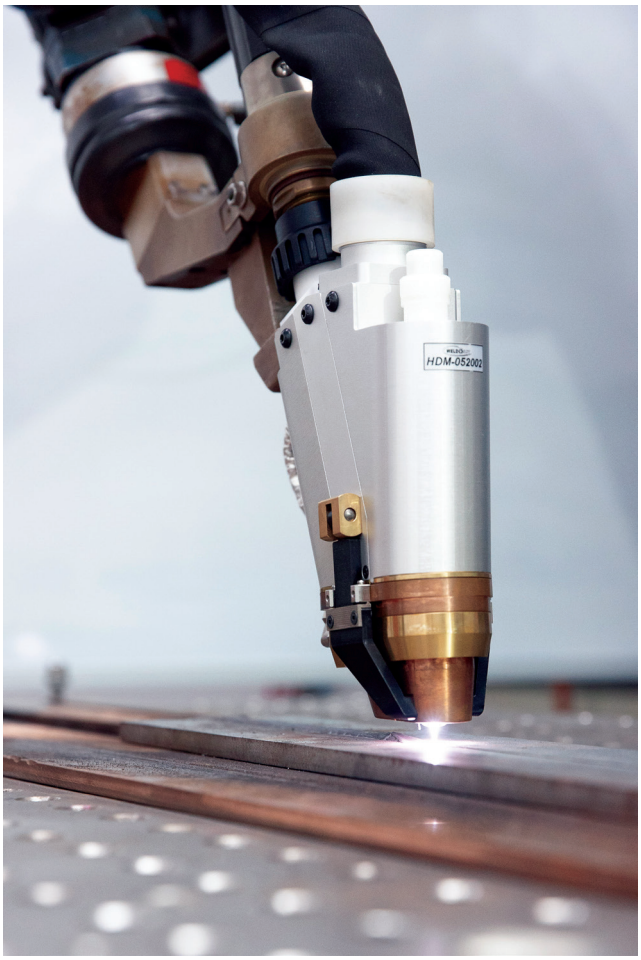
BY ILAN BAR

Combining Plasma and GMAW Arcs to Save Costs

This process can weld materials without beveling, flux, or slag

The cost of welding, like any industrial manufacturing process, includes labor, materials, and overhead. It also consists of the cost of joint preparation, or beveling, which adds to the total weldment cost. Typically, to weld ferrous-based materials above a ¼ in. (6 mm) thickness, most conventional arc welding processes, such as gas metal arc welding (GMAW), require beveling. The process, particularly manual beveling, is highly labor intensive and may require a dedicated area to limit noise and other factors.



The SuperMIG® welding system is based on a combination of the plasma arc welding and gas metal arc welding processes.

To minimize welding and total weldment costs, it is wise to consider alternative welding processes. Welding processes such as electroslag and submerged arc may not require extensive beveling or might be able to use square-groove mill edges; however, these processes also require a flux, which adds to the cost of materials and produces a slag that must be removed postwelding. This adds to the total labor costs. Tandem GMAW and other twin-wire processes can increase the deposition rate compared to conventional GMAW and are easier to automate; however, these processes often still require beveling and multipass welding on thicker materials.

Plasma and GMAW Arcs in a Single Torch

PlasMIG technology is an advancement in welding process development designed to increase welding efficiency and decrease welding cost. It combines a high-energy plasma arc with a high-deposition GMAW arc in a single torch. This marriage of existing welding processes gives the technology the ability to weld materials beyond ¼ in. (6 mm), often using square-groove mill edges without beveling or other joint preparation and without the flux and slag associated with other processes. It also offers increased deposition rates compared to other GMAW process variations.

In the process, the plasma arc is leading and gouges a small groove into the material ahead of the trailing GMA. This trailing GMA adds additional fusion depth while simultaneously filling the groove created by the leading plasma arc, forming the weld. The process is suitable for all ferrous-based materials and can provide benefits in most welding applications. The plasma arc also essentially cleans the weld joint by removing and vaporizing possible contaminants, such

as mill scale, rust, or other coatings, further reducing the prewelding operations and overall weldment costs.

The technology uses electromagnets to force the plasma and GMAs to work together. This development wasn't simple, taking a few years until the required results were achieved, and it's now patent protected.

Although still relatively new, the technology has proven to be a reliable welding process. Earliest adoptions were for the manufacture of telescopic mobile crane booms and large-diameter process piping, both of which continue to rely on the process. For each of these applications, the technology was able to eliminate the need for beveling, which eliminated a full step from the manufacturing process and reduced the number of required weld passes. This decreased the amount of time and cost per weld, thus total cost per weldment. For reference, on a ¼-in. (6-mm) material, changing from a square groove with a 1⁄16-in. (1.6-mm) root opening to a 60-deg single-v-groove with the same sized root opening increased the groove area more than 200%.

As another example of the process, a single-pass complete joint penetration weld was made on 0.314 in. (8 mm) NuHeat™ 160 ksi material using a square groove with a root opening of 0.052 in. (1.4 mm) and a travel speed of 25 in./min (635 mm/min). It was welded in the flat (1G) position on grooved copper backing with 95/5 (argon/CO_2) shielding gas and 0.052-in. (1.4-mm) ER70S-6 wire.

A weld created using the PlasMIG process.

It should also be noted for materials sensitive to high heat input, the increased travel speeds achievable with the technology allow for decreased heat input and a smaller heat-affected zone compared to other welding processes. When single-pass welds are achievable, the technology can also reduce the amount of distortion, because the full thickness of the material solidifies equally at the same time rather than one layer at a time as it does with multipass welds.

The technology was evaluated by an external welding expert and compared to conventional/standard welding technology. The analysis in Table 1 is for butt joint welding carbon steel that's ⅜ in. and has a part length of 26 ft and production batch of 1000 parts:

Table 1 — Butt Joint Welding Carbon Steel (⅜ in.)

	Welding Technology			
Activity and Cost	**Submerged Arc**	**Plasma**	**GMAW**	**PlasMIG**
Beveling/machining required? (Yes/No)	Yes	Yes	Yes	No
Additional cost of preparation per part	$10	$14	$10	$0
Number of passes per weld	2	3	2	1
Welding speed (in./min)	23	10	18	35
Total welding time per part (minutes)	27	96	36	9
Labor cost/part (average manpower cost $40/h)	$17.78	$64	$23.70	$5.93
Cost of material (wire, gas, flux) (per part)	$6.67	$9.60	$4.74	$2.07
Heat input (KJ/cm)	17	24	13	10
Additional cost of straightening postwelding	$8	$10	$2	$0
Total cost per part	$42.44	$97.60	$40.44	$8
Total cost — 1000 parts	$42,444	$97,600	$40,444	$8000

Note: Results may vary on a case-by-case basis.

As can be seen, the process was efficient and reduced the welding costs. Another aspect was speed; the higher welding speed increased productivity and production output.

User Feedback

Here's a testimonial from a customer who uses the technology and produces 6-mm-thick stainless steel pipes.

"The SuperMIG [a welding system by Weldobot, see the lead photo], replacing a previously used MIG [GMAW] process, significantly increased welding productivity. The savings are a result of:

- Reducing the number of operations from welding two-sided to single-sided,
- More than 50% reduction of filler metal use,
- Elimination of beveling/root grinding processes, and
- 120% increase in welding speed from 9.5 to 20 in./min (240 to 510 mm/min).

As an outcome, investment payback was achieved in the first job (three months)."

The PlasMIG technology was successfully implemented and is already in use. A challenge has been controlling arcs of opposite polarities, but the product makes this possible with its patented welding torch that maintains alignment of both welding arcs. The welding system is simple to automate using robotics or hard automation, and it can be paired with virtually any industrial welding robot and GMAW power source.

Parting Thoughts

With so many potential advantages available, the PlasMIG welding technology can be useful for manufacturers across a variety of industries. If beveling is required prior to welding with conventional welding processes or welding speed is an issue, there may be an opportunity for significant cost savings and improvements. WJ

ILAN BAR (*ilan@weldobot.com*) is vice president at Weldobot USA Inc., Holly, Mich.