JJG

METROLOGICAL VERIFICATION REGULATION

OF THE PEOPLE'S REPUBLIC OF CHINA

JJG 1033-2007

Electromagnetic flowmeters

电磁流量计

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Verification regulation of electromagnetic flowmeters

1 Scope

This Regulation applies to the type evaluation, initial verification, subsequent verification, in-use inspection of electromagnetic flowmeters (hereinafter referred to as flowmeters), which are installed in closed pipelines. It is not applicable to flowmeters for measuring blood, liquid metal, iron ore slurry and open channel flow measurement, nor is it applicable to the verification of insertion electromagnetic flowmeters and electromagnetic water meters.

2 Normative references

The provisions contained in the following standards and regulations constitute the provisions of this Regulation through reference.

JJF 1004-2004 Metrological terms and their definitions for flow rate

GB/T 18659-2002 (idt ISO 9104:1991) Measurement of fluid flow in closed conduits - Methods of evaluating the performance of electromagnetic flow - Meters for liquids

GB/T 18660-2002 (idt ISO 6817:1992) Measurement of conductive liquid flow in closed conduits - Method using electromagnetic flowmeters

JB/T 9248-1999 Electromagnetic flowmeters

It shall be noted that the current valid versions of the above references shall be used.

3 Terms

3.1 Primary device (sensor)

A device used to generate a signal proportional to the flow rate. The primary device mainly includes the following units:

- A measuring tube through which the conductive liquid to be measured flows; its inner surface is usually electrically insulated;

- One or more pairs of radially opposed electrodes, which are used to measure the signal generated by the flow of the conductive liquid;

- An electromagnet that generates a magnetic field in the measuring tube.

3.2 Secondary device (converter)

A circuit device, that converts the induced electromotive force taken from the primary device into a standard output signal proportional to the flow rate.

3.3 Meter characteristic coefficient

A parameter that can change the metering performance of the flowmeter by modifying its value.

Note: 1. Due to different processes or names of flowmeters produced by different manufacturers, this parameter may be a sensor coefficient, a converter coefficient, a correction coefficient or other parameter;

2. This parameter may consist of one or a group of parameters.

3.4 Flow conditioner

A component that can reduce vortices and improve velocity distribution.

3.5 Fiducial error

The error of the flowmeter divided by the specific value of the flowmeter.

Note: This specific value is generally called the reference value, which can be the upper limit of the flowmeter's range or nominal range.

4 Overview

4.1 Working principle

In a closed pipe, a magnetic field perpendicular to the flow direction is set up. The flow rate is calculated by measuring the induced electromotive force generated by the movement of the conductive liquid in the magnetic field.

4.2 Structure and use

The flow meter consists of a primary device and a secondary device. According to the combination of the primary device and the secondary device, the flow meter can be divided into a split type and an integrated type. The flow meter is mainly used to measure the volume flow of conductive liquids.

7.1.1.2 The expanded uncertainty of the device measurement result shall not be greater than 1/3 of the absolute value of the maximum allowable error of the flow being tested.

7.1.1.3 When the vapor pressure of the verification liquid is higher than the atmospheric pressure, the device shall be closed.

7.1.1.4 The electrical equipment used for verification shall be grounded.

7.1.1.5 The equipment used to collect the output signal of the meter being tested during the verification shall match the collected signal and meet the verification requirements.

7.1.1.6 If the instantaneous flow of the meter being tested is calibrated, the flow stability of the device shall meet the following requirements: For flow meters with an absolute value of the maximum allowable error equal to or less than 0.5%, the flow stability of the device shall be better than 0.2%; for flow meters with an absolute value of the maximum allowable error greater than 0.5%, the flow stability of the device shall be better than 0.5%.

7.1.2 Verification liquid

7.1.2.1 The verification liquid can generally be clean water without air, fibers, magnetic particles and other visible particles. If other liquids are used, their type (including commercial name), viscosity, density, conductivity shall be stated in the verification certificate.

7.1.2.2 During the verification, the liquid shall always fill the test pipe and flow in a single phase, stable and vortex-free manner.

7.1.2.3 The pressure of the verification liquid at any point in the pipeline system and flowmeter shall be higher than its saturated vapor pressure. For easily vaporized verification liquids, there shall be a certain back pressure downstream of the flowmeter. The recommended back pressure is 1.25 times the saturated vapor pressure of the verification liquid at the highest verification temperature.

7.1.2.4 The conductivity of the verification liquid shall be in the range of 5 mS/m (50 μS/cm) to 500 mS/m (5000 μS/cm), or determined separately according to the technical indicators given by the flowmeter manufacturer.

7.1.2.5 The temperature range of the verification liquid shall be between 4 °C and 35 °C. During each verification process at each flow point, the liquid temperature change shall not exceed ±0.5 °C.

7.1.3 Verification environmental conditions

7.1.3.1 Atmospheric environmental conditions shall generally meet the following requirements:

- Ambient temperature: 5 °C ~ 35 °C;

- Relative humidity: 15% ~ 85%;

- Atmospheric pressure: 86 kPa ~ 106 kPa.

7.1.3.2 The AC power supply voltage shall be (220 ± 22) V; the power supply frequency shall be (50 ± 2.5) Hz. A suitable AC or DC power supply (such as a 24V DC power supply) can also be used, according to the requirements of the flow meter.

7.1.3.3 The external magnetic field shall be small enough to have negligible effect on the flow meter.

7.1.3.4 Mechanical vibration and noise shall be small enough to have negligible effect on the flow meter.

7.1.4 Installation conditions

7.1.4.1 Length of straight pipe segment on the upstream and downstream sides of the flowmeter

Determine the length of the straight pipe segment on the upstream and downstream sides of the flowmeter, according to the requirements of the flowmeter instruction manual.

If there is no provision in the instruction manual, the primary device of the flowmeter shall be installed in a straight pipe segment at least 10 times the nominal diameter (10 DN) away from any upstream disturbance component and 5 DN away from any downstream disturbance component.

When the upstream straight pipe segment is not long enough, a flow regulator can be installed; after installation, the length of its straight pipe segment shall meet the requirements of the flow regulator instruction manual.

7.1.4.2 Requirements for straight pipe segments on the upstream and downstream sides of the flowmeter

The inner wall of the straight pipe segment on the upstream and downstream sides of the flowmeter shall be clean, without obvious dents, scale, peeling.

In the absence of specific provisions by the manufacturer, the deviation BETWEEN the inner diameter of the straight pipe segment on the upstream and downstream sides of the flowmeter AND the flowmeter measuring pipe diameter shall be less than 3%.

7.1.4.3 During installation, the flow direction of the flowmeter mark shall be consistent with the flow direction of the fluid.

7.1.4.4 There shall be no leakage at the connection between the flowmeter and the test

7.2.3 Tightness inspection

After installing the flowmeter on the device, pass the test liquid to the maximum test pressure and check the tightness of the flowmeter, which shall comply with the requirements of Article 6.4.

7.2.4 Verification of relative indication error (or fiducial error)

7.2.4.1 Pre-operation inspection

Connect, start up, preheat, check the flowmeter parameter settings and zero point verification, according to the method specified in the flowmeter manual.

7.2.4.2 Allow the verification liquid to flow through the flowmeter. Allow the flowmeter to be in normal operation. Wait for the liquid temperature, pressure, flow rate to stabilize before formal verification.

7.2.4.3 Verification flow points

The flowmeter verification shall include the following flow points: q_{max}, q_{min}, $0.10q_{max}$, $0.25q_{max}$, $0.50q_{max}$, $0.75q_{max}$. When the verification point is less than q_{min}, the verification point can be cancelled.

During the verification process, the deviation between the actual verification flow rate and the set flow rate at each flow point shall not exceed ±5% or $\pm 1\% q_{max}$.

7.2.4.4 Number of verifications

For flow meters using relative indication error, the number of repeated verifications for each flow point, which has an accuracy level equal to or better than 0.2, shall not be less than 6. The number of repeated verifications for each flow point, which has an accuracy level lower than 0.2, shall not be less than 3.

For flow meters using fiducial error, the number of repeated verifications for each flow point shall not be less than 3.

7.2.4.5 Verification procedure

(1) Adjust the flow rate to the specified flow rate value; wait for the flow rate, temperature, pressure to stabilize;

(2) Record the initial indications of the standard instrument and the flow meter to be tested (or reset to zero); start the standard instrument (or the recording function of the standard instrument) and the flow meter to be tested (or the output function of the flow meter to be tested) at the same time;

(3) After running for a period of time according to the device operation requirements, turn off the standard instrument (or the recording function of the standard

Appendix A

Type evaluation outline

A.1 Scope

This outline applies to the type evaluation of electromagnetic flowmeters.

A.2 References

The provisions contained in the following standards and regulations constitute the provisions of this Regulation by reference.

JJF 1015-2002 General norm for pattern evaluation and pattern approval of measuring instruments

JJF 1016-2002 The rules for drafting program of pattern evaluation of measuring instruments

GB/T 6587.4-1986 Vibration test for electronic measuring instruments

GB 4208-1993 Degrees of protection provided by enclosure (IP code)

GB/T 17626.2-2006 Electromagnetic compatibility (EMC) - Testing and measurement techniques - Electrostatic discharge immunity test

GB/T 17626.4-1998 Electromagnetic compatibility - Testing and measurement techniques - Electrical fast transient/burst immunity test

GB/T 17626.5-1999 Electromagnetic compatibility - Testing and measurement techniques - Surge immunity test

GB/T 17626.8-2006 Electromagnetic compatibility (EMC) - Part 8: Testing and measurement techniques - Power frequency magnetic field immunity test

GB/T 17626.11-1999 Electromagnetic compatibility - Testing and measurement techniques - Voltage dips, short interruptions and voltage variations immunity tests

JB/T 9329-1999 Basic environmental conditions and testing methods for instruments transportation and storage in the transportation

When using this outline, attention shall be paid to the current valid versions of the above-mentioned references.

A.3 Technical data and test prototypes submitted by the applicant

A.3.1 According to the requirements of Chapter 5 of JJF 1015.

A.3.2 For flowmeters with a diameter not greater than 100 mm, it shall provide 3 prototypes. For flowmeters with a diameter of 100 mm ~ 300 mm, it shall provide 2 prototypes. For flowmeters with a diameter greater than 300 mm, it can provide 1 prototype.

A.3.3 For the electromagnetic flowmeter series products for type evaluation, 1/3 of the representative specifications, including the smallest caliber, shall be selected for prototype testing.

A.3.4 If major defects or deficiencies are found in the technical data review results, the data and prototypes shall be returned to the applicant for correction.

A.4 Regulatory management requirements

A.4.1 Requirements for measurement units

The flowmeter shall use legal measurement units. The flow measurement unit is preferably m^3/h; the volume unit is m^3; the pressure unit is MPa or kPa; the temperature unit is °C.

A.4.2 Accuracy level (maximum allowable error) requirements

The accuracy level of the flowmeter shall comply with the requirements of 5.1 of this Regulation. The flowmeter using the fiducial error shall comply with the requirements of 5.2 ~ 5.3 of this Regulation.

A.4.3 Requirements for measurement legal system signs and measurement instrument identification

The measurement legal system signs and measurement instrument identification must be marked on the nameplate or panel, meter head and other obvious parts of the flowmeter. The signs, numbers (space shall be left for those without manufacturing license numbers) and instructions must be clear and reliable.

A.4.4 Requirements for external structure design

For flowmeters that are not allowed to be adjusted by users, a closed structure design or a place for stamping shall be used. Any man-made mechanical interference that can affect the measurement accuracy will cause permanent tangible damage to the flowmeter or the verification protection mark or protective sign.

A.4.5 Installation identification

The flow meter body shall be marked with installation instructions.

A.4.6 If any errors or non-compliance are found during the data inspection, the applicant shall be informed in time to correct them.

In the ambient temperature range of -10 °C ~ 40 °C, the lower limit value of the output signal and the change of the range of the converter for every 10 °C change in temperature shall not be greater than 1/2 of the absolute value of the maximum allowable error of the instrument.

A.6.2.2 Humidity

The converter shall be able to withstand a humidity test of 40 °C ± 2 °C and relative humidity of 91% ~ 95% for 48 hours. After the test, the lower limit value of its output signal and the change of the range shall not be greater than 1/2 of the absolute value of the maximum allowable error of the instrument.

A.6.3 Mechanical environment and transportation and storage performance requirements

A.6.3.1 Mechanical vibration

The mechanical vibration test of the converter of the flowmeter is carried out in accordance with GB/T 6587.4. After the test, the converter shall be intact. Compared with before the test, the lower limit value of its output signal and the change of the range shall not be greater than 1/2 of the absolute value of the maximum allowable error of the flow measurement.

A.6.3.2 Transportation and storage performance

Under packaging conditions, the flowmeter shall be able to withstand the following tests in accordance with the provisions of JB/T 9329. After the test, its performance shall still meet the requirements of this Regulation.

(1) High temperature test (+55 °C ± 2 °C);

(2) Low temperature test (-25 °C ± 2 °C);

(3) Collision test (acceleration 100 m/s^2 ± 10 m/s^2, number of collisions 1000 ± 10, collision frequency 60 times/minute ~ 100 times/minute);

(4) Free fall test (height 100 mm);

(5) Inclined drop test (angle 30°).

A.6.4 Influence on safety performance

A.6.4.1 Explosion-proof performance

For flow meters used in explosive gas environments, an explosion-proof test report and explosion-proof certificate issued by a nationally designated explosion-proof inspection agency shall be obtained.

A.6.5.4 Surge immunity

AC powered flowmeters shall be tested according to GB/T 17626.5, with a test level of 2. Prototype errors are allowed during the test; they shall be able to recover automatically after the test.

A.6.5.5 Power interruption test

It is performed according to GB/T 17626.11 test level 0% U_T. The prototype shall work normally after power is restored.

A.6.6 Other electrical performance requirements

A.6.6.1 Power supply voltage change test

For AC powered flowmeters, place them in the power supply state for a sufficient period of time; adjust the power supply voltage within the range of (187 ~ 242) V. The prototype shall work normally during the test.

A.6.6.2 DC reverse protection

For a two-wire DC powered flowmeter, 1.1 times the nominal voltage value is applied in reverse between the power supply terminals for 1 minute without damage.

A.6.6.3 Power supply undervoltage protection

The data in the flowmeter shall be able to be maintained for a long time and not be affected by low voltage, battery replacement, etc.

A.6.6.4 Grounding influence

This Article is only applicable to converters with output terminals insulated from the ground.

When the output terminals of the converter are grounded in sequence, the change in the lower limit value and range of its output signal shall not be greater than 1/2 of the absolute value of the maximum allowable error of the instrument.

A.6.7 After the flowmeter undergoes the above test, the relative indication error at the re-measured q_{min}, $0.25q_{max}$, $0.5q_{max}$ flow points shall still meet the requirements of 5.1 of this Regulation (if the fiducial error is used, it shall meet the requirements of 5.2 of this Regulation).

A.7 Conditions and methods for type evaluation

A.7.1 Conditions for type evaluation

A.7.1.1 The flow standard device for type evaluation test shall meet the requirements

of 7.1.1 of this Regulation.

A.7.1.2 The test liquid for type evaluation test shall comply with the requirements of 7.1.2 of this Regulation.

A.7.1.3 The environmental conditions for type evaluation test shall comply with the requirements of 7.1.3 of this Regulation.

A.7.2 Regulatory management

Inspect item by item according to the requirements of A.4 of this Regulation.

A.7.3 Inspection of accompanying documents, labels, appearance

Visual inspection shall comply with the requirements of A.6.1.1, A.6.1.2, A.6.4.1.

A.7.4 Shell protection performance test

The shell protection performance test shall be carried out in accordance with the provisions of A.6.1.3 and the method specified in GB 4208.

A.7.5 Safety performance impact test

A.7.5.1 Pressure resistance test

The liquid for pressure resistance test is water. Fill the inner cavity of the measuring tube of the primary device with water. Remove the air. Gradually increase the water pressure in the inner cavity of the measuring tube to 1.5 times the rated working pressure. Maintain it for 5 minutes. The flow meter shall comply with the provisions of A.6.4.2 of this Regulation.

A.7.5.2 Insulation strength test

The insulation strength test is conducted under normal test conditions according to the items and test voltage specified in A.6.4.3. The test voltage shall rise smoothly to the specified voltage value without any perceptible transient change; it is maintained for 1 min; then slowly drop to zero and cut off the power supply.

A.7.5.3 Insulation resistance test

The insulation resistance test is conducted under normal test conditions according to the provisions of A.6.4.4 using a 500 V megohmmeter; it is stabilized for 5s.

A.7.6 Metering performance test

A.7.6.1 Select the test conditions that meet the requirements of A.7.1 for the test.

A.7.6.2 The installation of the flow meter shall meet the requirements of 7.1.4 of this

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