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The Experimental and Numerical Analysis of the Joining Processes for Air Conditioning Systems

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Abstract : In the paper the results of welding of car’s air-conditioning elements are presented. These systems based on, mainly, the environmental unfriendly refrigerants. Thus, the producers of cars will have to stop using traditional refrigerant and to change it to carbon dioxide (R744). This refrigerant is environmental friendly. However, it should be noted that the air condition system working with R744 refrigerant operates at high temperature (up to 150 °C) and high pressure (up to 130 bar). These two parameters are much higher than for other refrigerants. Thus new materials, design as well as joining technologies are strongly needed for these systems. AISI 304 and 316L steels as well as aluminium alloys 5xxx are ranked among the prospective materials. As a joining process laser welding, plasma welding, electron beam welding as well as high rotary friction welding can be applied. In the study, the metallographic examination based on light microscopy as well as SEM was applied to estimate the quality of welded joints. The analysis of welding was supported by numerical modelling based on Sysweld software. The results indicated that using laser, plasma and electron beam welding, it is possible to obtain proper quality of welds in stainless steel. Moreover, high rotary friction welding allows to guarantee the metallic continuity in the aluminium welded area. The metallographic examination revealed that the grain growth in the heat affected zone (HAZ) in laser and electron beam welded joints were not observed. It is due to low heat input and short welding time. The grain growth and subgrains can be observed at room temperature when the solidification mode is austenitic. This caused low microstructural changes during solidification. The columnar grain structure was found in the weld metal. Meanwhile, the equiaxed grains were detected in the interface. The numerical modelling of laser welding process allowed to estimate the temperature profile in the welded joint as well as predicts the dimensions of welds. The agreement between FEM analysis and experimental data was achieved.

Keywords : car’s air–conditioning, microstructure, numerical modelling, welding
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