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# Summary of Research on Ultrasonic Wall Flaw Detection Technology for Gas Storage Wells

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## Abstract

**Gas storage wells are widely used in the storage of compressed natural gas because they are installed in the ground, have a small footprint, and can resist atmospheric corrosion. With the wide application of gas storage wells as CNG natural gas storage equipment in my country, regular inspections are required to ensure the safe use of gas storage wells. In the daily use and monitoring of gas storage wells, there are examples of leakage caused by corrosion on the inner and outer walls of the gas storage well, which burst and cause the gas storage well to fail, causing huge economic losses and safety accidents. This article mainly introduces the technical principle of ultrasonic flaw detection, the application of ultrasonic flaw detection in the flaw detection of gas storage wells, and the data analysis after field use.**

## Keywords

**Gas Storage Well; Water Immersion Ultrasonic Flaw Detection; Ultrasonic; Corrosion Detection.**

## 1. Introduction

As the proportion of natural gas in my country's energy structure continues to grow, it has gradually become an indispensable resource for people's daily life, and people's research on natural gas has become more and more in-depth. In addition to the physical performance and production technology of main equipment such as gas storage wells and gas storage tanks, people are paying more attention to the flaw detection of gas storage wells and continue to study its impact on gas storage performance. This article mainly introduces the technical principles of ultrasonic flaw detection, the application of ultrasonic flaw detection in the flaw detection of gas storage wells and the data analysis after field use.

## 2. Ultrasonic flaw detection technology introduction

Ultrasonic flaw detection is based on the feature that ultrasonic waves do not damage the metal . It penetrates into the interior of the metal material, and when it penetrates from one side of the metal to the other side, the ultrasonic wave will reflect on the edge of the interface to determine one of the defects of the metal device. Kind of method. When the ultrasonic wave from the surface of the gas storage well wall reaches the inside of the gas storage well from the probe , when it encounters the defect and the bottom surface of the gas storage well, it will be reflected separately. Images are formed on the screen through the software, and the defect location and size are judged based on these images.

Ultrasonic flaw detector is an instrument commonly used in industry. It can accurately detect various problems in gas storage wells. It can be used both in the laboratory and on the engineering site. Widely used in boilers, pressure vessels, aerospace, aviation, electric power, petroleum, chemical, offshore oil, pipelines, military industry, shipbuilding, automobiles, machinery manufacturing, metallurgy,

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metal processing industry, steel structure, railway transportation, nuclear power, universities, etc. Industry.

### 2.1 Fundamental

When ultrasonic waves propagate in the medium, there are many types of wave patterns, and the most commonly used detection methods are longitudinal waves, transverse waves, surface waves and flat waves. Longitudinal waves can be used for inclusions, cracks, shrinking tubes, white spots, delamination and other defects in gas storage wells; transverse waves can be used for detecting gas storage wells and axial cracks, scratches, weld pores, slag inclusions, cracks, and incomplete penetration Other defects; surface wave can be used to detect surface defects of simple gas storage wells; plate wave can be used to detect well wall defects.

### 2.2 Main features

Fast measurement speed: Most of them can be monitored and counted independently, and some expensive instruments can also automatically perform depth compensation and independently select the appropriate sensitivity, so the measurement speed is fast and the consumption time is short.

High accuracy: Ultrasonic flaw detectors can quickly collect, quantify, calculate and make judgments for signals, and its accuracy is generally better than that of traditional instruments. Digital ultrasonic flaw detectors can provide historical records of inspections and defect images.

Reliable and stable: The digital ultrasonic flaw detector collects all-round and accurate storage data, performs real-time processing or post-processing on the collected data, analyzes the signal in the time domain, frequency domain or image, and stores the data through pattern recognition. The quality of gas wells is classified to reduce the influence of human factors and improve the reliability and stability of retrieval. The main functions that can be achieved are:

a. Autonomous correction: the "zero point", "K value", "leading edge" of the automatic detection head and the "speed of sound" of the material;

b. Independently display the defect's return to the ultrasonic position such as [3]: depth, level, distance, etc.;

c. Automatically convert the required scale;

d. Autonomous tracking of the entire inspection process and playback on demand;

e. The detection data can be set manually or automatically by the detector;

f. One or more complementary related flaw detection channels, which can be freely and independently input and store any flaw detection standards.

### 2.3 Verification of Ultrasonic Flaw Detector Performance

Ultrasonic flaw detector performance refers to the performance related to the instrument only, according to the requirements of JJG 746-2004 "Verification Regulations for Ultrasonic Flaw Detectors", it can control the horizontal linearity, attenuator error, vertical linearity, and vertical linearity of ultrasonic flaw detectors. Performance indicators such as dynamic range, electrical noise level, and maximum use sensitivity are calibrated .

## 3. Ultrasonic flaw detection application scenarios

With the rapid development of our country's economy, the consumption structure of our people is constantly changing, from the original coal to the current natural gas, and the proportion is further expanding. Gas storage wells are the most important equipment for storing natural gas because of their high safety, small footprint, and low construction cost. However, with the long-term use of gas storage wells, there is widespread corrosion caused by external factors such as groundwater. The main manifestation is that the casing pipe wall of the gas storage well becomes thinner or even bursts. Due to the complex and changeable conditions at the bottom of the well, it is inconvenient for people to enter the well for inspection. The inspection of the gas storage well can only be limited to the wellbore,

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and does not involve the inspection of the well wall and bottom of the well. These two parts are precisely the places that are susceptible to corrosion.

Due to the fact that there are few instruments for detecting gas storage wells in my country, a large number of gas storage wells are still undetectable. At the same time, most of the gas storage wells in my country have been in use for a long time, and safety issues cannot be ignored.

### 3.1 Examples of leakage from natural gas storage wells

On October 23, 2015, one of the largest natural gas storage facilities in the United States, an underground natural gas storage facility in the northern San Fernando Valley area of California, experienced an uncontrolled natural gas leak from a gas storage well. The Aliso Canyon storage facility operated by Southern California Gas is located in the remote Santa Susana Mountains. The company's spokesperson Javier Mendoza said in an e-mail on October 29: "It may take several days or even longer for experts from our company and other companies to determine the safest best way to stop leaks and repair gas wells. But for now Repair has not yet begun." This storage facility has a total of 115 gas storage wells.

According to the report, the above-mentioned natural gas storage facility was built in the early 1970s and can store 84 billion cubic feet (approximately 2.38 billion cubic meters) of natural gas, making it one of the largest natural gas storage facilities in the United States. This facility has undergone many technological transformations since it was put into operation.

According to a series of on-site investigations conducted by some experts, the main reason for gas leakage is that the gas storage well has been in service for a long time and the prevention of well wall corrosion has been neglected, which leads to the leakage of natural gas. Therefore, it is of great significance to conduct safety inspections on gas storage wells on a regular basis.

### 3.2 Ultrasonic flaw detector based on water immersion method thickness measurement experiment

Since the flaw detector directly displays the sound path, the sound velocity in the parameter setting must be the sound velocity of the same propagation medium, which limits its thickness measurement function only to the contact method immersion thickness measurement. It is the difference between the non-contact method probe and the measured workpiece. There is a water layer in between. The ultrasonic wave propagates in the water and in the test piece. The reflected echoes of the two interfaces are displayed on the fluorescent screen. Because of the propagation in the two media, the sound speed setting in the parameter cannot determine the water to the flaw detector. Dip thickness measurement brings difficulties . Through the principle of water-filled repetition, the problem that the sound velocity of the flaw detector cannot be determined in the propagation of ultrasonic waves in two media is solved.

### 3.3 Experiment summary

Theoretical investigation on the water immersion thickness measurement of the flaw detector, the BH-50 standard test block is used to determine the relevant parameters suitable for the water immersion thickness measurement, and the SGB-1 standard test block is used to verify the water immersion thickness measurement. In the experiment, the thickness measurement experiment of the bottom hole head was carried out using the water immersion thickness measurement method. The experimental results show that the detection results of the water immersion method are relatively close to the actual results, and the relative deviation is small, which meets the detection requirements.

## 4. Conclusion

Underground gas storage wells have become the main gas storage means at present due to the advantages of large gas storage capacity, fast gas refueling, small area, convenient management and operation, and low maintenance and operation costs. However, because of drilling, cementing, and natural gas desulfurization and dehydration, Gas station management and operation and other

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imperfect links, so that domestic underground gas storage wells in the process of long-term service generally have the phenomenon of internal and external wall corrosion, especially some gas storage wells have begun to fail and age, and they are likely to develop into potential The hidden dangers of safety accidents. After the feasibility demonstration of the application of ultrasonic water immersion thickness measurement in the field of bottom hole candlestick detection in gas storage wells, this thesis completed the overall scheme design of the bottom hole candlestick detection system for gas storage wells, and completed the ultrasonic bottom hole candlestick detection system. The prototype of the detection device was made on the laboratory simulation test platform, and the detection device was used to conduct laboratory verification experiments for the bottom corrosion candle of the gas storage well. The experimental results show that the detection device can automatically detect bottom-hole corrosion candles in gas storage wells. The rationality and feasibility of the experimental results laid the foundation for further research on the detection of bottom-hole candlesticks in gas storage wells. During the thesis, the following tasks were mainly completed:

(1) Determine the detection method. Through investigation, according to the standard SY/T6535-2002 for high-pressure underground gas storage wells, the standard SY/T544.7-92 oil well pipe non-destructive testing ultrasonic thickness measurement method is adopted for the detection of CNG gas storage wells.

(2) Propose the overall plan design. Through extensive investigation of the various characteristics (materials, dimensions, working environment) of the tested object, and according to the relevant detection method regulations in the high-pressure underground gas storage well standard SY/T6535-2002, an overall research plan is proposed.

(3) Propose the design index of the prototype of the ultrasonic testing device for bottom hole corrosion candles.

(4) Specific design and assembly.

(5) Device debugging and simulation experiment.

(6) Experimental conclusions and analysis.

The research work in the paper is all carried out in the laboratory, and the actual detection effect on the real site has yet to be verified. The ultrasonic detection device for bottom hole rot candles also needs to be improved: the production of high-frequency ultrasonic data acquisition and processing system. The working frequency of the ultrasonic water immersion probe used in this design is 50MHz. According to the sampling principle, the sampling frequency of the data acquisition card is at least 10MHz or more. The lowest price of a finished ultrasonic data acquisition card on the market is 10,000 yuan (single channel). Due to experimental conditions, funding and related technology constraints, the design and production of the water immersion ultrasonic data acquisition system has not been completed.

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