Design of Remote Helium Mass Spectrometer Leak Detector

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Abstract

Leak detection is the key to get a good vacuum system. For the dangerous areas, or facility with complicit structure required to be detect online, it is a hard mask to seek for the suspected leaks one after another. After studying the basic principle of helium mass leak detection, design a remote leak detector based on the PLC, as well as multi monitoring cameras, which can achieve successfully injection and sniffer probe leak detection during the range of 270 degree. Compared with the manual operation, this device aims at accurately and reliably detecting leak rate, which can greatly provide technique support of online leak detection. And it can bring the value of reducing the labor intensity and ensuring personal safety.

INTRODUCTION

With the continuous development of science and technology and industrial production, the requirements of vacuum equipment are higher and higher, and vacuum leak detection technology is also playing a more and more important role. The injection method and the inhalation method can be used to determine the location of the leak, and the helium mass spectrometry method is the most commonly used. In the process of leak detection, controlling the leak detector and auxiliary spray gun at the same time, observing the change of leak rate, data analysis and feedback operation in time, often requires multiple operators to work together, which greatly reduces the efficiency and accuracy of measurement. The development of computer technology leads the development of measuring instruments to automation and intelligence. At present, the helium mass spectrometer leak detector is controlled by microcomputer, but the intelligent leak detection and defect diagnosis still have a long way to go.

Overall design of the device

The remote vacuum leak detector consists of two main modules: the control and adjustment module of the probe and helium mass spectrometer leak detector, and the identification and monitoring module of the camera. The core function is to realize the remote control of the helium mass spectrometer leak detector and its accessory spray gun based on the auxiliary identification and real-time monitoring of the camera, so as to complete the leak detection operation of the vacuum specimen. The overall block diagram of the remote helium mass spectrometer leak detector is shown in Figure 1.

Sketch of leakage detecting database system

Basic principles and method

- **With vacuum leak detection technology is a technology to determine whether there is air leakage in the vacuum system and to determine the location and size of the leakage. Helium mass spectrometer leak detection is to add helium to one side of the workpiece to be tested by certain means, and then use helium mass spectrometer leak detector to detect the helium overflowing through the leak hole by appropriate methods on the other side, so as to achieve the purpose of detection. Helium injection method and positive pressure method are two basic methods of helium mass spectrometry leak detection.**
- **Helium injection leak detection is to vacuum the inner cavity of the tested part, and use the gun to inject helium with a certain pressure on the surface of the tested part, so as to detect the helium leakage into the tested part. Helium injection method takes a lot of time, but it can determine the location of the leak, and has the advantages of high sensitivity and low cost. It is a common qualitative leak detection method.**

Helium injection leak test

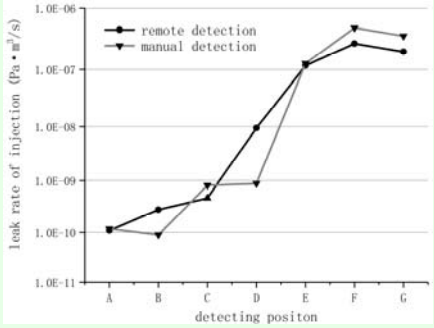
- **The test is divided into two parts: helium injection method and positive pressure suction gun. During the test, the ambient temperature is about 24 ℃. Firstly, the leakage rate of different positions is detected by the conventional manual method as the benchmark, and then the leakage rate data of each position is detected by the remote control mobile probe. In order to eliminate the accidental error, repeated tests were carried out and the average value was taken as the final result.**
- **Add 0.5m long inner diameter Φ The 250 mm round vacuum box is used as the tested device. The kf250 quick release flange and blind plate are sealed by quick release chain, and then connected with vspd03 helium mass spectrometer leak detector to form a vacuum system. After confirming that the sealing state of the test vacuum system meets the test requirements, a leakage point is artificially made at the joint of the flange. After the leakage rate at each position of the joint is detected by the manual helium injection method, the helium cylinder is connected with the probe spray gun, and the remote control of the spray gun movement detection is carried out. When helium is sprayed into the leak area, it will be immediately inhaled into the mass spectrometer chamber of the leak detector, and the leak rate change response of the leak detector will be output.**

Result analysis of helium injection leak test

• The spray gun probe detects and records the position of 7 vacuum box flange joints. During the test, the background leakage rate of the vacuum system gradually improved, and the average value was 9.0 × 10-11pa · m3 / s, and the pressure was 5.3×10-1pa. The final leakage rate after repeated helium injection is shown in Figure 3.

•In the helium injection leak detection test, the leakage rate difference of 7 points detected by manual and device is less than 1 order of magnitude, which indicates that the remote helium injection leak detection is effective and reliable. Compared with the background value, the leakage rate of remote detection points a, B, C and D of the device changes little, close to the order of 10-10pa · m3 / s; Point e began to increase significantly compared with the background, and the leakage rate was in the order of 10-7 PA · m3 / s; The maximum leakage rate at point F is 4.88× 10-7pa · m3 / s, while the leakage rate at point G is smaller but remains at the order of 10-7pa · m3 / s. Through the test results of the device, it can be judged that the leakage position of the test system should be in the range of radian DF.

The average leakage rate of point d manual method is 8.8 × 10-10pa · m3/s, while the leakage rate of remote detection of the device is 9.44 × 10-9pa · m3/s, which is relatively different from the other two methods. The helium injection method relies on the artificial control of helium duration and pressure, and the helium rapidly diffuses around to the adjacent leak hole, which leads to low detection repeatability. The same reason also leads to the device unable to further confirm the exact position of the leakage in the arc DF range. Although the helium injection method is qualitative, it is very positive to control the duration and pressure value of helium accurately.



Leak rate of injection detection

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