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Heat meters

热量表

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Heat meters

1 Scope

This standard specifies the terms and definitions, technical characteristics, requirements, test methods, inspection rules, marking, packaging, transportation, storage of heat meters.

This standard applies to the production and inspection of heat meters which use water as medium.

2 Normative references

The following documents are essential to the application of this document. For the dated documents, only the versions with the dates indicated are applicable to this document; for the undated documents, only the latest version (including all the amendments) are applicable to this standard.

GB/T 191 Packaging - Pictorial marking for handling of goods

GB/T 2423.1 Environmental testing for electric and electronic and electronic products - Part 2: Test methods - Tests A: Cold

GB/T 2423.2 Environmental testing for electric and electronic products - Part 2: Test methods - Tests B: Dry heat

GB/T 2423.4 Environmental testing for electric and electronic products - Part 2: Test method - Test Db: Damp heat, cyclic (12h + 12h cycle)

GB/T 26831.1 Society energy metering for reading system specification - Part 1: Data exchange

GB/T 26831.2 Society energy metering for reading system specification - Part 2: Physical and link layer

GB/T 26831.3 Society energy metering for reading system specification - Part 3: Dedicated application layer

GB 4208-2008 Degrees of protection provided by enclosure (IP code)

GB 4706.1-2005 Household and similar electrical appliances - Safety - Part 1: General requirements

GB/T 9113 Integral steel pipe flange

GB/T 17241.6 Integral cast iron flanges

GB/T 17626.2 Electromagnetic compatibility - Testing and measurement techniques - Electrostatic discharge immunity test

GB/T 17626.3 Electromagnetic compatibility - Testing and measurement techniques - Radiated, radio-frequency, electromagnetic field immunity test

GB/T 17626.4 Electromagnetic compatibility - Testing and measurement techniques - Electrical fast transient/burst immunity test

GB/T 17626.5 Electromagnetic compatibility - Testing and measurement techniques - Surge immunity test

GB/T 17626.8 Electromagnetic compatibility (EMC) - Part 4-8: Testing and measurement techniques - Power frequency magnetic field immunity test

GB/T 17626.9 Electromagnetic compatibility - Testing and measurement techniques - Pulse magnetic field immunity test

GB/T 17626.11 Electromagnetic compatibility - Testing and measurement techniques - Voltage dips, short interruptions and voltage variations immunity tests

GB/T 17626.29 Electromagnetic compatibility (EMC) - Testing and measurement techniques - Voltage dips short interruptions and voltage variations on D.C. input power port immunity tests

CJJ 34 Design code for city heating network

JB/T 8622-1997 Technical specification and reference table for industrial platinum thermal resistance

JB/T 9329 Basic environmental conditions and testing methods for instruments transportation and storage in the transportation

3 Terms and definitions

The following terms and definitions apply to this document.

3.1

Heat meter

A meter which is used to measure and display the released or absorbed

temperature of water supply and water return of the heat exchange system.

3.9

Calculator

A component that receives signals from the flow sensor and the temperature sensor pair for heat calculation, storage, display of heat values as exchanged by the system.

3.10

Temperature difference

The difference between the temperature of water supply and water return of the heat exchange system.

3.11

Minimum temperature difference

The lower limit of the temperature difference, under which the accuracy of the heat meter shall not exceed the error limit.

3.12

Maximum temperature difference

The upper limit of the temperature difference, under which the accuracy of the heat meter shall not exceed the error limit.

3.13

Minimum flowrate

Under the condition that the accuracy of the heat meter does not exceed the error limit, the lower limit of flowrate of the water when it flows through the heat meter.

3.14

The permanent flowrate

Under the condition that the accuracy of the heat meter does not exceed the error limit, the upper limit of flowrate when the heat meter is continuously operated for a long time.

3.15

4 Technical characteristics

4.1 Heat measurement

4.1.1 Method of heat measurement

The heat may be measured by the enthalpy difference method or the thermal coefficient method.

4.1.2 Enthalpy difference method

When water flows through an complete heat meter or a combined heat meter which is installed in a heat exchange system, according to the flowrate as given by the flow sensor and the temperature signal of water supply and return as given by the temperature sensor pair as well as the time the water flows, the calculator is used to calculate and display the released or absorbed heat of this system. The released or absorbed heat of this system is calculated according to formula (1):

$$Q = \int_{\tau_0}^{\tau_1} q_m \times \Delta h \times d\tau = \int_{\tau_0}^{\tau_1} \rho \times q_v \times \Delta h \times d\tau \quad \cdots\cdots (1)$$

Where:

Q - The heat released or absorbed by the system, in Joule (J);

q_m - The mass flowrate of water which flows through the heat meter, in kilograms per hour (kg/h);

q_v - The volume flowrate of water which flows through the heat meter, in cubic meters per hour (m^3/h);

ρ - The density of water which flows through the heat meter, in kilograms per cubic meter (kg/m^3);

Δh - The difference in enthalpy of water at the temperature of water supply and water return in the heat exchange system, in Joule per kilogram (J/kg);

τ - Time, in hours (h).

4.1.3 Thermal coefficient method

When water flows through an complete heat meter or a combined heat meter which is installed in a heat exchange system, according to the signal of temperature difference of water supply and water return as given by the temperature sensor pair as well as the total volume (the volume) of water as given by the flow sensor, the calculator is used to calculate and display the

5.2.1.3 The visible height of the displayed number shall not be less than 4 mm. The fractional part of the displayed value shall be clearly distinguishable from the rest of the value. When using display by multiple pages, the value as displayed on each page shall be complete.

5.2.2 Resolution of display

5.2.2.1 In the using mode, the minimum display resolution shall comply with the following requirements:

a) Calorific value: 1 kW • h, 1 MW • h or 1 MJ, 1 GJ;

b) Temperature value: 0.1 °C;

c) Temperature difference: 0.1 K;

d) Total volume:

1) Nominal diameter DN15 ~ DN25: 0.01 m^3;

2) Nominal diameter DN32 ~ DN400: 0.1 m^3.

5.2.2.2 In the verification mode, the minimum display resolution shall comply with the following requirements:

a) Calorific value: 0.001 kW • h or 0.001 MJ;

b) Temperature value: 0.01 °C;

c) Temperature difference: 0.01 K;

d) Total volume:

1) Nominal diameter DN15 ~ DN25: 0.00001 m^3;

2) Nominal diameter DN32 ~ DN100: 0.0001 m^3;

3) Nominal diameter DN125 ~ DN400: 0.001m^3.

5.2.2.3 The displayed value and unit of display shall be clearly and definitely marked. The displayed value shall be a valid number.

5.2.3 Display value of heat

5.2.3.1 When the heat meter is continuously operated for 3000 h under the maximum thermal power, the heat shall not exceed the maximum display value.

5.2.3.2 When the heat meter is continuously operated for 1 h under the maximum thermal power, the minimum effective display number shall be added

$$E_q = \pm\left(3 + 0.05\,\frac{q_p}{q}\right) \times 100\% \qquad \cdots\cdots(12)$$

The accuracy of the flow sensor of the grade-1 meter shall not exceed ±3.5%. The accuracy of the flow sensor of the grade-2 and grade-3 shall not exceed ± 5%.

5.6 Admissible pressure loss

When the heat meter is operated under the permanent flowrate, the admissible pressure loss is not more than 0.025 MPa.

5.7 Power supply

5.7.1 Basic requirements

The heat meter may use either a built-in battery or an external power supply. For heat meters which have a nominal diameter of less than or equal to DN40, it shall use the built-in battery.

5.7.2 Service life of built-in battery

The service life of the built-in battery shall be more than (5 + 1) years.

5.7.3 External power supply

5.7.3.1 The externally connected AC power supply's voltage shall be $V_n = (220^{+22}_{-33})\,V$. The frequency f_n = (50 ± 1) Hz.

5.7.3.2 The externally connected DC power supply's voltage may be (5 ± 0.25) V, (12 ± 0.6) V or (24 ± 1.2) V.

5.8 Repeatability

The error of repeatability of the heat meter shall not exceed the maximum admissible error limit.

5.9 Durability

The effective life cycle of the heat meter shall be more than 5 years. The effective life cycle shall be assessed by the durability test.

5.10 Safety performance

5.10.1 Power failure protection

When the power supply stops supplying power, the heat meter shall be able to save the heat stored before the power failure, the total volume and the

corresponding time data, the historical data in 5.3. After the power supply is restored, it shall automatically resume normal operation.

5.10.2 Undervoltage prompt of battery's voltage

When the voltage of the battery drops to the set undervoltage value, the heat meter shall have an undervoltage prompt message and shall be in normal working state.

5.10.3 Resistance to magnetic-field interference

When subjected to a magnetic-field interference which has a strength of not more than 100 kA/m, the heat meter shall work normally and the data is normal.

5.10.4 Electrical insulation

When the heat meter uses AC power supply, the electrical insulation shall comply with the provisions of category-I appliances in GB 4706.1-2005.

5.10.5 degree of protection of shell

The classification of the degree of protection of the shell shall be according to the provisions of GB 4208-2008.

For the heat meter which has an environment of use of category-A and category-B, the degree of protection of shell shall be IP54. For the heat meter which has an environment of use of category-C, the degree of protection of shell shall be IP65. For the heat meter which has an environment of use of category-D, the degree of protection of shell shall be IP65/IP68. The degree of protection of the shell of the cooling meter and the meters for heating and cooling shall be IP65. The shell of the heat meter shall have a marking of degree of protection.

5.10.6 Seal

The heat meter shall have a reliable seal. Without damaging the seal, it shall not dismantle the heat meter and relevant components.

5.11 Optical interface

The heat meter shall have an optical interface. Its structural and optical characteristics shall comply with the provisions of Appendix C.

5.12 Data communication

The data communication of the heat meter may be equipped with interfaces such as M-bus, RS-485, wireless transmission. The communication protocol shall comply with the provisions of Appendix C.

6.2.2 Resolution of display

6.2.2.1 Visually check the heat meter. In the using mode, the resolution of display shall comply with the provisions of 5.2.2.1.

6.2.2.2 Output the parameters of the heat meter from the optical interface of the heat meter. In the verification mode, the resolution of display shall comply with the provisions of 5.2.2.2.

6.2.3 Displayed value of heat

Make the heat meter continuously operate at the maximum thermal power for 1 h. Respectively record the displayed value of heat at the beginning and end of the test. Use visual inspection and calculation. The displayed value of heat shall comply with the requirements of 5.2.3.

6.3 Data storage

Simulate the operation of the heat meter for 18 months. Check the content and period of the data storage, which shall meet the requirements of 5.3.

6.4 Strength and tightness

6.4.1 Strength

For the heat meter which is installed in the closed pipeline, load the medium of water which has a temperature of the upper temperature limit minus 5 °C ~ 15 °C and a pressure of 1.5 times the maximum working pressure. After 30 minutes of stabilization, check the heat meter, which shall comply with the requirements of 5.4.

6.4.2 Tightness

For the heat meter, load the medium of water which has a temperature of the upper temperature limit minus 5 °C ~ 15 °C and a pressure of 1.5 times the maximum working pressure. After 30 minutes of stabilization, check the heat meter, which shall comply with the requirements of 5.4.

6.5 Accuracy

6.5.1 Measurement accuracy of heat meter

The test and calculation of the measurement accuracy of the heat meter shall be carried out according to the provisions of Appendix D.

6.5.2 Accuracy of calculator

The test and calculation of the accuracy of the calculator shall be carried out

a) Install the heat meter on the test bench to run it normally under the following conditions:

1) Flowrate: the permanent flowrate;

2) Water temperature: The heat meter is (50 ± 5) °C. The cooling meter is (15 ± 5) °C.

b) During the test, first empty the air from the heat meter, differential pressure gauge, pipeline. When the pressure is stable, measure the pressure difference between the front and back pressure measuring points.

c) The test shall separately measure the pressure difference between the front and back pressure measuring points when installing the heat meter and not installing the heat meter (replaced by a straight pipe segment of the same diameter). The difference between the two measured values is the admissible pressure loss of the heat meter.

d) Admissible pressure loss shall comply with the provisions of 5.6.

6.7 Power supply

The test of service life of the built-in battery is performed as follows:

a) Install the heat meter on the test bench, to run it normally under the following conditions.

b) Flowrate: the permanent flowrate;

c) Water temperature: The heat meter is (50 ± 5) °C. The cooling meter is (15 ± 5) °C.

d) Measure the working curve of power supply's current of the heat meter for no less than 10 complete working cycles. Use 80% of the rated capacity value of the battery as the reference data, calculate the effective value of the power supply's current of the heat meter and the corresponding battery life, which shall comply with the provisions of 5.7.2.

6.8 Repeatability

According to the test requirements for the measurement accuracy of the heat meter, at the same test conditions and the same test point, test the accuracy of the heat meter for 3 times. The maximum difference between any 2 test values shall meet the requirements of 5.8.

6.9 Durability

6.9.1 Durability of flow sensor

b) The flowrate shall be the maximum flowrate q_s of the heat meter. The deviation is $^{0}_{-5}$%;

c) The flow sensor runs continuously for 300 h.

6.9.1.4 After the durability test A and the durability test B are completed, the heat meter shall be at (50 ± 5) °C and the cooling meter shall be at the water temperature of (15 ± 5) °C; check the accuracy of the flow sensor of the heat meter, which shall meet the requirements of 5.5.4.

6.9.2 Durability of temperature sensor

The durability test of the temperature sensor shall comply with the following requirements:

a) Place the temperature sensor pair in the constant-temperature bath. Slowly increase the temperature to the upper limit of the product's calibrated use temperature. Then place it in room-temperature air. Slowly reduce the temperature to the lower limit of the product's calibrated use temperature. Repeat the temperature rise-fall for 10 times.

b) During the test, the temperature sensor shall have an immersion depth of 90% ~ 99% of its total length at each temperature boundary. Meanwhile the temperature shall be corrected.

c) After the test is completed, check whether the accuracy of the temperature sensor pair complies with the provisions of 5.5.3. The insulation performance shall comply with the provisions of 4.2.3.3.

6.10 Safety performance

6.10.1 Power failure protection

Make the calculator run for 24 h under the maximum temperature difference and the permanent flowrate condition. Then stop running for 24 h. Record the stored data of the heat meter. Interrupt the heat meter’s power supply for more than 24 h. Restore the normal power supply to the heat meter. Check the stored data before and after the interruption of power supply, which shall comply with the provisions of 5.10.1.

6.10.2 Undervoltage prompt of battery

The test of undervoltage prompt of battery shall meet the following requirements:

a) The test instrument is:

- Environment category;

- Marking of degree of protection;

- Marking and number of meter manufacture license.

8.2 Packaging

On the outside of the packaging box, according to the requirements of GB/T 191, print the marks of upwards, avoid moisture, handle with care; indicate the manufacturer's name, address, marking and number of meter manufacture license, net weight, data of production.

The accompanied files in the box shall include:

- Product's certificate;

- Instruction manual;

- Packing list.

8.3 Transportation

The heat meter shall be placed according to the marks during transportation. It shall not be directly affected by rain, frost or fog. It shall not be damaged by extrusion or impact.

8.4 Storage

8.4.1 The height of the product mat from the ground shall not be less than 0.3 m, the distance from the four walls shall not be less than 1 m, the distance from the heating equipment shall not be less than 2 m.

8.4.2 The environmental conditions of the warehouse shall comply with the following provisions:

a) Temperature:

- Environment category-A and environment category-C: 5 °C ~ 55 °C;

- Environment category-B and environment category-D: -25 °C ~ 55 °C.

b) Relative humidity: < 80%.

c) There shall be no acid, alkali, flammable, explosive, toxic, corrosive items in the warehouse. It shall avoid the actions of strong electromagnetic fields and direct sunlight.

Appendix C

(Normative)

Optical interface and data communication

C.1 Optical interface

The optical interface shall comply with the provisions of GB/T 26831.1.

C.2 Wakeup of optical interface

After the optical interface of the heat meter receives the initial wakeup message as specified below, the optical interface shall be able to wake up and enter normal operation state:

a) The wakeup message is a string of NUL characters (code 00 H) in the time period of 2.1 s ~ 2.3 s.

b) The maximum admissible delay between two NULL characters in this message is 5 ms.

c) After the last character of the wakeup message, the wakeup device shall wait for 1.5 s ~ 1.7 s, until the request message can be sent.

d) The baud rate of wakeup communication is 300 bit/s or 2400 bit/s. After wakeup, it uses the data communication as specified by C.3 for data communication.

e) End of transmission: After the heat meter sends the data message, the data transmission is completed. If the transmission is wrong, the wakeup device shall wait for 1.5 s before sending a new wakeup signal.

C.3 Data communication

C.3.1 Basic requirements for transmission

C.3.1.1 Sequence of transmission: For all multibyte data fields, it shall transmit the lower byte first and then the upper byte.

C.3.1.2 Transmission response: Each communication is initiated by the master station issuing a request command frame to the slave station as selected based on the information frame address field, the requested slave station responds after receiving the command.

Response delay after receiving the command frame Td: 20 ms ≤ Td ≤ 500 ms.

Appendix E

(Normative)

Test and calculation of calculator's accuracy

E.1 Standard device of electrical signal

The standard device of electrical signal shall comply with the provisions of 6.1.2.

E.2 Environmental conditions

The test is based on the following environmental conditions:

Indoor temperature: 15 °C ~ 35 °C;

Relative humidity: 25% ~ 75%;

Atmospheric pressure: 80 kPa ~ 106 kPa.

E.3 Measuring point

The test of calculator shall be performed under the following conditions:

a) The 3 measuring points at the return water's temperature of θ_{min} + 5 °C, and the temperature difference of $\Delta\theta_{min}$, 5 K, 20 K;

b) The 3 measuring points at the water supply's temperature of θ_{max} - 5 °C, and the temperature difference of 10 K, 20 K, $\Delta\theta_{max}$;

c) The water flowrate is any point within the range of q_i ~ q_s.

E.4 Test

E.4.1 For the accuracy test, make 3 measurements at each point.

E.4.2 Each measurement includes the reading of the standard device of the electrical signal and the effective reading of the calculator.

E.4.3 For the heat meter that cannot directly connect the electrical signal, in addition to the above method, it may also use the indicated value of the temperature difference between the simulated flow signal of the heat meter and that as provided actually, calculate it, use it as the standard heat value as provided to the calculator, to check the calculation error of the calculator.

E.4.4 If the temperature sensor and the calculator are not separable, it may use the test conditions of the entire meter of the component to carry out test. The

than 90% of its total length.

F.4 Test

F.4.1 For accuracy test, make 3 measurements at each point.

F.4.2 Each measurement includes a reading of the standard device of temperature and an effective reading of the temperature sensor.

F.4.3 When the temperature sensor and calculator are not separable, the components may be tested using the test conditions of this Appendix. The absolute value of the difference between the temperature value measured by the temperature sensor pair at each temperature point and the temperature value measured by the standard thermometer shall not exceed 2 °C. The difference of the temperature as measured at the same point by the water supply temperature sensor and the water return temperature sensor of the temperature sensor pair shall satisfy the accuracy requirements that the minimum temperature difference is between the sum of the formula (8) and (9).

F.4.4 When measuring temperature, it shall, according to the provisions of Appendix C, use the optical interface to enter and exit the test mode. Follow the provisions of the communication protocol to send high-precision temperature data to the master station, synchronize the data.

F.5 Calculation of test result

F.5.1 Error of single temperature sensor

The k^{th} basic error of the j^{th} measuring point of the temperature sensor is calculated according to the formula (F.1). The basic error of the j^{th} measuring point is calculated according to the formula (F.2). The basic error of the temperature sensor is calculated according to the formula (F.3).

$$R_{jk} = \theta_{jk} - \theta_{sjk} \qquad \cdots\cdots (F.1)$$

Where:

R_{jk} - The k^{th} basic error of the j^{th} measuring point of the temperature sensor, in degrees Celsius (°C);

θ_{jk} - The k^{th} reading of the temperature sensor at the j^{th} point j (j = 1, 2...n), (k = 1, 2...m), in degrees Celsius (°C);

θ_{sjk} - The k^{th} reading of the standard device at the j^{th} point, in degrees Celsius (°C).

Appendix G

(Normative)

Test and calculation of accuracy of flow sensor

G.1 Standard device of flowrate

G.1.1 The standard device of flowrate shall comply with the provisions of 6.1.2.

G.1.2 When testing, the front and rear pipelines of the flow sensor shall be straight pipe segments. The length of the straight pipe segment shall be according to the provisions of the measured flow sensor.

G.2 Environmental conditions

The test is based on the following environmental conditions:

Indoor temperature: 15 °C ~ 35 °C;

Relative humidity: 25% ~ 75%;

Atmospheric pressure: 80 kPa ~ 106 kPa.

G.3 Tested water temperature of flow sensor

The test is carried out at the following water temperatures:

a) Heat meter:

Exit-factory inspection: (50 ± 5) °C;

Type inspection: (θ_{min} + 5) °C; (50 ± 5) °C; (85 ± 5) °C.

b) Cooling meter:

Exit-factory inspection: (15 ± 5) °C;

Type inspection: (5 ± 1) °C; (15 ± 5) °C.

c) Meters for heating and cooling:

Exit-factory inspection: (50 ± 5) °C;

Type inspection: (5 ± 1) °C; (15 ± 5) °C; (50 ± 5) °C; (85 ± 5) °C.

G.4 Measurement point of flowrate

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