Selecting the Right Welding Transfer Modes

It's important to use different transfer modes with the proper parameters and align them with the right application.

This article can help you achieve the best results when GMAW

BY TRE' HEFLIN-KING

Transfer modes for gas metal arc welding (GMAW) play an important role in the level of quality and productivity that can be gained in a welding operation. The modes are influenced by the power source, welding parameters (amperage and voltage), and shielding gas. They also have an impact on the weldability of the welding wire — or, in other terms, its ease of use, arc performance, bead appearance, and more.

There are four main transfer modes for GMAW, each with its own characteristics, limitations, and best applications — Fig. 1. Each also affects the welding wire selection and the power source being used. Short circuiting, globular, and spray transfer all rely on a constant voltage power source, whereas achieving a pulsed spray transfer mode requires a more advanced power source with specific pulsed waveforms.

Short Circuiting Transfer

During the short circuiting transfer mode, the welding wire touches the base material, effectively creating a short from the electrical contact that transfers the weld metal to the joint. The short circuiting occurs between 90 and 200 times per second.

This transfer mode operates at lower parameters (wire feed speed and voltages) and generates lower deposition rates, making it a slower process than others. However, it is a versatile option for welding in all positions and on thinner materials (usually ⅛ in. or less), especially when using solid wire. Metal-cored wire can be used in this mode, too. For both wires, the mode can be used with a shielding gas mixture of roughly 75% argon and 25% CO_2.

The short circuiting transfer mode can also be used to weld thicker materials, but because of its lower welding parameters, it can be prone to incomplete fusion and penetration. Conversely, the lower heat input can help reduce distortion. Depending on the material thickness, this mode is susceptible to creating spatter which may make it less appealing to welding operators and can increase postweld cleanup.

In terms of technique, short circuiting is relatively easy for welding operators to manage, although it may involve some manipulation when welding in the uphill position. It typically requires a tighter, more consistent contact-tip-to-work distance (CTWD) due to the lower, colder settings it operates on.

Globular Transfer

The globular transfer mode operates in a state between short circuiting and spray transfer. During welding, large droplets or globs of the welding wire — typically irregular in shape and larger than the wire diameter — transfer across the arc into the weld pool. This transfer occurs at higher wire feed speeds and voltages than short circuiting transfer. This helps increase productivity, but the mode tends to generate spatter that will need to be removed and may be cumbersome to the welding operator.

The globular transfer mode pairs with gas-shielded flux cored arc welding (FCAW) wires using 100% CO_2, making it a relatively inexpensive process, and it can be used to weld ⅛-in. base materials or thicker. However, FCAW wires produce slag that welding operators must manually remove.

Because the globular transfer mode operates at higher welding parameters that increase heat input, welding operators can extend their CTWD to between ¾ and 1 in.

Spray Transfer

Welding operators often cite the appeal of the spray transfer mode as being quite high because it's an easy, smooth process to use; it provides a stable arc and welds faster than other transfer modes. As its name implies, the spray mode generates a spray of tiny droplets (smaller than the wire diameter) across the arc to the weld pool. This increases deposition rates, provides complete fusion and penetration, and creates little spatter. The transfer mode also generates a good weld bead appearance.

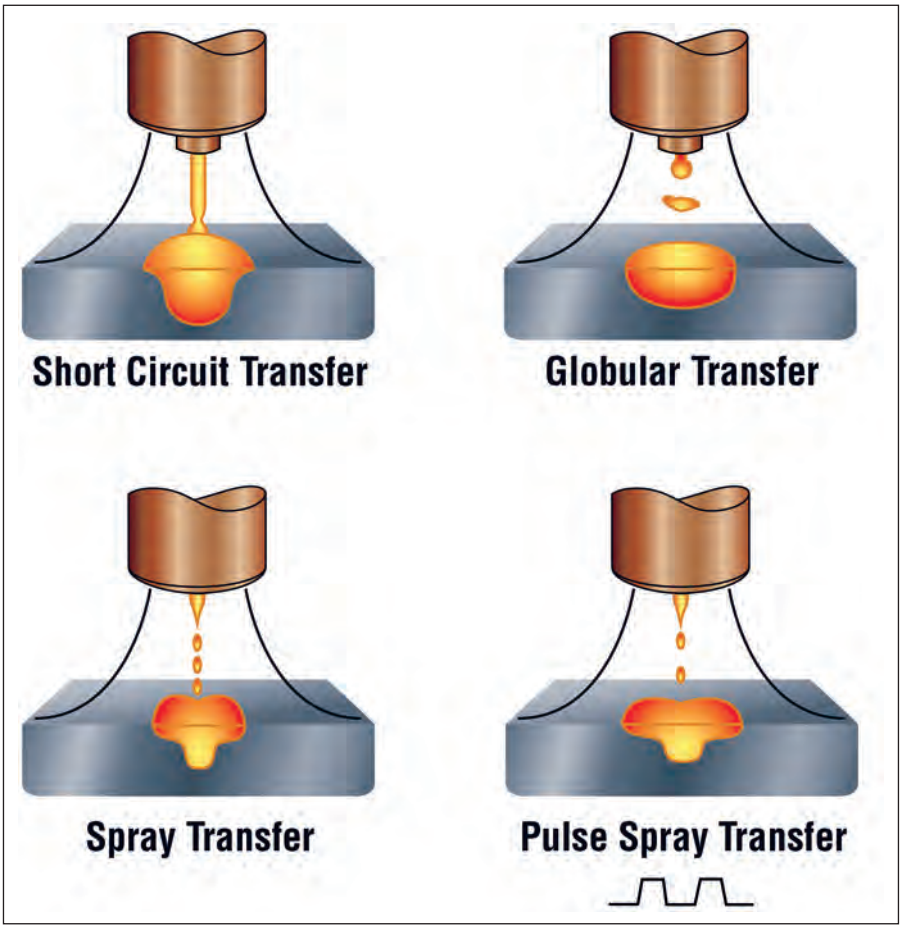

Fig. 1 — The four main transfer modes for GMAW.

The spray transfer mode operates at fairly high amperages and voltages, so it is capable of higher levels of productivity. Pairing the process with a metal-cored wire for flat and horizontal welding can increase that productivity further due to the ability to achieve fast travel speeds and minimize spatter. That eliminates or greatly reduces the need for postweld cleaning.

Generally, the spray transfer mode is used on material ⅛ in. and thicker, and it is suited to carbon steel and aluminum. It can operate at relatively high voltages with 80% argon and 20% CO_2 without too much risk of undercut; however, this defect can occur if the arc becomes too long.

Pulsed Spray Transfer

When welding in the pulsed spray transfer mode, welding operators will notice a distinct sound difference compared to other modes. This is the result of the power source cycling between a high peak current or voltage and a low background current. The peak current pinches off a small droplet of wire and propels it toward the weld pool, while the low background current doesn't generate weld metal transfer. This cycle occurs between 30 and 400 times per second.

While it requires a higher skill set to weld aluminum in the pulsed spray mode, it is easier on other materials. The welding operator can gain good control over arc starts and stops — and ultimately over weld bead appearance. Lower heat input also reduces the opportunity for distortion.

This mode also offers faster travel speeds and lower spatter levels, both of which support productivity initiatives, than other modes. Pairing this process with metal-cored wire allows for welding out of position and gaining the benefits of this filler metal — high deposition rates, low spatter, and good

Fig. 2 — Knowing which filler metals should be used with each transfer mode, along with the advantages and limitations of each process, can improve weld quality.

gap bridging to name a few. It can also be successfully paired with solid wires. The shielding gas mixtures for both may vary by the specific wire but include 80% argon mixes or greater.

Pulsed spray transfer typically requires a CTWD of ¾ in. for the best performance and consistent results.

Putting It to Work

Knowing which filler metals should be used with each weld transfer mode, along with the advantages and limitations of each process, can help welding operators gain consistent weld quality — Fig. 2.

While certain modes may be slower than others, each has its place in a given welding operation. It's important to remember to use the different modes with the proper parameters and align them with the right application to gain the best results. WJ

TRE' HEFLIN-KING (tre.heflin-king@hobartbrothers.com) *is lead welding engineer, CWI — applications, Hobart Brothers LLC, Troy, Ohio.*