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

GB/T 40297-2021

**Seamless austenitic stainless steel pipes for high pressure
hydrogen**

高压加氢装置用奥氏体不锈钢无缝钢管

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1 Scope

China's national standard for seamless austenitic stainless steel pipe for high pressure hydrogen service. It specifies the terms and definitions, the classification and the technical requirements. Hydrogen embrittles steel: atomic hydrogen diffuses into the lattice, collects at defects and grain boundaries, and turns a ductile material into one that cracks under load it would otherwise carry. The effect is worse at the pressures a hydrogen system uses - seventy megapascals at a refuelling station - and worse still in the steels that are otherwise attractive for pressure work. Stable austenitic stainless steels are the exception: their face-centred cubic structure dissolves hydrogen readily but is far less embrittled by it, provided the composition is stable enough that deformation does not transform it to martensite, which is embrittled severely. That stability requirement is what distinguishes this specification from an ordinary stainless pipe standard.

This document specifies the classification and code, order content, size, shape and weight, technical requirements, test methods, inspection rules, packaging, marking and quality certificate of seamless austenitic stainless steel pipes for high pressure hydrogenation unit. This document applies to seamless austenitic stainless steel pipes for high pressure hydrogenation units (hereinafter referred to as "steel pipes"); it also applies as a reference

for seamless austenitic stainless steel pipes for other hydrogen condition devices.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. 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 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 223.25, Methods for chemical analysis of iron, steel and alloy. The dimethylglyoxime gravimetric method for the determination of nickel content

GB/T 223.28, Methods for chemical analysis of iron, steel and alloy. The alpha-benzoinoxime gravimetric method for the determination of molybdenum content

GB/T 223.37, Iron, steel and alloy - Determination of nitrogen content - Indophenol blue spectrophotometric method after distillation separation

GB/T 223.40, Iron, steel and alloy - Determination of niobium content by the sulphochlorophenol S spectrophotometric method

GB/T 223.59, Iron, steel and alloy - Determination of phosphorus content - Bismuth phosphomolybdate blue spectrophotometric method and antimony phosphomolybdate blue spectrophotometric method

GB/T 223.60, Methods for chemical analysis of iron, steel and alloy - The perchloric acid dehydration gravimetric method for the determination of silicon content

GB/T 223.63, Methods for chemical analysis of iron, steel and alloy - The sodium (potassium) periodate photometric method for the determination of manganese content

GB/T 223.82, Steel and iron - Determination of hydrogen content - Thermal conductivity/infrared method after fusion under inert gas

GB/T 223.84, Steel and iron - Determination of titanium content - Diantiprylmethane spectrophotometric method

GB/T 223.85, Steel and iron - Determination of sulfur content - Infrared absorption method after combustion in an induction furnace

GB/T 223.86, Steel and iron - Determination of total carbon content - Infrared absorption method after combustion in an induction furnace

3 Terms and definitions

Terms and definitions determined by GB/T 30062 are applicable to this document. The end faces of both ends of the steel pipe shall be perpendicular to the axis of the steel pipe; the cut burrs shall be removed. As required by the buyer, negotiated between the supplier and the buyer, and indicated in the contract, the two ends of the steel pipe can be processed with grooves, and the groove type shall be determined through negotiation between the supplier and the buyer.

6.5 Out-of-roundness and unevenness in wall thickness The out-of-roundness and unevenness in wall thickness of the steel pipe shall not exceed 80% of the outside diameter allowance and the wall thickness allowance, respectively.

6.6 Weight

6.6.1 Steel pipes shall be delivered by actual weight. After it is negotiated between the supplier and the buyer, and indicated in the contract, the steel pipes can also be delivered according to the theoretical weight. The theoretical weight of the steel pipe per meter is calculated according to Formula (1): Where: W - theoretical weight of the steel pipe, in kilograms per meter (kg/m); π - pi, which shall be 3.141 6; ρ - density of steel, in kilograms per cubic decimeter (kg/dm³), as shown in Table 4; S - wall thickness of the steel pipe, in millimeters (mm); D - nominal outside diameter of the steel pipe, in millimeters (mm).

6.6.2 For steel pipes delivered according to the nominal outside diameter and minimum wall thickness, the theoretical weight shall be calculated by the average wall thickness. The average wall thickness is the average value of the maximum and minimum wall thicknesses calculated according to the wall thickness and its permissible deviation.

6.6.3 When the steel pipes are delivered according to the theoretical weight, the supplier and the buyer can negotiate the weight permissible deviation and indicate it in the contract.

7 Technical requirements

7.1 Steel designation and chemical composition The tube blank shall be manufactured by hot rolling (forging) method, and shall comply with the provisions of YB/T 5137; the total elongation coefficient of processing deformation shall not be less than 3.

Note: The total elongation coefficient of processing deformation is usually expressed by the cross-sectional area ratio, length ratio or height ratio before and after deformation.

7.2.3 Manufacturing method of steel pipes Steel pipes shall be manufactured by cold rolling (drawing) or hot rolling (extruding, upsetting, forging). Where the buyer specifies a certain manufacturing method, it shall be indicated in the contract.

7.3 Delivery state

7.3.1 Steel pipes shall be delivered after heat treatment and pickling. All steel pipes that have been wholly ground, bored or heat-treated in protective atmosphere can be delivered without pickling. See Table 4 for the recommended heat treatment system for steel pipes.

7.3.2 06Cr18Ni11Ti, 07Cr19Ni11Ti, 06Cr18Ni11Nb and 07Cr18Ni11Nb steel pipes shall be subjected to stabilization heat treatment after solution heat treatment. The stabilization heat treatment system shall be determined through negotiation between the supplier and the buyer.

7.3.3 For hot-rolled (extruded, upset, forged) steel pipes, if direct water cooling or other rapid cooling is carried out within the heat treatment temperature range specified in Table 4 after hot deformation, it shall be deemed that the steel pipe solution heat treatment requirements have been met.

7.3.4 After it is negotiated between the supplier and the buyer, and indicated in the contract, other heat treatment systems other than those specified in Table 4 can be adopted for the steel pipe.

7.4.1 Mechanical properties

7.4.1 Room temperature mechanical properties The room temperature mechanical properties of the steel pipes in the delivery state shall comply with the requirements in Table 4. Where: p - test pressure, in megapascals (MPa), which shall be rounded off to the nearest

0.5 MPa when $p < 7$ MPa, and to the nearest 1 MPa when $p \geq 7$ MPa; S - wall thickness of the steel pipe, in millimeters (mm); R - allowable stress, which shall be 60% of the minimum plastic elongation strength specified in Table 4, in megapascals (MPa); D - nominal outside diameter of the steel pipe, in millimeters (mm).

7.5.2 The chloride ion (Cl^-) content (mass fraction) in the water used for the hydraulic test shall not exceed 25×10^{-6} .

7.5.3 With the consent of the buyer, the supplier may use eddy current testing instead of the hydraulic test. In eddy current testing, the acceptance grade shall meet the requirements of E4H or E4 in GB/T 7735-2016.

7.6.1 Flattening

7.6.1.1 The steel pipes shall be subjected to a flattening test. Flattening shall be performed in the following two steps.

a) The first step is the ductility test. The sample shall be pressed to H , the distance between the two plates, and shall not have cracks or breaches. H shall be calculated according to Formula (3). Where: H - the distance between the two plates, in millimeters (mm); α -