ENGINEERING AND TECHNOLOGY IN INDIA
Volume 1 Issue 2 (October, 2010) Page : 118-122

REVIEW ARTICLE

Accepted : *August, 2010*

Optimization of pulsed GTAW process parameters for bead geometry of aluminium alloy 6061 using Taguchi method

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ABSTRACT

The selection of process parameters for obtaining optimal weld bead geometry of aluminium alloy 6061 (AA6061) with pulsed gas tungsten arc welding (GTAW) is presented. The bead geometry includes bead penetration, bead width and bead height. All these characteristics were considered together in the selection of process parameters using Argon as a shielding gas with sinusoidal AC wave and modified taguchi method was used to analyze the effect of each welding process parameter on bead geometry properties. Experimental results were furnished to illustrate the approach.

Key words : Pulse parameters, Modified Taguchi Method, Al Alloy 6061, Bead geometry

AA6061 aluminium alloy (Al-Mg-Si alloy) has gathered wide acceptance in fabrication of food equipments, chemical containers, passenger cars, road tankers and railway transportation systems (Kumar *et al.*, 2007). Welding of aluminium and its alloys presets some peculiarities in contrast to ferrous materials, due to the physical and chemical properties of aluminium like passive oxide layer, high thermal and electrical conductivity, low fusion temperature, heat coefficient of thermal expansion, solidification shrinkage and high solubility of hydrogen and other gases in molten state. Further problems can rise when attention is focused on heat-treatable alloys, since heat, provided by welding process, is responsible for the decay of mechanical properties, due to phase transformations and softening induced in alloy (Norman *et al.*, 1999).

Pulsed GTAW process is frequently used in welding of aluminium alloys, because of its possible heat input control. This control can be utilized through a good selection of the pulse process variables, which in turn results in optimizing the bead dimensions (Mohamed, 2001). Also pulse GTAW process is strongly characterised by the bead geometry because the bead geometry plays a very important role in determining the mechanical properties of the weld (Jeneey *et al.*, 2001). The important process parameters which affects the bead profile are pulse current, secondary current (base / back ground current), pulse frequency, pulse duty cycle, welding voltage, welding speed and gas flow rate. The thermal behaviour of weld governed by arc characteristics significantly influences the geometry, chemistry, microstructure and stresses of weld (Dieter, 1992; Balasubramanian and Balasubramanain, 2008). Deep penetration in pulsed current welding is produced mainly by arc pressure at peak duration and significantly long peak duration is needed for deep penetration (Ko and Yoo, 2001).

The linear relationship exists between the heat input of a weld and the maximum temperature at a given distance from weld centre line shows that pulsed arc welds would be cooler and therefore exhibit less thermal distortion than conventional GTA welds of the same penetration (Lietner *et al.*, 1973). The heat input is typically calculated as follows: H = [60EI] / 1000 S, where H = Heat Input (kJ/mm), E = Arc Voltage (Volts), I = Current (Amps) and S = Travel Speed (mm/min).

Taguchi method is a powerful tool for design of high-quality systems, widely used for improving quality without increasing cost and with minimum experimentation. It provides a simple, efficient and systematic approach to optimize designs for performance, quality and cost. This method is valuable when process parameters are qualitative and discrete. The parameter design based on the Taguchi method can optimise the quality characteristics through the settings of process parameters and reduce the

Kumar, Pawan and Datta, C.K. (2010). Optimization of pulsed GTAW process parameters for bead geometry of aluminium alloy 6061 using Taguchi method, *Engg. Tech. India,* **1** (2) : 118-122