INFLUENCE OF THERMAL INCREASING THE STATIC STRENGTH OF ALLOY STEELS

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Abstract:The basic operational and technological properties of steel are defined (determined) by the contents of their chemical elements. Elements allow reaching (achieve) necessary hardening of a firm solution. In clause the decision these problems is considered.

Key words: technological properties, hardening, defect of a crystal structure, stability, particles, durability, viscosity, stability(resistance), micro distortions, size of blocks, deterioration, thermal processing.

ВЛИЯНИЕ ТЕРМИЧЕСКАЯ ПРЕДЫСТОРИЯ НА ПОВЫЩЕНИЕ СТАТИЧЕСКУЮ ПРОЧНОСТЬ ЛЕГИРОВАННЫХ СТАЛИ

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Abstract:Основные эксплуатационные и технологические свойства легированных сталей определяются их легированием. Легирование позволяет достигать необходимую прокаливаемость, упрочнение твердого раствора, упрочнение за счет дисперсности второй фазы. В статье рассмотрено решение эти проблемы.

Ключевые слова и выражения: технологические свойства, прокаливаемость, упрочнение, дисперсности, дефектности кристаллического строения, устойчивость, коагуляции частиц, прочность, вязкость, теплостойкость, микроискажений, величины блоков, износостойкость, термической обработка.

The main operational and technological properties of steels are determined by their alloying. Alloying allows achieving the necessary hardenability, hardening of the solid solution, hardening due to the dispersion of the second phase. Alloying elements in die steel, for hot deformation, provide resistance to coagulation of particles of the second phase (carbides). In particular, the strength, viscosity, and heat resistance directly depend on the amount and dispersion of carbides, their resistance to coagulation during heating, as well as on the elements of the fine structure of the structure: the size of the blocks, the level of micro-distortion, the density of dislocations and the degree of their fixation.

Increasing the wear resistance and reducing the softening of die steels is achieved by introducing 3-5 % carbide-forming elements, nickel and chromium are introduced to increase the hardenability and grinding of grain. In this case, not only carbides of the M_3C type are formed in the steel , but also $M_{23}C6$, M_7C_3, M_6C, M_2C, MC. Since the coagulation of carbides occurs after the decomposition of martensite, the dissolution of small carbides of the M_3C type, the increase in resistance to coagulation is associated with the formation of carbides MC (VC) and M_2C (Mo_2C or W_2C) [1]. The stability of carbides of the M_6C (Fe_3Mo_3C) type is somewhat less. Carbides of the M_7C_3 and $M_{23}C_6$ types ($Сч_7C_3$ and $Сч_{23}C_6$).) are even less resistant to coagulation. Heat-resistant die steels, complex-alloyed with chromium, molybdenum, tungsten, vanadium, are prone to secondary hardening during tempering. The maximum hardening (peak of secondary hardening) is achieved after tempering at 500 - 550 ^{0}C. A higher tempering temperature leads to softening.

The hardness increases most intensively during secondary hardening with an increase in the content of carbon, chromium and silicon in the steel. In addition to the formation of special carbides of the M_7C_3 and $M_{23}C_6$

types, chromium dissolves in ferrite, increasing the strength, and dissolves in carbide phases of the M_6C, MC and M_2C types, contributing to a more complete dissolution of special austenite carbides when heated for quenching.

The thermal background, the initial structure of the steel, strongly affects the properties after the final heat treatment. The most pronounced influence of thermal previous history affects the phenomenon of structural inheritance. Structural inheritance is expressed in the restoration of the original grain in shape and orientation after phase recrystallization. Numerous studies in the field of structural inheritance have been conducted by acad. Sadovsky V.D. with others. In particular, it was found that the formation of a fine structure during final heat treatment occurs under the conditions of inheritance of elements of the initial submicrostructure [2].

In many cases, in order to improve the service properties of finished products, pre-heat treatment is carried out, i.e., an optimal thermal background is created. These methods include all modes of heat treatment with multiple phase recrystallization [3].

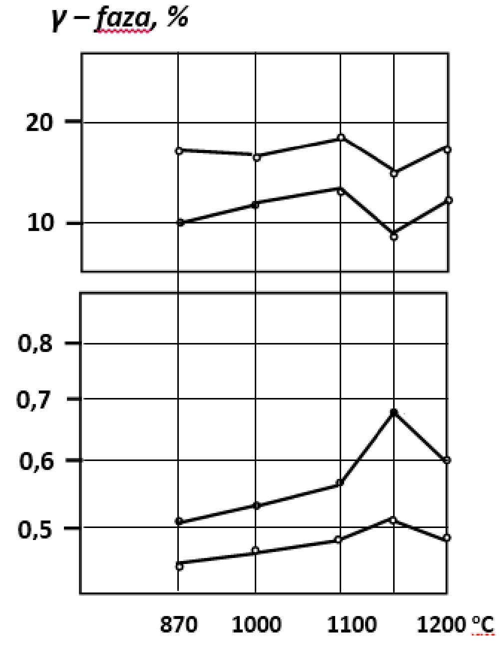
Such heat treatment includes the first phase recrystallization with heating to extreme temperatures, accelerated cooling, the second phase recrystallization with heating to the temperatures usually accepted for this steel, quenching and final tempering.

The essence of the method of heat treatment with double phase recrystallization by the optimal mode is to create the necessary thermal prehistory of steel. During the first phase recrystallization, heating is carried out to extreme temperatures of 1100 ^{0}C for carbon and low-alloy steels. After accelerated cooling from these temperatures, a structure with the maximum level of defect of the crystal structure is formed. At high-temperature heating, the dissociation of refractory nitride, carbonitride and oxygen-containing phases occurs and their transition to a solid solution. This process is intensive in the area of heating temperatures of 1100 ^{0C}. The beginning of the dissolution of these phases is characterized by the chemical micro-uniformity of the solid solution. In this case, during cooling, during the γ-α transformation, a structure with an increased level of defect in the crystal structure is formed.

There is the creation of «zone» structures, the fragmentation of coherent scattering regions (CSR) and the growth of micro-distortions of the crystal lattice [4]. A further increase in temperature in the region beyond the extreme temperatures leads to the homogenization of austenite. After cooling and γ-α transformation, the defect of the α – phase lattice is obtained lower. During the quenching process, the carbon atoms switch to dislocations, and the tetrogonality of the martensite lattice decreases.

The high heating temperatures used during the first phase recrystallization contribute to the dissolution of almost all the excess phases, but lead to a sharp increase in the austenitic grain. With accelerated cooling, a supersaturated solid solution is fixed during quenching. During intermediate tempering, not only carbide release occurs, but also the release of refractory impurity phases in the form of dispersed particles (nitrides, carbon nitride, oxides) [5]. During normalization, the release of these particles occurs without intermediate release.

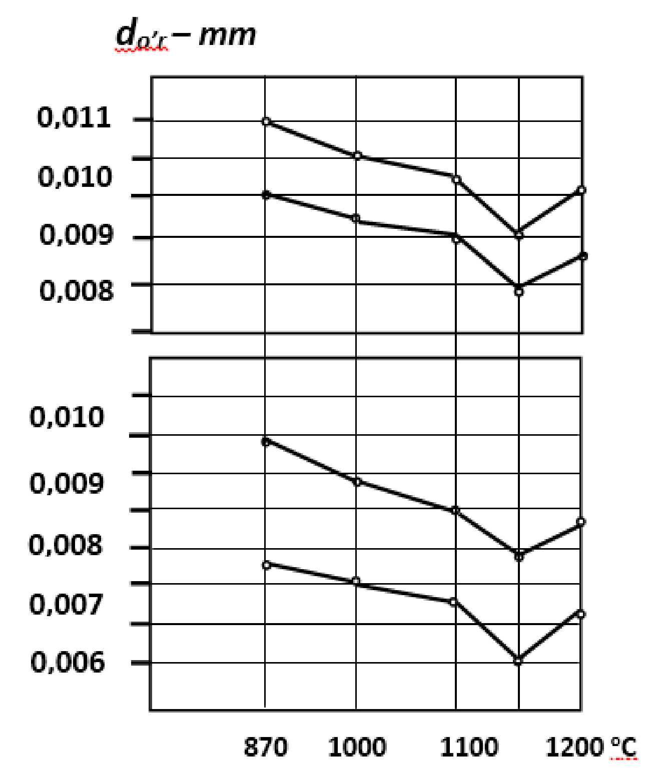
Repeated phase recrystallization carried out from the heating temperature of Ac1 + 30 – 50 ^{0}C or Ac3 + 30 – 50 ^{0}C takes place under the conditions of strong influence of the initial micro and submicrostructure. Dispersed particles of refractory admixture phases are both ready-made crystallization centers and barriers to the growth of austenitic grains [6].



Previous quenching temperature ^{0}C

Fig. 1. Change in the amount of residual austenite (% γ phase) and the content of the amount of carbon in the residual austenite (%C in the γ phase) 5XHM steel, depending on the temperature of previous quenching and intermediate tempering

Therefore, after the second phase recrystallization, a redistribution of the amount of residual austenite and the content of the amount of carbon in the residual austenite is formed (Fig. 2).



Previous quenching temperature ^{0}C

Fig. 2. Change the diameter grain in dependencies of the temperature preliminary heating

In addition, the increased dislocation density formed during the first phase recrystallization with heating to extreme temperatures is inherited during the new α-γ-α transformation. This inheritance is accompanied, however, by a significant increase in the density of dislocations in the α - phase. According to the data of [6], the initial dislocations in austenite play an important role in the martensitic transformation. Their specific constructions can serve as places of preferential origin of martensitic crystals. Such significant structural differences after heat treatment with double phase recrystallization were carried out in comparison with heat treatment using standard technology, which led to a noticeable increase in wear resistance during rolling friction with slipping, when sliding on hardened and loose abrasive, when sliding metal on metal.

It can be concluded that after the double phase recrystallization, the lattice period and the value of the austenitic grain takes a minimum value if the preliminary quenching was carried out with 1150 ^{0}C and the intermediate tempering was 550 ^{0}C. Heat treatment of alloy steels carried out under extreme conditions increases the static strength (within the flowability) from 11% to 20%.

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