Assessment of the impact of process parameters on temperature fields during laser cutting of AISI 304 steel sheets

Eva Babalová and Mária Behúlová

Slovak University of Technology in Bratislava, Faculty of Materials Science and Technology in Trnava, ul. Jána Bottu Č. 2781/25, Trnava 91724, Slovakia

Laser cutting has experienced significant advancements in recent times. Consequently, this technique now boasts exceptional precision and high cutting speed [1]. In CO_2 laser cutting, the quality of the final product is primarily determined by the input parameters, including laser power, cutting speed, and assist gas pressure. Within the laser cutting process, the size of the heat affected zone (HAZ) is significantly influenced by both laser power and assist gas pressure. These two parameters play a pivotal role in both material melting and the ejection of molten material from the cutting aperture [2].

The consumption of the cutting medium depends on the laser focus position and the relationship between the assist gas pressure and the output nozzle diameter. These parameters collectively define the overall quality of the cuts. To decrease assist gas consumption along with preserving the desired cut quality, it is recommended to decrease the nozzle diameter and simultaneously increase the gas pressure [3].

The article is focused on the investigation of the influence of nitrogen assist gas pressure on temperature fields developed during a cutting process using numerical simulation. A simulation model was developed for the laser cutting process of a test specimen made from AISI 304 steel, with dimensions of $50 \times 35 \times 2$ mm. The material properties for AISI 304 steel were determined using the JMatPro software. The conical heat source model was employed to describe the power input from the moving laser beam source to the cutting material. The sample cooling by free convection and radiation to the surrounding air and the nitrogen jet impingement was taken into account. Various available correlations [4] were utilized to calculate the heat transfer coefficient during a nitrogen gas jet cooling and their results compared. Finally, a series of numerical experiments was conducted using ANSYS software to evaluate the impact of the assist nitrogen gas pressure on temperature fields during the cutting process.

The research has been supported by the Scientific Grant Agency of the Slovak Republic within the VEGA Project No. 1/0796/20.

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