Numerical simulation of the resistance spot welding of parts from the AISI 304 steel

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Resistance spot welding (RSW) belongs to the highly effective methods of production weld joints. It is applied with many advantages such as high productivity, low cost, reliability, easy to operate and automate, predominantly in automotive industry [1]. The weld quality is usually affected by several welding and technological parameters: the current intensity, welding time, the force applied by electrodes, contact resistance, the size of electrodes, etc. [2]. Numerical analysis of RSW represents complex problem which involves multi-physics coupling of thermal, fluid, metallurgical and mechanical phenomena [3]. Despite the complexity and difficulty of modeling these coupled phenomena, numerical simulation of RSW processes can provide valuable information on nugget formation and the influence of different parameters on the weld properties [4].

The paper deals with the FEM simulation of the RSW of two sheet parts from the austenitic stainless steel AISI 304. To analyze the process of resistance spot welding, the simulation model considering geometrical characteristics of welded parts, temperature dependent material properties, the initial conditions, thermal, electrical and mechanical boundary conditions and loadings was developed and validated by the realization of real experiments of RSW of two sheet samples from the AISI 304 steel. Using the simulation model of RSW, the effect of chosen welding parameters on the characteristics of weld joints was evaluated by the numerical experiments in the program code ANSYS.

As it follows from obtained results, the welding current is the most important factor influencing the size of molten zone as well as the dimensions of heat affected zone. The welding time and the contact resistance as an indirect process parameter are the less significant factors. However, the correct setting of the contact electrical resistance and its dependence on the contact pressure is very important. Finally, based on the results of numerical simulations, the Lobe diagram enabling to find optimal process window for RSW was predicted. This diagram can help the process engineers to propose suitable welding parameters for production of high quality weld joints.

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