3D FEM thermal transient model for optimization of laser cutting parameters for stainless steel plate.

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The main area of the research was the proposal of parameters for laser cutting of AISI 304 stainless steel plate based on numerical simulation of laser cutting process using FEM modelling in the ANSYS.

The high-intensity laser beam melts or evaporates the workpiece in the thickness of materials and creates a kerf wall. Molten material is then blown away using an assistant gas. In laser machining, unlike traditional methods, material removal is conducted without applying any force. In laser machining, the final surface quality can be achieved in one step, and no further finishing operations are needed to smooth and clean the surface [1]. Understanding of thermal behaviour resulting from a moving laser beam is essential to control the product quality [1,2].

One of the possibilities for predicting products with the required technological properties and quality is the use of numerical simulation. The 3D FEM model was used for the design of laser cutting parameters. In the numerical simulation of transient thermal behaviour of the laser moving heat source, the conical model with Gaussian laser beam power distribution is widely used [3]. The main data required in the thermal analysis of the moving heat source problem are such as: laser power, spot diameter and intensity distribution of the heat source, the convection of surrounding atmosphere, the thermal properties of the work material, and the moving speed of the heat source [2].

Simulation model for cutting of test samples with the dimensions of $10 \times 35 \times 2$ mm was developed in order to perform numerical experiments applying variable cutting parameters and to design proper combination of these parameters for formation of stainless steel quality cuts. Thermal properties of cutting materials in the dependence on temperature were computed using JMatPro software. The conical model of the heat source was exploited for description of the heat input to the cutting model due to the moving laser beam source. The sample cooling by convection and radiation to the surrounding air and nitrogen process gas was taken into account. Developed simulation model was verified by comparison of obtained results of numerical simulation with the temperatures measured during real experiments of laser cutting by the CO_2 Laser Cutting Machine Bystronic Bysprint 3015.

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