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Steel castings for water passage components of small and medium sized hydraulic turbines

中小型水轮机通流部件铸钢件

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Steel castings for water passage components of small and medium sized hydraulic turbines

1 Scope

This Standard specifies the ordering, manufacturing, testing methods and inspection and acceptance rules for steel castings used in flow-through components of small and medium-sized turbines.

This Standard is applicable to small and medium-sized Francis, axial, tubular and Pelton turbine steel castings. For other types of turbine steel castings, it may be used as reference.

2 Normative references

The following documents contain the provisions which, through reference in this Standard, become the provisions of this Standard. For dated references, their subsequent amendments (excluding corrigendum) or revisions do not apply to this Standard. However, the parties who enter into agreement based on this Standard are encouraged to investigate whether the latest versions of these documents are applicable. For undated reference documents, the latest versions apply to this Standard.

GB/T 222-1984, *Method of sampling steel for determination of chemical composition and permissible variations for product analysis*

GB/T 223.3~78, *Chemical analysis methods for steel and alloys*

GB/T 228-2002, *Metallic materials -- Tensile testing at ambient temperature* (eqv ISO 6892:1998)

GB/T 229-1994, *Metallic materials -- Charpy pendulum impact test method* (eqv ISO 148:1983)

GB/T 231-1984, *Metallic materials -- Brinell hardness test*

GB/T 2100-2002, *Corrosion-resistant steel castings for general applications*

GB/T 5677, *Methods of radiographic testing and classification of radiographs for steel castings*

GB/T 6397-1986, *Metallic materials -- Test pieces for tensile testing*

GB/T 6414, *Castings -- Dimensional tolerances and geometrical tolerances and machining allowances* (eqv ISO 8062:1994)

GB/T 6967-1986, *Medium and high strength stainless steel castings for engineering structure purposes*

GB/T 7233, *Methods for ultrasonic testing and for specifying quality levels of steel castings*

GB/T 9443, *Methods of liquid penetrant testing and classification of indication for steel castings*

GB/T 9444, *The methods for magnetic particle testing and for specifying quality levels of steel castings*

GB/T 10969-1996, *Specifications for water passage components of hydraulic turbines* (neq IEC 193-1:1977)

GB/T 11351, *Mass tolerances for castings*

GB/T 11352-1989, *Carbon steel castings for general engineering purposes*

3 Ordering requirements

3.1 The supplier and the purchaser shall specify the name of the casting, implementation standard, material designation, order quantity and supply status in the order contract and order agreement.

3.2 The ordering party must provide the supplier with the order drawing and indicate the product size, tolerance, surface roughness and test items, etc.

3.3 When inquiring and placing orders, the supplier and the purchaser negotiate to determine the location and quantity of the test blocks, as well as the method, location and level of non-destructive testing.

3.4 When inquiring and placing orders, the supplier and the purchaser negotiate to determine the mold line detection method, which can refer to GB/T 10969-1996, but the impact of grinding and machining allowance on the casting blank shall be considered.

4 Technical requirements

4.1 Manufacturing process

4.1.1 Smelting

When inquiring and placing orders, the supplier and purchaser shall negotiate and determine whether to use one of the methods such as medium frequency furnace, electric arc furnace, refining, etc. or a combination of methods for smelting. If the ordering party has no special requirements, the supplier can decide on his own.

4.1.2 Heat treatment

Steel castings must be heat treated. Unless otherwise agreed upon at the time of ordering, the heat treatment process is determined by the supplier. Commonly used heat treatment processes are one of the following:

4.1.2.1 Carbon steel

a) Annealing:

b) Normalizing;

c) Normalizing and tempering.

4.1.2.2 Low alloy steel

a) Annealing;

b) Normalizing and tempering.

4.1.2.3 Martensitic stainless steel

Normalizing and tempering.

The number of repeated normalizing shall be agreed upon by both parties during the inquiry and ordering. If the ordering party has no special requirements, it shall be decided by the supplier. There is no limit to the number of tempering.

4.2 Chemical composition

The chemical composition shall be in accordance with GB/T 2100-2002, GB/T 6967-1986, GB/T 11352-1989 and shall conform to the requirements of Table 1. When other material designations are selected, they shall be in accordance with the order contract between the supplier and the purchaser.

a) According to GB/T 9444, not less than level 3.

b) Surface of mixed flow runner blades.

c) Surface of axial flow and cross-flow runner blades, flange surface, and shaft head surface.

d) Surface of bucket of water bucket runner.

e) Surface of guide vane body and shaft head surface.

5.3.1.2 Penetrant testing

a) According to GB/T 9443, not less than level 3.

b) Blade surface.

c) Water bucket surface, water bucket root.

d) Guide vane body surface, guide vane shaft head surface.

5.3.1.3 Ultrasonic flaw detection

a) According to GB/T 7233, longitudinal wave straight probe, sensitivity of Φ6 mm, not less than level 3. When transverse wave oblique probe is required for flaw detection, it shall be determined during inquiry and ordering.

b) The welding heat affected zone with a width of $0.04D_2$ is where the upper crown, lower ring and blades of the mixed flow impeller intersect with the upper crown and lower ring respectively.

c) The intersection between axial flow and cross-flow blades and flanges, flanges, and shaft heads.

d) The intersection of the guide vane shaft neck and the guide vane plate body.

e) Pelton wheel hub.

5.3.1.4 Radiographic inspection

a) According to GB/T 5677, the sensitivity $K_A \leq 2.0\%$, not less than level 4.

b) For areas where ultrasonic testing cannot be determined or where both parties have disagreements, if the geometric shape and other conditions allow, radiographic testing shall be used for confirmation.

5.3.2 When inquiring and placing orders, if the ordering party has non-destructive testing requirements, non-destructive testing shall be carried out on castings according to the ordering party's requirements. But the testing location, testing method, area,

standard and level shall be specified. The different situations such as blank, rough processing and fine processing shall be distinguished. Among them, the blank casting testing requires grinding or processing the corresponding testing parts to achieve the surface roughness required by the testing.

6 Reinspection

6.1 The ordering party has the right to re-inspect the supplied castings. The reinspection items are the same as the inspection items in the ordering contract.

6.2 If the mechanical properties are unqualified, double the specimen shall be taken for retest. If the retest is unqualified, the test block is allowed to be heat treated in the same furnace as the casting and retested.

6.3 When non-destructive testing fails, it shall be handled in accordance with 4.4.3.

7 Quality certificate

When delivering the goods, the supplier shall provide the ordering party with a quality certificate. According to the order contract, the quality certificate generally includes all or part of the following contents:

a) Order contract number;

b) Order drawing number;

c) Casting name, material designation;

d) Melting furnace number, part number;

e) Chemical composition analysis results;

f) Standard number of the adopted standard;

g) Mechanical properties test results;

h) Non-destructive testing results;

i) Other additional test results;

j) Supplier factory (company) name.

8 Marking, packaging and transportation

8.1 The castings shall have the following markings: order contract number, drawing

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