Optimising SAW deposition rates using Long Stick Out

At an SAIW evening meeting earlier this year, Thulani Mngomezulu, technical manager at Lincoln Electric South Africa, presented a talk about submerged arc welding and highlighted a simple and cost-effective way of achieving higher deposition rates.

Describing the submerged-arc welding (SAW) process, Mngomezulu says that the process involves solid or cored wire electrodes that are externally shielded via a granular flux. "DCEP (dc+), DCEN (dc-) or ac polarity can be used, with each option being associated with different deposition rates and penetration characteristics," he says.

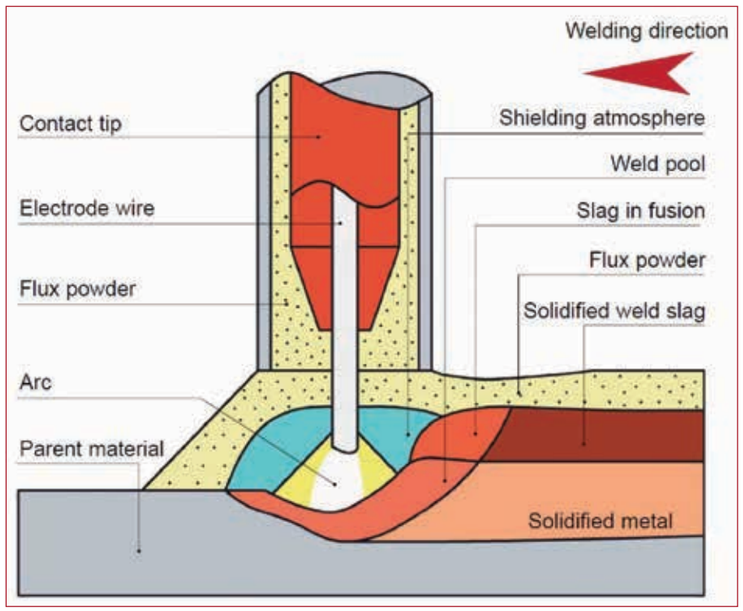
SAW relies on an electric arc or arcs between one or more wires and the weld pool. The arc and molten metal are shielded by a blanket of granular flux, deposited while welding onto the workpiece and into the weld joint. "The process is used without gas and with filler metal from the consumable electrode – and sometimes from a supplemental source," explains Mngomezulu.

The advantages over other welding processes include: high deposition rates; typically deep penetration; high operating factors, due to the mechanised nature of the process; and low hydrogen levels in deposited weld metal.

"SAW does have its limitations, though," he confirms, citing portability, since external shielding flux and a flux delivery system is required; the process can only accommodate downhand welding, because the flux is gravity fed; and relatively tight fit-up is required.

"SAW welding finds ideal applications in pipe mills and pipelines, for longitudinal, spiral or orbital seams; offshore for cans, topsides and decks; in the process and power generation industries for pressure vessels, nuclear containers, wind tower structures and hardfacing; and in the construction industry for fabricating oil, water or LNG tanks as well as beams and girders. "Being ideal for thick section welding, SAW is also widely used in heavy fabrication; shipbuilding; for rail car vehicle chassis, hoppers and tanks," he says.

Lincoln's range of advanced SAW process options includes single arc; Tiny Twin arc – a process that feeds two wires from the single power source to increase deposition rates; and multiple arc options, such as Tandem, Tandem Twin and Triple Arc systems, which all require more than one welding power source.



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"Today, I am going to introduce a way of significantly increasing SAW deposition rates with a single arc, one wire and one power source," says Mngomezulu. "Deposition rate is calculated from the amount of weld metal deposited per unit of time. The deposited weld metal is generally equal to the volume of the groove plus some overfill above the weld seam. Deposition rate is easily calculated from the wire diameter and wire feed speed.

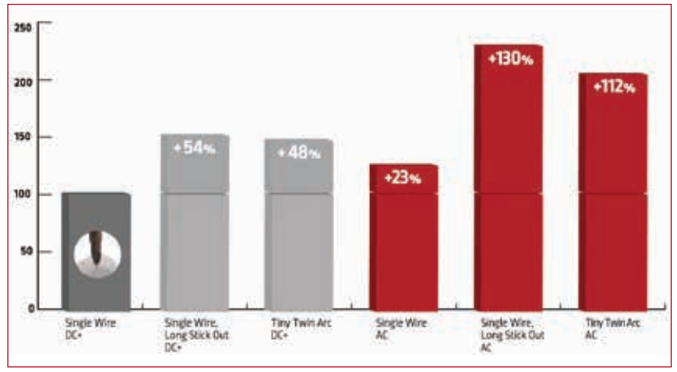
Showing a table for deposition rates at different amperages for different feed wire diameters, Mngomezulu points out that, for the same arc current, deposition increases with decreasing wire size. At 500 A, for example, the deposition rate for a 2.0 mm wire is 6.7 kg/h, while a 4.8 mm wire will be deposited at 4.7 kg/h at the same current.

This is due to resistive or I2R heating effect, which caused thinner wires to melt faster than thicker ones if the current is held the same.

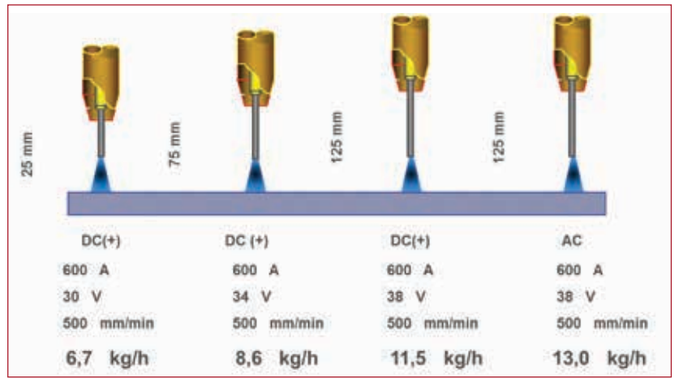
Moving on to describe how Lincoln SAW users can take advantage of this effect, Mngomezulu says that Lincoln's Long Stick Out process takes full advantage of the resistive heating in order to drive depositions rates up.

By extending the electrical stick-out length during welding, the Long Stick Out process preheats the electrode above the welding arc. This significantly increases the I2R heating and, therefore, the total melt-off rate. "Deposition rates using Long Stick Out can be increased by up to 100% without having to increase the current setting," he suggests.

Critical to the success of this process, however, is the arc striking sequence. "The arc characteristics, as well as the specific arc strike sequence used on Lincoln Power Wave AC/DC 1000 machines overcome this disadvantage and gives reliable and steady results in all welding modes: dc+; ac; or dc–," says Mngomezulu.



A comparison of deposition rates from Lincoln's advanced SAW processes.



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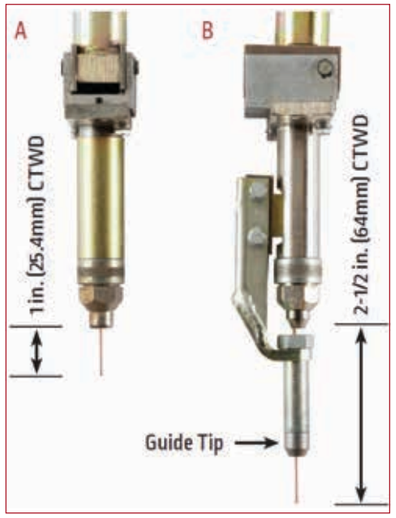
Showing a slide comparing submerged arc welds being done using a 4.0 mm wire at 600 A with the stand-off distance increased from the traditional 25 mm up to 125 mm, we see that the deposition rate can be increased from 6.7 kg/h to 11.5 kg/h using the dc+ process. And if ac power is applied with a 125 mm stand off, a deposition rate of 13.0 kg/h is possible.

Citing a case study performed for a customer in Europe who was welding a 40 mm plate with a 60° V-prep using a single 4.0 mm electrode with dc+ polarity at 700 A, Mngomezulu says that, at 25 mm electrode stick-out (ESO), the joint was being filled at rate of 8.3 kg/h. "By adopting Lincoln's Long Stick Out system with a 125 mm ESO, this was increased to 15 kg/h," he points out.

The Power Wave AC/DC 1000 power source from Lincoln is the essential enabler for this process, and it can be used in either dc or ac mode. "The inverter-based control technology, which synchronises the wire feed rate, the arc ignition currents and ramp up to full welding current, secures the arc striking.

Larger wire sizes (3.2 or 4.0 mm) are preferable and Lincoln has developed range guide tips that are bolted onto the torch to guide the wire below the electrical contact tip. These keep the extended length of heated (and softening) wire on the weld seam.

Concluding with the net advantages of this solution, Mngomezulu points to some calculations relating to welding time and associated labour cost savings. "Increasing the deposition rate from 8.3 to 15 kg/h reduced the arc time and, therefore the labour costs – from €54 966 to €30 415. This represents a cost saving for this weld of 44.67%, from a simple switch to Lincoln's Long Stick Out SAW welding process," he says.



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Process	Deposition rate (kg/h)	Welding arc time (hours)	Labour cost (€)	Labour cost saving (€)	Labour cost saving (%)
Single electrode dc+	8.3	916.1	€54 966		
Long stick out ac	15	506.9	€30 415	€24 552	44.67%

A comparison of the use of Lincoln's Long Stick Out (CTOD: 125 mm) process with conventional stick out (CTOD: 25 mm) SAW welding. Plate thickness: 40 mm. Weld prep: 60° V. Weld length: 1 000 m. Hourly labour rate: €60.