The Interaction of Pulsed Current GMA Welding Variables on the Shape and Size of the Weld

Fabricators to derive the fullest benefits from GMAW-P in high quality or automatic or robotic welding

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ABSTRACT

Introduction

The Pulsed Current GMA Welding (GMAW-P) is one of the high quality welding processes in the automotive welding industry especially to weld aluminum and its alloys because of its inherent advantages including good puddle control, smooth weld surface, less material distortion, easy to weld in any welding position, ability to be used in conjunction with both automatic and robotic welding processes, and good penetration and wetting action. This welding process combines the good features of a high current such as good penetration, good fusion, and steady arc with the advantages of low currents such as smoother bead, no burn through, better energy, and material usage. The economic production of high quality welds in the GMAW-P process with optimum shape and size of the weld is a challenge faced by most welding engineers in today's automotive, and fabrication industries.

Experimental Procedure

An experimental study was carried out and results were analyzed to solve the problems faced by welding engineers relating the process variables with the weld shape and the size. The welding was carried out using a transistorized pulsed GMA welding power supply and solid filler metal ER 5356 Al-Mg alloy having a diameter of 1.2 mm (0.047 in.) and with the compatible AA 5083 Al-Mg alloy of 6.0 mm (0.236 in.) thick base metal. The bead-on-plate welds were deposited in the flat position. Mathematical models were developed to relate the GMAW-P variables and the shapes and sizes of weld.

Results/Discussion

The optimization was carried out with the help of computer software packages and this model was used in predicting the geometrical dimensions of weld. This model was also used in setting the GMAW-P process parameters at optimum values to achieve the desirable weld bead shape and size, with a high degree of repeatability and increased production rate.

Various geometrical dimensions of the welds were measured and analyzed using a computer. The process parameters such as peak current (I_P), peak duration (T_P), background current (I_B), background duration (T_B), welding speed (W_S), and wire feed

speed (W_F) were varied during experimentation. This helped to evaluate the interaction effects of the process parameters with the geometrical dimensions of weld and to optimize the geometrical dimensions of the weld. The geometrical dimensions of the weld are reinforcement height (H), penetration (P), weld width (W), W/P ratio, reinforcement boundary length (L_R), penetration boundary length (L_P), W/L_R ratio, W/L_P ratio, area of penetration (A_P), area of reinforcement (A_R), total weld area (A_T), bead-plate wetting angle (θ_W), and fusion angle (θ_F). The percentage of dilution (%D) and heat input (H_{IN}) are calculated.

The mathematical models were developed on the basis of the above study to minimize weld width, maximize penetration, minimize dilution, minimize heat input, minimize reinforcement, and maximize production rate. This study helped to obtain a high-quality welded joint at a relatively low cost with high productivity. The mathematical model thus developed was much helpful to optimize GMAW-P process to make it a more cost-effective process. The diagrams, graphs and developed models were successfully used in the selection of GMAW-P parameters to achieve the desired weld bead shape and size. The results were also compared with steady current welding.

Conclusions

1. This study is very helpful for monitoring and improving the GMAW-P process and for optimizing the parameters of the GMAW-P process.

2. This study can be very much useful for fabricators to derive the fullest benefits from GMAW-P in high quality or automatic or robotic welding.

3. This model is very much useful in setting the GMAW-P process parameters at optimum values to achieve the desirable weld bead shape and size, with a high degree of repeatability and increased production rate.

4. This study is very much helpful to obtain a high-quality welded joint at a relatively low cost with high productivity.