Making our world more productive

ARCLINE® PP.

TIG quality at MIG productivity in aluminium welding.

ARCLINE® PP. Integrated welding solutions.

As one of the leading global suppliers of industrial gases, Linde has a long-standing commitment to the welding industry. Our global research and development team, based in Munich, continues to research, refine and develop integrated welding solutions that meet existing and future customer needs, while also pioneering game-changing innovations such as ARCLINE® PP that open up entirely new possibilities in the world of welding.

TIG quality at MIG productivity in aluminium welding.

When developing new welding processes and technologies, our aim is always to empower our customers by helping them to:

- Reduce operating costs
- Improve a customers productivity and remove their bottlenecks
- Improve weld integrity and reduce weld failure rates
- Enhance the working environment by reducing fume emissions
- Reduce reliance on increasingly scarce trained labour

Some of these welding challenges can be addressed by selecting the correct shielding gas. Linde delivers a range of gas mixtures that help our customers optimise and balance the interplay between welding speed, spatter control, porosity, weld penetration and ease of use.

For further information on our range of shielding gas mixtures, refer to www.linde-gas.com/arcline

Fine-tuning all elements of the welding process

Our intensive R&D efforts extend beyond shielding gas optimisation to focus on various welding parameters and tools that optimise welding outcomes. By fine-tuning the interactions between welding parameters and equipment, we create integrated solutions that make a real difference to our customers.

Our local application engineers have in-depth expertise in all welding gas processes and are always happy to advise on the best solution to suit your individual process and manufacturing needs.

Addressing welding challenges.

Aluminium welding challenges

Aluminium and its alloys are becoming more important across a wide range of industries and applications. But it remains a difficult material to work with.

Aluminium welding challenges include:

- Slow welding speeds which, in turn, negatively impact productivity and tensile strength of the component
- Significant time required for pre-cleaning the surface prior to welding, and removal of soot deposits post-welding
- Risk of hydrogen diffusing into the weld pool
- Risk of tungsten and aluminium oxide inclusions
- Difficulty controlling distortion
- Difficulty controlling heat losses due to clamping of workpieces
- Shortage of skilled TIG welders

The MIG welding process is quickly and easily mastered but creates issues with strength and weld integrity and thus results in many rejects. Meanwhile, TIG welding reliably creates quality welds but requires a high level of skill and experience.

Innovating aluminium welding so you don't have to compromise

Traditionally, aluminium fabricators have to choose between speed or quality when selecting either TIG or MIG welding.

Here at Linde, we believe that you shouldn't have to compromise on either. Therefore we developed ARCLINE® PP welding.

This ground-breaking plus pole welding solution gives you the high welding speeds you typically associate with MIG welding in perfect symbiosis with the high quality you expect from TIG.

ARCLINE PP challenges all previous assumption you made about aluminium welding, opening up a world of new possibilities.

ARCLINE PP torch and hose.

ARCLINE PP. Technology & innovation.

ARCLINE PP has been designed to sidestep the traditional issues that aluminium welders face, finally resolving the dilemma of speed versus quality and giving you a new benchmark in across-the-board productivity.

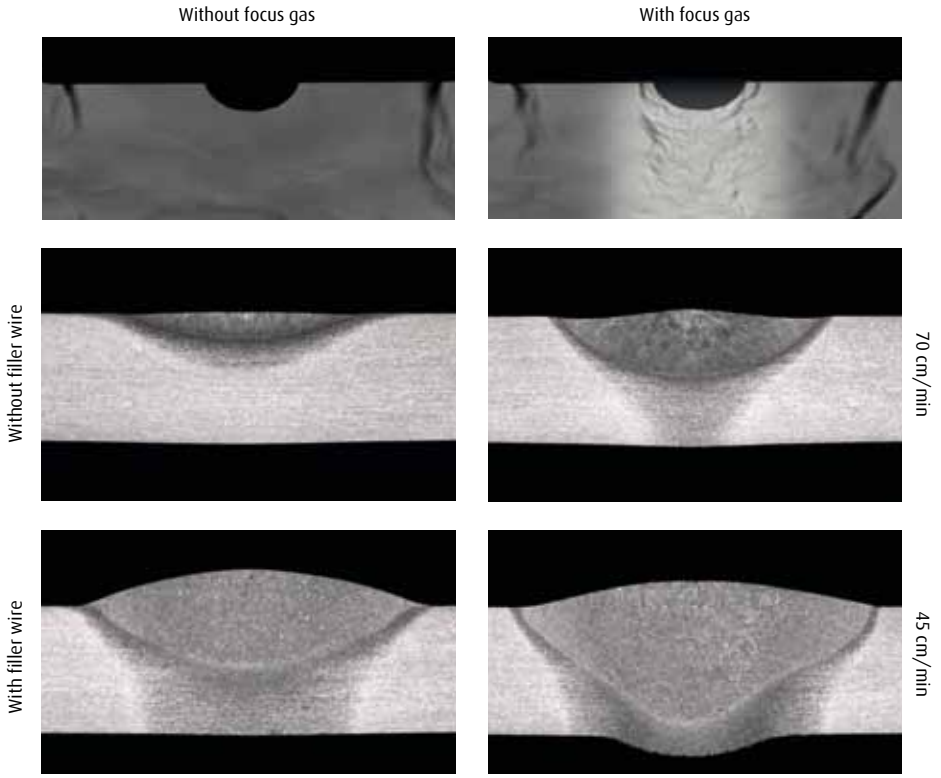
Game-changer in TIG welding of aluminium

The groundbreaking performance of the ARCLINE PP aluminium welding system relies on three unique characteristics:

1. ARCLINE PP features a positively energised tungsten electrode that provides constant cathodic cleaning of the welding area. This cuts down the risk of inclusions and minimises the need for pre-weld cleaning.
2. ARCLINE PP uses two separate gas streams. The outer shroud of shielding gas protects the weld from atmospheric impurities, improving its quality. The inner stream of focus gas concentrates the arc, increasing its power density, improving arc stability and ensuring safe single-pass welding of workpieces that are up to 10mm thick.
3. ARCLINE PP is equipped with a highly sophisticated liquid cooling system that supports the tungsten electrode. This greatly extends the consumable lifecycle while giving you the ability to weld with peak currents of up to 450A.

The result: singular quality with minimal weld preparation, post-processing and rejects, paired with extraordinary speed and a significant reduction in fume emissions when compared to MIG aluminium welding.

Performance boost with additional focus gas



Material	EN AW 5083
Plate thickness	6mm
Current	275A
Arc length	5mm
Shield gas	Argon -20 l/min
Focus gas	VARIGON® S -10 l/min
Wire feed speed	7m/min
Filler wire diameter	1.2mm

Illustrating the benefits of an additional, inner gas shroud. The images on the left use a shielding gas only, in contrast to the images on the right, which demonstrate the benefits of using a focus gas, resulting in deeper weld penetration.

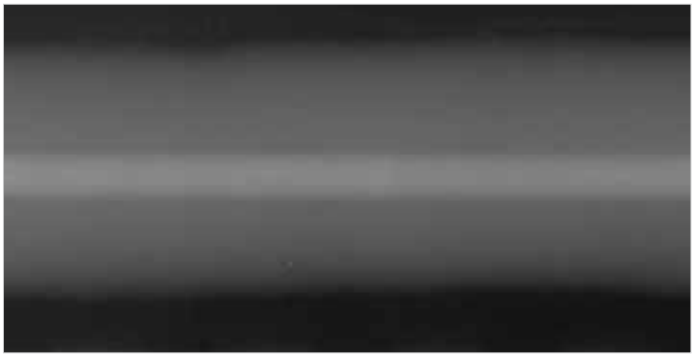
Performance comparisons between MIG, TIG-AC and ARCLINE PP

	MIG	TIG-AC	ARCLINE PP
Productivity	+	–	++
Automation	+	–	+
Filler wire consumption	–	+	+
Weld preparation	–	+	++
Weld integrity (High risks of pores, cracks, undercuts, etc.)	–	+	++
Penetration	+	–	+
Weld surface	–	+	++
Particle emissions	–	+	+
Noise emissions	+	–	+
Post-weld clean	–	+	++
Risk of inclusions	–	–	++

Compelling benefits

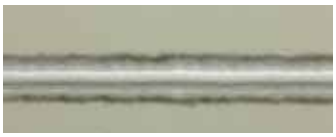
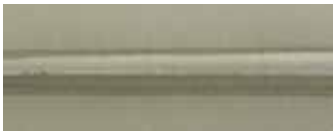
Thanks to these unique features, ARCLINE PP provides productivity gains without compromising on weld integrity. Additional benefits include:

- → Reduced weld preparation
- → Reduced post-weld work
- → Reduced reject rates
- → Higher welding speeds
- → Penetration of workpieces with up to 10mm thicknesses in a single welding pass



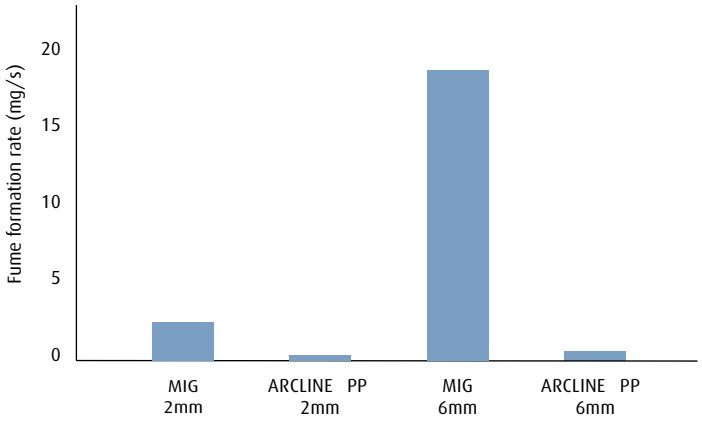
X-Ray of ARCLINE PP I-Butt weld in PA position with root backing, t = 8mm

Cleaner welds

		MIG	TIG-AC	ARCLINE® PP
	Welding speed	40 cm/min	25 cm/min	200 cm/min
2mm	Top			
2mm	Root			
	Welding speed	29 cm/min	18 cm/min	38 cm/min
6mm	Top			
6mm	Root			

MIG, TIG-AC and ARCLINE PP comparison of weld surfaces and roots (2 mm and 6 mm material thicknesses). With ARCLINE® PP, the cleaner weld surface reduces post-weld costs, while safe penetration is achieved at significantly higher speeds.

High performance with low emissions



Reduce your fume emissions

ARCLINE PP can also make a valuable contribution to occupational safety. As the graph above illustrates, it enables a dramatic drop in fume emissions compared with MIG welding. With higher productivity, ARCLINE PP generates significantly less fume emissions than MIG per meter welded.

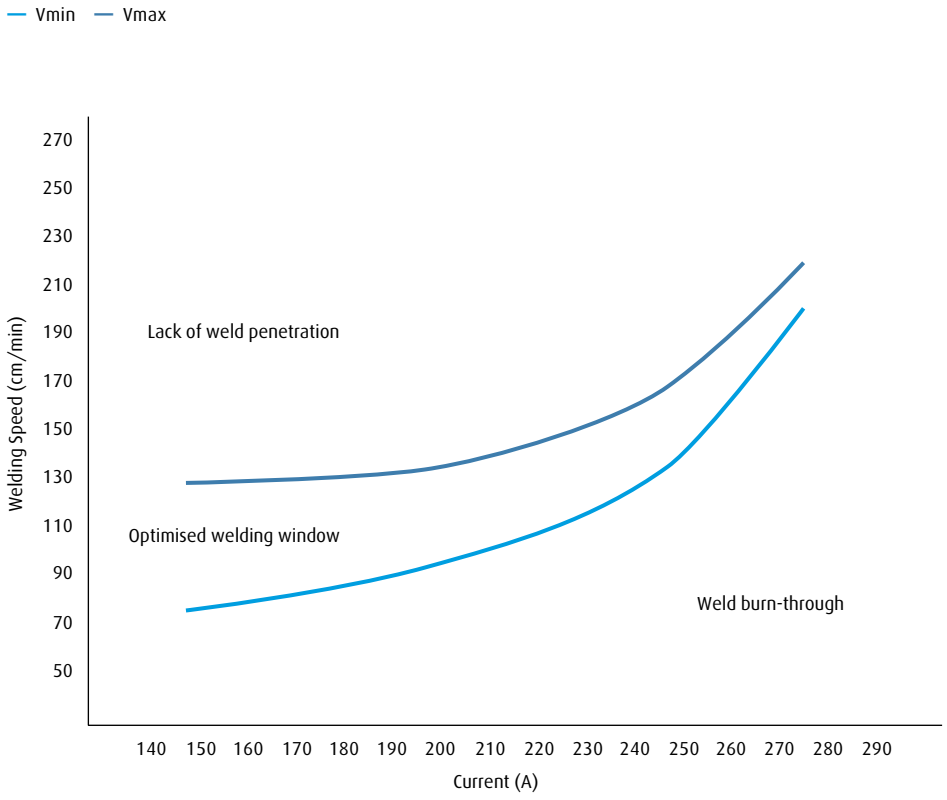
Stable and high performance

The ARCLINE PP welding process performs at previously unattainable levels, while offering exceptional ease of us.

Welding parameters for safe and high-performance welding can be set across a wide range of current and welding speed combinations (see graph below).

To help operators select the optimum welding parameters, Linde offers an ARCLINE PP weld parameter dial for I-butt and fillet welds.

Large safe operation envelope/window



Material	EN AW 5083
Plate thickness	2mm
Weld type	Longitudinal I-butt weld

ARCLINE PP offers a broad operational window for successful welding across a wide range of welding parameters.

Productivity. Experienced like never before.

ARCLINE PP can provide substantial savings to manufacturers required to weld aluminium components. The total cost of welding components depends on a few key variables:

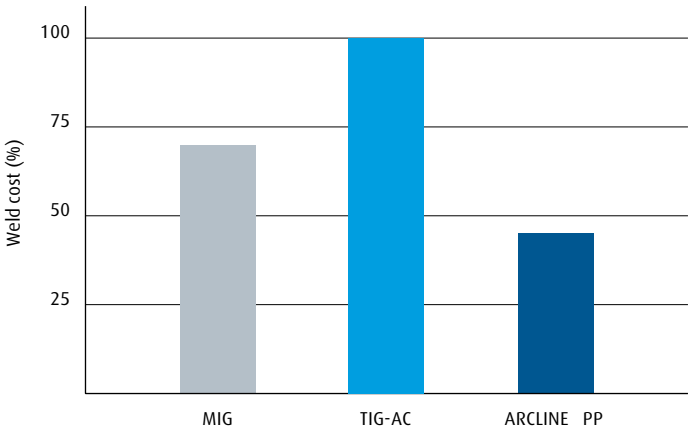
- Labour, equipment, industrial gases and consumables as well as
- Component failure rates, specifically for high-value industrial parts, which can include additional raw material and labour costs, particularly if a new component has to be fabricated.

Regardless of how component manufacturing costs are measured, ARCLINE PP is guaranteed to benefit your bottom line.

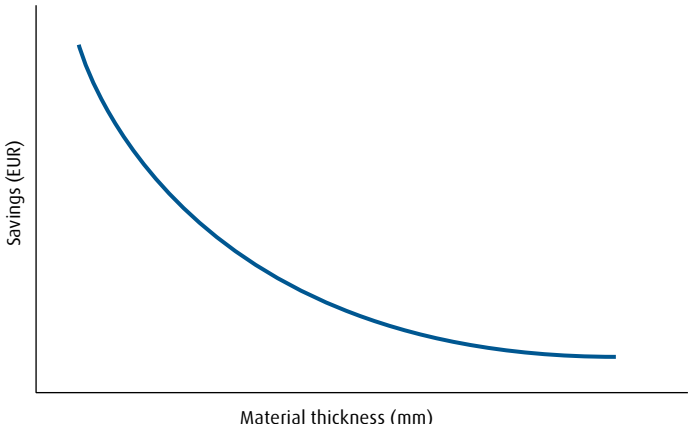
- **Operating expenses:** While you may experience a marginal rise in the cost for industrial gases and welding equipment, this is offset by savings in filler wire and a marked reduction in your labour costs.
- **Failure rates:** Improved weld integrity with fewer weld inclusions, particularly if you are now MIG welding, will minimise failure rates both on and off site, reducing the need for remedial welding or component replacement.

ARCLINE PP demonstrates significant cost savings across a range of aluminium thicknesses and weld types versus TIG-AC and MIG welding.

Costs savings between TIG-AC, MIG and ARCLINE PP*



Aluminum material thickness = 6mm



* Costs include labour, industrial gases and consumables. Savings are indicative and will vary depending on the individual customer application.

Process visualisation

ARCLINE PP burner

ARCLINE PP. Extended process flow in focus.

ARCLINE PP is more than just a revolutionary TIG welding torch. It's a convenient end-to-end solution that consists of an entire range of components designed to help you optimise your aluminium welding procedures.

Simple and robust process

ARCLINE PP is a simple and robust process that empowers operators to maximise productivity and minimise downtime. The ARCLINE® PP torch consists only of four pieces:

- Torch body
- Electrode
- Focus gas nozzle
- Shielding gas nozzle

Because the electrode is screwed onto the torch body, the tool centre point (TCP) always remains consistent after the electrode has been changed.

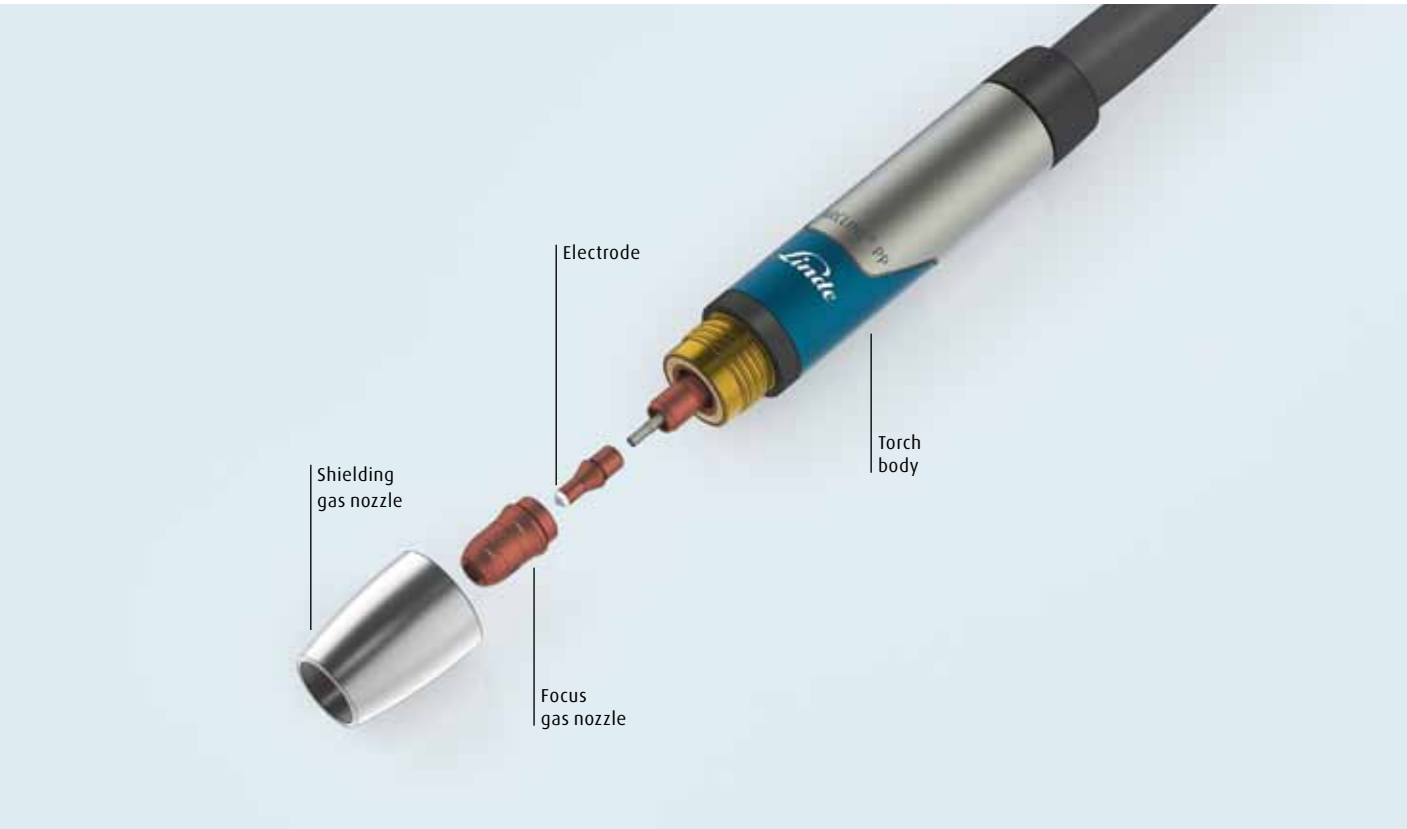
Selection of the correct focus and shielding gases is critical to ensure that ARCLINE PP maintains its unrivalled speed and accuracy.

Focus gas

The focus gas concentrates the arc, increasing its power density and improving arc stability. Our focus gases combine the inert gas argon with an active component to improve weld penetration and seam appearance.

- VARIGON® S (ISO 14175 - Z – ArO – 0.03)
- MISON® Ar (ISO 14175 - Z – ArNO – 0.03)

In both cases, inert argon is doped with small quantities of active components (300ppm O_2 or 275ppm NO). The same results cannot be achieved without these additions.



Shielding gas

Argon is used as the shielding gas, forming the outer shroud protecting the weld from the risk of oxidisation and unwanted soot deposits, while allowing for smooth bead formation and deep weld penetration.

Complying with ISO standards

Because they contain active components in low concentrations, the focus gases are classified as Z group gases according to ISO 14175. To dispel any concerns about the possible negative influence of these shielding gases on the performance of the finalised weld, Germany's safety inspectorate TÜV Süd conducted a thorough test of VARIGON® S. The resulting report confirms that it offers the same performance as argon when used as a shielding gas in gas-shielded arc welding of aluminium.

The process number according to ISO 4063 for the ARCLINE PP welding process is 141 (TIG welding using an inert gas and solid filler material).

Linde can offer all the components needed including:

Water cooler
For optimal welding performance, ARCLINE PP requires the welding torch to be efficiently cooled. This is mandatory. We recommend a cooling capacity of 1kW per 100A of welding current.

Power source
A dedicated ARCLINE PP power source is available. It is possible to use existing power sources already in use for TIG-AC welding.

Wire feeder
Linde only recommends high-quality wire feeding units that allow safe feeding of aluminium filler wire across several meters.

Connector box
The connector box is a device that allows the ARCLINE PP torch to be connected to different types of welding machines. It also translates the gas flow signal from the power source into two separate gas flows.

If the distance from the power source to the welding torch is in excess of 8m, we recommend using the connector box, which must be placed close to the welding torch (<1.5m) to ensure accurate gas flows.

Automation
For maximum performance, we recommend integrating an automatic height control mechanism for constant arc length and a crash box into the ARCLINE PP setup.

A spare parts package for the torch is available with:

- Electrodes
- Shielding gas nozzles
- Focus gas nozzles

Each ARCLINE PP installation is customised to individual aluminium welding requirements to ensure optimal speeds are achieved at impeccable weld quality.

ARCLINE PP summary

- Automated mechanised welding
- Outstanding weld integrity
- Unprecedented increase in welding power compared with standard TIG-AC
- Single-pass penetration welding on workpieces with up to 10mm material thicknesses
- Reduced weld preparation and post-weld cleaning
- TIG quality at MIG productivity

Experience Perfection.

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