BRAZING AS A SUBSTITUTE FOR GMA (MIG) WELDING?

Brazing instead of GMA (MIG) welding or STRSW? Can it be used on non-structural AND structural applications? To some European automakers, the answer is a resounding “yes!” After years of being told that MIG brazing is strictly for cosmetic purposes such as filling joints and seams, this type of joining process has advanced to the point of being a possible substitute for GMA (MIG) welding. European automakers such as Vauxhall contend that MIG brazing provides adequate joining strength and maintains more of the galvanizing that is so important to the corrosion protection of the vehicle. They believe this so much that repair GMA (MIG) welding is not recommended on the 2002 Holden Vectra.

Why MIG Brazing?

It is widely known that GMA (MIG) welded, fully galvanized steel will lose some of its properties, including corrosion protection, due to the heat created during welding. We counter this problem by using weld-through primer to restore corrosion protection along with “stitch” and “skip” welds to control the heat. With MIG brazing, the lower heat input burns away a minimal amount of the zinc corrosion protection (galvanizing) adjacent to the weld (see Figure 1). Generally the melting temperature of GMA (MIG) welding electrode wire is higher than the evaporation temperature of zinc 910° C (1,670° F), causing the zinc to vaporize both in and around the weld zone. However, by reducing the welding temperature, less zinc will vaporize adjacent to the weld bead and the zinc disturbed by the process will “return.” To achieve a temperature that limits the amount of vaporization, it is important to use a MIG brazing program on the welding machine that has been developed for the specific coating, electrode wire, and shielding gas.

Figure 1–Note the difference in the heat-effect zone between the MIG brazed joint and the GMA (MIG) welded joint.

In addition to protecting the galvanized coating, the low heat involved in MIG brazing does not compromise the strength of the steel. A number of other characteristics associated with MIG brazing include:

- Less welding spatter. The material is transferred into the weld pool without any short circuiting. As a result, the arc is almost entirely free of spatter.
- Easier finishing of the welded joint. The bronze bead is soft.
- Less potential of panel warpage when the weld heat is lowered.
- Reduced potential for burnthrough.
- A good seal along the joint.
- Cathodic corrosion protection next to the weld bead (cathodic corrosion protection prevents rust “creep” between zinc and steel along cut edges of the panel).

Adhesion vs. Fusion

During GMA (MIG) welding, the base metal melts and fuses with the melted filler metal at a temperature of approximately 1,650° C (3,000° F). This is considered a fusion process. When brazing, however, the temperature is considerably less, with a welding temperature between 960–1,000° C (1,760–1,830° F). Therefore, only the filler metal melts. It does not melt the surrounding metal in the weld zone, rather it lies on top without penetrating the base metal. At these temperatures, only minor superficial melting of the steel can occur.

Equipment Recommendations

Figure 3–Copper-silicon (CuSi3) is the most common type of electrode wire used for MIG brazed joints.

Figure 4–The bead of a MIG-brazed weld should not lay flat on the joint.

MIG brazing can be performed using a GMA (MIG) welding machine, equipped with a spool gun, a conventional torch, or a push feeder with Teflon® cable liner. This type of liner is used to minimize particle throw-off from the filler material.

Pulse MIG brazing equipment has yielded the best results when MIG brazing. Pulse equipment provides lower heat input into the base metal. It uses one molten drop of electrode per pulse, which results in virtually spatter-free welding. Generally, this type of equipment has a computerized program that controls a number of different parameters and uses a conventional torch with a push feeder.

Recommended Filler Materials

The recommended brazing wire includes copper-silicon (CuSi3) which is most common for sheet steel, or bronze alloy solder (CuAl8 and CuSn6) (see Figure 3). This type of electrode is available in 6 mm (0.025"), 0.8 mm (0.030"), or 1.1 mm (0.045"). It is recommended to treat this wire similar to aluminum wire. There cannot be any abrasions to the wire when it is fed. Therefore, use half-round, smooth wire drive rolls. Recommended base wire liner may include Teflon®, plastic-graphite, or carbon fiber.

The recommended shielding gas is 100% argon. However, argon with a small amount of CO_2 (18%) may be used to improve arc stability. The shielding gas flow rate should be set at 25–30 cfh.

Machine Settings

The most common error that technicians make when setting a GMA (MIG) welder for MIG brazing operations is setting the output of the welding machine too high and making too hot of a weld. When MIG brazing using a GMA (MIG) welding machine, use a lower wire speed (lower current) setting than what is generally used for welding with steel electrode wire. Also, use lower voltage settings (shorter arc length). This requires the power source on the welder to deliver a stable arc in the low power range. When using a GMA (MIG) pulse welding machine, the specific parameters may be programmed into the machine, so limited adjustments may be required. The program will automatically adjust the arc length and droplet detachment force, as well as a variety of other factors that may affect joint integrity. When welding with lower heat, the weld bead does not lay down flat (see Figure 4). Unlike welding steel, this is acceptable. Do not adjust the heat settings to get a smoother, flatter bead. Increased heat settings defeat the benefits of lower heat MIG brazing.

Welding Technique

When performing overlap welds, position the torch 45° from vertical and 60° away from the direction of the weld (see Figure 5). This ensures that any vaporized zinc gas passes out of the weld zone without affecting the quality of the weld. It is recommended to have a small groove opening of 0.5–1.0 mm between the coupons. This opening will help the passage of the weld pool into the groove to create more welded surface area, increasing adhesion.

It is recommended that you push the torch when MIG brazing. This technique preheats the base metal and vaporizes zinc in the weld zone, thus reducing weld porosity. If using pulse equipment, this method allows the background current to preheat the base metal. Using the pull method does not preheat the metal as much, therefore, vaporizes less zinc and increases weld porosity. Also, because of the higher zinc vapor content trying to escape the seam, the arc stability will fluctuate more.

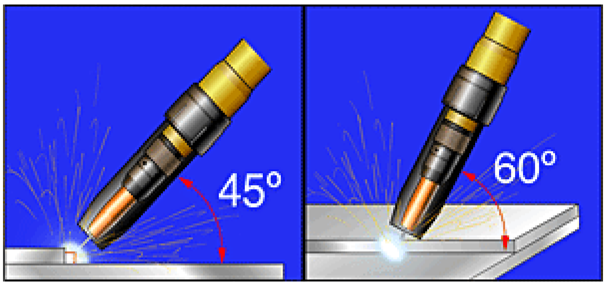

Figure 5–Proper torch position helps ensure that vaporized zinc gas passes out of the weld zone.

When working with steel electrode wire, “stick-out" must remain constant along the weld pass and the amount of recommended stick-out should be between 6–25 mm depending on the electrode wire thickness. The stick-out distance with MIG brazing does not need to be as precise. If the stick-out is not constant while making the weld, the adverse effects, such as splatter, should be minimal.

Testing

MIG brazing welds may be tested in a manner similar to GMA (MIG) welds. A proper weld will cause the top plate to tear out along the weld bead. The destructive test is similar to the technique taught in the I-CAR Steel GMA (MIG) Welding (WCS01) programme and for the Automotive Steel GMA (MIG) Welding Qualification Test (WCS03) programme. To destructively test the weld:

1. Secure the bottom coupon in a vise with the fillet weld facing the front.
2. Use both hands to rock the top piece back and forth until it breaks free from the bottom piece.

The weld is good only if there is tearout along the weld on the top coupon.

Applications

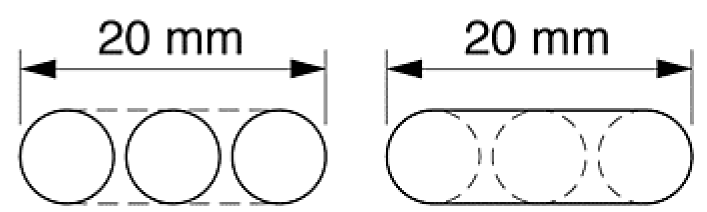

Figure 6–Slotted plug weld holes are used in place of round holes when welding structural parts.

MIG brazing can be used for all types of joints. These include butt with backing, fillet on lap, and plug weld joints. Vehicles that recommend the use of MIG brazing include the 2004 Holden Vectra C Opel, 2004 Volkswagen Golf, and the PSA Peugeot Citroen1s.

On the Holden Vectra, areas around the door openings, rail flanges, roof rails, and wheelhouse are slot welded (See Figure 6). This process is similar to plug welding with the exception that instead of a round hole, the area to be welded is a slot. To make the slot, the body repair manual recommends drilling or punching three 6 mm holes within 20 mm of each other. That area is then drilled into a slot. Each slot is placed 30–40 mm apart. For structural member section joints, the butt joint seams are welded with a backing.

Toyota also recommends MIG brazing. You will most likely find reference to that in body repair manuals at the roof panel–to-pillar joints and the rear body panel to quarter panel drip channel joint.

Conclusion

Depending on the steel alloy used, MIG brazed joints are as strong as a GMA (MIG) welded joint, while maintaining the original level of corrosion protection. However, to ensure these characteristics are maintained, the welders must be set to precise settings and the proper MIG brazing techniques must be used.

At the date of this publication (August 2004), all of the vehicles where MIG brazing is recommended on structural parts are European models that are not currently available in North America. The recommendation in North America is to use GMA (MIG) welding or STRSW where applicable. MIG brazing has not been recommended for use on structural parts for any of the vehicles sold in North America.