

Your Guide to Shielding Gases

Revised 2023 edition



Introduction

What are Shielding Gases?

Molten metal is highly reactive to contamination through contact with excessive amounts of atmospheric gases. This can cause serious weld defects, hence the need for a gas to 'shield' the weld pool from the atmosphere. Almost all welds produced today use some form of shielding gas.

However, the right choice of shielding gas can also give you so much more: improving deposition rates, fusion, penetration, corrosion resistance and cosmetic profile – in other words all the key elements of a successful weld.

Read on to discover the difference shielding gases could make to your welding business.



Your Guide to Shielding Gases

The Purpose of this Guide

- To explain why certain gas mixes are suited to particular jobs
- To demonstrate the performance benefits of advanced shielding gases
- To understand the business case for trying them.

Who's it for?

This guide is for all welding companies but particularly those who regularly:

- Use pure argon to TIG weld all kinds of metals
- Use pure argon to MIG weld aluminium
- Use an argon/CO₂ or argon/O₂ mix to MAG weld stainless steel.

Key takeaways

- *Argon is still an effective versatile gas but other mixes will give you better results for many jobs*
- *Precision-mixes in shielding gases have now optimised weld performances*
- *Improvements come in every area: weld quality, speed and reduced pre and post weld treatments*
- *Increases in productivity and efficiencies overshadow any per unit increase in gas price*



Looking Beyond Argon

Is the performance of a 'jobbing all-rounder' good enough any more?

Argon has been the willing workhorse of shielding gases when TIG welding for decades. For many, its versatility has made it a good all-round jobbing gas. If your welders just use argon, they probably feel comfortable with it, and it does bring results. But with margins getting tighter while customers demand ever-higher standards, is the performance of a 'jobbing all-rounder' good enough any more?

It wouldn't make sense to change your shielding gas for just a slight improvement, but hard data demonstrates that the benefits of correct shielding gas selection are no longer marginal. Each gas has distinct characteristics that make it best suited for certain welds and materials. So you can choose a specific gases mix to give you precisely the results you need and optimum benefits.

How does this help your bottom line? Because by far your highest cost is your skilled workforce, and when they use a dedicated shielding gas their productivity can increase dramatically. If you want to increase your welding throughput, it's a lot more cost effective to buy different gas than employ extra skilled welders, and the weld quality is often better as well.

There is still a place for argon when TIG welding but not for everything. Now the key to boosting your productivity and profitability is taking the time to find and use the appropriate shielding gas instead. (This is also worth considering if you traditionally use a standard argon/CO₂ or argon/O₂ mix for MAG welding stainless steel.) If you make that change, and nothing else, it can produce a big enough difference to be worth your while. Yes, it's a silver bullet.

Shielding Gases. What's What?

There are a number of gases that can be used either on their own or in a mixture to shield the weld pool. Each has its own characteristics and benefits.



Argon

- Inert
- Easy arc ignition
- Used on its own or base for almost all gas mixtures.

Carbon Dioxide

- CO₂ addition increases heat transfer and improves penetration profile
- Additions over 20% can increase spatter and create arc instability
- Ar/CO₂ mix produces better welds for stainless steel than Ar/O₂
- Higher levels of CO₂ help when welding dirty, rusty or primed steel.

Oxygen

- Can't be used on its own as a shielding gas
- Added to argon to stabilise the arc
- Reduces surface tension
- Ar/O₂ (2%) mix is ideal for welds on thin carbon steel where appearance is a priority, such as office furniture, etc.

Nitrogen

- Rarely used on its own for shielding
- Can be suitable for root shielding applications
- Mainly used as addition to Duplex shielding gases and the main component of Forming Gas mixtures (90% to 95%).

Helium

- Rarely used on its own for TIG welding due to problems with HF arc initiation
- High thermal conductivity
- Broadens the weld pool and improves the penetration profile
- Will improve virtually all aspects of the deposited weld (penetration, deposition rates, surface profile, reduced gas pore formation, etc) when added to argon or Ar/CO₂ mixes.

Hydrogen

- Can't be used on its own as a shielding gas
- High thermal conductivity
- Constricts or narrows the arc giving a much more concentrated 'hot spot'
- Produces better 'bead width to penetration depth ratio', higher deposition rates and reduced distortion and surface oxide formation
- Not suitable for welding aluminium or carbon/ferritic steels.

Doped gases

- Relatively new
- Gains benefits from adding trace elements to gas mixtures (e.g. 500 ppm of O₂ in gases used to weld aluminium).

The Right Gas Mix For Your Job

BOC offers a wide range of advanced shielding gas mixes tailored to provide optimum performance for specific jobs. Here are some of our most popular.



MAG welding on thin section stainless steel
STAINSHIELD® Light
 (argon +85% helium +1.5% CO₂)



MIG and TIG welding of thinner section aluminium and copper
ALUSHIELD® Light
 (argon +30% helium)



TIG welding of thin section austenitic stainless steel (up to 3 mm)
STAINSHIELD TIG
 (argon +1.5% hydrogen)



MAG welding on heavy section stainless steel
STAINSHIELD Heavy
 (argon +55% helium +2% CO₂)



MIG and TIG welding across a range of thickness in aluminium and copper. TIG welding of carbon and ferritic/martensitic stainless steel
ALUSHIELD Universal
 (argon +50% helium)



TIG welding of heavier section austenitic stainless steel (above 3 mm) and automatic applications
SPECSHIELD® 5% hydrogen
 (argon +5% hydrogen)



MAG welding across a range of thickness in stainless steel
STAINSHIELD Universal
 (argon +38% helium +2% CO₂)
 Excellent for pulsed welding.



MIG and TIG welding of heavy section (above 6mm) aluminium and copper
ALUSHIELD Heavy
 (argon +75% helium)

BOC also stock many other variants of shielding gas to provide the bespoke solution for your welding task.

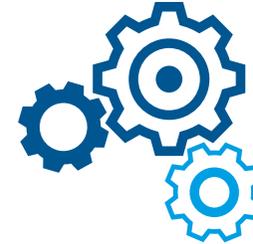
Advanced Shielding Gases. The Benefits

As we've highlighted in this guide already, most welders use a shielding gas merely to protect their weld from the damaging effects of excess oxygen and nitrogen from the atmosphere. But with the right mix of shielding gases other important benefits can be achieved.



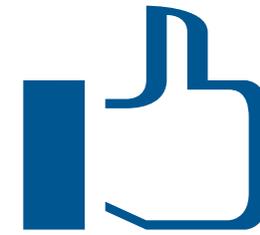
Advanced
Materials

+



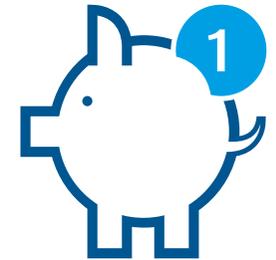
Improved
Efficiency

+



Improved
Weld Quality

=



Reduced
Cost

These benefits can be **metallurgical** such as improved resistance to corrosion, **mechanical** such as improved penetration and reduced porosity and **financial** due to improved productivity and reduced weld cost.

Rising Productivity

- **Faster welding** – using the correct mix of gas can give you better deposition rates. Adding the right amount of hydrogen to argon for TIG welding austenitic stainless steel produces a more fluid weld pool and improved welding speeds. Equally, adding helium to argon achieves faster welding and also may reduce or eliminate the need to preheat components before welding can begin.
- **Less time spent tidying-up spatter** – removing spatter after welding is costly and can leave surface imperfections which can have an adverse effect on surface coatings, painting etc. Prevention is the best cure and using the right shielding gases can make a real difference to spatter generation from the weld pool, for example

when MAG welding carbon steel. A cleaner finish is particularly important when the cosmetic appearance of the weld is a priority. Remember, spatter is wasted welding wire so reducing or eliminating it also helps reduce consumable costs.

Improved weld quality

The correct choice and use of shielding gas will influence virtually all aspects of the weld such as penetration profile, weld bead shape and size, corrosion resistance, pore formation and overall weld integrity.

- **Increased heat and fluidity of the weld pool** – the most fundamental benefit. Good quality welding starts with a good quality weld pool and using the right shielding gas can improve the transfer of energy from the arc to the weld. Higher quality welds will reduce defects and re-works.

The Cost-benefit Calculation

We regularly visit welding companies to run trials. This helps us to identify the best shielding mix and to demonstrate the benefits it can bring in raised productivity and efficiencies. See the following results from real trials.



Company A

.....
 22% increase in welding speed

Using argon shielding gas on straight line welders, manufacturing duplex domestic heating boilers.

Trial
 A replacement argon/nitrogen mix.

Trial result
 Improved product quality and around 22% increase in welding speed with a reduction in post weld cleaning operations.



Company B

.....
 45% increase in welding
 30% reduction in purging

Orbitally TIG welding austenitic steel pipe, using argon as both shielding and back purging gas.

Trial
 A replacement argon/hydrogen mix.

Trial result
 Greatly improved weld quality, with need for post weld cleaning almost eliminated, a 45% increase in welding speed plus a 30% reduction in purging gas consumption.



Company C

.....
 Overall, a reduction in production costs of over 50%.

Depositing TIG welds on 240mm long lap joints in 3.00mm thick 4043 aluminium, using argon as shielding gas.

Trial
 A replacement argon/helium mix.

Trial result
 Welding speed faster with improved, flatter weld profile. Overall, a reduction in production costs of over 50%.



Company D

.....
 A 76% reduction in welding time and a 73% reduction in total production cost.

TIG welding stainless steel components.

Trial
 A replacement argon/hydrogen mix.

Trial result
 A 76% reduction in welding time and a 73% reduction in total production cost. Any per unit increase in gas price was completely over-shadowed by the significant reduction in gas used for each component weld.

*Company names have been kept anonymous for data protection

How BOC Can Help Choose Your Optimum Shielding Gas

BOC has been producing industrial gases for over 140 years. The use of individual or mixed gases to optimise welding dates back to the 1940's and 50's. Since then gas shielded welding processes have grown to be the norm.

We continue to research and develop gas mixes to provide optimum performance for different welding tasks and materials. We are committed to sharing this knowledge with the welding sector to improve productivity and weld quality and deliver business benefits to our customers.

Central to this is our team of technical engineers who tour the country running shop-floor trials at individual welding companies. They will advise not only on gas mixes (and will trial different ones until they find the best solution for you) but also welding equipment, settings and all other operational processes.

That includes pre weld preparation and post weld cleaning which can consume a great deal of valuable skilled worker time. Often both can be reduced or avoided completely by choosing a different shielding gas. For example, switching from argon to an argon/helium mix can eliminate time spent on removing the oxide layer that forms on the surface of aluminium.

We can also guide you on the safe use of your shielding gases. We deliver bespoke safety training courses at customer sites. We'll also regularly check your gas-supply system to ensure it's working safely and, if required, maintain or repair it. We can also undertake professional analysis of gas in the lab or on site to ensure high and consistent quality in your processes.

As we have seen, refining your use of shielding gas alone can bring immediate and significant benefits to your bottom line.

Call it a silver bullet or just plain business common sense, can you afford any longer to ignore how it might help you?