ISKUSTVA U PROIZVODNJI S UREĐAJIMA ZA EPP POSTUPAK ZAVARIVANJA KOJI IMAJU KONTROLIRANE OBLIKE KRIVULJA

EXPERIENCE IN PRODUCTION WITH WAVE FORM CONTROL AC/DC POWER SOURCE SAW

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Ključne riječi: EPP zavarivanje, kontrolirani oblici krivulja

Key words: SAW welding procedure, wave form control

Sažetak: Zavarivanje uz primjenu "Powerwave AC / DC 1000" nudi veliki broj mogućnosti promjena po pitanju količine nataljenog metala i kvalitete zavarenih spojeva. Doprinosi isto tako većoj iskoristivosti i dugotrajnosti u radu strojeva u odnosu na klasične EPP uređaje. Ukratko jedan važan iskorak u razvoju opreme za zavarivanje unazad nekoliko godina. Oprema se može lako primjeniti i za daljinsko upravljanje kao i priključenje na Lincoln software, putem Ethernet, Divicenet, itd mreže.

Abstract: Welding with the Powerwave AC/DC 1000 offers numerous possibilities to enhance productivity in terms of higher deposition rates and weld quality. It also contributes to substantial savings in power consumption as opposed to conventional SAW equipment. In short, a real breakthrough in submerged arc welding development since many years. The equipment can also easily be linked to remote operation and control facilities such as Ethernet, Divicenet etc. by using the Lincoln Electric software.

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1. SAW PROCESS PRINICIPLE

Submerged Arc Welding (SAW) involves formation of an arc between a continuously-fed wire electrode (bare wire, basic flux cored wire or composite metal cored electrodes wire) and the workpiece. The process uses a flux to generate protective gases and slag, and to add alloying elements to the weld pool. The arc moves along the joint line and as it does so, excess flux is recycled. Remaining fused slag can be easily removed after welding. As the arc is completely covered by the flux layer, heat loss is extremely low. There is no visible arc light, welding is spatterfree and there is no need for fume extraction.

Submerged arc welding is usually operated as a fully-mechanised or automatic process. The welding parameters as current, arc voltage and travel speed all effect bead shape, depth of penetration and chemical composition of the deposited weld metal.

Submerged arc welding process is mostly operated with a single wire on either AC or DC current. Common variants are:

- Twin-arc welding, is one power source with one wire feed unit and two spools of wire
- Tandem welding, is two power sources with two wire feed units and two spools of wire

The SAW process has a lot of variants but all contribute to improve the productivity through an increase deposition rate of deposited weld metal and/or travel speed.

2. WHAT IS AC/DC SUBMERGED ARC WELDING

A Submerged Arc Welding (SAW) option that combined the advantages of AC and DC SAW welding was not possible.

An inverter power source coupled with waveform control technology provides control over the ratio of positive to negative amplitude, as well as the amount of time spent at each polarity.

The limiting factor for SAW AC welding has always been that it takes too long to cross from electrode positive (EP) to electrode negative (EN). This lag can cause arc instability, penetration, and deposition problems in certain applications.

The Powerwave AC/DC 1000 with waveform control was designed specifically to solve this problem, allowing the operator to take full advantage of the reduction in arc blow experienced with DC, while maintaining the penetration advantages of DC positive and the advantageous deposition rate of DC negative. Using these controls, the shape of the output waveform is changed, and in turn the weld output characteristics are controlled.

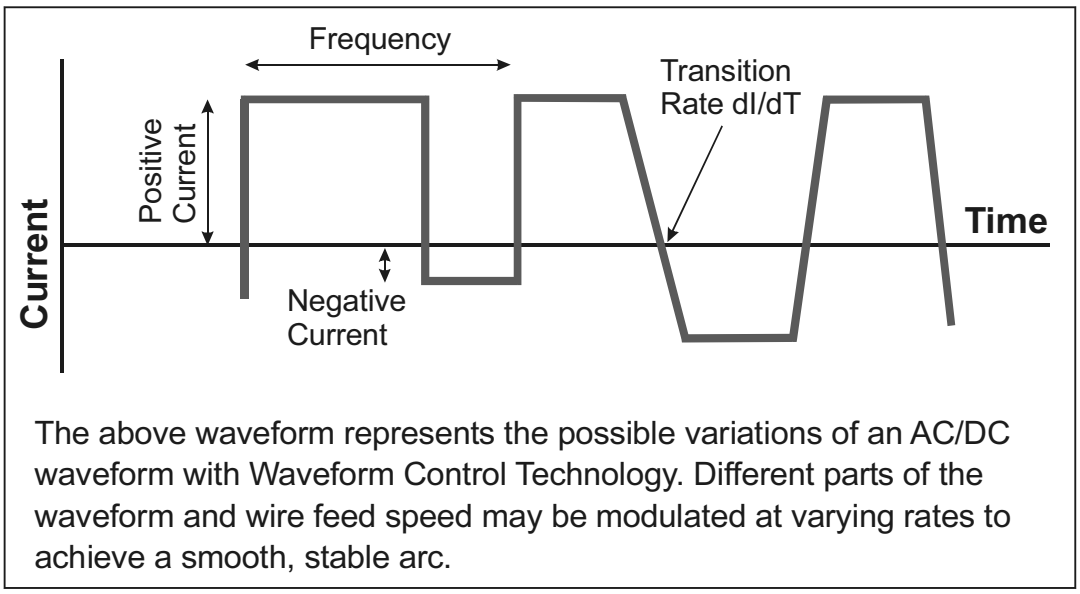


Figure 1. The AC/DC Submerged Arc process

With the Powerwave AC/DC, you get the best of both worlds: the speed, deposition rate, and penetration that DC SAW offers, and the resistance to arc blow that AC SAW offers.

In single arc processes, the Powerwave AC/DC provides flexibility with waveform control technology. In multiple arc processes, that same flexibility is achieved through control of phase shifting between arcs.

3. HOW AC/DC SUBMERGED ARC WELDING WORKS

Figure 2. shows the conventional AC and DC with balanced amplitudes.

Waveform control technology (Figure 3.) gives the operator the ability to change the positive and negative amplitude and time intervals independent of each other, to achieve the penetration and deposition rate that suits their application. In other words, if a weld requires greater penetration and reduced deposition, the operator would add a positive DC offset, forcing an imbalance in the waveform. Adding negative current results in higher deposition rates. Changing the balance of the positive or negative time intervals provides additional penetration or deposition control.

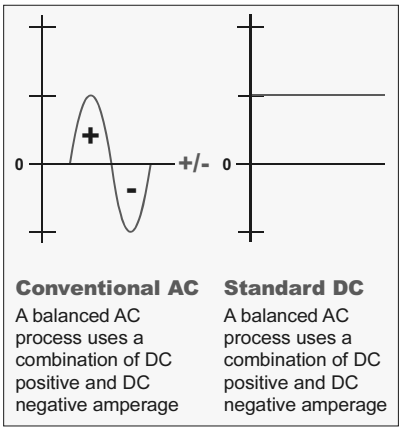


Figure 2. Conventional

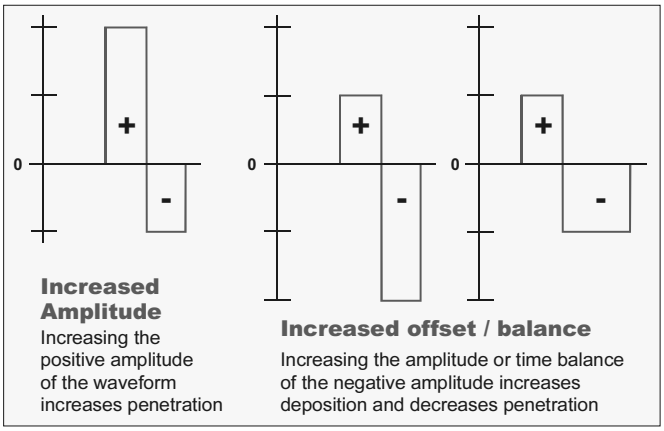


Figure 3. Wawe Form Control Technology

4. PRACTICAL SOLUTIONS

The waveform may be varied to:	The waveform control Technology capability provides precise control over:
Control penetration Control bead shape Control deposition rate Eliminate arc interactions which can cause arc blow	AC frequency Balance (percentage positive and negative polarity portion of one cycle) Arc current level positive and negative polarity portion of one cycle

Figures 4., 5. and 6. demonstrated what is happen in practice when we change the AC/DC waveform.

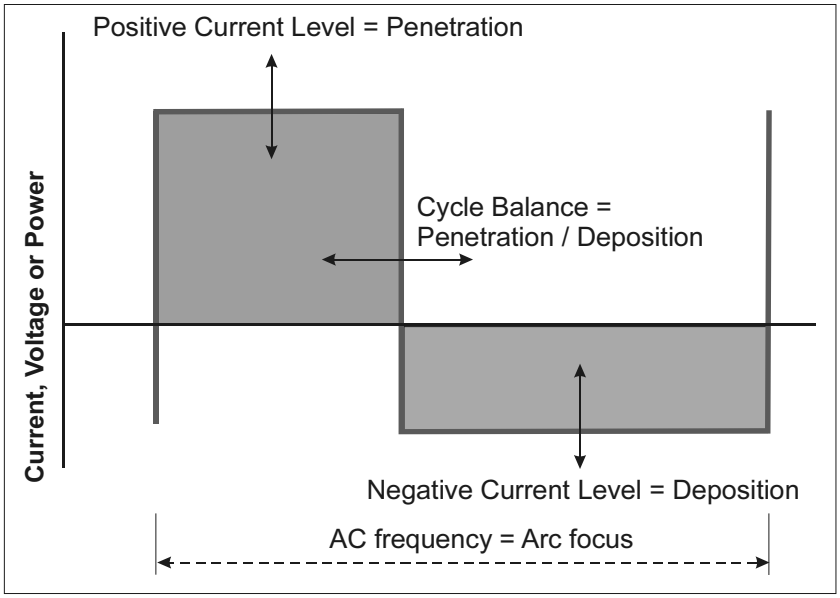


Figure 4.

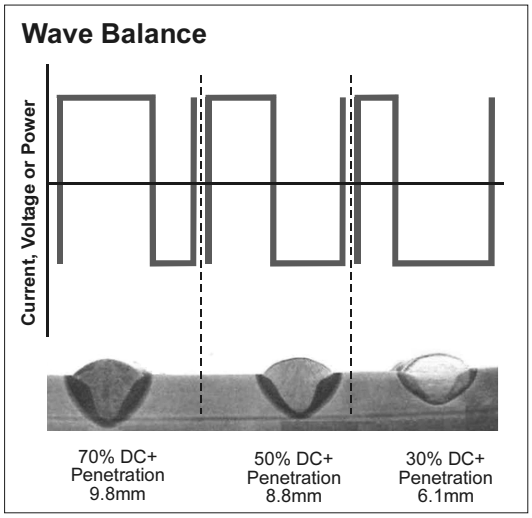


Figure 5.

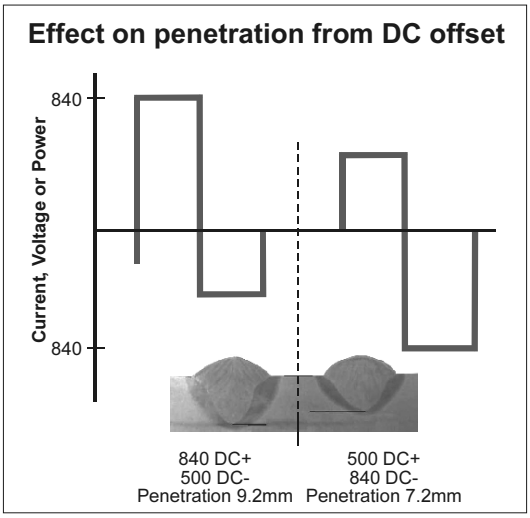


Figure 6.

5. DEPOSITION RATE

To establish methods for welding constructions all factors that contribute to the total costs have to be considered. Depending on location, labour costs contribute heavily to the total costs. On the other hand the cost of the welding consumables are limited, compared to the labour costs. The total costs per kilogram deposited weld metal can be decreased by:

- increasing deposition rate
- increasing duty cycle (process and production)
- reduction of failure rate
- reduction of post weld cleaning time
- etc.

Due to the high deposition rate, submerged arc welding can greatly contribute to decreasing the costs per kilogram deposited weld metal.

With the new Powerwave AC/DC now we have the possibility to increase the deposition further more. As long as the SAW process will be used mostly for heavy and/or long plate, an increase of the deposition rate will shorten the production time and there fore decreasing the total welding costs.

5.1. Single arc

Tube welding ø 1060 x 35mm wall thickness with conventional equipment and Wave Form Control technology

	Conventional	Waveform control
Equipment	DC 1000	PW AC/DC; with 40 Hz; 55% DC- and 5% offset
Fill layers, ø4.0mm wire	500/520 A – 31 Volt = 6 kg/h	550 A – 34 Volt = 9 kg/h
Cap layers, ø4.0mm wire	650/680 A – 34 Volt = 7.6 kg/h	720 A – 38/40 Volt = 10.2 kg/h
Travel speed	40 cm/min	60 cm/min
Welding time	60 min.	40 min.

Table 1.

As shown in the Table 1., the deposition rate was more than 30% increased. Due to the higher deposition rate the welding time per circumferential weld was decreased from 1 hour to 40 minutes. This means an increased production time of > 30%.

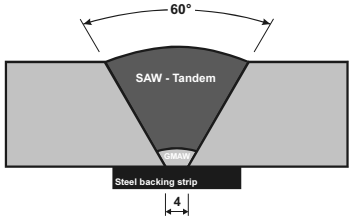


Figure 6. Joint preparation

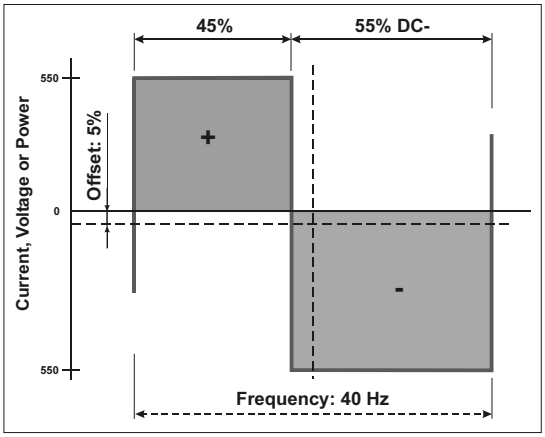


Figure 7. Wawe Form settings from Table 1.

5.2. Tandem

Offshore structures:
Conventional DC/AC deposition was yielding 15 kg/h deposition. By using the two arc AC/AC submerged arc process, deposition increased to 20 kg/h.

Tandem twin is the other possibility to increase the deposition rate and use as well the AC/AC submerged arc process. Using the tandem twin process the deposition will increase again. This means a deposition rate under normal conditions of ~ 30 kg/h.

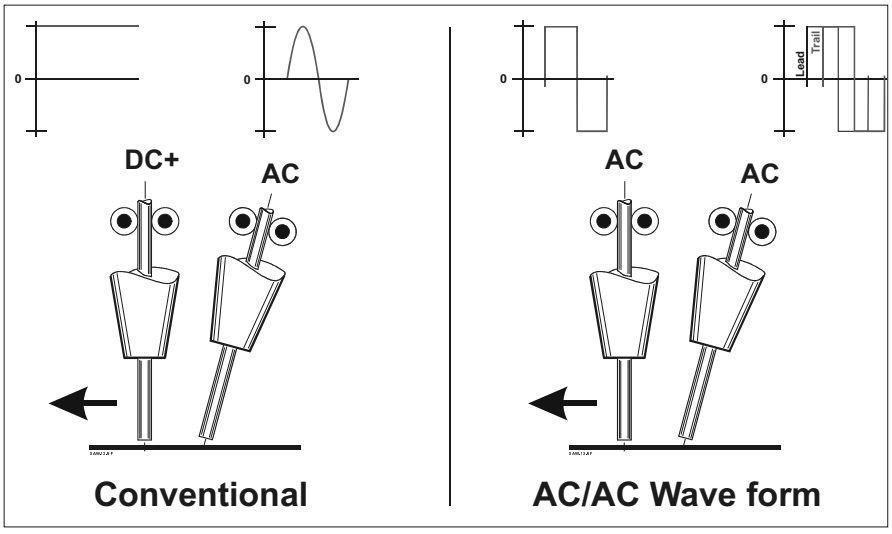


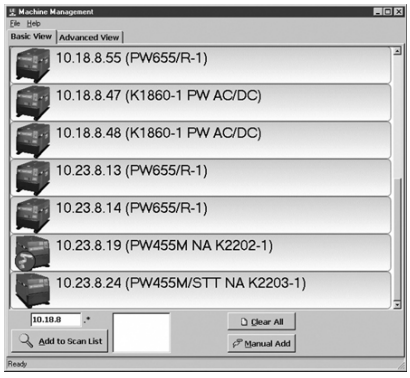
Figure 8. Principle of SAW – Tandem technique

6. SOFTWARE

The PowerWave AC/DC includes software to assist with the installation and operation of the equipment. From an intelligent configuration utility to a high-level monitoring and data logging tool, these packages are designed for ease of use.

6.1. Network

Each power source is assigned to an Internet protocol (IP) address. Through an "Ethernet" Local Area Network (LAN) machines are connected with a PC. The network can be a wired system but also wireless is an option. The Lincoln Software tools communicate with the PowerWaves and can be used for data requisition, diagnostic analysis, to command or even update the machines at a distance.



6.2. Command center

Provides monitoring and control of each arc in a multiple arc system, presenting master/slave relationship and configuration of the arc in the system. Weld mode selection, parameters of weld states, and diagnostics are also available.

6.3. Production monitoring

All of the welding equipment accessible over the local network can be added to the production monitoring utility. Weld data, wire usage, machine run-time, and weld histories can be tracked, and reports of each generated. Finally, gathered weld data can be stored in files that can be shared over the network and/or e-mailed to a user-defined distribution list.