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NB/T 47008-2017

Replacing NB/T 47008-2010, JB/T 9626-1999

**Carbon and alloy steel
forgings for pressure equipment**

承压设备用碳素钢和合金钢锻件

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Foreword

This Standard is drafted according to the rules given in GB/T 1.1-2009 "Directives for standardization - Part 1: The structure and drafting of standards".

This Standard replaces NB/T 47008-2010 "Carbon and alloy steel forgings for pressure equipment" and incorporates the relevant contents of JB/T 9626-1999 "Specification for boiler forging". Compared with NB/T 47008-2010, the main technical changes are as follows:

- ADD 5 steel forging designations, i.e. 12CrMo, 30CrMo, 10Cr9MoW2VNbBN, 09CrCuSb, 08Cr2AlMo, and 2 steel forging designations, i.e. 35CrNi3MoV, 36CrNi3MoV, for ultra-high pressure vessels;
- CANCEL the contents of design pressure and design temperature in the scope;
- REFINED the relevant requirements for the order content;
- ADD the requirements for low magnification test;
- ADD the requirements for metallographic examination;
- IMPROVE the quality grade of ultrasonic testing for steel forgings;
- ADD the requirements for hydrogen-induced cracking (HIC) test;
- MODIFY the permissible criteria for welding;
- ADD 6 forging designations, i.e. 25,25Cr2MoV, 25Cr2MoIV, 20CrIMoIVNbTiB, 20CrIMoIVTiB, 38CrMoAl, for supporting valves and special components;
- ADD the table of high temperature mechanical properties of commonly used forging steels.

Annex A and Annex C of this Standard are informative. Annex B is normative.

This Standard is proposed by and shall be under the jurisdiction of China Standardization Committee on Boilers and Pressure Vessels (SAC/TC 262).

Drafting organizations of this Standard: Hefei General Machinery Research Institute, China Special Equipment Inspection and Research Institute, Shanghai Power Equipment Research Institute, China First Heavy Industries, Dalian Jinzhou Heavy Machinery Group Co., Ltd., Zhangjiagang Haiguo New Energy Equipment Manufacturing Co., Ltd., Dashi-qiao Petrochemical Machinery Forge (general Partnership), China Sinopec Engineering Incorporation, Wuxi Hongda Heavy Forging Products Co., Ltd., Shanghai Boiler Works Co., Ltd., Dongfang Boiler Group Co., Ltd.

Carbon and alloy steel forgings for pressure equipment

1 Scope

This Standard specifies terms and definitions, order content, technical requirements, test methods, inspection rules and markings and quality certificates of carbon and alloy steel forgings for pressure equipment.

2 Normative references

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

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

GB/T 223 Methods for chemical analysis of iron, steel and alloy (applicable parts)

GB/T 226 Test method for macrostructure and defect of steel by etching

GB/T 228.1 Metallic materials - Tensile testing - Part 1: Method of test at room temperature

GB/T 228.2 Metallic materials - Tensile testing - Part 2: Method of test at elevated temperature

GB/T 229 Metallic materials - Charpy pendulum impact test method

GB/T 231.1 Metallic materials - Brinell hardness test - Part 1: Test method

GB/T 4336 Carbon and low-alloy steel - Determination of multi-element contents - Spark discharge atomic emission spectrometric method (routine method)

GB/T 6394 Metal - Methods for estimating the average grain size

GB/T 8650 Evaluation of pipeline and pressure vessel steels for resistance to hydrogen-induced cracking

GB/T 10561 Steel - Determination of content of nonmetallic inclusions - Micrographic method using standards diagrams

GB/T 13298 Inspection methods of microstructure for metals

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 (routine method)

NB/T 47013.3 Nondestructive testing of pressure equipment - Part 3: Ultrasonic testing

NB/T 47013.4 Nondestructive testing of pressure equipment - Part 4: Magnetic particle testing

NB/T 47013.5 Nondestructive testing of pressure equipment - Part 5: Penetrant testing

3 Terms and definitions

3.1

hollow forging

Axisymmetric hollow forging with an axial length L greater than its outer diameter D , as shown in Figure 1 a). t is the nominal thickness.

3.2

ring forging

Axisymmetric hollow forging with an axial length L less than or equal to its outer diameter D , as shown in Figure 1 b). The smaller one of L and t is the nominal thickness.

3.3

disk forging

Axisymmetric solid forging with an axial length L less than or equal to its outer diameter D , as shown in Figure 1 c). L is the nominal thickness.

3.4

bowl forging

5 Technical requirements

5.1 Smelting method

Forging steel shall be killed steel smelted using electric furnace or oxygen converter and subjected to secondary refining. Agreed upon between the supply and demand parties, electroslog remelting and other smelting methods can be used.

5.2 Chemical composition

5.2.1 Smelting analysis

5.2.1.1 Forge steel designation and chemical composition (smelting analysis) shall comply with the provisions of Table 1.

5.2.1.2 Designation and chemical composition of steel for forgings of supporting valves and special components is shown in Annex A.

5.2.1.3 As required by the demand party, and indicated in the contract in Table 1, the P, S content of 35 steel in Table 1 can be $P \leq 0.025 \%$, $S \leq 0.015 \%$.

5.2.2 Finished product analysis

5.2.2.1 The demand party may carry out the finished product analysis, and the analysis result and the allowable deviation of the specified value in Table 1 shall comply with the provisions of GB/T 222.

5.2.2.2 For designations with $P \leq 0.020 \%$ in Table, the allowable positive deviation of phosphorus content is 0.003% in finished product analysis; for designations with $S \leq 0.010 \%$, the allowable positive deviation of sulfur content is 0.002% in finished product analysis.

5.12 Repair by welding

5.12.1 Steel forgings are not allowed to be repaired by welding without the consent of the demand party.

5.12.2 As agreed by the demand party, the repair by welding of steel forgings shall comply with the provisions of relevant regulations and standards. The position, depth, area of repair by welding, welding material, welding technology, welder qualification requirements, nondestructive testing methods and qualification grades before and after repair by welding shall be agreed upon between the supply and demand parties.

5.12.3 The supply party shall provide the demand party with the schematic diagram of the position, depth and area of repair by welding, and information such as the welding material, the welding technology parameters and the nondestructive testing report.

5.13 Additional requirements

As required by the demand party, agreed upon between the supply and demand parties, and indicated in the contract, it may add other inspection items of Annex B.

6 Test methods

6.1 Chemical analysis

The chemical analysis shall comply with the provisions of GB/T 223, GB/T 4336, GB/T 20123, GB/T 20124. The arbitration test shall comply with the provisions of GB/T 223.

6.2 Tensile test

The room temperature tensile test shall comply with the provisions of GB/T 228.1, and the high temperature tensile test shall comply with the provisions of GB/T 228.2.

6.3 Impact test

The impact test shall comply with the provisions of GB/T 229.

6.4 Hardness test

The hardness test is carried out according to GB/T 231.1.

6.5 Low magnification test

The low magnification test shall comply with the provisions of GB/T 226.

6.6 Metallographic examination

7.3.2.2 For heat treated forgings with a mass greater than 3 500 kg, take 2 sets of samples (in each set, 1 for room temperature tensile, 3 for impact), and 2 sets of samples are at an interval of 180 °. If the length of the forging is greater than 1.5 times the diameter, each take a set of samples at two ends of the forging and at an interval of 180 °.

7.3.3 Low magnification test

TAKE 1 sample form each batch for low magnification test.

7.3.4 Metallographic examination

TAKE 1 sample form each batch for metallographic examination.

7.4 Sampling direction

For forgings (excluding bar forgings), tangential samples should be taken; if the tangential sample cannot be made, take longitudinal or radial samples. For bar forgings, it should take longitudinal samples.

7.5 Sampling site

7.5.1 Samples for hollow forgings and ring forgings shall be taken from the ends of the forgings and at 1/2 of the wall thickness, see Figure 2 a) and Figure 2 b).

7.5.2 Samples of disk forgings shall be taken from the ends of the forgings. When the diameter of disk forgings is less than or equal to 350 mm, take samples from the outer edge; when the diameter is greater than 350 mm, take samples at a distance greater than or equal to 20 mm from the edge, see Figure 2 c).

7.5.3 Samples of bowl forgings shall be taken at 1/2 of the wall thickness at the open ends of the forgings, see Figure 2 d).

7.5.4 Samples of neck flange forgings shall be taken at the nominal thickness at a distance greater than or equal to 20 mm from the outer edge of the forgings (or from the inner surface), see Figure 2 e).

7.5.5 Samples for bar forgings shall be taken from the ends of the forgings and at 1/4 of the nominal thickness.

7.5.6 In addition to Grade IV forgings, samples for mechanical properties of forgings can also be prepared from the separately-forged inspection ingots from the same batch. The inspection ingots shall have the same forging technology with forgings, with the thickness greater than or equal to the nominal thickness of forgings, and are heat treated in the same furnace.

8 Markings and quality certificates

8.1 The marking shall be printed on the obvious part on forgings or the part specified by the demand party, and the location and manner of the marking shall not affect the use of forgings. For small forgings, the label may be stuck on the packaging box.

8.2 Forgings qualified and delivered according to this Standard shall have the following markings:

- a) manufacturing organization (or code);
- b) standard number;
- c) material designation;
- d) forging grade;
- e) batch number.

8.3 Forgings shall be accompanied by a quality certificate when delivering, which includes:

- a) forging manufacturing organization;
- b) order contract number;
- c) standard number, material designation, forging grade, batch number, forging quantity;
- d) inspection results of each item, inspection organization and inspection personnel signature;
- e) heat treatment curve (copy);
- f) inspection results of the special requirements specified in the contract.

Annex B

(normative)

Additional requirements

These requirements are only implemented when the demand party specifies in the order contract, or it may only implement one or several of them, and the details of the additional requirements are agreed upon between the supply and demand parties.

B.1 Simulated post-weld heat treatment of sample ingots for mechanical properties

Before the mechanical properties test, all sample ingots shall be subjected to one or more heat treatments at the temperature lower than the critical temperature, mainly due to the fact that the forgings are subjected to post-weld heat treatment or other heat treatments during the manufacture of pressure-bearing components. The supply party shall provide the demand party with detailed heat treatment specification requirements, including temperature, holding time and cooling rate.

B.2 Heat treatment using heat buffer ring or ring section

Before the heat treatment of forgings, the edge of the ring section with a cross section of at least $t \times t$ (t is the nominal thickness of the forging) or the ring section with a cross section of at least $t \times t$ and an arc length of at least $3t$ is welded to the sampling end of the forging, and the heat buffer ring or ring section are made of carbon steel or low alloy steel with good weldability. After the heat treatment of forgings, remove the heat buffer ring or ring section, and the sample is taken from the area that has been heat-buffered by the heat buffer ring or ring section on the forging. When the heat buffer ring section is used, the sample shall be taken from the part correspondences to 1/3 of the middle of the heat buffer section on the forging. The sample shall be at least 13 mm away from the heat buffer surface of the forging and at least $t/4$ from the heat-treated surface of the forging.

B.3 Magnetic particle or penetrant testing

The magnetic particle and penetrant testing methods can be in accordance with the provisions of NB/T 47013.4, NB/T 47013.5, respectively, and Grade I is deemed qualified.

B.4 Hazardous elements (smelting analysis) restrictions

The content limits of hazardous elements in forgings: $As \leq 0.015\%$, $Sn \leq 0.015\%$, $Sb \leq 0.010\%$, $Pb \leq 0.010\%$, $Bi \leq 0.010\%$, $As + Sn + Sb + Pb + Bi \leq 0.035\%$.

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Linkin: <https://www.linkedin.com/in/waynezhengwenrui/>

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