Corrosion Inspection System of CNG Storage Well Bottom Head

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Abstract. Domestic CNG storage wells are common in the process of serving for a long time, both inside and outside walls exist corrosion phenomenon. According to their characteristic, an overall design scheme for corrosion detection of the CNG storage well bottom head was presented, which using water immersion ultrasonic testing and screw inspection way. After testing for a standard bottom head, the test results showed that the measurement system can effectively automatic detect the corrosion of bottom head.

1. Introduction

In recent years, as petroleum prices continued to rise and increased demand for clean energy, the proportion of natural gas in energy consumption structure is growing. Compressed natural gas (CNG) is a safe, efficient, economical and environmentally friendly automotive energy, there are three storage mode: large cylinders, cylinder groups and underground storage wells[1]. Compared to other two storage mode, underground storage wells of high security, low maintenance costs, large storage capacity and small footprint advantages, So this mode use a very wide range[2]. In the process of construction and use of CNG gas wells will corrode by stratigraphic and storage of material, etc. With the increased use of time, it is likely to leak or even well pipe bursting accidents, and these are basically CNG storage wells built in densely populated urban areas, once the accident, the consequences could be disastrous[3].

In view of this. It is essential to research and development CNG storage wells corrosion detection technology. Ultrasound technology is one of the most widely used and rapid development of industrial nondestructive testing technology. It has been widely applied in the fields of manufacturing, iron and steel metallurgy, metal processing industry, chemical industry and other needs of defect detection and quality control [4,5] .

2. The structure of detection system

CNG storage well is the use of oil and natural gas drilling special technology compressed natural gas stored in underground 100 ~ 300m. Currently there are two sizes CNG storage well wellbore: 7” wellbore (Steel Pipe specifications: Φ177.8mm×10.36mm, Steel grade: N80G) and 9-5/8”wellbore (Steel Pipe specifications: Φ244.5mm×11.05mm, Steel grade: P110), cementing wells outside the body well to protect against corrosion of stratigraphic. Bottom head and wellbore connection as a whole through the threaded, composition of the high-pressure gas wells sealed. The models of bottom head connected with the wellbore is API-7 "(Specifications: f196mm×200mm)[6]. According to such a configuration designed monitoring system, as shown in Figure 1.

2.1 Mechanical design

Centralizers ensure well bottom corrosion ultrasonic detection means axis and gas wells geometrical axis coinciding components as much as possible, with both the protection of motors, sensors and other parts and other anti-collision function. In addition, the upper centralizer 1 is connected multi-core cables, centralizer 2 is a mounting position of the stepper motor seat and tilt head. The positioning device use servo encoder to determine the position of the device in well bottom.

2.2 Bottom head detecting section

Taking into account the shape of the inner wall of the bottom head is elliptical sphere, Ultrasonic probe can be mounted on a two-dimensional rotating Rocker arm. Stepper motor drives the tilt head to rotate. The tilt head equipped with 360° rotating servos, Servo drive rocker arm to rotate around the curved surface sphere center of well bottom head. Ultrasonic probe is mounted on rear of the rocker arm is equipped with elastic automatic clamping device, so that the probe can always fit the test surface. When detected, Servos does not run the first to keep rocker arm to maintain its angle. Tilt head rotating, so that Ultrasonic probe sweep of a circle well bottom head. Then adjust Servos Rocker arm angle to change, tilt head rotating again. So back and forth, the probe in a spiral manner scanning the bottom head.

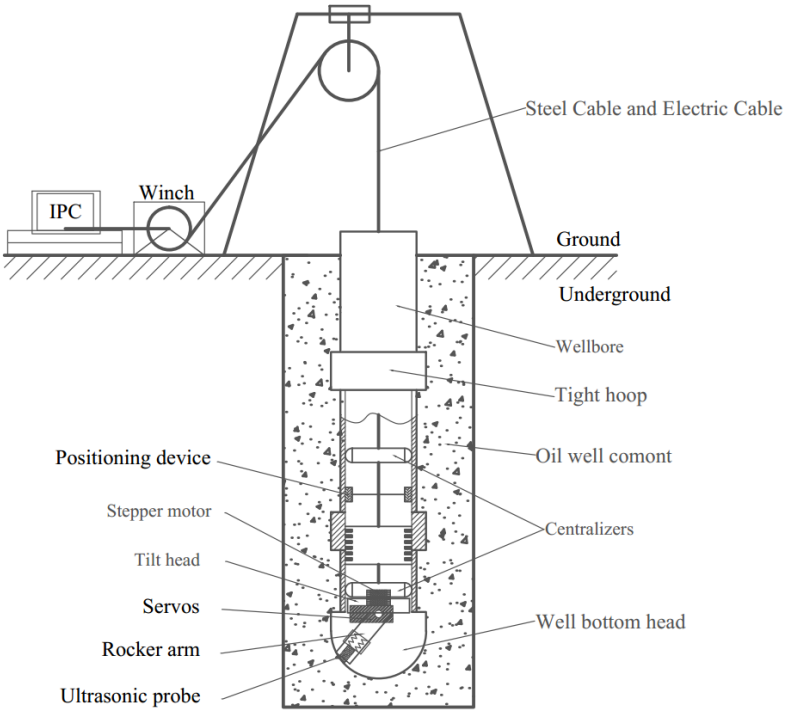

Fig.1 Structure diagram of system

3. Ultrasonic Inspection System

Ultrasonic Inspection System be composed of Ultrasonic probe, ultrasonic card, IPC, Schematic shown in Figure 2.

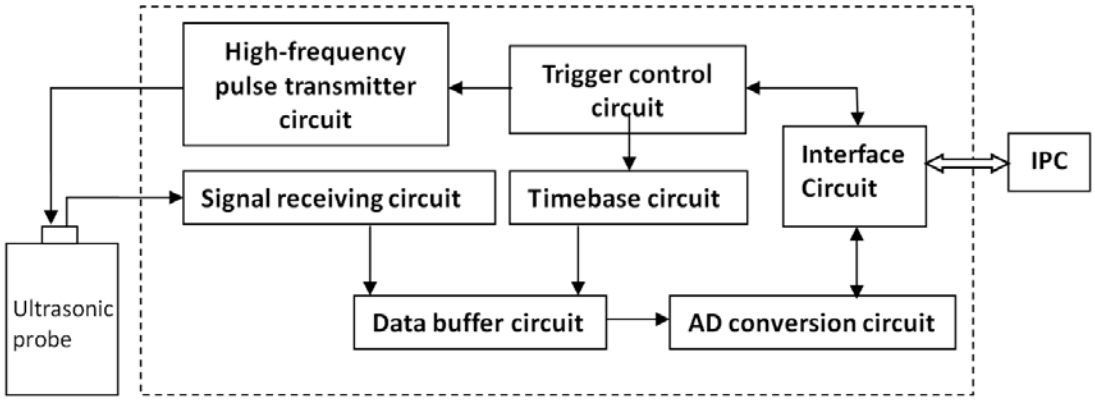

Fig.2 Schematic diagram of ultrasonic detection system

Wherein the ultrasonic card consists of High-frequency pulse transmitter circuit, trigger control circuit, timebase circuit, the signal receiving circuit, a data buffer circuit, AD converter circuit, an

interface circuit. Selection CUT-2000 high-speed automatic ultrasonic card, the card incorporates an ultrasonic transmitter and receiver circuit, and It has 16 independent transmit channels, 100MHZ hardware sampling frequency, 10 data accuracy, and high-capacity storage function. And through the TCP / IP protocol to communicate with the host computer.

Ultrasonic probe is ultrasonic transducer, Usually have straight probe and oblique probe, The difference between two probe is whether test defect in parallel with the detection surface, for wall corrosion detection usually used straight probe. Straight probe can only transmit and receive longitudinal waves. The wafer size have a greater impact for acoustic beam directivity, near field length, close-range and long-range scanning defect detection ability[7]. Narrow pulse has a higher range resolution, but its beam spread angle pulse width is larger than the same frequency, so the resolution is slightly lower, this can be accurately gathered to narrow the beam cross-section to compensate[8]. According to inspection requirements, system selection Φ10mm, 5MHZ narrow pulse focused straight probe, coupled with the flooding method vertically incident to detect borehole wall.

4. Experiment

In this paper, the experiment in the oil casing testing bench which developed by Electrical and Information Engineering, Southwest Petroleum University. Test object is steel ellipsoidal 9th gas well bottom head, according to standard elliptical head JB1154-73, the basic parameters are shown in Figure 3 and Table 1.

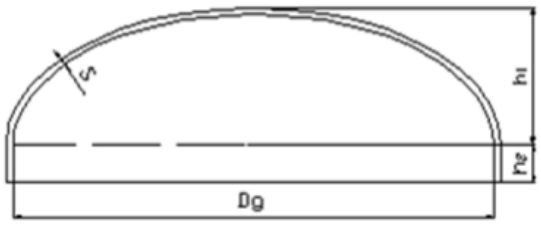

Fig.3 The ellipsoidal standard bottom head (JB1154-73)

Table 1 basic parameters of the oval standard bottom whole assembly

Nominal diameter	Curved surface height	Straight edge height	Wall thickness	The internal surface area	Volume	Weight
Dg(mm)	h1(mm)	h2(mm)	S(mm)	F(m^2)	V(m^3)	G(kg)
300	75	25	8	0.121	0.0053	7.97

Manufacturing several defects hole at the wall bottom head, defect depth is 3-5mm, diameter of 4mm and 8mm.When doing experiments, the detection device slowly approaching the bottom of the wellbore by winch, use of water as a coupling agent? Start IPC, set system parameters detected, ultrasound probe in a spiral manner on the bottom head for testing. Computer records and displays the data. The results are shown in Table 2.

Table 2 Measured results of defect depth

Defect depth	Defects diameter	First detection	Second detection	Third detection	Average error
3	4	2.9	2.8	2.8	0.17
	8	2.9	2.9	2.8	0.13
4	4	3.6	3.7	3.7	0.33
	8	3.8	3.6	3.7	0.30
5	4	4.6	4.7	4.6	0.37
	8	4.8	4.7	4.7	0.27

Ultrasound probe during exercise and well bottom head inside wall friction vibrations will cause an error, Probe accuracy, signal acquisition and processing, A/D conversion error detection accuracy also factors influence.

5. Conclusion

Experimental results show that the device is capable of detecting gas well bottom head corrosion automated testing, further research will be the following three aspects.

(1) Screening ultrasound probe, to further improve the detection accuracy.

(2) Make more sophisticated and flexible member, the structure is more reasonable.

(3) Taking into account the detection of CNG storage wells wellbore, design Integration detection device combined with wellbore detection and well bottom head detection.

References

[1]. Han Zhanqun. CNG filling station underground storage wells Safety Analysis and Evaluation [D]. Xihua University, 2008.

[2]. Cheng Zongming. The Best Choice for Storage of CNG Vehicles - Underground Storage Wells [J] Oilfield Energy Conservation, 2004, 14 (3): 1-2.

[3]. LIU Qingyou, HE Xia, Meng Shaohui. CNG underground gas storage well safety analysis [J] Natural Gas Industry, 2005, 25 (1): 138-140.

[4]. Wang Ruili, Li Bin. Application Comparison between MFL&UT Techniques [J] Pipeline Technology and Equipment, 2006, (5): 15-17

[5]. Zhao Xiufen, Yin Guofu, Su Wei. Development of Ultrasonic Testing System for Large Cylindrical Parts [J] Journal of Sichuan University: Engineer Science Edition, 2008, 40 (3): 173-177.

[6]. Feng Xia, He Yulin, Li Bin. Filling Stations Underground Gas Well Bottom Head Finite Element Analysis [J] Oil-Gasfield Surface Engineering, 2008, 27 (3): 5-5.

[7]. Li Guohua, Wu Miao. Modern Non-Destructive Testing and Evaluation [M]. Beijing: Chemical Industry Press, 2009: 53-55.

[8]. Zhang Junzhe. NDT technology and its application [M] Beijing: Science Press, 2010: 221-226.