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Seamless steel tubes and pipes for petrochemical and chemical facilities

石化和化工装置用无缝钢管

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Table of Contents

Seamless steel tubes and pipes for petrochemical and chemical facilities

1 Scope

This document specifies the classification, code, ordering content, manufacturing process, technical requirements, specimens, test methods, inspection rules, packaging, marking and quality certificate of seamless steel tubes and pipes for petrochemical and chemical facilities.

This document applies to seamless steel tubes and pipes for petroleum cracking, seamless steel tubes and pipes for high-pressure fertilizer equipment, high-pressure alloy steel tubes and pipes for polyethylene, and stainless-steel seamless tubes and pipes for industrial furnaces in petrochemical hydrogenation units (hereinafter referred to as "steel tubes and pipes").

2 Normative references

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

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

GB/T 223.5, *Steel and iron -- Determination of acid-soluble silicon and total silicon content -- Reduced molybdosilicate spectrophotometric method*

GB/T 223.9, *Iron, steel and alloy -- Determination of aluminium content -- Chrome azurol S photometric method*

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

GB/T 223.12, *Methods for chemical analysis of iron, steel and alloy. The sodium carbonate separation-diphenyl carbazide photometric method for the determination of chromium content*

GB/T 223.14, *Methods for chemical analysis of iron, steel and alloy. The N-benzoyl-N-phenylhydroxylamine extraction photometric method for the determination of vanadium content*

GB/T 223.18, *Methods for chemical analysis of iron steel and alloy -- The sodium*

GB/T 20972.2, *Petroleum and natural gas industries -- Materials for use in H2S-containing environments in oil and gas production -- Part 2: Cracking-resistant carbon and low alloy steels, and the use of cast irons*

GB/T 30062, *Terminology of steel pipes and tubes*

GB/T 31925-2015, *Ultrasonic Test Methods of Heavy Wall Thickness Seamless Steel Pipes and Tubes*

GB/T 42673, Non-destructive testing of steel tubes -- Magnetic particle inspection of seamless and welded ferromagnetic steel tubes for the detection of surface imperfections

GB/T 42677, *Non-destructive testing (NDT) methods of steel tubes -- Liquid penetrant inspection of seamless and welded steel tubes for the detection of surface imperfections*

SH/T 3037, *Calculation of heater-tube thickness in petroleum refineries*

YB/T 4149, *Continuously cast round billet for seamless steel tube rolling*

YB/T 4395, *Steel. Determination of molybdenum, niobium and tungsten contents. Inductively coupled plasma atomic emission spectrometric method*

YB/T 4396, *Stainless-steel. Determination of multi-element contents. Inductively coupled plasma atomic emission spectrometric method*

YB/T 5137, *Hot rolled and wrought round blank for high-pressure seamless steel tube*

3 Terms and definitions

For the purposes of this document, the terms and definitions defined in GB/T 30062 apply.

4 Classification and symbols

4.1 The seamless steel tubes and pipes in this document are divided into two categories according to the product manufacturing method. The categories and codes are as follows:

a) Hot-rolled (extruded, top-rolled, forged, expanded) steel tubes and pipes, with a code name as W-H;

b) Cold drawn (rolled) steel tubes and pipes, with a code name as W-C.

4.2 The following symbols apply to this document.

D: Outer diameter (unless otherwise specified, includes nominal outer diameter and/or calculated outer diameter, in millimeters).

S: Wall thickness (unless otherwise specified, includes nominal wall thickness and/or average wall thickness, in millimeters).

Sc: Average wall thickness (the average of the maximum and minimum wall thicknesses calculated based on the minimum wall thickness and its allowable deviation, in millimeters).

S_{min}: Minimum wall thickness.

L: Length.

5 Ordering content

The contract for steel tubes and pipes ordered under this document shall include the following:

a) Product name;

b) Reference to this document;

c) Steel designation or unified numerical code;

d) Order quantity (total weight or total length);

e) Dimensions (outer diameter × wall thickness, in millimeters);

f) Delivery condition;

g) Any special requirements.

6 Manufacturing process

6.1 Steel smelting methods

6.1.1 High-quality carbon steel, low-alloy steel and alloy steel should be smelted by electric arc furnace with external refining and vacuum refining, or oxygen converter with external refining and vacuum refining, or electroslag remelting.

6.1.2 Stainless-steel should be smelted using an electric arc furnace with external refining, an oxygen converter with external refining, or an electroslag remelting method.

6.1.3 Other smelting methods with higher requirements may be used after consultation between the supplier and the purchaser, if it is specified in the contract. If the purchaser

specifies a particular smelting method, this should be specified in the contract.

6.2 Method for manufacturing tube and pipe billets

The tube and pipe billets can be manufactured by continuous casting, die casting or hot rolling (forging).

6.3 Manufacturing methods for steel tubes and pipes

6.3.1 High-quality carbon steel, low alloy steel and other alloy steel tubes and pipes except 35CrNi3MoV steel tubes and pipes for polyethylene should be manufactured by hot rolling (extrusion, top, expansion) or cold drawing (rolling) seamless method.

6.3.2 Stainless-steel tubes and pipes should be manufactured by hot rolling (extrusion) or cold rolling (drawing) seamless method.

6.3.3 35CrNi3MoV steel tubes and pipes for polyethylene can be manufactured by forging round billets or rolling round billets through mechanical processing, or by hot rolling (extrusion, top) seamless method.

6.4 Delivery states

6.4.1 High-quality carbon steel, low alloy steel and alloy steel tubes and pipes should be delivered in heat-treated state.

6.4.2 Stainless-steel tubes and pipes should be delivered in a heat-treated and pickled passivation state. Steel tubes and pipes that have been through overall grinding, boring, or heat treatment in a protective atmosphere may be delivered without pickling.

6.4.3 The heat treatment system of steel tubes and pipes shall comply with the requirements of Table 1.

7 Technical requirements

7.1 Steel designation and chemical composition

7.1.1 The steel designation and chemical composition (melting composition) shall comply with the requirements of Table 2. For a comparison of domestic and foreign steel designations, see Annex A.

c) The grain size grade of 07Cr19Ni10, 07Cr19Ni11Ti and 07Cr18Ni11Nb steel tubes and pipes should be 4~7.

7.9 Intergranular corrosion

7.9.1 Stainless-steel tubes and pipes shall be subjected to an intergranular corrosion test. The test method shall comply with the provisions of Method E in GB/T 4334-2020. After the test, the specimens shall show no tendency towards intergranular corrosion.

7.9.2 The purchaser may specify other corrosion test methods after consultation between the supplier and the purchaser and after stating it in the contract.

7.10 Surface quality

7.10.1 The inner and outer surfaces of the steel tubes and pipes shall be free of cracks, folds, scars, rolls, and delamination. These defects shall be completely removed. The removal depth shall not exceed 10% of the wall thickness. The actual wall thickness at the defect removal site shall not be less than the minimum allowable wall thickness.

7.10.2 Except for 35CrNi3MoV steel tubes and pipes for polyethylene, the allowable depth or height of straight lines on the inner and outer surfaces of steel tubes and pipes shall comply with the following provisions:

a) Cold drawn (rolled) steel tubes and pipes: not more than 4% of the wall thickness, and a maximum of 0.2 mm;

b) Hot rolled (extruded, topped, expanded) steel tubes and pipes: not more than 5% of the wall thickness and a maximum of 0.4 mm.

7.10.3 Except for 35CrNi3MoV steel tubes and pipes for polyethylene, other local defects that do not exceed the lower allowable deviation of the wall thickness are allowed.

7.10.4 The iron oxide scale on the inner and outer surfaces of the steel tubes and pipes should be removed, but a thin oxide layer that does not hinder inspection is allowed to exist.

7.10.5 The inner surface roughness Ra of 35CrNi3MoV steel tubes and pipes for polyethylene shall not exceed 0.8 μm. The outer surface roughness Ra shall not exceed 1.6 μm. Special requirements shall be negotiated between the supplier and the purchaser and shall be specified in the contract.

7.11 Nondestructive testing

7.11.1 For steel tubes and pipes with a wall thickness to outer diameter ratio not greater than 0.2, ultrasonic testing shall be carried out along the entire length of each pipe in accordance with the provisions of GB/T 5777-2019. The acceptance level shall be U2.

7.11.2 For steel tubes and pipes with a wall thickness to outer diameter ratio greater than 0.2 and less than 0.3, each tube and pipe shall be ultrasonically tested along its entire length in accordance with the provisions of GB/T 31925-2015. The acceptance level shall be U2.

7.11.3 For steel tubes and pipes with a wall thickness to outer diameter ratio of not less than 0.3, unless otherwise specified in the contract, each tube and pipe shall be ultrasonically tested along its entire length in accordance with A.3 of Annex A to GB/T 5777-2019. The acceptance level shall be U2.

7.11.4 When steel tubes and pipes are delivered according to the minimum wall thickness, the groove depth of the comparison sample tube and pipe is calculated based on the average wall thickness.

7.11.5 Upon agreement between the supplier and purchaser, and as otherwise specified in the contract, the exterior and end surfaces of steel tubes and pipes may be subjected to 100% magnetic particle inspection in accordance with GB/T 42673 or 100% penetrant inspection in accordance with GB/T 42677. Acceptance levels are M1 or P1, respectively. For the interior surface within a 100 mm length of the ends of steel tubes and pipes with a nominal diameter of 114 mm or more, 100% magnetic particle inspection in accordance with GB/T 42673 or 100% penetrant inspection in accordance with GB/T 42677. Acceptance levels are M1 or P1, respectively.

7.11.6 35CrNi3MoV steel tubes and pipes for polyethylene shall also be subjected to eddy current testing one by one in accordance with GB/T 7735. The acceptance level shall be E2 or E2H.

7.11.7 Other non-destructive testing may be performed upon request of the purchaser, after consultation between the purchaser and the supplier, and if specified in the contract.

7.12 High-quality carbon steel tubes and pipes for use in H_2S-containing environments

When the purchaser specifies in the contract that the pipes are to be used in an environment containing H_2S, the supplementary technical requirements for crack resistance of high-quality carbon steel tubes and pipes shall comply with the provisions of Annex D. It is the purchaser's responsibility to select steel tubes and pipes suitable for the expected service conditions in GB/T 20972.2.

7.13 Stainless-steel tubes and pipes for industrial furnaces in petrochemical hydrogenation units

When the purchaser specifies in the contract that the stainless-steel tubes and pipes are used for an industrial furnace in a petrochemical hydrogenation unit, the supplementary technical requirements for the stainless-steel tubes and pipes shall comply with the provisions of Annex E.

7.14.8.2 For steel tubes and pipes delivered according to the minimum wall thickness, the average wall thickness should be used to calculate the theoretical weight.

7.14.9 Weight tolerance

According to the purchaser's requirements, after consultation between the supplier and the purchaser and specified in the contract, the deviation between the actual weight of the delivered steel tubes and pipes and the theoretical weight shall comply with the following provisions:

a) Single steel tube and pipe: $^{+10}_{-5}$ %;

b) Steel tube and pipe batches with a minimum of 10 tons: ±7.5%.

8 Specimens

8.1 Tensile test specimens

8.1.1 For steel tubes and pipes with a diameter of D < 219 mm, samples for the tensile test should be taken along the longitudinal direction of the steel tubes and pipes.

8.1.2 For steel tubes and pipes with a diameter of D ≥ 219 mm, when the tube and pipe size permits, a circular cross-section specimen with a diameter of 10 mm shall be cut from the transverse direction of the tube and pipe for the tensile test. If the tube and pipe size is insufficient to allow a 10 mm specimen to be cut, a transverse circular cross-section specimen with a diameter of 8 mm or 5 mm, whichever is larger, shall be used.

If the tube and pipe size is insufficient to allow a 5 mm circular cross-section specimen to be cut, the tensile test shall be conducted by sampling along the longitudinal direction of the tube and pipe. Transverse circular cross-section specimens shall be taken from un-flattened samples.

8.2 Impact test specimens

For impact test, specimens should preferably be cut transversely along the steel tube and pipe. If transverse specimens are not possible, specimens should be cut longitudinally. Regardless of whether the specimens are cut transversely or longitudinally, the impact specimens should be standard size, 7.5 mm thick, or 5 mm thick, whichever is larger.

8.3 Bending test specimens

8.3.1 Specimen preparation

Bending test specimens should be cut transversely from one end of the steel tube and pipe. Specimen preparation should comply with the requirements of GB/T 232. Forward bend specimens should be cut as close to the outer surface as possible. Reverse bend specimens should be cut as close to the inner surface as possible. The tensile deformation surface of the specimen should be free of visible scratches and other defects.

8.3.2 Specimen size

The cross-sectional dimensions of the specimen after processing are 12.5 mm × 12.5 mm or 25 mm × 12.5 mm (width × thickness). The four corners of the cross-sectional area should be rounded. The fillet radius should not exceed 1.6 mm. The specimen length should not exceed 150 mm.

9 Test methods

9.1 Sampling for chemical composition analysis of steel tubes and pipes shall comply with the rules of GB/T 20066. Chemical composition analysis generally complies with the provisions of GB/T 4336, GB/T 11170, GB/T 20123, GB/T 20124, GB/T 20125, YB/T 4395, YB/T 4396 or other general methods. The arbitration shall comply with GB/T 223.5, GB/T 223.9, GB/T 223.11, GB/T 223.12, GB/T 223.14, GB/T 223.18, GB/T 223.19, GB/T 223.23, GB/T 223.25, GB/T 223.26, GB/T 223.28, GB/T 223.29, GB/T 223.30, GB/T 223.31, GB/T 223.36, GB/T 223.37, GB/T 223.38, GB/T 223.40, GB/T 223.43, GB/T 223.47, GB/T 223.50, GB/T 223.59, GB/T GB/T 223.63, GB/T 223.78, GB/T 223.80, GB/T 223.84, GB/T 223.85, GB/T 223.86, GB/T 20125, YB/T 4395, and YB/T 4396.

9.2 The size and shape of steel tubes and pipes should be measured one by one using measuring tools that meet the accuracy requirements.

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