Optimal joint preparation for Laser Hybrid and Tandem MIG/MAG welding

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Abstract

In this report new butt joint preparations have been evaluated in order to improve the weld quality and productivity for tandem MIG/MAG and laser hybrid welding in aluminium, stainless steel and carbon steel with 10 and 12.8 mm thickness. The specific advantages and disadvantages of the different joint preparations are discussed and weld parameters and weld quality assessments are given. Examples of weld cost calculations and indexing of weld costs are also presented.

The welded joints were evaluated by radiography, tensile testing, hardness mappings, impact toughness testing, corrosion testing and metallographic examinations. The corrosion resistance of the stainless steel was measured according to the ASTM G150 Critical Pitting Temperature method (CPT). The measurements were performed in a so called “Avestacell” developed primarily for measuring the occurrence of pitting corrosion of stainless steels without influence of crevice corrosion. Highspeed imaging was used to study the interaction between the two arcs in tandem MIG/MAG welding and to optimize the weld parameters for the selected joint types. As reference, welding trials were performed with single wire Rapid Processing welding on the 10 mm carbon steel butt joints.

The smallest V-groove without gap that was possible to weld with tandem MIG/MAG was 15°+15° for the carbon steel grade. With a heat-input of 1.3kJ/mm the cooling time between 800°C to 500°C (t8/5) was as low as 13 s. Regardless of the joint preparation it was necessary to use root backing for tandem MIG/MAG to avoid burn through. Most suitable joint design for laserhybrid welding of carbon steel and stainless was a 3°+3° V-groove or alternatively a 6°+6° V-groove with 4mm nose. Acceptable weld quality was not achieved for the aluminium butt joints due to porosity, sagging and excess penetration at the root side.