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**Mechanical property tests of product welded test coupons
for pressure equipments**

承压设备产品焊接试件的力学性能检验

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Mechanical property tests of product welded test coupons for pressure equipments

1 Scope

This document specifies the preparation of welded test coupons, specimen preparation, inspection methods, qualified indicators for pressure equipment (boilers, pressure vessels and pressure pipes).

This document is applicable to the mechanical and bending performance tests of welded test coupons (including welded test plates, simulation rings, certification rings) of steel, aluminum, titanium, copper, nickel, and zirconium pressure equipment products.

This document is not applicable to the mechanical and bending performance tests of welded test coupons of gas cylinder products.

2 Normative references

The contents of the following documents constitute essential clauses of this document through normative references in the text. Among them, for dated references, only the version corresponding to that date is applicable to this document; for undated references, the latest version (including all amendments) is applicable to this document.

GB/T 228 (all parts) Metallic materials - Tensile testing at ambient temperature

GB/T 229 Metallic materials - Charpy pendulum impact test method

GB/T 2652 Destructive tests on welds in metallic materials - Longitudinal tensile test on weld metal in fusion welded joints

GB/T 2653 Bend test methods on welded joints

GB/T 3375 Welding terminology

NB/T 47014 Welding procedure qualification for pressure equipments

3 Terms and definitions

The terms and definitions defined in GB/T 3375 and NB/T 47014 apply to this document. If there is any inconsistency, the terms and definitions of NB/T 47014 shall prevail.

4 General

4.1 In addition to complying with the provisions of this document, the mechanical property inspection of product welded test coupons shall also comply with the provisions of relevant safety technical specifications, standards, design documents.

4.2 The materials used for the test coupons shall be taken from qualified raw materials; they shall be of the same standard, code (designation, steel grade), specification (limited thickness), heat treatment state as the materials of the pressure equipment components they represent. When S11348 (06Cr13Al) steel is used to weld pressure equipment without post-weld heat treatment, the parent material of the test coupon shall include steel plates of each heat number.

4.3 Welded test coupons for pressure equipment products are divided into plate test coupons and tubular test coupons; tubular test coupons refer to pipes and rings.

4.4 Welding of product welded test coupons:

- a) Plate test coupons of welded joints of longitudinal seams (including the spliced joints of heads) shall be placed at the extended position of their welds and welded at the same time as the welds they represent;
- b) Tubular test coupons or plate test coupons used for welded joints of circumferential seams shall be welded during the welding procedure of the pressure equipment components they represent;
- c) Plate test coupons of welded joints of spherical containers shall be welded during the welding procedure of the manufacturing stage and installation stage of the pressure equipment components they represent.

4.5 Test coupon welding procedure

4.5.1 When the inspected welded joints undergo different welding procedures, the welding procedure and conditions experienced by the test coupon shall be the same as those of the welded joints they represent.

4.5.2 The welder of the test coupon shall be selected from the welders who weld the pressure equipment components.

4.5.3 The test coupon shall be prepared according to the prepared special welding procedure documents. The test coupon code, work order number or pressure equipment number, and material code shall be clearly stated in the welding procedure documents.

4.5.4 The test coupon shall have welding records.

4.6 After the test coupon has been inspected visually and tested non-destructively, it is

different, 3 impact specimens shall be taken from the heat-affected zone on each side;

- c) For composite metals, only impact specimens shall be made on the base except as specified in the design documents;
- d) Low-carbon steel, Q345R and chromium-nickel austenitic steel test coupons can be exempted from the heat-affected zone impact test;
- e) For aluminum-magnesium alloys with a magnesium content exceeding 3%, only the weld zone impact specimen shall be taken.

6.5 Specimen position

6.5.1 The sampling position of plate test coupons shall be as shown in Figure 1.

6.5.2 The sampling position of tubular test coupons shall be as shown in Figure 2.

6.6 The length of the discarded part at both ends of the test coupon varies with the welding method and plate thickness. It shall not be less than 30 mm for manual welding; it shall be not less than 40 mm for motorized welding and automatic welding.

6.7 The specimen blank is cut by cold working method, or hot working method; however, the oxide layer and other materials need to be removed by cold working method to expose the metallic luster.

6.8 After the specimen passes the inspection and marked, it is stamped with a steel stamp or permanent mark.

7 Inspection method and qualified index

7.1 Tensile test

7.1.1 Joint tensile specimen

7.1.1.1 Sampling and processing requirements:

- a) The tensile specimen shall include the welded joints of each welding method (or welding procedure with different important factors) on the test coupon.
- b) For composite metals, when the coating thickness is involved in the strength calculation of the composite plate, the tensile specimen includes the coating and the base layer; when the coating thickness is not involved in the strength calculation of the composite plate, the tensile specimen removes the coating, the transition layer weld metal in the base layer is not removed.
- c) The weld excess of the specimen shall be removed by cold working method, to

the tensile surface of the face bending and back bending specimens shall be flush; there shall be no scratches and damage on the tensile surface of the specimen.

- b) The face bending and back bending specimens shall be in accordance with the provisions of Figure 7 and Table 3.

- 1) The parent material category with serial number 1 in Table 3:

When $T > 3$ mm, take $S = 3$ mm and remove the excess thickness from the compressive surface of the specimen;

When $T \leq 3$ mm, S is as close to T as possible.

- 2) The parent material category other than serial number 1 in Table 3:

When $T > 10$ mm, take $S = 10$ mm and remove the excess thickness from the compressive surface of the specimen;

When $T \leq 10$ mm, S is as close to T as possible.

- 3) For plate and tubular test coupons with an outer diameter of $\Phi > 100$ mm, the specimen width $B = 38$ mm; when the outer diameter Φ of the tubular test

coupon is 50 mm ~ 100 mm, then $B = (S + \frac{\Phi}{20})$ mm and $8 \text{ mm} \leq B \leq 38 \text{ mm}$;

when $10 \text{ mm} \leq \Phi < 50 \text{ mm}$, then $B = (S + \frac{\Phi}{10})$ mm and the minimum is 8 mm; or

when $\Phi \leq 25$ mm, the test coupon is divided into four equal parts in the circumferential direction for sampling.

- c) See Figure 8 and Table 3 for transverse side bending specimens.

- 1) The thickness of the specimen with serial number 1 in Table 3 is 3 mm; the thickness of the specimens other than serial number 1 in Table 3 is 10 mm.

- 2) When the specimen thickness $T \geq 10$ mm, the specimen width B is close to or equal to the test coupon thickness; however, when the test coupon thickness $T \geq 38$ mm, it is allowed to test two or more specimens with a width B of 20 mm ~ 38 mm which is cut in the direction of the specimen thickness in a layered manner instead of a full-width side bending specimen.

inclusion or other internal defects shall be counted.

If the specimen thickness $T \geq 38$ mm and two or more specimens are used, each specimen shall meet the above requirements.

For composite metal materials produced by rolling composite method and explosive welding method, re-sampling test is allowed for delamination and cracks caused by unbonded defects in the composite interface of the side bending specimen.

7.3 Impact test

7.3.1 The weld metal and heat affected zone of each welding method (or welding procedure with different supplementary factors) shall be subjected to Charpy V-notch impact test.

7.3.2 Impact specimen:

- a) Orientation: The longitudinal axis of the specimen shall be perpendicular to the weld axis; the Charpy V-notch axis shall be perpendicular to the surface of the parent material.
- b) Sampling position: The sampling position on the thickness of the specimen is shown in Figure 9; when a combined welding method is used, if the weld metal and heat affected zone of a certain welding method (or welding procedure with different supplementary factors) are not within the sampling range of Figure 9, separate sampling can be performed on the test coupon.
- c) Notch position: The notch axis of the weld metal specimen shall be located on the center line of the weld.

The distance k -- from the notch axis of the heat-affected zone specimen to the intersection of the longitudinal axis of the specimen and the fusion line -- is > 0 mm; it shall pass through the heat-affected zone as much as possible, see Figure 10 for details.

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