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Assessment of Steel Oil & Gas Pipeline with Dent

钢质油气管道凹陷评价方法

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Assessment of Steel Oil & Gas Pipeline with Dent

1 Scope

This Standard specifies the technical requirements for test and assessment of under-construction steel oil & gas pipeline with dent.

This Standard is applicable to the assessment of land carbon steel and low-alloy steel oil & gas pipeline with dent.

2 Normative References

The following documents are essential to the application of this document. For the dated documents, only the versions with the dates indicated are applicable to this document; for the undated documents, only the latest version (including all the amendments) are applicable to this standard.

SY/T 6151 Assessment of Corroded Steel Pipelines

SY/T 6597 Technical Standard of Intelligent Pigging on Steel Pipeline

SY/T 6825 In-line Inspection Systems Qualification

SY/T 6889 In-line Inspection of Pipelines

3 Terms and Definitions

The following terms and definitions are applicable to this document.

3.1 Dent

The local elastic-plastic deformation of significant change on the curvature of pipe surface that is caused by external impact or squeeze.

3.2 Smooth dent

Dent, of which the pipe-wall curvature is changed smoothly.

3.3 inked dent

Dent, of which the pipe-wall curvature is changed significantly; the sharpest part's

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5 Dent Inspection

5.1 Internal inspection

5.1.1 As for pipeline dent, apply the internal inspection to inspect; and implement as per SY/T 6597, SY/T 6825 and SY/T 6889.

5.1.2 Apply deformation, magnetic-leakage or ultrasound and other internal inspection technologies; detect the dent position (absolute distance, relative distance, clock direction), depth, axial length and circumferential width or overall outline; give out the position relationship between dent and pipeline weld seam, as well as other defect information relevant to the dent such as corrosion, scratches, cracks, arc burns and etc.

5.2 Direct inspection

5.2.1 Get rid of the anti-corrosion layer of pipe section where the dent exists; if the dent belongs to constrained dent, then firstly remove the constraint against the dent.

5.2.2 Precisely measure the dent shape; give out the dent's maximum depth, axial length, circumferential width, axial and circumferential profile shape through the maximum depth position, and the overall shape of dent. The available shape measurement methods include but not limited to:

a) Laser scanning measurement: this method, through laser, scans the dent area; it can accurately record and describe the overall shape of dent. The implementation can refer to Appendix A.

b) Profile gauge measurement: divide the external surface of dent along the circumferential direction at equal distance; use profile gauge, successively at different segmentation line, along the axis, to tightly attach to the dent surface; according to the gauge shape, obtain the dent outline at different section, and describe the dent shape.

c) Template measurement: divide equal-distance grid on the external surface of the dent; use template to measure the deformation depth on each grid; according to the measurement data, describe the dent shape.

NOTE: After removal constraints from the constrained dent, it appears to spring back and rebounding, which have certain influence on the measurement result.

5.2.3 Through visual observation, check the positions relationship among dent, weld seam and other defects, such as corrosion, scratches, cracks, arc burns, and etc.; if necessary, apply magnetic power, penetration, ultrasound, X-ray and other methods to inspect the dent further.

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6 Dent Assessment

6.1 Determination of dent type

Through the internal inspection or direct inspection results, determine the dent type; dent can be divided into kinked dent and smooth dent. Smooth dent can be further divided into the following ones:

a) Dent containing scratches, cracks, arc burns or weld seam defects.

b) Dent on the weld seam.

c) Dent containing corrosion.

d) Ordinary smooth dent.

6.2 Depth-based assessment

6.2.1 When the dent shape information is limited; it shall carry out dent depth assessment. The procedure of dent-depth-based assessment can refer to Figure 1.

6.2.2 The following dents shall be repaired:

a) Kinked dent.

b) Dent containing scratches, cracks, arc burns or weld seam defects.

c) Dent on the weld seam, whose depth is more than 2% pipeline diameter.

d) Dent containing corrosion and corrosion depth is more than 40% pipeline wall thickness.

e) Dent containing corrosion and corrosion depth is 10%~40% pipeline wall thickness; it shall be repaired as per SY/T 6151.

f) Dent whose depth is more than 6% pipeline diameter.

6.2.3 When repairing the ordinary smooth dent, it shall be sequenced as per the ratio (*d/L*) between dent depth and length; the dent whose ratio is larger shall be given priority to repair. In case the *d/L* values are equal, the dent whose wall thickness is larger shall be given priority to repair.

6.3 Strain-based assessment

6.3.1 When the data of dent shape are sufficient, the strain-based assessment against dent shall be carried out; the assessment flow can refer to Figure 2. The calculation method of dent strain can refer to Appendix B.

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Appendix A

(Informative)

Dent Laser Scanning Measurement

A.1 Pipeline preparation

A.1.1 Verify that the excavated dent is to-be-measured dent.

A.1.2 If it is the constrained dent, firstly remove the constraints.

A.1.3 Remove the anti-corrosion layer on the pipeline segment where the dent exists; polish and eliminate all sediments, dirt, grease and dust, so that the pipeline surface roughness can reach Grade 2~3.

A.2 Installation and calibration of laser scanner

A.2.1 Verify, in the target scanning area, the pipeline segment circumferential 360°'s pipeline wall cleanliness.

A.2.2 In the pipeline's to-be-scanned area, arrange positioning patches at certain distance. When arranging pitch nearby the dent, ensure that the distance between pitch and dent's two axial ends is not less than 10mm.

A.2.3 Use calibration plate to calibrate the portable laser scanner.

A.2.4 Scan the positioning pitches.

A.3 Scanning

A.3.1 Maintain portable laser scanner perpendicular to the pipeline surface; conduct circumferential 360° scanning.

A.3.2 As for hollow-imaging area, it shall be rescanned till it appears in the imaging software.

A.3.3 Set coordinate origin and coordinate axis; save the setting and scanning results.

A.3.4 After the completion of scanning, close the software, and remove the device.

A.4 Data extraction

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Appendix B

(Informative)

Dent Strain Calculation Method

B.1 Strain

B.1.1 Dent strain shall, according to the dent profile obtained through the internal and direct measurement of deformation, be calculated.

B.1.2 When coarse profile information is obtained; it can, through Interpolation method or other mathematical method, construct more accurate dent profile information.

B.2 Strain calculation

B.2.1 Schematic diagram of stain calculation can refer to Figure B.1. When passing through the cross-section of dent, determine curvature radius R_1 on the dent part of pipeline external surface. When the pipeline curvature direction is the same as the initial surface curvature direction, R_1 is positive number; when the pipeline curvature direction is opposite to the initial surface curvature direction, R_1 is negative number.

B.2.2 When pass through the axial section of dent, determine the dent's curvature radius R_0, generally R_0 is negative number.

B.2.3 Circumferential bending strain ε_1 shall be calculated as per Formula (B.1):

$$\varepsilon_1 = \frac{1}{2}t\left(\frac{1}{R_0} - \frac{1}{R_1}\right) \qquad \text{(B.1)}$$

Where:

t – Pipeline wall thickness, unit is mm;

R_0 – Pipeline's initial radius, unit is mm;

R_1 – Curvature radius of dent on pipeline cross-section, unit is mm.

B.2.4 Axial bending strain ε_2 shall be calculated as per Formula (B.2)

$$\varepsilon_2 = -\frac{1}{2}\left(\frac{t}{R_2}\right) \qquad \text{(B.2)}$$

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