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ANALYSIS OF THE INFLUENCE OF WIRE PREHEATING ON THE GTAW HOT WIRE PROCESS: A EMPIRICAL APPROACH

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ABSTRACT

The GTAW (Gas Tungsten Arc Welding) process stands out as one of the most representative arc welding processes, being used in joining, coating and additive manufacturing applications. The electric arc is established between a tungsten electrode and the workpiece, under a curtain of ionizable gas or gas mixture, which has the main function of protecting the melting pool and the heated electrode. Through the heat generated by the electric arc, the substrate is melted, whether or not filler materials can be used. This independence between the heat input and the wire feeding rate represents one of the main advantages of the GTAW process, thus allowing to achieve high metallurgical quality and control of root pass penetration. However, the GTAW process has lower deposition rates when compared to other arc welding processes. In order to overcome this limitation, the application of a secondary current in the wire stands out, originating the process known as GTAW - Hot Wire. The wire-fed GTAW process is significantly influenced by the temperature at which the wire contacts the melting pool. The heat needed to promote the wire fusion is lower with preheating, which influences the melting pool internal temperature. The heat absorbed by the wire comes from the Joule effect resulting from preheating and from the conduction and convection transmitted to the wire by the arc. Isolating the heat generated by the preheating, it is possible to obtain an exact correlation between the Hot Wire current used and the average final wire temperature. The present work presents an empirical evaluation of the relationship between the Hot Wire current and the final wire temperature, and consequently with the operational and microstructural characteristics of the welds produced, comparing with procedures performed with GTAW Cold Wire, i.e., without wire preheating. A AWS ER70S-6 wire, 1 mm in diameter, with a wire feeding speed of 1.5

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m/min and a hot wire current of 75 A was used. For the analyzed scenario, a temperature of 361 ºC was reached in the tip of the wire. The welding processes carried out with GTAW Hot Wire showed a significant possibility of a 100% increase in the wire feeding speed, to the point that the wire needs a lower value of the electric arc to be fused, reaching a stable process with 3.0 m/min. wire feeding speed. Besides that, there was an increase in wettability and width of the weld bead, and a reduction of 15% in the dilution reached. The obtained results corroborate the importance of the GTAW Hot Wire welding process used in applications that aim at higher deposition rates and a control of the resulting dilution, such as coating applications.

Keyworkds: Coating; Dilution Control; Gas Tungsten Arc Welding; TIG.