СЕКЦІЯ 5
ЗВАРЮВАННЯ ТА СПОРІДНЕНІ ПРОЦЕСИ І ТЕХНОЛОГІЇ. МАТЕРІАЛОЗНАВСТВО

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STRUCTURAL CHANGES IN THERMAL HARDENING OF CONSTRUCTION REINFORCING STEELS

Annotation. Heat treatment of building fittings was carried out immediately after rolling to improve the physical and mechanical properties of steels obtained by smelting in the electric arc of the charge furnace using metal waste. The use of low-carbon and low-alloy steels with thoroughly high manufacturability and weldability is recommended. It has been determined that high requirements can be achieved by joint deformation and heat treatment. At the same time, a hardening heat treatment effect is achieved by heating due to the heat of rolling.

It is known that the requirements for the strength properties of structural reinforcing steels are being tightened day by day. At present, the main directions of increasing the strength of construction steels are known. Reinforcement is achieved by increasing the density of dislocations, creating solid solutions in the structure, breaking up the size of the grains and creating dispersed particles of the second phase (for example, by alloying) [1, 2]. Another way to increase strength is to alloy steel. The effect of alloying is manifested in the crushing of grains, the formation of solid solutions, dispersion hardening. The complex effect of alloying ensures the formation of a somewhat reinforced structure: part of the alloying element forms a solid solution in ferrite, ferrite is strengthened due to the difference in size of the atoms of iron and alloying elements [3,4].

Another way to increase the strength of structural reinforcing steels is a dispers reinforcement mechanism. In this case, the increase in the fluidity limit of steel depends on the number, size, distribution nature of the dispersed particles and the distance between them. The listed reinforcement mechanisms of construction reinforcing steels are carried out during rolling and thermomechanical processing. Thermomechanical treatment (TMT) is also an effective method of strengthening steel, which involves annealing the metal during plastic deformation in the case of austenite [5].

The spreading of reinforcing steels and then the subsequent heat treatment can be called high thermomechanical processing (HTMP). The purpose of HTMP is to obtain a non-recrystallized saturated solid solution after hot plastic deformation during the rolling process and immediately after annealing. High mechanical properties are formed as a result of stratification carried out after tabulation. Additional reinforcement during HTMP is provided at virtually constant plasticity values.

Thus, during the rolling process during HTMP, austenite is deformed in a thermally stable zone, then annealed, and after annealing is subjected to high stratification. Meeting the requirements for the strength properties of structural reinforcing steels, including increasing strength, improving cold resistance is important for reinforced concrete structures. These properties can be provided by low alloying of the steel and then thermal strengthening. For this purpose, methodical furnaces are widely used in modern processing shops for rolling of fittings.

The methodical furnace currently used in Baku Steel Company LLC is a 3-zone thermal furnace. The temperature in the first zone is 500-1000ºC, in the high temperature zone 1200-1250ºC, and in the long-term heating zone it is 50-100ºC higher than the temperature required for processing. The fact that the metal coming out of the furnace is in the range of 1250-1350ºC for rolling allows the rolling process to go better.

Thus, thermal reinforcement can be considered the most effective technology to increase the strength properties of low-carbon and low-alloy structural reinforcing steels. Thus, after the rolling operation, the steel is rapidly cooled directly in the form of austenite, resulting in a low-temperature decomposition structure of austenite, unlike conventional steel.

During thermal hardening, the decomposition temperature of austenite drops, resulting in a slight delay in the separation of extreme ferrite and the formation of dispersed perlite (sometimes bainite). Here, a small thickness of martensite structure can be obtained on the surface of steel plates. However, since the initial temperature of martensite conversion (M_b = 400-450ºC, 0.2% - C) is high in these steels, the resulting martensite structure is self-leveling due to the internal heat of the spread. In other words, the surface temperature of rapidly cooled slabs is then equalized by the heat in the inner layers, and the resulting reinforced structure is self-leveling. Thus, no additional stratification is required for the armature bearings and energy is saved.

As noted, the thinning of only a thin surface layer of steels during thermal hardening is explained by the low stability of the supercooled austenite and the high rate of crushing of the coating (500-1000ºC/sec.). The free ferrite formed during thermal hardening is distributed around and inside the grains in the form of thin layers in the form of needles. Such a structure leads to a 1.3-1.5 fold increase in mechanical properties and a decrease in the incidence of colds. This saves 15-60% of metal in construction, increasing the reliability of welded structures. The temperature of the armature in the inlet zone is in the range of 980-1080ºC, and in the outlet zone in the range of 580-650ºC depending on the required mechanical properties.

A 500 fold increase in the unstructured and annealed microstructure of HTMP former low-carbon reinforcement steel shows that the microstructure of the reinforcement consists of troostite-sorbitol. Such a structure is obtained only after tabulation in HTMP and high-temperature (580-620°C) stratification due to the heat of the spread. Thus, our research has shown that the effect of HTMP on the cooling rate, which can provide a martensite structure in low-carbon low-alloy steels, is observed when the final rolling temperature is up to 1070°C. As this temperature decreases, the effect of TMT increases.

Conclusion. The application of thermomechanical processing in the production of fittings from low-carbon and low-alloy steels is more effective. In this case, it is possible to increase the flow rate of steel up to 1000 MPa. In building structures, this characteristic is in the range of 500 MPa, it is possible to exceed this figure twice. The advantage of annealing due to the rolling temperature is that it uses the rolling heat without reheating the reinforcing steel. This saves a lot of energy needed to reheat steel.

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SOME ASPECTS OF MODELING OF THE STEEL-MAKING PROCESS

Annotation. The article discusses some aspects of the electric steel making process. It is shown that the production of electric steel mainly consists of three units - preparation of the charge, melting and pouring of the liquid became. At the same time, in the mixed mathematical model there are equations of both functional and correlation coupling. This reflects the function of the deterministic-static model. It is shown that, depending on the installation of all these models, they can be used in electric steel making.

The production of electric steel is associated with complex physicochemical processes, and some of these processes are either difficult to control or impossible to control [1]. At present, all the physicochemical processes controlled in order to obtain the required chemical composition of electric steel can be divided into two main groups [2]: metal refining; deoxygenation and alloying of the metal.

Innovative metallurgical technologies require the control of electric steel melting processes based on accurate calculations, which is possible through mathematical modeling of these processes. Mathematical modeling allows: first, to successfully solve different types of problems without conducting production experiments; second, to ensure optimal regimes of alloys under specific production conditions [2, 3].

The mathematical model of the process of electric steel making is a system of equations that connects the factors influencing this process with its parameters [3]. The mathematical model of the solution serves as a prerequisite for creating an algorithm for the process. By this is meant the sequence of calculations to be performed, which allows for a complete and accurate description of the calculation process. The algorithm of the solution is usually slightly broader than the mathematical model, because it can contain not only mathematical notation, but also logical conditions and other elements [4, 5].

Several complete and incomplete mathematical models differing in the scope of the parameters; due to the ability to take into account changes in parameters over time - static and dynamic; It is possible to compile statistical, deterministic and mixed types according to the method of compilation. At present, the physical and chemical bases of electric steel production processes are well studied. That is, the theoretical data obtained allow to establish a functional relationship between the final values of the main parameters of the smelting process and most of the factors that significantly affect them.

Thus, in our opinion, using the thermodynamic data of electropolarization, it is possible to create reliable statistical mathematical models consisting of equations expressing functional relationships with maximum limitation of regression equations [6].