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Specification for valve cryogenic test rig

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(English Translation)

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## Foreword

SAC/TC188 is in charge of this English translation. In case of any doubt about the contents of English translation, the Chinese original shall be considered authoritative.

This standard is drafted in accordance with the rules given in the GB/T 1.1-2009 Directives for standardization — Part 1: Structure and drafting of standards.

This standard was proposed by China Machinery Industry Federation.

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This Standard is issued for the first time.

# Specification for valve cryogenic test rig

## 1 Scope

This standard specifies the terms and definitions, structural type, technical requirements, operation specification of valve cryogenic test rig, etc.

This standard is applicable to valve cryogenic test rig. The scope of test valves is: nominal pressure PN16 ~ PN 420, nominal sizes DN15 ~ DN 900, medium temperature -196°C to -29°C, with flanged, wafer and welding end of low temperature gate valves, globe valves, check valves, ball valves and butterfly valves.

Other cryogenic valves can also be used this standard as reference, but the test valves must be suitable for cooling from outside method.

## 2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 5099 (All parts) Seamless steel gas cylinders

GB/T 24159 Welded insulated cylinders

GB/T 18442 (All parts) Static vacuum insulated cryogenic pressure vessels

GB/T 24925 Low temperature valve—Technical specifications

JB/T 9081 Cryogenic shutoff valves and throttle valves used for air separation plants

## 3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

### 3.1

valve cryogenic test rig

A device for performing low temperature performance tests on valves at temperatures ranging from -196°C to -29°C.

### 3.2

cooling by immersing method

A method by immersing part of the valve or the whole valve in cryogenic liquid ( low temperature medium) in order to cool down the test valve temperature.

### 3.3

cooling by spray method

A method by spraying a kind of cryogenic liquid on the valve surface in order to cool down the test valve temperature.. The test valve shall be placed in an environment with certain thermal Insulating container.

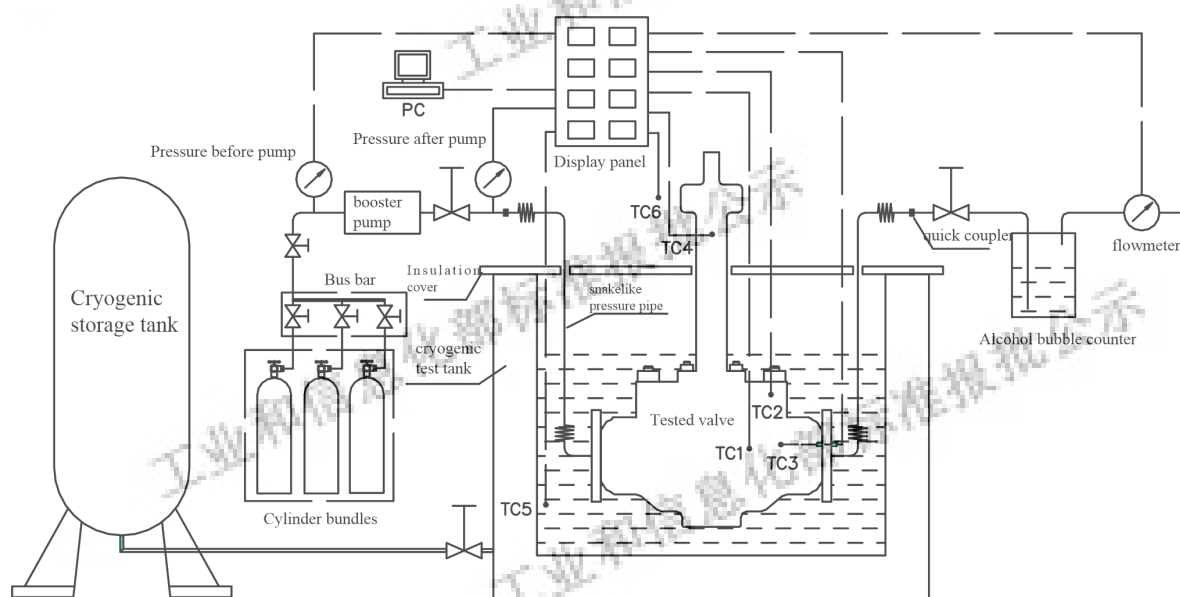
## 3.4

## cryogenic test tank

With heat insulation performance, it can provide a stable low temperature groove container for the valve to perform cryogenic test.

## 4 Structural type

The typical structural type of valve cryogenic test rig is shown in Figure 1.



Temperature sensor

TC1— Body temperature

TC4— Valve stem temperature (stuffing box)

TC2— Bonnet temperature

TC5— Cooling medium temperature

TC3— Valve inside temperature

TC6— Environment temperature

Figure 1 Typical structural type of valve cryogenic test rig

## 5 Technical requirements

## 5.1 General requirements

5.1.1 Valve cryogenic test rig shall be able to provide test conditions for low-temperature valves at specified test temperature. If necessary, it can also provide conditions of low temperature valves' components for cryogenic treatment .

5.1.2 All components of the valve cryogenic test rig, which located in low-temperature environment or may be in low-temperature state, must be made of low-temperature resistant materials, and the pressure-containing components must be made of austenitic stainless steel.

## 5.2 Cryogenic system

### 5.2.1 Component

The cryogenic system provides required cryogenic test environment. The cryogenic system shall be consist of cryogenic storage tank, cryogenic test tank, cryogenic connection pipe, cryogenic control valve, etc.

### 5.2.2 Cryogenic storage tank

According to the specifications of test rig, Static vacuum insulated cryogenic pressure vessels can be selected for cryogenic storage tanks, which shall meet the provisions of GB/T 18442. Or choose welded insulated gas cylinder, which shall meet the provisions of GB/T 24159.

### 5.2.3 Cryogenic test tank

5.2.3.1 The cryogenic test tank shall be designed as an open double-layer structure. The inner container shall have a proper wall thickness and a certain reinforcement plate to withstand the weight of test valves, cooling medium, test accessories and possible lifting impact. An insulating structure shall be formed between the inner and outer walls of the test tank. When the inner wall of the tank is under low temperature, the outer surface of the tank shall be free of visible frost except for the positions of gas vents, cryogenic liquid inlets and outlets.

5.2.3.2 The cryogenic test tank shall be equipped with an opening-closing thermal insulation cover. The cover shall be designed with coupling round hole to ensure that the stem packing of the test valve can be exposed outside the tank.

5.2.3.3 The bottom of the test tank shall have a fixed and supporting mechanism, which can fix the test valve and make its height adjustable. The torque generated during opening or closing test valve shall be considered when designed fixed and supporting mechanism in order to balance the torque.

5.2.3.4 The cryogenic storage tank, cryogenic test tank and all cryogenic test tanks can be connected by cryogenic insulation pipes. Pipe design shall take site conditions into consideration, and set switch valve groups reasonably. Safety pressure relief devices shall be installed for potential closed pipe-segments.

5.2.3.5 The cryogenic test tank should be designed in sinking style. Safety passages with a width of no less than 1m must be reserved around the cryogenic test tanks, and safety isolation measures should be taken.

### 5.2.4 Cooling by immersing method

5.2.4.1 The height of liquid level shall be controlled.

5.2.4.2 The low-temperature medium is normally liquid nitrogen.

5.2.4.3 The test temperature can be adjusted by adding a certain proportion of liquid nitrogen into alcohol, but this method is only applicable to test temperature above -110°C.

### 5.2.5 Cooling by spray method

5.2.5.1 The quantity and time of spray medium shall be controlled reasonably.

5.2.5.2 The spray medium is liquid nitrogen.

5.2.5.3 The nozzle position and injection direction shall be adjustable.

5.2.5.4 The test temperature in test tank shall be adjustable within the range of  $-196^{\circ}\text{C}$  to  $-29^{\circ}\text{C}$ , and the temperature difference in the tank shall be within  $\pm 5^{\circ}\text{C}$ .

### 5.3 Pressure piping system

5.3.1 The pressure piping system shall be capable of pressurizing, maintaining pressure and relieving pressure of test valve at low temperature. It mainly consists of snakelike pressure pipe or flexible metal hose, bus bar, gaseous storage equipment, needle valve, gas booster pump, control pipe network, pressure blind plate, etc. The gas storage equipment shall meet with GB/T 5099 when steel seamless gas cylinders are selected.

5.3.2 The test medium is helium. However, for cryogenic test with a temperature not lower than  $-110^{\circ}\text{C}$ , the test medium can either use pure nitrogen or 99% nitrogen mixed with 1% helium.

5.3.3 The pressure piping system shall be capable of being realized, and bear test pressure not less than 27.5MPa, and shall take the impact of pressure pulse into consideration.

5.3.4 For valves with bi-directional pressurization requirement, the pressure piping system shall be able to switch between positive and reverse pressure.

5.3.5 Recycling and reuse of valuable test media shall be taken into consideration.

5.3.6 The test medium must be warmed to ambient temperature before entering the storage container When recycling; Or a low-temperature resistant storage container is selected.

5.3.7 The pressure piping system shall fully consider the safety of operation and shall have an emergency pressure relief device.

### 5.4 Measurement and control system

5.4.1 Instruments and meters under low temperature environment shall be work well to the low temperature of  $-196^{\circ}\text{C}$ .

5.4.2 Temperature measurement shall reflect the temperature value of the main components of test valve and their changes.

5.4.3 The temperature inside the valve to be tested shall be measured to reflect the temperature difference between inside and outside.

5.4.4 Pressure measurement shall reflect the change of valve pressure during the whole test process.

5.4.5 Leakage rate measurement shall meet the requirements of GB/T 24925.

5.4.6 Pre-and post-processing capability and convenient communication mechanism shall be provided, which can automatically record test parameters, form curve records and test reports and can be transmitted remotely.

## 6 Operation regulation

6.1 The cryogenic test methods and procedures for valves shall be consistent with relative test standards.

6.2 The valve shall be fully dried before cryogenic test, and sundries such as grease shall be removed.

- 6.3 Install test valve in a suitable test tank and connect all joints to ensure that the stem packing of the valve is above the insulation cover and the temperature is kept above 0°C.
- 6.4 Fix and connect all measuring instruments and meters to ensure their normal operation.
- 6.5 Before the test, A purge of test gas shall continuously flow through the valve cavity to prevent the moisture contained from condensing.
- 6.6 When cooling by immersing method, the low temperature test medium shall covers at least the top of the valve body to bonnet joint, and the test valve shall be cooled to required test temperature.
- 6.7 When cooling by spray method, the temperature of all parts of test valve shall be below the insulation cover, and the test valve shall be cooled to required test temperature.
- 6.8 Cooling by immersing method shall be used for components cryogenic treatment of cryogenic valves.
- 6.9 Before test, the test valve shall be maintained under low temperature for enough time to make the internal and external temperature of all components of the valve balanced, the temperature difference shall be within  $\pm 5^{\circ}\text{C}$ .
- 6.10 During the cryogenic gas test, the pressure shall be gradually increased according to the test requirements of standard. Pay close attention to the pressure change after reaching the rated test pressure, and increase the pressure immediately when the pressure loss caused by gradual decrease of test medium temperature.
- 6.11 For the test that required test valve to be cooled first and then moved outside from test tank for pressure test, Close attention shall be paid to the temperature changes inside and outside the valve, and the test shall be performed at the required temperature inside the valve.
- 6.12 Low temperature test of cryogenic shutoff valves and throttle valves used for air separation plants shall meet the requirements of JB/T 9081.
- 6.13 The test area must be ventilated, and forced ventilation shall be adopted when necessary to prevent local hypoxia caused by volatilization of low-temperature medium.
- 6.14 Warning signs shall be set up for exposed cryogenic equipment or component of the equipment, and cryogenic test area shall be safely isolated.
- 6.15 Single person operation is forbidden on site.
- 6.16 The danger of cryogenic test shall be fully recognized. Safety protection for personnel and equipment shall be strengthened, and remote operation or automatic operation shall be implemented whenever possible.
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