

By Troy Gurkin, Lincoln Electric - Segment Director, Heavy Fabrication

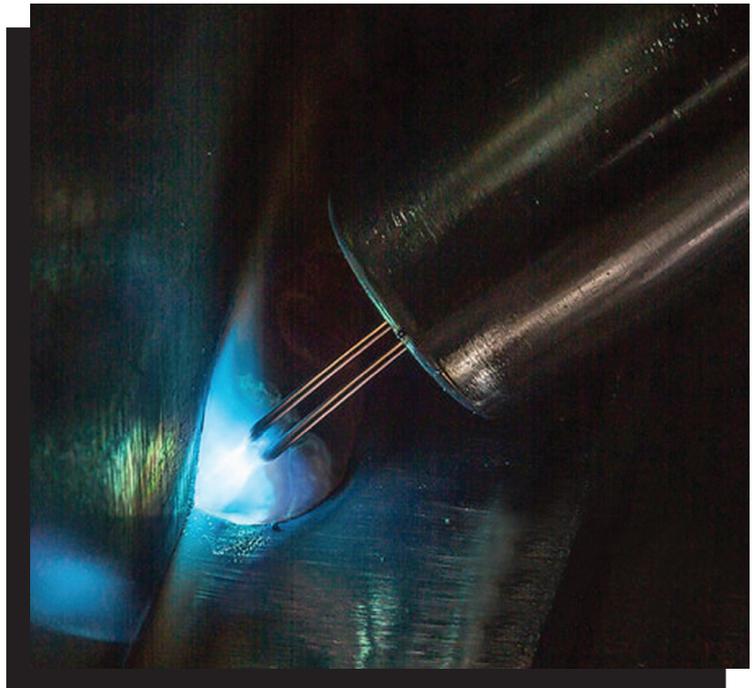
HOW ADVANCEMENTS IN TWIN-WIRE WELDING HELP INCREASE DEPOSITION AND IMPROVE WELD QUALITY

Introduction

The skilled worker shortage, labor and material costs, as well as the complexities involved with adopting new technology, are among the biggest pain points for manufacturers.

But when production calls for larger-sized welds on thicker metals, these issues can be exponentially problematic. In these applications, operations that rely on traditional single-wire or complex tandem welding processes risk efficiency losses that can have long-term impact on their bottom line.

Fortunately, advancements in twin-wire welding – specifically the patented Lincoln Electric HyperFill® twin-wire process – have made it possible to achieve higher levels of productivity while eliminating or reducing the impact of these common challenges.



Learn how a new twin-wire GMAW process can increase productivity from 25-85%

In This Report We Will:

- Summarize the specific welding challenges that keep manufacturers from experiencing increased productivity and profits.
- Outline the problems welding operations can encounter when attempting to increase deposition rates using existing processes.
- Identify results, advantages and applications that make Lincoln Electric's HyperFill a better process alternative for heavy component fabrication.

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The Challenge

Welding thicker materials using traditional single-wire processes tests the abilities of a manufacturer's welding workforce and budget. Because these applications call for larger welds, requiring more filler metal and multiple passes, controlling costs can be a substantial undertaking for operations already facing the following challenges:



Skilled Labor Shortages

Skilled Labor Shortages

The skilled-employee shortage is a major problem for many manufacturers. At one point, 40% of manufacturing companies declined new contracts because not enough skilled workers were available, according to the American Welding Society.¹

Achieving high deposition welding efficiently using single-wire processes requires highly skilled welders. When elevated wire-feed speeds are used, controlling the welding puddle can be difficult for the average welder. This is why many operations struggle to achieve higher levels of productivity.



High Labor and Material Cost

Labor and Material Cost

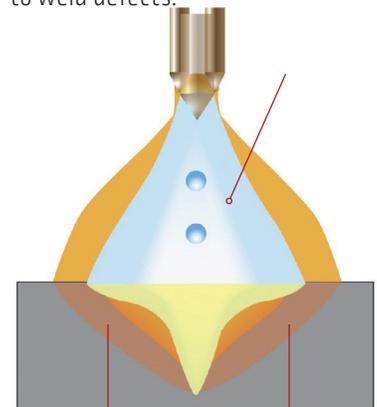
As the cost of welding labor and materials goes up, so does the need to conserve those resources. When done properly, high deposition welding can reduce unnecessary rework and allocate labor more efficiently, resulting in increased savings.

Sources of common welding production expenses include:

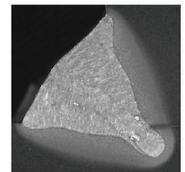
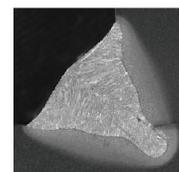
- Overwelding
- Reject, rework and scrap rates
- Post-weld grinding of spatter and excess weld metal
- Labor overtime
- Excessive arc time

Welding processes that increase deposition rates and productivity help lower the largest component of welding expenses – welding labor and overhead, which account for 60-70% of total welding costs.²

The deep, narrow arc cone of a single wire produces puddle instability at higher deposition rates and can lead to weld defects.



- | | |
|-------------------------------|-------------------------------|
| • .052in. (1.32mm) solid wire | • .052in. (1.32mm) solid wire |
| • 20lb/hr (9.1 kg/hr) | • 22lb/hr (10 kg/hr) |
| • 3/8in. (9.5mm) fillet | • 3/8in. (9.5mm) fillet |



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Production Inefficiencies

Production Inefficiencies

Achieving high deposition welds on thicker gauge materials efficiently is a complicated process. While it is possible to achieve high deposition using .045in. (1.2mm), .052in. (1.32mm) and 1/16in. (1.6mm) solid and metal-cored wires, many welders have trouble surpassing the 12 to 15lb/hr (5.4 to 6.8kg/hr) threshold.

After conducting a series of in-house tests, Lincoln Electric's research and development team found several challenges welders can encounter when utilizing either constant voltage (CV) or pulsed GMAW for high deposition welds. Mainly, welders can't just turn up the wire feed speed to get the deposition they want without affecting welding quality.

In addition to being difficult to manage for even highly skilled welders, the arc cone that results is very narrow and produces a deep, spiked shaped penetration profile that increases the risk of plasma-induced defects. The weld puddle collapses on the shielding gas and traps it deep inside the weld. These types of discontinuities, evident through non-destructive testing, can add major costs associated with non-productive rework.



New Technology Adoption Constraints

Adopting New Technology

Most manufacturers understand the importance of innovation. Execution, on the other hand, is where most struggle. According to a Boston Consulting Group survey, nearly 90% of manufacturing leaders regard adopting Industry 4.0 technologies (such as automation) as a way to improve productivity, but only about one in four said they could see opportunities to use these advances to build revenue streams. Respondents cited defining a strategy as the biggest challenge in adoption efforts, followed closely by rethinking their organization and processes.³

Having the right skills and talent to implement new technology is also a critical factor. Operations should closely consider the capabilities of their current workforce, the ease of adoption and whether additional training is needed for a more complete cost benefit analysis.

The Solution

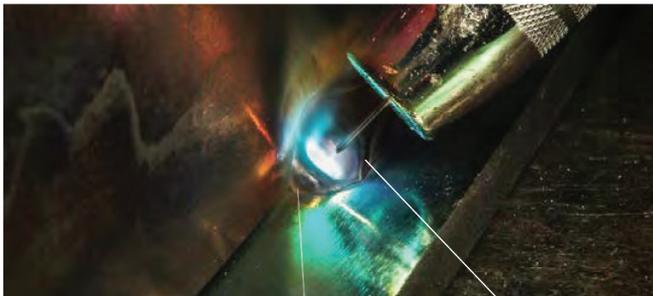
Recent technological advancements in twin-wire GMAW are making it easier for welders and robotic technicians to achieve more favorable results on thicker materials.

Lincoln Electric's patented HyperFill twin-wire process eliminates many of the limitations posed by traditional single-wire welding. Developed for both semi-automatic and robotic applications, HyperFill offers the ability to address manufacturers' pain points by increasing deposition rates while improving weld quality and arc stability with a low complexity solution.

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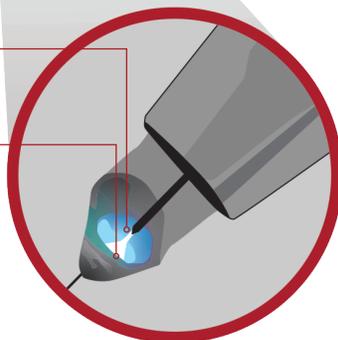
SingleWire

E70C-6M .052 IN (1.32 MM)



Generates a deep, narrow arc cone.

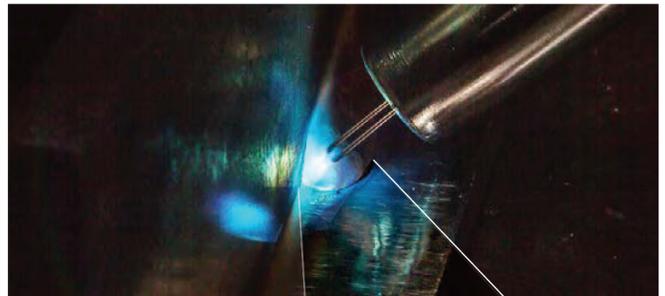
Arc stability deteriorates at higher wire feed speeds, making process more difficult to use.



vs.

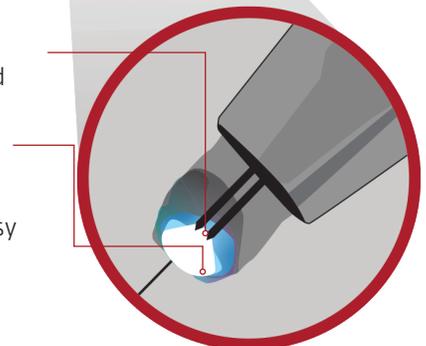
HyperFill

SuperArc® .040 IN (1.0 MM)

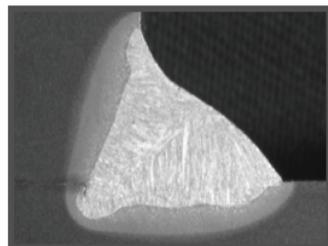


Generates a wide, evenly-distributed arc cone.

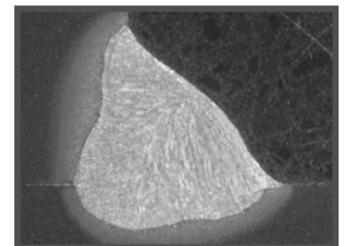
Smooth, stable puddle is more favorable and makes process easy to use at higher deposition rates.



Narrow arc cone leads to a narrow penetration profile, increasing risk of weld defects at higher deposition rates.



Wide arc cone leads to a favorable, robust penetration profile and helps to improve weld quality at high deposition rates.



Used by a Growing Number of Global Industries

- Heavy Fabrication
- Structural
- General Fabrication
- Maintenance and Repair
- Transportation
- Power Generation
- Shipbuilding
- Process Industries



Did You Know

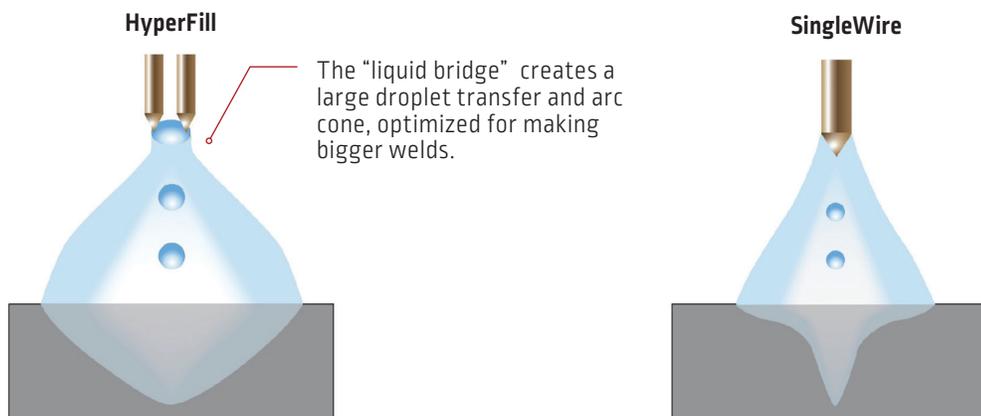
On average, Lincoln Electric's HyperFill Solution can increase usable deposition rates by **50%**

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How Twin-Wire Welding Works

Unlike tandem welding, which requires two separate equipment configurations, twin-wire welding utilizes two smaller-diameter wires with a single power source, feeder, gun liner and contact tip. The setup feeds two wires through a single torch and uses a special output waveform to produce a "liquid bridge" that creates a single, large weld droplet and arc cone optimized for making bigger welds.

The special output waveform increases arc stability and lowers spatter on large welds. This makes it more forgiving than other high deposition processes because the operator does not have the challenge of controlling a small focused arc with a large weld puddle.



Ideal Applications

Twin-wire welding is suitable for a wide variety of heavy fabrication manufacturing, and has potential to continue to expand and be adapted to other applications.

It is ideally suited for welding in flat and horizontal positions.

HyperFill Advantages

- Greater Comfort and Control
- Higher Usable Deposition Rates
- Lower Fume Generation
- Return on Investment

Greater Comfort and Control

Because HyperFill closely mirrors the single-wire GMAW process, welders do not have to change their behavior patterns or learn new techniques. The wire orientation does not affect arc characteristics, due to the creation of the single droplet arc cone. With HyperFill, the energy is more evenly spread over a wider area, which makes it easier to complete large welds. This makes it more comfortable and seamless for both semi-automatic welders and robotic technicians to pick up and implement into their processes.

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Higher Usable Deposition Rates

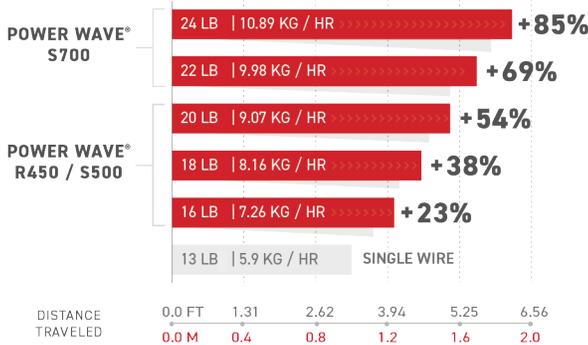
Most single-wire processes run optimally around 13lb/hour, but with HyperFill’s semi-automatic system, welders can achieve rates up to 20lb/hour. When automated with Lincoln Electric’s Fab-Pak® robotic welding cell, manufacturers can deposit metal at more than 24lb/hour for up to 85% increased productivity.

Productivity Increase

Single Wire vs. Hyperfill

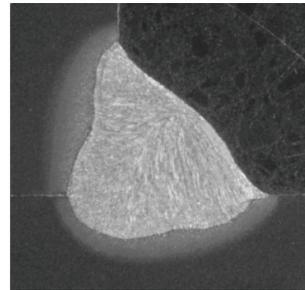
Baseline Parameters

- Single-wire at 13lb/hr (5.9 kg/hr)
- 5/16in. (8mm) 2F weld
- 3.28 ft (1m) weld distance
- 13in/min (33cm/min) travel speed
- 3 min weld time

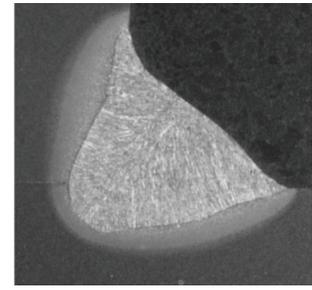


Larger Arc Cone And More Evenly Distributed Arc Energy Equates To More Robust Penetration Profiles

2F 5/16in. (8mm) Fillet 18lb/hr (8.2 kg/hr)



HyperFill 0.040in. (1.0mm)



HyperFill 0.045in. (1.2mm)

Superarc L-59 Hyperfill Test Results

	AWS A5.18 ER70S-6 Requirements	Certificate of Conformance July 2019*	HyperFill® Results**
Yield Strength @ 0.2% offset, MPa [ksi]	400 [58] min.	470 [68]	500 [73]
Ultimate Tensile Strength	490 [70] min.	580 [83]	610 [88]
Elongation, %	22 min.	24	25
Charpy V-Notch, J [ft-lb] @ -18°C [0°F]	27 [20] min. avg. 20 [15] min. single value	NA NA	NA NA
J [ft-lb] @ -29°C [-20°F]		47 [35]	106 [79]

* CVN's with 100% CO2 per AWS specification

** CVN's with 90/10 Ar/CO2

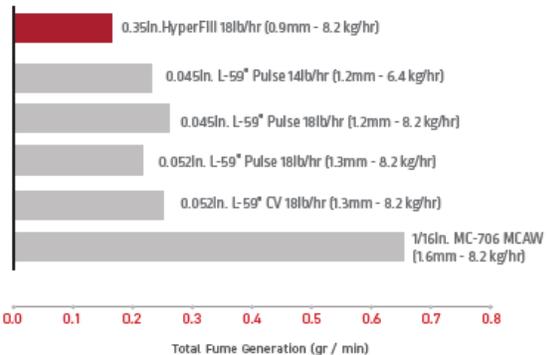
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Did You Know

Compared to processes used in similar applications, HyperFill produces less fume.

Reducing worker exposure to potentially hazardous compounds in welding fume starts with the arc. After rigorous in-house testing, HyperFill was found to give off significantly less welding fume than other processes.

Fume Generation Chart



Fume Generation Report

DATE: January 2020

PRODUCT: SuperArc® L-59

PROCESS: HyperFill®

Product	DIA.	WFS	TRIM	ESO	MODE	SHIELDING GAS
SuperArc L-59	.035in. [.9mm]	561in. [14.2m/min]	1	1in. [25mm]	601	90Ar/10CO2

Product	Melt-Off Rate	FGR	% PARTICULATE	ELEMENTAL FUME CHEMISTRY				
				Fe	Mn	Si	Cu	Ni
SuperArc L-59	18.2lb [8.3KG]	.11	.08	46.9	12.4	4.1	0.8	0.1

- Fume chemistries reported are +/- .2%
- Fume Generation rates reported are +/- .02 g/Min.

DISCLAIMER: 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 information or advice about their use of our products. Our employees respond to inquiries to the best of their ability based on information provided to them by the customers and the knowledge they may have concerning the application. Our employees are not in a position to verify the information provided or to evaluate the engineering requirements for a particular weldment. The selection and use of specific products sold by Lincoln Electric are solely within the control of, and remains the sole responsibility of the customer. These test results for elemental fume chemistry were obtained from welding fume produced and tested according to prescribed standards, and should not be assumed to necessarily represent the expected results in a particular application. Actual results will vary depending on many factors, including, but not limited to: the consumable product, the base material or substrate, the welding procedure, the specific welding process and process settings being utilized, and the workplace or environment where the welding is taking place. Users and employers have the sole responsibility for and control over workplace conditions, including the manner in which work is performed and the safety measures taken. Always read and follow applicable OSHA regulations as well as all information on product labeling and safety data sheets when using Lincoln Electric products. Safety Data Sheets (SDS) for Lincoln Electric products can be found at <http://www.lincolnelectric.com/en-us/support/msds/Pages/sds-search.aspx>. Users and employers should have an industrial hygienist check worker exposure levels to be certain that they are within applicable OSHA PEL and ACGIH TLV® limits for the particular application or weldment.

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Return on Investment

Greater speeds, higher-quality welds and reduced scrap contribute to a quick return on investment. Both the semi-automatic and robotic HyperFill processes can help eliminate the need for complex, costly tandem welding systems. In addition, the consistent quality and repeatability encourage high part throughput.

The ROI continues to pay dividends when you consider the ease of use factor, which helps welders of various skill levels to achieve a quality weld. Because of ease of use and high adoption rates by operators, no extensive retraining is required, which provides additional cost savings.

Conclusion

In a competitive environment, operations should closely consider any solution or process that can help them position their current workforce for improved productivity and labor savings. Along these lines, applications that demand large-sized welds represent the greatest potential for cost reduction.

Making the decision to adopt new equipment and practices can appear overwhelming at first glance. However, manufacturers should look for solutions that are aligned with the skill level of their workers to make the process as pain-free as possible.

Offering low system complexity and a seamless process for welders of all skill levels is where HyperFill excels. To learn how easily HyperFill can be integrated into your specific operation, you should consult with a process expert from Lincoln Electric. As a producer of the industry's most advanced waveform technologies, consumables and automated solutions, we not only bring extensive welding expertise, but in-depth knowledge in fabrication and general manufacturing applications to the table.

By working closely with you to understand your needs for increased productivity, we can recommend the right system (whether semiautomatic or robotic) for your specific application. From better welding process capabilities to improved robotic technologies, advanced welding solutions like HyperFill provide manufacturers with a way to confront production challenges by making bigger welds faster and easier than previously thought possible.



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Sources

1- "Teaching Welding Robots By Demonstration" Manufacturing News

<https://www.mfgnewsweb.com/archives/4/40337/Applying-Technology-jul14/Teaching-Welding-Robots-by-Demonstration.aspx>

2- "Estimating Total Welding Costs" Fabricating & Metalworking Magazine

<https://www.fabricatingandmetalworking.com/2012/04/estimating-total-welding-costs/>

3- "Manufacturers Too Slow to Adopt Industry 4.0: BCG Study" Industry Week

<https://www.industryweek.com/technology-and-iiot/article/22006106/us-manufacturers-too-slow-to-adopt-industry-40-bcg-study>

Solution Requirements

HyperFill® is a patented and licensed twin-wire MIG solution that is designed to perform specifically with select Lincoln Electric welding wire. To access this licensed solution, activation is required through the Lincoln Electric REVEAL™ Activation Platform. For more details, reference document MC20-106

Test Results

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.

About the Author

Troy Gurkin is the Director of Lincoln Electric's Heavy Fabrication Segment. He has more than 30 years of industry experience and is responsible for developing new products and solutions for customers involved in heavy fabrication manufacturing.



About Lincoln Electric

Lincoln Electric is the world leader in the design, development and manufacture of arc welding products, robotic arc welding systems, plasma and oxy-fuel cutting equipment and has a leading global position in the brazing and soldering alloys market. Headquartered in Cleveland, Ohio,

Lincoln has 60 manufacturing locations, including operations and joint ventures in 19 countries and a worldwide network of distributors and sales offices covering more than 160 countries. For more information about Lincoln Electric and its products and services, visit the Company's website at lincolnelectric.com.

HyperFill® Waveform Activation Capability with Power Wave® and PIPEFAB™ Systems

Your purchase of a Lincoln Power Wave or PIPEFAB Welding System comes with (i) a license to use Lincoln Electric standard Power Wave / PIPEFAB waveforms, and (ii) HyperFill waveform capability, which requires the purchase of premium Lincoln Electric wire or purchase of a separate license. Unless one of these is purchased, the HyperFill waveform will not be available for use on these machines, and only the standard Power Wave / PIPEFAB waveforms are usable.