Application of non-contact magnetic corresponding on the detection for natural gas pipeline

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Abstract: This study examined natural gas pipeline by the non-contact magnetic corresponding. To confirm the reliability for the examination of natural gas pipelines by non-contact magnetic corresponding, three abnormal nodes were detected by the appearance inspection and ultrasonic testing. The results suggested that the grade of abnormal nodes by non-contact magnetic corresponding were not absolutely agree with that of the corrosion by ultrasonic testing. However, there was an obvious relevance between the comprehensive index of F by non-contact magnetic corresponding and the maximum degree of corrosion by ultrasonic testing. To sum up, the magnetic corresponding was an effective non-contact detection technology for the natural gas pipeline, while it was necessary to rationally grade the abnormal node according to the comprehensive index of F.

1 Introduction

Detecting the natural gas pipeline was essential for the safe production of natural gas industry[1]. The conventional detecting technologies included the low frequency long distance ultrasonic testing, high frequency guided wave detection, the C-SCAN, ultrasonic wall thickness measurement, magnetic flux leakage testing and the remote field eddy current technology [2]. Although the above technologies could accurately detect the state of natural gas pipelines, they were contacting technologies [3,4]. Therefore, it was necessary to develop a non-contact detection technology, which could meet the acquirement of simple operation and accurate detection.

Recently, the non-contact magnetic corresponding of ferromagnet for the steel in the geomagnetic field had been used for the detection of materials. There were few reports about the application of non-contact magnetic corresponding for petroleum pipeline [5]. While there was no study on the detection by non-contact magnetic corresponding. Herein, this study investigated the application of non-contact magnetic corresponding on the detection of natural gas pipeline. And the reliability by non-contact magnetic corresponding was verified by appearance inspection and ultrasonic testing.

2 Basic information

The natural gas pipeline was gas gathering flow line with a length of 6.35 kilometer and an operation pressure of 5.7 Mpa, being made of 20# steel. The diameter and thickness of gas gathering flow line were 114 mm and 12 mm. Additionally, the it was laid out along the hills (Figure 1).

Figure 1. Layout of the gas gathering flow line

3 Detection by the non-contact magnetic corresponding

3.1 Detection index by non-contact magnetic corresponding

Generally, the degree of defect for a pipeline could be evaluated by the comprehensive index of F by the non-contact magnetic corresponding, being expressed as in equation (1).

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$$F = A \exp(1 - Q_\phi Q_{aH}^{-1}) \quad (1)$$

Where, A is a corrected coefficient, which implied an influence of geomagnetic field on the pipeline; Q_{aH} and Q_ϕ are the densities of magnetic intensity alone with the direction of Z axle and background of pipeline,

respectively.

The degree of defect was graded by the comprehensive index of F and listed in the Table 1.

Table 1. Degree of defect and grading for the pipeline by non-contact magnetic corresponding

Grade	Comprehensive index of F by the non-contact magnetic corresponding	Degree of defect
I	0~0.2	High
II	0.2~0.55	Medium
III	0.55~1.0	Low

3.2 Results of detection by non-contact magnetic corresponding

The Figure 2 was the distribution of abnormal nodes for the gas gathering flow line by non-contact magnetic corresponding. It showed that there were 15 abnormal nodes with a grade of II and 63 abnormal nodes with a grade of III, indicating that there was about 20% of abnormal nodes for the gas gathering flow line was in medium risk.

Figure 2. Abnormal nodes for the gas gathering flow line by non-contact magnetic corresponding

4 Verification

In order to verify the reliability by the non-contact magnetic corresponding, there were 3 abnormal nodes were examined by the appearance inspection and ultrasonic testing on. It should be noted that the direction of ultrasonic testing was clockwise.

The Figure 3 was the wall thickness distribution by ultrasonic testing and magnetic intensity distribution by non-contact magnetic corresponding for the 3 abnormal nodes. At 1# abnormal node, the length of pipeline was 0.53 m, the magnetic intensity (DQ) was 981 nT/m, and the comprehensive index of F was 0.575. The verifying examination showed that the minimum wall thickness was 10.60 mm, corresponding a corrosion degree of 11.67%. The length of abnormal node, DQ and comprehensive index of F for the 2# abnormal pipeline were 0.51 m, 333 nT/m and 0.662, respectively. Similarly, there was a maximum corrosion degree of 6.17%. As for the 3# abnormal node, the length of abnormal pipeline, DQ and comprehensive index of F were 0.77 m, 2365

nT/m and 0.482, respectively. Although there was no obvious corrosion, the minimum wall thickness was only 9.92 mm, corresponding a reduction degree of 17.33%.

Figure 3. Wall thickness detection by ultrasonic testing and magnetic intensity distribution by non-contact magnetic corresponding for the 3 abnormal nodes (a, b and c were the results of 1#, 2# and 3# abnormal node, respectively.)

5 Analysis

The appearance inspection and ultrasonic testing suggested that the wall thickness reduction was a common phenomenon. According to the standard of SY/T 0087.2, the corrosion degree of 1# and 3# abnormal nodes were middle, while the corrosion degree of 2# abnormal node was light. However, the detection by non-contact magnetic corresponding indicated that the degree of defection for 1# and 2# abnormal nodes were middle, but it was light for 3# abnormal node. Therefore, the grading by non-contact magnetic corresponding for the gas gathering flow line was not agree well with that of conventional technology.

However, it was also found that the comprehensive

index of F was negatively relative with the maximum reduction degree for the gas gathering flow line significantly (Figure 4).

Figure 4. Linear fitting between the comprehensive index of F by non-contact magnetic corresponding and the maximum corrosion degree by ultrasonic testing for the G-A gas gathering flow line

6 Conclusion

In summary, this study applied the non-contact magnetic corresponding on the detection of natural gas pipeline (G-A gas gathering flow line). It was found that there were few abnormal nodes with a grade of II and a lot of nodes with a grade of III, while without the abnormal node with a grade of I. Although the grading by the non-contact magnetic corresponding for the G-A gas gathering flow line was not agree well with that of verified examination by ultrasonic testing, there was a significant correlation between the comprehensive index of F and the maximum corrosion degree for the G-A gas gathering flow line. Therefore, the non-contact magnetic corresponding could be used for the detection of natural gas pipeline with a condition of corrected grading according to the special natural gas pipeline.

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