RAISE YOUR DEPOSITION RATE TO 40 kg/h

HIGH PRODUCTIVITY WELDING SOLUTION FOR THE WIND INDUSTRY

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DEMAND FOR GREEN ENERGY IS RISING SHARPLY

As the world population approaches 8 billion, global energy consumption is growing exponentially. To fight global warming, clean energies are increasingly popular. Hence the number of Wind farms is rising sharply across the globe.

At the same time, governments are reducing or eliminating clean energy subsidies and the Wind industry is challenged with producing at lower costs. To remain profitable, the only way forward is to increase productivity whilst maintaining quality.

Regarding welding productivity, Lincoln Electric has the products, knowledge, experience and support teams to help wind tower manufacturers achieve their targets. In particular, the Tandem Long Stick Out (TLSO) submerged arc welding process can deliver substantial savings.
## Tandem Process Average Deposition Rate (kg/h) Welding time per tower (h) using 85% operating factor

<table>
<thead>
<tr>
<th>Tandem Process</th>
<th>Average Deposition Rate (kg/h)</th>
<th>Welding time per tower (h)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Multi Run</td>
<td>Two Run</td>
</tr>
<tr>
<td>2 torches with standard SO*</td>
<td>18</td>
<td>15</td>
</tr>
<tr>
<td>2 torches with long SO*</td>
<td>32</td>
<td>15</td>
</tr>
</tbody>
</table>

*SO – Stick out

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**REDUCE YOUR WELDING TIME WITH THE SAW TANDEM LONG STICK OUT PROCESS**

**On-shore tower**
- Height: 96 m
- 4 m diameter at the base and 3 m at the top
- 14-35mm wall thickness
- Symmetrical 60° X bevel type used between 14 and 20 mm
- 60° Y bevel type used above 20 mm

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**CUT YOUR WELDING TIME BY 33%**

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REDUCE YOUR FLUX CONSUMPTION WITH TANDEM LONG STICK OUT

- LSD increases the deposition rate and at the same time significantly reduces the flux consumed during welding.
- Higher volumes of metal are deposited whilst the amount of slag produced is moderately increased.
- Due to the difference in materials density, the consumed flux to deposited metal ratio decreases.

**CONSUMPTION DECREASED BY 27%**

- At 1 m/min travel speed, 30 and 35V for standard and Long Stick Out respectively.
- For 100 kg of deposited weld metal, the quantity of additional recyclable flux is 16 kg.
SAVINGS CALCULATION

Application:

Joint welding
Base material: S355 G10+M
Thickness: 40 mm
Length per year: 10,000 m

<table>
<thead>
<tr>
<th>PROCESS: SAW</th>
<th>DC+/AC Tandem Standard SD</th>
<th>DC+/AC Tandem 1 Long SD</th>
<th>AC/AC Tandem 2 Long SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>CONSUMABLE: FLUX + SOLID WIRE</td>
<td>Oerlikon/Lincoln EH 12 K</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stick Out (mm)</td>
<td>35</td>
<td>35-120</td>
<td>120</td>
</tr>
<tr>
<td>Wire Diameter (mm)</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Current range (A)</td>
<td>[600-720]</td>
<td>[650-850]</td>
<td>[650-850]</td>
</tr>
<tr>
<td>Av. Heat Input (kJ/mm)</td>
<td>3,6</td>
<td>3,3</td>
<td>3,4</td>
</tr>
<tr>
<td>Av. Deposition Rate (kg/h)</td>
<td>18,0</td>
<td>25</td>
<td>32,7</td>
</tr>
</tbody>
</table>

| CONSUMABLES COST |
| Wire (€/kg) | 1,20 | 1,20 | 1,20 |
| Flux (€/kg) | 1,70 | 1,70 | 1,70 |
| Ratio Flux/Wire | 0,73 | 0,67 | 0,53 |
| Total cost/kg weld (€/kg) | 2,44 | 2,34 | 2,10 |

| PRODUCTION COST |
| Labour cost (€/h) | 60 | 60 | 60 |
| Duty cycle (%) | 100 | 100 | 100 |
| Weight per meter weld (kg/m) | 6,00 | 6,00 | 6,00 |
| Time per meter weld (h/m) | 0,33 | 0,24 | 0,18 |
| Cost per meter weld (€/m) | 35 | 28 | 24 |

| TOTAL |
| Total length (m) | 10 000 |
| Total weight (kg) | 60 000 |
| Total welding time (h) | 3 333 | 2 400 | 1 835 |
| Total cost (€) | 346 460 | 284 340 | 236 152 |

TIME SAVINGS VS TANDEM STANDARD STICK OUT
-933 h | -1498 h

COST SAVINGS VS TANDEM STANDARD STICK OUT
-62 120 € | -110 308 €

-45% | -32%
EXAMPLE: PERFORMANCE COMPARISON OF TANDEM WELDS

Application: S355G10+M, 40 mm plate thickness, 1 m length
Heat input range: 3.3-3.6 kJ/mm
Consumables: Oerlikon OPI28TT with OE-SD3 [EH12K] wire (diameter 4 mm)

- Tandem Standard Stick Out (DC+/AC)
  - Max deposition rate 21.3 kg/h
  - Average deposition rate 18 kg/h
  - Average heat input 3.6 kJ/mm
  - 11 passes
  - Average CVN at -50°C: 103 J

- Tandem 1 Long Stick Out (DC+/AC) (trail)
  - Max deposition rate 29.4 kg/h
  - Average deposition rate 25 kg/h
  - Average heat input 3.3 kJ/mm
  - 10 passes
  - Average CVN at -50°C: 116 J

- Tandem 2 Long Stick Out (AC/AC)
  - Max deposition rate 39.7 kg/h
  - Average deposition rate 32.7 kg/h
  - Average heat input 3.5 kJ/mm
  - 8 passes
  - Average CVN at -50°C: 131 J

USER’S ADVANTAGE

- 40 kg/h in tandem with heat input below 3.5 kJ/mm
- Number of passes reduced by 27%
- Preserved Charpy impact toughness

ARC TIME REDUCTION

90% DEPOSITION INCREASE

-43% ARC TIME REDUCTION

Arc time to fill 1 m weld

Weld A 9 min saved/m
Weld B
Weld C
THE LONG STICK OUT PROCESS

In submerged arc welding, Stick Out, is the distance between the contact tip and the work piece. This distance can be increased using dedicated extensions of various lengths to obtain what is known as Long Stick Out (LSO). The wire electrical resistance increases with its length. Thanks to the “Joules” effect, the electrode is pre-heated and melts faster than it would, at the same amperage, with standard Stick Out.
KEY COMPONENTS

REQUIRED equipments:
- Power Wave® AC/DC1000® SD: State of the art power source which insures consistent arc starts.
- Maxsa 10622 controller and head: Robust and easy to use operator interface.
- Positive contact torch (K148) and its extension (K149): Easy to mount and engineered for LSO.

Power Wave® AC/DC 1000® SD

WELDING POLARITY CHARACTERISTICS

<table>
<thead>
<tr>
<th>DC+</th>
<th>DC-</th>
<th>AC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Most common mode</td>
<td>Improves deposition rate</td>
<td>A compromise between the two DC modes</td>
</tr>
<tr>
<td>Deep penetration and stable arc</td>
<td>Limits penetration</td>
<td>The optimum choice</td>
</tr>
<tr>
<td>Limits penetration</td>
<td>Limited arc stability</td>
<td></td>
</tr>
<tr>
<td>Limited arc stability</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Waveform Control Technology®: customised AC mode

<table>
<thead>
<tr>
<th>Offset</th>
<th>Frequency</th>
<th>Balance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive/Negative Amplitude</td>
<td>Number of switches per second from positive to negative polarity</td>
<td>Percentage of time in the positive polarity part of a cycle</td>
</tr>
</tbody>
</table>

USER’S ADVANTAGES
- Wave form control
- Low electrical consumption
- Easy set up and control of multiples arcs
- Check Point (welds recording and monitoring)

FOR MORE INFORMATION SCAN HERE

www.lincolnelectriceurope.com SOLUTIONS FOR HIGH PRODUCTIVITY WELDING OF WIND TOWERS

ALERTS
Receive email notifications based on equipment conditions and wire consumption.

PRODUCTION MONITORING
View live status of each welder and weld details.

TRACEABILITY
Satisfy reporting requirements by capturing audit trail data.
In Tandem, 1 or 2 LSO torches can be used. In the 2 LSO configuration, deposition rates can easily exceed 40 kg/h using 4 mm wires.

The long stick out process is the most productive of the single power source processes.

USER’S ADVANTAGES
- Easy torch installation
- Reduced number of passes
- Reduced flux consumption
- Preserved mechanical properties

TANDEM LSO:
40kg/h at 3.5 kj/mm

Comparison carried out at:
*800/875A for double power source processes
Lincoln Electric offers a wide portfolio of welding consumables fulfilling the highest standard requirements. The most frequently used in the wind industry are reported below. Depending on required mechanical properties and joint configuration more options are available.*

### SPECIFIC CONSUMABLES

**Two-run welds & Multi-run welds**

- **FLUX**
  - OP 128TT

- **WIRE OPTIONS**
  - OE-SD2
  - OE-SD3
  - OE-S2Mo

**Multi-run welds with -60°C requirements**

- **FLUX**
  - OP 121TT

- **WIRE OPTIONS**
  - OE-SD3
  - OE-SD3 1Ni 1/4Mo

### USER’S ADVANTAGES

- Excellent slag release
- Multi-wire configuration
- High purity weld deposits
- Low diffusible hydrogen
- Excellent resistance to moisture pick up

*Please contact your local representative for Lincoln equivalent consumables

Want to learn more?
Please contact us to book an appointment.

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*Solutions for high productivity welding of wind towers*
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