ICS 77.040.20
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YB

Black Metal Industry Standard of the People's Republic of China

YB/T 4082-2020
Replace YB/T 4082—2011

Measurement method of comprehensive properties for automatic ultrasonic testing system for steel tubes and steel bars

钢管、钢棒自动超声检测系统综合性能测试方法

(English Translation)

Issue date: 2020-XX-XX Implementation date: 2020-XX-XX

Issued by Ministry of Industry and Information Technology of the People's Republic of China

Contents

Forward

SAC/TC 183 is in charge of this English translation. In case of any doubt about the contents of English translation, the Chinese original shall be considered authoritative.

This standard is drafted in accordance with the rules given in the GB/T 1.1 - 2009.

This standard was proposed by China Iron and Steel Association.

This standard was prepared by SAC/TC 183 (Technical Committee 183 on Steel of Standardization Administration of China).

This standard replaces YB/T 4082-2011" Measurement method of comprehensive properties for automatic ultrasonic testing system for steel tubes". Compared with YB/T 4082-2011, the main technical changes are as follows:

——The name of the standard is changed to " Measurement method of comprehensive properties for automatic ultrasonic testing system for steel tubes and steel bars";

——The measurement method of comprehensive properties of steel bars is added (see Chapter 1);

——The standard of instrument performance should be changed from JB/T 10061 to JJG 746 is added (see 4.1, 4.1 of 2011 Edition);

——The reference sample of steel bar are added (see 5.2);

——The informative Appendix A is deleted (see Appendix A of 2011 Edition).

The previous versions of this standard are as follows:

——YB/T 4082-1992、YB/T 4082-2000、YB/T 4082-2011。

Measurement method of comprehensive properties for automatic ultrasonic testing system for steel tubes and steel bars

1 Scope

This standard specifies the measurement conditions, reference samples, measurement items, methods and reports of the comprehensive properties of the automatic ultrasonic testing systems which generally including ultrasonic testing instrument and probes and transmission devices for tubes and bars.

This standard is applicable to the measurement of comprehensive properties of the automatic ultrasonic testing systems (including phased array ultrasonic testing systems) for tubes and bars. The comprehensive properties of the automatic ultrasonic testing systems for the ends of tubes or bars and automatic electromagnetic acoustic testing systems for tubes and bars can also be measured refer to this document.

2 Normative references

The following referenced documents are indispensable for the application of this standard. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

GB/T 5777 *Automated full peripheral ultrasonic testing of seamless and welded (except submerged arc-welded) steel tubes for the detection of longitudinal and/or transverse imperfections*

GB/T 12604.1 *Non-destructive testing - Terminology - Terms used in ultrasonic testing*

GB/T 37566 *Method of ultrasonic testing for round steel*

YB/T 145 *Die casting and size measurement method of artificial defects on the reference sample pipes*

JJG 746 *Verification regulation for ultrasonic flaw detectors*

ISO 18563.1 *Non-destructive testing - Characterization and verification of ultrasonic phased array equipment - Part 1: Instruments*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in GB/T 12604.1 apply.

4 Measurement conditions

4.1 The instument shall be a pulse echo type multi-channel or single-channel ultrasonic testing instrument. The performance of each channel shall meet the requirements of JJG 746, and its attenuator (or gain control) accuracy, vertical linearity and dynamic range shall be calibrated. The phased array instrument shall meet the requirements of ISO 18563.1.

4.2 The measurement speed of the system shall be the highest testing speed in normal use. When each one of multi-channel instrument is measured, the line speed of circumferential scanning shall be constant and the measurement speed shall be no less than the ratio of the normal testing speed to the number of channels. The frequency, pulse repetition rate, rejection, speed, probe

specifications shall be completely recorded during the measurement.

4.3 For the instrument with linear gain control, the adjusted amplitude of pulse echo shall be converted into logarithm value in dB during the measurement.

5 Reference samples

5.1 Reference tubes

5.1.1 The reference tubes for measurement shall be made according to the product type and specifications. Their lengths shall meet the requirements of the testing method and equipment, and their curvatures shall be no greater than 1.5 mm/m. The reference standards are usually longitudinal notches, and also transverse or diagonal notches to be added when necessary..

5.1.2 One notch shall respectively be on outer surface in the middle and on inner and outer surfaces at either ends of the tube, as shown in Figure 1, where L is the length of the dead zone at the end. When the inner diameter of the tube is less than 25 mm, the longitudinal notch on inner surface is not necessary. For the stainless steel tubes for aviation and other important purposes, when their inner diameters are less than 12 mm, the longitudinal notch on inner surface is not necessary. Where there not is the inner notch, an outer notch is needed at the same position.

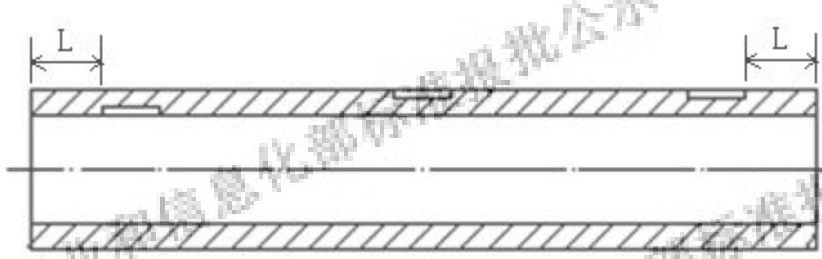

Figure 1 Reference tube for measurement of system's comprehensive properties

5.1.3 The shape, width, depth and length of the notches and their tolerances shall meet the requirements of GB/T 5777.

5.2 Reference bars

5.2.1 The reference bars for measurement shall be made according to the product type and specifications. Their lengths shall meet the requirements of the testing method and equipment, and their curvatures shall be no greater than 1.5 mm/m. The reference standards are usually central side drilled holes (SDHs), and also flat bottom holes (FBHs), eccentric SDHs, near surface SDHs or notches to be added when necessary.

5.2.2 One SDH shall respectively be in the middle and at both ends of the bar, as shown in Figure 2, where L is the length of the dead zone at the end.

Figure 2 Reference bar for measurement of system's comprehensive properties

5.2.3 The shape, diameter and length of the SDHs and their tolerances shall meet the requirements of GB/T 37566.

5.3 Dimension of reference samples for measurement

The reference samples for measurement shall be made separately according to the maximum and the minimum diameter of the tubes or bars which the system can test.

5.4 Requirements for reference standards

The reference samples can be used only after the standards on them are calibrated. The calibration certificate shall record the number, steel type, dimension and surface condition of the sample, size of each standard and the distance between the standard at the end and the sample end, which indicates the length of the end dead zone of the system. The sizes of the standards may be measured with optical, mechanical or equivalent comparison method, and replica method specified in YB/T 145.

6 Measurement items and methods

6.1 Measurement items

The measurement shall be carried out dynamically with the reference samples whose diameters are respectively equal to the maximum and minimum ones of tubes or bars which the system can test. The circumferential sensitivity difference (CSD) or circumferential sensitivity fluctuation (CSF), the sensitivity difference between inside and outside walls (only for tubes), signal to noise ratio (SNR) and stability shall be measured for each channel. If the results of each channel measured are different, the worst value shall be taken.

6.2 Measurement of CSD and CSF

6.2.1 For the system whose probes rotate and pieces to be tested advance straightly, the reference sample shown in Figure 1 or 2 is used to let the standard in the middle to pass repeatedly through the system. First, set 0° position for the sample, adjust the gain control of each channel, record the dB value when the standard triggers the alarm. Second, rotate the sample to carry out the measurement in the same way at the 120 ° and 240 ° positions and record the dB value when the standard just triggers the alarm. The maximum difference between these dB values is the CSD whose absolute value shall be no greater than 4dB. Each channel shall be measured 3 times. If the results are different, the worst value shall be taken.

6.2.2 For the system whose probes rotate (including the electronically rotated phased array system) and pieces to be tested advance straight, use the reference sample shown in Figure 2 to let the standard in the middle to pass repeatedly through the system. First, set 0° position for the sample, adjust the gain control of each channel, record dB value when the standard just triggers the alarm. Second, rotate the sample to carry out the test in the same way at the 120 ° and 240 ° positions and record the dB value when the artificial defect just triggers the alarm. The maximum difference between these dB values is the CSD, and the absolute value of this difference should be no greater than 4dB. Each channel should be measured 3 times. If the results are different, the worst value shall be taken.

6.2.3 For the system whose probes fix and pieces to be tested advance spirally, or probes move axially and pieces rotate in its place, the CSF shall be measured. The reference sample shown in Figure 1 or 2 is used to let the standard in the middle to pass repeatedly through the system 3 times. For each channel, record three dB values when the standard just triggers the alarm. The maximum difference between these dB values is the CSF whose absolute value shall be no greater than 4dB.

6.2.4 For the system whose probes fix and pieces to be tested advance spirally, or probes move axially rotate in its place, the CSF should be tested. The reference sample shown in Figure 2 is used to let the standard in the middle to pass repeatedly through the system for 3 times. For each channel, record three dB values when the standard just triggers the alarm. The maximum difference between these dB values is the CSF, absolute value shall be no greater than 4dB.

6.3 Measurement of sensitivity difference between inside and outside walls (only for tubes)

The reference tube shown in Figure 1 is used to let the notches on its inside and outside walls at both ends to pass repeatedly through the system, adjust the gain control of each channel of the instrument and record the dB values when the notches just trigger the alarm. The difference between the dB values is the sensitivity difference between inside and outsid walls whose absolute value shall be no greater than 4dB. Each channel is measured 3 times. If the results are different, the worst value shall be taken. For the system using the same gate level for standards on inside and outside walls, this measurement shall be conducted; and for the system using different gate level, the results are recorded but not judged.

6.4 Measurement of SNR

The reference sample shown in Figure 1 or 2 is used to pass repeatedly through the system. For the system using different gates level for inside and outside walls, the gates shall be connected. First, adjust the gain control of each channel of the instrument and respectively record the dB value when all standards just trigger the alarm that is the defect detection sensitivity (DDS); Second, increase gain of each channel and record the dB value when the noise just triggers the alarm. The difference between this value and DDS is the SNR. Each channel is measured 3 times. If the results are different, the worst value should be taken. The SNR shall be no less than 8dB.

6.5 Measurement of missed test rate and false alarm rate

The gains of all channels may be increased by 2dB on the basis of DDS. The reference sample is tested continuously 25 times at the highest speed in normal use, and the number of missed alarms and false alarms for the standards is recorded respectively. For the multi-channel system, if no channel gives an alarm when a standard passes, it will be called as a missed test. If any channel gives an alarm when no standard passes, it will be called as a false alarm. If there are 1 or more false alarms during each measurement, it will be counted as 1 time false alarm. If there are too many missed tests and false alarms within the number measured above, the number may be increased to 50 times. The missed test rate (MTR) of the system shall be no greater than 1.5%, and the false alarm rate (FAR) should be no greater than 3%. The missed test rate and false alarm rate are calculated respectively by Formula (1) and (2):

$$\mathrm{MTR}=\frac{\text{the number of standards missed alarm}}{\text{the number of standards on reference sample}\times\text{the number of measurement}}\times 100\% \tag{1}$$

$$\mathrm{FAR}=\frac{\text{the number of false alarm}}{\text{the number of measurement}}\times 100\% \tag{2}$$

6.6 Measurement of dead zone at the end

The dead zone at the end shall be measured on the basis of 6.5. If the standards at both ends of the reference sample are reliably alarmed in three successive measurements, the distance from the standard to the end will be recorded as the dead zone at the end which shall be no greater than 200mm. When the dead zone at the end is larger than 200mm, it shall be noted in the measurement report.

6.7 Measurement of stability

6.7.1 The CSD or CSF is measured again according to 6.2 after the system works continuously for 2h. The CSD or CSF difference between 2 hours ago and later shall be no greater than 2 dB, and shall meet the requirements of 6.2.

6.7.2 The DDS and SNR are measured again according to 6.4 after the system works continuously for 2h. The DDS difference in the same channel between 2 hours ago and later shall be no greater than 2 dB, and the SNR should meet the requirements of 6.4.

6.7.3 The measurement stability is only applicable for the maximum diameter reference sample is only measured.

7 Measurement report

The measurement report shall include at least the following information:

a) CSD or CSF, sensitivity difference between the inside and outside walls (only for tubes), DDS, SNR, MTR, FAR, dead zone at the end, stability;

b) manufacturer names, models and numbers of the testing equipment and instrument;

c) steel type, specification, status and number specifications of the reference sample and reference standards in it;

d) parameters such as frequency, pulse repetition rate, rejection, speed, probe specifications for the measurement;

e) name of tester and test date;

f) test location, environmental conditions, etc.;

g) exceptional circumstances and explanations.