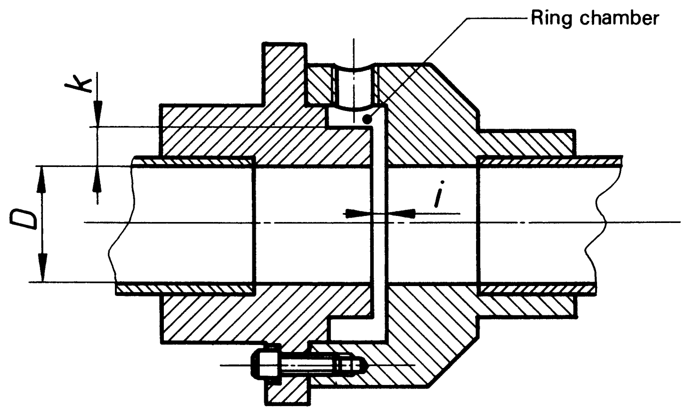


Figure 3 — Example of slit type of pressure tapping with ring chamber, suitable for small/medium diameter test sections