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shielding gases and applications

introduction

Quality improvement and rationalisation are crucial for any company wishing to become more competitive in the welding industry. Coregas shielding gases offer a variety of options for achieving these goals.

As one of Australia's leading manufacturers of industrial gases, Coregas has decades of experience in the development, manufacture and the application of shielding gases for welding.

Coregas technology ranges over all modern welding applications and is continuously updated by innovative solutions.

The Coregas Technology Centre, using the most advanced welding equipment, solves customer problems on a case-by-case basis. Application engineers provide on-site assistance to customers in making optimal use of Coregas shielding gases.

Our shielding gases fall into two categories:

Shield*pro* gas mixtures predominantly have additions of helium, hydrogen or nitrogen, thus giving the shielding gas the ability to achieve higher performance in the areas of welding speed, penetration, profile, surface appearance, metallurgical benefits etc. giving advantages to the two major areas of concern in a welding process – quality and economics.

Core*gas* comprises argon, carbon dioxide, oxygen and mixtures thereof. They offer you an extensive range from which to choose a gas for a clean, quality and economical weld.

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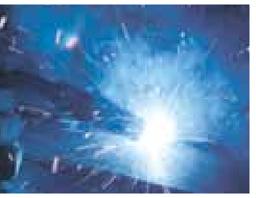
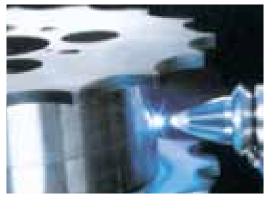
Process	Shielding gases		Materials
GMAW with Active Gas	Gas mixtures: Coregas® 16/3 Coregas® 5/2 Coregas® 18 CO_2	 Coregas® 10 Coregas® 07 Coregas® He30	Steels for pipe, boilers, shipbuilding, structural and fine-grain structural, case hardening and heat-treatable steels.
	Shieldpro® 21 Shieldpro® 20 Shieldpro® 33 Shieldpro® 32	Shieldpro® 20 Shieldpro® 31	CrNi, Cr and other alloy steels; Ni based alloys, duplex, super duplex.
FCAW Flux Cored Arc Welding	Coregas® 25 Coregas® 18 CO_2		Nickel and nickel alloys. Medium and high carbon steel. Low CrNi, Cr and other alloy steels.
GMAW with Inert Gas	ARGON Shieldpro® 25 Shieldpro® He75	 Shieldpro® 32	Aluminium, copper, nickel and other alloys.
GTAW with Inert Gas	ARGON HELIUM Shieldpro® 25 Shieldpro® He75	 Shieldpro® 32	All weldable metals such as unalloyed and alloy steels, aluminium, copper, nickel and other alloys;
	ARGON 5.0 (99.999%) (special applications) Shieldpro® 22		CrNi steels. Gas-sensitive materials such as titanium, tantalum and zirconium.
	Shieldpro® 23		CrNi steels ⟷ nickel and nickel-based alloys.
PAW Plasma Arc Welding	Central supply gas: ARGON External gas: ARGON Shieldpro® 22		Austenitics duplex and super duplex. All weldable metals; see GTAW.
Laser Beam Welding	ARGON HELIUM	Shieldpro® He50 Laspur®	All weldable metals; see GTAW.
Root protection	Forming gas: Shieldpurge N_2 100% 95% 90% 80%	 H_2 Ar 0% 100% 5% 10% 20%	For all materials when oxidation at the root must be avoided. Burn off hydrogen at levels over 10%.





Gas selection chart process/application

Shielding gas	Carbon Steel	Stainless Steel	GMAW	GTAW/ Plasma	Purging	Shieldpro Coregas	Classification AS 4882 2003	Classification EN 439 code
Argon (Ar)			•	•	•	✦	SG–A	I1
Helium (He)				•		S	SG–He	I2
Carbon Dioxide (CO_2)	•					C	SG–C	C1
Coregas® 5/2	•	•*				C	SG–ACO–5/2	M23
Coregas® 16/3	•					C	SG–ACO–16/2	M24
Coregas® 10	•					C	SG–AC–10	M21
Coregas® 18	•					C	SG–AC–18	M21
Coregas® 25	•					C	SG–AC–25	M21
Coregas® 07	•					C	SG–AO–7	M22
Coregas® He 30	•					S	SG–AHeC–30/10	M21(1)
Shieldpro® 21		•				C	SG–AO–1	M13
Shieldpro® 20		•				C	SG–AC–2	M12
Shieldpro® 20		•				S	SG–AHeC–20/2.5	M12(1)
Shieldpro® 31		•				S	SG–AHeC–35/5	M12(2)
Shieldpro® 33		•				S	SG–AHeO–35/1	M13(2)
Shieldpro® 32		•				S	SG–AHeC–50/2	M12(2)
Shieldpro® 23				•		S	SG–AN–2	SI1 + $2N_2$
Shieldpro® 25			•	•		S	SG–AHe–25	I3
Shieldpro® 32			•	•		S	SG–AHe–50	I3
Shieldpro® He 75			•	•		S	SG–HeA–25	I3
Shieldpro® 22				•	•	S	SG–AH–5	R1
Shieldpro® 26				•	•		SG–AH–10	R1
Nitrogen (N_2)					•		SG–N	F1
Shieldpurge 95/5					•			
Shieldpurge 90/10					•			

* Recommended only for non critical applications ✦ Depending on purity level

shielding gases selection chart

As one of Australia's leading manufacturers of industrial gases, Coregas has decades of experience in the development, manufacture and the application of shielding gases for welding.

In a bid to maintain a competitive advantage over competitors, Coregas has focused it's efforts on offering it's customers product solutions ensuring quality improvements and rationalisation.

As a result of this, we are able to offer a variety of shielding gases to specifically meet our customer's requirements. We offer tailored solutions that create added value, competitive advantages and greater profitability regardless of your industry or company size.

Our shielding gases fall into two categories:

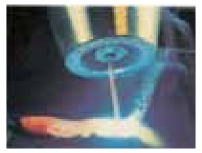
Shieldpro gas mixtures predominantly have additions of helium, hydrogen or nitrogen thus giving the shielding gas the ability to achieve higher performance in the areas of welding speed, penetration, profile, surface appearance, metallurgical benefits etc. giving advantages to the two major areas of concern in a welding process – quality and economics.

Coregas comprises argon, carbon dioxide, oxygen and mixtures thereof. They offer you and extensive range from which to choose a gas for a clean, quality and economical weld.

The Shielding Gas Selection Chart below offers a basic overview of the welding process, materials and the suitable shielding gases for each application.

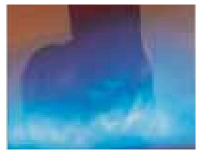
Material	Shielding gas	Composition	Process	Features and benefits
Carbon steel	Coregas 5/2	Ar-CO_2-O_2	GMAW	Up to 8mm. Dip transfer, minimal spatter, good control when positional welding.
	Coregas 07	Ar-O_2	GMAW	Up to 6mm. Minimal spatter, good weld profile, reduced penetration. Smooth running. Not good for out of position. Good for galvanised.
	Coregas 10	Ar-CO_2	GMAW	All thicknesses. Good arc transfer, smooth appearance, little spatter. Good for robotic welding.
	Coregas 16/3	Ar-CO_2-O_2	GMAW	12mm and above. Dip and spray transfer, good penetration profile and smooth running.
	Coregas 18	Ar-CO_2	GMAW–FCAW	Heavy section material. Spray transfer. Also FCAW carbon and stainless steel. Improved working environment and easy to set the working point
	Coregas 25	Ar-CO_2	GMAW–FCAW	Heavy section material. Mainly intended for short arc welding with less risk of porosity when plates are dirty, oily or having mill scale. Also spray transfer, FCAW carbon and stainless steel.
	Coregas He 30	Ar-HE-CO_2	GMAW	High deposition rates. Good weld profile and penetration. Mainly for automation and good for heavier sections of galvanised material.
	Carbon Dioxide	CO_2	GMAW–FCAW	Up to 10mm. Dip transfer only. Increased spatter levels. Also for some FCAW applications.
	Argon	Ar	GTAW	All thicknesses.
Stainless steel	Shieldpro 20	Ar-CO_2	GMAW	All thicknesses. Dip and spray transfer, minimal oxidation. Excellent for pulsed MAG. Good penetration and flat weld bead. Improved working environment.
	Shieldpro 21	Ar-O_2	GMAW	Up to 3mm. Dip transfer. Reduced penetration and smooth running.
	Shieldpro 22	Ar-H_2	GTAW	Hydrogen addition gives higher welding speed due to hotter and more constricted arc. 2mm and above. Austenitic stainless steels only. Increased deposition rates. Reduced oxides. Improved weld profile.
	Shieldpro 23	Ar-N_2	GTAW	The Nitrogen addition reduces Nitrogen loss from the weld metal resulting in better corrosion properties compared to welding with pure Argon. Mainly for orbital GTAW. Increased pitting corrosion resistance.
	Shieldpro 30	Ar-HE-CO_2	GMAW	All-round gas for stainless steels and duplex. 3mm and above. Good deposition rates and weld profile. Increased penetration and fluidity of the weld pool. Higher welding speed compared to gases without Helium.
	Shieldpro 31	Ar-HE-CO_2	GMAW	All thicknesses. Good deposition rates, weld profile and smooth surface appearance.
	Shieldpro 32	Ar-HE-CO_2	GMAW	Over 6mm. Good deposition rates and weld profile.
	Shieldpro 33	Ar-HE-O_2	GMAW	Over 3mm stainless steel and Duplex. Good deposition rates and weld profile. Reduced spatter. good edge wetting.
	Argon	Ar	GTAW	All thicknesses. Most commonly used.
Non-ferrous	Shieldpro He 25	Ar-HE	GMAW–GTAW	Over 3mm. Good deposition rates and weld profile.
	Shieldpro 32	Ar-HE	GMAW–GTAW	Over 3mm. Good deposition rates and weld profile.
	Shieldpro He 75	Ar-HE	GMAW	Above 6mm. Good deposition rates and weld profile. Smooth arc characteristics, rotate, clean, smooth surface appearance.
	Argon	Ar	GMAW–GTAW	Below 3mm. Acceptable deposition rates and weld profile.
Copper and alloys	Shieldpro He 25	Ar-HE	GMAW–GTAW	Above 3mm. Good deposition rates and weld profile.
	Argon	Ar	GMAW–GTAW	Below 3mm. Acceptable deposition rates and weld profile.
Nickel and alloys	Shieldpro 22	Ar-H_2	GTAW	2mm and above. Increased deposition rates. Reduced oxides. Improved weld profile.
	Argon	Ar	GMAW–GTAW	Below 3mm. Acceptable deposition rates and weld profile.

NB The above recommendations are only a basic guide. For the most accurate recommendation several other aspects must be considered including wire diameter, the setting of parameters and welding position.



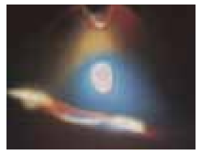
Short Arc

Globular Transition Arc



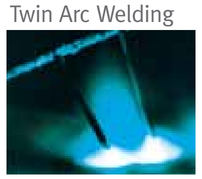
Spray Arc

Pulsed Arc



Rotating Arc

Twin Arc Welding



GTAW Arc

With shielding gases, many parameters of the welding process can be controlled and optimised for specific applications.

The gas or gas mixture must be selected so as to bring about the desired effects. Possibilities for optimisation include virtually every factor in the welding process.

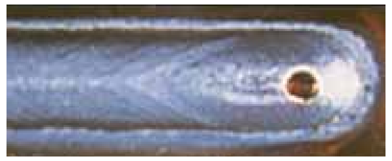
Physical properties of the gas affect metal transfer, wetting behaviour, depth and form of penetration, welding speed and arc setting. Gases with low ionisation energies, such as Argon, facilitate arc starting and stabilisation better than those with high ionisation energies, such as Helium.

On the other hand, Helium is a better choice for laser beam welding, where it helps control the plasma and thus the penetration depth. The dissociation energy of polyatomic components in gas mixtures enhances heat delivery to the base metal by virtue of the energy release in recombination.

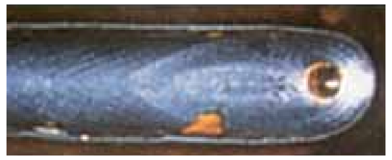
The thermal conductivity influences weld forming, weld-pool temperature, degassing and welding speed. For example, the welding speed and penetration can be markedly increased by the addition of helium in the GMAW and GTAW of aluminium materials, or by the addition of Hydrogen in the GTAW of stainless steels. These shielding gases come under the Shieldpro brand.

Chemical properties influence the metallurgical behaviour as well as the weld surface qualities. Oxygen, for example, burns off alloy constituents and leads to more fluid weld pools, while Carbon Dioxide adds carbon and gives slightly reinforced welds. Argon and Helium show metallurgically neutral behaviour and Hydrogen acts as a reducing agent.

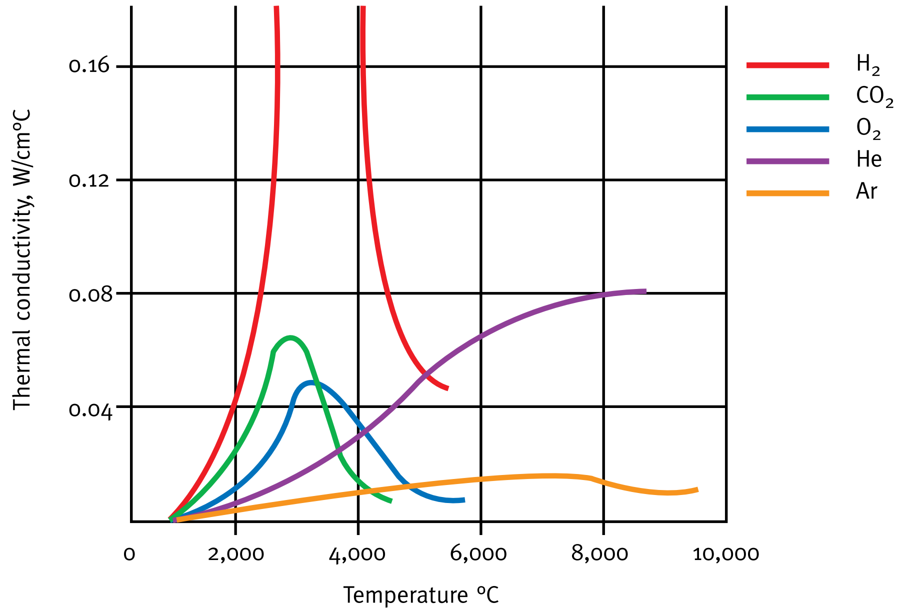
GMA welding of 5383 aluminium with Coregas Argon shielding gas



Argon + 5% CO_2



Coregas® 18



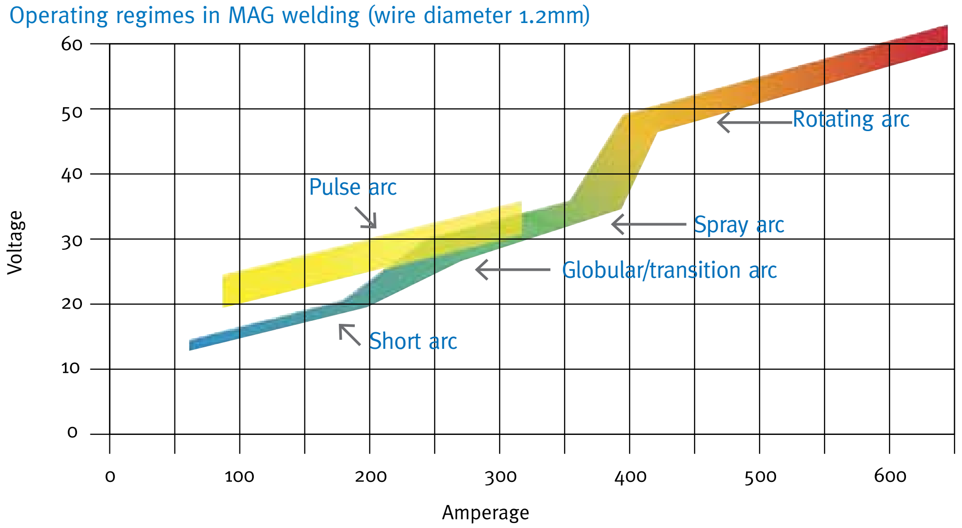
Graph showing the thermal conductivities of components in shielding gases.

With high purities and continuous quality control, Coregas shielding gases for welding offer an excellent way to achieve optimal welding results.

Correction factors for Argon flowmeters shielding gas						Factor
Ar %	He %	CO_2%	O_2%	H_2%	N_2%	k
100	–	–	–	–	–	1
–	–	100	–	–	–	0.95
98	–	2	–	–	–	1
82	–	18	–	–	–	0.99
93	–	5	2	–	–	1
93	–	–	7	–	–	1
75	25	–	–	–	–	1.14
50	50	–	–	–	–	1.35
25	75	–	–	–	–	1.75
–	100	–	–	–	–	3.16
–	20	80	–	–	–	1.05
–	50	50	–	–	–	1.29
95	–	–	–	5	–	1.03
–	–	–	–	–	100	1.19
–	–	–	–	10	90	1.25
–	–	–	–	15	85	1.29
–	–	–	–	20	80	1.32

Physical properties of gases		
Gas	Dissociation Energy, eV	First Ionisation energy, EV
H_2	4.5	13.6
O_2	5.1	13.6
CO_2	4.3	14.4
N_2	9.8	14.5
He		24.6
Ar		15.8
Kr		14.0

Operating regimes in MAG welding (wire diameter 1.2mm)



A variety of arc types are employed in gas metal-arc welding (GMAW) with consumable wire electrodes. Crucial factors in the selection of arc type are the shielding gas, the plate thickness and the welding position.

Short arc for thin plates, out-of-position welding, and root-pass welding at low power levels. The metal transfer takes place in a short circuit, with little spatter.

Long arc for high-power GMAW of thicker sections under carbon dioxide. Metal transfer is globular, with considerable spatter.

Transition arc for the medium power range in the GMAW of moderate plate thickness under Argon-based gas mixtures. Metal transfer is globular and takes place partly in the short circuit but spatter is less than in long-arc welding under CO_2.

Spray arc for high deposition rate and higher welding speeds on thicker sections, under Argon-based gas mixtures. Metal transfer is by droplets, with no short circuiting, and very little spatter results.

Pulsed arc for all power levels; used in GMAW under Argon-rich mixtures, chiefly at moderate powers (replacing transition arc). Metal transfer is free from short circuits, with one well-defined droplet formed per pulse. Less spatter than with other arc types. The pulsed arc cannot be used under CO_2.

Rotating arc for very high deposition rates on structures with heavier wall thickness, welding with Coregas® He 30 shielding gas.

Twin arc for extremely high deposition rates on a variety of materials and material thicknesses.

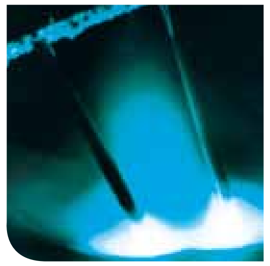

Short arc


Transition/ globular arc


Spray arc


Pulsed arc


Rotating arc


Twin arc

The arc projector in Coregas' Applications Technology Centre at Yennora in Sydney is used for training, research and development. This equipment enables you to view different arc types and clearly shows the variation between Coregas and Shieldpro shielding gases under different parameter settings and arc conditions. The projector is the only one of its kind in Australia.

The arc viewing system has been used in Australia for over 25 years. A parameter board with laser pointer shows the working range.

The most effective point for measuring gas flows is at the shroud.

Typical flow rates

GTAW:	8–12 litres per minute
GMAW:	15 litres per minute
Aluminium:	20 litres per minute

For correction factors see page 9.

After selecting your shielding gas, the gas flow must be correctly set and flow meters calibrated to ensure sound welds.

The arc projector in use at Coregas' Applications Technology Centre, Yennora in Sydney

Flow meter

Effect of shielding gas on mechanical and engineering properties

Shielding gas	R_m	R_e	A_5*	Weld metal analysis %			Notch impact value J (mean of 4 specimens)							O_2 content of weld
N/mm²	N/mm²	N/mm²	%	C	Mn	Si	+20°C	+0°C	−20°C	−30°C	−40°C	−50°C		material
Coregas® 5/2	610	472	28.1	0.08	1.32	0.67	138	124	87	83	58	48		0.031
Coregas® 10	640	544	25.7	0.09	1.43	0.72	130	88	64	55	60	41		0.029
Coregas® 18	620	522	26.8	0.09	1.37	0.70	144	120	86	62	50	40	47J limit	0.0305
Coregas® 25	601	505	29.3	0.09	1.30	0.65	124	97	76	61	51	41		0.034
100% CO_2	594	437	27.8	0.10	1.21	0.62	84	54	48	35	28	22		0.062
Wire electrode SG2 A(18)				0.115	1.53	0.98								

*R_m is tensile strength; R_e yield strength; A_5 elongation at fracture.

Shielding gases for the MAG welding of structural steels are:

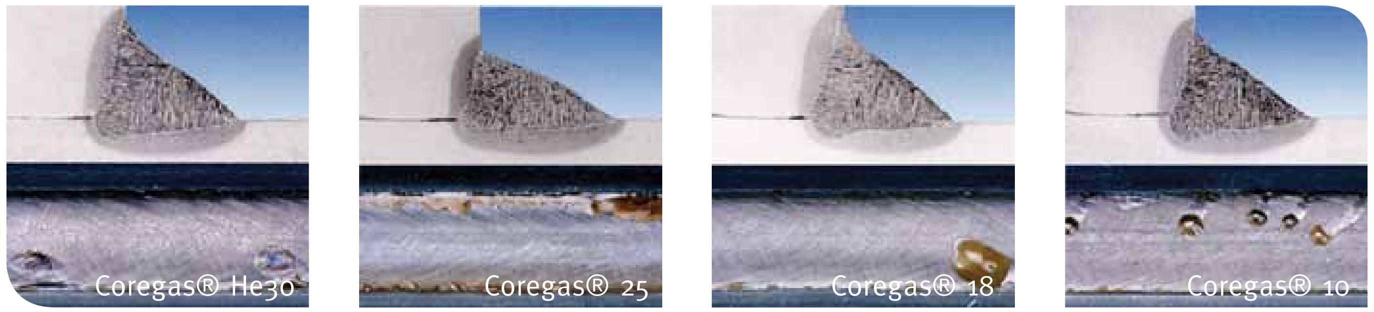
Coregas® 07	Coregas® 18
Coregas® 5/2	Coregas® 25
Coregas® 16/3	CO_2
Coregas® 10	Coregas® He 30

These shielding gases are suitable for pipe steels, structural and fine-grain structural steels, case-hardening steels and heat-treatable steels of all qualities.

Properties of some Coregas shielding gases

Property	Ar/CO_2	Ar/He/CO_2	Ar/O_2	CO_2
Penetration				
• Ordinary flat position	Good	Good	Good	Good
• Out of position	More reliable with increasing CO_2 levels	More reliable with increasing CO_2 levels	Can become critical if fluid weld pool leads arc	Reliable
Thermal stress on torch	Lower with increasing CO_2 level	Improved by the He content	High because excessive torch temperature can limit power	Low because of good thermal conductivity
Degree of oxidation	Higher with increasing CO_2 levels	Higher with increasing CO_2 levels	High e.g. at 7% O_2	High
Porosity	Lower with increasing CO_2 levels	Lower with increasing CO_2 levels	Most sensitive	Reliable
Gap-bridging ability	Better with decreasing CO_2 level	Improved by the He content	Good	Worse than with gas mixtures
Spatter	Increasing with increasing CO_2 levels	Increasing with increasing CO_2 levels	Low	Greater spatter, increasing with increasing power
Heat input	Increasing with increasing CO_2 levels	increasing with rising CO_2 He content	Lowest	High
Effect of heat input in welding-critical materials e.g. C 35, C 45	Cooling rate lower; less danger of cracking of cracking	Cooling rate lower; less danger of cracking cracking	Cooling rate high; greater danger	Cooling rate low; little danger of
Arc type	Short arc Transition arc Spray arc Pulsed arc up to 20% CO_2 content	Short arc Transition arc Spray arc (also high performance) Spray arc (also high performance)	Short arc Transition arc Spray arc Pulsed arc	Short arc Long arc

These properties of the various shielding gases govern their use in welding.



Recommended filler metals for dissimilar metals joint welding

Parent Metal ASTM Type (AISI)	201 202	303 304 304L	309 309S	310 310S	317 316	317L 316L 316Ti	321 347	S30815 (253MA)	409 410 430	446 446	Duplex S31500 S31803 S32304	NiCrFe Alloys	Carbon Steels	Low Alloy Steels	501 502 505	Parent Metal ASTM Type (AISI)
201 202	308 308L	308 308L 312	308 308L 347	308 308L 347	308 308L 347 318	308 308L 318	347 318 308	308 347	309 310	309 310	22.8.3L 309	NiCr-3 NiCrFe-6	309	309	309	201 202
304[1] 304L 303		308 308L 347	308 308L 347	308 308L 347	308 308L 347	308 308L 347	347 308 308L 318	22.12.HT 308 347	309 310	309 310	22.8.3L 309L 309	NiCr-3 NiCrFe-6	309	309	309	304[1] 304L 303
309 309S			309 309L 310	309 309L	309 309L 316L	309 309L 308L 318	374 308 347	22.12.HT 309	309 310	309 310 309L	22.8.3L 309	NiCr-3 NiCrFe-6	309	309	309	309 309S
310 310S				310 310L	317L 316L 318 309	317L 316L 318 309 309L	347 308 308L 310	22.12.HT 310 309	309 310	310 309	22.8.3L 309 309L	NiCr-3 NiCrFe-6	310 309	310 309	310 309	310 310S
317 316					317 316 318	317L 316L 316 318	347 318 316	22.12.HT 309	309 310	309 310	22.8.3L 309Mo 309	NiCr-3 NiCrFe-6	309	309	309	317 316
317L 316L 316Ti						317L 316L 318	347 318 308 316L	22.12.HT 309	309 310	309 310	22.8.3L 309Mo 317L 316L	NiCr-3 NiCrFe-6	309	309	309	317L 316L 316Ti
321 347							347 318 308	22.12.HT 309 347	309 310	309 310	22.8.3 309	NiCr-3 NiCrFe-6	309	309	309	321 347
S30815 (253MA)								22.12.HT	22.12.HT 309 310	22.12.HT 309 310	22.8.3L 309 310	NiCr-3 NiCrFe-6	22.12.HT 309 310	22.12.HT 309 310	22.12.HT 309 310	S30815 (253MA)
409 410 430									410 309	446 310 309	22.8.3L 309 309L	NiCr-3 NiCrFe-6	309	309	309	409 410 430
446										446 310 309	309 309L	NiCr-3 NiCrFe-6	309	309	309	446
S31500 S31803 S32304											22.8.3L 309Mo	NiCr-3 NiCrFe-6	22.8.3L 309	22.8.3L 309	22.8.3L 309	S31500 S31803 S32304
NiCrFe(2) Alloys												NiCr-3 NiCrFe Alloys	NiCrFe(2) 312	NiCrFe(2) 312	NiCrFe(2) 312	NiCrFe(2) Alloys

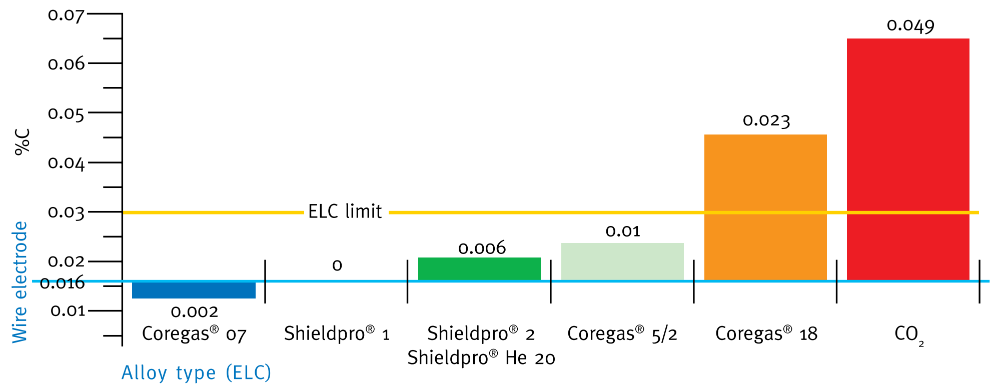
Shielding gases for the MAG welding of high-alloy steels are:

- Shieldpro® 21
- Shieldpro® 20
- Shieldpro® He 20
- Shieldpro® 31
- Shieldpro® 32
- Shieldpro® He 33

The short, transition, spray and pulsed arc types can be employed. The carbon content is important for maintaining corrosion resistance. For low carbon ELC steel qualities, the maximum level in the weld metal is 0.03%.

Survey of applications

Shielding gas	Properties	Materials
Shieldpro® 21	Low oxidation Moderate wetting	Ferritic Cr steels Corrosion-resistant austenitic CrNi steels
Shieldpro® 20	Low oxidation Very good wetting Higher welding speed Minimal spatter	High temperature austenitic CrNi steels Special steels e.g. duplex
Shieldpro® He 20 Shieldpro® 31 Shieldpro® 32	Excellent wetting even at great section thickness Very good overweldability of runs Stable arc Minimal spatter Excellent penetration	Special steels e.g. duplex and super duplex Corrosion resistant and high temperature CrNi steels, especially for high welding speed
Shieldpro® 33	Excellent wetting even at great section thickness Stable arc Minimal spatter Excellent for out of position welding Excellent penetration	Special steels e.g. duplex and super duplex Corrosion resistant and high temperature CrNi steels, especially for high welding speed
Shieldpro® 23	Reduction of ferrite content Control of the austenite/ferrite ratio	Full austenitics Duplex and super duplex steels Mainly for orbital GTAW



Carbon pickup under various gases

Measurement of carbon burnout and pickup show clearly that no corrosion problems occur with the current shielding gases.

Although the carbon content in welding with Coregas® 5/2 is below the ELC limit, this gas should not be used for components that will see service in corrosive environments.

Austenitic CrNi steels and ferritic Cr steels can be welded quite well with the spray arc, which begins at currents some 20% below those struck on unalloyed materials.

The use of the pulsed arc insures stable metal transfer with little spatter over the full range of melting rates. Heavier wires, which can be fed more reliably and offer better current transfer, can thus be used. What is more, pulsed-arc welding is an excellent technique for vertical-down welds. Nickel based materials and most special steels should preferably be welded with the pulsed arc.

Interpass welding temperatures depend on the type of base metal:

- 150–200°C for austenitic CrNi steels
- 50–100°C for Ni-based materials

Research at the Coregas Technology Centre has revealed some interesting features:

- The weld geometry, surface finish, wetting behaviour, and arc stability are affected in different ways by the base and filler materials.
- The torch position should be approximately 10° forehand no matter what materials are involved.
- The weld metal should be applied in stringer beads. The arc must always lead the weld pool. If the weld pool leads the arc even slightly, heavy spatter results, especially in Ni-based materials.

shielding gases for GMAW non-ferrous metals

Shielding gases for the GMAW of nonferrous metals are inert gases such as Argon, Helium or Argon-Helium (Shieldpro®) mixtures. The short, spray and pulsed arc types can be used with these gases.

The pulsed arc offers significant advantages, especially for softer aluminium filler metals, because it allows the use of larger-diameter wire electrodes with their improved feeding reliability. The hotter arc in Helium and Argon mixtures has proven suitable especially for aluminium and copper materials with their high thermal conductivities.

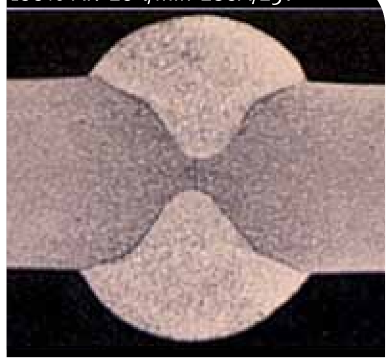
Application notes on Helium

Arc voltage: For a given arc length, a higher arc voltage is required as the Helium content increases.

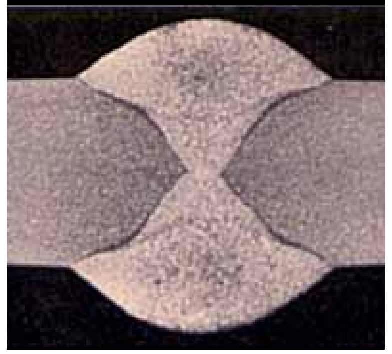
Penetration form A rise in Helium content leads to a wider and therefore flatter weld. The penetration is not "finger-shaped" as when Argon is used, but instead becomes more rounded and deeper. The better penetration behaviour facilitates safe penetration in the root region.

Helium is much lighter than air. This fact must be considered in the measurement of flow rate (correction factor) and also in the determination of the minimum flow rate of shielding gas. Helium improves the degassing conditions of the weld pool and reduces the porosity. Higher gas prices can often be offset by increased welding travel speeds and reduced costs for post weld machining.

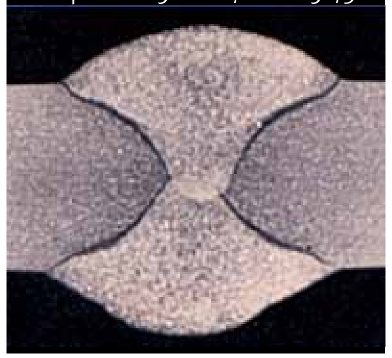
100% Ar: 20 l/min 280A/25v



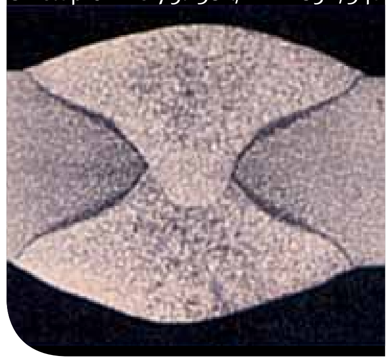
Shieldpro® 25: 20 l/min 282A/27v



Shieldpro® He 50: 28 l/min 285A/30v



Shieldpro® He 75: 38 l/min 285A/34v



Correction factors and minimum flow rate of shielding gas

Shielding gas multiply flowmeter reading by:	Correction factor: multiply flowmeter reading by	Minimum flow rate
Shieldpro® 25	1.14	18 l/min
Shieldpro® He 50	1.35	28 l/min
Shieldpro® He 75	1.75	35 l/min
100% He	3.16	40 l/min

GMAW of aluminium (5383) with Coregas Argon shielding gas

shielding gases for GTAW

In contrast to GMAW, in GTAW the arc burns between a non-melting tungsten electrode and the work. Inert gases, such as Argon or Helium, or mixtures of these with non-oxidising components are used to protect the tungsten electrode and the weld pool.

GTAW can be used with all fusion-weldable metals. The selection of current type, polarity and shielding gas depends on the base material.

Higher Helium levels in Argon-Helium mixtures promote heat evolution in the arc and permit higher welding speeds. Hydrogen can also be used to improve the energy balance of the GTAW arc, but only with high-alloy CrNi steels, nickel and Ni-base alloys. Up to 10% Hydrogen in Argon improves penetration and welding speed. Gases containing Hydrogen must never be used for welding aluminium materials (higher porosity) or Hydrogen-sensitive steels.

Shielding gases of higher purity are recommended for the welding of gas-sensitive materials such as titanium or tantalum. The 5.0 quality is therefore used for these metals (versus 4.2 for other materials); with a purity of 99.999%, this grade contains less than 10ppm of impurities by volume.

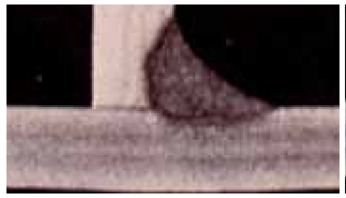
A typical analysis of a 5.0 gas quality is as follows: $N_2 \le$ 5ppm, $H_2O \le$ 3ppm, $O_2 \le$ 2ppm (by volume).

Material, current and polarity

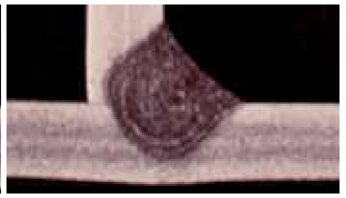
Materials	Current type and polarity
Unalloyed steels, Copper and Cu alloys, Nickel and Ni alloys, Titanium and Ti alloys, Zirconium, tantalum and tungsten	dc(–)
Aluminium and Al alloys	ac/dc(–) with helium
Magnesium and Mg alloys	ac

Shielding gases and materials

Shielding gas	Materials	Remarks
Argon	All weldable metals	Used most frequently Root protection required for gas-sensitive materials
Shieldpro® He 25 Shieldpro® He 50 Shieldpro® He 75	Al and Al alloys; Cu and Cu alloys	Hotter arc results in → Better penetration → Higher wetting speed
Helium		Arc starting difficulties due to He → Strike arc under Argon
Shieldpro® 21 Shieldpro® 26	High alloy CrNi steels	Hotter arc results in → Better penetration → Higher wetting speed
	Ni and Ni base alloys	To avoid porosity
	Full austenitics	Control of austenite/ferrite ratio
Shieldpro® 23	Duplex	Reduction of ferrite content Increased pitting control resistance Mainly used for orbital GTAW

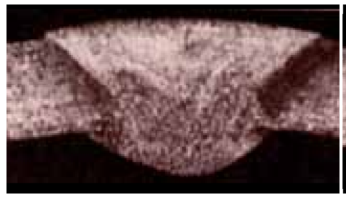


Argon:
welding speed 7cm/min

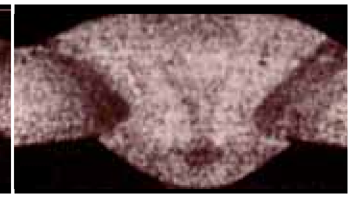


Shieldpro® 22:
welding speed 11cm/min

Fillet welds in material 304 stainless steel. Penetration and welding speed improve markedly with increased Hydrogen.



Argon @10l/min:
welding speed 10cm.min



Shieldpro® He 50: 15l/min:
welding speed 20cm/min

A higher level of Helium leads to higher welding speeds. These photographs illustrate welds in 3mm thick aluminium (5383) butt joint.

shielding gases for plasma arc welding

As in GTAW, the arc in plasma welding is formed between a non-melting tungsten electrode and the work. In contrast to GTAW, however, the plasma arc is constricted by the torch design (water-cooled copper tip) so that the power density is comparatively higher.

There are three variants of the plasma-arc welding process:

Micro-plasma-arc welding for thin and very thin sheet (minimum thickness approx. 0.1mm at minimum current approx. 0.3A)

Melt-in welding for thickness of 1–3mm.

Keyhole welding for thicker sections, up to approx. 8mm in one run or thicker work in multiple runs.

Plasma-arc welding always involves two gases:

- Orifice gases, chiefly Argon, sometimes with added Hydrogen and Helium
- Shielding gases, which may have other gases added to the Argon, for example Hydrogen in welding of CrNi steel and Ni materials, or Helium in welding of aluminium, aluminium alloys, titanium and copper-base materials.

Other plasma techniques include plasma powder welding for the application of high-melting alloy coatings, plasma hot-wire surfacing, and plasma/GMAW for high-performance fusion welding.

This process is being used more in recent times for welding.

Joining by micro-plasma-arc welding

shielding gases for laser beam welding

Shielding gases also find use in laser-beam welding. Gases perform two functions in welding with the CO_2 laser.

Laser Gases

Proper laser operation depends on the laser gases, which consist of Helium with admixtures of CO_2 and Nitrogen. Coregas supplies laser gases either as the individual components or as a premix (Laspur) depending on laser type. Uniform beam quality is insured by adequate purity in either form of gas.

Slab lasers can also be used for welding. These lasers require a six-part mixture (Laspur 208) standard in Coregas' product range.

Working Gases

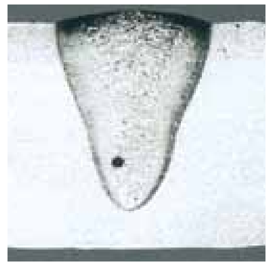
Working gases simultaneously mediate energy deposition in the work and afford protection for the weld pool and torch. When a certain energy flux density (intensity) is exceeded, a thermally-induced plasma is formed; this together with other factors determines the depth of penetration.

For example, increasing energy absorption in the plasma with increasing energy flux density can diminish the penetration.

The working gas controls plasma formation and penetration. Helium, with its high ionisation energy, has proven as an excellent choice for this process. Refer to the Laser Welding publication for more in-depth information.

For high powered laser welding and diode laser welding Lasershield is the correct choice of shielding gas.

Argon



Helium

Nd-YAG laser

Robotic laser welding

oxidation prevention by purging gases

Protection of the weld root is often needed in order to insure the optimal corrosion resistance of the part. Oxidation and temper colours are prevented by excluding atmospheric Oxygen.

Two approaches can be taken to this problem:

- Displacement of air by inert gases such as Argon or Nitrogen.
- Displacement of air plus utilisation of the reducing action of Hydrogen.

For this reason, most purging gases consist of:

- Nitrogen with added Hydrogen.
- Argon with added Hydrogen.

Pure Argon, on the other hand, finds use, for example, with Hydrogen-sensitive steels. Proper use of purging gases requires that their relative densities be taken into account.

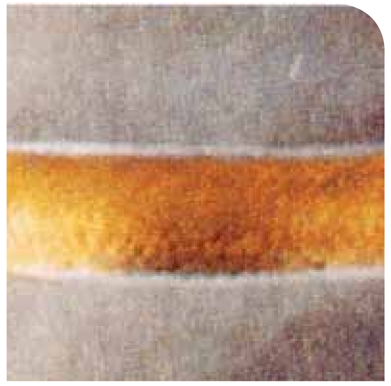
Application Notes

For safety reasons, Coregas recommends burning off Hydrogen at levels higher than 10% volume. In order to positively prevent temper colours, the delivery of the purging gases must continue until the part has cooled to approximately 220°C.

Preventing oxidation in the welding of pipe requires pre-purging for a time that depends on the purge gas flow rate.

Before the start of welding on pipe, air is eliminated by purging. A guideline for the needed volume of shielding gas is 2.5–3.0 times the geometric volume of the pipe from the injection point to the weld. The flow rate should be from approx. 5–12 l/min, depending on the diameter of the pipe.

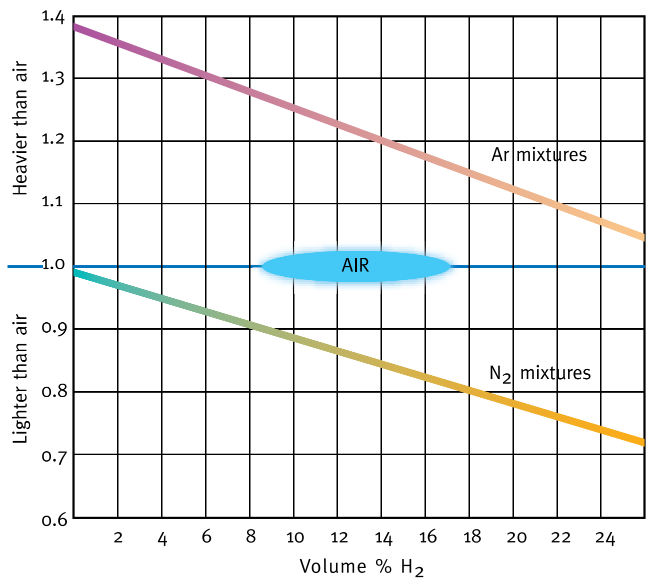
In titanium-stabilised CrNi steels, purging gases containing N_2 cause a yellow colouration in the weld root, as shown below.



Typical yellow colouration: Titanium-stabilised CrNi steel formed with Nitrogen

No colouration: Titanium-stabilised CrNi steel formed with Argon-Hydrogen

Graph showing relative densities of forming gases



Shielding gas	Material
Argon	All materials
Ar/H_2 mixtures	Austenitic steel Ni and Ni based material
N_2H_2 mixtures	Steels, with the exception of high strength structural steels, austenitic steels (not titanium stabilised)
Ar Ar/N_2 mixtures	Austenitic CrNi steel Duplex and super duplex steel

high performance GMAW

This method of welding increases the product quality, economic efficiency and gives greater flexibility of use.

Economical shielding gas from Coregas; Coregas® He 30

An important factor in weld quality is the composition of the shielding gas. Highly suitable for both the T.I.M.E.® process and high-performance GMAW, it has optimal heat conduction and little oxidising action. While Argon shields the weld pool from the ambient atmosphere by virtue of its high density, Carbon Dioxide influences the heat balance of the arc by dissociation and recombination, thus improving the penetration.

Even more important for weld formation, however, is the admixture of helium. With its comparatively high conductivity, this gas enhances heat transfer into the base metal, ensuring a highly stable welding process while improving the penetration shape and minimising the notch effect at the interface between weld and base metals. The joining process which many metal- processing companies use the most is GMAW of non-alloyed steels. In contrast, high-performance GMAW which also became established under the designation of T.I.M.E.® welding in the 1990s, has a much greater deposition rate and welding speed in comparison with conventional GMAW. This means greater efficiency.

A unique feature of T.I.M.E. welding with high wire feed rates: the rotating twin arc.

Transverse section of a fillet weld made with Coregas® He 30 showing the typical wide, trough-shaped penetration. Wire feed rate: 25m/min.

Coregas® He 30 being used with the T.I.M.E. welding process

Streamlined gas systems for your business

Coregas shielding gases can be supplied in single cylinders, multi cylinder packs and bulk liquid form any combination of which may be arranged to meet specific demands. Tele-monitoring can be installed on request.

E- and G-size cylinders

6-pack cylinders

12-pack cylinders

Bulk-liquid supply

Optimising welding operations using the weld cost calculator

The DMG5, a wire measuring unit will enable you to optimise welding applications.

Welding parameters can be determined and welding costs calculated.

After the input of labour costs, wire costs and gas costs, the following data can be calculated

- Labour rate in dollars
- Wire costs in dollars
- Gas costs in dollars
- Total welding costs

Indicated are:

- Wire feed speed
- Wire length
- Wire weight
- Welding (arc-on) time
- Gas consumption

Thus enabling customers to:

- Monitor quality assurance
- Analyse productivity
- Review cost estimates

Coregas can conduct weld cost calculations on site to determine the most economical shielding gas for your application. On completion of the welding trial, Coregas' specialist will provide an analysis and recommendation for the correct shielding gas.

Storage and Handling

- Protect the cylinder and valve from physical damage, whether empty or full.
- Secure and use cylinders in an upright position. Ensure all cylinders are correctly labelled in accordance with AS 2992.
- Store in clean, well ventilated areas, away from combustible materials and heat sources.
- Ensure all devices, including fittings and regulators, are free from dust, oil and grease.
- Always open the valve fully to activate the valve stem seal.
- Close valve fully when not in use.
- Check regularly for leaks.
- Do not attempt to transfer contents from one cylinder to another.
- The use of cylinder trolleys for moving cylinders is recommended.

N.B. Always use regulators to control the flow of gas. Only regulators, manifolds, and ancillary equipment rated for the appropriate pressure and compatible with the relevant gas, shall be connected to or downstream of these cylinders.

In Case of Leaks:

- Locate leaks with a leak detector solution.
- Stop leak, if possible, and only if safe to do so.
- If leak cannot be stopped—and only if safe to do so—remove cylinder to a safe area outdoors free of combustible material and allow to empty.
- When empty, close valve and return cylinder to Coregas with warning tag attached.
- Notify supplier about the leak.

First Aid

- If the victim inhales the gas, remove to fresh air.
- Apply artificial resuscitation if necessary.
- Treat for shock and seek medical attention if required.

Fire

- In case of fire, evacuate the area, contact the fire brigade and gas supplier. Never use cylinders that have been exposed to fire.
- Return these cylinders to the supplier, with warning tag attached.

Coregas has manufactured and distributed high quality industrial, medical and speciality gases in Australia since 1976.

Core to our business is providing outstanding customer service and advice.

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Coregas Pty Ltd
Head Office – Sydney
66 Loftus Road
Yennora NSW 2161
Telephone: (02) 9794 2223
Facsimile: (02) 9794 2264
Internet: www.coregas.com

Adelaide
6 Jonal Drive
Cavan SA 5094
Telephone: (08) 8222 1111
Facsimile: (08) 8262 1104

Brisbane
Cnr Pradella Street &
Ipswich Road
Darra QLD 4076
Telephone: (07) 3291 7111
Facsimile: (07) 3274 0079

Melbourne
3 Milne Street
Thomastown VIC 3074
Telephone: (03) 9463 9111
Facsimile: (03) 9464 0079

Newcastle
6 Laurio Place
Mayfield NSW 2304
Telephone: (02) 4968 5111
Facsimile: (02) 4967 3533

Wollongong
228 Berkeley Road
Unanderra NSW 2526
Telephone: (02) 4271 5337
Facsimile: (02) 4271 3348

Yennora
Cnr Loftus Rd & Boola Avenue
Yennora NSW 2161
Telephone: (02) 9794 2223
Facsimile: (02) 9794 2264

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