Research on a Logistics Conveying Device for Hydrostatic Testing of Gas Cylinders

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Abstract. Our regular inspection during the use of cylinders is an important means to ensure the safe use of cylinders, and reasonable periodic inspection efficiency is a necessary means to ensure the normal circulation of cylinders and maintain the stability of the cylinder industry. As a bottleneck in the testing process of the hydrostatic test, the efficiency of periodic inspection of gas cylinders has been affected for a long time. In order to solve the above problems, this thesis mainly researches and solves the bottleneck problems that affect the efficiency of hydraulic pressure tests, in order to achieve rapid detection of the hydraulic pressure tests of cylinders, and develops a kind of gas cylinders to dial, rotate, flip, water, hoist, weigh. It can accurately and accurately locate the water jacket, pour water, purge, and dry the cylinder logistics conveying device, and realize the fast and accurate cylinder hydraulic pressure test, eliminating the bottleneck problem in the detection process and achieving the effect of rapid cylinder detection.

1. Introduction
Gas cylinders are bottle-type packaging containers for gases such as oxygen, hydrogen, carbon dioxide, acetylene, liquefied petroleum gas, compressed natural gas, helium, argon, liquid chlorine, and liquid ammonia. A gas cylinder is a removable pressure vessel. As an important basic equipment for national economic and social development, gas cylinders are closely related to all aspects of people's production and life. They play a significant role in national defense and military and civilian facilities [1]. However, the safety of gas cylinders cannot be ignored. At present, gas cylinder accidents are concentrated in liquefied petroleum gas cylinders, oxygen cylinders, low-temperature thermal insulation gas cylinders, etc. The occurrences are concentrated on filling, transportation, and use, posing an important threat to people's life and property [2]. At present, most countries in the world have promulgated specific laws on gas cylinders, set up specialized agencies, and implemented strict safety management. According to the relevant regulations of gas cylinders, gas cylinders need to be inspected periodically during use. The inspection process mainly includes appearance inspection, non-destructive testing, water pressure test and air tightness test [3].

At present, most of the cylinder inspections adopt modular inspection methods, and the inspection items are independent and discontinuous, which greatly affects the inspection efficiency. In addition, the base number of gas cylinders is huge, with about 100 million in China, and the annual growth rate
has reached 10%, and the annual inspection volume of gas cylinders has also increased. Low-efficiency inspections have gradually affected the entire cylinder inspection industry, making it face the problem of lack of development potential [4]. Therefore, in order to ensure that the inspection of each item can be carried out smoothly and the efficiency of the inspection, the bottleneck that affects the detection speed must not occur during the inspection process. In order to improve the inspection efficiency, the current development direction of gas cylinder inspection devices is mostly pipeline inspection. The transmission of inspection data is aided by advanced information technology, which has also become a current research hotspot [5].

During the cylinder inspection process, the hydraulic pressure test, as a bottleneck in the inspection process, has a long-term impact on the efficiency of the periodic inspection of the gas cylinder; and the main factor affecting the efficiency of the hydraulic pressure test is the problem of cylinder logistics transportation. Aiming at the hydraulic pressure test and the advanced automatic control technology, this article has developed a set of cylinder pressure conveying device for the hydraulic pressure test of the external pressure of the cylinder, which can greatly improve the inspection efficiency of the cylinder.

2. Traditional hydraulic test method
At present, most of the hydraulic pressure test operations of cylinders are completed by manual operations. The cylinders are independently operated from the cylinder lifting, water injection, pressurization, pouring, and drying (the specific process is shown in Figure 1). Vertical movements are performed manually. In the water injection process, the gas cylinder is manually pushed to the fixed position of the fixture, and the clamping and turning switch is operated. After the clamping and turning is completed, the water is filled. At this time, the electric hoist is manually operated, and the hoisted water jacket cover is operated to the top of the gas cylinder at the irrigation site, while ensuring that the horizontal position must be accurate. Then tighten the gas cylinder, and at the same time operate the gas cylinder clamping switch box electric hoist, hoist the gas cylinder to the water jacket, because the smoothness of the electric hoist is not enough, when it is adjusted to the upper part of the water jacket, it is necessary to wait for the cylinder to stop shaking. The cylinder falls into the water jacket, at this time, the preparation work before the hydraulic test can be performed, and the hydraulic pressure test can be performed after completion. After the hydraulic pressure test is completed, the electric hoist is manually operated to remove the cylinder from the water jacket, and then drained to the water pouring position. When the cylinder is no longer shaking, manually operate the switch to clamp the cylinder, unscrew the water jacket cap, adjust the water jacket cap, and flip the cylinder, and manually push the filled cylinder to the inverted pour point to dry it. After the drying is completed, manually push the cylinder away from the drying place. During the entire process, the horizontal and vertical movements of the gas cylinders are heavy due to the weight of the gas cylinders. Manual operation requires great physical effort. The labor intensity of the operators is high. The gas cylinders are shaken during lifting and walking. Conducive to operation safety; and the hydraulic pressure test work efficiency is low, generally only 10 / hour, far from meeting the needs of manufacturers and inspection stations, seriously restricting the improvement of the level of gas cylinder manufacturing and inspection.

The cylinder is placed in the water injection area. The cylinder clamps the cylinder. The cylinder begins to fill with water. Tighten the water jacket cover, loosen the cylinder, weigh the cylinder and lift it to the water jacket, seal the water jacket, connect the hose and exhaust the pipe. A hydraulic test is performed. After the hydraulic test is completed, the cylinder is lifted to the pouring area. The cylinder clamps the cylinder, loosens the water jacket cap, and the inside of the cylinder is dried and automatically rolled to the next step.
On the whole, the development of cylinder hydraulic pressure test equipment generally lags behind the development of cylinder manufacturing industry. The cylinder hydraulic pressure test equipment is inefficient, the operation process is not intuitive, there is no automated system, and the information of the data depends on the eyes and the notes. Therefore, in order to solve the above problems, on the one...
hand, it is necessary to develop automatic control software for related processes and information, and on the other hand, it is necessary to configure more optimized hardware facilities.

3. Cylinder logistic conveying device for hydrostatic test of cylinder external pressure test method

In order to further increase the efficiency of the hydraulic test of the cylinder, this article designs the introduction of the PLC automatic control system into the hydraulic test. Starting from the separate links of the hydraulic test, the view integrates it into an organic system to achieve a high degree of automation and reliability. Strong, greatly improve work efficiency and save labor costs.

![General layout of the flow arrangement of the gantry trolley type hydraulic pressure test logistics conveying device](image)

Figure 3. General layout of the flow arrangement of the gantry trolley type hydraulic pressure test logistics conveying device

This paper has designed a kind of logistics conveying device for cylinder hydraulic pressure test. The general layout of the device is shown in Figure 4. The principle of the device is to use the middle gantry trolley to control the lifting, starting, stopping and walking of the gantry trolley through a PLC program. The distance plays the role of automatic operation and precise positioning. And the use of magnetic components, pneumatic components and relays and other tools to develop automatic pour water purge and dry and automatically transport the cylinder to the next process device, combined them, to achieve a fully automatic hydraulic pressure test of the cylinder. The relationship between the various systems of the hydrostatic test and how it works will be divided into the following sections.

3.1. The process of automatic filling of gas cylinders

The principle of automatic water injection for gas cylinders is that a contact type travel switch is installed on the steering wheel. The gas cylinder automatically runs until the steering wheel collides with the contact type travel switch. The stroke switch automatically controls the turntable and the electromagnetic time relay switch is used to control the gas cylinder. Scroll to the flap of the water injection turning machine, and then turn on the cylinder. The cylinder pushes the cylinder to the water injection turning machine and returns to the original position automatically. After that, the clamp cylinder switch on the gas cylinder turning plate is activated. The bottle is clamped and flipped upright to prepare water for injection.

In the water injection process, the oil filling gun is closely pressed against the inner wall of the cylinder to fill the bottle with water. After the water is filled, the oil filling gun is automatically closed and the water filling is completed.
3.2. **The process of automatic cylinder walking**

After the water injection is completed, turn on the return-to-origin switch on the control panel of the gantry crane to control the gantry car to automatically move to the top of the gas cylinder, tighten the water jacket cap, loosen the cylinder of the water injection flap to clamp the cylinder, and open the gantry crane to lift the oil pump. The oil pump drives the lifter to vertically raise the gas cylinder to the control position of the magnetic induction stroke controller installed on the gantry crane, and then the lifting stops.

The operation of the gantry trolley is completed by PLC automatic control technology. The servo motor is used to control the walking speed and distance. The process is fully automated.

3.3. **The process of automatic water pressure test**

At the same time as one cylinder performs the hydrostatic test, the gantry trolley is driven to another water jacket, and the next cylinder is filled with water. This can ensure the continuity of the entire hydrostatic test and greatly improve the work efficiency.

After the hydraulic pressure test of a cylinder is over, the lifting oil pump that controls the gantry crane lifts the cylinder vertically out of the water jacket to reach the height controlled by the magnetic induction travel switch on the gantry crane, and automatically walks to the drainage purge and dry place.
3.4. Automatic purge process after the test is completed
After the gas pressure test cylinder is sent to the purge dry place, turn on the water pour process switch, clamp the flipper to turn the gas bottle and pour water. After the water pour is complete, the purge station clamps the cylinder to automatically clamp the gas. The cylinder is turned upside down to make the cylinder upright. When the cylinder reaches the upright position, the air vapour is alternately purged to dry the cylinder. The entire purge and drying process uses PLC automatic control technology to realize the cylinder drainage purge and dry. At the valve station on the bottle, the hydrostatic test is completed.

![Figure 6](image)

**Figure 6.** a) Cylinder clamping and turning machine release process; b) Cylinder clamping and turning machine clamping process; c) The process of pouring water after the end of the hydraulic test; d) the process of automatic operation of the cylinder on the track

4. Conclusion
This article aims at the current low efficiency of the hydraulic pressure test of the gas cylinder. The hydraulic pressure test of the gas cylinder is hoisted, filled with water, hoisted to the water jacket, pressurized (hydraulic test), lifted from the water jacket, poured water, and dried. Become an organic whole; according to the process, we have developed a linkage device that uses a combination of magnetic switches, relays and pneumatic components to rotate the bottle, push the bottle, and flip the bottle. The cylinder filling process, and also developed a gantry trolley specially used for cylinder lifting, moving and precise positioning of the water jacket, greatly improving the mechanization and automation of the cylinder hydraulic device, and significantly improving the hydraulic pressure test device. Work efficiency.
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