

WAVEFORM CONTROL TECHNOLOGY™

Surface Tension Transfer® (STT®)

STT Open Root

For many years, pipe fabricators have been searching for a faster, easier method to make single-sided low hydrogen open root welds. It is difficult even for skilled welders to weld open root pipe and inflexible positioning makes pipeline welding more difficult, time consuming and expensive.

Higher strength pipe steels are driving a requirement to achieve a low hydrogen weld metal deposit. GTAW has been the only available process capable of achieving the quality requirements but GTAW root welds are very expensive to make. The GMAW process has been avoided because of problems with sidewall fusion and lack of penetration.

Lincoln Electric has developed and proven the Surface Tension Transfer (STT) process to make single-sided root welds on pipe. STT is a patented controlled short-circuit transfer GMAW process made possible by Lincoln Electric's exclusive Waveform Control Technology™. STT produces a low hydrogen weld deposit and makes it easier to achieve a high quality root weld in all positions. The STT process has a field proven quality record. STT eliminates the lack of penetration and poor sidewall fusion problems encountered when using the traditional short-arc GMAW process.



*Inside of an
8 in. x .375 in.
wall API 5L-X52
pipe, welded in
5G position.*

STT process using 100% CO₂ and .045 in. wire.



a d v a n t a g e s

PENETRATION CONTROL

- Provides reliable root pass, complete back bead, and ensured sidewall fusion.

COST REDUCTION

- Uses 100% CO₂, the lowest cost gas, when welding carbon steel.

FLEXIBILITY

- Provides the capability of welding stainless steel, alloys, and mild or high strength steels without compromising weld quality.
- Capable of welding out of position.

LOW HEAT INPUT

- Reduces burn through, cracking, and other weld defects.

LOW HYDROGEN WELD METAL DEPOSIT

- Hydrogen levels meet the requirements for use on high strength pipe steels.

SPEED

- High quality open root welds at faster travel speeds than GTAW.

CURRENT CONTROL INDEPENDENT OF WIRE FEED SPEED

- Allows operator to control the heat put into the weld puddle.

EASE OF OPERATOR USE

- More forgiving process than conventional short arc welding with CV machines.



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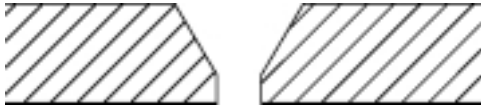
2/6

STT Open Root

Using

STT for Open Root welding

Open root welding is used for pipe and single-sided plate welding in situations that preclude welding from both sides of the material. This type of welding is common in the petrochemical and process piping industries.



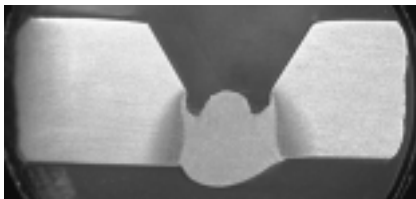
Comparing

STT to other pipe welding processes

Conventional CV GMAW welding processes produce a flat internal bead, or "suck back" where the bead shrinks back into the root due to high weld puddle temperatures. Another disadvantage with CV GMAW welding on pipe is decreased tolerance for arc deviation. To obtain a weld without defects, the arc must be on the leading edge of the puddle. If the arc is too far back on the puddle, the arc will not penetrate completely. If the arc is too far ahead, the electrode shoots through the gap and causes "whiskers" to form on the inside of the pipe.

GTAW welding produces good pipe welds, but travel speeds are slow and heat input is high.

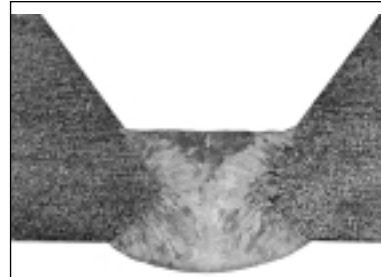
Stick welding with cellulose electrodes provides good fusion characteristics, but leaves deep wagon tracks (requiring more labor for grinding), a very convex root weld, and a high hydrogen deposit.



Open Root Pass with Stick Electrode.

The STT process produces a low hydrogen weld metal deposit in open root joints with easier operation, better back beads, better sidewall fusion and less spatter and fumes than other processes. STT differs from the traditional GMAW short-arc welding process because the arc current is precisely controlled independently from the wire feed speed. Changes in the electrode extension do not affect

the heat input. Additionally, the arc current is carefully regulated to reduce puddle agitation and to eliminate violent "explosions" that occur during the traditional short-arc GMAW process. In comparison with traditional short-arc GMAW processes, STT is a controlled short circuit transfer GMAW process that offers the operator increased control over the welding process and produces less spatter and fumes.



- Superior weld profile (no wagon tracks)
- Slight convexity of root weld
- Improved hydrogen deposit

Open Root Pass with STT provides a weld ligament thickness of approximately 0.22".

The flexibility

of STT for open root welding



STT is a viable option for welding in any position, and is effective for welding mild and high strength steels, as well as stainless steel and related alloys. When welding duplex stainless, the CPT (critical pitting temperature) is significantly better with STT than with GTAW, and travel speeds three to four times that of GTAW.

Surface Tension Transfer (STT)

3/6

STT Open Root

Automated open root welding

and the STT process



The STT in the Autoweld system.

Another strength of STT is that it can also be used in automated welding procedures without the need for copper or ceramic backing. The patented Autoweld® system, combined with the STT process makes pipe welding faster and easier, with exceptional weld quality. This is especially true on pipeline projects that require many joints of uniform, high quality to meet code requirements.

The semi-automatic open root welding process

and the STT process

This process requires the following technique: The 12 to 2 o'clock position may require a drag angle of 45 degrees and weave side to side. Between 2 and 6 o'clock, reposition the electrode on the puddle with a drag angle of 10 to 20 degrees in the direction of travel. Stay on top of the puddle while making the weld. Between 4 and 6 o'clock, it may be necessary to weave side to side. After a few practice joints, the operator will find STT easy to use.

In the 5G position, the operator must stay in the puddle. Experienced pipe welders almost always find the process a welcome improvement, both in ease of welding and comfort. They particularly appreciate the reduction in spatter when welding in the 6 o'clock position.

1G position.



Application Data—Starting Point Root Pass

Material	Joint Type (included angle)	Root Opening < or > mm (in.)	Root Face [land] mm (in.)	Welding Position	Shielding Gas	Backing Gas	Electrode		STT Settings			WFS m/min (ipm)	ESO mm (in)
							Type	Diam mm (in.)	PEAK Amps	BACK-GROUND Amps	TAIL-OUT		
Carbon Steel	60 deg inc.	1.6-2.8 (.062-.11)	1.6 (.062)	5G vertical down	100% CO ₂	NA	L-56 ER70S-6	1.2 (.045)	360	55-65	0	3.0 (120)	10.0 (3/8)
Stainless Steel	60 deg inc.	2.0-2.8 (.080-.11)	1.6 (.062)	5G vertical down	90% He 7% Ar 2% CO ₂	100% Ar	Blue Max	1.2 (.045)	340	55-65	4	3.0 (120)	10.0 (3/8)
Stainless Steel	60 deg inc.	2.0-2.8 (.080-.11)	1.6 (.062)	5G vertical down	98% Ar 2% CO ₂	100% Ar	Blue Max	1.2 (.045)	260	80-90	4	3.0 (120)	10.0 (3/8)

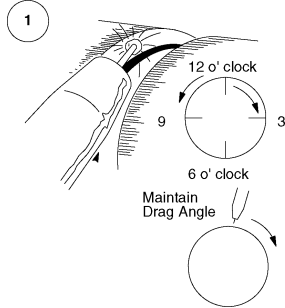
Surface Tension Transfer (STT)

4/6

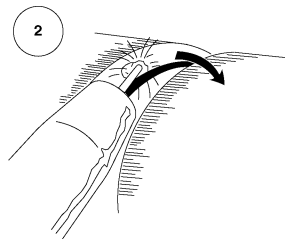
STT Open Root

The semi-automatic open root welding procedure

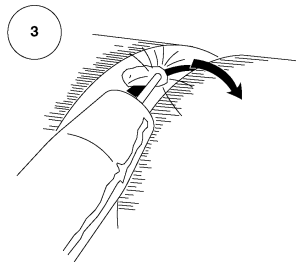
1 Start arc on sidewall, not in gap.



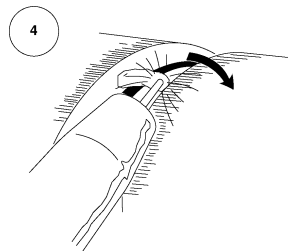
2 After puddle is established, maintain the arc on the forward portion of the puddle.



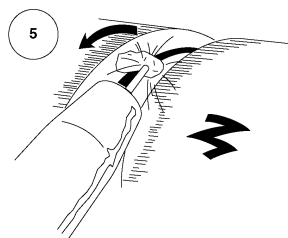
3 Move across the gap.



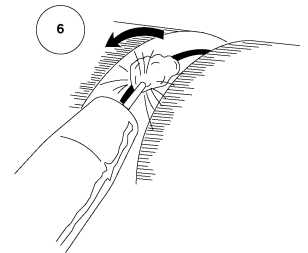
4 Move slightly up the sidewall.



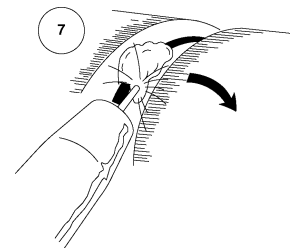
5 Stay in the puddle and move the electrode back across the gap. Move the electrode down the joint in a half-moon motion.



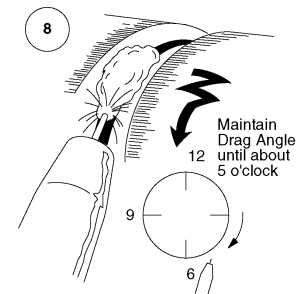
6 Continue moving back and forth (weaving) across the gap until reaching the 1 o'clock position.



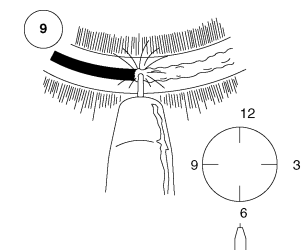
7 At 1 o'clock, stop weaving. Concentrate the arc on forward weld puddle and move down the pipe joint until you reach the 5 o'clock position.



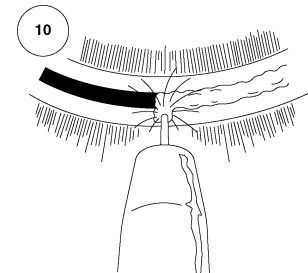
8 At 5 o'clock, reposition the torch angle to be perpendicular to the pipe.



9 End the weld at 6 o'clock by moving the arc onto the sidewall.



10 DO NOT stop welding while in the root. This may cause pin holes.



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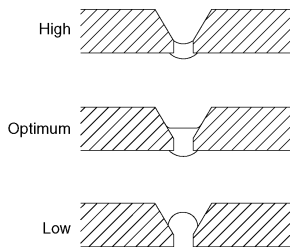
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STT Open Root

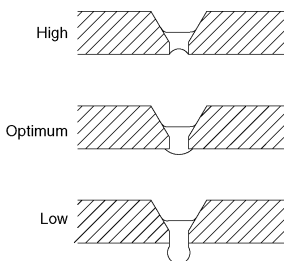
Effects of Operating Variables

WIRE FEED SPEED – controls the deposition rate.

PEAK CURRENT – controls the arc length. Arc length affects the shape of the root face.



BACKGROUND CURRENT – this is a “fine” heat control, which affects the back bead.



TAIL-OUT CURRENT – serves as a “coarse” heat control (many open root applications set this control to zero).

LINCOLN WELDING SYSTEMS FEATURING STT



Invertec® STT II

The STT II combines high frequency inverter technology with advanced Waveform Control Technology in place of traditional short-arc GMAW welding. The STT II's precise control of the electrode current during the entire welding cycle significantly reduces fumes, spatter and grinding time. In addition, the unit offers independent control of wire feed speed and current.

Lincoln Welding Systems featuring STT (cont.)

STT-10

The sophisticated STT-10 Process Controller was designed specifically to work with the revolutionary STT II power source.

Microprocessor controls make it easy to develop optimal procedures and set the range of operator adjustments. Dual procedure control can increase or decrease the energy in the arc without changing the wire feed speed.



LN-15

LN-15 is one of the smallest and most maneuverable wire feeders available on the market today. Control Cable model includes STT capabilities and is compatible with the STT II power source for outstanding welding performance including pulse welding on a wide variety of steel, stainless steel, aluminum and alloy materials.



Pipeliner™

Lincoln's family of premium Stick, GMAW, FCAW and Submerged Arc electrodes developed specifically to meet the demands of the pipe welding industry. Thoroughly tested for consistent performance. Lot-tested and certified. Certifications available to contractors upon request.



Surface Tension Transfer (STT)

6/6

STT Open Root

Lincoln Welding Systems featuring STT (cont.)

Power Wave® 455M/STT

Power Feed® 10M

The Power Wave 455M/STT is a high performance, digitally controlled inverter power source designed to be part of a modular, multi-process welding system. Optional DeviceNet™ and Ethernet modules provide networking capabilities to create a highly integrated, flexible welding cell. Power Feed 10M is a compact wire feeder designed for use with Power Wave power sources.



Power Feed 15M

This compact wire feeder is designed for field construction, pipelines, offshore and shipyard applications where portability, ruggedness and arc performance are demanded. It is the only wire feeder on the market that is digital. It is designed to work exclusively with the Power Waves.

Autoweld®

Combines the STT process for open root welding, a spacer clamp to provide exact root opening and a simple, lightweight Autoweld welding head.



Customer Assistance Policy

The business of The Lincoln Electric Company is manufacturing and selling high quality welding equipment, consumables, and cutting equipment. Our challenge is to meet the needs of our customers and to exceed their expectations. On occasion, purchasers may ask Lincoln Electric for advice or information about their use of our products. We respond to our customers based on the best information in our possession at that time. Lincoln Electric is not in a position to warrant or guarantee such advice, and assumes no liability, with respect to such information or advice. We expressly disclaim any warranty of any kind, including any warranty of fitness for any customer's particular purpose, with respect to such information or advice. As a matter of practical consideration, we also cannot assume any responsibility for updating or correcting any such information or advice once it has been given, nor does the provision of information or advice create, expand or alter any warranty with respect to the sale of our products.

Lincoln Electric is a responsive manufacturer, but the selection and use of specific products sold by Lincoln Electric is solely within the control of, and remains the sole responsibility of the customer. Many variables beyond the control of Lincoln Electric affect the results obtained in applying these types of fabrication methods and service requirements.

Subject to change – This information is accurate to the best of our knowledge at the time of printing. Please refer to www.lincolnelectric.com for any updated information.

Test Results Disclaimer

Test results for mechanical properties, deposit or electrode composition and diffusible hydrogen levels were obtained from a weld produced and tested according to prescribed standards, and should not be assumed to be the expected results in a particular application or weldment. Actual results will vary depending on many factors, including, but not limited to, weld procedure, plate chemistry and temperature, weldment design and fabrication methods. Users are cautioned to confirm by qualification testing, or other appropriate means, the suitability of any welding consumable and procedure before use in the intended application.

THE LINCOLN
www.lincolnelectric.com
1.216.481.8100