INTERNATIONAL

RECOMMENDATION

OIML R 72

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Hot water meters

Compteurs d'eau destinés au mesurage de l'eau chaude

ORGANISATION INTERNATIONALE
DE MÉTROLOGIE LÉGALE

INTERNATIONAL ORGANIZATION
OF LEGAL METROLOGY

Foreword

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HOT WATER METERS

1. Scope

This Recommendation applies to hot water meters metering the volume flow of hot water which has flowed in a pipe past the measuring cross section. The hot water meters shall have integrating mechanisms, indicating volume flow.

The Recommendation does not apply to hot water meters indicating in units of heat.

This Recommendation sets out the conditions with which hot water meters must comply to meet the requirements of the Services of Legal Metrology in countries where these instruments are subject to state control.

This Recommendation applies to hot water meters intended for the following applications :

Type 1 Hot water meters [(*)].

Type 2 Hot water meters forming the flow sensor of a heat meter [(*)].

Type 3 Hot water meters (e.g. drum type) in which the outlet is at atmospheric pressure ; for example, when metering condensate.

References

Hot water meters of type 2 forming the flow sensor of a heat meter are also the subject of the requirements of the Recommendation on heat meters elaborated by the OIML Secretariat SP 12-Sr 8.

2. Materials and construction

2.1. The hot water meters shall be made of materials of adequate strength and durability for the purpose for which the hot water meter is to be used.

2.2. The hot water meters shall be constructed of materials which shall not be adversely affected by the water temperature variations within the working temperature range(s), nor by a temperature which exceeds the upper limit of the temperature range by 20 °C for a short period of time.

2.3. The materials used in the construction of those parts of the hot water meters which are in contact with the hot water, shall not cause any measureable degradation of the potable quality of the water.

2.4. The hot water meters shall be constructed throughout of materials which are resistant to internal and normal external corrosion or protected by some suitable surface treatment.

2.5. The hot water meter's indicating device, when the meter is installed in service, shall be protected by a transparent window. Further protection may be provided by a suitable lid.

(*) See point 5 for subdivisions of types 1 and 2.

2.6. The volume of the drum chamber for drum meters of type 3 shall be 1, 2 or $5 \cdot 10^n$ litres, where n is a positive or negative whole number, or zero. In addition, these meters shall be provided with means for levelling.

3. Adjustment

3.1. The hot water meters may be provided with an adjusting mechanism for adjustment of the relation between the volume indicated and the actual volume of liquid which has passed through the hot water meter. This device is advisable for hot water meters in which the effect of water velocity on a rotating part is used for measurement.

Where such a mechanism is provided, it shall allow sufficient adjustment of the indications to allow initial calibration and compensate for wear or repair shop reconstruction, as appropriate.

The adjusting mechanisms, if on the outside of the meter, shall be capable of being sealed (see point 14.2).

4. Installation conditions

4.1. Hot water meters of types 1 and 2 shall be installed so that the meter is completely filled with water under normal conditions.

4.2. If the accuracy of the measurement of volume flow by the hot water meter is likely to be affected by the presence of debris in the water (for example, turbine and displacement hot water meters) then it shall be provided with a strainer or filter installed at the inlet or in the pipe upstream to remove the debris [(*)].

4.3. If the accuracy of the hot water meter can be affected by upstream disturbances (caused by the presence of bends, valves or pumps, for instance), then the hot water meter must be preceded by a sufficient length of straight pipe, with or without a flow straightener, so that when installed its indications satisfy the requirements of point 10.2 in relation to the maximum permitted errors.

5. Working temperature range

5.1. The working temperature ranges for the different types of hot water meter are as follows :

Type 1 Hot water meters :

1 a	30 °C — 70 °C
1b	30 °C — 90 °C
1c	30 °C — 130 °C
1d	30 °C — 180 °C

(*) Installation engineers should note that debris will collect in the hot water meter, for example following work on the pipeline upstream of the hot water meter.

Type 2 Hot water meters forming the flow sensor of a heat meter :

2a	≤ 30 °C — 70 °C
2b	≤ 30 °C — 90 °C
2c	≤ 30 °C — 130 °C
2d	≤ 30 °C — 180 °C

Type 3 Hot water meters in which the outlet is at atmospheric pressure :

> 0 °C — 90 °C

Hot water meters may operate and indicate at temperatures below 30 °C, but not necessarily within the maximum permissible errors.

6. Maximum operating pressure

6.1. Hot water meters are constructed to operate at a variety of pressures depending on their application. The minimum value of the maximum operating pressure shall be 1 MPa (10 bar) [(*)] except for meters of type 3, where the maximum operating pressure is equal to the pressure loss across the meter plus the atmospheric pressure.

7. Pressure loss

7.1. The pressure loss across the hot water meter, together with its strainer if this is an integral part of the hot water meter, shall not exceed 0.1 MPa (1 bar) at its maximum flowrate.

8. Marks and inscriptions

8.1. The hot water meter body (i.e. the entire hot water meter except the lid over the indicating device) shall be marked clearly and indelibly so as to be easily legible under normal installation conditions, with at least the following information :

a) unit of measurement : cubic metre (as near as possible to the indicating device),
b) maximum flowrate (Q_{max}), for example : Q_{max} 15 m^3/h OIML [(**)],
c) maker's name or trade mark,
d) the year of manufacture and the identification number (as near as possible to the indicating device),
e) direction of flow (to be shown on both sides of the body or on one side only provided the direction of flow indication will be easily seen),
f) pattern approval sign (according to national regulations),
g) maximum operating pressure, if different from 1 MPa (10 bar),
h) maximum working temperature,
i) the letter V or H if the meter can operate properly only in the vertical (V) or horizontal (H) position.

The above requirements shall be regarded as a minimum, but other information shall be added if required by national regulations or as thought necessary.

(*) In practice the maximum operating pressure for a hot water meter is accepted as being 1 MPa (10 bar) : see point 8.1 g.

(**) It is recommended that the symbol « Q_{max} » and the OIML sign should be marked on the hot water meter.

Examples of this are :
— the volumetric chamber capacity for discontinuous or drum meter types,
— the temperature range where this does not include ambient conditions.

The hot water meter lid being detachable should not be used for marks and inscriptions.

9. Indicating device

9.1. The indicating device of the hot water meter must give an indication of the volume of water in cubic metres which has passed through the hot water meter.

Aligned numbers on cylindrical rollers or pointers moving in front of circular scales or a combination of these two systems, shall be used to display this indicated volume. Numerals aligned on the roller shall move from the bottom to the top. Pointers moving in front of a circular scale shall rotate in a clockwise direction. Each roller fitted with an index and each pointer moving in front of a circular scale is called an « indicating element ».

The arrangement of the indicating elements shall give an unambiguous reading of the indicated volume. If the device comprises several elements, it shall be possible to read the results of the measurement by simple juxtaposition of the indications of the different elements.

The first indicating element, that is that which, after one complete revolution, gives the smallest fraction of a cubic metre, shall have a continuous movement.

9.2. Each indicating element shall be divided into 10 equal parts, except for the first indicating element which may be divided into 10, 20, 50, 100 or 200 equal parts, known as « scale divisions ».

The advancement, by one figure, of any indicating element other than the first must be completed while the preceding element moves through a fraction not exceeding 1/10 of its revolution.

Numbers aligned on cylindrical rollers should have a real or apparent height of at least 4 mm.

If the indicating element is divided into 10 equal parts, the actual or the optically enlarged interval between the axes of two consecutive scale marks shall be at least 4 mm and not greater than 5 mm.

The actual scale spacing of the first indicating element or, if a magnifying lens is incorporated, its apparent scale spacing at normal reading distance, shall comply with the provisions of the following Table :

Number of scale divisions	Actual or apparent scale spacing d in millimeters
10	$4 \leq d \leq 5$
20	$2 \leq d \leq 5$
50	$1 \leq d \leq 4$
100	$0.8 \leq d \leq 2$
200	$0.8 \leq d \leq 2$

Indicating elements of the type with a pointer moving in front of a circular scale shall be marked with the scale interval. This interval shall be of the form 10^n where n is a positive or negative whole number or zero. The distance between the index and the circular scale or roller shall not exceed 1 mm. The width of the index at the tip shall not exceed 0.5 mm or one quarter of the scale spacing, whichever is the smaller.

The width of a scale mark shall not exceed one quarter of the scale spacing.

Two clearly contrasting colours, for example black and red, shall be used for the numerals and scale marks on the indicating elements to differentiate between multiples and submultiples of a cubic metre.

9.3. The indicating device shall be such that the scale interval is small enough so that it is possible for a test to be made at the minimum flowrate Q_{min}, in a testing time not greater than 90 minutes, the scale interval not exceeding 1.25 % of the volume flow [(*)].

9.4. The indicating device of hot water meters of type 2 may take the form of a device which closes or opens an electrical circuit to allow a signal to be emitted each time a stipulated volume of hot water has passed through the hot water meter. These meters may also be fitted with an indicating device corresponding to that described in points 9.1, 9.2 and 9.3. Pulse emitting devices for hot water meters of type 2, if detachable, shall be so constructed to be non-interchangeable with hot water meters of other type or size so that the requirements in point 11.11 can be complied with.

9.5. The indicating device shall be constructed so that it functions correctly and without deterioration in the legibility of its indication, in an ambient air temperature of 50 °C [(**)].

10. Metrological characteristics

10.1. Hot water meter identification

10.1.1. A hot water meter can be identified by a pair of ratios q_t and q_{min} [(***)].

10.1.2. Pending the publication of an International Recommendation concerning the classification of hot water meters, meters having the same identification, that is to say, all meters for which the ratio $q_{min} = \frac{Q_{min}}{Q_{max}}$ has the same value and also for which the ratio $q_t = \frac{Q_t}{Q_{max}}$ has the same value, can be presumed to belong to the same class.

10.1.3. National regulations may fix the classes to which hot water meters intended for particular applications must belong ; (the ratios q_t and q_{min} chosen depend principally on the type of hot water meter to be used).

(*) This prescription ensures that a hot water meter has an adequate scale interval. This is not a prescription for pattern approval or initial verification tests.

(**) For safety reasons the indicating device (and those parts of the hot water meter that are not insulated) should be constructed so that under the maximum operating temperature of the hot water meter no exposed surface exceeds a temperature of 80 °C.

(***) The distribution of hot water meters into different classes on the basis of these ratios or by other means could if necessary be the subject of a future Recommendation.

10.2. Maximum permissible errors

10.2.1. The errors of measurement are expressed as a percentage and are equal to :

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

where :

V_c is the volume when a volume flow is measured by accurate means, and

V_i is the volume indicated by the hot water meter when the same volume is measured at the same temperature.

10.2.2. a) For meters of type 1, the maximum permissible error shall be :

± 5 % for flowrates in the lower zone ($Q_{min} \leq Q < Q_t$), and

± 3 % for flowrates in the upper zone ($Q_t \leq Q \leq Q_{max}$).

b) For meters of type 2, the maximum permissible error shall be :

± 3 % over the flowrate range.

However, if the nominal flowrate Q_n [(*)] does not exceed 3.0 m^3/h the maximum permissible error shall be ± 5 % for the flowrates in the lower zone ($Q_{min} \leq Q < Q_t$).

Note : the ratio of the nominal flowrate to the minimum flowrate shall be a minimum of 10. This requirement is not applicable to heat meters which include a flow controller.

c) For meters of type 3, the maximum permissible error shall be :

± 2 % over the flowrate range.

10.2.3. The requirements relating to the maximum permissible errors shall be satisfied for all temperature variations within the working temperature ranges.

11. Pattern approval

11.1. Each pattern of hot water meter submitted shall be inspected externally to ensure that it complies with the appropriate preceding clauses of this Recommendation before undergoing a pattern approval test.

11.2. The approval tests shall be made on a minimum number of hot water meters of each pattern as given in the following Table, as a function of the maximum flowrate of the pattern presented.

Maximum flowrate, m^3/h	Number of meters
$Q_{max} \leq 200$	3
$200 < Q_{max} \leq 2\,000$	2
$Q_{max} > 2000$	1

The number of hot water meters in the above Table may be regarded as the minimum to be tested and the authority responsible for pattern approval may request further hot water meters.

(*) The Recommendation « Heat meters » uses the term Q_s for the maximum flowrate of the flow sensor. However, Q_s is equivalent to Q_n as defined in this Recommendation ; there is no requirement for the flow sensor to operate at flowrates greater than Q_s.

11.3. During the tests the pressure at the outlet of the hot water meter shall be sufficiently above the ambient atmospheric pressure to avoid boiling and cavitation in the meter.

11.4. The errors of indication of the hot water meters (in the measurement of the volume flow) shall be determined for at least the following flowrates :

a) between Q_{min} and 1.1 Q_{min},
b) between Q_t and 1.1 Q_t (for meters of type 1 only),
c) between 0.225 Q_{max} and 0.25 Q_{max},
d) between 0.45 Q_{max} and 0.5 Q_{max}, and
e) between 0.9 Q_{max} and Q_{max}.

The errors found at each of these flowrates shall not exceed the maximum permissible errors specified in point 10.2.2. The errors shall be determined as near as possible to the mid-point of the working temperature range [(*)].

It is recommended that the characteristic curve for each hot water meter be plotted in terms of error against flowrate so that the general behaviour of the meter over the flowrate range can be evaluated.

11.5. The hot water meter shall withstand without leakage or damage a hydraulic pressure of 1.5 times the maximum working pressure conducted at a temperature of 10 °C (± 5 °C) less than the maximum temperature of the working temperature range, or shall withstand a hydraulic test pressure equal to the maximum operating pressure, but conducted at 5 °C above the maximum temperature of the Working temperature range, depending on the materials of construction of the hot water meter.

11.6. The pressure loss values shall be determined at least at the maximum flowrate, to ensure that this pressure loss complies with the specification given in point 7.1.

11.7. The hot water meter (except for hot water meters of type 3) shall then undergo an endurance test to simulate service conditions.

In addition to periods of extended running at specified flowrates and temperatures, hot water meters shall undergo if necessary [(**)] intermittent tests in which the hot water meter is operated at any flowrate for short periods followed by a period of rest.

11.8. On completion of the endurance test a hot water meter may then be subjected to a thermal shock resistance test. The test consists of subjecting the hot water meter to alternate cycles of flow with cold water and then with hot water. The temperature of the hot water shall be 10 °C (± 5 °C) less than the maximum temperature of the working temperature range. The cycles shall be of sufficient duration for all parts of the hot water meter (except the indicating device) to attain the temperature of the fluid flowing at that phase of the cycle. The test shall run for at least 25 cycles.

Hot water meters with a $Q_{max} \leq 20$ m^3/h shall be subject to such tests.

[(*)] In case of doubt the tests shall be extended to establish that over the working temperature range the maximum permissible errors are not exceeded.

[(**)] This depends on the use intended for the hot water meter. Where a hot water meter is destined for domestic use e.g. $Q_{max} \leq 10$ m^3/h then intermittent tests shall be made.

11.9. After the test described in point 11.7, the errors shall be determined again at the flowrates specified in point 11.4.

For meters of type 1 the shift in the error curve shall not exceed :

3 % for flowrates in the lower zone ($Q_{min} \leq Q < Q_t$), and

1.5 % for flowrates in the upper zone ($Q_t \leq Q \leq Q_{max}$).

For meters of type 2 the shift in the error curve shall not exceed 1.5 %.

For meters of type 3 the shift in the error curve shall not exceed 0.5 %.

11.10. The pattern approval certificate may state that during initial verification the error determination tests of a hot water meter may be carried out with cold water. This modification to the requirement of point 11.4 would only be permitted if, during the pattern approval tests, a study of the hot water/cold water rules of equivalence on a sufficient number of sample hot water meters, has enabled a cold water error determination test to be established and has shown that a meter passing this test also complies with the maximum permissible errors specified in point 10.2.

In this case the pattern approval certificate shall include a description of this test and the relevant requirements, in particular those regarding the permissible errors and the test flowrates.

11.11. Pattern approval certificates for meters of type 2 shall state the mean relationship between the signal emitted and the volume flow at a defined temperature e.g. 150 pulse/m^3 at 100 °C, for the particular hot water meter.

11.12. The pattern approval certificate shall indicate if a meter has not been subjected to an endurance test.

12. Initial verification

12.1. Hot water meters shall undergo the following initial verification tests. This verification shall be carried out after pattern approval has been granted.

12.2. Hot water meters of the same size and pattern may be tested in series except meters of type 3 ; but in that case the requirement of point 11.3 (concerning the pressure at the meter outlet) shall be adhered to for each hot water meter and there must be no significant interaction between meters.

12.3. The errors of indication of the hot water meters in the measurement of volume flow shall be determined at the following three flowrates at least, and at a temperature midway between the extremes of the working temperature range :

a) between Q_{min} and 1.1 Q_{min},

b) between Q_t and 1.1 Q_t (approximately 0.25 Q_{max} for meters of type 3), and

c) approximately 0.5 Q_{max}.

12.3.1. The errors found at each of the above flowrates shall not exceed the maximum permissible errors specified in point 10.2.2.

12.4. If all the errors of indication of the hot water meter in the measurement of the volume flow are found to have the same sign, then the hot water meter shall be adjusted so that not all the errors exceed one half of the maximum permissible error.

12.5. If the pattern approval certificate so states, the error determination test may be carried out with cold water instead of as required in point 12.3. In this case the test is carried out in accordance with the procedures laid down in the certificate.

13. Errors in test methods

13.1. For pattern approval and initial verification the error in the method used for the determination of the volume of water passed through the hot water meter shall not exceed one fifth of the relevant maximum permissible error.

The maximum permissible inaccuracy in the measurement of temperature is ± 1 °C.

In the measurement of pressure the maximum permissible inaccuracy is ± 5 % and in the measurement of loss of pressure ± 2.5 %.

During each test the relative variation in the flowrates shall not exceed ± 2.5 % between Q_{min} and Q_t, and ± 5 % between Q_t and Q_{max} for meters of types 1 and 2. When testing meters of type 3, the relative variation in the flowrates shall not exceed ± 5 % over the flowrate range.

13.2. It is accepted that the maximum interpolation error for a scale does not exceed half a scale interval per observation. Thus in the measurement of a volume of flow delivered by the hot water meter (consisting of two observations of the hot water meter) the total interpolation error can reach 1 scale interval.

This scale interval shall not exceed one quarter of the relevant maximum permissible error of the volume flow delivered (see point 9.3).

13.3. One revolution or whole numbers of revolutions of the first indicating element shall be used in determining the error of indication of the hot water meter in the measurement of volume flow.

14. Verification marks and protection devices

14.1. A place must be provided on hot water meters visible without dismantling the hot water meter on which the main verification mark is to be applied.

14.2. Hot water meters shall also have protection devices which can be sealed in such a way that, both before and after the hot water meter has been correctly installed, there is no possibility of dismantling or altering the hot water meter or its adjustment device without damaging these devices.

TERMINOLOGY

The terminology used in this Recommendation conforms with the Vocabulary of Legal Metrology.

1. Flowrate (Q)

The volume of hot water passing through the hot water meter divided by the time taken for the volume of water to pass through the hot water meter.

2. Volume flow (V)

The volume of hot water passing through the hot water meter, disregarding the time taken.

3. Flowrate range

The range of flowrates, delimited by the minimum and maximum flowrates, for which the indications of the hot water meter, obtained under normal conditions of use, are not affected by an error exceeding the maximum permissible errors.

4. Maximum flowrate (Q_{max})

The flowrate value corresponding to the upper limit of the flowrate range, being the highest flowrate at which the hot water meter is required to give, during a restricted or predetermined period of time, indications which are not affected by an error exceeding the maximum permissible errors.

5. Nominal flowrate (Q_n)

The flowrate value which is defined as half the value of the maximum flowrate.

At the nominal flowrate Q_n the hot water meter should be able to function in normal use, that is under continuous and intermittent conditions, without exceeding the maximum permissible errors.

6. Relative flowrate ($q = Q/Q_{max}$)

The ratio q of any given flowrate Q to the maximum flowrate Q_{max}. The two particular ratios used in this Recommendation are q_t (Q_t/Q_{max}) and q_{min} (Q_{min}/Q_{max}).

7. Minimum flowrate (Q_{min})

The flowrate value corresponding to the lower limit of the flowrate range, being the lowest flowrate value at which the hot water meter is required to give indications which are not affected by an error exceeding the maximum permissible errors.

8. Transitional flowrate (Q_t)

The flowrate value, within the maximum and minimum flowrates, at which the flowrate range is separated into two zones, called upper and lower zones, each characterised by the value of the maximum permissible error in this zone.

9. Working temperature (T)

The temperature of the hot water in the pipeline immediately upstream of the hot water meter.

10. Maximum working pressure (P_{max})

The maximum applied gauge pressure (i.e. above atmospheric pressure) for which the hot water meter is designed for continuous operation.

11. Pressure loss

The pressure loss caused by the presence of the hot water meter in the pipeline.

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