

Development of Fire-resistant Experimental Device for Valve Flange

Jilin Li^{*}, Yingjun Xiang

National Quality Supervision and Inspection Center of Petroleum Mechanical Products, Jiangsu, China

^{*} Corresponding Author Email: 563957088@qq.com

Abstract. This paper mainly describes the principle of end fire resistance test equipment and the current research status of valve fire resistance test equipment at home and abroad. In view of the shortcomings of the traditional test device, we made several improvements: 1. We added the burner at the bottom. 2. We added the rail car that can be electrically driven in and out. 3. We optimized the cooling circulation system of the high pressure gas with internal leakage. 4. We improved the overall structure of the valve combustion chamber. 5. We added the end connection bending moment system. The test shows that the temperature, pressure and other performance indicators of the test device meet the relevant requirements of API standards.

Keywords: Flange, fire resistance test, control system.

1. Introduction

The valve fire test device was developed earlier in Europe and the United States. They formulated the American Petroleum Institute's valve fire certification rules and issued standards such as API607 [1] and API6FA [2]. They made detailed requirements for the 6A and 6D valve fire test devices and test requirements. At present, various types of test devices have been developed at home and abroad based on the API fire resistance test standards. Some are for small size valves, some are only designed for ball valves, and some are made of stainless steel. It is an integral structure made of fire bricks. Each has its own advantages and disadvantages. The research standards for land and sea end connection mainly include the following standards: API SPEC 6FB-1998 [3] end connection fire resistance test specification and SY/T6745-2008 [8] end connection fire test specification.

These two standards provide for the testing and evaluation of the pressure-bearing performance of land and marine end connections under burning conditions, mainly for fire tests, bending tests, and leak tests.

2. Overall design of test device system

Aiming at the research on the integrated fire resistance test device for valve and end connection, the overall design plays a role in introducing the valve fire resistance test and end connection fire resistance test. This chapter mainly includes the overall block diagram of the test device, the description of the components on the device and the design of the ground map, and the analysis of the principle of the test device.

Machinery and control device mainly include four parts: test rail car, cooling pipe, bending moment system and control cabine. The software system mainly has four parts: login interface, information input interface, test operation interface and data statistics interface. The foundation map mainly designs the water and electricity for the entire test device. Detailed overall block diagram of the test device system, as shown in Fig 1.

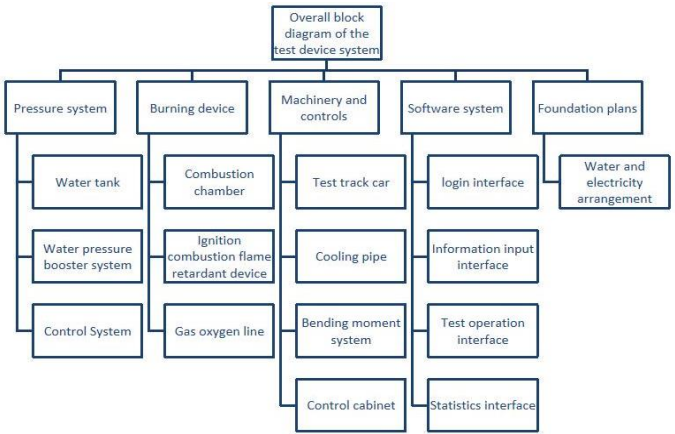


Figure 1. Overall block diagram of the test device system

3. Fire resistance test equipment design system layout

According to the valve test device system schematic diagram, we can know that the entire refractory system includes 5 parts: pressure system, combustion chamber, ignition system, fuel and air delivery system, mechanical device and control device, and cooling system. The design of each part must take into consideration the research objectives and research content of this topic. It can carry out the integrated test of the valve and the end connection, solve the problems of low automation and poor safety of the previous valve fire test device, and also solve the problem in the market. Need for end-to-end fire resistance test equipment. We designed the components of the valve and end connection integrated fire test device. The schematic layout of the specific design system is shown in Fig 2.

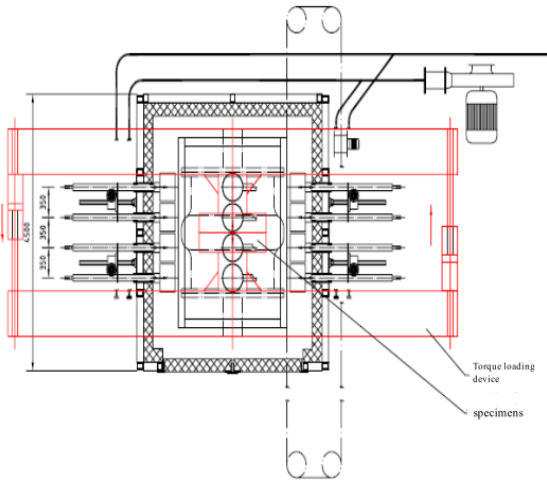


Figure 2. Top view of system layout of valve fire test device

The schematic diagram of the end connection fire resistance test (Fig 3) is consistent with the valve fire resistance requirements. The difference is that the end connection requires a bending moment test.

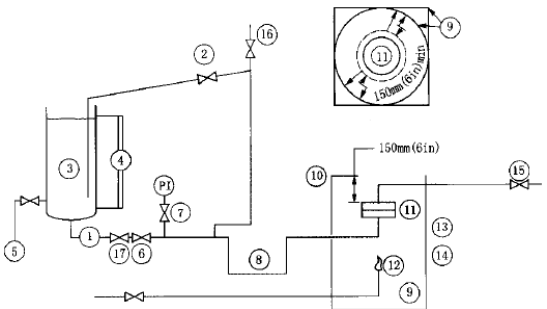


Figure 3. Principle of the end connection test device

Therefore, the design of the integrated fire test device is mainly based on the valve fire test device, and the bending moment system is suitable for the test of the end connection, so that the fire test of the valve and the end connection can be taken into account at the same time.

4. Design of Bending Moment System

At present, the experimental research on end connections in the market is mainly in the verification of underwater end connections. There are fewer studies on end connections on land and ocean platforms, and there are almost no test devices. Therefore, in order to meet the fire resistance research of end connection of land and ocean platforms, and ensure industrial production safety. We put forward a scheme of adding a bending moment system to the valve fire test device according to relevant standards, which can solve the three major test requirements of the end connection fire test, bending test and leak test required by the standard. From the principle of the test device of the two products, the combustion device and leak test system they use are almost the same, so we use the same device. In order to achieve the bending test at the end connection, we add the structure of the bending moment system thus forms a set of integrated fire resistance test device system that simultaneously meets the valve and end connection.

5. Requirements for bending moment systems

SY/T6745-2008 "Specifications for Fire Resistance Test of End Connections" has made clear requirements for bending test. The bending moment is generated by the movement of the hydraulic cylinder. When designing the hydraulic cylinder, make sure that the tensile force produced does not exceed the end of the connector 10% of the total pressure load of the part, any device that applies bending moment shall be designed to be able to withstand the test load safely, and will not form a separation between the connector and the flame.

Two sets of typical devices of the bending moment system are also described in the standard, one is a bending test device with a piston hydraulic cylinder (Fig 4), and the other is a bending test device with two piston hydraulic cylinders).

6. Design of Bending Moment System

According to the typical structure of the above two bending moment systems, we can choose a bending test device with two piston hydraulic cylinders according to the conditions of the valve fire test device and the consideration of the test requirements. In order to ensure that the test piece can be adjusted during installation We designed the bending moment system to be movable and adjusted by adding a piston cylinder. In this way, the movement of the three piston cylinders can ensure the clamping stability of the test piece.

The main structure of the bending moment system is a hydraulic station, a piston cylinder, and a bending member. Bending moment system diagram 6.

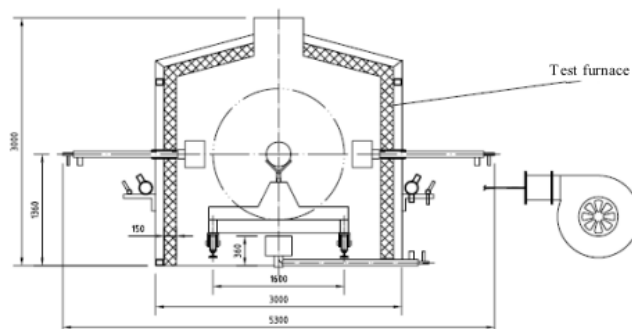


Figure 4. Schematic diagram of bending moment loading device

The hydraulic station provides power for the operation of the piston hydraulic cylinder, and applies bending moment tension pressure to the end connection through the movement of the two piston cylinders outside the combustion chamber.

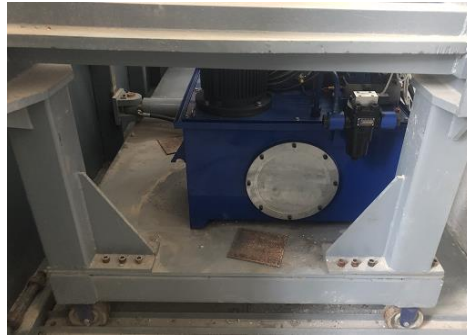


Figure 5. Hydraulic station

The design of the entire device of the bending moment system has special circumstances in order to take into account the difference in end connection specifications. Therefore, the entire device is designed with a roller at the bottom to move the fine adjustment, so a piston hydraulic cylinder is added at the bottom. This bending moment system can satisfy the positioning and bending moment test of the end connection by designing three piston hydraulic cylinders.

7. Test data acquisition system

To complete the design of the hardware part, to achieve the operability of the test and visualization of the test results, a set of test operation software needs to be designed. The software can record the operation of the test steps and the test process, and finally organize the recorded results for easy induction. to sum up.

7.1. Test software program flow

According to the valve fire resistance test standard API607 data collection requirements for pressure and temperature during the test, all data collection needs to be recorded every 30 seconds, so 30 seconds is used as a collection cycle.

The main flow of the fire test of this device is shown in Fig 6.

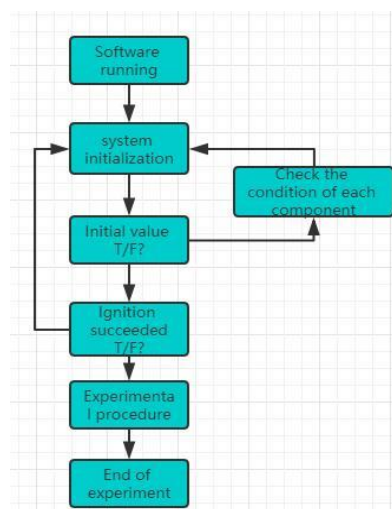


Figure 6. Main flow chart of fire resistance test

7.2. Design of the control cabinet

The control cabinet part is the control center for the fire resistance test. The control of this test device is designed as two methods of program control and ground control. There are two control

cabinets, one with digital display and adjustment instruments, which can display data and adjust controllable equipment in real time, and one is the centralized control center of the entire control system. Switches for thrusters, gas valves, solenoid valves, igniters, etc., as well as power and emergency switches.

The design of the electrical control cabinet must first design the electrical schematic and layout drawings. The electrical layout drawings will tell us the placement and wiring of electrical components. The layout of the cabinet and the installation layout of the components inside the cabinet are determined by the electrical layout drawing. Then determine the overall size of the cabinet as needed.

The electrical control cabinet can be said to be the control brain of the entire experiment, and the basis for the establishment of this system is the selection of an appropriate electrical control cabinet.

The electrical control cabinet is designed in two levels, the upper level is mainly for the layout of the ground control control part, and the lower level is for the control system power supply.

The test device is provided with two methods of ground control and program control for test operation, including the switch of the flame retardant machine, the switch of the ignition device, the start and stop of the specified car, etc. The test operation process is smooth and safe.

8. Full text summary

This article mainly developed a set of automatic recording test system for the fire resistance test of industrial valves. The test methods are based on API SPEC 6FA "Code for Fire Resistance Test of Valves" and API 607 "Fire Resistance for Turn-A-Quarter and Non-Metal Seat Valves" Test "API SPEC 6FB-1998" Specifications for Fire Resistance Test of End Connections "and other standards, carried out test device design, test verification, and the specific work and conclusions completed in the paper are as follows:

(1) According to the design requirements of the fire resistance valve performance test system, the overall mechanism of the test system is determined, and the components of the valve performance test system are designed, including the main pressure system, combustion device, mechanical device, control device, software application, etc.

(2) According to the design goals of the fire resistance valve performance test system, the hardware part of the control system is selected and designed to complete the selection of the temperature sensor and pressure sensor.

(3) According to the actual requirements, the valve fire test software is based on Kingview as the development platform, and the software operating environment is the simplified Chinese Windows XP operating system. The software system has complete functions of test operation, data acquisition, curve generation and report generation.

References

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