THE IMPACT OF THE STRATEGY OF LASER TREATMENT ON STRUCTURE FORMATION OF STEEL IN A STATE OF PRE-TRANSFORMATION

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Introduction. Study of the relationship between the temperature distribution and the formation of regions with different structure in the heat affected zone (HAZ) is an urgent task, since this could make it possible henceforward to carry out optimization of laser cutting technology (LCT), including in terms of preventing a significant decrease in the mechanical characteristics of the processed material in the HAZ. This work is devoted to the study of the temperature distribution near the cutting zone after LCT by example of steel St3 sheets and its comparison with the location of various structural domains found in the HAZ.

Materials and methods. The object of investigation was sheets of steel St3 (A53 AISI), with a thickness of 6 and 10 mm. LCT was carried out using a unit equipped with an EIP1119 optical head produced by STC IRE-Polus [1,2]. The parameters of laser cutting were varied within the following ranges: radiation power W = 1200–1900 W, cutting speed V = 700–1600 mm/min, gas pressure P = 0.015–0.05 MPa, focal length F = 295–305 mm. The investigation of the HAZ microstructure was performed using an Observer Dim light microscope at ×200 and ×500 magnification. For making microsections 10 × 25 mm in size, the samples were cut out near the surface of the cut after LC performed in different modes. The etching of the samples was performed via immersion in a 4% solution of nitric acid in alcohol.

Results and discussions. A calculation is performed for the temperature distribution and studies are conducted for the structure of the HAZ in sheet steel St3 with a thickness of 6 and 10 mm after LCT. It is shown that, with increasing LCT speed, the temperature in any section of the HAZ is reduced. Increasing laser power in the studied range has almost no effect on the temperature distribution in the HAZ. The temperature fields appearing in the course of LCT are compared with the location of the HAZ regions differing in structure. The area with ferrite structure under heating stays in a state of pre-transformation before a eutectoid transformation; the cause of its formation could be an enhanced diffusion mobility of interstitial atoms near the critical point Ac_1.

Conclusions. The calculation of the temperature distribution in the heat-affected zone during the laser cutting of steel St3 sheets for different modes has allowed us to compare the temperature field with the arrangement of different structural domains and to reveal that the area with the most defective structure in the course of heating was in a pre-transformation state before the eutectoid transformation. (2) The estimate of the carbon diffusion coefficient in the heat-affected zone of steel sheets indicates an accelerated diffusion of carbon in the course of laser cutting and confirms the possibility of decarburization of the alloy areas the temperature of which corresponded to a temperature range inherent in the state before transformation in critical point Ac1.

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