Research on Detection Technology of Joint Sealing of Large Diameter PVC Water Supply Pipe

Meng Fanzhao 1*, Yang Ruiqing 1, Yang Yonghai 2, Wei Daifeng 3

1 School of Mechanical Engineering, Shandong Huayu University of Technology, Dezhou 253034, China
2 Xinji Jiqing Environmental Protection Energy Co., Ltd. Hebei Xinji 052360, China
3 School of Safety and Ocean Engineering, China University of Petroleum (Beijing), Beijing 102249, China

*Corresponding author’s e-mail: mfzhthy@huayu.edu.cn

Abstract: With the increasing application of PVC water supply pipe in production and life, this paper aims at the problem that there is no single sealing ring connected large diameter PVC pipe interface sealing detection equipment in the construction site of agricultural water supply. According to the sealing test method of negative pressure test, a set of large diameter PVC pipe interface sealing test device is designed, and the corresponding test procedures and standards are put forward. The field sealing test of large diameter PVC pipe interface is carried out, and the portable aviation aluminum box with universal wheel is designed and customized. The device has the advantages of simple structure, easy installation and disassembly, easy carrying, and is suitable for field operation. It provides important equipment support for the better promotion and use of large PVC pipes.

1. Introduction

In the past, steel pipe and cast iron pipe are the main materials for water supply pipeline. PVC pipe and PE pipe are typical products of emerging materials for water supply pipeline [1]. Compared with traditional water supply pipeline, they have the characteristics of high product strength, low fluid resistance, acid and alkali corrosion resistance, convenient installation and long service life, which are widely used in agricultural irrigation, sprinkler irrigation and other water-saving projects [2]. As a water supply pipeline, good sealing is the prerequisite for its normal water supply. But in fact, in the process of pipeline production, there may be problems of poor tightness due to process problems, or poor sealing conditions such as seal ring damage caused by poor interface treatment in the process of pipeline laying. Only after sealing test, can the pipeline whose tightness meets the requirements be put into production. The traditional method of pipeline sealing detection is to inject water or gas into the pipeline, and then find the leakage point through various indirect leak detection methods [3-4]. At present, the commonly used pipeline leakage detection methods include pressure gradient method, infrasonic detection method, negative pressure detection method, etc. [5-8]. When visiting Xinjiang Tianye Co., Ltd., the author found that the large-diameter PVC water supply pipe produced by the company adopts a structure with one end of the outer single hoop and the inner sealing groove and the other end of the straight cylinder. When the two pipes are connected, the sealing ring is placed in the inner sealing groove of the single hoop and inserted adjacent to the straight cylinder end of the other pipe, forming a radial seal by the sealing ring, as shown in Figure 1. During the installation and
construction, it is impossible to detect the sealing of each installed pipe interface in real time. When all the installation is completed, the water filling and pressure testing is very expensive, and once the leakage occurs, the maintenance is difficult and the cost is high. There is no method and equipment to solve the sealing detection in the installation process of PVC water supply pipe in the existing research. Therefore, this paper studies and designs a large diameter PVC pipe interface sealing detection device, which has the advantages of easy to carry, suitable for field operation, automatic pressure test and so on. The local negative pressure method is used for real-time test, and it can be detected before the pipe is buried underground without irrigation and pressure After installation, the problems of unqualified pressure test and difficult maintenance are avoided.

Figure 1 PVC pipe interface diagram

2. Overall structure

Design principle: the pipe interface is wrapped with silica gel sealing plate, and the rack and pinion mechanism is used to drive the movable seat of the fixed sealing plate to move to the fixed seat, so as to form a closed space in the wrapped area, and then the vacuum device is used to vacuum the closed space and maintain the pressure; if the pressure can be maintained, and the negative pressure value is basically unchanged during the pressure maintaining period, it indicates that the pipe interface is well sealed, otherwise the sealing is poor.

The large diameter PVC pipe interface sealing detection device is mainly composed of fixed seat, movable seat (including stepping motor and reducer), rack and pinion mechanism, silica gel sealing plate, vacuum pump, control panel (including power switch, electric and gas interface, LCD, etc.), PLC control system, lithium battery, aviation aluminum box, etc. the main structure is shown in Figure 2.

1. Movable seat 2. Rack 3. Fixed seat

Figure 2 main structure of PVC pipe joint sealing detection device

2.1. Motion system

The designed rack is arc-shaped and the radius is the same as that of the water supply pipe. One end is fixedly connected with the fixed seat, and the other end is matched with the driving gear of the
movable seat. The fixed seat and the movable seat can fit with the surface of the pipe interface in the axial direction of the pipe, and are equipped with a locking device of the silica gel sealing plate. The movable seat is provided with a stepping motor and a reduction device for driving the movement of the rack and pinion mechanism. The motion system is shown in Figure 3.

2.2. Control system
The control system of the device is composed of control panel, PLC controller, vacuum pump, pressure sensor, LCD screen, lithium battery, etc., which are integrated and installed in the customized aviation aluminum box, as shown in Figure 4. The control panel is equipped with power switch, circuit, gas circuit interface, power voltage and current display screen, pressure display screen, LCD touch screen and other components. As a component of PLC control system, LCD touch screen can realize the operation of various preset functions.
2.3 portable design
According to the design requirements of field operation and portability, a portable aviation aluminum box with universal wheel is designed and customized. Spare parts such as motion system components, control system components, random tools, power charger, sealing plate and air nozzle are included, as shown in Figure 5. When the box is opened, the modules can be assembled quickly; after use, the modules can be disassembled and opened back to the designated position in the box, which is very convenient for transportation.

3. Seal detection
Methods and steps of seal detection. When the installation and construction of large diameter PVC water supply pipe need to be inspected, after opening the portable box, first power on the control system, turn on the power supply for self inspection, after passing the self inspection, install the sealing detection device on the pipe interface, and the fixed seat, rack, movable seat and sealing plate wrap the pipe interface on the circumference together, as shown in Figure 6(1); then connect the
control circuit and gas circuit between the motion system and the control system. As shown in Figure 6(2), the stepping motor is controlled by the LCD touch screen, the silicone sealing plate is stretched to wrap the pipe interface to form a closed space, and the sealing plate between the fixed seat and the movable seat is checked to see if it is squeezed tightly, as shown in Figure 6(3-4); then the vacuum pump is started to form a vacuum of -0.1MPa in the sealing area to maintain the pressure, as shown in Figure 6(5).

After testing, the device can complete the sealing test of large diameter PVC pipe interface according to the above process, and the test results are feasible, but the device can only be used for the sealing test of single specification pipe.
4. Conclusion

(1) In this paper, from the perspective of practical application, through the combination of theoretical research and field experimental research, a large diameter PVC pipeline interface sealing detection device for single seal ring connection is designed. The device adopts PLC automatic control system, controls the stepper motor drive gear rack mechanism, stretches the silicone plate to wrap the pipeline interface and seal, and then pumps vacuum, and tests according to the negative pressure. The pressure sensor is used to detect the pressure change.

(2) The test procedure and standard adapted to the device are put forward, and the field sealing test of large diameter PVC pipe interface is carried out. It is proved that the test method and standard are simple, the operability is strong, the result is reliable, and the expected goal is achieved.

(3) According to the design requirements of field operation and portability, a portable aviation aluminum box with universal wheel is designed and customized. Spare parts such as motion system components, control system components, random tools, power charger, sealing plate and air nozzle are included.

(4) The device has the advantages of simple structure, easy installation and disassembly, easy carrying, and is suitable for field operation. It provides important equipment support for the better promotion and use of large PVC pipes.

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