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INDUSTRY STANDARD OF THE
PEOPLE'S REPUBLIC OF CHINA

NB/T 47010-2010 (JB/T 4728)

Replacing JB 4728-2000

Stainless and Heat-Resisting Steel Forgings for Pressure Equipment

承压设备用不锈钢和耐热钢锻件

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Foreword

Compared with JB 4728-2000, this Standard has the following main changes:

- Design pressure in application scope has been improved from not greater than 35 MPa to less than 100 MPa;
- Steel grade in this Standard adopts unified numerical code; ADD steel grade comparison between the new and old standards in Annex B (Informative);
- ADD two austenitic stainless steel grades (S31703 and S39042); four austenitic heat-resisting steel grades (S30409, S34779, S31609 and S31008); two austenitic - ferritic stainless steel grades (S22253 and S220553);
- REDUCE sulfur contents in a majority of steel grades;
- ENLARGE nominal thickness range of all the steel forgings;
- IMPROVE tensile strength index of steel forging with nominal thickness greater than 100 mm;
- It is specified that Class I forgings are only applicable to S11306 and S30408 steel grades with nominal thickness less than or equal to 150 mm.

Annex A of this Standard is normative, and Annex B is informative.

This Standard was proposed by and under the jurisdiction of the National Technical Committee on Boilers and Pressure Vessels of Standardization Administration of China (SAC/TC 262).

Drafting organizations of this Standard: Hefei General Machinery Research Institute, China National General Machinery Engineering Corporation, China Special Equipment Inspection and Research Institute, Anhui Bureau of Quality and Technical Supervision, Wuxi Falan Forging Co., Ltd., Shanghai Power Equipment Research Institute, Nanjing Develop Industry Co., Ltd., Changzhou Sunshine General Petrochemical Fittings Co., Ltd.

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National Technical Committee on Boilers and Pressure Vessels of Standardization Administration of China (SAC/TC 262) is in the charge of the explanation of this Standard.

The previous editions of the standards replaced by this Standard are:

Stainless and Heat-Resisting Steel Forgings for Pressure Equipment

1 Scope

This Standard specifies the technical requirements, test methods and inspection rules of stainless and heat-resisting steel forgings for the pressure equipment's.

This Standard is applicable to the stainless and heat-resisting steel forgings for pressure equipment's with a design pressure less than 100 MPa.

2 Normative References

The following documents are indispensable for the application of this Standard. For dated references, only the dated edition is applicable to this document. For undated references, the latest editions of the normative documents (including all the amendments) are applicable to this document.

GB/T 222-2006 Permissible Tolerances for Chemical Composition of Steel Products

GB/T 223 Methods for Chemical Analysis of Iron, Steel and Alloy

GB/T 228 Metallic Materials - Tensile Testing at Ambient Temperature (ISO 6892:1998 (E))

GB/T 231.1 Metallic Materials - Brinell Hardness Test - Part 1: Test Method (ISO 6506-1:2005)

GB/T 6394 Metal-methods for Estimating the Average Grain Size (ASTM E112:1996)

GB/T 10561 Steel Determination of Content of Nonmetallic Inclusions - Micrographic Method Using Standards Diagrams (ISO 4967:1998)

GB/T 11170 Stainless Steel - Determination of Multi-Element Contents - Spark Discharge Atomic Emission Spectrometric Method (Routine Method)

GB/T 20066 Steel and Iron - Sampling and Preparation of Samples for the Determination of Chemical Composition (ISO 14284:1996)

JB/T 4730.3 Nondestructive Testing of Pressure Equipment - Part 3: Ultrasonic Testing

3 Terms and Definitions

For the purposes of this Standard, the following terms and definitions apply.

3.1

Hollow forging

It refers to the axisymmetrical hollow forging, whose axial length L is greater than its outer diameter D , as shown in Fig. 1 a). t shall be the nominal thickness.

3.2

Ring forging

It refers to the axisymmetrical hollow forging whose axial length L is less than or equal to its outer diameter D , as shown in Fig. 1 b). The smaller one of L and t shall be the nominal thickness.

3.3

Disk forging

It refers to the axisymmetrical solid forging, whose axial length L is less than or equal to its outer diameter D , as shown in Fig. 1 c). L shall be the nominal thickness.

3.4

Bowl forging

It refers to the axisymmetrical forging with concave section, whose height H is less than or equal to its outer diameter D , as shown in Fig. 1 d). The greater one of t_1 and t_2 shall be the nominal thickness.

3.5

Neck flange forging

It refers to the axisymmetrical hollow forging with two axials outside diameters, as shown in Fig. 1 e). The greater one of t_1 and t_2 shall be the nominal thickness.

3.6

Bar forging

It refers to the solid forging with circular section, whose axial length L is greater than its outer diameter D , as shown in Fig. 1 f). D shall be the nominal thickness.

4.2 The Buyer shall provide order drawing.

4.3 When the additional requirements in Annex A (Normative) of this Standard and other requirements which exceed or are higher than this Standard are used, they shall be indicated in the order contract by the Buyer.

5 Technical Requirements

5.1 Smelting process

The steel for forging shall be smelted through electric furnace or oxygen converter and also shall adopt external refining process.

5.2 Chemical Compositions

5.2.1 Chemical compositions (heat analysis) of the steel for forging shall be in accordance with those specified in Table 1.

5.2.2 The Buyer may carry out product analysis, the allowable deviation between the analysis results and the specified values in Table 1 shall comply with the requirements in Table 3 of GB/T 222.

5.3 Forging

5.3.1 Steel ingot, billet steel, rolled metal used for forging shall be accompanied with the quality certificate of the smelter.

5.3.2 Steel ingots to be used to produce forgings shall have sufficient cut-off quantities at their tops & bottoms, ensuring no shrinkage cavity, serious segregation and other defects within the forgings.

5.3.3 Forging ratio of main section of the forging shall not be less than 3 (not less than 2 for electroslag remelting steel) when steel ingot or billet steel is used for forging. And the forging ratio of main section of the forging shall not be less than 1.6 when rolled metal is used for forging.

5.3.4 The forging shall be formed through hot working by press, forging hammer or rolling mills, the metal on the whole section shall be forged thoroughly and should be close to the shape and dimension of the finished parts as far as possible.

5.4 Forging class

Forgings are divided into four classes of I, II, III and IV. The inspection item of each class shall follow the requirements in Table 2. Class I forging is only applicable to S11306 and S30408 steel forgings of nominal thickness less than or equal to 150 mm.

Table 2

Forging class	Inspection item	Inspection quantity
I	Hardness (HBW)	Piece-by-piece inspection
II	Tension (R_m , $R_{p0.2}$, A)	Inspect one forging randomly from each batch composed of the forgings of the same smelting furnace number and heat treated in the same furnace
III	Tension (R_m , $R_{p0.2}$, A)	
	Ultrasonic testing	Piece-by-piece inspection
IV	Tension (R_m , $R_{p0.2}$, A)	Piece-by-piece inspection
	Ultrasonic testing	Piece-by-piece inspection

5.5 Heat treatment

Forgings shall be delivered at the heat treatment state specified in Table 3. If the

6 Test Methods

6.1 Chemical analysis

Chemical analysis shall be in accordance with GB/T 223 or GB/T 11170. Arbitration test shall be in accordance with GB/T 223.

6.2 Hardness test

Hardness test shall be in accordance with GB/T 231.1. Other determination methods may also be used as required.

6.3 Tensile test

Tensile test shall be in accordance with GB/T 228.

6.4 Ultrasonic testing

Ultrasonic testing shall be in accordance with JB/T 4730.3.

7 Inspection Rules

7.1 Forgings shall be inspected by the Supplier's inspection department according to the order contract.

7.2 Specimen for chemical analysis shall be prepared according to GB/T 20066. One specimen shall be taken from each smelting furnace number.

7.3 Tensile specimen sampling rules

7.3.1 Sampling quantity

7.3.1.1 One specimen shall be taken from the heat-treated forgings whose weight of single piece is less than or equal to 3500 kg.

7.3.1.2 Two specimens in a 180° interval shall be taken from the heat-treated forgings whose weight of single piece is greater than 3500 kg. If the length of the forging is greater than 1.5 times of its diameter, one specimen shall be taken from both ends of the forging respectively.

7.3.2 Sampling direction

Tangential specimens should be taken from the forgings (excluding strip type); if unavailable, the longitudinal or radial specimens shall be taken. Longitudinal specimens should be taken from the strip-type forgings.

7.3.3.6 Except Class IV forgings, mechanical property specimens of forgings may also be prepared and taken from the independently-forged inspection forging stocks of the same batch number. Inspection forging stock shall have the same forging process and forging ratio with the forging; its nominal thickness shall be greater than or equal to that of the forging; it shall be heat treated in the same furnace with the forging.

7.3.3.7 As for the ferrite or austenite stainless steel, specimens may be cut from any convenient position.

7.3.4 Specimen

7.3.4.1 Tensile specimens shall adopt No. R4 specimens ($d = 10$ mm and $L_0 = 50$ mm) in GB/T 228. Due to the sampling dimensional restrictions, No. R7 specimens ($d = 5$ mm and $L_0 = 25$ mm) in GB/T 228 may also be adopted according to the agreement between the Buyer and the Supplier.

7.4 Class I forgings to be accepted on the basis of hardness shall be tested on the surface of the forgings.

7.5 Re-inspection

7.5.1 When the Buyer asks for re-inspection, the Supplier shall provide the Buyer the specimen for re-inspection. The effective re-inspection period shall be 3 months from the date the Buyer receives the forging.

7.5.2 When tensile test proves unqualified, another two tensile specimens may be taken nearby the original sampling position of the inspected forging for re-inspection. All the data of the re-inspection results shall be in accordance with those specified in Table 3.

7.5.3 When the mechanical property test or re-inspection prove the forgings not qualified, it is permissible to carry out the inspection again after re-heat treatment of this batch (piece) of forgings, however, the number of re-heat treatment shall not exceed twice.

8 Marking and Quality Certificate

8.1 Marks shall be stamped at apparent position of forgings or at the position designated by the Buyer. The location of the stamped marks and the way to stamp shall not impact the final use of the forgings. For small sized forgings, marks may be stuck on the packing box.

8.2 The delivered forgings, qualified in the inspection according to this standard, shall include the following marks:

Annex A

(Normative)

Additional Requirements

This requirement will only be implemented when specified in order contract by the Buyer. One or some of the items may be adopted, and the details of additional requirements shall be determined through negotiation between the Buyer and the Supplier.

A.1 Simulated post-weld heat treatment of mechanical property specimen blank

One or several heat treatment(s) shall be carried out for all the specimen blanks below the critical temperature before the test, for the purpose of simulating the post-weld heat treatment or other heat treatment that the forgings will experience in the subsequent vessel manufacture process. The Buyer shall provide the Supplier detailed heat treatment specifications and requirements, including temperature, holding time and cooling speed.

A.2 Heat treatment by using heat buffering ring or ring section

Before the heat treatment of forgings, edge of heat buffering ring at least $t \times t$ (t is the nominal thickness of forging) in section or ring section at least $t \times t$ in section and at least $3t$ in arc length shall be welded to the sampling end of the forging; heat buffering ring or ring section shall adopt the carbon steel or low alloy steel of favorable weldability. Heat buffering ring or ring section shall be cut off from the forging after heat treatment; specimens shall be taken from the heat buffering areas on the forgings by heat buffering ring or ring section. When the heat buffering ring section is adopted, specimen shall be taken from the forging corresponding to $1/3$ of arc length of and in the middle of the heat buffering ring section, at least 13 mm away from the heat buffering surface of the forging and at least $t/4$ away from the heat treatment surface of the forging.

A.3 Corrosion test

Corrosion test requirements of forgings shall be determined through negotiation between the Buyer and the Supplier.

A.4 Determination of grain size

Grain size qualification class of forging shall be determined through negotiation between the Buyer and the Supplier. Determination method of grain size shall be in accordance with GB/T 6394.