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METERING CALIBRATION SPECIFICATION OF THE PEOPLE'S REPUBLIC OF CHINA

JJG 882-2019

Pressure transmitters

压力变送器

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Verification regulation of pressure transmitters

1 Scope

This regulation applies to the initial verification, subsequent verification, in-use inspection of pressure (including positive pressure, negative pressure, differential pressure, absolute pressure) transmitters.

2 Normative references

This regulation refers to the following documents:

JJG 875 Digital pressure gauge

JJF 1008-2008 Pressure measurement terms and definitions

For dated reference documents, only the dated version applies to this regulation; for undated references, the latest version (including all amendments) is applicable to this regulation.

3 Terms and units of measurement

3.1 Terms

3.1.1 Pressure transmitter

An instrument that can convert a pressure variable into a standardized signal that can be transmitted, the output signal of which has a given continuous function relationship (usually a linear function) and the pressure variable.

[JJF 1008-2008, definition 7.2]

3.1.2 Intellectual pressure transmitter

A pressure transmitter with automatic temperature compensation, linearity, static pressure and other functions, as well as communication and self-diagnosis functions.

[JJF 1008-2008, definition 7.8]

3.2 Unit of measurement

6 General technical requirements

6.1 Appearance

6.1.1 The marking on the pressure transmitter shall be complete and clear; meanwhile it shall have the following information: product name, exit-factory number, production year, model specifications, measurement range, measurement unit, accuracy grade, rated working pressure, power supply form, signal output form, manufacturer's name or trademark, type approval marking and number, etc.; explosion-proof products shall also have explosion-proof marks.

6.1.2 The high-pressure and low-pressure chambers of the differential pressure transmitter shall be clearly marked.

6.1.3 The connection terminals of the pressure transmitter shall have corresponding marks.

6.1.4 The main body and parts of the pressure transmitter shall be intact; the fasteners shall not be loose or damaged; the movable parts shall be flexible and reliable. For pressure transmitter with pressure indicator (digital display function), the digital display shall be clear and there shall be no missing strokes.

6.1.5 The outer surface of the main body and parts of the pressure transmitter for the first verification shall be smooth, intact, free of rust and mildew.

6.2 Tightness

When the measuring part of the pressure transmitter is subjected to the upper limit of the measured pressure (the differential pressure transmitter is the rated working pressure), there shall be no leakage; the pressure value of the last 5 min shall not drop (or rise) beyond 2% of the upper limit of the measured pressure.

6.3 Insulation resistance

When the ambient temperature is 15 °C ~ 35 °C and the relative humidity is 45% ~ 75%, the insulation resistance between the terminals (including the housing) of the pressure transmitter shall not be less than 20 MΩ (the test voltage is in accordance with the enterprise standard).

The two-wire pressure transmitter only tests the output terminal to the housing.

6.4 Insulation strength

When the ambient temperature is 15 °C ~ 35 °C and the relative humidity is 45%

Visual observation and power-on inspection.

7.3.2 Tightness inspection

Increase (or evacuate) the pressure steadily so that the pressure in the measuring chamber of the pressure transmitter reaches the upper limit of measurement (or vacuum at 90% of the local atmospheric pressure). Turn off the pressure source. Maintain the pressure for 15 minutes. Observe whether there is any leakage. Determine the change in pressure value by observing the pressure representation or the equivalent value of the output signal of the pressure transmitter in the last 5 minutes.

When the differential pressure transmitter is subject to the tightness inspection, the high-pressure chamber and the low-pressure chamber are connected, meanwhile the rated working pressure is applied for observation.

7.3.3 Verification of indication error

7.3.3.1 Connection and installation of equipment

- a) In order to achieve thermal equilibrium, the tested pressure transmitter must be placed for 2 hours under the verification conditions; for the pressure transmitters with an accuracy grade of less than 0.5, it can shorten the placement time, generally shortened to 1 h.
- b) The standard device, supporting equipment and the pressure transmitter to be inspected are connected in accordance with the requirements of Appendix A. The pressure guiding tube is filled with pressure transmission medium. When the pressure transmission medium is gas, the medium shall be clean and dry. When the pressure transmission medium is liquid, it shall consider the liquid recommended by the manufacturer or designated by the sender.
- c) The pressure transmitter to be inspected is placed in the specified installation position.
- d) When the pressure transmission medium is liquid, the reference plane of the pressure transmitter's pressure tap and the reference plane of the standard device's pressure tap (or the lower end surface of the piston of a piston pressure gauge) shall be on the same level. If it is not in the same horizontal plane, the height difference is not greater than the calculation result of formula (1), the error caused can be ignored, otherwise it shall be corrected.

$$h = \frac{|\alpha \%| P_m}{10\rho g} \quad (1)$$

7.3.3.5 Verification method

From the lower limit, input the pressure signal to each verification point steadily; read and record the output value to the upper limit of the measurement; then change the pressure signal to each verification point in the opposite direction; read and record the output value to the lower limit of the measurement. This is a cycle. Pressure transmitters of grade 0.1 and below shall be subject to 1 cycle of verification. The pressure transmitters of grade 0.1 and above shall be subject to 2 cycles of verification.

The pressure transmitters under mandatory verification shall be subject to at least the above 3 cycles of verification.

During the verification process, it is not allowed to adjust the zero point and range; it is not allowed to tap and vibrate the pressure transmitter. When approaching the verification point, the input pressure signal shall be slow enough to avoid overshoot.

7.3.3.6 Calculation of indication error

The indication error of the pressure transmitter is calculated according to formula (2).

$$\Delta I = I - I_L \quad (2)$$

Where:

ΔI - The indication error of each verification point of the pressure transmitter, mA, V or digital quantity;

I - The actual output value of each verification point of the positive stroke or reverse stroke of the pressure transmitter, mA, V or digital quantity;

I_L - The theoretical output value of each verification point of the pressure transmitter, mA, V or digital quantity.

The principle of data processing in the error calculation process: The number of digits reserved after the decimal point shall be limited to the rounding error which is less than 1/10 of the maximum allowable error of the pressure transmitter. To judge whether the pressure transmitter is qualified, the rounded data shall prevail.

Note 1: For the pressure transmitter with pressure indicator, the verification of the indication error of the indication part is carried out according to JJG 875.

Note 2: For pressure transmitters with digital signal transmission function, it may use the data as read by the computer monitoring software that can ignore its own indication

Disconnect the power supply of the pressure transmitter. Short-circuit the power terminal and output terminal, respectively. Use an insulation resistance meter to measure the insulation resistance between the power terminal and the ground terminal (housing), the power terminal and the output terminal, the output terminal and the ground terminal (housing). Except as otherwise specified by the manufacturer, a megohmmeter with a rated voltage of 500 V is generally used as the measuring equipment for the verification of the insulation resistance of pressure transmitters.

Note: When the capacitive pressure transmitter is tested, a megohmmeter with a rated voltage of 100 V shall be used as the measuring device, or be verified according to the requirements of the enterprise standard.

7.3.7 Verification of insulation strength

Disconnect the power supply of the pressure transmitter; short-circuit the power terminal and output terminal, respectively. According to the requirements of 6.4, use a withstand voltage tester to measure the insulation strength between the power terminal and the ground terminal (housing), the power terminal and the output terminal, the output terminal and the ground terminal (housing). When measuring, the test voltage shall increase from zero, smoothly and evenly rising to the test voltage value specified in Table 2 within 5 s ~ 10 s (the error is not more than 10%); keep it for 1 min; then smoothly reduce the voltage to zero, and cut off the test power .

Note: During the test of the pressure transmitter, it may use a withstanding voltage tester with alarm current setting and the setting value is generally 10 mA. When using this instrument, whether to alarm is used as the basis for judging whether the insulation strength is qualified or not.

7.4 Processing of verification results

7.4.1 The pressure transmitter that has passed the verification shall be issued a verification certificate.

7.4.2 For pressure transmitters that are not qualified for verification, a verification result notice shall be issued, which shall indicate the unqualified items and content.

7.5 Verification cycle

The verification cycle of the pressure transmitter can be determined according to the environmental conditions and frequency of use, generally not more than 1 year.

Appendix D

Example of uncertainty evaluation of current output measurement results of grade 0.1 pressure transmitter

D.1 Evaluation basis

JJG 59 Retroreflectometer;

JJF 1059.1-2012 Evaluation and expression of uncertainty in measurement.

D.2 Measurement conditions

Ambient temperature: 20.0 °C ~ 20.1 °C; ambient relative humidity: 50% ~ 51%.

Shanghai gravitational acceleration: 9.7946 m/s².

Pressure transmission medium: A mixture of transformer oil and kerosene, with a density of $0.838 \times 10^3 \text{ kg/m}^3$.

Metrology standard device: Grade 0.02 piston pressure gauge with a measuring range of 0.1 MPa ~ 6 MPa; FLUKE8508A digital multimeter 20mA gear, technical indicators: $\pm (0.0016\% \times \text{indicating value} + 0.0002\% \times 20 \text{ mA})$.

Tested sample: Grade 0.1 pressure transmitter with a measuring range of 0 MPa ~ 2 MPa.

D.3 Measurement method

Place the pressure transmitter in the laboratory verification environment for at least 2 h, to make it fully adapt to the laboratory environment. After the pressure transmitter is energized and preheated for 30 minutes, install it on the dedicated interface of the piston pressure gauge's calibration platform. Try to make the pressure point of the pressure transmitter and the working position of the piston pressure gauge on the same level. When the position of the person is not on the same level, the liquid level difference shall be accurately measured (the pressure point of the measured pressure transmitter is 0.135 m lower than the working position of the piston pressure gauge). After installation, use a piston pressure gauge to pressurize the pressure transmitter to 2 MPa, to check the tightness of the system.

Load the weight on the piston pressure gauge to provide the standard pressure value. When the static balance is reached, take the reading of the digital multimeter; check the environmental conditions at the same time; take record as required. In the test, the nominal pressure is selected as 0 MPa, 0.2 MPa,

$$\Delta P = \pm \rho g h \quad (\text{D. 4})$$

Where:

ρ - The density of the pressure transmission medium (838 kg/m³);

g - Local acceleration of gravity (9.7946 m/s²);

h - The height difference between the pressure point of the standard device and the pressure transmitter, m.

D.5 Sources of measurement uncertainty

- (1) The standard uncertainty $u(I)$ introduced by the reading value I of the digital multimeter.
- (2) The standard uncertainty $u(P)$ introduced by the pressure value P of the piston pressure gauge.
- (3) The standard uncertainty $u(\Delta P)$ introduced by the pressure ΔP produced by the difference between the working position of the piston pressure gauge and the pressure surface of the pressure transmitter.

D.6 Evaluation of the standard uncertainty $u(I)$ of the input quantity I

D.6.1 Standard uncertainty $u_1(I)$ introduced by the measurement of the digital multimeter

The maximum allowable indication error of the 20 mA measurement gear of the digital multimeter is: $\pm (0.0016\% \times \text{indication value} + 0.0002\% \times 20 \text{ mA})$, the maximum output current of the pressure transmitter is 20 mA, so the half-width $a = (0.0016\% \times 20 + 0.0002\% \times 20) \text{ mA} = 0.0004 \text{ mA}$. In the interval, it can be considered to obey a uniform distribution, and $k = \sqrt{3}$, therefore:

$$u_1(I) = \frac{a}{k} = 0.0002 \text{ mA}$$

D.6.2 The standard uncertainty $u_2(I)$ introduced by the measurement repeatability of the output current of the pressure transmitter

Perform 3 cycles of positive and negative strokes at the nominal value of 2.0 MPa; there are 6 measurement results in total, as shown in Table D.1:

Table D.1 -- Data column

No.	1	2	3	4	5	6
Indication value / mA	20.002	20.002	20.003	20.003	20.004	20.004

Appendix E

Determination of the extended uncertainty U of the standard unit

After the standard devices form into a set, the expanded uncertainty U introduced during verification can be determined according to the following methods:

Uncertainty evaluation is carried out according to the requirements of Appendix D; only the influences as brought by the standard uncertainty $u_1(I)$ introduced by the measurement error of the digital multimeter and the standard uncertainty $u(P)$ introduced by the pressure standard indicator error are considered in the evaluation.

E.1 Example 1 for the expanded uncertainty of the complete standard unit wherein the digital pressure gauge is used as a pressure standard device

Measurement standard device:

Name	Measurement range	Accuracy grade/maximum allowable error
Digital pressure gauge	0 MPa ~ 2 MPa	Grade 0.02
Calibrator	-30 mA ~ 30 mA	$\pm (0.01\% \times \text{indication value} + 0.0015 \text{ mA})$

Samples inspected:

Name	Measurement range	Accuracy grade/maximum allowable error
Pressure transmitter	0 MPa ~ 2 MPa	Grade 0.2 / $\pm 0.032 \text{ mA}$

E.1.1 Measurement model of pressure transmitter

$$\Delta I = I - \left[\frac{I_m}{P_m} \cdot (P + \Delta P) + I_0 \right]$$

Where:

I_m - The current output range of pressure transmitter (16 mA);

P - The input pressure value of the standard device, MPa;

P_m - The pressure range of pressure transmitter (2 MPa);

I_0 - The initial value of the output current of the pressure transmitter (4 mA).

E.1.2 Standard uncertainty $u_1(I)$ introduced by the current measurement of calibrator

The maximum allowable indication error of the 20 mA measurement gear of the

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