Argon/Helium gas properties and uses

Objectives: At the end of this lesson you shall be able to
- **state the properties of argon gas**
- **compare the performance characteristics of argon and helium gas for TIG welding**
- **identify an argon gas cylinder and ceramic nozzles**
- **state the uses of argon and helium gas.**

Shielding gases

Chemical activity of shielding gases: The behaviour of gases in welding is related to their chemical activity so it is convenient to group them according to this activity.

Inert gases: These are argon and helium. Other inert gases such as krypton, Radon, xenon and neon have been tried, but their low availability results in them being expensive. Also their characteristics do not, at present, give them any particular advantage.

Argon and helium are monatomic (their molecule contains only one atom) and do not react with other bodies (in the arc plasma) and hence the designation 'inert'. This precious property allows them to protect the electrode and molten metal against the atmospheric gases. However they are not suitable in every case. Pure argon for example does not allow a smooth droplet transfer when welding carbon steels. To obtain the desired transfer mode it is necessary to add a certain proportion of oxygen or carbon di oxide.

The different ionisation potential of argon and helium cause them to behave differently.

Properties of argon and helium gas

These gases are colourless, odourless.

Argon is heavier than air and helium is lighter than air.

They do not chemically react with any metals in hot or cold conditions.

They give a good shielding action for molten metal from the atmosphere.

Gases for TIG welding of aluminium

Argon gas

An argon cylinder is identified by the peacock blue colour painted on it.

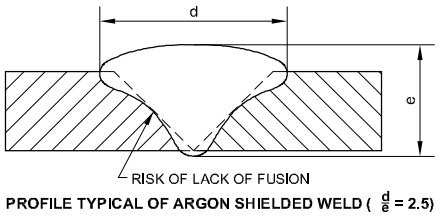
Quality : Argon gas of welding quality should be used.

The rate of flow of argon should be adequate to obtain a clean weld. This depends on several factors such as type of parent metal, current used, shape and size of nozzle, type of joint and whether the work is done indoors or outdoors. Generally a higher rate of flow is required with higher welding currents, for outside corner joints, edge welds and work outdoors. Generally flow rates 2 to 7 litres per minute will be found sufficient to weld all thicknesses.

If tungsten inert gas welding has to be done outdoors during inclement weather, especially during period of high wind, the welding area should be effectively protected. Draughts tend to break the gas shielding, resulting in porous and oxide contaminated welds.

The penetration profile of argon shielded welds has a characteristic shape in the form of a finger.Fig.1

Fig 1



PROFILE TYPICAL OF ARGON SHIELDED WELD ($\frac{d}{e}$ = 2.5)

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Helium: Helium is used mainly in TIG welding and is normally used with direct current whatever the metal being welded (light alloys, copper, etc.)

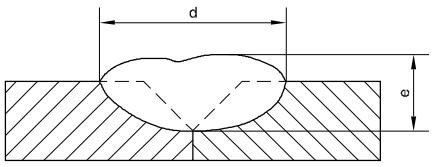
The main advantages of helium shielding are:

– Increase in welding speeds

– More intense local heating, important with metals which are good conductors of heat

– Fig.2 shows the penetration, profile typical of a helium shielded weld

Fig 2



PROFILE TYPICAL OF HELIUM SHIELDED WELD ($\frac{d}{e}$ = 3.5)

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Argon gas gives more penetration than helium gas.

Characteristics and comparative performance of argon and helium as shielding gases

Argon

Low arc voltage : Results in less heat; thus argon is used almost exclusively for manual welding of metals less than 1.6mm thick.

Good cleaning action: Preferred for metals with refractory oxide skins, such as aluminium alloys or ferrous alloys containing a high percentage of aluminium.

Easy arc starting: Particularly important in welding of thin metal.

Arc stability is greater than with helium

Low gas volume: Being heavier than air, argon provides good coverage with low gas flows and it is less affected by air drafts than helium

Vertical and overhead welding: Sometimes preferred because of better weld puddle control but gives less coverage than helium.

Automatic welding: May cause porosity and undercutting with welding speeds of more than 60cm per min. Problem varies with different metals and thicknesses and can be corrected by changing to helium or a mixture of argon and helium.

Thick work metal: For welding metal thicker than 5mm a mixture of argon and helium may be beneficial

Welding dissimilar metals: Argon is normally superior to helium

Helium

High arc voltage: Results in a hotter arc, which is more favorable for welding thick metal (over 5mm) and metals with high heat conductivity.

Small heat affected zone: With high heat input and greater speeds, the heat affected zone can be kept narrow. This results in less distortion and often in higher mechanical properties.

High gas volume: Helium being lighter than air, gas flow is normally 1 1/2 to 3 times greater than with argon. Being lighter, helium is more sensitive to small air drafts, but it gives better coverage for overhead welding and often for vertical position welding.

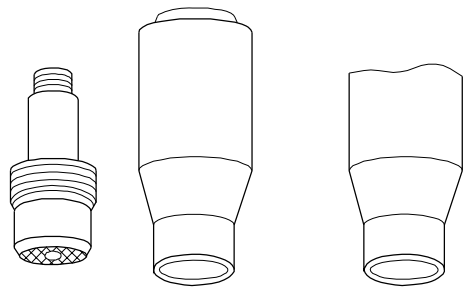
Automatic welding: With welding speeds of more than 60cm per min. welds with less porosity and undercutting may be attained (depending on work metal and thickness).

Comparision between argon and helium shielding

Argon	Helium
1 Smoother arc.	1 Smaller heat affected zone.
2 Easy starting.	2 Best for thicker metal welding due to higher arc voltage.
3 Best for thinner metal welding due to lower arc voltage.	3 Better for welding at higher speed.
4 Good cleaning action while welding Al.	4 Gives better coverage in vertical and overhead positions.
5 Heavier than air - Lower flow rates.	5 When used in back shieldings flatens the root face.
6 Lowe cost, more availability.	
7 Better for welding dissimilar metals.	
8 Better control of puddle on positional joints.	

Ceramic shields/nozzles: Gas nozzles are usually designed for installation into a particular type of torch and generally do not adapt to another make or model. They come in all sizes, shapes and materials. Gas nozzles are reasonable in cost, therefore they should be replaced when they become unusable. A nozzle which has chips or cracks or a metal build up on the outlet end should be discarded. These types of defects can alter the gas flow pattern from the nozzle and cause contamination of the weld metal. Typical nozzle configuration are shown in Fig.3.

Fig 3



COMMON GAS NOZZLE AND GAS NOZZLE WITH GAS LENS

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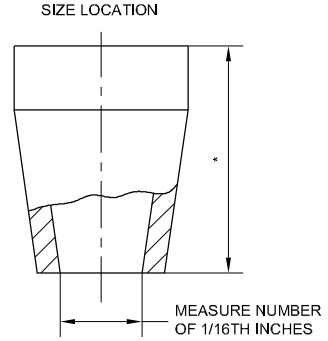
Nozzles are identified by the size of the orifice (opening) and the length of the nozzle as shown in Fig.4 Each torch manufacturer assigns part numbers to the various nozzles for individual type torches and these must be used when ordering for replacement of nozzles.

Fig 4



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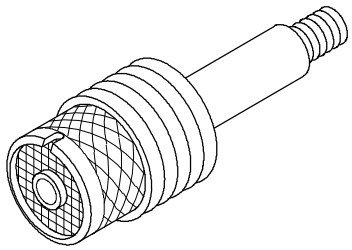
Size in mm	No.
5	No.3
6.3	No.4
8	No.5
10	No.6
11	No.7
12.5	No.8
14.5	No.9
16	No.10
18	No.11
20	No.12

Gas lens: The gas lens device allows the welder to use a longer electrode extension than with a standard nozzle. The device uses a series of stainless steel wire mesh screens to 'firm up' the argon gas column. This aids in maintaining a blanket of inert gas around the tungsten and over the weld area. This is very helpful when wind drafts are present, or the tungsten must be extended due to the location of the weld area. Use of the gas lens requires a special gas lens collet body and gas nozzle. A gas lens device is shown in Fig. 5 & 6.

Fig 5



GAS LENS USE A STAINLESS STEEL SCREEN TO ESTABLISH A COLUMN OF SHIELDING GAS RATHER THAN A BLANKET OF GAS

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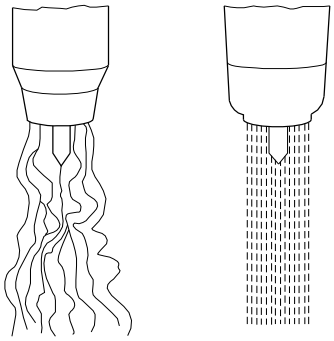
Fig 6



FLOW OF SHIELDING GAS

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Defects causes and remedy

Objectives: At the end of this lesson you shall be able to
- **state the different type of defects in GTAW**
- **state the causes and remedies of GTAW defects.**

The following table relates to the cause and prevention of the more common defects encountered in welds made by the TIG welding process. (Fig. 1)

Defect	Appearance	Cause	Remedy
Porosity	Pin holes in the weld.	Insufficient shielding gas. Bore of gas nozzle too small arc length too long. Surplus degreasing agent.	Satisfactory supply gas. Correct ceramic shield. Remove all degreasing agents and dry. Shorten arc length.
Undercut	Irregular grooves or channels	Incorrect welding technique. Current too high. Incorrect welding speed.	Correct current. Correct rod manipulation. Clear weld surface. at the toes of the weld.
Lack on fusion. (side root or inter run)	Surface on to which weld is deposited has not been melted. Not always visible. Usually	Incorrect current level. Incorrect filler rod manipulation. Unclean plates surfaces. detected by bend test or by non-destructive techniques (e.g.ultrasonic flaw detection).	Correct current. Use correct rod manipulation. Clean plate surfaces.
Lack of Penetration	Notch or gap at the root of a weld.	Incorrect preparation and set up. Incorrect current level. Welding speed too fast.	Use the correct preparation and set up. Correct current. Correct weld speed.
Inclusions	Usually internally and only detected by suitable testing techniques. Normally oxide or tungsten inclusions.	Oxide inclusions. Inadequate cleaning of parent material before welding. Contamination onsurface of filler rod. Inadequate protection of underside of a weld.Loss of gas shield.	Clean all metal surfaces. Ensure a satisfactory supply of shielding gas. Excluide draughts.

Defect	Appearance	Cause	Remedy
Cracking	Cracks can occur in the weld metals and in the parent metal alongside the weld. They may not be visible on the surface and may only be detected by the use of suitable testing techniques.	The type of crack and therefore its cause will depend on the material being welded. The correct diagnosis of the cause of a crack frequently calls for expert knowledge.	Use correct welding procedure. Pre-heating and post heat treatment. Use correct preparation Set up current. Use correct filler rod. Always adhere strictly to the procedure specified when welding materials that are susceptible to cracking. Always ensure the correct type of filler is used and the correct amount of filler metal is added.

Fig 1