Onder poeder lassen

in de 21e eeuw
AC/DC

Harm Meelker, IWE
Lincoln Smitweld

LINCOLN ELECTRIC
THE WELDING EXPERTS®

1938

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Thema's

- Inleiding
- Traditionele apparatuur verhogen neersmeltsnelheid / efficiëntie
  - ✓ *Gevulde draad*
  - ✓ *Meerdraads (twin)*
  - ✓ *naadvorm*
- Nieuwe generatie apparatuur
  - ✓ *Conventioneel vs inverter (AC/DC)*
  - ✓ *Verhogen neersmeltsnelheid LSO*
- Energie besparing
- Extra's
- Samenvatting/Conclusies

3

Principe van onder het poeder lassen

- Bij onder poeder lassen brand de lasboog tussen een wekstuk en een continue aangevoerde draad
- De lasboog is niet zichtbaar deze bevind zich onder een laag poeder
- Het poeder beschermt het lasbad tegen het milieu

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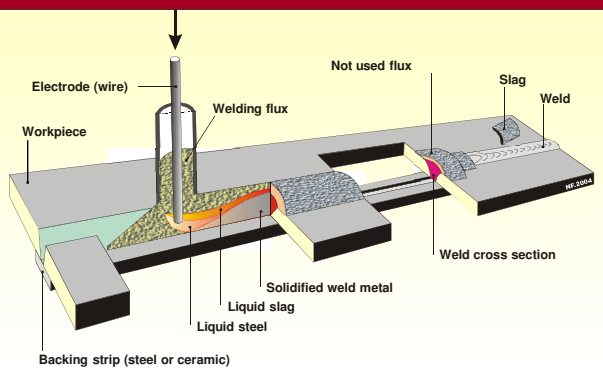
Principe van onder het poeder lassen



Karakteristieken van OP-lassen (+)

- Milieu- en lassers- vriendelijk
  - Geen lasrook
  - Hoge inschakelduur
- Economisch zeer aantrekkelijk
  - Hoge stroombelastbaarheid van de draad
  - Hoge neersmeltsnelheid
  - Grote lassnelheid
- Laag-tegenlaag techniek tot 30mm plaatdikte
- Eénzijdig lassen
- Veel procesvarianten
- Uitermate geschikt voor
  - Dikke materialen
  - Lange lengtes
- Uitstekende mechanische eigenschappen

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Karakteristieken van OP-lassen (-)

- Grote investering
- Lange omschakeltijden
- Één laspositie
- Diepe inbranding
- Lasbad is niet zichtbaar
- Alléén geschikt voor
  - ✓Dikwandig materiaal
  - ✓Lange lengtes
  - ✓Grote diameter

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Wat vraagt de markt?

- ✓ **Lagere produktiekosten ⇨ toename van de produktie**
- ✓ **Toename van de kwaliteit**
- ✓ **Hogere sterkte materialen ⇨ verlagen van het gewicht van een constructie + mogelijk lagere materiaal kosten**
- ✓ **Flexibiliteit**

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OP-lassen proces varianten

Enkeldraads	Meerdraads
Één draad	Twin-arc
Lassen op DC-	Tandem
Gevulde draad	Tandem twin
IJzer poeder	3 – 6 draden
Long Stick Out	Cold wire
Narrow gap	Hot wire
Semi-narrow gap	Semi-narrow gap

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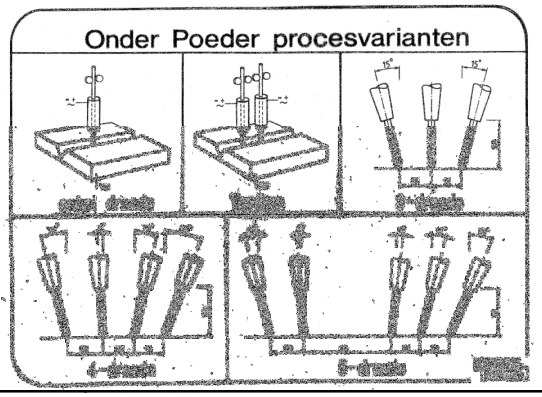

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Stroomdichtheid

Draaddiameter (mm)	Stroomsterkte (A)	Stroomdichtheid (A/mm2)
3.2	500	63.5
4.0	750	60.5
5.0	1000	55.8

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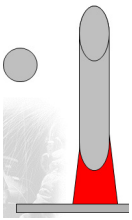
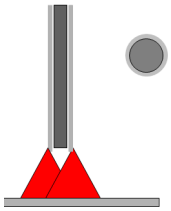
Ééndraads lassen



Massieve draad

versus

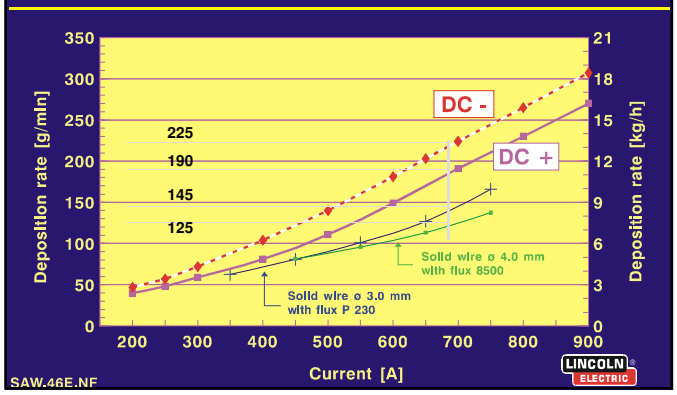
Gevulde draad



Stroomdichtheid (A/mm2)

12

Deposition rate LNS T55, ø2.8 mm with flux P 230, 860 and 8500 as function from polarity



OP-lassen met gevulde draden

Voordelen tov massieve OP-draden

- Hogere productiviteit
  - Neersmeltsnelheid = f (A en de draad/poeder combinatie)
- Hoge lassnelheden
  - Lagere Hi = minder vervorming
- Goede mechanische eigenschappen
  - Ondanks hogere neersmelt en vaak dikkere rupsen
- Uitstekende lasbaarheid
  - Range stroomsterkte met ø 2,8 mm draad van 160 tot 700A.
- Penetratie = f (laspoeder en A)
- Logistiek voordeel
  - Veranderen draaddiameter is niet nodig

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Meerdraads OP-lassen

Twinarc

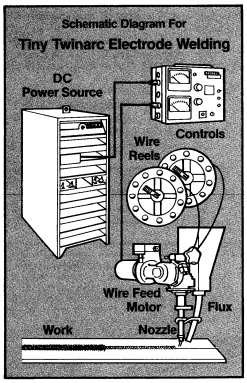
1.2 tot 3.2 mm

Tiny Twinarc voor dunne draden

1,2 mm. tot 2,0 mm.

Twinarc voor dikkere draden.

2,0 mm. tot 3,2 mm.



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Stroomdichtheid incl. Twinarc

Draaddiameter (mm)	Stroomsterkte (A)	Stroomdichtheid (A/mm2)
3.2	500	63.5
4.0	750	60.5
5.0	1000	55.8
2 x 1.6	850 – 925	215 - 234
2 x 2.0	950 – 1250	153 - 201

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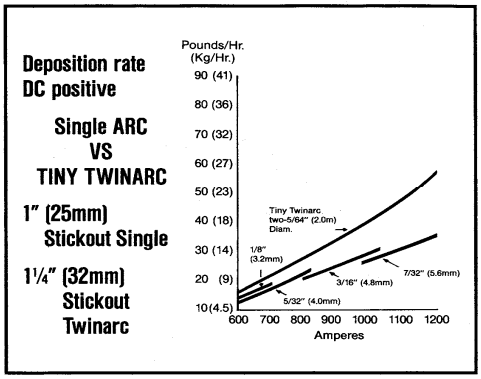
Twinarc



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Twinarc voordelen

- Hogere productiviteit
  - Neersmeltsnelheid is 40% hoger dan met enkele massieve draad
- Geen extra stroombron nodig
  - Eenvoudig ombouwen naar Twinarc kop, lasopstelling is er al
- Hoge lassnelheden
  - Lagere Hi = minder vervorming
- Goede mechanische eigenschappen
  - Ondanks hogere neersmelt en vaak dikkere rupsen
- Logistiek
  - Veranderen aandrijfrollen en eventueel aandrijfverhouding

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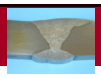
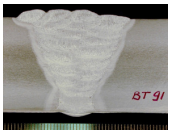
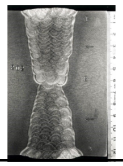
Naadvormen



V - naad
X - naad
K - naad





I - naad
Semi narrow groove
Narrow groove

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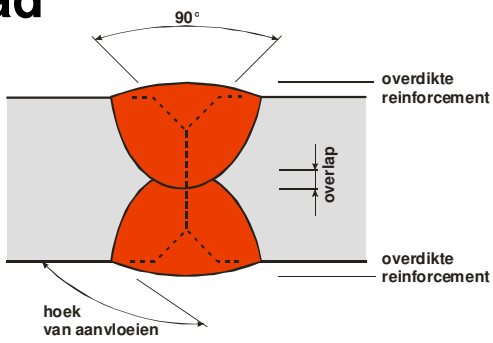
Laag-tegenlaag lassen

I naad



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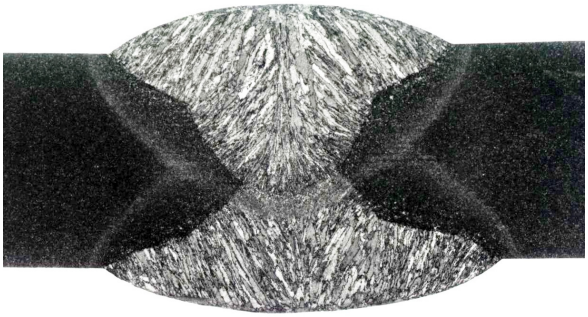
Laag-tegenlaag lassen



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Laag-tegenlaag lassen

- Resultaat is afhankelijk van:
  - Keuze draad/poeder combinatie
  - Te lassen staalkwaliteit
  - Heat Input (Δt 8/5)
- Betekent dat de keuze draad/poeder het allerbelangrijkst is en moet voldoen aan:
  - Goede bevochtigingseigenschappen
  - Geen poreusiteiten
  - Afhankelijk van de toepassing goede taaiheids eigenschappen

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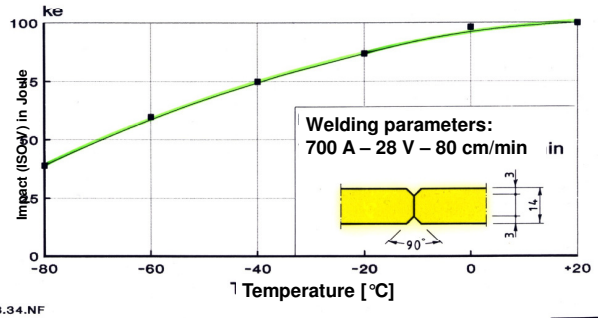
Two-run technique (Square butt welding)

LNS 140A/P230



SB.34.NF

(Semi)-Narrow groove

- Standaard zijn V - X - and K-naden voor grotere plaatdiktes met een openingshoek van 45 tot 60°
- Nadeel is de dramatische volume toename in deze naad resulterend in;
  - Toename van neergesmolten lasmetaal
  - Toename van krimp (spanningen)
- Minimaliseer de openingshoek en vooropening van de te lassen verbinding

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(Semi)-Narrow groove

- "Narrow groove" kan hieraan voldoen, de openingshoek α nadert tot nul. Nadelen;
  - grotere kans op lasfouten
  - dure hulpmiddelen noodzakelijk
  - perfecte lasnaadvoorbereiding end
  - foutloze opbouw is een must
- Semi-narrow groove
  - openingshoek 10 - 15°
  - root straal ~8 á 9 mm
  - Voordeel: ook bij grote materiaal diktes kan zonderproblemen met standaard apparatuur gewerkt worden
  - Ook geschikt voor meerdraads varianten

> 100 mm

< 100 mm

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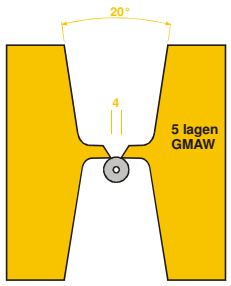
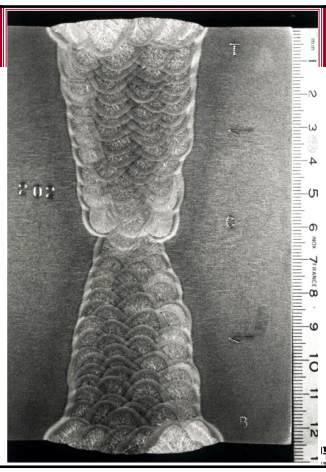
Semi-Narrow gap





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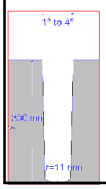
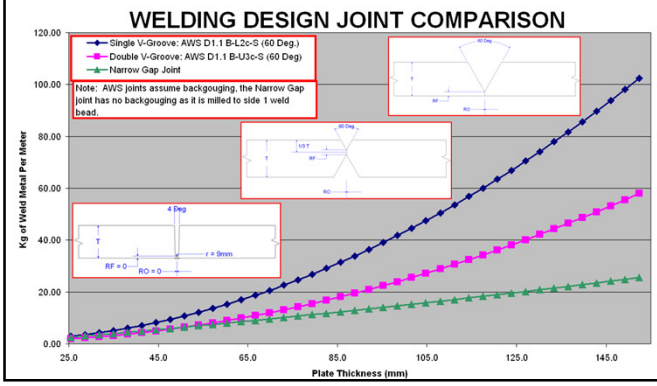
Narrow Gap



Narrow Gap:
- Zeer smal vanaf de bodem; 20mm typical (10mm radius)
- Sidewall bevel: 1.5° typical (1.2° min.)
- Resulteerd in een zeer nauwe naad over de totale dikte

Nadelen:
- Moeilijker lassen
- Moeilijk te repareren en slak verwijderen
- Grote investering
- Fitten/samenbouwen zeer kritisch
- Naad moet gemachineerd zijn

Potentiele besparingen verschillende naadvormen



Samenvatting, conventionele apparatuur

Efficiëntieverhoging	Investering
Juiste keuze draaddiam.	-
Gevulde draad	-
Twin arc	+/-
Naadvoorbewerking	+(++)
AC variabel (inverter)	+++++

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Onder poeder stroombronnen

Conventionele (transformatoren)

Moderne (inverters)

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De nieuwste generatie onder poeder lassen

"State-of-the-Art" in inverter technologie
- Hoge capaciteit inverter
- Zeer efficiënte inverter

Waveform Control Technology ™
- Uitstekende controle over het lasproces

Solid State Switching Technology
- AC of DC lassen

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Power Wave® AC/DC 1000® SD

Waveform Control Technology

- Inverter stroombron
- Energie zuinig
- DC+, DC- & AC (3 Phase)
- CV en CC Modes
- AC to DC Electronic Switch
- Wave Balance Control
- 100% inschakelduur
- Frequentie regeling
- Wave Shape Design
- Productie monitoren
- Las history
- Integrated Multi Arcs

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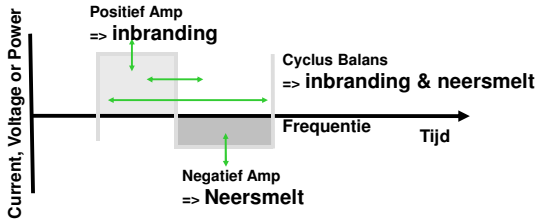
Oneindig variabel AC



De golfvorm kan volledig gevarieerd worden voor - inbranding - lasuiterlijk – voorkomen van arc blow (DC-) & boog interactie bij meerdraads lassen door fase verschuiven

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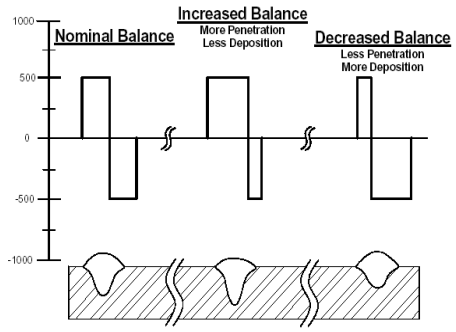
Wave Balance



Typically run at 25% positive & 75% negative

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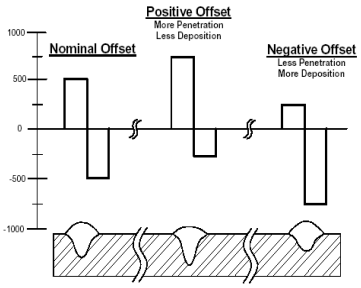
Offset

- **Offset is a very sensitive parameter**
- **Typical range limited to 0 to -10%. 8% offset => 25% balance.**
- **Large values of current offset interferes with voltage regulation causing system instability**



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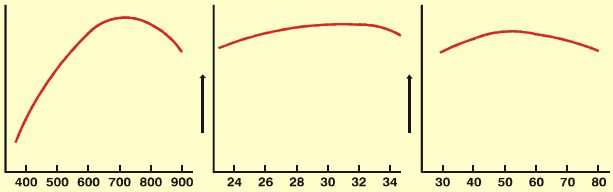
Invloed van A – V - lassnelheid op de inbranding bij OP-lassen

Constant wire diameter and stick-out



Current [A]	Voltage [V]	Travel speed [cm/min]
constant voltage and travel speed	constant current and travel speed	constant current and voltage

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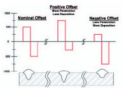
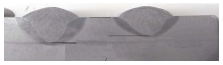
Waveform Control Technology

Offset

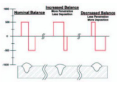


Positive = 835 Amps
Negative = 519 Amps
Penetration = .366"

Positive = 450 Amps
Negative = 822 Amps
Penetration = .280"



Wave Balance



70% Positive
Penetration = 0.387"

50% Positive
Penetration = 0.346"

30% Positive
Penetration = 0.242"

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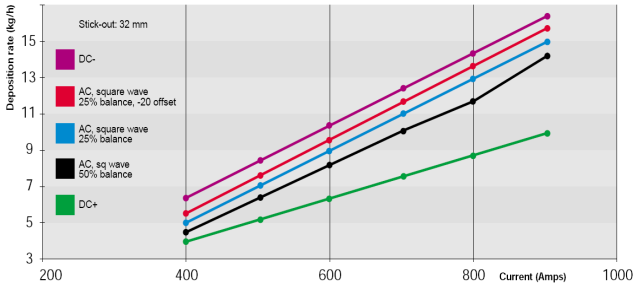
Neersmelt kg/uur

Melting curves of a 4 mm diameter wire with a PW AC/DC 1000



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AC/DC onder poeder lassen

- Uniek in de industrie
- Variabele polariteit voor nog betere procescontrole - beheersing
  - Grote neersmelt
    - Hoge snelheid lassen
    - Dikke secties lassen
  - Inbrandings profiel
  - Stabiele boog in meerdraads toepassingen
  - Lagere warmte-inbreng (heat input)
- Technologisch geavanceerd
  - Waveform control technologie
  - Digitale communicatie technologie

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Boog configuraties

Tandem
Meerdraads proces tot 6 bogen
Ééndraads-twin combinaties
DC+ lead met AC trails
Alle AC
Toevoegen van warme/koude draad
Alle bovenstaande combinaties

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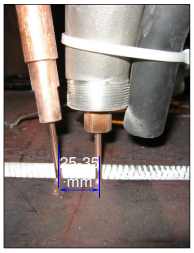
Powerwave technologie

TANDEM CAPABILITIES

Advantages:

CV & CC mode (CC is prefered).
Short distance between wires (one puddle).
Better duty cycle rating.



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Meerdraads lassen

- Power Wave AC/DC 1000 SD can be used with up to six arcs
- Phase angles for up to six arcs can be controlled
- All machines can be tied into the lead arc start/stop buttons
- Lead arc is AC or DC+, all trailing arcs are AC

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Neersmelt gegevens (intern onderzoek)

Samenvattend;

Traditioneel tandem, 2x4.0mm -20 C and 21kg/hr
Powerwave 1x4.0mm/2x2.4mm -50 C and 35 kg/h
Powerwave 3x4.0mm -40 C and 45 kg/hr

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Voorbeeld efficiëntie verhoging

Company	Herstaco Tube Welding B.V.
Adress	Nijverheidsweg 24, Middelburg, The Netherlands
Type of business	Metal trading company Tube/pile welding
Project team	Distributor Wagenvoorde Lastechniek, Lincoln Smitweld
Area of cost savings/target	Higher deposition rate by use of Powerwave AC/DC 1000 Target; 30% Cost Reduction
Procedure/Follow up	Introduce and demonstrate PW AC/DC 1000
Results	More than 33% reduction in labor costs Sold SAW welding station, PW AC/DC 1000 with column & Boom Consumables; L61/LW860 Deposition rate filling layers from 6 up to 9 Kg/Hr Welding time per weld (1060x28mm) in a pile was 60 min., decreased to 40 min.

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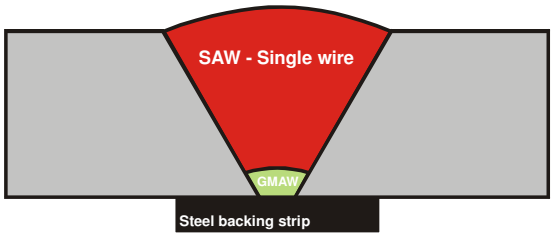
Practical example: Tube welding ø 1060 x 35mm



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Practical example: Tube welding ø 1060 x 35mm

Equipment	Conventional DC 1000	Wave Control PW AC/DC; with 40 Hz; 55% DC-; 5% offset
Fill	500/520 A - 31 Volt = 6 kg/h	550 - 34 Volt = 9 kg/h
Cap	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.

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Herstako cost reduction result based on labor rate (€35,-/hr)

Project Humber UK; 350 Piles x 4 = 1400 Welds

Conventional process

Labor costs 1400 x 1hr x €35,-/hr = **€ 49.000**,-

Wave Control process

Labor costs 1400 x 0.67 hr x €35,-/hr = **€ 32.830.-**

Labor Cost savings for this project; € 16.170,-

Energy savings are there too, but were not calculated, so the total cost saving is more than the calculated 33%. The investment of 1 machine is almost paid in 1 project.

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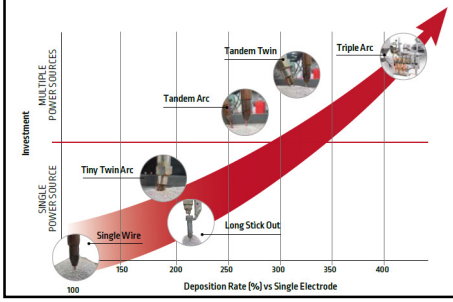
MOVING YOUR SUBMERGED ARC SOLUTION TO THE NEXT LEVEL

Lincoln Electric is the submerged arc process specialist. Together we will develop the best solution while maximizing your savings through highest deposition rates, highest quality and optimized parameters with your actual equipment or potential investments.

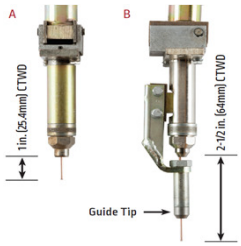


ELECTRICAL LONG STICK OUT

The electrical stick out or CTWD (contact tip to work distance) is the distance set between the contact tip end and the work piece and is normal set around 25mm. Long Stick Out is increase to 125mm.

The Power Wave AC/DC1000SD inverter technology secures the striking condition every time.

Due to the wire resistance, wire extension is preheated ($R x I^2$) making it easier to melt in the arc and leading to higher wire feed speed at same Amperage.



Video

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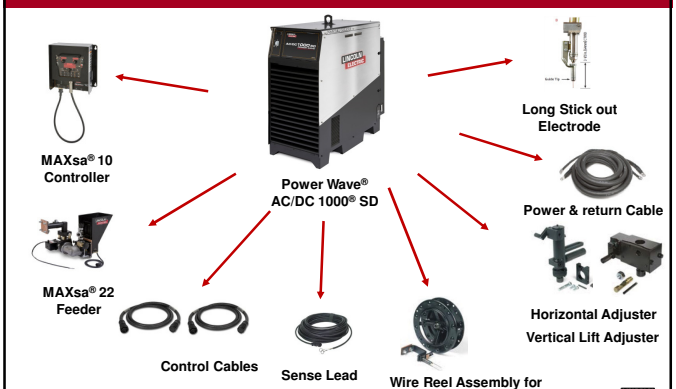
Equipment LONG STICK-OUT:



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The Validation Centre (T.V.C.)

ALX WELDING PROCEDURE O… …OR

Project : TEST1

Procedure No : Proc1 …2012

WELD PARAME…

Weld No.	Run /Pass	Weld Time	Welder	Weld Process	Consumables Elec/Wire Diam	Polarity	Gas	Balance	A	Dep. Rate	Length (mm)	Arc Time sec	Travel Speed (cm/min)	Wire FeedSpeed (M/min)	Heat Input (J/mm)
		11:12	piet		L61-P230	dc+			750	8 kg/hr	497	85,7	0,0	0,0	
		11:16	piet		L61-P230	dc+			750	13 kg/hr	618	88,4	42,0	1,4	2356,0
		11:21	piet		L61-P230				750	11 kg/hr	602	594	63,4	56,0	1,8	2126,0
		11:25	piet		L61-P230				750	12 kg/hr	601	54,8	66,0	2,2	2121,0
		11:28	piet		L61-P230				750	13 kg/hr	508	612	86,1	43,0	1,4	2342,0
		11:33	piet		L61-						489	622	72,7	51,0	2,1	1729,0
		11:39	piet								573	579	68,5	51,0	2,7	2031,0
		11:41	piet								663	597	54,5	66,0	3,2	1777,0
		11:51	piet								666	594	55,9	64,0	3,0	1781,0
		13:12	piet								603	404	45,0	54,0	3,4	3075,0
		13:14	piet								703	492	47,3	53,0	4,7	3611,0
		13:17	piet								487	397	45,0	53,0	2,8	2587,0
		13:27	piet								580	422	46,8	54,0	3,8	2985,0
		13:…	piet								662	423	51,8	49,0	4,9	3744,0

Standaard vs long stick out proces

COMPARISON BETWEEN Standard torch K231/ LONG STICK OUT

Customer: IPRO (Slovenia)

Parameters common to all the tests:

Current: 600Amps

Voltage: 30 Volts (CC DC+); 32 Volts (CC Square Wave for K231); 34 Volts (CC Square Wave for K148+K149)

Welding speed (single torch): 40cm/min

STANDARD TORCH K231

(Stickout: 30mm)

1st welding: deposit **6.92** Kg/hour – Average WFS **1.20** m/min (CC DC+)

2nd welding: deposit **8.69** Kg/hour – Average WFS **1.50** m/min (CC Square Wave, balanced)

3th welding: deposit **9.86** Kg/hour – Average WFS **1.75** m/min (CC Square Wave, 30BAL)

4th welding: deposit **10.45** Kg/hour – Average WFS **1.85** m/min (CC Square Wave, 30BAL and -25 OFFSET)

LONG STICKOUT torch K148+K149 (LSO)

(Stickout: 120mm)

1st welding: deposit **9.57** Kg/hour – Average WFS **1.7** m/min (CC DC+)

2nd welding: deposit **10.75** Kg/hour – Average WFS **1.9** m/min (CC Square Wave, balanced)

3th welding: deposit **11.92** Kg/hour – Average WFS **2.1** m/min (CC Square Wave, 30BAL)

4th welding: deposit **12.66** Kg/hour – Average WFS **2.2** m/min (CC Square Wave, 30BAL and -25 OFFSET)

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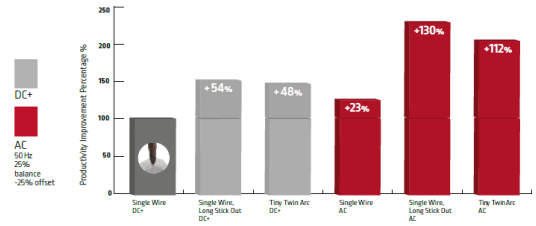
TYPICAL STANDARD DEPOSITION RATES FOR SINGLE POWER SOURCE

DC+			AC		
Single Wire 4.0 mm		Tiny Twin Arc 2.0 x 2.0 mm	Single Wire 4.0 mm		Tiny Twin Arc 2.0 x 2.0 mm
Standard Stick Out	Long Stick Out	Standard Stick Out	Standard Stick Out	Long Stick Out	Standard Stick Out
Typical Deposition Rate					
6.5 kg/h	10.0 kg/h	9.6 kg/h	8.0 kg/h	15.0 kg/h	13.8 kg/h
Improvement vs. Single Wire 4.0 mm					
100%	154%	148%	123%	230%	212%



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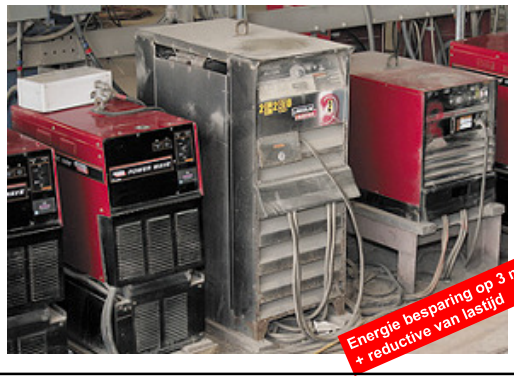
Besparingen met de PW1000AC/DC SD



Energie besparing op 3 manieren
+ reductive van lastijd

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Energiebesparing op 3 manieren

Energie verbruik van de PW1000AC/DC als de machine aanstaat maar niet last

De Inverter technologie toegepast in de PW1000AC/DC is zeer efficiënt

Het AC onder poeder lasproces geeft een hogere neersmelt en een lagere warmte inbreng. Er wordt dus minder energie gebruikt.

PW 1000AC/DC
400V 3Ph 50Hz

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PW1000AC/DC SD versus conventionele machine

Three machines running 600A 30V Comparison

Commonly used in the industry

AC 1200	PW1000 AC/DC	DC1000
Efficiency 80%	Efficiency 86%	Efficiency 78%
Power Factor 0.81	Power Factor 0.95	Power Factor 0.73
KW 22.5	KW 20.9	KW 23.1
KVA 27	KVA 22	KVA 31.6
Line current 67A	Line current 32A	Line current 32A
Idle Power 2500W	Idle Power 300W	Idle Power 2000W

Efficiency, line current and idle power levels are supporting savings

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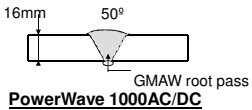
Field experience Application: SA Twin 2.0mm



Vessel fabrication
Material SA517 Grade 65
Wire LNS 133 2.4mm
FLUX 960
Vessel diameter Ø1250mm

PowerWave 1000AC/DC

Layer	Amps	Volts	TS (cm/min)	HI (Kj/cm)	KJ/layer
1	325	27	75	7.020	2.755
2	340	27	75	7.344	2.883
3	640	30	95	12.126	4.760
4	800	32	110	13.964	5.481
5	885	33	110	15.930	6.253
6	850	33	110	15.300	6.005
					28.136

Total time per joint 26 minutes

DC1000

Layer	Amps	Volts	TS (cm/min)	HI (Kj/cm)	KJ/layer
1	325	27	66	7.977	3.131
2	340	27	66	8.345	3.276
3	640	30	95	12.126	4.760
4	800	32	95	16.168	6.346
5	885	33	85	20.615	8.092
6	880	33	85	20.499	8.046
7	850	33	85	19.800	7.772
					41.421

Total time per joint 34 minutes

Savings: 23.5% weld time per joint, 32% energy cost

The PW1000AC/DC is saving joint time + Energy

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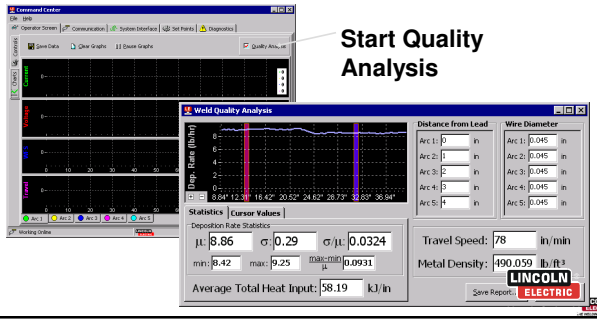
Quality Analysis



Start Quality Analysis

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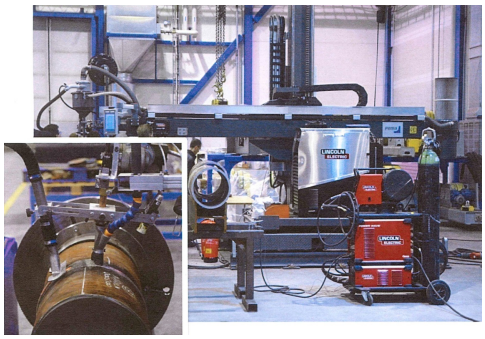
Power Wave® Software oplossingen

Overal en altijd toegang tot monitoring van het lassen

STT powerwave MIG + SAW set-up



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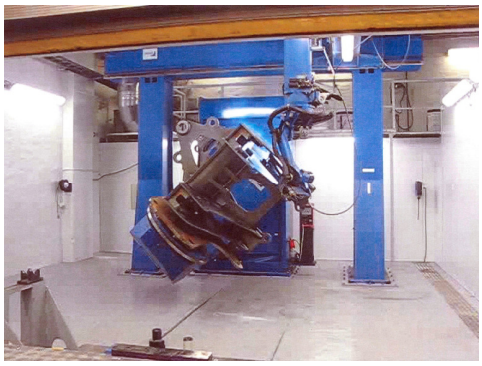
SAW robot



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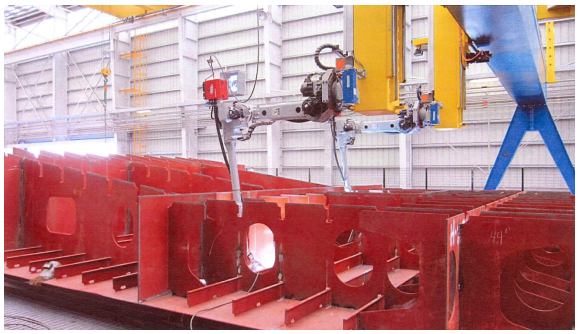
Shipbuilding with SAW robot



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Toepassing produkie van pijpen

- Longitudinal pipe welding
- Conversion standard 3- and 4-arc welding to wave control 3- and 4- arc welding
- 1.7m/min travel speed increased to 2.3m/min
- No change to weld bead profile or mechanical properties
- 35% increase in production

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Conclusies

- Nieuwe OP-lastechnologie was ontwikkeld
  - Inverter technologie
  - Waveform controle
- Besparingen
  - Energie
  - Neersmelt tot 30% hoger
  - Investering redelijk snel terug te verdienen
- Verhoogde kwaliteit
  - Superieure parameter controle
  - Diagnostiek
  - Weld-log
  - Energie
  - Hogere productiviteit
  - Snelle reactietijden

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Dank U, vragen?

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LSO Demonstratie

Standaard CTWD versus Long Stick Out (125mm)

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Submerged Arc Full Solution

TECHNICAL SPECIFICATIONS - Power Wave® AC/DC 1000® SD (K2803-1)

INPUT AT RATED OUTPUT - THREE PHASE ONLY					
INPUT VOLTS 3 PHASE 50/60 Hz	INPUT CURRENT AMPS	OUTPUT CONDITIONS	IDLE POWER WATTS	POWER FACTOR @ RATED OUTPUT	EFFICIENCY @ RATED OUTPUT
380 400 460 500 575	82 79 69 62 55	1000A@44V. 100% Duty Cycle	225	.95	86%

	Transformer Technology	Power Wave AC/DC 1000 SD
Volts	44	
Amps	1000	
Efficiency	0.83	0.85
Power Factor	0.54	0.95
Input VA	98170	54489
cost / hour	$8.64	$4.80
cost / shift	$69.11	$38.36
cost / year	$34,556.00	$19,180.19
Annual savings		**$15,375.82**

Calculations are based off utility charge of $0.11 / KVA. Equipment is run at rated output, 2 eight hour shifts / per day, 80% Operator Factor, 5 days a week , 50 weeks / year. (3200 Hours per year)

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SAW Large size packaging :

Large packaging are designed to minimize run off time :

- Using large packaging and dedicated accessories is not only a cost saving, it is also a way to **improve safety at the working station :**
  - Minimizing numbers of operations
  - Mecanized handling
  - Use of longer liner gives the opportunity to position packaging at the floor level, away from welding head.
- **An estimate of the cost saving including only labor cost :**

Pakaging type	Packaging capacity	Quantity of 25kg coil equivalent	25kg coil change over time total (15mn each)	Packaging change over time	Net saving (60€/h)
Accutrak 1T	1000	40	10	1	540
1T liftable coil	1000	40	10	1	540
SF/AC 600kg	600	24	6	0.5	330
SF 350kg	350	14	3.5	0.5	180
100kg coil	100	4	1	0.25	45

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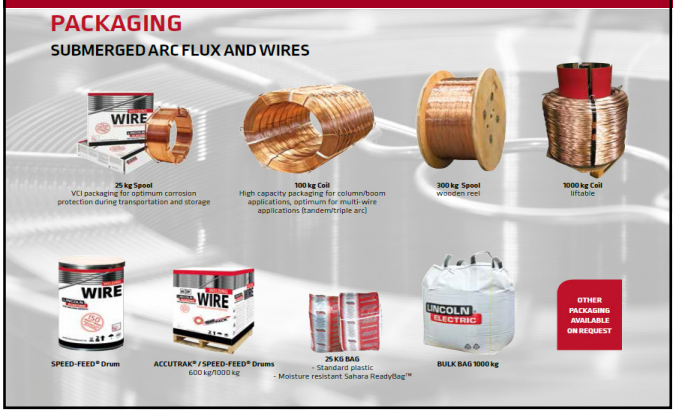
THE FULL SOLUTION FOR SUBMERGED ARC WELDING



Speed Feed Drums

- 400kg Speed Feed Drum
- Any grade, any wire diameter
- Turn table available
- Equivalent to 16 25kg spools

600kg Accutrak Or 1T Accutrak drum

- Any grade, wire diameter 4mm maximum
- No rotating table needed
- Accessories needed : mexican hat & cover
- Wire bagged in VCI bag for moisture protection
- 600kg Equivalent to 24 spools of 25kg
- 1 Ton Equivalent to 40 25kg spools

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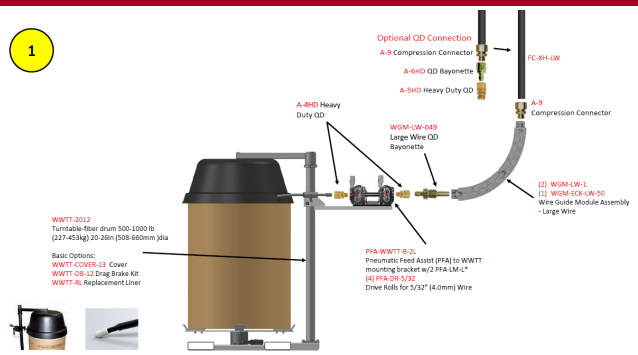
LARGE PACKAGING wire feeding system description :



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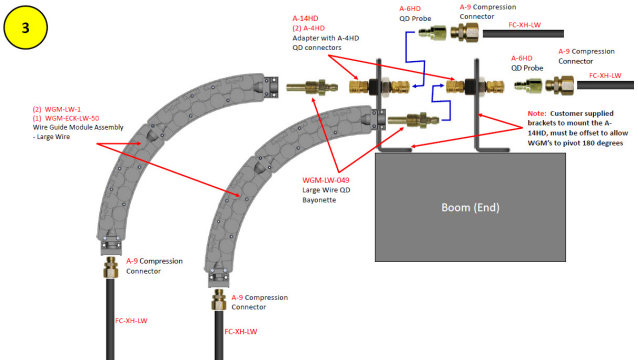
LARGE PACKAGING wire feeding system description :



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