Advanced high deposition rate

On November 3, 2016 at its Midrand premises in South Africa, Lincoln Electric held its Welding Technology Centre open day. *African Fusion* attends and reports on the company's high deposition rate submerged-arc welding process, presented and practically demonstrated by Lincoln's senior technical representative, Josef Henning.

Now available for advanced submerged-arc welding (SAW) in extreme environments, Lincoln's Electric's new Power Wave 1000 SD ac/dc power source uses Waveform Control Technology® to bring software-driven square wave ac, dc-positive or dc-negative current waveforms to this high deposition rate process. By allowing users to control the deposition rate and penetration independently, increased weld speeds, consistently higher quality welds and improved efficiencies in single or multi-arc environments become possible.

"The drive is to weld faster so that production rates increase," says Henning, pointing out the two Lincoln Electric 1000 SDs interconnected on an SAW system at the company's Welding Technology Centre. Along with the 2 000 A of current available from two of these power sources, two MAXsa™ wire feeders with two pedant controllers are mounted on a column and boom system at the centre.

"By interconnecting 1000 SD systems, up to six arcs delivering up to 6 000 A of combined current can be used simultaneously, with huge associated increases in productivity," he says.

"The power sources can also be operated in parallel, though, to give a combined current into a single submerged arc wire, which is typical of how pipe mills are running, with two machines coupled to produce 1 250 A to close an 18 to 20 mm pipe seam," Henning says.

"Two arcs can sometimes also be used separately, one inside and another on the outside – and with a technique called punch through welding, back gouging of the root can often be avoided," he says, adding that typical weld preparations include a V-prep of between 55 and 60° with a 2.0 mm nose – and if the seam is going to be closed from the inside following punch through welding, an X-preparation with a smaller V on the inside can be used.

Presenting a bar graph showing the productivity increases on offer by using two and three arcs, respectively, Henning reveals that, with a dc-positive lead arc and a balanced ac trailing arc, 100% productivity increases are immediately available over single arc SAW. This can be further increased by using two balanced ac arcs and, by carefully synchronising the fast-switching square wave current outputs, up to 125% increases can be achieved.

The Power Wave machines offer a number of special waveform options: CV, CC, ac and dc, but the ac waveform is not the traditional sine wave. The power source is an inverter type power source that operates at 40 kHz, allowing it to produce fast-switching square wave ac power. "You can also tell the machine exactly how long you want the positive and negative half cycles to be," he explains.

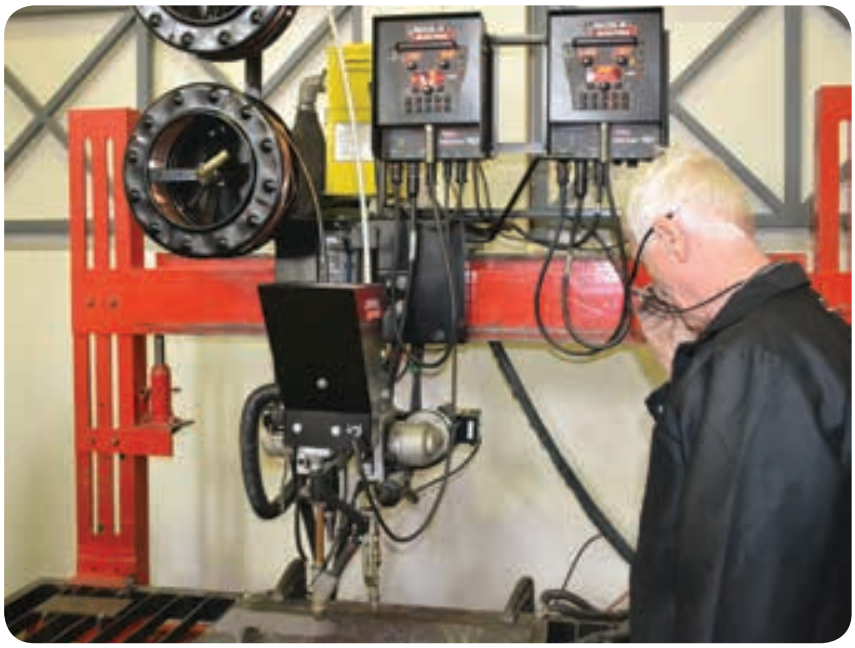
This is called variable balance. By extending the dc+ percentage, penetration increases, while increasing the dc- balance increases deposition and decreases penetration – "and this can be done on multiple wires without causing arc blow," Henning assures.

As well as variable balance, the entire wave pattern can be offset to be more electrode positive or electrode negative. This again shifts the penetration and deposition values to give further options to optimise weld quality while maintaining highest possible production levels.

"And the waveform parameters can be adjusted on the fly!" says Henning. "Should you need to start a job with higher penetration for the first 300 mm, then switch to higher deposition as the heat builds up, all you need to do is switch in a higher deposition setting on the MAXsa pendant box, which has eight pre-programmed settings available. While welding proceeds, the welder simply pushes the switch to access the next programme required," he explains.

Henning goes on to show us how to set up a single wire system for welding. The menu-driven process starts with the selection of the material, wire diameter and mode. He chooses CC, DC+, "which is closest to normal sub-arc welding, but because of the machine response speed, the control is much better".

He then selects 600 A of current at



Josef Henning demonstrates submerged-arc welding using a Power Wave 1000 SD in dc constant current mode.

submerged-arc welding

36 V and says that in CC mode, the wire feed rate will self adjust to maintain the selected voltage. After feeding a little flux over the start point, he sets the machine welding. A gentle hiss comes from the covered weld seam. After stopping and vacuuming up the excess flux, we see the flux lifting itself off a perfectly even weld seam.

"Now I am going to show you the combined effect of using the ac square wave mode, along with a stick out extender," he says before selecting a second programme on the pendant, "I am using 60 Hz for this programme, but it can be up to 100 Hz. The balance percentage is adjustable from the 50/50 dc+/dc- point and the offset can be varied between -25 and +25 percent of the zero offset position," he says.

Expanding on the difference between CV and CC control modes, Henning explains that in CV mode, the current will change with stick-out to keep a constant arc gap. "In CC mode, if the stick out increases, the current does not change. Instead, the wire feed speed automatically increases to maintain the voltage. So the deposition rate increases at the same amps," he explains, adding that CC mode, is best for thicker wires – 3.2 mm and up – while for thinner material and wires, he prefers CV mode.

Henning then adds the stick-out extender, which is fitted onto the end of the torch instead of the normal contact tip. "This is a 125 mm extender and we will maintain the gap to the plate at the 30 mm we used previously. The electrical contact tip is now higher, so the wire will experience more resistive heating before reaching the arc. The extender supports and directs the wire, because

Two Power Wave 1000 SDs are interconnected at the Lincoln Welding Technology Centre allowing twin-wire welding with up to 1 000 A per arc. The units can also be operated in parallel to give a combined current of up to 2 000 A into a single submerged-arc wire.

it will soften due to the additional heating," he explains.

"I am also going to increase the voltage, which increases the actual arc length. This is to flatten the weld bead, which would otherwise become peaky due to the additional deposition, which we expect to be up to 75% higher," he notes.

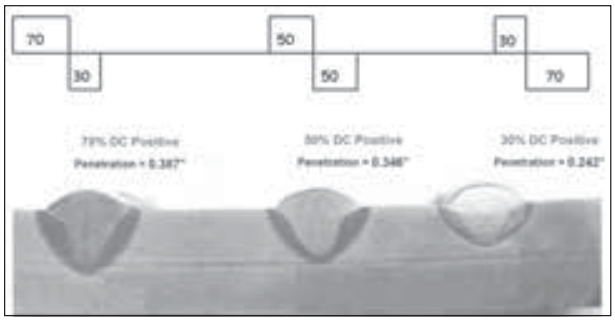
When the second weld is started, the 60 Hz hum confirms ac-pulsing and the wire feed rate has jumped to 2.0 m/min, compared to 1.2 m/min previously. After welding, the flux falls away and a slightly higher and significantly wider weld bead is evident.

"All Lincoln Electric Power Wave products come with Production Monitoring built in," continues Henning, directing attention to a side screen. While welding, monitored data for every registered and connected Power Wave power source is stored on the cloud. After welding, it is possible to browse to see the exact welding parameters used from a time-stamped record of every weld – and because the data

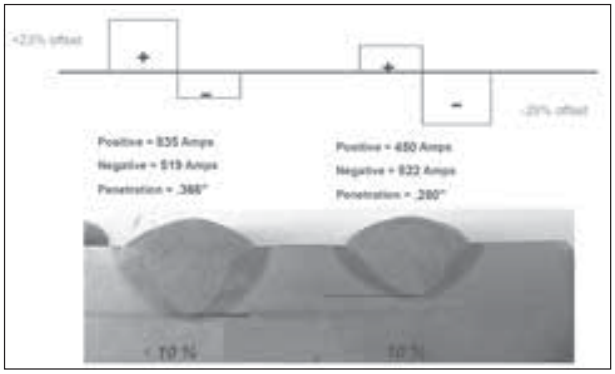
The stick-out extender, which is fitted onto the end of the torch instead of the normal contact tip, raises the electrical contact tip for more resistive heating. Along with the deposition advantages of ac pulsing, stick-out extenders increase deposition rates significantly.

is stored in the cloud, this can be done from any web-connected device. Data analytics also enable deposition rates and True Energy – an accumulation of instantaneous VA values that better reflects the actual heat input effect of fast switching and pulsing data – to be recorded for analysis.

"Power Wave process control for SAW offers complete configuration flexibility; outstanding efficiency and power factor correction; and bigger welds produced faster under optimum fusion and process control. If thinking about expanding in the future, then this is the choice to make now," Henning concludes.



The effect of variable balance on the ac waveform: by extending the dc+ pulse width percentage, penetration increases, while increasing the dc- pulse width increases deposition.



The effect of dc offset: Increasing dc+ offset has a marked effect on penetration, while dc- offset can be used to minimise penetration.