

Variable Polarity GMAW for Improved Weld Brazing of Galvanized Sheet

by Andy Joseph, Edison Welding Institute

Introduction

Joining of galvanized materials using GMAW with steel filler wire can result in porosity, lack of fusion, cracking, spatter and erratic arc behavior. Previous research has shown that GMA Brazing can overcome the problems posed by coated materials listed above, while maintaining sufficient joint strength (Ref. 1 - 3). GMAW Brazing typically takes advantage of Pulsed GMAW's low heat input compared to constant voltage GMAW. However, a significant amount of the zinc coating is typically burned off in the HAZ and backside of the braze weld due to excessive heat input, despite the use of GMAW-Pulse. An investigation into the use of Variable Polarity GMAW (VP-GMAW) with standard weld brazing filler wire was conducted to determine the potential of this process for further reduction in weld heat input and zinc loss.

Experimental Procedure

Pulsed GMA braze welding parameters were developed using a Lincoln Electric Powerwave 455, and the VP-GMA braze welds were produced using a Kobelco AL-350 power supply. Two brazing filler wires were tested: 0.045" (1.2mm) ER CuSi-A and 0.045" (1.2mm) ER CuAl-A2. The weld joint was a lap using 1.2 mm galvanized sheet with a 1.2 mm gap and was welded in the horizontal (2F) position. Weld size was optimized (WFS/TS=7.6) for this joint configuration, and travel speeds ranged from 13 - 45 IPM (0.3-1.2 m/min). Table 1 lists the testing matrix for each power supply / wire type combination.

Table 1. Test matrix for each power supply / wire type combination.

Travel Speed (IPM)	Wire Feed Speed (IPM)
13	106
21	167
29	234
37	296
45	362
Constant: 100% Argon shielding gas at 40 CFH 15 degree push travel angle 30 degree work angle 1/8 inch arc length 5/8 inch contact tip-to-work distance	

Arc stability was monitored and optimized using high speed video and the Analysator Hannover (AH) data acquisition system. The AH system gave voltage and current waveforms as well as statistical histograms to determine the repeatability of weld parameters.

Tensile tests were taken from welds that represented the maximum satisfactory productivity level for each process combination (37 IPM). Cross sections of each weld were mounted and polished to ensure proper bead shape and wetting characteristics. Visual inspection of the weld surface and spatter levels were also made.

Results and Discussion

The maximum productivity level for both power supplies was found at 37 IPM travel speed. Figure 1a shows a macro photograph of the GMAW-Pulse braze weld at 37 IPM. Significant melting of both the top plate and the bottom plate occurred, resulting in a high level of zinc and steel contamination in the braze weld (seen as dark areas). Figure 1b shows a cross section of the VP-GMAW braze weld at the same speed. There was very little melting of the top plate, and no melting of the bottom plate, resulting in a low level of contamination in the braze weld. The smaller HAZ of the VP-GMAW braze weld compared to the GMAW-Pulse weld also indicated that the heat input was lower in the VP-GMAW weld.

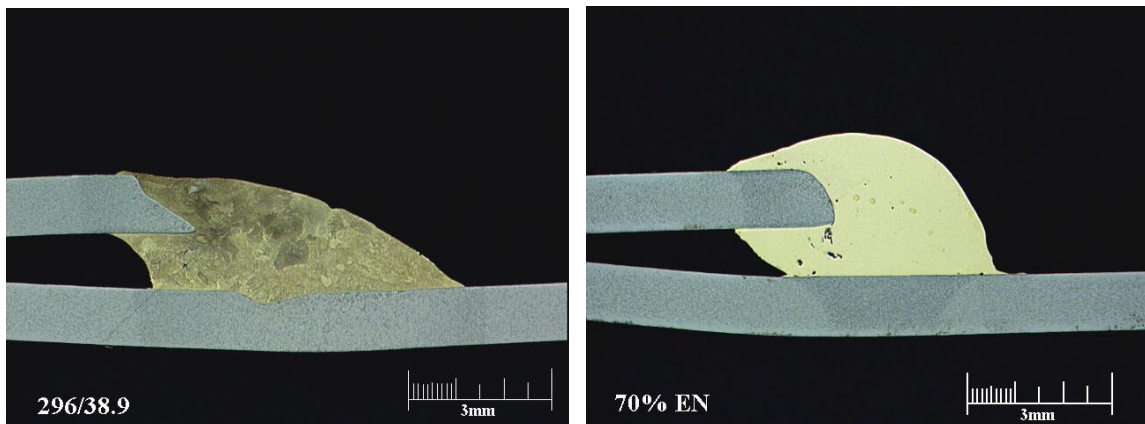


Figure 1a and 1b – GMAW-Pulse braze weld where high heat input caused melting of top and bottom plates, and high levels of zinc diluted into the weld metal (left). Variable Polarity GMA braze weld with almost no melting of the base material, and very little zinc dilution (right).

Figure 2 shows the backside of two welds produced at 37 IPM travel speed. The top weld is the GMA-Pulse braze weld with an excessive amount of zinc burn off in the HAZ and on the weld backside. The zinc burn off indicated a loss of corrosion protection in these areas. The bottom weld is the VP-GMAW braze weld with very little zinc burn off. The VP-GMAW process reduced the weld heat input and resulted in significantly less zinc burn off on the backside of the weld.



Figure 2 – Black soot on backside of the GMA-Pulse braze weld caused by excessive heat input (top). Significant reduction in the amount of zinc removed as a result of using Variable Polarity GMA brazing (bottom).

Conclusions

The following conclusions were made upon completion of this project

1. The GMAW-Pulse and the Variable Polarity GMAW processes were used to produce sound welds for two standardized braze wires at travel speeds ranging from 13-45 in/min (0.3-1.2 m/min).
2. Mechanical testing and metallurgical cross sections confirmed that joint integrity, wetting, and gap bridging was acceptable for both GMAW-Pulse and the Variable Polarity GMAW processes.
3. The Variable Polarity GMAW process produced a significant reduction in zinc coating loss when compared to the GMAW-Pulse process.

References

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3. Frings, Stockel, Fully mechanized inert-gas metal-arc brazing of hot dip aluminized thin steel sheet, Schweissen & Schneiden 41 (1989) E192-E194