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**NATIONAL STANDARD OF THE
PEOPLE'S REPUBLIC OF CHINA**

GB/T 21832.1-2018

Replacing GB/T 21832-2008

**Welded austenitic-ferritic duplex stainless steel tubes and
pipes - Part 1: Tubes for heat exchangers**

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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1 Scope

China's national standard for welded duplex stainless steel tube for heat exchangers. It is Part 1 of GB/T 21832 and specifies the order content, the dimensions, shape and weight, the technical requirements, the test methods, the inspection rules, and the packaging, marking and quality certification. Duplex stainless steel is roughly half austenite and half ferrite, and the mixture gives what neither phase gives alone: about twice the yield strength of an austenitic grade, so a thinner wall carries the same pressure, and far better resistance to chloride stress corrosion cracking, which is the failure that destroys austenitic stainless steel in seawater, in brackish cooling water and in chloride process streams. In a heat exchanger both matter directly. A thinner tube transfers heat better and costs less per metre, and the tube bundle is precisely where chloride cracking occurs, in the crevices at the tubesheet and under deposits. The difficulty is the welding, and that is what most of this standard is about. The phase balance of a duplex steel is set by the composition and by the cooling rate, and a weld cools fast: without control the weld metal and the heat affected zone come out too ferritic, which costs toughness and corrosion resistance, and holding the material in the wrong temperature range precipitates sigma phase, which embrittles it. So the standard specifies the delivery condition and the solution annealing after welding, the

corrosion tests, the flattening, flaring and hydrostatic or eddy current tests, and the dimensional tolerances that a tubesheet demands. Issued on 14 May 2018 and in force since 1 February 2019, it replaces GB/T 21832-2008.

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 alpha-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 alpha-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 x wall thickness, in mm);
- e) quantity ordered;
- f) special requirements.

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. D - the outer diameter, in mm.

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; steel tubes of each batch

6 Back bend of welded joints One sample separately taken from two steel tubes of each batch See

7 Inspection rules

7.1 Inspection and acceptance The inspection and acceptance of steel tubes shall be carried out by the quality and technology supervision department of the supplier.

7.2 Group-batch rules Except that chemical composition can be inspected and accepted by furnace, the other test items of steel tubes shall be inspected and accepted by batch. Each batch consist of steel tubes of the same designation, heat number, specification, welding process and heat treatment system (heat). The quantity of each batch of steel tubes shall not exceed those specified as follows:

a) 400 steel tubes for $D \leq 40$ mm;