ENG MAT CON
II CONGRESSO ONLINE DE ENGENHARIA DE MATERIAIS

INFLUENCE OF THE WIRE FEEDING DIRECTION ON GEOMETRY AND MICROSTRUCTURE IN THE HYBRID LASER GMAW WELDING PROCESS

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ABSTRACT

Welding processes are present in all sectors of the industry. Among these, sectors that use thick plates and pipelines stand out, such as the oil and gas, shipbuilding and railway industries. The conventional arc welding processes have the attainable penetration depth as a limitation, making it necessary to pre-chamfer the joint in order to allow metallurgical joining in the entire thickness of the joint. The LASER Beam Welding (LBW) process, characterized by a high-power density, allows to achieve a high welding speed and a high penetration and width rate. Despite its advantages, the LBW process has limitations such as low geometric tolerance of the joint, and occurrence of porosity when high penetration is obtained. In this context, hybrid LASER-arc welding (HLAW) processes are notoriously considered to compensate for the limitations of individual processes, using both techniques in one melting pool, achieving high metallurgical quality, high welding speed and high penetration with a reduction in the necessary geometric precision of the weld joint. Besides to the high number

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of parameters involved in the two individual processes, the hybrid process becomes extremely complex to be analyzed and applied due the interaction of the arc plasma and the LASER beam. The relative positioning between them has a significant influence on all the results of the process. Among the geometric parameters of the HLAW process, the wire feed direction stands out. Two main directions can be set: leading arc, with the electric arc in front of the LASER beam, and trailing arc, with the arc behind the LASER beam. Through welding tests involving the two configurations mentioned, the present work presents comparatively the operational, geometric and microstructural results. Three welding repetitions were performed with the two proposed configurations, under ASTM A516 GR70 substrate, 1.2 mm diameter AWS ER 70S-6 filler material, argon as shielding gas, 7 kW of LASER power and 250 A of GMAW average current. After visual analysis and metallographic preparation, a 16% increase in penetration depth and a 23% width reduction were observed for the leading arc configuration. In general, the procedures performed with the leading arc configuration showed a greater tendency to undercut, impacting the final quality of the weld. The cross sections were evaluated according to their microhardness, with a reduction of 19% in the central and lower region of the welds in the leading arc configuration. This fact is justified by the more significant action of the electric arc, behaving as a cooling retardant agent. When welding pipelines and tubes of high thickness, perfect alignment between all regions of the circumference of the joint to be welded is almost impossible. This difficulty is due to the manufacturing process of the parts to be welded, where ovalization is common. Thus, the hybrid welding process with trailing arc orientation is advantageous in these industrial processes that are susceptible to geometric variations in the joints to be welded.

Keyworkds: HLAW; Hybrid LASER-Arc Welding; LBW; Torch Arrangement