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Brief Discussion on Non-destructive Testing Methods for Pressure Pipeline Defects

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Abstract: With the development of China's oil and gas energy industry, the specifications of pressure pipelines for oil and gas transport are also becoming higher and higher, such as large caliber, ultra-thin wall, high pressure and other requirements, and the defects of pressure pipelines are becoming increasingly prominent. Due to the use of the environment, the material of the pipeline and other reasons, the pressure pipeline will produce a variety of defects in use. Non-destructive testing should be carried out on the defects caused by the pipeline in a timely manner, and according to the test results, defects should be graded according to the corresponding testing standards, so as to prevent the in-service pipeline from containing excessive defects and prevent pipeline breakage or explosion accidents.

Keywords: Pressure pipeline; Pipeline defects; Non-destructive testing; Detection standard.

1. Introduction

With the rapid development of the oil and gas energy industry, the pressure of its production and transportation has put forward higher requirements, but the higher requirements are accompanied by risks. With the development of materials, the emergence of high-strength steel, such as large caliber, ultra-thin wall, high pressure and other high requirements can be met. Due to the influence of factors such as steel material, interface welds and the harsh use environment of oil and gas transmission pipelines, there will be defects in the use of pressure pipelines themselves. If ignored, pipeline breakage and explosion accidents may occur in the future, causing environmental pollution, national energy waste, and even threatening the safety of people's lives and property.

2. Pressure Pipeline Defect Detection Method

2.1. Application background of non-destructive testing technology

Pipeline transportation is one of the five major transportation modes along with road transportation, railway transportation, water transportation and air transportation. With the rapid development of oil and gas energy industry, pressure pipelines are widely used in petroleum, petrochemical, refining and other oil and gas transportation. With the extensive use of pressure pipelines, accidents caused by pipeline defects occur many times, and the problem of pipeline defects has been paid attention to.

Due to the various causes of accidents, whether it is imported pipeline or domestic pipeline in the process of manufacturing, installation and long-term use will produce different degrees of different types of defects, but most of the accidents are due to pipeline corrosion and other defects. Pipeline in the manufacturing of its own defects, this situation can generally be avoided through acceptance testing, etc., however, the pressure pipeline in the long-term use of the process due to the impact of external environmental factors and welding and other quality problems, pipeline defects will gradually appear and then further development, in most cases this defect can not be intuitively found, need to be tested to give the internal wall of the pipeline The various types of defects on the outer wall, such as planar defects such as cracks, non-fusion, non-penetration and volume defects such as pits, pores and slag inclusion, provide theoretical basis for subsequent maintenance methods. Pipeline accidents caused by defects emerge in an endless stream, only in 2013 and 2014, there were three major pipeline burst accidents in Qingdao, Gansu and Dalian.

This explains why the pressure pipeline should be inspected for defects, repaired and even replaced in time, in order to avoid the occurrence of the above accidents and ensure the safety of the pipeline. For the detection of pipeline, in the detection process can not cause damage to the pipeline, but also to detect the pipeline defects. Non-destructive testing technology in the use of the process will not cause damage to the pressure pipeline, the use of non-destructive testing technology to meet our requirements in the pipeline testing process, but also indirectly reflects the importance of non-destructive testing technology in the pressure pipeline defect detection.

2.2. Types of NDT technology

The most commonly used non-destructive testing method for pressure pipelines in the oil and gas industry is ultrasonic testing (UT), because ultrasonic testing does not cause equipment damage, and it is fast. In addition, there are ray detection, magnetic particle detection, penetration detection, infrared detection, laser holographic detection and other detection technologies.

2.2.1. Ultrasonic Test (UT)

Ultrasonic testing (UT), the development is very rapid, currently used in the pressure pipeline ultrasonic wall thickness measurement, conventional ultrasonic testing, phased array ultrasonic testing, diffraction time difference ultrasonic testing, full focus phased array testing and other methods.

The principle of ultrasonic detection technology is based on the propagation characteristics of ultrasonic waves in the medium. In the pressure pipeline detection, the ultrasonic

wave is first emitted to the pipeline by the transmitting probe, and the ultrasonic wave will propagate inside the pipeline, and will occur reflection, refraction and attenuation. When the ultrasonic wave encounters a defect in the pipeline, part of the ultrasonic wave will be reflected back by the interface at the defect, and the other part of the ultrasonic wave will continue to propagate through the defect. The receiving probe will pick up ultrasonic waves reflected back from the defect or transmitted waves after passing through the pipe. By analyzing the received waveform and measuring the propagation speed of the ultrasonic wave, inspectors can determine whether there are defects in the pipeline and locate, qualitatively and quantitatively the defects. For example, by analyzing the reflection time and amplitude of ultrasonic waves, the location and size of defects can be determined. By comparing the ultrasonic propagation speed at different locations, the type and nature of the defect can be judged.

2.2.2. Ray Detection (RT)

Ray detection technology uses the attenuation characteristics of rays (such as X-rays, gamma rays and neutron rays) as they propagate in a medium for detection. In the case of X-rays, we inject X-rays of uniform intensity from one side of a pressure pipe. Due to the different attenuation characteristics of the defect and the pipe material to the X-ray, the X-ray intensity through the pressure pipe will change.

When X-rays pass through the pipe, if there is a defect, the material at the defect will attenuate the X-rays. Therefore, by detecting changes in the intensity of the X-rays passing through the pipe, we can tell if there are defects on the surface or inside of the pipe.

The specific detection method can use different detectors to measure the intensity of the X-ray. Common methods include traditional film inspection and modern digital X-ray inspection. Film detection determines whether there is a defect by shining an X-ray onto the film and then observing the image on the film through steps such as developing and fixing. Digital radiography uses a digital detector to measure the intensity of the X-rays and presents the results in digital form.

2.2.3. Magnetic Particle Detection

The application of magnetic particle detection technology in the detection of pressure pipeline defects is to make use of the fact that the pipeline defects are different from the magnetic resistance of the pipeline material, and the magnetic field line passing through the pipeline will bend at the pipeline defects and may escape from the pipeline surface, thus forming a leakage magnetic field. In the detection process, the pressure pipeline should be magnetized in advance, and the magnetic powder should be evenly sprayed on all positions of the pipeline surface, otherwise the detection result will be inaccurate. The leakage magnetic field at the defect of the pipeline will absorb magnetic powder, so that magnetic marks will be formed at the defect, showing the size and location of the defect.

2.2.4. Penetration detection

Penetration testing technology is a common method used in the detection of pipeline defects, which takes advantage of capillary phenomenon and infiltration of permeating fluid on the inner wall of the defect. The specific operation steps include infiltration of penetrant, washing of excess penetrant and application of developer, so as to obtain the image of the defect.

Penetration testing technology is mainly used to detect defects on the surface of pressure pipelines, such as cracks. When the permeate is applied to the surface of the pipe, the permeate penetrates into the defect and fills the void in it due to the capillary phenomenon. The excess penetrant is then washed away, leaving only a thin film that the penetrant forms on the inner wall of the defect.

In order to make the defect more obvious, a developer is applied to the surface of the defect. The developer reacts with the penetrant to form a visible color change or fluorescence that makes the defect apparent. Inspectors can check for defects on the pipe surface by visual observation or by using a specific light source.

It should be noted that when using penetration testing technology, it is very important to clean the penetrant and developer at the defect in time. If these chemicals remain inside the pipeline, they may cause damage to the pipeline and affect the quality and service life of the pipeline. Therefore, after the data of the defect is obtained, thorough cleaning and cleaning work must be carried out.

2.2.5. Infrared Detection

Infrared detection technology can measure the infrared radiation energy on the surface or inside of the pipeline and convert it into temperature field to determine whether there are defects on the surface or inside of the pipeline. Through the uniformity of the observed temperature field, the state of the pipeline can be preliminarily judged. However, infrared detection technology can not directly measure the shape or size of the defect, and other factors need to be considered for analysis and evaluation.

2.2.6. Laser holographic detection

Laser holographic detection is a new detection technology used in the detection of pressure pipeline defects, which uses laser holography to detect the surface or internal defects of pressure pipeline. A load is applied to the pressure pipe to cause a local small deformation on its surface, and the deformation is observed from the resulting hologram, and compared with the hologram without the load, and then the type and size of the defect on the surface or inside the pipe are judged.

3. Conclusion

With the development of the oil and gas energy industry, a large number of pressure pipelines are used, and the problem of pipeline defects has become increasingly prominent. Regular testing of pressure pipelines can avoid major accidents. After all, the lesson is profound. However, pressure pipeline defects do not all affect the use of pipelines, if the pressure pipeline is maintained indiscriminately, it will not only increase the cost, but sometimes improper maintenance will further damage the pipeline, reduce the performance of the pipeline, and even produce new defects. Therefore, in the process of testing the pressure pipeline, it is necessary to reasonably select non-destructive testing technology based on the actual situation, and then combine the defect detection standards to obtain the defect level of the pipeline. Timely replacement of pipelines that need to be replaced, maintenance of those that need to be repaired, and the safe operation of pressure pipelines must be ensured. To ensure the safe operation of pressure pipelines is to protect national energy security and protect the lives and property of the country and people. With the development of science and technology, the future pipeline defect detection technology will be more and more simple and accurate, and the defect

detection standards will be more and more comprehensive.

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