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**Welded austenitic-ferritic (duplex) stainless steel
tubes and pipes – Part 1: Tubes for heat exchanger**

奥氏体-铁素体型双相不锈钢焊接钢管 第1部分：热交换器用管

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Welded austenitic-ferritic (duplex) stainless steel tubes and pipes – Part 1: Tubes for heat exchanger

1 Scope

This Part of GB/T 21832 specifies the ordering content, dimensions, shape, weight, technical requirements, test methods, inspection rules, packaging, marking and quality certification for welded austenitic-ferritic (duplex) stainless steel tubes for heat exchangers.

This Part applies to welded austenitic-ferritic (duplex) stainless steel tubes for heat exchangers (hereinafter referred to as steel tubes).

2 Normative references

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

GB/T 222, *Permissible tolerances for chemical composition of steel products*

GB/T 223.11, *Iron, steel and alloy – Determination of chromium content – Visual titration or potentiometric titration method*

GB/T 223.18, *Methods for chemical analysis of iron, steel and alloy – The sodium thiosulfate separation iodimetric method for the determination of copper content*

GB/T 223.19, *Methods for Chemical Analysis of Iron Steel and Alloy – the Neocuproine-Chloroform Extraction Photometric Method for the Determination of Copper Content*

GB/T 223.25, *Methods for chemical analysis of iron, steel and alloy – The dimethylglyoxime gravimetric method for the determination of nickel content*

GB/T 223.26, *Iron, steel and alloy – Determination of molybdenum content – The thiocyanate spectrophotometric method*

GB/T 223.28, *Methods for chemical analysis of iron steel and alloy – The α -denzoinoxime gravimetric method for the determination of molybdenum content*

GB/T 11170, *Stainless steel – Determination of multi-element contents – Spark discharge atomic emission spectrometric method (Routine method)*

GB/T 13305, *Micrographic method for determining area content of the α -phases in stainless steels*

GB/T 20066, *Steel and iron-sampling and preparation of samples for the determination of chemical composition*

GB/T 20123, *Steel and iron – Determination of total carbon and sulfur content Infrared absorption method after combustion in an induction furnace (routine method)*

GB/T 20124, *Steel and iron – Determination of nitrogen content – Thermal conductimetric method after fusion in a current of inert gas*

GB/T 21835, *Dimensions and masses per unit length of welded steel pipes*

3 Ordering content

Contracts or orders for purchase of steel tubes based on this Part shall include the following content:

- a) a reference to this Part;
- b) product name;
- c) steel designation;
- d) dimensions (outer diameter \times wall thickness, in mm);
- e) quantity ordered;
- f) special requirements.

4 Dimensions, shape and weight

4.1 Outer diameter and wall thickness

4.1.1 The outer diameter D of steel tubes shall not be greater than 203 mm; the wall thickness S shall not be greater than 8.0 mm; and their dimensions shall be as specified in GB/T 21835. Steel tubes of other outer diameters and wall thicknesses can be supplied in accordance with the requirements of the purchaser, which shall be as agreed on by the supplier and the purchaser.

The surface of both ends of steel tubes shall be perpendicular to the axis of steel tubes; burrs shall be removed at the cut.

4.6 Weight

Steel tubes shall be delivered in theoretical weight. Steel tubes can also be delivered in actual weight, which shall be as agreed on by the supplier and the purchaser and stated in contracts. The theoretical weight per meter of steel tubes is calculated in accordance with Formula (1).

$$W = \pi \rho S (D - S) / 1\,000 \quad \dots\dots\dots (1)$$

where:

W – the theoretical weight per meter of steel tubes, in kg/m;

π – taking 3.141 6;

ρ – the density of steel, in kg/dm³. Take the density 7.70 kg/dm³ for designation 022Cr19Ni5MoSi2N and the density 7.80 for other designations;

D – the outer diameter of steel tubes, in mm;

S – the wall thickness of steel tubes, in mm.

5 Technical requirements

5.1 Designations and chemical compositions

5.1.1 Designations and chemical compositions of steels (by smelting analysis) shall be as specified in Table 2.

5.1.2 When the purchaser requires product analysis, it shall be stated in contracts. The allowable deviations of chemical compositions of finished steel tubes shall be as specified in GB/T 222.

$$H = \frac{(1 + \alpha)S}{\alpha + S/D} \dots\dots\dots(2)$$

where:

H – the distance between parallel pressing plates after flattening, in mm;

α – the deformation coefficient per unit length, taking 0.07;

S – the wall thickness of steel tubes, in mm;

D – the outer diameter of steel tubes, in mm.

5.5.2 Flanging

Flanging test shall be carried out for steel tubes. Flanging width shall not be less than 15% of outer diameter. After flanging test, sample shall be free from cracks and gaps.

5.5.3 Back bend of welded joints

Back bend test of welded joints shall be carried out for steel tubes. Take a sample of a section 100 mm long from steel tubes; split it along the longitudinal direction at a location forming an angle 90° to both sides of welds; and then unfold it. The bending core diameter is 4 times of sample thickness; during bending, bending cores shall be close to and parallel to outer seams, to make welds locate at the maximum bending points; and the bending angle is 180°. After test, sample shall be free from cracks and weld defects.

5.6 Density

5.6.1 Hydrostatic pressure

Hydrostatic pressure test shall be carried out for steel tubes one by one. Test pressure is calculated in accordance with Formula (3); and the maximum test pressure is 10 MPa. Under the test pressure, the standup pressure time shall not be less than 5 s; and steel tubes shall be free from leakage.

$$P = 2SR/D \dots\dots\dots(3)$$

where:

P – the test pressure, in MPa. When *P* < 7 MPa, round off to the nearest 0.5 MPa. When *P* ≥ 7 MPa, round off to the nearest 1 MPa;

S – the wall thickness of steel tubes, in mm;

R – the allowable stress, 50% of the plastic elongation strength *R*_{p0.2} specified in Table 3, in MPa;

D – the outer diameter, in mm.

5.6.2 Underwater air-tightness

5.6.2.1 For steel tubes of outer diameter not greater than 50.8 mm, carry out underwater air-tightness test in place of hydrostatic test one by one. Test pressure for underwater air-tightness test shall not be less than 1.0 MPa; and test medium is compressed air. Under the test pressure, steel tubes shall be fully immersed in water; the standup pressure time shall not be less than 10 s; and steel tubes shall be free from leakage.

5.6.2.2 Other test pressures can be used for air-tightness test in accordance with the requirements of the purchaser, which shall be as agreed on by the supplier and the purchaser and stated in contracts.

5.6.3 Eddy current testing

The supplier can use eddy current testing to replace hydrostatic test. The artificial defects of contrast sample tubes for eddy current testing shall comply with the specifications for acceptance level E4H of GB/T 7735-2016.

5.7 Metallographic structure

5.7.1 The metallographic structure of steel tubes shall be austenitic-ferritic; the austenitic content of the base metal zones shall be 40% ~ 60%; and the austenitic content of the weld zones (the heat affected zones) shall be 35% ~ 65%.

5.7.2 Austenitic contents of other ranges can be specified, which shall be as agreed on by the supplier and the purchaser and stated in contracts.

5.8 Surface quality

5.8.1 The inner-outer surfaces of steel tubes shall be smooth, without cracks, folds, undercuts, lack of penetration or weld sags. These defects shall be removed completely; the removing depth shall not exceed the lower deviation of nominal wall thickness; the actual wall thickness at the removing spots shall not be less than the minimum value allowed by wall thickness.

5.8.2 The surfaces of steel tubes allow the existence of local scratches, indentations and pits, but their depth shall not exceed 50% of the lower deviation of wall thickness. Those exceeding can be polished, however, the actual wall thickness at the polishing spots shall not be less than the minimum value allowed by wall thickness. Other local defects are allowed, which will not affect the minimum value allowed by wall thickness.

5.8.3 Reinforcements of inner-out welds shall comply with the following specifications:

- a) not greater than 0.1 mm for steel tubes of $S \leq 1.0$ mm;