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Vacuum heat treatment

真空热处理

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Vacuum heat treatment

1 Scope

This Standard specifies the special requirements for vacuum heat treatment equipment, commonly-used metal materials for vacuum heat treatment, technological process of vacuum heat treatment and its basic technological parameters.

This Standard applies to technologies such as metal vacuum quenching, vacuum tempering, vacuum annealing, vacuum solution heat treatment, and vacuum aging.

2 Reference standards

The following standards contain the provisions which, through reference in this Standard, constitute the provisions of this Standard. At the time of publication of this Standard, the editions indicated are valid. All standards are subject to revision. The parties who are using this Standard shall explore the possibility of using the latest version of the following standards.

GB/T 230-1991 Metallic materials - Rockwell hardness test

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

GB/T 1818-1994 Metallic materials - Rockwell superficial hardness test

GB/T 4340-1984 Metallic materials - Vickers hardness test

GB/T 10066.1-1988 Test methods for electroheat installations - General

GB/T 10067.1-1988 Basic specifications for electroheat installations - General

GB/T 10067.4-1988 Basic specifications for electroheat installations - Indirect resistance furnaces

GB 15735-1995 Requirements for the safety and health in production process of metal heat treatment

3 Commonly-used materials for vacuum heat treatment

Alloy tool steel, high-speed tool steel, chromium bearing steel, heat-resistant steel bar, high-temperature alloy, titanium alloy, precision alloy, etc.

4 Equipment

4.1 The technical parameters of the resistance furnace for vacuum heat treatment shall comply with the relevant provisions of GB/T 10067.1 and GB/T 10067.4.

4.2 The test items shall be tested or inspected according to the methods specified in the corresponding clauses of GB/T 10066.1.

4.3 The temperature deviation in the effective heating zone of vacuum quenching furnace and vacuum tempering furnace must generally not exceed $\pm 5\text{ }^{\circ}\text{C}$. For vacuum annealing furnace, it must not exceed $\pm 8\text{ }^{\circ}\text{C}$. Temperature shall be adjustable, brake-controlled, and track-recorded.

4.4 During the use of the furnace, the vacuum degree shall be able to meet the corresponding technological requirements. The vacuum leakage rate shall not be greater than $1 \times 10^{-1}\text{ Pa}/(\text{L} \cdot \text{s})$ (The leakage rate shall be measured after the furnace is fully dried).

4.5 The insulation resistance to ground of the heating elements of vacuum quenching furnace, vacuum tempering furnace, and vacuum annealing furnace shall be greater than $2\text{ k}\Omega$.

4.6 The pressure of cooling water shall be greater than 0.2 MPa or determined according to the requirements of the furnace. The flow rate shall be adjustable. No sudden water interruption is allowed.

4.7 Between the gas source for air cooling and the furnace, there shall be a corresponding pressure reducing valve and a vacuum pressure gauge, which can accurately indicate and adjust the gas pressure. The pipeline shall meet the sealing requirements.

4.8 The purity of the cooling gas shall meet the requirements of the corresponding technology. 99.995% pure nitrogen is generally used for steel. 99.999% pure nitrogen or argon is generally used for high-temperature alloy. 99.995% pure argon shall be used for titanium alloy.

4.9 The transmission mechanism in the furnace shall be stable and reliable. The running speed shall be adjustable. The opening-closing of the hot gate shall be flexible and reliable.

4.10 The quenching oil shall meet the requirements of hardness and brightness of the workpiece after vacuum quenching. It shall not be easy to age; shall not cause corrosion and other harmful effects on the workpiece. The quenching oil tank shall be equipped with heating and stirring devices.

4.11 The vacuum tempering furnace shall have a quick cooling device.

than that of salt bath furnace heating; and 1 times longer than that of air furnace heating. The holding time of vacuum tempering heating is slightly longer than that of air furnace heating; but 1~2 times longer than that of nitrate furnace heating. The holding time of vacuum annealing heating is generally 1 times longer than that of air furnace heating.

5.5.3 According to the material of the workpiece and the heating temperature, the vacuum degree during heating is controlled by backfilling high-purity nitrogen. When the steel is heated below 900 °C, the vacuum degree is generally about 1.33×10^{-1} Pa. When heating at 900~1100 °C, the vacuum degree is generally about 13.3~1.33 Pa. When heating at 1100~1300 °C, the vacuum degree is generally about 13.3~665 Pa.

5.5.4 During vacuum tempering, when the furnace reaches a certain degree of vacuum (usually 0.133 Pa), high-purity nitrogen is introduced into the furnace to about 6.6×10^4 Pa. A fan is used to circulate. Keep this state until the end of tempering heating.

5.6 Cooling

5.6.1 The quenching oil shall be fully degassed and properly heated if necessary. During quenching, gas (high-purity nitrogen or argon) shall be charged to about 5.3×10^4 Pa. The quenching oil shall be stirred.

5.6.2 According to the technological requirements, positive-pressure gas quenching or negative-pressure gas quenching can be used. During positive-pressure gas quenching, $2 \times 10^5 \sim 6 \times 10^5$ Pa of high-purity nitrogen is introduced. During negative-pressure gas quenching, $7.9 \times 10^4 \sim 9.3 \times 10^4$ Pa of high-purity nitrogen is introduced for quenching. High-speed steel workpieces should adopt the positive-pressure gas quenching method.

5.6.3 After the tempering heating is completed, the gas shall be used for forced quick cooling.

5.6.4 After the annealing heating is completed, it shall be cooled according to the technological requirements. During the cooling process, it shall continue to vacuumize to a certain temperature before stopping.

5.7 Furnace discharging and cleaning

5.7.1 Discharge the furnace at a cold state.

5.7.2 After oil-quenched workpieces are discharged from the furnace, they shall be de-oiled and cleaned.

5.8 Correction

When the deformation of the workpiece exceeds the technical requirements, the correct correction method shall be used to correct to meet the specified requirements.

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