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Irradiation-resistant and heat-resistant steels

抗辐照耐热钢

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Irradiation-resistant and heat-resistant steels

1 Scope

This standard specifies the terms and definitions, order content, dimensions, shape, weight, technical requirements, test methods, inspection rules, packaging, markings and quality certificates of radiation-resistant heat-resistant steel.

This standard applies to hot-rolled and forged bars (hereinafter referred to as steel bars) which has a diameter of not more than 150 mm for the nuclear industry.

The designation and chemical composition as specified in this standard are also applicable to steel ingots, billets and their products.

2 Normative references

The following documents are essential to the application of this document. For the dated documents, only the versions with the dates indicated are applicable to this document; for the undated documents, only the latest version (including all the amendments) are applicable to this standard.

GB/T 222 Permissible 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 223.11 Iron, steel and alloy - Determination of chromium content - Visual titration or potentiometric titration method

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

GB/T 223.21 Methods for chemical analysis of iron steel and alloy - The 5-CL-PADAB spectrophotometric method for the determination of cobalt content

GB/T 223.26 Iron, steel and alloy - Determination of molybdenum content - The thiocyanate spectrophotometric method

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

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 351 Metallic materials - Resistivity measurement method

GB/T 702 Hot-rolled steel bars - Dimensions, shape, weight and tolerances

GB/T 908 Forged bars - Dimensions, shape, weight and tolerances

GB/T 2039 Metallic materials - Uniaxial creep testing method in tension

GB/T 2101 General requirement of acceptance packaging marking and certification for section steel

GB/T 2975 Steel and steel products - Location and preparation of samples and test pieces for mechanical testing

GB/T 3217 Method of test of the magnetic properties of permanent magnetic (magnetically hard) materials

GB/T 3651 Measuring method for thermal conductivity of metal at high temperature

GB/T 3850 Impermeable sintered metal materials and hard metals - Determination of density

GB/T 4067 Testing method for electrical resistance-temperature characteristic parameters of metallic materials

GB/T 4339 Test methods for thermal expansion characteristic parameters of metallic materials

GB/T 4340.1 Metallic materials - Vickers hardness test - Part 1: Test method

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

GB/T 8170 Rules of rounding off for numerical values & expression and

Differential scanning calorimetry

3 Terms and definitions

The following terms and definitions apply to this document.

3.1

Irradiation-resistant and heat-resistant steels

The steel alloy which, after being irradiated by neutrons, has good elongation after fracture and low swelling rate, maintains high enduring strength, creep resistance and good chemical stability in high temperature environment, has low activation characteristics.

Note: Low activation characteristics, that is, the radioactivity after neutron irradiation mainly comes from short-lived or medium-lived radioactive elements.

4 Order content

The contract or order for ordering according to this standard shall at least include the following contents:

a) Number of this standard;

b) Product name;

c) Designation;

d) Smelting method;

e) Dimensions and allowable deviations (see Chapter 5);

f) Order weight;

g) Delivery status (if necessary, see 6.3.2);

h) Qualified level of macrostructure (see 6.5);

i) Qualified level of ultrasonic testing (see 6.9);

j) Special requirements (if necessary, see 6.11).

The steel bar shall be ultrasonically tested in accordance with NB/T 47013.3. Its qualification level shall be determined through negotiation between the supplier and the buyer and shall be indicated in the contract.

6.10 Surface quality

6.10.1 There shall be no visible cracks, scars, folds and inclusions on the surface of the steel bar. If the above defects exist, partial removal is allowed. The removal depth shall not exceed half the tolerance of the steel bar from the actual size of the steel bar. The removal width shall not be less than 5 times the depth. The number of positions where maximum removal depth is reached on the same section shall be not more than 1. It allows for the individual small scratches, indentations, pits and small cracks which has a depth of not more than 0.2 mm that do not exceed half of the dimensional tolerance from the actual size. The defect removal place shall be smooth and without corners.

6.10.2 The surface of the steel bar delivered in a polished or peeled state shall be clean and smooth. There shall be no cracks, folds, scars and oxide scale. If the above defects exist, local grinding is allowed, but the maximum grinding point shall ensure the minimum size of the steel bar.

6.11 Special requirements

According to the requirements of the buyer, after negotiation between the supplier and the buyer and indicated in the contract, the steel bar may be tested of the physical properties (see Appendix A), non-metallic inclusions, Vickers hardness, (pre-irradiation) impact absorption energy-temperature curve, other non-destructive testing, etc.

7 Test method

7.1 The inspection items and test methods of steel bars shall meet the requirements of Table 6.

7.2 Chemical composition analysis is usually carried out according to general methods such as GB/T 22368 and GB/T 11170. During arbitration, it shall follow the requirements of GB/T 223.5, GB/T 223.11, GB/T 223.14, GB/T 223.21, GB/T 223.26, GB/T 223.31, GB/T 223.53, GB/T 223.54, GB/T 223.60, GB/T 223.62, GB/T 223.63, GB/T 223.67, GB/T 223.75, GB/T 223.81, GB/T 223.84, GB/T 223.86 and GB/T 20127.13.

7.3 The content testing of tantalum, tungsten, antimony, silver, oxygen and nitrogen is carried out in accordance with GB/T 223.42, GB/T 223.43, GB/T 223.47, GB/T 20127.1, GB/T 11261, GB/T 20124, YB/T 4395, respectively.

Note: ●Compulsory inspection items; ○Inspection items negotiated between the supplier and the demander; - No such item.

8 Inspection rules

8.1 Inspection and acceptance

The inspection and acceptance of steel bars are carried out by the supplier's technical supervision department. When necessary, the purchaser has the right to inspect and accept any inspection items specified in this standard or contract.

8.2 Inspection classification

The inspection of steel bars is divided into type inspection and exit-factory inspection.

8.3 Type inspection

8.3.1 Type inspection shall be carried out in one of the following situations:

a) Type finalization of new product;

b) When the material composition and preparation process have changed significantly;

c) When required by the contract.

8.3.2 See Table 6 for type inspection items, sampling quantity, sampling locations and test methods.

8.3.3 If all inspection results meet the requirements of Chapter 6, the type inspection is passed.

8.4 Exit-factory inspection

8.4.1 Group-batching rules

Steel bars shall be submitted in batches for inspection and acceptance. Each batch is composed of steel bars of the same designation, same heat number, same processing method, same size, same delivery status.

8.4.2 Sampling quantity and sampling location

The sampling quantity and sampling location of the steel bars shall meet the requirements of Table 6.

8.4.3 Re-inspection and judgment rules

8.4.3.1 When the chemical composition is unqualified, re-sampling is allowed

to analyze the unqualified elements. If one element is unqualified in the reinspection result, the furnace steel bar is judged as unqualified.

8.4.3.2 When a certain test result of tensile, non-metallic inclusions, grain size, Brinell hardness, Vickers hardness is unqualified, it is allowed to take double from the batch of steel bars (including the steel bars that failed the original inspection) for reinspection of the unqualified items. If one sample is unqualified in the reinspection result, the batch of steel bars shall be deemed unqualified.

8.4.3.3 When the result of the impact test is unqualified, it is allowed to take two more steel bars from the batch of steel bars (including the steel bars that failed the original inspection), take a set of 3 samples from each steel bar. For the test results of the two sets of samples, if one set does not meet the requirements of Table 3, the batch of steel bars is judged as unqualified.

8.4.3.4 When the macrostructure inspection fails, it is allowed to take double samples from the batch of steel bars for re-inspection (except for the white spots). If one sample is unqualified in the re-inspection result, the batch of steel bars is judged as unqualified; however, for regular defects such as shrinkage residuals, the supplier is allowed to perform re-inspection after removal.

8.4.3.5 When the ultrasonic testing, size, shape, and surface quality are unqualified, it is judged as unqualified. For steel bars that fail to pass the inspection of size, shape, and surface quality, the supplier is allowed to repair, straighten or grind them one by one and then carry out reinspection; only those qualified can be delivered.

8.4.3.6 If the supplier can guarantee that the steel bars are qualified, for the test results of the mechanical properties, macrostructure, non-metallic inclusions of the same batch of steel bars or billets, it is allowed to substitute billets for materials and large ones for small ones.

8.4.3.7 The testing and inspection results of the steel bar shall be rounded to the digits identified by the standard number by the rounding value comparison method; the rounding off rules shall comply with the provisions of GB/T 8170.

9 Packaging, marking and quality certificate

The packaging, marking and quality certificate of the steel bars shall comply with the provisions of GB/T 2101.

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