ador WELDING
e-Weldone
SEPTEMBER 2015 | Vol. 03

Increase Productivity by Submerged ARC Welding

The last edition on SAW (edition no. 1) spoke about variables that affect performance and efficiency.

This edition focusses upon the use of different variables / variants of the Submerged Arc process for increased productivity.

Submerged arc welding (SAW) is a high deposition rate process when compared to Gas Metal Arc Welding (GMAW) or Gas Tungsten Arc welding (GTAW) processes. The SAW process does not generate smoke, spatter or arc rays. Applications such as welding on large flat panels, girth welds in pipe or spiral pipe mills use the SAW process to increase deposition rate, and thereby productivity.

SAW being a semi-automated process, SAW equipment are generally used for welding automation installations. The SAW process is very stable between current ranges of 400A to 700A and even higher currents which makes it suitable for welding higher thicknesses than is possible with other conventional welding processes.

The Submerged arc welding (SAW) operation can be performed in various ways; from the simplest process using a single wire and a DC power source to more advanced Twin-wire and tandem operations. While many wire sizes can work between 300A to 1500 A, the most common diameters range from 2.4mm to 4 mm and work between 400A to 900 amps. Choosing the right SAW process, methods and accessories goes a long way in increasing deposition rates and productivity.

This article describes various ways to enhance the productivity with SAW.

1) Wire Diameter:

Selection of the correct wire diameter for any application depends on many factors. The power source selection is quite crucial. Most common SAW power sources are 1,000 amps DC or AC/DC although sometimes a 600-amp power source is used for small diameter wires between 1.6 to 2.4mm.

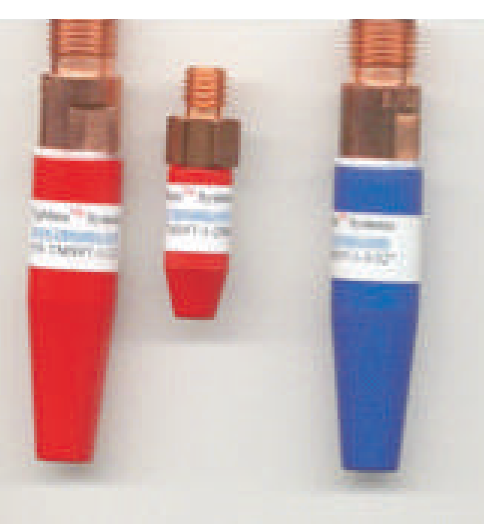
A 2.4mm.-dia. wire is typically recommended for welding at 300 to 600 amps, a 3.2mm wire works in the range of 300 to 800 amps, and a 4 mm dia. wire works at 400 to 900 amps.

It is also essential to consider penetration and fill requirements while selecting the wire diameter. The smaller the wire diameter, the greater is the current density& the higher is the depositions rate at the given amperage. For instance, while a 2.4mm.-dia. wire welding at 600 amps may deposit 7.7kg/hr; a 4 mm wire at the same current deposits 6.8kg/hr. Smaller-diameter wires also offer more penetration than larger-diameter wires at the same current.

2) Increased Stickout:

Increased stickout welding operates on the principle that an increased amount of the welding current will be used to preheat the welding wire due to the increase in electrical resistance created by using a long stickout. The amount of preheat is determined by the I2R relationship, where I is the welding current and R is the resistance of the welding wire from the contact point to the arc. This causes an increase in the wire speed for a given current level which results in higher deposition rates. Use of non-conductive materials helps provide consistent electrode placement when welding with a long stickout technique. Insulating the Electrode Extension nozzles attached to the end of the SAW head leads to an increase of 25-40% in productivity

Figures show the Insulated Electrode Extension nozzles to be fitted on the SAW head to increase the stickout.



3) Higher deposition by Metal-cored SAW wires:

Metal-cored SAW offers the same advantage as twin-wire SAW. High current density is achieved through the current-carrying sheath. A powdered metal core adds to the deposition rate. However, the penetration is wider and shallower as compared to twin wire. Metal-cored SAW is of benefit when welding joints have fit-up gaps. Gaps in parts are common in butt welds and fillet welds. Also, Metal-cored wire is easier to integrate than twin-wire SAW because it is similar to the single wire SAW welding process with only the wire type being different.

Metal-cored SAW offers good wetting at high travel speeds and resists burn-through on gapped parts better than single solid-wire welding.

4) DC(-) Negative Polarity:

Using negative polarity DC for SAW increases deposition by 20 to 30 percent against normally used

DC+ polarity. However using DC(-) results in the lower depth of penetration depth .

There are several other options available to increase the productivity over single-wire DC SAW. Each option offers certain advantages and disadvantages when compared to single-wire SAW.

Following are some of the options available:

a) Twin Wire System for Higher Deposition:

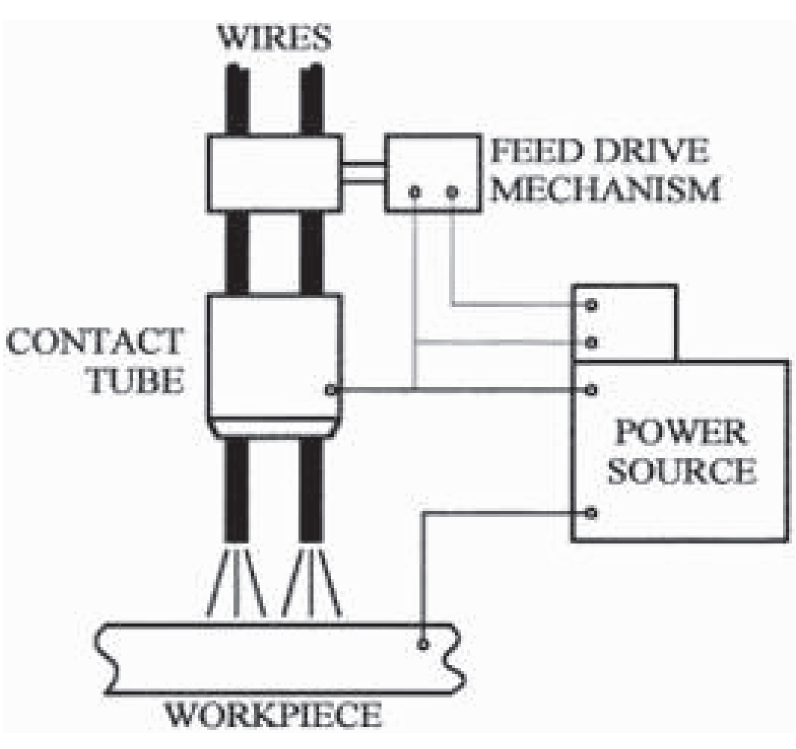
Twin-wire SAW also known as parallel wire SAW uses two relatively small-diameter wires but only a single power source and typically, a single contact tip. There are two wire spools mounted on the welding head and driven by a single wire feeding system. Both the wires are simultaneously fed through the same contact tip.

This method increases deposition rates by 20 to 30 percent over single-wire DC SAW without significantly increasing heat input. The increase comes from the greater current density achieved by pushing a similar current over smaller, cross-sectional areas of wire.

Twin-wire welding offers excellent penetration as the current density is directed axially along each wire. Wires can be aligned in the direction of travel for high travel speeds or oriented perpendicularly to the direction of travel to achieve a wider bead profile.

It is important to use a heavy-duty contact assembly. One may also use a good contact assembly comprising of heavy-duty contact tips or a single contact tip with slots for both wires.

Beware of contact assemblies that use tips built for manual hand welding. These tips will not hold up to the intense heat of two wires running into one puddle at high duty cycles.



b) AC SAW:

AC SAW provides a welding output oscillating between DC(+) and DC(-). It offers increased deposition rates compared with positive-polarity welding and greater penetration versus negative-polarity welding. A key benefit of AC welding is the elimination of arc blow that may occur in many different steel welding configurations. Arc-blow is common in high amperage DC applications near fixtures, ground clamps, and corners.

Square-wave AC output provides a more stable arc than conventional sine-wave AC welding because the current switches much more rapidly from peak positive current to peak negative current, with almost no time near zero current. Modern SAW power sources provides square wave which can be manipulated to make the power more like a low-penetration DC(-) arc or deeper-penetrating DC(+) arc.

b) AC SAW:

AC SAW provides a welding output oscillating between DC(+) and DC(-). It offers increased deposition rates compared with positive-polarity welding and greater penetration versus negative-polarity welding. A key benefit of AC welding is the elimination of arc blow that may occur in many different steel welding configurations. Arc-blow is common in high amperage DC applications near fixtures, ground clamps, and corners.

Square-wave AC output provides a more stable arc than conventional sine-wave AC welding because the current switches much more rapidly from peak positive current to peak negative current, with almost no time near zero current. Modern SAW power sources provides square wave which can be manipulated to make the power more like a low-penetration DC(-) arc or deeper-penetrating DC(+) arc.

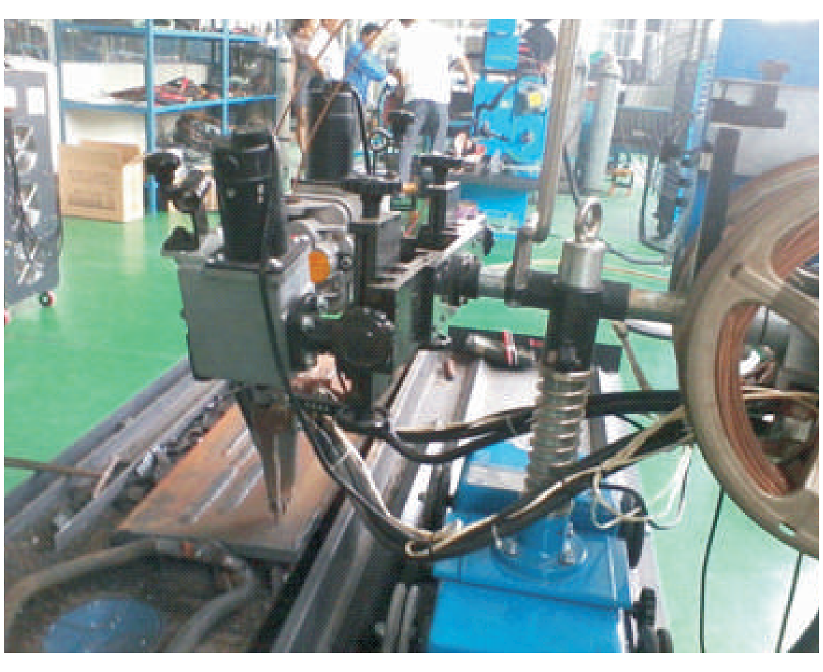
c) Tandem SAW:

Tandem welding uses two separate power supplies, two wire feeders, and two large-diameter wires (typically 4 mm). Both wires feed into the same molten puddle, but each has a separate contact tip, separate power supply, and separate control. Deposition rates are at least double from those achievable with single-wire SAW.

The lead arc is most often DC(+), and the trail arc is AC. The DC(+) lead wire provides deep penetration, even at high travel speeds, while the AC trail wire fills the weld joint at a higher deposition rate.

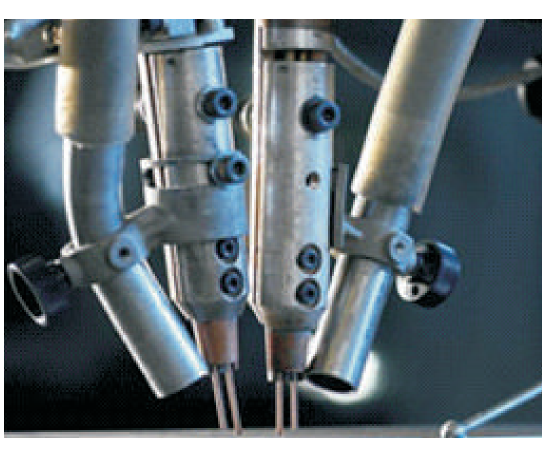
The most important aspect of the AC trail arc is that it does not cause significant interference with the lead arc. (It would not be practical to run two DC arcs in close proximity to each other. They would deflect each other and cause a highly unstable process.)

It can also use a combination AC/AC for greater deposition rates.



The Figure above shows Tandem Twin Submerged Arc Welding

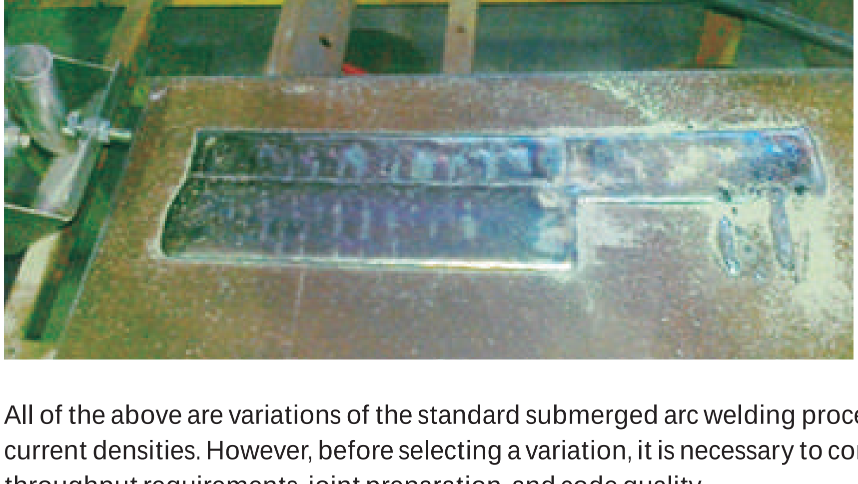
Even higher deposition rates can be obtained when tandem welding is combined with twin wires, metal-cored wire, or a modified AC wave. A tandem twin welding head is shown in the figure below:



d) Strip Cladding SAW:

In this type of welding, instead of a wire, foils/strips of various widths are used. A power source of current capacity ranging from 1000A to 2000A is used for this welding. This process uses a different welding head than that used for SAW wires.

Figure bellow shows the strip cladding SAW welding head mounted on column and boom and weld bead by strip cladding.



All of the above are variations of the standard submerged arc welding processes that give increased productivity by using higher welding currents and current densities. However, before selecting a variation, it is necessary to consider other factors, such as material thickness, production level, batch size, throughput requirements, joint preparation, and code quality.