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USING ULTRASOUND TO GAUGE PIPELINE INTERNAL CORROSION WITH COATING FOR ICDA

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ABSTRACT

Put abstract text here. Internal corrosion direct assessment (ICDA) for pipeline enhances the abilities to assess internal corrosion in pipeline and is based on the principle that corrosion is most likely where water first accumulates. ICDA employs the same four-step process as all other direct assessment methods. The important step is direct examinations: the pipeline is excavated and examined at locations prioritized to have the highest likelihood of corrosion. A variety of in-service non-destructive examination processes are available to pipeline operators to inspect for internal corrosion. Manual assessment of internal corrosion is considered more challenging than normal external corrosion assessments since the corrosion feature is not visible and must be interpreted by the ultrasonic response, but in the past ultrasonic test need always remove the coating and then measure on the surface of bare pipe, which brings the measurement point of the pipe body more risk because of weaker quality of patch coating.

Recently, advances in the design of ultrasonic corrosion thickness gauges utilizing dual element transducers have made it possible to take accurate metal thickness measurements while coatings need not to be removed. This feature is often referred to as echo-to-echo thickness measurements. Using the ultrasound thickness gauge to measure pipeline internal corrosion while external coatings need not to be removed can keep the integrity of coating, make pipeline operating and monitoring more economical and improve inspection activities to estimate corrosion in pipelines for ICDA. Gauge equipment requirement, Measurement procedures and Accuracy were validated in laboratory. How to arrange the gauge locations, interval test time and data treatment and analysis also are the key steps of ICDA for integrity management.

Key words: Ultrasound Thickness Gauge, Pipeline, coating，ICDA

INTRODUCTION

Internal corrosion direct assessment (ICDA) methods have been developed to enable to meet the need for pipeline operators to assess the integrity of pipeline with respect to internal corrosion. [1]ICDA is a method to prioritize the likelihood of corrosion along a pipeline segment. Its goal is to identify the locations most likely to have the maximum internal corrosion damage and to analyze measurement data of remaining wall thickness within a pipeline segment. The locations with the greatest likelihood of severe corrosion are excavated and examined. The results of these examinations are used as a basis for assessing the status of the remaining pipeline segment (i.e., with less likelihood of corrosion). But, a particularly important problem that pipeline operators have to face is measurement of remaining wall thickness in pipes subject to internal corrosion. Such corrosion is often not detectable by vision under some conditions, even when the area is accessible. When detecting the wall thickness without coating, corrosion from the patching of test point, damaged point of good coating, may be will weaken strength of walls and possibly lead to failures, and even cause dire consequences in safety, economy, or environment.

Ultrasound thickness gauges, which use an ultrasonic principle, are becoming increasingly popular for pipe wall thickness measurement. They continuously develop and gradually replace traditional destructive measurement techniques for pipe. In the past, thickness measurement of pipe wall with coatings had been a challenge. Earlier techniques need to remove the coated part from body of pipe, and then measure the bare body of pipe. So it was difficult for inspectors and researchers to perform the tests. Traditional ultrasonic corrosion gauges make thickness measurements by determining transit pulse echo time from the one backwall to the next backwall. This technique generally works very well, except for some special cases where the surfaces of the pipe or tank are covered with a layer of paint or other coatings. In these cases, traditional corrosion gauges only have abilities to measure the total thickness of both the coating and the metal substrate, Because normally, sound transmitting velocity in paint and similar coatings is much slower than in the metal substrate, as a result that the total ultrasonic thickness reading of pipe wall with a coating will usually be two to three times greater than its actual thickness reading. Therefore, inspectors often may have to remove the paint or other coatings in order to get true metal wall thickness readings. This often proves to be very time-consuming, and usually the measurement point has to be repainted as well.

Inspectors find measurement methods with destructivity impractical because they require patching and may compromise the coating system. However, with the arrival of ultrasonic echo-to-echo methods, many applicators and inspectors have switched to nondestructive inspection.

Recently, the advances in the design of ultrasonic corrosion thickness gauges utilizing dual element transducers have made it possible to take accurate metal thickness measurements at the same time not need to remove paint or coatings. This feature is often referred to as echo-to-echo thickness measurements. Now inspectors can use handheld thickness gauges for these types of measurements as long as these gauges have the echo-to-echo feature. This technique works well, but requires more operating skills and validate test with same structure material samples in laboratory.

HOW ULTRASONIC TEST INSTRUMENTS WORK

The Echo-to-Echo measurement feature allows some of Ultrasonic test tools, such as the Model 37DL PLUS, to measure remaining wall thickness of metal painted while ignoring the coating thickness.[2], Echo-to-Echo mode refers to measuring from one backwall echo to the next backwall echo. The time interval between these echoes does not include the time through any paint, resin, or organic coating that is present. The waveform display indicates the exact pair of echoes used to determine the thickness. The internal datalogger saves and recognizes all necessary Echo-to-Echo information to upload and download thickness, waveform, and setup data. To change Measurement mode between the normal total wall thickness mode and the Echo-to-Echo mode, do the following: Press [2nd F] [ZOOM].

All measurement, display, and datalogger functions in the Echo-to-Echo mode can be used. Echo-to-Echo measurement can use either the same dual transducers that are used for normal measurements, or a single element delay line transducer (GE Panametrics P/N: M201 with cable and adapter).

When dual transducers in the Echo-to-Echo mode are used, some gates or thresholds need to be set, however the special blanking gates can also be set conveniently if the application requires them. Additionally, when using a single element transducer, the Extended Blank to skip the paint/metal interface echo can be set.

The 37DL PLUS can display value of both metal and coating thickness, after it is adjusted by correcting sound wave velocity through different materials. The gage can also be set to display only the true metal thickness at the same time not need to remove the paint or coating from the surface. Thru-Coat measurements use the new D7906-SM and D7908 dual element transducers.

MEASUREMENT ACCURACY

To make sure optimum accuracy, however— especially when measuring pipe wall thickness for the first time—a known thickness of that pipe is measured with ultrasonic gauge. Main procedures of first obtaining this known thickness value include removing the coating and measuring with an ultrasound gauge, or micrometer, measuring the sample thickness with coating in echo to echo model. If the result is not within tolerance of the known thickness of body, the displayed value should be adjusted to match the thickness value obtained by other means, otherwise, means this method can't be used to measure the wall thickness with the coating type, such as bitumen coating.

To ensure fitness of this measure, the sample coated with 3-layer PE is selected and some defects as the photo show are made artificially, figure 1.

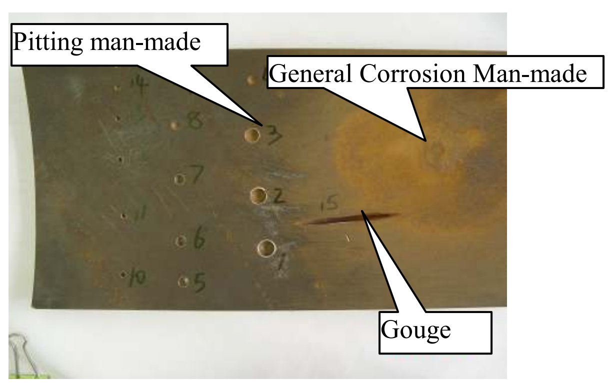

Figure 1

Valid test steps include:

- Preparing samples;
- Measuring wall thickness on back of samples without coating (normal thickness and remaining thickness on

general corrosion site) with ultrasound gauge, figure 2;

Figure 2

- Measuring the depth of defects, figure 3;

Figure 3

- Measuring remaining wall thickness of samples with coating at same place of defects, figure 4.

Figure 4

- Calculating and analyzing the test results.

The test results (table 1) proved this method suitable to measure the thickness of pipe body made up of X60 material with 3-layer-PE. For all the defects exist at different size, the test results show that the size of defect must be larger than the size of gauge probe.

APPLICATIONS

Now operators and inspectors can now take quick, nondestructive thickness measurements on pipe with coating that were required to take destructive measurement previously. Such applications include:

Remaining wall thickness measurement of gas or liquid pipeline site;

Processing pipeline on station with coating;

Setting steel casing pipe;

Installing defect repair Sleeves;

Testing can't be done on the body with coating of bitumen coating and heat insulation coating.

CASING

LCY product pipeline of PetroChina need using ultrasound gauge to measure internal corrosion of pipeline with coating for ICDA. The pipeline originates in LanZhou city, routes through Chengdu city, and ends in City ChongQing. It has a total length of 1,247 km. (780 miles). The pipeline transports gasoline and diesel oil. The line has 508mm, 457mm and 324mm diameter sections (NPS20, NPS18, and NPS12), and is constructed of API 5L X52 and X60 material. The MAOP ranges from 7.62 MPa to 14.76 MPa. (1105 psi to 2140 psi). Main body coating is 3-layer-PE and joint coating is heat shrink sleeve.

This pipeline is the first and largest product pipeline in China and is one of PetroChina's most critical pipelines. The fact that it passes through numerous high consequence areas (HCA's) and regions with high geotechnical and other natural hazards, combined with the fact that local terrain makes it difficult to perform emergency repairs in the event of pipeline failure, presents that the operator can't run in-line inspection tool because of too much dust and rust in pipeline. From the basic analysis of dust and rust pigged out, general corrosion is thought the most impossible before commissioning and is internal of corrosion caused by water is considered the most terrible. For the last reason, it is necessary to analyze the rust pigged out from pipeline and take field survey. In the case of four-year running and unpigging, it is very important for the operators to apply ICDA immediately.

An ICDA method services for pipelines that normally carry dry natural gas, but may suffer from short-term liquid water upsets. [1] But ICDA method for product pipeline that may suffer from water upsets had never be used. Locations of water accumulating are considered the most likely to have suffered from corrosion. For normal product pipeline, corrosion only possibly appear at the places where water accumulates due to MIC (Microbiologically Induced Corrosion) or abrasion corrosion because of big angle and altitude differences of pipeline (figure 5)[3]. In addition, it is expected that corrosion in a product system is more likely closer to the point where water may have deposited during shutdown. The reason is that separate water flows and assembles together at the bottom of pipe. For abrasion corrosion, it may occur at elbow or at the bottle of slope.

Based on the measurement method of thickness gauge of pipe body covered with coating, a proposal of site gauge of internal corrosion inspect is prepared for improving the ICDA. The goal of site gauge is to identify locations of greatest corrosion damage, and to build rate models that fit into the overall process and serve as a tool to predict future corrosion growth rate. Therefore, the number of excavation points may become impractically large. If it is assumed that corrosion was uniform along a pipeline segment (e.g., dependent on corrosion before commissioning alone), a single inspection point anywhere along the segment would sufficiently serve to represent the entire length. If it is assumed that corrosion occurred at expectable locations during operation, the easy measure way would give the tester to measure the thickness freely without remove coating and patching action, also, not single point measure result would be more reliable.

SUMMARY

Using ultrasound thickness gauge with that thickness of pipe wall with coating can be accurately measured has become an acceptable and reliable testing method in service pipeline wall thickness measurement for ICDA. These instruments are usually affordable, reliable, and simple to operate. Easy application, ability to keep the coating integrity, economical and reliable operating is the character of the measurement method to estimate corrosion status in pipelines for ICDA.

The casing showing the value of the measure method that used in service product pipeline. This method will be widely used in pipe wall thickness measurement and inspection of gas pipeline or liquid pipeline with coating.

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Table 1 Test result on sample with coating

Test Position On Sample	Normal Thickness Of Substance （mm）	Coating Thickness （mm）	Depth Of Defect （mm）	Defect Size R （mm）	Test Result （mm）	Calculate Thickness （mm）	Test windage (mm)
Pitting man-made 1#	6.48	3.12	3.94	5	2.56	2.54	0.02
Pitting man-made 2#	6.48	2.99	3.23	3	N/A	3.25	N/A
Pitting man-made 3#	6.48	3.13	2.05	3	N/A	4.43	N/A
general corrosion man-made 1#	6.48	3.21	1.24	>5	5.21	5.24	-0.03
general corrosion man-made 2#	6.48	3.12	0.92	>5	5.56	5.56	0
general corrosion man-made 3#	6.48	3.04	0.74	>5	5.77	5.74	0.03
normal thickness of substance 1#	6.48	3.31	0	>5	6.49	6.48	0.01
normal thickness of substance 2#	6.48	3.02	0	>5	6.46	6.48	-0.02
normal thickness of substance 3#	6.48	2.91	0	>5	6.48	6.48	0

PetroChina LCY Pipeline OVERVIEW

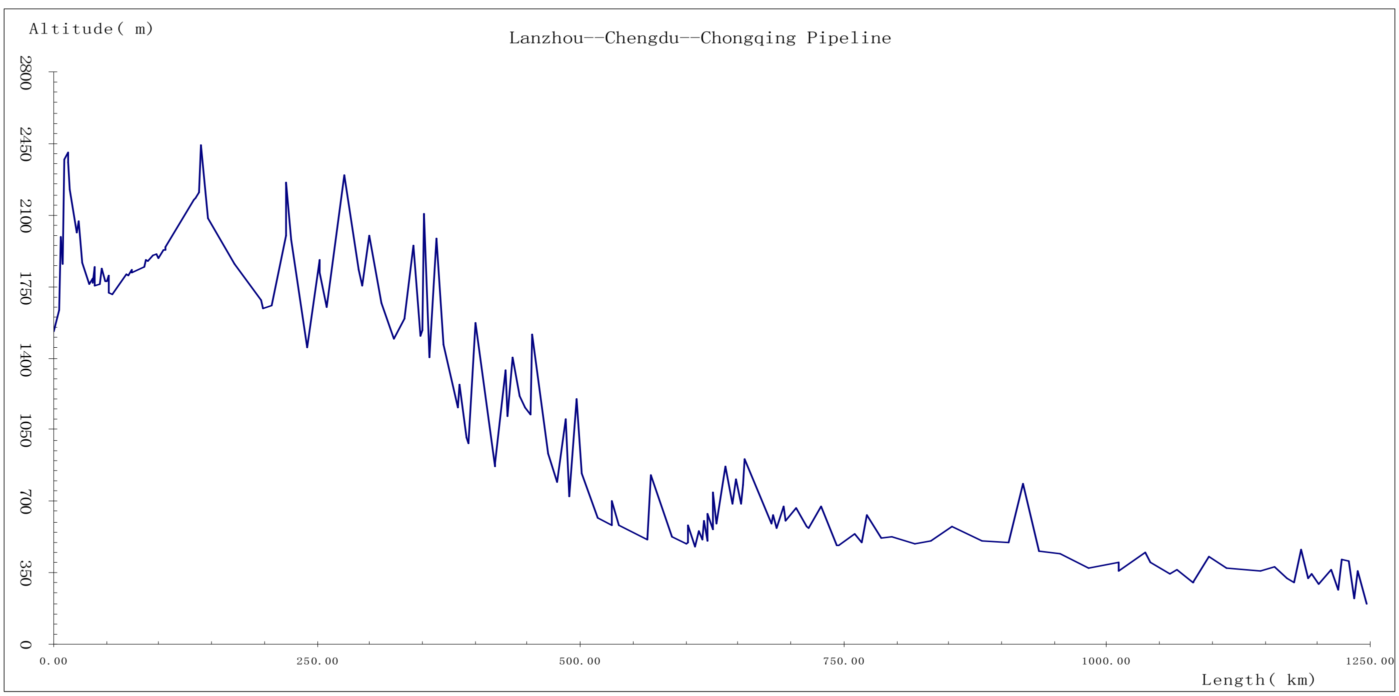

Figure 5. Elevation Profiles