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W-22 STAINLESS STEEL PIPES

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Foreword:

This Guide is a part of CCS Rules, which contains technical requirements, inspection and testing criteria related to classification and statutory survey of marine products.

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Historical versions and release date :

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STAINLESS STEEL PIPES

1 Application

1.1 This chapter applies to the works approval and product inspection of stainless steel pipes manufactured in accordance with CCS Rules for Materials and Welding and other applicable standards.

1.2 The Guidelines apply to stainless steel pipes made by electric arc furnace or converter furnace + AOD or VOD furnace, or by other methods such as electroslag or vacuum consumable remelting; seamless steel pipes formed by means of extrusion, piercing and drawing, rolling, or by other deep processing methods such as cold drawing, cold pulling, cold rolling, rotary extrusion, etc.; finished seamless austenitic stainless steel pipes and seamless duplex steel pipes which are delivered in the solution treated or solution + ageing treated condition.

1.3 The Guidelines apply to straight seam welded pipes made of austenitic stainless steel plate or duplex stainless steel plate.

2 Normative references

Chapter 4, PART ONE of CCS Rules for Materials and Welding

Other applicable standards.

3 Definitions

3.1Austenitic stainless steel

Austenitic stainless steel is a kind of stainless steel having austenite structure at normal temperature.

3.2 Austenite

Austenite is an interstitial solid solution formed by carbon dissolved in γ iron, in face centered cubic structure and is not magnetic. Austenites are the structures of ordinary steels at high temperatures and exist within a certain range of temperature and composition. For some quenched steels, a portion of the austenites can be retained to room temperature. Such austenites are called retained austenites. For alloy steels, other alloy elements besides carbon can also dissolve in austenites and enlarge or reduce the temperature and composition range of the stable austenite area.

Addition of manganese and nickel into the steel will reduce the critical transition temperature of austenites to the values below the room temperature and enable the steel to retain its austenite structures at such temperature. Such steel is called austenitic steel.

3.3 Duplex stainless steel

Duplex stainless steel is a kind of steel for which the ferrite phase and austenite phase account for approximately fifty percent respectively in its solution structures, and the content of the lesser phase needs to reach 30%. With lower C content, the Cr content is 18%-28% and the Ni content 3%-10%. Some steels also contain the elements such as Mo, Cu, Nb, Ti, N, etc. Duplex stainless steel has the characteristics of both austenitic and ferritic stainless steels. Compared with ferritic steels, duplex stainless steel features higher plasticity and ductility, does not have brittleness at room temperature and its pitting corrosion resistance is significantly improved; in addition, it retains the 475 ℃ brittleness of ferritic stainless steel and has the characteristics of high heat transfer coefficient, superplasticity, etc. Compared with austenitic stainless steels, the duplex stainless steel has higher strength and its pitting corrosion resistance and chloride stress corrosion resistance are significantly improved. Duplex stainless steel has good pitting corrosion resistance and is also a kind of nickel saving stainless steel.

3.4 Seamless steel pipe

Seamless steel pipe is a circular steel material with hollow cross section and without peripheral joints. A steel ingot or solid pipe billet is pierced and made into a rough pipe, and then the rough pipe is made into a seamless steel pipe by means of hot rolling, cold rolling or cold drawing. Seamless steel pipes have hollow cross sections and are extensively used for fluid delivery and widely used to manufacture structural components and machinery parts such as drill pipe, automobile transmission shaft, bike frame, steel scaffold used in building construction, etc.

3.5 Welded steel pipe

Welded steel pipe is made of steel plate or band which is rolled into tubular shape and welded. Welded steel pipe may be categorized into electric arc welded pipe, high-frequency or low-frequency electric resistance welded pipe, gas welded pipe, furnace butt-welded pipe, etc. depending on welding method.

3.4 Intercrystalline corrosion

Under the action of corrosive media, corrosion between the crystal grains of stainless steel may occur. This phenomenon is referred to as intercrystalline corrosion.

Stainless steel that has sustained intercrystalline corrosion will experience fracture along the crystal boundary and its strength will almost be completely lost. This is the most harmful form of damage for stainless steels. Intercrystalline corrosion usually occurs in the heat affected zone (HAZ) of the welded joint, welding seam or fusion line. Intercrystalline corrosion occurring in the fusion line is also referred to as knife line attack (KLA).

3.5 Pitting corrosion

Pitting corrosion of stainless steel is a phenomenon in which a certain portion of the stainless steel is corroded into some small and deep pits, and the corrosion products and corrosive media concentrate at the bottom of the corrosion points to exert further corrosive action.

4 Documents and information

4.1 The following documents and information are to be submitted to CCS for review:

4.1.1 Basic information of the manufacturer

Name, address, contact information, history and current situation of the manufacturer, information on production history and use of existing products, product types and specifications, delivery condition, the level and number of operating personnel, etc.;

4.1.2 Name/intended purpose of main production equipment, the time when the equipment was put into use, technical parameters of the equipment

Mainly including the following equipment for seamless steel pipes:

(1)Steel making, refining and vacuum degassing treatmentequipment (if any)

(2)Mold casing equipment (if any)

(3)Peeling machine

(4)Heating furnace

(5)Extruding machine or piercing machine

(6)Pipe expanding, drawing, pulling and rolling equipment

(7)Degreasing unit/pickling unit

(8)Straightening machine

(9)Heat treatment furnace

and mainly including the following equipment for welded steel pipes:

(1)Steel plate shearing machine, steel plate cutting machine

(2)Steel plate planning machine

(3)Hydraulic U forming machine, hydraulic O forming machine

(4)Automatic welding set

(5)Degreasing unit

(6)Heat treatment furnace

(7)Sizing press

(8)Pickling unit.

4.1.3 Test/testing equipment

Name, model and calibration status of equipment used for chemical components analysis, mechanical test, process test, metallurgical and macrostructre tests, hydraulic test, NDT, etc.

4.1.4 List of qualified raw material suppliers

The manufacturer is to prepare a list of qualified raw material suppliers as a formal document. The list is required to include the following details:

Name of the manufacturer, names of raw material suppliersor manufacturers, whether the material is purchased or produced by the manufacturer itself, the method of raw material quality control, signature and stamp of the company, document number, etc. Steel ingots or plates used as raw materials for seamless stainless steel pipes and welded steel pipes are to be manufactured by steel mills approved by CCS.

4.1.5 Details of products for which approval is being applied (grade designation, specifications, delivery condition, etc.)

The grade designation, scope of specifications, heat treatment status and executive standard of the products are to be indicated.

4.1.6 Process flow chart and detailed manufacture and fabrication process of the products for which approval is being applied

In addition to process flow chart, the manufacturer is also to submit the documents related to the operation and control of the main process points.

4.1.7 Copies of enterprise legal person certificate and trademark certificate, manufacturer quality management system certificates

4.1.8 Technical specifications or relevant enterprise standards for product delivery and acceptance

4.1.9 Quality certification (quality conformity certificate) is to be prepared in the format and content specified by CCS.

4.1.10 Quality system documents (including manuals and procedures)

4.1.11 Qualification certificate and competency level of personnel of special trades such as mechanical and chemical tests and NDT.

4.2Type test plan is to be submitted to CCS for approval

The test program may be proposed by the applicant and approved by CCS after mutual consultations, or prepared by CCS and upon confirmation by the applicant, approved by CCS. The test program is to cover at least the following aspects:

(1) Type, specifications and delivery conditions of the products for which approval is being applied;

(2) Typical samples selected for type test;

(3) Specific type testitems and adopted codes, standards, etc.;

(4) Test specimen sampling drawing;

(5) Type and number of test specimens, sampling locations, etc.;

(6) Test location and laboratory qualification;

(7) Disposal of nonconformities.

5 Selection of typical samples for type test

5.1 In the test program, the typical samples to be selected are to represent the production capacity range and quality control level of the manufacturer. The principle for selection: products with greater wall thickness are to be selected for the test based on the manufacturer’s production capacity.

5.2 Manufacturers applying for approval of multiple products are required to sample the test specimens for austenitic stainless steel pipes and duplex stainless steel pipes respectively by abovementioned principle.

6 Type test

6.1 The type testitems and requirements of seamless stainless steel pipes are as follows:

6.1.1Chemical components analysis

The chemical components analysis is to include steel makingcomponents analysis and finished product (sampled steel pipe) analysis and to test at least the following elements: C, Si, Mn, P, S, Cr, Ni, Mo, N, Ti, Nb, etc. For specific steel types, reference may be made to the corresponding applicable standards for the products.

6.1.2 Tensile test

The tensile test is to determine the proof strength at non-proportional extension Rp1.0 (Rp0.2 may be used as reference), tensile strength and elongation rate. The tensile test specimens are generally to be the plate specimens of full material thickness and to be taken along the longitudinal direction and tangential direction of the steel pipe respectively. The tensile test specimens are to be taken respectively at locations close to the head end and tail end of the steel pipe. For the tensile test of steel pipes of diameters less than φ30mm, the requirements described in the applicable codes are to be complied with.

6.1.3 Bend test

Where a bend test is to be carried out, two flattened plate strips of full material thickness are to be taken along the tangential direction of the steel pipe as the test specimens. The test specimens are to be at a bend angle of 180 °and undergo normal bend test and reverse bend test. The mandrel

diameter D=3t. Steel pipes of diameters less than φ30mm are defined as small diameter steel pipes and may be exempted from bend test; only flattening test is required for them.

6.1.4 Impact test

Where an impact test is to be carried out, V-notch impact test specimens are to be taken along the longitudinal direction and tangential direction respectively. The impact test temperature is to be -20 ℃ and -196 ℃ for austenitic stainless steel pipes and -20 ℃ for duplex stainless steel pipes. The test may be conducted to determine the impact values only.

6.1.5 Flattening test

For steel pipes of diameters less than φ30mm, flattening test may be carried out. Flattening test specimens are to be taken at the head end and tail end of the steel pipe respectively.

6.1.6 Hardness test

Hardness test specimens are to be taken from the finished steel pipe.

6.1.7 Flanging test, drift expanding test

Flanging and drift expanding tests may be carried out as necessary in accordance with the applicable standards.

6.1.8 Hydraulic test

Hydraulic test is to be carried out at the pressure specified by CCS. Using eddy current testing to be in lieu of hydraulic test is to be approved by CCS. Hydraulic test is not to be replaced by ultrasonic testing or X-ray testing.

6.1.9 Microstructure examination

100× and 500× microstructures are to be sampled respectively from a finished steel pipe and examined to determine the crystal grain size, non-metallic inclusion, etc. For duplex stainless steels, the contents of austenite and ferrite are required to be determined.

6.1.10 Macrostructure examination

The macrostructure examination of pipe billets and finished steel pipes may be carried out in accordance with other testing standards.

6.1.11 Corrosion test

Austenitic stainless steel plates are to be subject to intercrystalline corrosion test and duplex stainless steel plates subject to intercrystalline corrosion test and pitting corrosion test, in accordance with the requirements of CCS rules.

6.1.12 NDT

Non-destructive test, including eddy current testing and ultrasonic testing, may be carried out in accordance with applicable standards.

6.1.13 Visual and dimensional inspection is to be carried out in compliance with the requirements of applicable codes and standards.

6.2 Type testitems and requirements of welded stainless steel pipes are as follows:

6.2.1Chemical components analysis

Specimens are to be taken from a finished steel pipe for chemical components analysis of at least the following elements: C, Si, Mn, P, S, Cr, Ni, Mo, N, Ti, Nb, etc. For specific steel types, reference may be made to the corresponding applicable standards of the products

6.2.2 Tensile test

The tensile test specimens are to be sampled from the weld and parent metal respectively. For weld metal, the tensile test specimens are to be taken along the direction vertical to the welding seam and only tensile strength is to be determined. For parent metal, the tensile test specimens are generally to be the plate specimens of full material thickness and to be taken along the longitudinal direction and tangential direction of the steel pipe respectively. Tensile strength and elongation rate are to be determined. The tensile test specimens are to be taken respectively at locations close to the head end and tail end of the steel pipe. For the tensile test of steel pipes less than φ30mm in diameter, the requirements described in the applicable codes are to be complied with.

6.2.3 Bend test

Where a bend test is to be carried out, two flattened plate strips of full material thickness are to be taken along the tangential direction of the steel pipe parent metal as the test specimens. The test specimens are to be at a bend angle of 180 °and undergo normal bend test and reverse bend test.

Steel pipes less than φ30mm in diameter are defined as small diameter steel pipes and may be exempted from bend test; only flattening test is required for them.

6.2.4 Impact test

Where an impact test is to be carried out, V-notch impact test specimens are to be taken along the longitudinal direction and tangential direction respectively. The impact test temperature is to be -20 ℃ and -196 ℃ for austenitic stainless steel pipes and -20 ℃ for duplex stainless steel pipes. The test may be conducted to determine the impact values only.

6.2.5 Flattening test

For steel pipes of smaller outer diameter and thickness, flattening test may be carried out. Flattening test specimens are to be taken from the head end and tail end of the steel pipe respectively.

6.2.6 Hardness test

Hardness test specimens are to be taken from the parent metal of the finished steel pipe.

6.2.7 Hydraulic test

Hydraulic test is to be carried out at the pressure specified by CCS. Using eddy current testing to be in lieu of hydraulic test is to be approved by CCS. Hydraulic test is not to be replaced by ultrasonic testing or X-ray testing.

6.2.8 Microstructure examination

100× and 500× microstructures are to be sampled respectively from the parent metal of a finished steel pipe and examined to determine the crystal grain size, non-metallic inclusion, etc. For duplex stainless steels, the contents of austenite and ferrite are required to be determined.

6.2.9 Macrostructure examination

The macrostructure examination of the parent metal of finished steel pipes may be carried out in accordance with other testing standards.

6.2.10 Corrosion test

Austenitic stainless steel pipes are to be subject to intercrystalline corrosion test and duplex

stainless steel pipes subject to intercrystalline corrosion test and pitting corrosion test, in accordance with the requirements of CCS rules.

6.2.11 NDT

Non-destructive test, including eddy current testing and ultrasonic testing, may be carried out in accordance with the applicable standards.

6.2.12 Visual and dimensional inspection is to be carried out in compliance with the requirements of the applicable codes and standards.

6.2.13 Special tests of welded steel pipe

6.2.13.1 Welding seams of steel pipes are to be subject to 100% X-ray testing in accordance with the applicable standards.

6.2.13.2 Weld tensile test

Tensile test specimens are to be taken from the weld metal depending on the grade designation and specifications to determine the tensile strength. The weld tensile test specimens are to be taken from the welding seam and the welding seam is to be located in the middle of the test specimen and represent the full thickness of the pipe from which the test specimen is taken.

6.2.13.3 Weld bend test

Circumferential plate strips of full material thickness are to be taken with the welding seam as the center line. Bend diameter D=3t (t means wall thickness). The test specimens are to be bent along the original bend direction at a bending angle of 180 °, with one specimen for face bend test and the other for root bend test. The test specimens after bending are to be free of crack or delamination.

Steel pipes less than φ30mm in diameter may be exempted from weld bend test.

6.2.13.4 Weld impact test (only limited to welded duplex stainless steel pipes):

Specimens are to be taken from a welded steel pipe at the locations of welding seam, fusion line and fusion line+5mm for Charpy V-notch impact test. Three transverse impact test specimens are to be prepared. The test temperature is to be -20 ℃ and the transverse impact energy is to be no less than 27J.

6.2.13.5 Weld hardness test (only limited to welded duplex stainless steel pipes)

One test specimen is to be taken along the welding seam respectively (at the locations of heat affected zone, fusion line and weld zone) for hardness test in accordance with the applicable standards.

7Unit/batch inspection

7.1 The manufacturer, once qualified through works approval by CCS, is to apply to CCS for product inspection of the steel pipes produced under the conditions of approval and within the scope of approval. The products are allowed to be used on board only after satisfactory inspection.

7.2 Specific requirements on unit/batch inspection items will be informed in writing to the manufacturer in the form of product inspection program when CCS issues the works approval certificate.

7.3 List of approval test and manufacturer inspection items is included in the appendix.

8 Identification

The manufacturer is to identify the steel pipes qualified through inspection with CCS inspection marks and the following marks on one end or both ends.

8.1 Name and trademark of the manufacturer

8.2 Specifications and type of steel pipes

8.3 Product heat number, batch number

8.4 Time of inspection

8.5 CCS steel stamp or anti-counterfeiting label.

9 Product warranty certificate

The contents of manufacturer’s quality conformity certificate or warranty certificate are to be prepared in accordance with the relevant requirements of CCS.

Upon satisfactory inspection, the product certificate will be issued or the warranty certificate will be endorsed.

Appendix 1:

Test items for seamless stainless steel pipes

No.	Items	Technical requirements	Test type	
			Approval test	Manufacturer test
1.	Chemical components analysis	6.1.1	×	×
2.	Tensile test	6.1.2	×	×
3.	Bend test	6.1.3	×*	×
4.	Impact test	6.1.4	×	--
5.	Flattening test	6.1.5	×*	--
6.	Hardness test	6.1.6	×*	--
7.	Hydraulic test	6.1.8	×	×
8.	Microstructure examination	6.1.9	×	--
9.	Macrostructure examination	6.1.10	×	--
10.	Corrosion test	6.1.12	×	×
11.	NDT	6.1.13	×*	×*
12.	Visual and dimensional inspection	6.1.14	×	×

Notes:

(1) Explanation of test type: "×" represents mandatory inspection items, "×*" represents optional inspection items and "–" represents the test or inspection is not to be carried out.

(2) The selection of flattening test and bend test is to be in accordance with the requirements of CCS Rules for Materials and Welding.

Appendix 2:

Test items for welded stainless steel pipes

No.	Items	Technical requirements	Test type	
			Approval test	Manufacturer test
1	Chemical components analysis	6.2.1	×	×
2	Tensile test	6.2.2	×	×
3	Bend test	6.2.3	×*	×
4	Impact test	6.2.4	×	--
5	Flattening test	6.2.5	×*	--
6	Hardness test	6.2.6	×*	--
7	Hydraulic test	6.2.7	×	×
8	Microstructure examination	6.2.8	×	--
9	Macrostructure examination	6.2.9	×	--
10	Corrosion test	6.2.11	×	×
11	NDT	6.2.12	×*	×*
12	Visual and dimensional inspection	6.2.13	×	×
13	Special tests of welded steel pipes	6.2.14	×	--

Notes: ① Explanation of test type: "×" represents mandatory inspection items, "×*" represents optional inspection items and "–" represents the test or inspection is not to be carried out.

② The selection of flattening test and bend test is to be in accordance with the requirements of CCS Rules for Materials and Welding.