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City gas pressure regulator

城镇燃气调压器

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City gas pressure regulator

1 Scope

This Standard specifies the terms and definitions, symbols, classification and marking, structure and materials, requirements, test methods, inspection rules, marking, labeling, instruction manual, packaging, transportation and storage of gas pressure regulators for city gas (hereinafter referred to as pressure regulators).

This Standard applies to pressure regulators for regulating outlet pressure with an inlet pressure not exceeding 10.0 MPa, an operating temperature range not exceeding -20°C~60°C and a lower limit not lower than the gas dew point temperature, and a nominal size not exceeding 400 mm.

This Standard does not apply to pressure regulators for bottled liquefied petroleum gas and dimethyl ether.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

GB/T 150 (all parts), *Pressure vessels*

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

GB/T 229, *Metallic materials -- Charpy pendulum impact test method*

GB/T 528, *Rubber, vulcanized or thermoplastic -- Determination of tensile stress-strain properties*

GB/T 531.1, *Rubber, vulcanized or thermoplastic -- Determination of indentation hardness -- Part 1: Durometer method (Shore hardness)*

GB/T 699, *Quality carbon structure steels*

GB/T 1047, *Pipework components -- Definition and selection of nominal size*

GB/T 1173, *Casting aluminium alloy*

GB/T 1220, *Stainless steel rod*

GB/T 1239.2, *Cold coiled helical springs technical specifications -- Part 2:*

and custom number of A;

- b) RTZB-15/0.01L indicates a meter pressure regulator with a nominal size of DN15, a maximum inlet pressure of 0.01 MPa, in threaded connection.

5 Structure and materials

5.1 General requirements

5.1.1 Design pressure

5.1.1.1 Metal pressure-bearing parts

The design pressure of metal pressure-bearing parts (including metal parts that bear pressure during normal operation and metal parts that bear pressure after the failure of diaphragms or differential pressure seals) shall meet the following requirements:

- a) When the metal pressure-bearing parts are subjected to the inlet pressure p_1 , their design pressure shall not be less than the maximum inlet pressure and not less than 0.4 MPa;
- b) When metal pressure-bearing parts are protected by safety protection devices, if the pressure they withstand after the failure of the diaphragm or differential pressure seal is less than the inlet pressure and not less than the normal working pressure, the design pressure of the metal pressure-bearing parts shall not be less than 1.1 times the pressure they withstand after the failure of the diaphragm or differential pressure seal, or the design pressure specified in a) shall be adopted;
- c) For metal pressure-bearing parts whose pressure after failure of diaphragm or differential pressure seal is less than the normal working pressure, the design pressure shall not be less than 1.1 times of the maximum normal working pressure, or the design pressure specified in a) shall be adopted.

5.1.1.2 Metal partition

The design pressure of the metal diaphragm shall not be less than 1.1 times the difference between the maximum pressure on the high-pressure side and the minimum pressure on the low-pressure side. However, the design pressure of the metal diaphragm in the valve body shall comply with the requirements of 5.1.1.1 a).

5.1.1.3 Diaphragm

The diaphragm design pressure shall meet the following requirements:

- a) When the maximum pressure difference $\Delta p_{\max}$ that the diaphragm withstands is < 0.015 MPa, the diaphragm design pressure shall not be less than 0.02 MPa;

- b) When $0.015 \text{ MPa} \leq \Delta p_{\max} < 0.5 \text{ MPa}$, the diaphragm design pressure shall not be less than $1.33\Delta p_{\max}$;
- c) When $\Delta p_{\max} \geq 0.5 \text{ MPa}$, the diaphragm design pressure shall not be less than $1.1\Delta p_{\max}$ and shall not be less than 0.665 MPa .

5.1.2 Operating temperature range

The operating temperature range of the voltage regulator shall be $-10^{\circ}\text{C}\sim 60^{\circ}\text{C}$ or $-20^{\circ}\text{C}\sim 60^{\circ}\text{C}$.

5.2 Structure

5.2.1 Inlet and outlet connection types

5.2.1.1 The connection between the pressure regulator and the upstream and downstream pipelines shall meet the following requirements:

- a) The connection dimensions and sealing surface type of the flange shall comply with the requirements of GB/T 9124.1, GB/T 9124.2, HG/T 20592 or HG/T 20615;
- b) Pipe threads shall only be used for pressure regulators with a nominal size not greater than DN50 and shall comply with the requirements of GB/T 7306.1, GB/T 7306.2 or GB/T 12716.

5.2.1.2 The nominal pressure of the flange shall not be less than the design pressure of the regulator housing and shall be selected from the series of 0.6 MPa , 1.0 MPa , 1.6 MPa , 2.0 MPa , 2.5 MPa , 4.0 MPa , 5.0 MPa , 6.3 MPa , 10.0 MPa and 11.0 MPa .

5.2.1.3 The nominal pressures of the inlet and outlet flanges of the pressure regulator shall be the same.

5.2.2 Other configurations

5.2.2.1 The driving pressure of the indirect acting pressure regulator shall be provided by the inlet gas of the pressure regulator.

5.2.2.2 The pressure signal sampling position of the voltage regulator and the size of the signal tube shall be able to provide a stable pressure signal.

5.2.2.3 The breathing tube or breathing apparatus shall have measures to prevent the entry of foreign matter.

5.2.2.4 Integrated safety units such as integrated shut-off device, integrated monitor, integrated release device, etc. shall be independent of the operation of the voltage regulator.

- b) Austenitic stainless steel is not subjected to impact test;
- c) When the tensile strength of forged and cast aluminum alloys is not higher than 350 MPa, impact test is not performed.

5.3.2.3 The materials of pressure-bearing parts shall meet the following requirements:

- a) The material of steel pressure-bearing parts shall comply with the requirements of GB/T 12224 and GB/T 12229;
- b) The material of iron pressure-bearing parts shall comply with the requirements of GB/T 12227 or GB/T 9440;
- c) The material of aluminum pressure-bearing parts shall comply with the requirements of GB/T 15115, GB/T 1173 or GB/T 32249.

5.3.2.4 When the pressure-bearing parts of the voltage regulator are made of carbon steel, high-quality carbon structural steel shall be selected. The chemical composition of carbon steel and low-alloy steel used for welding shall meet the following requirements:

- a) Carbon mass fraction: shall not exceed 0.23% when using pre-furnace analysis, and shall not exceed 0.25% when using finished product analysis;
- b) Sulfur mass fraction shall not exceed 0.020%. Phosphorus mass fraction shall not exceed 0.025%;
- c) Carbon equivalent: shall not exceed 0.43% when using pre-furnace analysis, and shall not exceed 0.45% when using finished product analysis.

NOTE: The carbon equivalent (CE) calculation formula is: $CE = w_C (\%) + w_{Mn}/6 (\%) + [w_{Cr} (\%) + w_{Mo} (\%) + w_V (\%)]/5 + [w_{Ni} (\%) + w_{Cu} (\%)]/15$.

5.3.2.5 Nondestructive testing of steel pressure-bearing parts shall comply with the following requirements:

- a) Steel pressure-bearing parts shall be subjected to nondestructive testing according to the requirements of Tables 8 and 9.
- b) Nondestructive testing shall be carried out after the material heat treatment is completed or after the welding heat treatment is completed, or before or after machining. Surface nondestructive testing shall include internal and external surfaces, except for external threads, holes and internal threads.
- c) During random inspection, if the pressure-bearing parts are unqualified, two or more samples shall be taken from the production batch for re-inspection. If there are still unqualified ones, the inspection scope shall be expanded to all similar pressure-bearing parts in the production batch.

6 Requirements

6.1 Appearance

6.1.1 The surface of the voltage regulator shall be treated with anti-corrosion. The anti-corrosion layer shall be uniform and have a uniform color without any defects such as peeling, cracking, or bubbles.

6.1.2 The connecting pipes between the pressure regulator and the auxiliary devices and the pilot shall be smooth and free of damage such as dents and bumps.

6.1.3 The surface of the pressure regulator valve body shall be marked with a permanent arrow according to the medium flow direction.

6.2 Strength of pressure-bearing parts

6.2.1 Pressure-bearing parts shall be subjected to strength tests at 1.5 times the design pressure p and not less than $p + 0.2$ MPa. The test results shall meet the following requirements:

- a) There is no leakage during the test;
- b) After unloading, the residual deformation between any two points on the test piece shall not be greater than the larger of the following values:
 - 0.2% multiplied by the distance between the two points;
 - 0.1 mm.

6.2.2 Metal diaphragms shall be subjected to hydraulic pressure tests. The test pressure shall meet the requirements of 6.2.1 and there shall be no leakage or abnormal deformation.

6.3 Inspection of finished diaphragm products

6.3.1 The test pressure of the diaphragm pressure test shall be 1.5 times the design pressure specified in 5.1.1.3. There shall be no leakage during the pressure maintenance period.

6.3.2 The gas resistance of the diaphragm shall comply with the requirements of Annex A.

6.3.3 The finished diaphragm shall not be damaged after being kept at -20°C for 1 h.

p_{2s} and SG are the values obtained from the test at room temperature.

6.7.3 Opening and closing flexibility

Under extreme temperatures, the voltage regulator shall be opened and closed flexibly within the full stroke range.

6.8 Durability

After the regulator has been opened and closed for 30,000 times at room temperature with a stroke greater than 50% of the full stroke (excluding the closed and fully open positions), the external seal of the regulator shall meet the requirements of 6.4. The accuracy shall meet the requirements of 6.5.2. The lock-up performance shall meet the requirements of 6.5.4.

6.9 Failure state

The control member of a fail-open regulator shall tend to open or open. The control member of a fail-closed regulator shall tend to close or close under any of the following conditions:

- a) The main diaphragm of the pressure regulator or pilot fails (such as rupture);
- b) The pressure regulator driver loses continuous energy supply (such as gas outage, signal pipe blockage or leakage, etc.).

NOTE: The same voltage regulator has only one post-failure state.

6.10 Performance of integrated shut-off device

6.10.1 Valve seat tightness

When the pressure regulator has an integrated shut-off device, the valve seat sealing shall comply with the requirements of 6.1.5 in CJ/T 335-2010.

6.10.2 Shut-off pressure accuracy class

When the pressure regulator has an integrated shut-off device, the shut-off pressure accuracy class shall meet the following requirements in addition to the requirements of 6.1.6 of CJ/T 335-2010:

- a) At laboratory temperature, it shall comply with the requirements of 6.1.6.2 of CJ/T 335-2010, and the shut-off pressure p_{ta} shall comply with the requirements of formula (5):

the requirements of 6.5.

6.11.2 Adaptability at extreme temperatures

The adaptability of the integrated monitor of the voltage regulator under extreme temperature shall comply with the requirements of 6.7.

6.11.3 Durability

The durability of the integrated monitor of the voltage regulator shall comply with the requirements of 6.8.

6.11.4 Failure state

The failure state of the integrated monitor of the voltage regulator shall comply with the requirements of 6.9.

6.12 Performance of integrated release device

The integrated release device of the voltage regulator shall meet the following requirements:

- a) The relief pressure setting value of the integrated release device shall be greater than the lock-up pressure value of the pressure regulator and shall be less than the shut-off pressure value. The relief pressure setting error shall not be greater than $\pm 5\%$ of the setting value.
- b) The return pressure shall not be less than the lock-up pressure. There shall be no leakage after return.

6.13 Torsion and bending resistance of meter pressure regulator

After the torsion resistance test and bending resistance test, the voltage regulator shall not be deformed, cracked or damaged. The external seal and internal seal shall comply with the requirements of 6.4 and 6.5.5.

7 Test methods

7.1 General requirements

7.1.1 Laboratory temperature and test pressure

7.1.1.1 The temperature of the laboratory shall be between $5^{\circ}\text{C}\sim 35^{\circ}\text{C}$. The room temperature fluctuation during the test shall be less than $\pm 5^{\circ}\text{C}$.

7.3 Strength of pressure-bearing parts

7.3.1 When the test pressure is not greater than 0.6 MPa, gas may be used as the strength test medium when safety protection measures are adopted.

7.3.2 During the test, the pressure in the pressure-bearing chamber shall be slowly increased to the specified test pressure of each chamber.

7.3.3 During the test, the test piece shall be able to deform in all directions. There shall be no external force that affects the test results.

7.3.4 The force applied by the fasteners shall be consistent with the force they are subjected to under normal use.

7.3.5 The chambers separated by a diaphragm shall have the same pressure applied simultaneously on both sides of the diaphragm.

7.3.6 When conducting a metal diaphragm test, the test pressure shall be applied to the high-pressure side of the diaphragm. The pressure on the low-pressure side shall be zero.

7.3.7 No residual deformation assessment is performed during exit-factory test.

7.3.8 The pressure holding time shall not be less than 3 min. Check whether the test results meet the requirements of 6.2.

7.4 Inspection of finished diaphragm products

7.4.1 Diaphragm pressure resistance test

The diaphragm shall be tested in combination with the diaphragm disc (or corresponding fixture) in the test fixture. The test fixture shall place the diaphragm in the position with the maximum effective area. The movement of the diaphragm exposed from the diaphragm disc (or corresponding fixture) and the fixture shall not be restricted by the test fixture. During the test, the pressure shall be slowly increased to the test pressure on the high-pressure side of the diaphragm. The pressure holding time shall not be less than 10 min. Check whether the test results meet the requirements of 6.3.1.

7.4.2 Gas resistance test of diaphragm

The gas resistance test of the diaphragm shall be carried out according to the method specified in GB/T 1690. Type II specimens shall be used for the test. The specimens shall be cut from the finished diaphragm. When the finished product size is less than 25 mm×25 mm, the actual size of the finished product shall be used as the test size. When the diaphragm thickness is not greater than 2.0 mm, the actual thickness shall be used as the test specimen thickness. When the diaphragm thickness is greater than 2.0 mm, the specimen shall be processed so that the thickness is within 1.8 mm~2.0 mm. Check

whether the test results meet the requirements of 6.3.2.

7.4.3 Low temperature resistance test of diaphragm

Place the diaphragm in a low temperature box at $-20^{\circ}\text{C}\pm 1^{\circ}\text{C}$ for 1 h, then fold the specimen in half in the low temperature box. Take out the specimen from the low temperature box and magnify it by one time. Visually check that the sample shall be free of breakage, cracks and delamination. Wear gloves when handling the low temperature test specimen. Check whether the test results meet the requirements of 6.3.3.

7.5 External seal

7.5.1 After the pressure regulator has passed the hydraulic strength test of the pressure-bearing parts, an external seal test shall be carried out. During the external seal test, the pressure regulator and its additional devices shall be assembled as a whole.

7.5.2 The test pressure on the inlet side of the meter pressure regulator shall be 1.1 times the maximum inlet pressure and shall not be less than 0.02 MPa. The test pressure on the outlet side shall be 1.1 times the lock-up pressure and shall not be less than 0.02 MPa.

7.5.3 Except for the meter pressure regulator, the test pressure of other pressure regulators shall be 1.1 times the design pressure of the pressure-bearing parts and all connections and shall not be less than 0.02 MPa.

7.5.4 During the test, the pressure in the pressure-bearing chamber of the pressure-bearing part shall be slowly increased to the specified test pressure of each chamber. Protective measures shall be taken for the diaphragm.

7.5.5 During the test, the pressure regulator in the closed state shall be charged and pressurized at the shell inlet and outlet at the same time. During the test, the test piece shall be able to deform in all directions. There shall be no external force that affects the test results.

7.5.6 The force applied by the fasteners shall be consistent with the force under normal use.

7.5.7 When checking with leak detection liquid or immersing in water, slowly pressurize the test piece to the specified test pressure and maintain the pressure. The test pressure shall remain unchanged during the test duration. The pressure maintenance time in type inspection shall not be less than 15 min. The pressure maintenance time in factory inspection shall not be less than 1 min. The test results shall meet the requirements of 6.4.2 a).

7.5.8 When using the pressure drop method, slowly pressurize the test piece to the specified test pressure and maintain the pressure. Perform two measurements during

regulator according to the test method specified in 6.2.8 of CJ/T 335-2010. Check whether the test results meet the requirements of 6.10.4.

7.11.5 Durability

Test the durability of the integrated shut-off device of the voltage regulator according to the test method specified in 6.2.10 of CJ/T 335-2010. Check whether the test results meet the requirements of 6.10.5.

7.12 Integrated monitor

7.12.1 Performance

Test the performance of the integrated monitor according to the test method in 7.6 and check whether the test results meet the requirements of 6.11.1.

7.12.2 Adaptability at extreme temperatures

According to the test method in 7.6, test the adaptability of the integrated monitor under the extreme temperature. Check whether the test results meet the requirements of 6.11.2.

7.12.3 Durability

Test the durability of the integrated monitor according to the test method in 7.6 and check whether the test results meet the requirements of 6.11.3.

7.12.4 Failure state

Test the failure state of the integrated monitor according to the test method in 7.6. Check whether the test results meet the requirements of 6.11.4.

7.13 Integrated release device

Introduce test gas that meets the inlet pressure range of the pressure regulator to the inlet of the pressure regulator. After the pressure regulator is in the closed state, introduce test gas to its outlet. Gradually increase the test pressure until the integrated release device starts. Record the pressure at the start, which is the relief pressure. Gradually reduce the test pressure until the integrated release device closes. Record the pressure at the close, which is the return pressure. Repeat three times. Check whether the test results meet the requirements of 6.12.

7.14 Torsion and bending resistance of meter pressure regulator

The torsion resistance test of the meter pressure regulator shall be carried out according to the test method specified in 7.7 of CJ/T 180-2014. The bending resistance test of the meter pressure regulator shall be carried out according to the test method specified in

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