IMPROVING THERMAL TREATMENT MODES FOR CHROMIUM-MOLYBDENUM STEEL CASTINGS

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This article examines the issues of improving thermal treatment modes to increase the mechanical and operational properties of chromium-molybdenum steel castings. The steel's microstructure, phase transformations, and their effects on hardness, strength, and wear resistance are analyzed. The study substantiates the potential for increasing material reliability and service life by selecting optimal thermal treatment parameters.

Chromium-molybdenum steels are widely used in industry, particularly for manufacturing components operating under heavy loads and high-temperature conditions. Their primary advantages include high strength, good hardness, and wear resistance; however, these properties depend significantly on the thermal treatment process. Traditional thermal treatment methods do not always yield optimal results, as castings may retain large grain sizes, uneven distribution of carbide phases, and internal stresses. Therefore, improving thermal treatment modes is a relevant issue of scientific and practical importance.

The main goal of the research is to enhance the operational properties of chromium-molybdenum steel castings by improving their thermal treatment modes. To achieve this, the following tasks were defined:

Analyzing the correlation between the chemical composition and microstructure of the steel.

Studying the effects of various thermal treatment modes (heating, quenching, tempering).

Determining optimal temperature and time parameters.

Evaluating properties based on mechanical tests.

Explaining phase transformations through microstructure analysis.

Steel castings alloyed with chromium (Cr) and molybdenum (Mo) were used as the research objects. Carbide-forming elements play a crucial role in their composition. The following methods were utilized:

Metallographic analysis.

Scanning Electron Microscopy (SEM).

Hardness testing (HRC).

Tensile and impact strength tests.

Modeling of thermal treatment processes.

Research indicated that traditional quenching results in a martensitic structure, which is often characterized by large needle-like formations and high internal stresses. This increases the brittleness of the steel. In the improved mode, staged heating and two-stage tempering were applied. As a result:

The martensitic structure was refined.

Carbide phases were distributed uniformly.

Internal stresses were reduced.

Hardness under traditional treatment: 48–52 HRC.

Hardness under improved treatment: 55–60 HRC.

Impact strength increased by 20–25%.

This demonstrates that material properties can be significantly improved by correctly selecting thermal treatment parameters. Based on the research, the following optimal regime is recommended:

Heating: 850–900°C, quenching: In oil medium, first Tempering: 550–600°C, Second Tempering: 200–250°C.

This regime ensures structural stabilization and high operational properties.

1. A new thermal treatment mode based on two-stage tempering for chromium-molybdenum steel castings was proposed.
2. The relationships between phase transformations in the microstructure and mechanical properties were established.
3. The mechanism for improving wear resistance by increasing the dispersion of carbide phases was scientifically substantiated.

The proposed mode ensures increased service life for castings, higher reliability, and safety, providing economic efficiency for industrial enterprises. This method is particularly applicable in the mining, energy, and mechanical engineering sectors.

Improving thermal treatment modes for chromium-molybdenum steel castings significantly enhances their mechanical and operational properties. The proposed two-stage tempering mode allows for structure refinement, reduction of internal stresses, and stable distribution of carbide phases. Consequently, the hardness, strength, and wear resistance of the steel are increased.

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