

Design and Research of the Automatic Hydraulic Testing and Testing Device for Gas Cylinder

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Abstract: Gas cylinder is a typical storage and transportation equipment, which plays an important role in the national economy. Cylinder hydrostatic test is the core project in cylinder quality inspection, which mainly refers to GB /T 9251-2011 cylinder hydrostatic test method and CGA C-1-2009 methods for pressure testing compressed gas cylinders. These two standards are hydrostatic test by external measurement, which is mainly used to check whether the overpressure bearing capacity of gas cylinder meets the requirements. Hydrostatic test is an essential part of gas cylinder production. Therefore, we must produce a good hydrostatic test device, which will directly affect the reliability, production efficiency and testing efficiency of the gas cylinder quality test results. Firstly, this paper analyzes the detection method of gas cylinder. Then, this paper designs the flow chart of gas cylinder hydraulic testing. At last, this paper designs the testing device of cylinder water pressure detection.

1. Introduction

The national standards are as follows. During the production process of gas cylinder, hydrostatic test must be carried out, which is because the gas cylinder itself is used to store high-pressure gas. Once leakage or explosion occurs, it will cause great loss to the national economy and people's life and property. Therefore, the quality control requirements for gas cylinders are extremely strict. Hydrostatic test is an essential part of gas cylinder production. Therefore, we must produce a good hydrostatic test device, which will directly affect the reliability, production efficiency and testing efficiency of the gas cylinder quality test results. With the development of science and technology, the hydraulic test device of gas cylinder has been developed rapidly, and the automation of the hydraulic test device has been improved.

2. Water pressure test method of gas cylinder

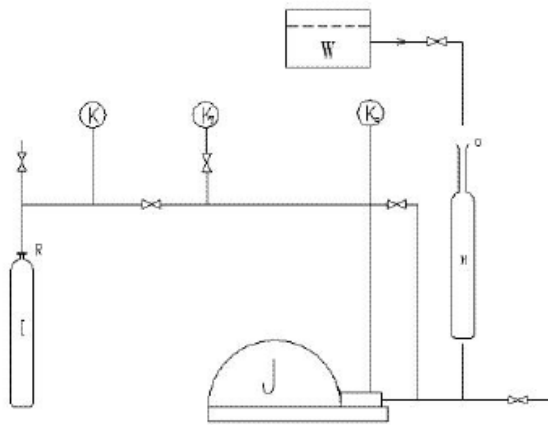
2.1 Withstand voltage method

The pressure test is the simplest method of cylinder water pressure test, which does not need to measure the volume deformation of the cylinder. The production personnel only need to complete the pressurization, pressure maintaining, pressure relief and other tests on the gas cylinder. Then, the inspectors observe whether there is irregular deformation, leakage and other phenomena. Therefore, the test results are not accurate enough and one-sided. Pressure method can only be applied to low pressure gas cylinder, which is not universal.

2.2 Internal measurement

The internal measurement method is based on the pressure test, which needs to measure the internal deformation of the cylinder. By measuring the maximum deformation and residual deformation of gas cylinder, we will find out the residual deformation rate, which is the basis for us to judge whether it is qualified. The method of internal measurement is very simple, which is more accurate than the pressure method. Therefore, in the initial stage of gas cylinder testing, the manufacturer mostly uses the internal testing method. However, there are some defects in the

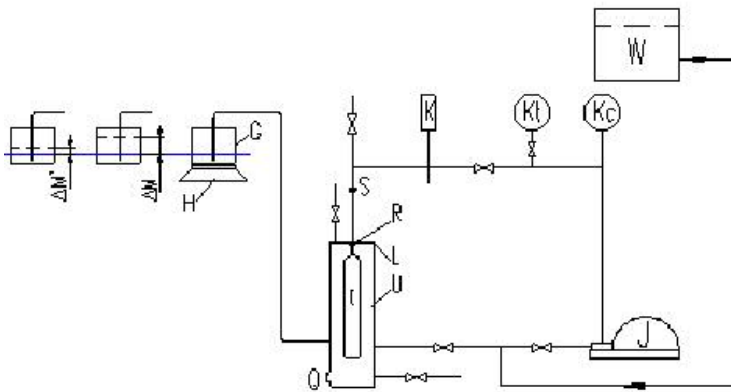
internal measurement method, which will increase the detection error. Therefore, the internal measurement method has been gradually replaced by the new method. In many foreign standards, some gas cylinders have been forbidden to use the internal measurement method. The schematic diagram of internal water pressure test is shown in Figure 1.



W is the test water tank;
 J is hydraulic pump;
 H is a measuring tube.
 I is the test bottle;
 R is a special joint;
 Kc is a pressure measuring instrument (pump outlet pressure)
 K is the pressure measuring instrument (the test pressure);
 Kt is a precision pressure gauge (other pressure measuring instruments)

Figure 1. The schematic diagram of internal water pressure test is shown in

2.3 Lateral method



W is the test water tank;
 J is hydraulic pump;
 H is a measuring tube.
 I is the test bottle;
 R is a special joint;
 Kc is a pressure measuring instrument;
 K is the pressure measuring instrument;
 Kt is a precision pressure gauge;
 H is the electric balance;
 G is the measuring cup;
 q is the safety relief port;

Figure 2. The principle diagram of lateral water pressure test

The external test method is the most widely used hydraulic test method in the world. During the hydrostatic test, the external measurement method reflects the change of cylinder volume through the change of water volume in the water jacket, which can measure the relevant parameters of the cylinder and complete the cylinder detection. Compared with the internal method, the external method overcomes many disadvantages, which has greatly improved the reliability and accuracy of the cylinder hydrostatic test. The schematic diagram of lateral water pressure test is shown in Figure 2.

3. Inspection flow chart of gas cylinder

In accordance with the latest pressure vessel testing standard GB / t9251-2011 edition of cylinder hydrostatic test method. The safety inspection of gas cylinder must pass the qualification standard of hydraulic test. With the development of gas cylinder technology, the reliability, efficiency and convenience of gas cylinder detection methods are gradually improved. The gas cylinder inspection process is shown in Figure 3.

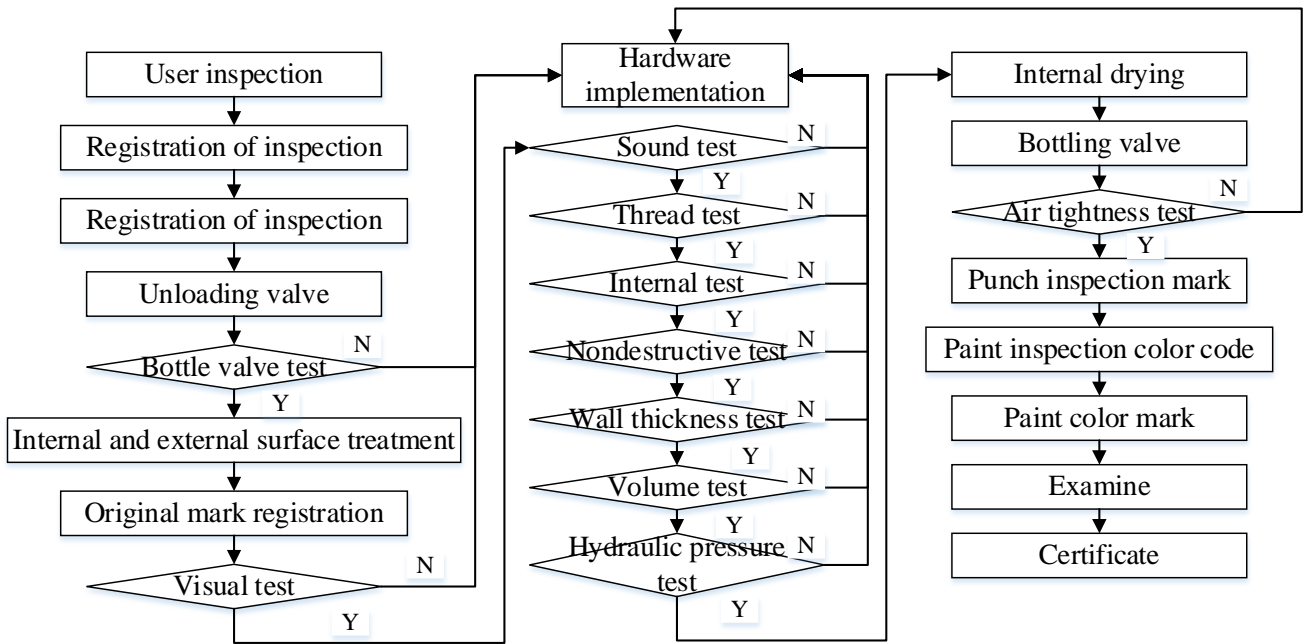


Figure 3. The gas cylinder inspection process

4. Design of automatic water pressure test device for gas cylinder

4.1 Test device design

The test device is composed of three parts, including automatic control software system, low-pressure circuit and high-pressure circuit. The high-pressure circuit is composed of pressure device, high-performance high-pressure solenoid valve, pneumatic relief valve, high-pressure stainless steel pipe, high-precision pressure sensor, electric contact shock resistance pressure gauge, etc. The device adopts a double station 4 water jacket, which significantly improves the detection efficiency of gas cylinders. This test device is suitable for all kinds of seamless gas cylinders. The design schematic diagram of the test device is shown in Figure 4.

4.2 Low voltage circuit design

The low-pressure circuit is composed of water jacket, expansion sleeve water jacket cover, high-performance solenoid valve, imported high-performance electronic balance and other components, which are mainly used for water supplement, drainage and water quantity measurement of water jacket. The low-voltage circuit design is shown in Figure 5.

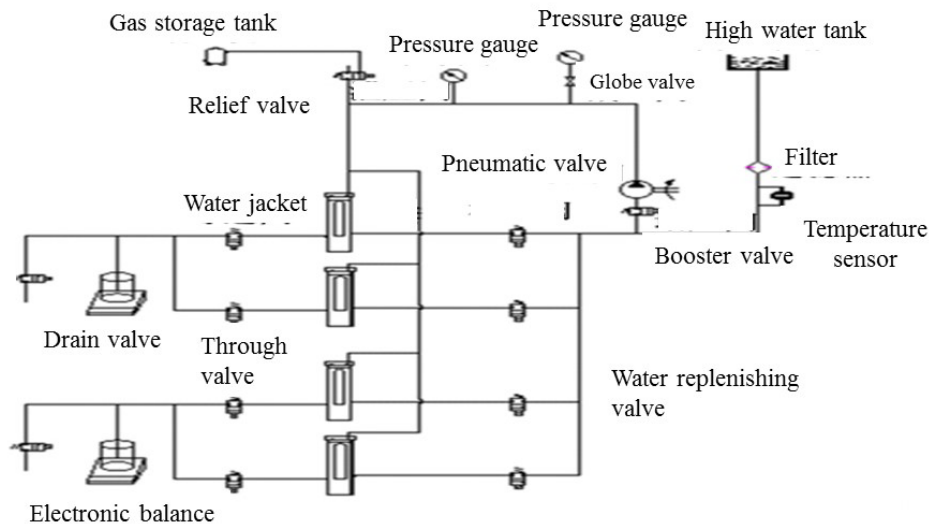


Figure 4. Schematic diagram of hydrostatic test for double station gas cylinder

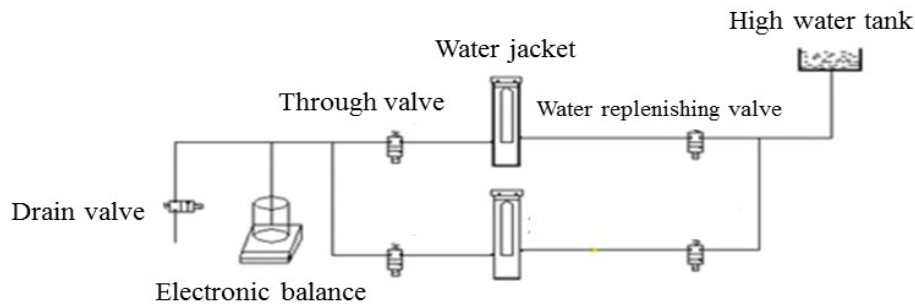


Figure 5. Low voltage circuit design

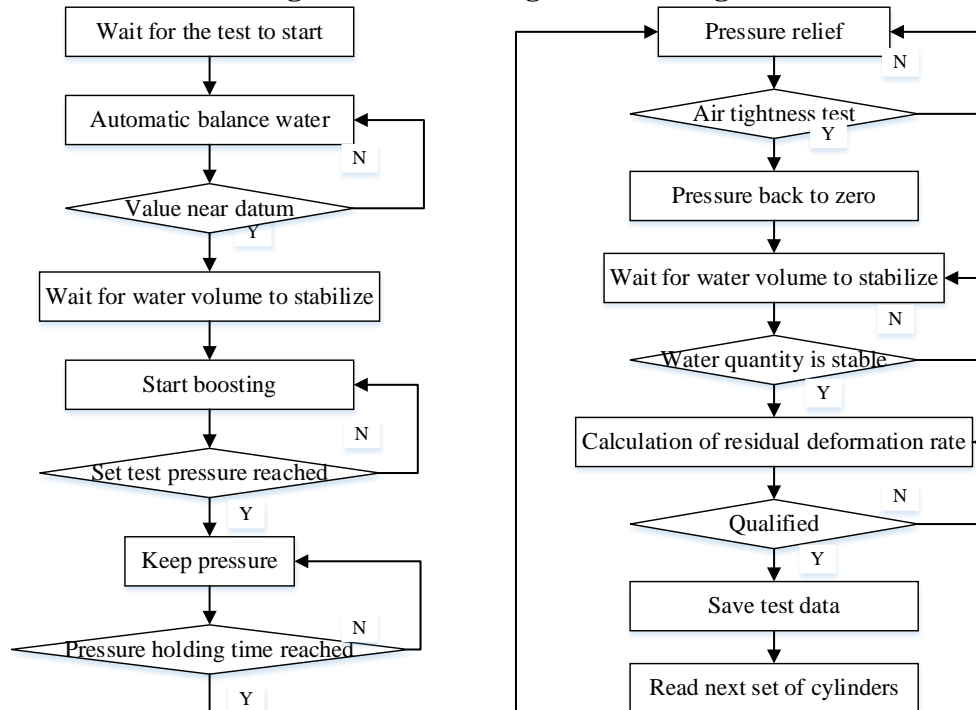


Figure 6. The flow chart of full automatic hydraulic test control

4.3 Automatic detection control process

The process of automatic detection and control is mainly to control the detection of gas cylinder. Through the input of gas cylinder information, we can collect real-time signals, which will realize the whole process automatic control of hydraulic test. The flow chart of full automatic hydraulic test control is shown in Figure 6.

5. Conclusions

Compared with other devices in China, this automatic hydraulic test device has higher precision and repeatability, which will improve the automation and real-time of the manufacturer. This software design has a variety of features, such as easy to use, fast response, one key operation, etc., which makes it easier for ordinary workers to learn to use. This design is applicable to wound cylinder, vehicle cylinder and all kinds of seamless cylinder.

Acknowledgement

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