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Heat treatment of cast aluminium alloys

铸造铝合金热处理

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Heat treatment of cast aluminium alloys

1 Scope

This Standard specifies the heat treatment condition, heat treatment equipment, heat treatment process, quality control and inspection, safety, health and environmental protection requirements of cast aluminium alloys.

This Standard applies to the heat treatment of cast aluminium alloy workpieces.

2 Normative references

The terms in the following documents become the terms of this Standard by reference to this Standard. For dated references, all subsequent amendments (not including errata content) or revisions do not apply to this Standard. However, parties to agreements that are based on this Standard are encouraged to study whether the latest versions of these documents can be used. For undated references, the latest edition applies to this Standard.

GB/T 228, Metallic materials - Tensile testing at ambient temperature

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

GB/T 1173, Casting Aluminium Alloy

GB 5959.1, Safety in installations for electroheating and electromagnetic processing - Part 1: General requirements

GB 5959.4, Safety in electroheat installations - Part 4: Particular requirements for safety resistance heating installations

GB/T 7232, Terminology of metal heat treatment

GB/T 9452, Testing method for working zone of heat treatment furnace

GB 12348, Emission standard for industrial enterprises noise at boundary

GB/T 13324, Terminology of heat treatment equipment

GB 15735, Requirements for the safety and health in production process of metal heat treatment

GB/T 16839.2, Thermocouples - Part 2: Tolerances

5.1.4 Each heating furnace must be regularly tested for the effective heating zone. The test cycle is shown in Table 3; the test method shall be in accordance with the provisions of GB/T 9452; its insulation accuracy shall meet the requirements of Table 2. An inspection certificate with the schematic diagram of the effective heating zone shall be hung in a conspicuous position. The heating furnace can only be used within the validity period that is specified in the valid heating zone inspection certificate.

5.1.5 The temperature measurement system used on site shall be regularly subjected to system check under normal use. During the check, the distance between the detection thermocouple and the hot end of the recording instrument thermocouple shall be close. The check shall be performed with the furnace in a thermal stability. The allowable temperature deviation for system check is $\pm 1^{\circ}\text{C}$. When the temperature deviation is exceeded, the cause shall be identified or corrected.

5.2 Temperature control equipment

5.2.1 The accuracy of the on-site testing equipment shall be higher than that of the tested equipment.

5.2.2 The grades of temperature control and recording instruments used on site shall meet the requirements of Table 2; the verification cycle shall be performed according to Table 3.

5.2.3 The accuracy of the standard potentiometer for on-site system check shall not be lower than 0.05; the resolution shall not be lower than 1 mV; the verification cycle shall be 6 months.

5.2.4 Mercurial thermometer for measuring room temperature, with a resolution of 0.1°C and a verification cycle of 1 year.

5.2.5 The thermocouple shall comply with the provisions of GB/T 16839.2. See Table 5 for the technical requirements for the thermocouple commonly used on site.

5.3 Solid solution cooling tank

5.3.1 The solid solution cooling tank shall be located as close to the heating furnace as possible, so as to ensure that the heated castings are quickly immersed in the solid solution cooling tank; the solid solution cooling transfer time shall meet the requirements in Table 5.

5.3.2 The solid solution cooling tank shall have sufficient capacity to ensure that the solid solution cooling castings can be rapidly solution cooled while all immersed in the solid solution cooling medium.

5.3.3 The solid solution cooling tank shall be equipped with cooling circulation and stirring device and temperature measuring device; if necessary, heating device can be configured to ensure the temperature and uniformity of the cooling medium.

5.3.4 The solid solution cooling tank shall be provided with a tank cover; the cooling medium in the solid solution cooling tank shall be regularly inspected and replaced as required.

6 Heat treatment process

6.1 Preparation before heat treatment

6.1.1 Check the conditions of the heating furnace, temperature control equipment, solid solution cooling tank, etc. before use, to ensure that the equipment is in good condition.

6.1.2 Clean the oil and dirt on the surface of the casting, and keep the casting clean before entering the furnace.

6.1.3 For castings that are prone to distortion, special heat treatment fixtures shall be provided.

treatment temperature shall be solution cooled; the castings that have not reached the solution treatment temperature can be air cooled. The heat treatment holding time when they are reloaded in the furnace is generally calculated cumulatively with the first holding time; the point holding time can be extended.

6.3.10 During the aging treatment, if the insulation is interrupted for some reason, and the work cannot be resumed in a short time, it shall be air-cooled. The holding time for re-entering the furnace for heat treatment can be calculated cumulatively with the holding time before the interruption; the effective holding time shall be equal to or slightly longer than the original holding time.

6.3.11 See Appendix A for the mechanical properties of cast aluminium alloys after heat treatment.

6.4 Repeated heat treatment

6.4.1 When the mechanical property of the casting after heat treatment is unqualified, a repeated heat treatment can be performed; the holding time of the repeated heat treatment can be reduced according to the circumstances; the times of repetition of solution treatment shall not exceed two times in general; the times of repetition of the aging treatment is not limited.

6.4.2 For castings where the solution treatment is staged heating, during the repeated heat treatment, the heated temperature of the solution treatment may not adopt the staged heating process.

7 Quality control and inspection

7.1 Quality control

7.1.1 Personnel requirements

Heat treatment operators, instrument staff, and inspectors shall be trained according to regulations, and they can take up their posts after passing the examination and obtaining the qualification certificate.

7.1.2 Heat treatment process control

7.1.2.1 Pending control

Confirm that all the processes before the heat treatment of the casting are completed according to the requirements of the process documents.

7.1.2.2 Equipment control

The equipment shall be checked and confirmed according to the relevant requirements of this Standard, and shall have the conformity mark.

7.1.2.3 Process control

The technological process shall be checked and confirmed according to the relevant requirements of this Standard; the technological parameters such as heating temperature, holding time, solution cooling transfer time, and cooling medium temperature shall be ensured to meet the requirements of the technological documents; the operation process and quality shall meet the requirements.

7.1.3 Record

- a) Each heating furnace shall have special records, including:
 - 1) Furnace number and type;
 - 2) Operating temperature range;
 - 3) Temperature uniformity test cycle and results;
 - 4) Serial number and location of the thermocouple;
 - 5) Condition after overhaul, etc.
- b) After completing the heat treatment and inspection, operators and inspectors shall fill in the process flow card, heat treatment production record card and heat treatment record chart, and sign or seal, and shall indicate abnormal conditions.
- c) All original records shall be submitted for inspection together with the castings, and finally archived; the archived original records shall be kept in good condition according to the specified storage period.

7.2 Inspection

7.2.1 Appearance inspection

Castings after heat treatment shall be free of cracks, surface blistering, oxidation blackening and deformation.

The appearance inspection shall be carried out visually (or with a magnifying glass below 10 times).

7.2.2 Penetrant inspection

Penetrant inspection shall be free of surface cracks.

The penetrant inspection shall be carried out according to GB/T 18851.1 or other corresponding standards.

7.2.3 Mechanical property

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