

UNIMIG



GAS WELDING & CUTTING EQUIPMENT

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1. Safety

Gas equipment can be dangerous to both the operator and people in or near the surrounding working area if the equipment is not correctly operated. Equipment must only be used under the strict and comprehensive observance of all relevant safety regulations.

Read and understand this instruction manual carefully for all system components, especially the safety instructions and warning notices before the installation and operation of this equipment.

Product specifications and features are subject to change without notice. While every effort has been made to provide accurate and current information at the time of publication, this manual is intended as a general guide and is not exhaustive regarding safety, welding, cutting, or the operation and maintenance of this unit. Due to the many variables in the welding field and the evolving nature of both the field and the UNIMIG product line, Welding Guns of Australia Pty Ltd. does not guarantee the accuracy, completeness, authority, or authenticity of the information in this manual or provided by any UNIMIG employee during conversations or business dealings. The product owner assumes all liability for its use and maintenance. Welding Guns of Australia Pty Ltd. does not warrant this product or this document for fitness for any particular purpose, performance, accuracy, or suitability of application. Furthermore, Welding Guns of Australia Pty Ltd. accepts no liability for injury or damages, whether consequential or incidental, resulting from the use of this product or from the content of this document, nor does it accept third-party claims of such liability.

Note:

- Observe the accident prevention regulations and any regional regulations.
- Safety and warning labels on the machine indicate any possible risks.
- Keep these labels clean and legible at all times.
- Technical changes due to further development in machine technology may lead to different welding behaviour.

Items in the manual that require particular attention in order to minimise damage and harm are indicated with the below symbols. Read these sections carefully and follow their instructions.

 **Note:** Gives the user a useful piece of information.

 **Caution:** Describes a situation that may result in damage to the equipment or system.

 **Warning:** Describes a potentially dangerous situation. If not avoided, it will result in personal damage or fatal injury.

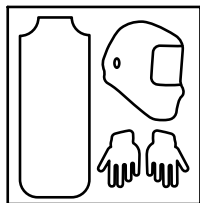
Safety Considerations

Safety precautions must be taken for both the operator and surrounding area when using a heat source created by mixing compressed oxygen with a fuel gas and igniting the resulting mixture.

When performing any of these processes, specific safety risks must be considered, including:

- Burns caused by flames, hot surfaces, malfunctioning hand-held tools, molten particles, and similar hazards.
- Explosions resulting from mixed gas concentrations due to fuel gas leaks from cylinders, bulk supplies, hoses, or faulty equipment connections.
- Fires caused by the ignition of flammable materials, leaking fuel gases, contact with hot slag, or using poorly maintained equipment. Such incidents have led to plant, building, ship, and bush fires.
- Ignition of materials not normally considered flammable due to oxygen enrichment.
- Violent rupture or explosion of components that have been pressurised beyond their design limits.
- Asphyxiation from displacement of breathable air by inert or toxic gases, such as leaks in confined spaces or oxygen depletion from excessive rusting within those spaces.
- Radiation exposure, primarily affecting the eyes and other exposed body surfaces.

- Hazardous fumes produced by the materials being welded, heated, or cut.
- Electric shock hazards when welding or cutting near or on cables or other high-voltage conductors.
- Additional risks to the workplace arising from any of the above hazards, particularly when working around containers, vessels, elevated surfaces, and similar environments.
- Only qualified persons should install, operate, maintain, and repair this equipment.
- During operation, keep everyone, especially children, away.



Eye & Clothing Protection

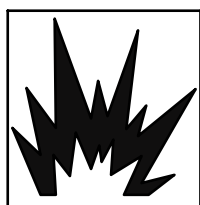
The oxy-acetylene flame produces a bright, intense light that can cause discomfort and potential injury to the eyes. To safely and comfortably view the flame while welding or cutting, welding goggles are essential.

- Always wear approved welding goggles with the correct shade of filter lens.

Recommended filter shades for various processes

Shade 4	• Oxy-cutting and gouging • Flame cleaning • Braze welding of light copper and steel • Silver brazing
Shade 5	• Fusion welding of steel, cast iron, nickel and copper • Braze welding of heavy steel and cast iron • Hardfacing
Shade 6	• Fusion and braze welding of cast iron and steel castings

- Measures should be taken to protect people in or near the surrounding working area. Use protective screens or barriers to protect others from glare and sparks.
- Wear proper PPE and body protection made from durable, flame-resistant materials like leather to protect against heat from the work and burns that may result from contact with the workpiece or molten metal.
- Suitable protective clothing, including long sleeves that fit snugly at the wrists, leather gloves, long pants, and leather boots, must be worn while the welding or cutting operation is performed.
- Nylon and synthetic clothing and open shoes should not be worn.
- An apron, spats and a welder's cap can help protect from sparks and spatter.

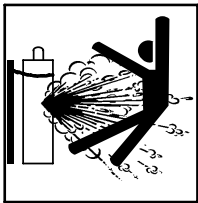


Fire Hazard

Welding and cutting on closed containers, such as tanks, drums, or pipes, can cause them to explode. Flying sparks, hot workpieces, and hot equipment can cause fires and burns. Accidental contact with metal objects can cause sparks, explosions, overheating, or fire. Check and be sure the area is safe before doing any welding and cutting.

- Remove any flammable materials well away from the working area. Cover flammable materials and containers with approved covers if they cannot be moved from the area.
- Do not weld or cut on closed containers or containers that have held combustible materials, such as tanks, drums, or pipes, unless they are correctly prepared according to the required Safety Standards to ensure that flammable or toxic vapours and substances are totally removed, these can cause an explosion even though the vessel has been "cleaned".
- Vent hollow castings or containers before welding or cutting. They may explode.
- Do not weld or cut where the atmosphere may contain flammable dust, gas, or liquid vapours (such as petrol).
- Have a fire extinguisher nearby and know how to use it.

- Be alert that sparks and hot materials from welding and cutting can easily go through small cracks and openings to adjacent areas.
- Be aware that welding and cutting on a ceiling, floor, bulkhead, or partition can cause a fire on the hidden side.
- Avoid welding and cutting on tyre rims or wheels, as heating can cause tyres to explode and repaired rims may fail.
- Before welding and cutting, remove any combustible items, like butane lighters or matches, from your person.
- Post welding and cutting, thoroughly inspect the area to ensure there are no lingering sparks, glowing embers, or flames.
- Wear proper PPE and body protection made from durable, flame-resistant materials like leather.
- Read and understand the Safety Data Sheets (SDSs) and the manufacturer's instructions for adhesives, coatings, cleaners, consumables, coolants, degreasers, fluxes, and metals.



Gas Cylinders

Gas cylinders contain gas under high pressure. If damaged, a cylinder can explode. Because gas cylinders are part of the welding and cutting process, be sure to treat them carefully.

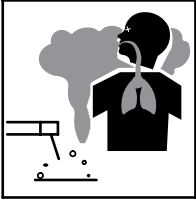
- Protect gas cylinders from excessive heat, mechanical shocks, physical damage, slag, open flames, sparks, and arcs.
- Ensure cylinders are secured upright to prevent tipping or falling over.
- Never weld or cut on a pressurised gas cylinder, it will explode and kill you.
- Open the cylinder valve slowly and turn your face away from the cylinder outlet valve and gas regulator. Stand to the side of the cylinder when opening the valve.
- Only use the correct gas, regulators, hoses, and fittings for your application and keep them in good condition.
- Keep full and empty cylinders separate.
- Keep ammonia-based leak detection solutions, oil and grease away from cylinders and valves.
- Never use force when opening or closing valves.
- Don't repaint or disguise markings and damage. If damaged, return cylinders immediately.
- When working with cylinders or operating cylinder valves, ensure that you wear appropriate protective clothing – gloves, boots and safety glasses.



Gas Buildup

The build-up of gas can cause a toxic environment and deplete the oxygen content in the air resulting in death or injury. Many gases used in welding are invisible and odourless.

- Shut off the shielding gas supply when not in use.
- Always ventilate confined spaces or use an approved air-supplied respirator.



Fumes & Gases

Fumes and gases are dangerous. Welding and cutting produces fumes and gases, and breathing these fumes and gases can be hazardous to your health.

- Do not breathe the smoke and gas generated while welding or cutting. Keep your head out of the fumes.
- Keep the working area well-ventilated and use fume extraction or ventilation to remove welding and cutting fumes and gases.
- In confined or heavy fume environments, always wear an approved air-supplied respirator.
- Welding and cutting fumes and gases can displace air and lower the oxygen level, causing injury or death. Be sure the breathing air is safe.
- Do not weld or cut in locations near degreasing, cleaning, or spraying operations. The heat can react with vapours to form highly toxic and irritating gases.
- Materials such as galvanised, lead, or cadmium-plated steel contain elements that can give off toxic fumes when welded. Do not weld these materials unless the coating is removed, the area is very well-ventilated and/or you are wearing an air-supplied respirator.
- Read and understand the Safety Data Sheets (SDSs) and the manufacturer's instructions for adhesives, coatings, cleaners, consumables, coolants, degreasers, fluxes, and metals.

Refer to the Australian Standards AS 4839, "The safe use of portable and mobile oxy-fuel gas systems for welding, cutting, heating and allied processes," for a comprehensive list of safety requirements, specifications, storage, handling, maintenance, assembly and proper operation.

For further information, see the Welding Technology Institute of Australia (WTIA) Technical Note 7 "Health and safety in welding" and Technical Note 5 "Flame cutting of steels."

The UNIMIG range of gas welding and cutting equipment has been independently tested and certified to meet the relevant Australian Standards for gas welding and cutting applications.

- Regulators: AS 4267
- Gas Hoses: AS 1335
- Flashback Arrestors: AS 4603

1.1 Regulator Safety & Operation

 **This equipment is designed for use with welding grade (inert) shielding gases only.**

This regulator is designed to reduce and control the flow of high-pressure gas from a cylinder down to a level that is suitable for the equipment it's supplying. Make sure the pressure regulator is designed for use with high pressure gas cylinders and that the connection nut thread matches the cylinder valve outlet.

Misuse of the equipment can lead to dangerous situations, which could result in accidents. It is crucial for users to avoid such scenarios. Prior to operating or handling the equipment, it is imperative to understand and adhere to the safety guidelines provided in this manual.

The following instructions detail specific practices for using regulators:

1. Do not expose the regulator to inlet pressures exceeding its maximum specified limit.
2. Do not pressurise a regulator if it exhibits any signs of damage, loose components, or appears to be in poor condition.
3. Never use a regulator that is leaking gas or showing signs of excessive creep (a gradual pressure build-up when the blowpipe valves are closed). If pressure continues to rise beyond 35 kPa, stop using the regulator immediately. It must be repaired or replaced before further use.
4. Do not attempt to loosen or detach any parts from the regulator without first ensuring the gas pressure has been fully released. Pressurised gas can forcefully eject a dislodged part, creating a hazard.
5. Do not open the cylinder unless a pressure regulator has been fitted.
6. An open valve should never be fully opened until resistance is encountered, but should be turned back at least half a turn to prevent the valve from becoming stuck in the open position. This can occur if the valve is left open for long periods of time.
7. Ensure the cylinder valve is fully closed and any gas within the regulator's high and low-pressure chambers has been vented before removing the device from a cylinder.
8. Do not use the regulator as a shut-off valve. To prevent gas flow when downstream equipment is not in use for an extended period, turn off the gas at the source and vent it from the system.
9. Open the cylinder valve slowly and make sure to close it after finishing. When you shut the valve, turn it just enough to stop the gas completely. Do not over tighten.
10. Always stand to the side of the regulator when opening the cylinder valve. Never position yourself directly in front of it.
11. Before opening the cylinder valve, make sure the regulator is securely fitted to the cylinder to prevent sudden gas release under high pressure.
12. Do not attempt to repair or modify the regulator.

DO NOT USE OIL

Never use oil, grease, or other petroleum-based substances on or near this regulator. The presence of oil can cause serious safety hazards, especially when regulators are used in applications involving high-pressure gases. Even with inert gases such as argon, contamination can lead to equipment malfunction, seal degradation, and dangerous cross-use if the regulator is later connected to flammable or oxidising gases. Always ensure all connections, fittings, and threads are clean and completely free of oil or grease before use. Failure to comply with this warning can result in fire, explosion, serious injury, or death.

User Responsibilities

This equipment will perform safely and reliably only if it is installed, operated, maintained, and repaired strictly according to the provided instructions. Regular checks are essential to ensure its ongoing safe and reliable operation.

Any necessary repairs, replacements, or adjustments must be carried out promptly. Do not use equipment that is defective. Immediate replacement is required for parts that are broken, missing, visibly worn, deformed, or contaminated.

Typically, the user will bear exclusive responsibility for any malfunctions resulting from improper usage, inadequate maintenance, or repairs conducted by individuals other than certified repair technicians.

Installation

Before connecting a pressure regulator to a full cylinder always screw out (anticlockwise) the regulation screw. This ensures that there will be no gas flow through the regulator upon initially opening the cylinder valve, reducing strain on the regulator's internal safety component (known as a diaphragm) and increasing the lifespan of the regulator.

Remove the plastic dust seal from the cylinder valve. Before attaching the regulator, ensure the cylinder valve outlet is free from any impurities that could block the orifices or damage the seats. Briefly open then immediately close the valve, directing the outlet away from both people and any potential sources of ignition. Clean the outlet with a lint-free cloth.

If grit, dirt, oil or dirty water enters the cylinder valve outlet, this may cause damage to the valve internals and result in leakage.

⚠ Match the regulator to cylinder. Never connect a regulator designed for a particular gas or gases to a cylinder containing any other gas.

To attach the regulator:

1. Attach the inlet of the regulator to the cylinder, securing it snugly with a proper wrench, but avoid over-tightening. Regulator connections can be fully threaded in by hand and then only require a fraction of a turn to achieve a gas tight seal.
2. Secure the outlet hose tightly, then connect any downstream equipment.
3. For downstream equipment that is sensitive, consider the installation of an additional safety device if the regulator does not include a built-in pressure relief feature.

Operation

Once the regulator is connected to the cylinder with the regulation screw completely disengaged, follow these steps to pressurise:

1. Position yourself to the side of the regulator and gradually open the cylinder valve. Rapid opening can cause a sudden pressure increase, potentially damaging the internal components of the regulator.
2. Ensure all valves on the downstream equipment are closed, then set the regulator to the desired working pressure.

ℹ It's advisable to perform a leak test at the connection points of the regulator using an appropriate leak detection solution or soapy water.

3. Purge any air or non-essential welding grade shielding gas from the system attached to the regulator by briefly opening and then closing each control valve. The duration of the purge process could last as long or longer than ten seconds, depending on both the length and diameter of the hose being cleared.

To adjust the operational flow rate of the regulator:

1. Slowly turn the regulator's regulation screw (clockwise) until the outlet gauge shows the desired flow rate.

i It might be necessary to re-evaluate the flow rate of the gas through the regulator after completing an initial series of welds or cuts, as back pressure within the gas hose assembly can affect readings.

2. To decrease the flow rate, first ensure the welding-grade shielding gas is safely vented from the regulator by opening the downstream valve. Direct the released gas to a well-ventilated area, away from any potential sources of ignition. Then, adjust the screw (anticlockwise) until the gauge reflects the desired flow rate. Finally, shut the downstream valve.

Shutdown

Always close the cylinder valve when the regulator is not in use. For shutdowns lasting longer than 30 minutes, follow these steps:

1. Close the gas cylinder or upstream valve.
2. Open downstream equipment valves to purge the lines, directing the gas to a well-ventilated area, and away from ignition sources.
3. Once the gas is fully vented, turn the regulation screw to its closed position and close the valves on the downstream equipment.
4. Prior to moving cylinders that are not fixed on a specifically designed cart, detach the regulators.

1.2 Equipment Safety

UNIMIG gas welding and cutting equipment is professionally designed, independently tested, and manufactured to comply with Australian Standards. It must be maintained and operated with full awareness of the inherent hazards associated with using oxy-fuel gas mixtures.

Safety Devices

Safety devices must always be used in oxygen-fuel gas systems, and should comply with AS 4603. Additional regulatory requirements may apply depending on your region.

UNIMIG gas welding and cutting kits are supplied with four flashback arrestors that fully comply with AS 4603. This includes:

- Two arrestors for the torch end
- Two arrestors for the regulator end

This configuration provides full protection across the system.

⚠ The gas welding and cutting kits must not be used without all four flashback arrestors installed. Failure to do so may result in a flashback event, which could cause serious injury or death.

The supplied flashback arrestors are designed to handle the flow rates required for the gas equipment and hose configurations included.

If higher flow equipment (such as large heating heads) is used, you must ensure that higher-capacity flashback arrestors are fitted to allow for correct gas flow.

For help selecting the correct arrestors, contact the manufacturer for flow rate data specific to your nozzles and tips.

ℹ The use of safety devices, including flashback arrestors and non-return valves, does not eliminate the need to follow safe operating procedures at all times.

Gas Leaks

Gas leaks are a serious hazard in any situation, regardless of the type of gas involved. Each type of gas presents its own risks:

- Fuel gases are highly flammable and can ignite even at low concentrations in air, requiring minimal energy, such as a small spark or hot surface, to trigger a fire or explosion.
- Oxygen increases the flammability of materials and will intensify any fire, making it burn hotter and faster.
- Inert gases can displace oxygen, leading to a loss of alertness and, if unnoticed, may result in asphyxiation.

Common sources of gas leaks include:

- Cylinder fittings, including valves and safety devices, that are damaged or poorly maintained.
- Valves left open when equipment is not in use.
- Breakable connections that are improperly fitted or in poor condition, such as:
 - Scored or dirty nipples
 - Worn or damaged conical seatings
 - Damaged or missing O-rings
- Hoses in poor or aged condition.

A typical oxygen-fuel gas system includes many connection points - cylinder valves, regulators, hoses, blowpipes, tips, and nozzles - all of which are potential leak points if not properly maintained.

If a leak is suspected or detected:

1. Stop all operations immediately.
2. Attempt to rectify the leak right away, if safe to do so.
3. Turn off or remove all ignition sources from the area.
4. Evacuate and ventilate the area until the gas has safely dispersed.

Hoses & Fittings

- Only use blue hoses for oxygen.
- Acetylene hoses must be red and LPG hoses must be orange. These hoses have different test methods and cover materials and must never be interchanged.
- All hoses must be protected from heat, sparks, slag, mechanical damage, oil, grease, and foot traffic to prevent piercing, burning, or other forms of failure.
- Avoid running hoses over sharp edges, manifolds, or through areas exposed to sparks or hot slag from welding and cutting.
- Hoses and fittings must comply with AS 1335, be securely attached, and leak-free.
- Wire must never be used to fasten hoses to fittings.
- Oxygen fittings use right-hand threads, while fuel gas fittings use left-hand threads.
- Only use UNIMIG hoses and connectors when replacing components.
- The maximum recommended hose length is 15 metres per gas line, or such distance that allows the operator to remain within sight of all connected gas cylinders, whichever is shorter.

Blowpipes, Cutting Attachments & Mixers

Blowpipes control and mix oxygen and fuel gases using a dedicated gas mixer. To ensure safe and effective operation, the following precautions must be followed:

- Ensure the inlet connections match the welding hose fittings provided. Never attempt to force incompatible fittings or connections. All fittings must be tight and leak-free.
- Control valves must be clearly labelled 'O' for oxygen and 'F' for fuel, and colour-coded blue and red to match the corresponding welding hoses.
- Only use mixers and attachments that are specifically designed to fit the blowpipe being used.
- Keep all components clean and free from oil or grease. Never handle blowpipes, cutting attachments, mixers, or accessories with oily rags, hands, or gloves.
- Always follow the manufacturer's recommended maximum and minimum operating pressures and flow rates for your blowpipe, mixer, tip, or nozzle.
- Never hang a blowpipe or gas hose from a regulator or gas cylinder valve.
- Never use a flame to test for gas leaks.

Tips, Nozzles & Fittings

- UNIMIG tips and nozzles are clearly marked with important usage information, including tip size, recommended gas pressures, and plate thickness ranges for cutting applications.
- Always use tips and nozzles that are matched to the specific fuel gas in use (e.g. acetylene or LPG).
- Tips and nozzles are designed to operate safely and efficiently within a limited flow range. Exceeding or dropping below these ranges can affect performance and increase the risk of flashback or overheating. Always follow the manufacturer's recommended operating pressures and flow rates to prevent this risk.
- When setting operating pressures, consider the pressure drop that may occur due to long hose lengths, small hose diameters, or the presence of additional safety devices in the gas line.

1.3 Setup Safety

The UNIMIG gas welding and cutting kit consists of multiple components designed to work together as a system. For safe operation, any replacement parts used in the future must be genuine UNIMIG components or fully compatible parts specifically suitable for use with UNIMIG gas equipment.

Fuel Gas

The choice of fuel gas will directly impact several key system parameters, particularly equipment selection and operating pressures.

- Only use equipment that the manufacturer has explicitly specified for use with the chosen fuel gas.
- Acetylene must not be used at pressures exceeding 150 kPa downstream of the pressure regulator (refer to AS 4267).
- Gas suppliers recommend that the acetylene draw rate should not exceed 1/7 of the cylinder's capacity per hour. For a standard 7m³ acetylene cylinder, this limits the maximum flow rate to 0.14m³/hr (17 L/min).
- LPG components, especially regulators and hoses, must never be used in acetylene systems.
- For LPG systems, only use components that are explicitly designated for LPG. Multi-fuel components may be used only if the manufacturer lists LPG as a supported gas.
- LPG systems are generally not subject to a maximum outlet pressure limit. However, at low temperatures, the vapour pressure in the cylinder may prevent high system pressures.
- A common upper pressure limit for LPG systems is 400 kPa.

Flow Capacity

The tip or nozzle being used dictates the required system pressure and flow rate, which directly determines the pressure regulator settings.

- Always account for pressure drops, especially when using long hoses, small-diameter hoses, or multiple safety devices.
- Excessive pressure drops can cause unstable system behaviour, including the flame retreating into the tip, which may lead to overheating, backfire, or flashback. Pressure drops are particularly important when using acetylene, as it is limited to a maximum pressure of 150 kPa.

 **Always follow the manufacturer's guidelines for pressure settings, flow rates, and component compatibility.**

Leak Testing

Before initial use, inspect all breakable connections, valves, and glands for leaks. Use a pressure drop method or a leak-detection fluid to check for leaks.

 **Do not rely on smell alone to check for leaks, as many individuals have a reduced sense of smell.**

 **Never use a flame to test for leaks.**

Purging the Gas

Purge oxygen and fuel gas hoses before use at the start of each day and after extended periods of inactivity.

 **Purging must never be carried out in confined spaces or near ignition sources. Refer to the operating instructions for the correct purging procedure.**

Lighting the Blowpipe

- Only use flint lighters or stationary pilot flames to ignite the gas flame.
- Do not use hot metal, matches, welding arcs, or hot electrodes to light or re-light the blowpipe.
- Ensure the flame does not come into contact with nearby personnel or combustible materials during ignition.
- Always follow the correct lighting procedure as outlined in the operating instructions.

Operation Intervals

When the blowpipe is not in use, close off both the oxygen and fuel gas at the supply. Blow down the hoses to prevent pressure build-up, leakage, or damage to gauges.

- Always store blowpipes and hoses in a safe location where they cannot be damaged or cause injury.

1.4 Fire Safety

Backfires & Flashbacks

Flame instability at the tip or nozzle is a common cause of emergencies in oxygen-fuel gas systems. These incidents may occur during lighting up or during operation.

The most common causes include:

- Incorrect lighting procedures (especially failing to purge hoses).
- Low gas pressure at the tip or nozzle due to restricted gas flow.
- Damaged or poorly maintained equipment.
- A combination of the above factors.

These issues typically present as one of the following: backfire, sustained backfire or flashback.

Backfire

A backfire is the sudden return of the flame into the blowpipe, usually with a popping sound. The flame may be extinguished or re-ignite at the nozzle.

Sustained Backfire

A sustained backfire occurs when the flame continues to burn inside the neck or handle of the blowpipe. It begins with a popping sound, followed by a hissing noise caused by internal burning. If this occurs:

1. Immediately shut off the gases at the blowpipe; oxygen first, then the fuel gas.
2. Inspect the nozzle or tip condition, gas pressures, and all torch and cylinder connections before restarting.

Flashback

A flashback is a severe condition where the flame travels back through the blowpipe and into the hoses, potentially reaching the regulators or even the gas cylinder. This can cause dangerous heating and decomposition of the gas contents.

If a flashback occurs:

1. Immediately close the oxygen valve on the blowpipe, followed by the fuel gas valve.
2. Close the cylinder valves.
3. If any cylinder shows signs of heating, cool it down according to emergency procedures.
4. Inspect all equipment and check for faults or unsafe conditions before resuming use.
5. Any hose that has experienced a flashback must be discarded and replaced, even if it appears undamaged.

Ignition of Oxygen Regulators, Hoses & High-Pressure Equipment

Although incidents involving ignition of oxygen equipment are rare, when they do occur, the consequences can be severe, including serious injury, major fires, or fatalities. For this reason, extreme care must be taken when using and maintaining oxygen regulators, hoses, and other high-pressure components.

Ignition can occur for several reasons, including spontaneous ignition from contamination, use of incorrect or incompatible equipment, particle ignition from high-velocity gas, the rapid opening of the cylinder valve, or direct flame contact from a nearby acetylene cylinder.

Spontaneous Ignition From Contamination

Oil, grease, and other hydrocarbon liquids can ignite spontaneously in the presence of high-pressure oxygen.

- Never allow oil or grease near oxygen regulators, valves, hoses, or any high-pressure equipment.
- Do not use oil or grease as thread lubricants, and avoid using oily rags, oily tools, or operating equipment with greasy hands.

Use of Incorrect or Incompatible Equipment

Only use equipment rated and marked specifically for oxygen use, with a pressure rating equal to or greater than that of the oxygen cylinders in use.

Regulators, manifolds, and high-pressure leads must be clearly marked for oxygen, kept clean, and maintained in good working condition.

Particle Ignition From High-Velocity Gas

Dirt or particles in fast-moving oxygen streams (such as through pipes or valve seats) can ignite in seals or seating surfaces. Ensure cleanliness in all fittings and connections.

- Always “crack” the cylinder valve momentarily (away from people and equipment) before fitting any regulator, to clear debris.

Rapid Opening of the Cylinder Valve

Opening an oxygen cylinder valve too quickly can generate excessive heat at the regulator seat and seals, leading to ignition.

- The oxygen cylinder valve **MUST** be opened slowly to prevent high-temperature shock to the system.

Direct Flame Contact From a Nearby Acetylene Cylinder

Although rare, incidents have been reported where oxygen cylinders have exploded due to direct flame contact from a nearby acetylene cylinder.

- The fusible plugs on the overheated acetylene cylinder melt, releasing gas.
- The escaping gas ignites, and the flame makes direct contact with the adjacent oxygen cylinder.
- This causes the oxygen cylinder wall to soften, bulge, and rupture, even without a significant rise in internal pressure.
- In such cases, the bursting disc may not activate, meaning there is no pressure relief, and the cylinder fails structurally.

Oxygen and fuel gas cylinders should be stored a safe distance apart (3m or more). When oxygen and acetylene cylinders are stored or used side by side, additional protection should be considered:

- Install a non-flammable shield between the cylinders.
- Suitable materials include a 2-3mm steel sheet or refractory fibre board.
- The shield should extend from the shoulder of the acetylene cylinder up to the top of the oxygen regulator.

Actions to be Taken in the Event of a Cylinder Fire

Gas cylinders can explode in a fire. The most frequent incidents involve ignition of fuel leaks at regulator or hose connections located near the cylinder. If there are cylinders in a fire, the following actions should be taken:

- Immediately close the cylinder valve or back off the regulator adjusting screw using a gloved hand, and extinguish the fire if possible.
- If the fire cannot be extinguished quickly, use a dry powder or CO₂ extinguisher and then close the cylinder valve to prevent re-ignition.
- If extinguishing attempts fail, do not continue. Evacuate the area (minimum 100m).
- Call the fire department.
- Direct others within a 100 to 300m area to take cover.
- If attempting to extinguish the fire, do so from a protected position and use large volumes of water.
- When the fire fighters arrive, inform them of the location, number and names of gas cylinders in the area.
- Gas cylinders not directly in the fire and that have not heated up should be moved as quickly as possible to a safe place so long as this can be done without undue risk, and ensure the cylinder valves are closed.
- Heated cylinders (especially acetylene) can explode even after the flames have been extinguished.
- Notify your gas supplier as soon as possible.
- If you are unsure of the gas contents, treat the situation as though acetylene is involved and follow the strictest safety protocols.

Acetylene Cylinder Overheating

Acetylene cylinders can become overheated due to flashback or external heat sources, such as contact with hot equipment or surrounding fires. Overheating poses a significant safety risk and must be addressed immediately.

If overheating is detected, follow this procedure:

- Shut the cylinder valve immediately and notify the gas supplier as soon as possible. If the cylinder is actively on fire, call the fire department immediately.
- Evacuate the area of all personnel.
- Begin cooling the cylinder using a large, continuous supply of water, preferably from a fire hydrant. The operator should remain behind a protective barrier while doing this.
- If the cylinder's safety device activates and the escaping gas ignites, continue cooling but do not extinguish the flames. If the gas does not ignite, all nearby ignition sources must be removed, but only if it can be done safely.
- Continue the cooling process, pausing periodically to observe whether the cooling water evaporates from the surface of the cylinder or remains.
- Once the water no longer evaporates and the cylinder remains wet, it should be moved, if safe to do so, to an open area away from ignition sources. The cylinder should then be submerged in water, such as in a 200-litre drum.
- Continue the cooling process for at least 24 hours, or as instructed by a qualified authority.

2. Gases

The flames used in gas welding, cutting, and related processes are produced by igniting mixtures of oxygen and suitable fuel gases, with acetylene and LPG being the most commonly used.

All of these fuel gases, especially when combined with compressed oxygen, can release extremely large amounts of energy as heat or through explosion, and they require only minimal energy to initiate such reactions.

As a result, they must always be handled with extreme caution and in strict accordance with clearly defined safety procedures.

Each fuel gas & oxygen combination requires careful handling, from the management of gas supplies to the point of ignition. Leaks significantly increase the risk of fire and explosion, and asphyxiation is also a potential hazard due to the displacement of air in areas where leaks occur.

All fuel gases possess specific properties that necessitate additional safety precautions.

Certain industrial gases may be flammable, oxidising, toxic, or corrosive, and handling them demands special precautions. Users must always keep Material Safety Data Sheets (MSDS), typically available from gas suppliers, for every type of gas stored or used on-site.

The table below provides a summary of the properties, characteristics, and associated hazards of the most commonly used gases.

Property	Oxygen (O ₂)	Acetylene (C ₂ H ₂)	LPG (C ₃ H ₈)
Density relative to air	1.103	0.901	1.52 to 2
Ignition limits V% in air		2.5 to 80	2.2 to 9.5
Ignition limits V% in oxygen		2.5 to 80	2 to 57
Ignition temp °C in air		423	554
Ignition temp °C in oxygen		428	530
Flame temp in air		2325	1925
Flame temp in oxygen		3100	2800
Smell	Odourless	Pungent	Pungent
Gas cylinder colour (AS 4484)	Black	Maroon	Silver/Grey
Regulator colour (AS 4267, AS 4480)	Black	Red	Orange
Welding hose colour (AS 1335)	Blue	Red	Orange
Safety device colour (AS 4603)	Blue	Red	Red

2.1 Physical & Safety Properties of the Gases Used

Oxygen

Oxygen cylinders are black and are compressed to 17,500 kPa. The pressure of the cylinder directly relates to the quantity of the gas. If the gas pressure is at half, only half the cylinder remains.

Oxygen is odourless and is generally considered non-toxic at atmospheric pressure. Pure oxygen is a single element (O₂) and makes up about 21% of the air by volume. When fuel gases are burned in pure oxygen, they reach higher temperatures compared to burning in regular air. Oxygen enhances the combustion process, increasing the flame's heat output.

Information: Air is a mixture of gases. It contains approximately 78% nitrogen, 21% oxygen, and small amounts of argon (0.93%), carbon dioxide (0.04%), and trace gases. Gases react differently in oxygen compared to air.

Warning: Oxygen should never be called air.

Oxygen itself does not burn but supports and accelerates combustion in other substances, including those not normally considered combustible and which may be readily ignited by sparks.

If the pressure of an oxygen cylinder rises due to a fire, a bursting disc safety device will fracture before the cylinder can rupture.

Oxygen in contact with oil, grease, rust, or other hydrocarbons can cause spontaneous ignition, potentially leading to fires or explosions. Therefore, all oxygen systems, such as cylinders, pipework, regulators, and blowpipes, must be kept entirely free from these contaminants to prevent violent reactions.

Proper advice should always be obtained, such as from gas suppliers or equipment manufacturers, before using any materials with oxygen. This is especially important for lubricants, seals, and thread sealants, including PTFE tape, unless they are specifically supplied and clearly marked as suitable for use with oxygen.

When working with oxygen, the following should be taken into account:

- Do not use oxygen to “refresh” or “sweeten” the air to improve air quality after welding or cutting. Gas cylinders under pressure can release large volumes of oxygen in a short time, creating a highly dangerous environment.
- Take care in confined spaces. Even slow leaks can cause hazardous conditions.
- Do not leave blowpipes or hoses connected to the supply gases within confined spaces.
- Ventilate confined spaces to reduce the risk of increased oxygen content in the air.
- Do not use oxygen as a substitute for compressed air.
- Never use oxygen to start engines, drive air tools, etc.
- Do not use oxygen or compressed air to dust off clothes. Clothes can become readily flammable and even self-igniting through oxygen enrichment.
- Do not kink pressure hosing. Gas can still bleed through the system or, more seriously, escape rapidly should the operator lose their grip or the hose rupture.

Each year, numerous accidents, ranging from minor injuries to fatal incidents, occur due to the misuse of oxygen or a failure to understand its properties and the risks associated with them.

Acetylene

Acetylene cylinders are maroon. It is a highly flammable gas in both oxygen and air. Acetylene cylinders are filled with a porous mass and acetone. The gas is dissolved in the acetone, allowing it to be stored safely up to 1,800 kPa. This is what gives acetylene gas the name ‘dissolved acetylene’ or ‘DA’.

Acetylene has a distinctive garlic smell. It is non-toxic, but it can lead to asphyxiation through the depletion of oxygen. Acetylene is lighter than air, so leaked acetylene will dissipate. However, a concentration of as little as 2.5% in the air can burn.

Acetylene can react with metals such as copper and silver to produce explosive acetylides. Copper alloys containing more than 70% copper or 43% silver should never be used with acetylene under pressure. Copper welding tips and nozzles are safe to use as they are downstream of the gas mixer.

Acetylene cylinders have fusible plugs in the neck ring, which will melt in the event of a fire.

The oxy-acetylene flame produced reaches 3,160°C and is the hottest flame available for gas welding mild steel. Tips and nozzles used with acetylene are stamped ‘A’ (for acetylene). They must not be used with LPG.

When working with acetylene, the following should be taken into account:

- High-pressure acetylene gas is unstable and must never be used outside the cylinder at a pressure exceeding 150 kPa.
- In its free state under pressure, this gas can decompose with explosive force, which is why it is stored in specially designed cylinders.
- Explosions can occur in pure acetylene subjected to excessive temperature or pressure.
- Mechanical shock to the cylinder due to mishandling or overheating when under high pressure may also cause decomposition, giving rise to high temperatures and possible detonation even in the absence of oxygen.
- Flashback in welding, heating, or cutting blowpipes is another potential cause of detonation, which is why safety devices are strongly recommended in the blowpipe gas supply line.

Acetylene’s properties are carefully considered in the design of storage and supply systems, and when safe procedures are followed, hazardous situations can be effectively prevented.

Liquefied Petroleum Gas (LPG)

Liquefied Petroleum Gas (LPG) cylinders are silver. It is a flammable gas and is stored as a liquid in the cylinder at a pressure of less than 1,000 kPa.

Standard LPG has been artificially odourised and has a fish-like smell for safety. It is non-poisonous, but it can lead to asphyxiation through the depletion of oxygen. LPG consists primarily of propane (C₃H₈) as well as a mixture of other gases.

LPG is heavier than air and will collect in low-lying or confined spaces, e.g. ducts, drains, basements, and closed tanks. A concentration of as little as 2.2% in the air can burn.

LPG cylinders have a spring-loaded safety device that releases gas in the event of the cylinder being overheated or overfilled.

The oxy-LPG flame produced is not suitable for gas welding mild steel, but is used for heating, brazing and cutting. Tips and nozzles used with LPG are stamped 'P' (for propane). They must not be used with acetylene.

When working with LPG, the following should be taken into account:

- It is a fire and explosion hazard and requires minimum energy to ignite when mixed with air or pure oxygen.
- LPG will ignite and burn instantly from a spark or piece of hot metal.

2.2 General Care of Cylinders

Cylinders used for oxygen, acetylene, and LPG are thin-walled, highly pressurised vessels. Due to the high internal pressure, both full and partially filled cylinders can cause serious injury or damage if they rupture. Slow gas leaks may also pose risks of fire, explosion, or asphyxiation.

- Oxygen, hydrogen, carbon dioxide, and inert gas cylinders are fitted with bursting disc safety devices.
- LPG cylinders are fitted with spring-loaded pressure relief valves.
- Acetylene cylinders are filled with a porous material saturated with acetone and these cylinders also include fusible safety plugs to allow safe gas escape during overheating.

Because of these risks and the specific properties of stored gases, the following precautions must be taken when handling and using cylinders:

- Cylinders are typically hired or loaned from gas suppliers, who ensure they undergo the periodic testing required by Australian Standards and statutory regulations.
- Do not tamper with cylinder markings or colour codes. Never use cylinders without labels or identifying colour codes. If unsure, return the cylinder to the supplier.
- Cylinders must only be refilled by authorised, competent organisations using the correct gas and with the owner's permission. Refilling with an incorrect gas is not allowed.
- Only use gases for their intended purpose. For example, do not use oxygen for dusting, ventilation, or breathing support.
- Always identify gases by their correct names to avoid dangerous mix-ups.
- Never attempt to disguise or repair a damaged cylinder (e.g. dented). Seek guidance from the gas supplier before use.
- Protect valve seats and outlets from dirt and contamination during connection or disconnection. Dirt, fibres, or oil can enter the system, causing leaks or ignition. This is especially dangerous with high-pressure oxygen, which can ignite oils or hydrocarbon residues. Report any valve or outlet damage.
- Keep cylinders away from any heat sources, such as furnaces, radiators, or welding flames. Avoid the flame from directly contacting cylinders or equipment surfaces from cutting or welding blowpipes. The fusible plugs in acetylene cylinders are particularly sensitive and overheating may lead to an acetylene flame venting vertically.
- Never tamper with safety devices.
- Always return cylinders with the valve properly closed.

2.3 Storage of Cylinders

UNIMIG gas welding and cutting equipment is intended for use with gases supplied from compressed gas cylinders. In all instances, gas supplies may be governed by statutory or regulatory requirements. Numerous Australian Standards apply to this area.

The placement, separation, permitted quantities, and appropriate signage for gas storage must comply with the relevant statutory regulations and the manufacturer's guidelines.

When storing gas cylinders, all requirements in the Australian Standard AS 4332:2004, "The storage and handling of gases in cylinders" and Dangerous Goods regulations must be followed. These include:

- Do not store cylinders near combustible materials or flammable liquids.
- Keep cylinders away from heat sources (e.g. open flames).
- Keep cylinders in well-drained areas away from water.
- Keep cylinders in well-ventilated areas, ideally not in confined spaces.
- Keep cylinders clean at all times.
- External storage is preferred whenever possible.
- Weather protection is desirable but must not compromise ventilation.
- Cylinders should not be stored alongside other products, particularly oil, paints, or corrosive liquids.
- Avoid below-ground storage, where possible and where it is unavoidable; consider enclosed space risks.
- Storage areas should be designed to prevent unauthorised entry, protect untrained people from hazards and guard cylinders from theft.
- Different types of gases should be stored separately.
 - Oxygen cylinders must be separated from fuel gas cylinders by a distance greater than 3 meters.
 - LPG cylinders in excess of 50kg total capacity should not be stored within 3 meters of any other cylinders, including acetylene.
- Storage areas must clearly display signage in accordance with the Dangerous Goods regulations, including:
 - Class Diamonds
 - HAZCHEM
 - No smoking and naked flame warning signs
- Full and empty cylinders should be kept separate; all cylinders should be treated as full, regardless of their content.
- Gas cylinders must be stored upright on a firm, level floor and restrained to prevent falling.
- Store cylinders away from heavy traffic and emergency exits.

2.4 Handling of Cylinders

When handling gas cylinders, current manual handling regulations should be followed, and precautions should be taken, including:

- Safety shoes and gloves should be worn when handling cylinders.
- Cylinders should be handled with care and not knocked violently or allowed to fall.
- Never lift a cylinder with magnets, chains or a sling. Use a cradle when lifting by crane.
- Do not move cylinders with the cylinder valves open.
- Cylinders should be moved with the appropriate size and type of trolley for manual handling and should incorporate a heat shield in the event of close proximity between the fuel gas and oxygen cylinder.
- Cylinder valves must be closed when moving cylinders and equipment detached.
- Never roll cylinders along the ground; this may damage the identification labels and/or cause the valve to open accidentally.

 **Follow all safety, storage and handling precautions recommended by the gas cylinder manufacturer.**

2.5 Use of Cylinders

Cylinders must always be used in accordance with the manufacturer's instructions and recommendations. The following precautions must be followed:

- Never "crack" a fuel gas cylinder valve near any ignition source.
- Valves or regulators that are damaged, or suspected to be damaged, must not be used until they have been inspected by a qualified service agent or technician.
- Cylinders must never be used as rollers or supports to move other objects.
- Acetylene and LPG cylinders must always be kept in a vertical or near-vertical position, whether in use or empty.
- Acetylene must never be used at a pressure above 150 kPa. Pressures beyond this limit can lead to gas instability and explosion.
- Cylinder valves must only be opened using approved hand wheels or keys. Do not use excessive force or extension bars to open or close valves.
- Acetylene cylinder valves should not be opened more than one and a half turns; one turn is recommended to allow quick shut-off in an emergency.
- Empty cylinders must have the valve fully closed, protective caps fitted, and be clearly marked, for example, with "MT" written in chalk.

2.6 Transport of Cylinders

When transporting gas cylinders, all requirements under the ADG Code and other applicable regulatory guidelines must be followed. Sensible precautions must be taken to ensure safe transport at all times.

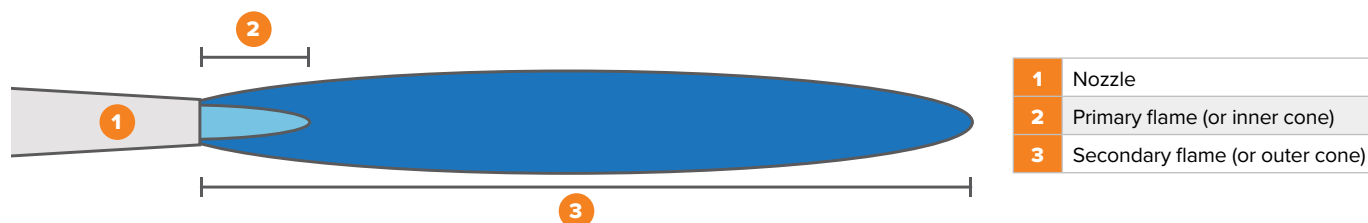
- Use open vehicles wherever possible.
- If closed vans or cars must be used, ensure they are properly ventilated at all times.
- Make sure all cylinder valves are fully closed and check for leaks before transport.
- Cylinders must be securely restrained to prevent any movement during transit.
- Do not allow any part of a cylinder to protrude from the vehicle. This includes never carrying cylinders horizontally across forklift tines.
- Disconnect all equipment, such as pressure regulators, from cylinders before transport.
- Do not use cylinders inside a closed vehicle.
- Acetylene and LPG cylinders must always be transported upright, even when empty. This ensures the cylinder's internal safety devices remain in contact with vapour, not liquid.

2.7 Flame Properties of the Fuel Gases

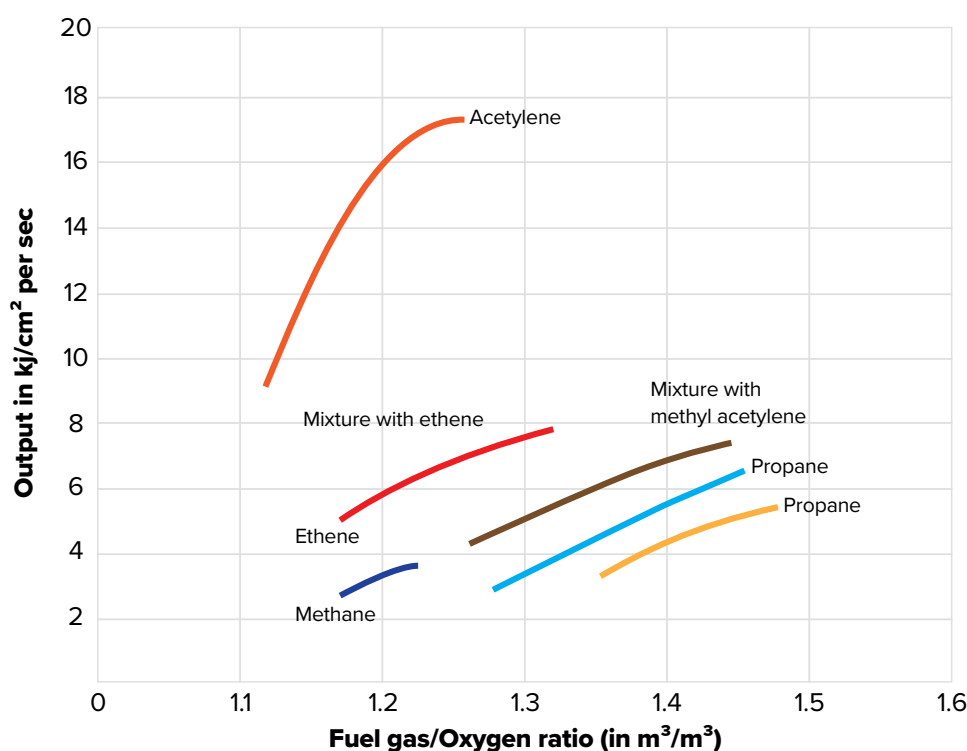
Each fuel gas has a unique carbon-to-hydrogen ratio, which determines the amount of oxygen required for efficient combustion. This fuel-to-oxidant ratio impacts the flame temperature, as well as the flammability and explosive limits of the gas.

The oxy-acetylene flame, when mixed at a 1:1.1 fuel-to-oxygen ratio, achieves the highest flame temperature (3,160°C) with the least amount of oxygen of all fuel gases. Increasing the oxygen ratio reduces the flame temperature while increasing oxidation caused by the gas mixture.

LPG is a by-product of crude oil refinement and is made up of several gases like methane, butane and propane. The ratios of these gases can vary, altering the flame properties between different suppliers. Propane flames can reach temperatures of up to 2,840°C but require a higher fuel-to-oxygen ratio of 1:3.75.



	Acetylene (C ₂ H ₂)	LPG (C ₃ H ₈)
Ratio of fuel to oxygen	1:1.1	1:3.75
Maximum flame temperature	3,160°C	2,840°C
Heat distribution in primary flame (kJ/m ³)	18,890	10,433
Heat distribution in secondary flame (kJ/m ³)	35,882	85,325



2.8 Applications

Process	Acetylene	LPG	Notes
Cutting	Yes	Yes	The choice to oxy-cut depends on the material thickness, equipment used, and operator preference.
Brazing*	Yes	Yes	Acetylene is recommended for brazing due to its higher primary flame heat.
Heating*	Yes	Yes	The material thickness, equipment, and operator preference are factors, but LPG is primarily used because of its higher secondary flame heat.
Welding	Yes	No	LPG is unsuitable for welding due to its low flame temperature and high water combustion.
Flame gouging	Yes	Yes	Acetylene is recommended for flame gouging because of its high primary flame temperature and heat.
Straightening/Bending	Yes	Yes	The material thickness, equipment, and operator preference are factors, but LPG is often used for its higher secondary flame heat.
Cleaning	Yes	Yes	The material thickness, equipment, and operator preference are factors, acetylene is typically used for its localised heat, which effectively cleans steel surfaces.
Spot heating	Yes	Yes	Acetylene is recommended for spot heating because of its higher primary flame heat.
Thermal spraying materials	Yes	Yes	Acetylene is recommended for thermal spraying due to its higher flame temperature.
Case hardening	Yes	Yes	Acetylene is recommended for case hardening because it adds carbon into the surface of the material.

**Fuel gas can be used with oxygen or air*

3. Package Contents

3.1 Oxygen/Acetylene Kit

SKU	Description
U11263	Vertical Inlet Oxygen Regulator
U11373	Vertical Inlet Acetylene Regulator
U11381	Blowpipe Handle
U11382	Gas Cutting Attachment
U11385	Type 550 Gas Mixer
U11475	Oxy-Acetylene Twin Gas Hose Set 10m
U11429	Type 551 Acetylene Welding Tip Size 8
U11430	Type 551 Acetylene Welding Tip Size 10
U11431	Type 551 Acetylene Welding Tip Size 12
U11432	Type 551 Acetylene Welding Tip Size 15
U11433	Type 551 Acetylene Welding Tip Size 20
U11392	Type 41 Acetylene High Speed Cutting Nozzle Size 6
U11393	Type 41 Acetylene High Speed Cutting Nozzle Size 8
U11394	Type 41 Acetylene High Speed Cutting Nozzle Size 12
U11395	Type 41 Acetylene High Speed Cutting Nozzle Size 15

SKU	Description
U11446	Oxy Welding Goggles
U11444	Flint Lighter
U11478	Roller Guide & Radius Bar
U11443	Tip Cleaner
U11439	Oxy-Acetylene Heating Tip Size 8x12
U11445	Combination Spanner
U11657	Fuel Gas Flashback Arrestor - Blowpipe Mount
U11659	Fuel Gas Flashback Arrestor - Regulator Mount
U11656	Oxygen Flashback Arrestor - Blowpipe Mount
U11658	Oxygen Flashback Arrestor - Regulator Mount

3.2 Oxygen/LPG Kit

SKU	Description
U11263	Vertical Inlet Oxygen Regulator
U11375	Side Inlet LPG Regulator
U11381	Blowpipe Handle
U11382	Gas Cutting Attachment
U11385	Type 550 Gas Mixer
U11472	Oxy-LPG Twin Gas Hose Set 10m
U11436	Type 554 LPG Brazing Tip Size 8
U11601	Type 554 LPG Brazing Tip Size 10
U11437	Type 554 LPG Brazing Tip Size 12
U11438	Type 554 LPG Brazing Tip Size 15
U11602	Type 554 LPG Brazing Tip Size 20
U11408	Type 44 LPG High Speed Cutting Nozzle Size 6
U11409	Type 44 LPG High Speed Cutting Nozzle Size 8
U11410	Type 44 LPG High Speed Cutting Nozzle Size 12
U11411	Type 44 LPG High Speed Cutting Nozzle Size 15

SKU	Description
U11446	Oxy Welding Goggles
U11444	Flint Lighter
U11478	Roller Guide & Radius Bar
U11443	Tip Cleaner
U11445	Combination Spanner
U11657	Fuel Gas Flashback Arrestor - Blowpipe Mount
U11659	Fuel Gas Flashback Arrestor - Regulator Mount
U11656	Oxygen Flashback Arrestor - Blowpipe Mount
U11658	Oxygen Flashback Arrestor - Regulator Mount

4. Gas Welding

4.1 Gas Welding Installation

 **Do not perform any part of the installation procedure near an ignition source.**

Installing the Regulators & Gas Hoses

 **There is a risk of an accident if the gas cylinder is improperly or inadequately secured, which could result in severe injury.**

1. Screw in the oxygen regulator to the oxygen cylinder and the acetylene regulator to the acetylene cylinder. Fasten them with a spanner to prevent leaks.

 **The fuel gas (acetylene) fittings are left-hand threads, as indicated by notches on the nuts.**

2. Attach the regulator-mounted oxygen flashback arrestor (FBA) to the oxygen regulator and the regulator-mounted acetylene FBA to the acetylene regulator.
3. Connect the blue oxygen hose to the oxygen FBA and the red acetylene hose to the acetylene FBA.
4. Open the gas cylinder valves slowly. Slightly turn the regulator knobs clockwise to open them and clear the gas hoses of dirt and dust.
5. Twist the knobs anticlockwise to close the valves.

Assembling the Gas Welding Torch

1. Attach the blowpipe-mounted oxygen (right-hand thread) FBA and acetylene (left-hand thread) FBA to the blowpipe handle. The valves are labelled 'O' for oxygen and 'F' for fuel gas.
2. Connect the gas mixer to the blowpipe.
3. Screw the gas welding tip into the mixer.
4. Loosen the gas mixer from the blowpipe to adjust the alignment of the welding tip to a suitable position and re-tighten the gas mixer.

Connecting the Gas Welding Torch

1. Connect the oxygen and acetylene gas hoses to the blowpipe-mounted oxygen and acetylene FBAs.

Checking for Gas Leaks

1. Close the blowpipe valves by turning them clockwise.
2. Slowly open the oxygen gas cylinder valve and set the oxygen regulator to roughly 100 kPa.
3. Close the oxygen cylinder.

If there are no leaks, the pressure registered by the regulator gauge will not change.

Repeat this process with the acetylene.

If there is a leak, it can be located by applying a leak testing solution (e.g. dishwashing liquid mixed with water) to the connection joints. The solution will bubble or produce suds if there is a gas leak.

 **Never use flames to locate gas leaks.**

4.2 Gas Welding Operation

Preparing for Operation

Before using the equipment, ensure that all the necessary installation actions have been completed according to your equipment setup and instructions.

-  **Always check before use that the gas hoses, regulators and torch fittings are in serviceable condition. Ensure that there is no oil or other contamination present on the connections.**

Lighting Up

1. Open the oxygen regulator knob before opening the oxygen cylinder valve.
2. Open the oxygen blowpipe valve and then adjust the oxygen regulator to set the correct pressure.
3. Let the gas flow to purge the system of air.
4. Close the blowpipe valve.
5. Repeat these steps for acetylene. Use a pressure chart if necessary to set the correct acetylene pressure.

-  **Never use acetylene at a gauge pressure above 100 kPa.**

6. Open the acetylene blowpipe valve slightly and light the blowpipe with a flint lighter.

-  **Do not use cigarette lighters or matches.**

7. Continue to open the acetylene blowpipe valve until the flame is no longer producing soot.
8. Open the oxygen blowpipe valve slowly until a neutral flame is produced (see “Gas Welding Flames” on page 27).

Shutting Down

1. Close the acetylene blowpipe valve.
2. Close the oxygen blowpipe valve.
3. Close both gas cylinder valves.
4. Open the oxygen blowpipe valve to drain the oxygen from the system. Close it again when both oxygen regulator gauges read 0.
5. Close the oxygen regulator knob.
6. Open the acetylene blowpipe valve to drain the acetylene from the system. Close it again when both acetylene regulator gauges read 0.
7. Close the acetylene regulator knob.

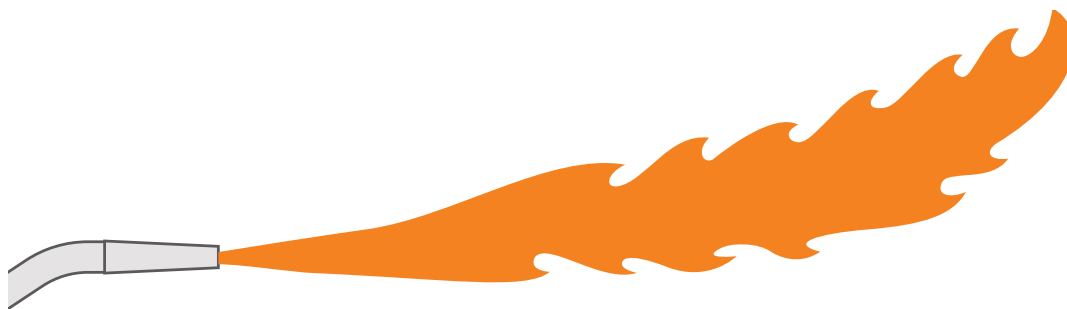
4.3 Gas Welding Guide

What Is Gas Welding?

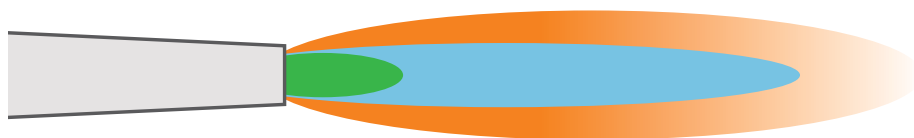
Gas welding is the process of joining metals by heating them with a flame produced from the combustion of a fuel gas and oxygen. The most commonly used fuel gas is acetylene, which, when combined with oxygen, creates an oxy-acetylene flame capable of reaching temperatures up to 3,160°C.

Gas Welding Flames

Acetylene burning in air



Carburising flame



Neutral flame



Oxidising flame



Carburising Flame

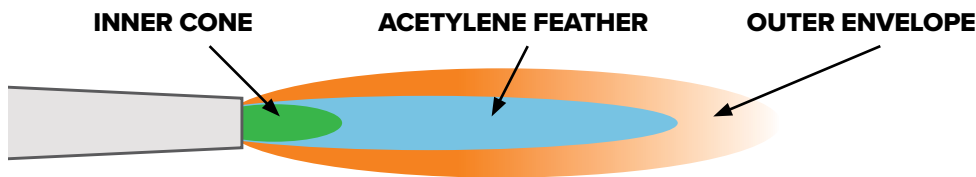
The carburising (or reducing) flame is produced when the acetylene content in the mixture is higher than the oxygen content. It has an approximate temperature of 3038°C.

There are three sections of the carburising flame:

- An inner cone
- An intermediate cone of whitish colour (acetylene feather)
- An outer envelope

The carburising flame is characterised by the prominent acetylene feather, which appears between the inner cone and the outer envelope. The outer flame envelope is longer and typically brighter than that of a neutral flame.

When using a carburising flame for welding, the metal may exhibit a boiling effect that reduces visibility. Steel absorbs carbon from the flame, transforming its composition. After cooling, the welded area may display properties similar to high-carbon steel.

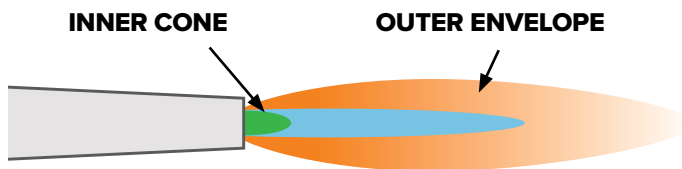


Neutral Flame

The neutral flame is produced when the ratio of oxygen to acetylene in the mixture is approximately one-to-one. It is called “neutral” because it has no chemical effect on the metal being welded - it does not oxidise the weld metal or increase its carbon content.

This flame is characterised by a clear, well-defined inner cone, which indicates complete combustion. While in use, the flame draws additional oxygen from the air, enhancing its combustion properties. The temperature near the inner cone tip averages about 3220°C, while the temperature at the outer envelope is around 1260°C.

The neutral flame is commonly used for welding materials such as mild steel, stainless steel, cast iron, copper, and aluminium. It must be properly adjusted before welding to ensure optimal performance.



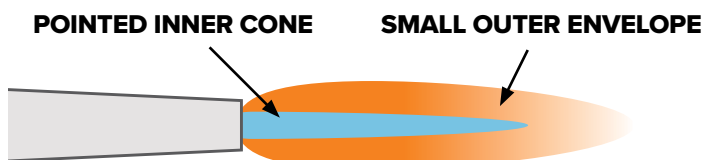
Oxidising Flame

The oxidising flame is produced when the oxygen content in the mixture exceeds the acetylene content. This flame is hotter than a neutral flame, reaching temperatures as high as 3480°C. The outer flame envelope is shorter and fans out at the end, in contrast to the sharp points of neutral and carburising flames.

To achieve an oxidising flame, the torch is first adjusted to a neutral flame, and then the oxygen flow is gradually increased. This process reduces the length of the inner cone to about one-tenth of its original size. The inner cone takes on a slightly purplish hue and becomes pointed, accompanied by a distinct hissing sound.

Oxidising flames are typically used for welding metals such as zinc, copper, manganese steel, brass, bronze and cast iron.

When applied to steel, this flame causes the molten metal to become foamy and release sparks, indicating that the steel is burning due to the excess oxygen. This results in porous, oxidised, and brittle welds, making the oxidising flame unsuitable for welding steel.



Gas Welding Thicknesses

Type 551 Welding Tip Size	Steel Thickness (mm)	Acetylene Pressure (kPa)	Oxygen Pressure (kPa)	Acetylene Gas Flow (L/min)	Oxygen Gas Flow (L/min)
4	<0.5	50	50	1.5	1.5
6	0.5-0.8	50	50	1.5	1.5
8	2.0	50	50	2	2
10	2.6	50	50	3	3
12	3.2-4.0	50	50	4	4
15	5.0-6.5	50	50	7	7
20	8.2-10.0	50	50	12	12
26	13.0-19.0	50	50	22	22

Travel Direction & Angle

The most common gas welding technique is to travel in a pushing direction (in the direction the tip is pointing) at an angle of 60-75° to the workpiece. The flame should spread ahead of the weld, preheating the material.

The angle may vary based on factors such as tip size, metal thickness, and specific welding conditions. For metals other than mild steel, angles between 30 and 45 degrees are sometimes required.

An oscillating or circular motion of the blowpipe is commonly used, and the cone of the flame should remain within the weld puddle. The tip of the inner flame cone should be positioned about 2-3mm above the metal surface.

Puddling

Puddling refers to the creation and control of a molten pool of metal that is carried along the seam being welded. The weld puddle provides critical feedback to the welder, including:

1. The weld penetration, as a larger puddle diameter indicates greater penetration.
2. The size and behaviour of the puddle help determine how quickly to move the blowpipe.
3. The type of flame:
 - A neutral flame produces a smooth, glossy puddle
 - A carburising flame results in a dirty, dull puddle
 - An oxidising flame causes the puddle to bubble and spark
4. The puddle indicates when and if filler material is needed.

Beginner welders should practice forming and controlling weld puddles without using filler metal to develop the proper technique.

Backfires

The blowpipe can backfire (pop), which is a small explosion at the blowpipe tip that occurs due to one or more of the following reasons:

1. The gas flow does not match the size of the tip being used.
2. The tip is overheating, which can happen from welding too close to the metal or for prolonged periods. Overheating may also lead to flashbacks, which should be avoided.
3. Particles of carbon or metal can become lodged inside the tip and cause blockages. Clean the tip using the correct-sized tip cleaning drill or a universal tip cleaner.

Welding With Rods

Most oxy-acetylene welding applications require a filler metal to enhance the strength and shape of the weld. This filler metal is supplied through a filler rod.

To use the filler rod:

1. Create a puddle at the starting point of the joint.
2. With your other hand, position the rod approximately 10mm from the blowpipe flame and 2-3mm above the surface of the puddle.
3. In this position, preheat the rod and dip it into the puddle as needed to add weld metal.

Filler Rod & Flux Selection Chart

Metal	Flame	Filler Rod	Flux
Iron			
Wrought iron	Neutral	Mild steel	None
Low carbon iron	Neutral	Mild steel	None
Carbon Steel			
Low carbon (M, S)	Neutral	Copper-coated steel	None
Medium carbon	Slightly carburising	Low carbon steel	None
Cast Steel			
Plain carbon	Neutral	Copper-coated steel	None
Low alloy	Neutral	Low carbon steel	None
Cast Iron			
Grey cast irons	Neutral	Cast iron	Cast iron
Low Alloy High Tensile Steel			
General	Neutral	Low carbon steel	None
Carbon & chrome-molybdenum steel (0.5 moly type)	Neutral	Cr-Mo steel	None
Manganese alloy steel	Neutral	Low carbon steel	None
Stainless Steel			
Stainless iron (12-28% Cr)	Strictly neutral	300 series stainless steel	None
Stainless steel (18% Cr to 8% Ni)	Strictly neutral	Stainless steel	None
Molybdenum bearing	Strictly neutral	316L stainless steel	None
Copper & Copper Alloy			
Commercial bronze & low brass	Slightly oxidising	Bronze	High-temperature brazing flux powder
Spring, admiralty & yellow brass	Slightly oxidising	Bronze	High-temperature brazing flux powder
Muntz metal, tobin bronze & navel brass	Slightly oxidising	Bronze	High-temperature brazing flux powder
Nickel silver	Neutral	Nickel bronze/silver	High-temperature brazing flux powder
Phosphor bronze	Slightly oxidising	Bronze	High-temperature brazing flux powder
Aluminium & Aluminium Alloy			
Pure	Neutral	Aluminium 1080	Aluminium
Aluminium manganese	Neutral	Aluminium 1080	Aluminium
Aluminium silicon magnesium	Neutral	Aluminium 4043	Aluminium
Aluminium magnesium	Neutral	Aluminium 5356	Aluminium

4.4 Gas Welding Troubleshooting

i The issues and potential reasons outlined are not exhaustive but indicate common scenarios that might arise with regular use of the machine.

Problem	Recommended Actions
The blowpipe backfires	• Increase the gas flow or reduce the size of the welding tip. • The welding tip may be too hot, allow it to cool. • The tip may have carbon or metal inside it, clean the tip.
Distortion & warping	• Clamp the parts properly to prevent shrinkage. • The parts may not be heating evenly, preheat the weld and distribute the welding across the workpiece. • The travel speed may be too slow, increase the travel speed. • Do not leave excessive space between the parts.
Welding stresses	• The joint may be too rigid, allow the parts movement as long as possible when fitting the joint. • The welding procedure may be incorrect, make as few welds as possible and clamp parts.
Cracked welds	• The weld may be too small for the plate size, increase the size of the weld by adding more filler material. • Check that the fusion is good. • Check that the joint preparation is uniform and there is a proper sized gap.
Undercut	• The welding technique may be incorrect, do not weave the torch or filler rod excessively. Do not hold the torch too close to the workpiece. • Check the welding tip size is correct. • Increase the amount of filler rod added.
Lack of penetration	• The joint preparation may be incorrect, or the material is too thick. The joint preparation and design should allow access to the bottom of the groove while maintaining proper welding technique. • The filler rod may be too large, decrease the size. • Reduce the travel speed. • The welding tip may be too small, increase the size.
Porous welds	• Check the chemical analysis of the chosen filler rods. • The puddling time is insufficient to allow trapped gas, oxides and slag inclusions to escape to the surface. • The flame adjustment is incorrect.
Brittle welds	• The base metal has a high carbon or alloy content. • The flame adjustment is incorrect.
Lack of fusion	• Check the welding tip size is correct. • Check the filler rod size is correct. • The welding technique may be incorrect, the weave should be wide enough to melt both sides of the joint. • Check that the joint preparation is uniform and there is a proper sized gap.
Corrosion	• Check the chemical analysis of the chosen filler rods. • Use the proper flux on both the base metal and the filler rod.

4.5 Other Joining Processes

Braze Welding

Braze welding is a welding method where the metal parts are joined over a localised area using a nonferrous filler metal with a melting point above 450°C but below the melting point of the base metals. Unlike brazing, the joint surfaces are not closely fitted, and the filler metal is not distributed by capillary attraction. Instead, the filler is deposited to create a weld, resulting in a joint that externally resembles a traditional welded joint.

Advantages

- There is minimal distortion due to the lower heat input in the base metal.
- The lower heat input allows for faster welding speeds.

Disadvantages

- The joint is weaker at higher temperatures compared to other welding methods.
- The colour between the base metal and the deposited weld is mismatched.

Compatible Joints

- Fillet joints
- Lap joints
- Butt joints

Brazing

Brazing is a metal-joining process in which a filler metal with a melting point above 450°C but below the melting point of the base metals is melted and drawn into the joint by capillary action. The base metals are heated but do not melt, and the filler metal bonds to their surfaces to form a strong, durable joint. Brazing is typically used for closely fitted joints and produces a clean, precise connection with minimal distortion.

Features

- Brazing rods have the lowest achievable melting point, allowing for the capillary action.
- The rod flows along the joint edges and through to the reverse side of the joint, forming a thin film (0.0254-0.0085mm) between the two.
- The entire joint is heated to the correct temperature (in comparison to the localised heat when braze welding).

Brazing Thicknesses

Brazing Tip Size	Steel Thickness (mm)	Oxygen Pressure (kPa)	Acetylene Pressure (kPa)
8	2.0	50	50
10	2.6	50	50
12	3.2-4.0	50	50
15	5.0-6.5	50	50
20	8.2-10.0	50	50

Pre-Cleaning

The components to be brazed must be clean and free of oil, grease, and surface oxides before joining. For most engineering components, simple degreasing prior to assembly is sufficient.

Oxides can be removed chemically or mechanically. Mechanical removal is preferable because it roughens the surface, enhancing bonding. A medium-grade emery cloth typically provides the ideal level of surface roughness.

Oil and grease are best removed with a solvent-degreasing agent, although if solvents are unavailable, hot, soapy water is a better alternative than not cleaning at all.

Fluxes & Fluxing

Fluxes are used when brazing to clean the base metal surface chemically. The cleaning allows a proper bond to form between the base metal and the brazing rod.

There are three properties of flux that are beneficial:

1. The flux must melt and become active before the melting point of the brazing alloy.
2. The flux must effectively remove oxides from the parent materials. A low-temperature fluoride-based flux is suitable for most common engineering materials, including mild steel, brass, and copper. However, special fluxes are necessary for highly alloyed steels, tungsten carbide tool tips, aluminium bronze, or aluminium brasses with more than 2% aluminium content.
3. The flux must remain active at the brazing temperature long enough to complete the operation. Fluxes dissolve oxides formed during heating, but they eventually reach a saturation point where they can no longer dissolve additional oxides. If flux residues appear blackened and glassy, it indicates the flux was exhausted during heating. In such cases, a flux with greater time and temperature stability should be used.

When brazing using copper phosphor brazing rods, a flux is not necessary.

Applying the Flux

The most effective way to apply flux is to mix it into a paste and paint it onto the joint before assembly.

While some operators use the “hot rodding” technique (heating the rod end, dipping it into flux, and then applying both to the joint), this method has drawbacks. It fails to protect the joint during the heating cycle and often applies insufficient flux, which can hinder alloy penetration into the capillary gap.

When using flux powder, it should be mixed with water and a few drops of detergent to achieve a double cream-like consistency. This mixture should then be applied to the joint with a paintbrush.

While an excess of flux is unlikely to cause issues, insufficient flux almost always results in poor-quality joints.

Heating the Joint & Applying the Filler Rod

When heating a joint for brazing, it is crucial to heat it slowly and evenly to the correct brazing temperature.

The type and size of the flame depend on the parent materials and the mass of the components. Common heat sources include oxy-acetylene, air-acetylene, and air-propane gas, though care should be taken with oxy-acetylene due to its high flame intensity, which can melt the parent material.

For large components that need to be brazed, multiple torches may be required to bring them to temperature before the flux becomes exhausted.

The temperature can be gauged either by the metal's colour or the flux's condition. At the correct brazing temperature, the flux will appear clear and fluid, flowing over the joint like water.

The filler metal is then applied by touching the rod to the joint gap and heating the parent material indirectly or with splash heat from the torch. The molten filler metal will follow the heat, which is directed along the joint.

For free-flowing alloys, such as a 56% silver alloy, the rod should be applied at a single point, allowing capillary action to draw the alloy into and around the joint. For less-free-flowing alloys, like a 39% silver alloy, the filler should be applied along or around the joint to build up a fillet.

When using phosphorus-bearing filler rods, such as a 5% silver, 95% copper/phosphorus alloy, heat the joint to a dull cherry red before applying the rod.

Once brazing is complete, stop heating to avoid metallurgical issues with the parent material or porosity in the filler metal. After the alloy has solidified, the joint may be quenched in water to remove flux residues, provided the parent metals are not susceptible to thermal shock, which could lead to cracking (e.g. with tungsten carbide components).

Removing the Flux

The method for removing flux residues depends on the type of flux used. Low-temperature fluoride-based flux residues can be easily removed by soaking the joints in hot water at a temperature of 60°C or higher.

Complete removal typically takes 10-15 minutes, provided the residues are not burnt or blackened. After soaking, the joints should be scrubbed under running water to ensure thorough cleaning.

In contrast, boron-based flux residues are not water-soluble and require mechanical removal, such as shot blasting. Acid pickling is generally ineffective for removing these residues unless they are burnt or blackened. If pickling is required, it should be performed only after the flux residues have been removed.

It is especially important to remove any flux residue after brazing on aluminium, as the residues can be very corrosive.



Brazing alloys and fluxes, when overheated, can produce fumes that are harmful. Proper ventilation, fume reduction and air-fed helmets or respirators need to be considered. Before use, read all the manufacturer's instructions and refer to warning labels.

Brazing Joints

The most common joint type used in brazing is the lap joint or the sleeve joint for tubular components. Designing an effective lap joint requires careful consideration of two key factors:

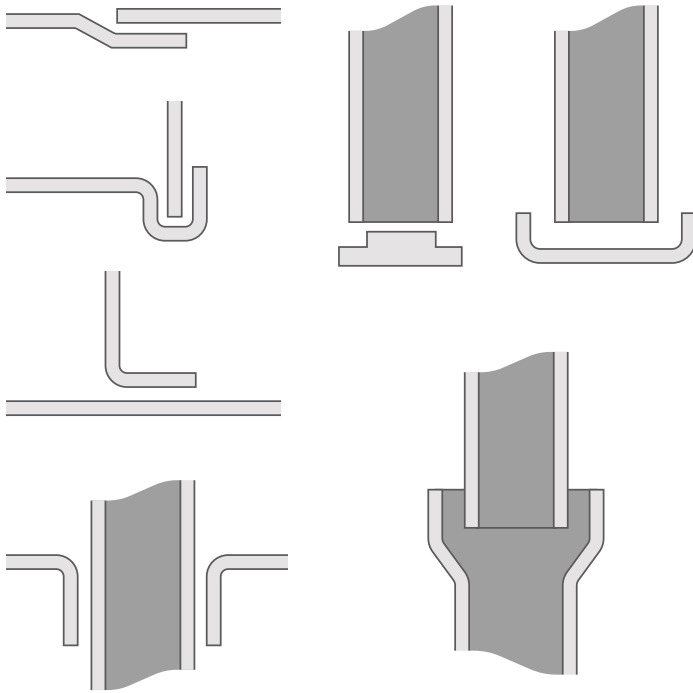
- Joint gap
- Degree of overlap

These two parameters determine the ultimate joint strength rather than the properties of the filler metal itself. When properly designed, a brazed joint is often stronger than the parent materials it connects.

The ideal degree of overlap for a brazed joint is 3-4 times the thickness of the thinnest parent metal in the joint. For tubular components, the general rule is that the overlap should equal the tube diameter for sizes up to 25mm in diameter.

The optimal joint gap depends primarily on the flow characteristics of the filler metal. Adjustments should be made to the cold clearances to account for differences in the expansion properties of the parent materials.

Joint Designs for Brazing



Soldering

Soldering is a low-temperature adhesion process that uses a filler metal, or solder alloy, with a melting point below 450°C. The filler metal wets the surface of the parent metal, spreads across it, and is drawn into the joint by capillary action, filling the joint opening and creating a strong bond.

Filler Metals

- The most commonly used filler metals are binary-tin-lead alloys.
- Certain tin-lead filler metals contain up to 3% antimony to improve the mechanical properties of the joints.

Fluxes

Flux is used when soldering in order to prevent, dissolve or remove oxide films and other contaminants from the base material. It is not used to clean dirt. Cleaning the joint properly before soldering is still a necessity.

Soldering fluxes consist of either:

- Various inorganic weak acid solutions and salts or
- Resins dissolved in organic solvents

Acidic and salt fluxes must be removed after soldering as they are very corrosive, while resin fluxes are not.

Compatible Joints

The best joint when soldering is the lap joint, as it provides the maximum strength.

To prevent moisture and corrosion getting into the joint, the solder alloy needs to completely fill the gap. Proper clearance between the joint faces is essential for the solder to flow into the joint via capillary action. The choice of filler alloy should match the joint gap, as alloys with a narrow melting range tend to flow more effectively than those with a wider melting range.

Suitability of Metals for Soldering

Metal	Solder	Flux
Stainless steel	965 solder	965 flux
Copper, copper alloys & brass	Lead-tin alloys	Moderately active flux
Aluminium & aluminium alloys	Alloys of zinc, cadmium, tin and aluminium	Active flux or aluminium zinc rub on fluxless alloys
Cast iron	Base metal must be pre-tinned with pure tin. This allows wetting of the joint despite the presence of free carbon.	965 flux
Tin-plated & galvanised steel	Soldering is widely used for thin sheet metal, galvanised or tin-plated. A wide variety of solders can be used.	Highly active flux to protect cut faces and joints

Plated Materials	
Chrome plating	965 solder
Silver plating	Lead-tin alloys
Anodised aluminium	Alloys of zinc, cadmium, tin and aluminium

5. Flame Heating

5.1 Flame Heating Installation

 **Do not perform any part of the installation procedure near an ignition source.**

Installing the Regulators & Gas Hoses

 **There is a risk of an accident if the gas cylinder is improperly or inadequately secured, which could result in severe injury.**

1. Screw in the oxygen regulator to the oxygen cylinder and the fuel gas (acetylene/LPG) regulator to the fuel gas cylinder. Fasten them with a spanner to prevent leaks.

 **The fuel gas fittings are left-hand threads, as indicated by notches on the nuts.**

2. Attach the regulator-mounted oxygen flashback arrestor (FBA) to the oxygen regulator and the regulator-mounted fuel gas FBA to the fuel gas (acetylene/LPG) regulator.
3. Connect the blue oxygen hose to the oxygen FBA and the fuel gas (red for acetylene, orange for LPG) hose to the fuel gas FBA.
4. Open the gas cylinder valves slowly. Slightly turn the regulator knobs clockwise to open them and clear the gas hoses of dirt and dust.
5. Twist the knobs anticlockwise to close the valves.

Assembling the Flame Heating Torch

1. Attach the blowpipe-mounted oxygen (right-hand thread) FBA and fuel gas (left-hand thread) FBA to the blowpipe handle. The valves are labelled 'O' for oxygen and 'F' for fuel gas.
2. Connect the gas mixer to the blowpipe.
3. Screw the heating tip into the mixer.
4. Loosen the gas mixer from the blowpipe to adjust the alignment of the heating tip to a suitable position and re-tighten the gas mixer.

Connecting the Flame Heating Torch

Connect the oxygen and fuel gas hoses to the blowpipe-mounted oxygen and fuel gas FBAs.

Checking for Gas Leaks

1. Close the blowpipe valves by turning them clockwise.
2. Slowly open the oxygen gas cylinder valve and set the oxygen regulator to roughly 100 kPa.
3. Close the oxygen cylinder.

If there are no leaks, the pressure registered by the regulator gauge will not change.

Repeat this process with the fuel gas.

If there is a leak, it can be located by applying a leak testing solution (e.g. dishwashing liquid mixed with water) to the connection joints. The solution will bubble or produce suds if there is a gas leak.

 **Never use flames to locate gas leaks.**

5.2 Flame Heating Operation

Preparing for Operation

Before using the equipment, ensure that all the necessary installation actions have been completed according to your equipment setup and instructions.

ⓘ Always check before use that the gas hoses, regulators and torch fittings are in serviceable condition. Ensure that there is no oil or other contamination present on the connections.

Lighting Up

1. Open the oxygen regulator knob before opening the oxygen cylinder valve.
2. Open the oxygen blowpipe valve and then adjust the oxygen regulator to set the correct pressure.
3. Let the gas flow to purge the system of air.
4. Close the blowpipe valve.
5. Repeat these steps for the fuel gas. Use a pressure chart if necessary to set the correct fuel gas pressure.

⚠ Never use acetylene at a gauge pressure above 100 kPa.

6. Open the fuel gas blowpipe valve slightly and light the blowpipe with a flint lighter.

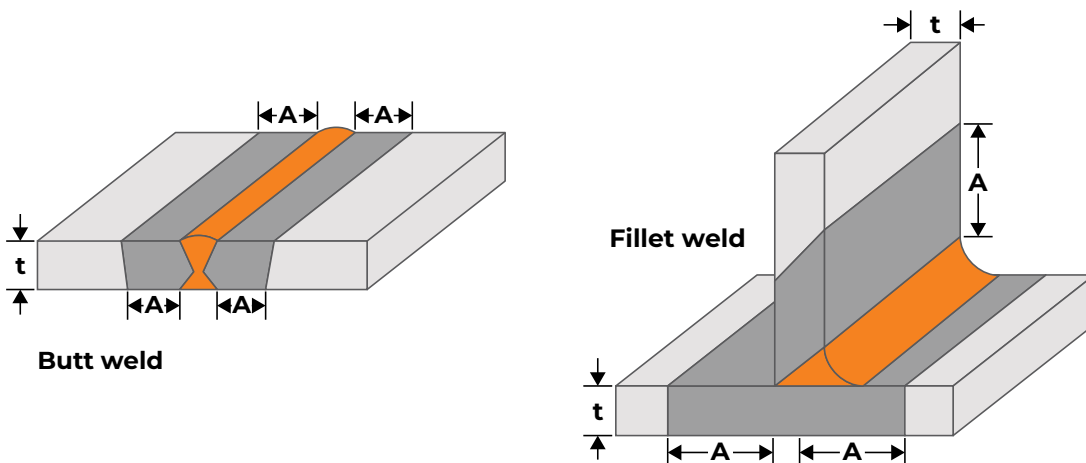
⚠ Do not use cigarette lighters or matches.

7. Continue to open the fuel gas blowpipe valve until the flame is no longer producing soot.
8. Open the oxygen blowpipe valve slowly until a neutral flame (clearly defined white cones with a faint trace of fuel haze) is produced.

Preheating the Area

The most common use for flame heating is for preheating metal for a weld. It is generally performed by the welder immediately before the weld.

The preheating temperature should penetrate the workpiece completely and is measured on the face opposite the one being heated.



t = material thickness

For materials with $t \leq 50\text{mm}$: The distance $A = 4 \times t$, but A cannot exceed 50mm

For materials with $t > 50\text{mm}$: The distance $A = 75\text{mm}$

Shutting Down

- 1.** Close the fuel gas blowpipe valve.
- 2.** Close the oxygen blowpipe valve.
- 3.** Close both gas cylinder valves.
- 4.** Open the oxygen blowpipe valve to drain the oxygen from the system. Close it again when both oxygen regulator gauges read 0.
- 5.** Close the oxygen regulator knob.
- 6.** Open the fuel gas blowpipe valve to drain the fuel gas from the system. Close it again when both fuel gas regulator gauges read 0.
- 7.** Close the fuel gas regulator knob.

6. Gas Cutting

6.1 Gas Cutting Installation

 **Do not perform any part of the installation procedure near an ignition source.**

Installing the Regulators & Gas Hoses

 **There is a risk of an accident if the gas cylinder is improperly or inadequately secured, which could result in severe injury.**

1. Screw in the oxygen regulator to the oxygen cylinder and the fuel gas (acetylene/LPG) regulator to the fuel gas cylinder. Fasten them with a spanner to prevent leaks.

 **The fuel gas fittings are left-hand threads, as indicated by notches on the nuts.**

2. Attach the regulator-mounted oxygen flashback arrestor (FBA) to the oxygen regulator and the regulator-mounted fuel gas FBA to the fuel gas regulator.
3. Connect the blue oxygen hose to the oxygen FBA and the fuel gas (red for acetylene, orange for LPG) hose to the fuel gas FBA.
4. Open the gas cylinder valves slowly. Slightly turn the regulator knobs clockwise to open them and clear the gas hoses of dirt and dust.
5. Twist the knobs anticlockwise to close the valves.

Assembling the Gas Cutting Torch

1. Attach the blowpipe-mounted oxygen (right-hand thread) FBA and fuel gas (left-hand thread) FBA to the blowpipe handle. The valves are labelled 'O' for oxygen and 'F' for fuel gas.
2. Connect the gas cutting attachment to the blowpipe.
3. Screw the cutting nozzle into the cutting attachment.

Connecting the Gas Cutting Torch

1. Connect the oxygen and fuel gas hoses to the blowpipe-mounted oxygen and fuel gas FBAs.

Checking for Gas Leaks

1. Close the blowpipe valves by turning them clockwise.
2. Slowly open the oxygen gas cylinder valve and set the oxygen regulator to roughly 100 kPa.
3. Close the oxygen cylinder.

If there are no leaks, the pressure registered by the regulator gauge will not change.

Repeat this process with the fuel gas.

If there is a leak, it can be located by applying a leak testing solution (e.g. dishwashing liquid mixed with water) to the connection joints. The solution will bubble or produce suds if there is a gas leak.

 **Never use flames to locate gas leaks.**

6.2 Gas Cutting Operation

Preparing for Operation

Before using the equipment, ensure that all the necessary installation actions have been completed according to your equipment setup and instructions.

 **Always check before use that the gas hoses, regulators and torch fittings are in serviceable condition. Ensure that there is no oil or other contamination present on the connections.**

Lighting Up

1. Open the oxygen regulator knob before opening the oxygen cylinder valve.
2. Open the oxygen blowpipe valve, keep the heating oxygen control valve closed, hold the cutting attachment lever down and then adjust the oxygen regulator to set the correct pressure.
3. Let the gas flow to purge the system of air.
4. Close the blowpipe valve.
5. Open the fuel gas regulator knob before opening the fuel gas cylinder valve.
6. Open the fuel gas blowpipe valve, keep the heating oxygen control valve closed, and adjust the fuel gas regulator to set the correct pressure. Use a pressure chart if necessary to set the correct pressure.
7. Let the gas flow to purge the system of air.
8. Close the blowpipe valve.

 **Never use acetylene at a gauge pressure above 100 kPa.**

9. Open the fuel gas blowpipe valve slightly and light the blowpipe with a flint lighter.

 **Do not use cigarette lighters or matches.**

10. Continue to open the fuel gas blowpipe valve until the flame is no longer producing soot.
11. Open the oxygen blowpipe valve and then slowly open the heating oxygen control valve until a neutral flame is produced with the cutting lever held down (see “Gas Welding Flames” on page 27).

Creating the Cut

1. Use the preheat flame to preheat the metal until it is glowing red.
2. Press the lever down to cut.
3. Release the lever to stop cutting.

Shutting Down

1. Close the fuel gas blowpipe valve.
2. Close the oxygen blowpipe valve.
3. Close both gas cylinder valves.
4. Open the oxygen blowpipe valve and hold down the cutting lever to drain the oxygen from the system. Close it again when both oxygen regulator gauges read 0.
5. Close the heating oxygen control valve.
6. Close the oxygen regulator knob.
7. Open the fuel gas blowpipe valve to drain the fuel gas from the system. Close it again when both fuel gas regulator gauges read 0.
8. Close the fuel gas regulator knob.

6.3 Gas Cutting Guide

What Is Gas Cutting?

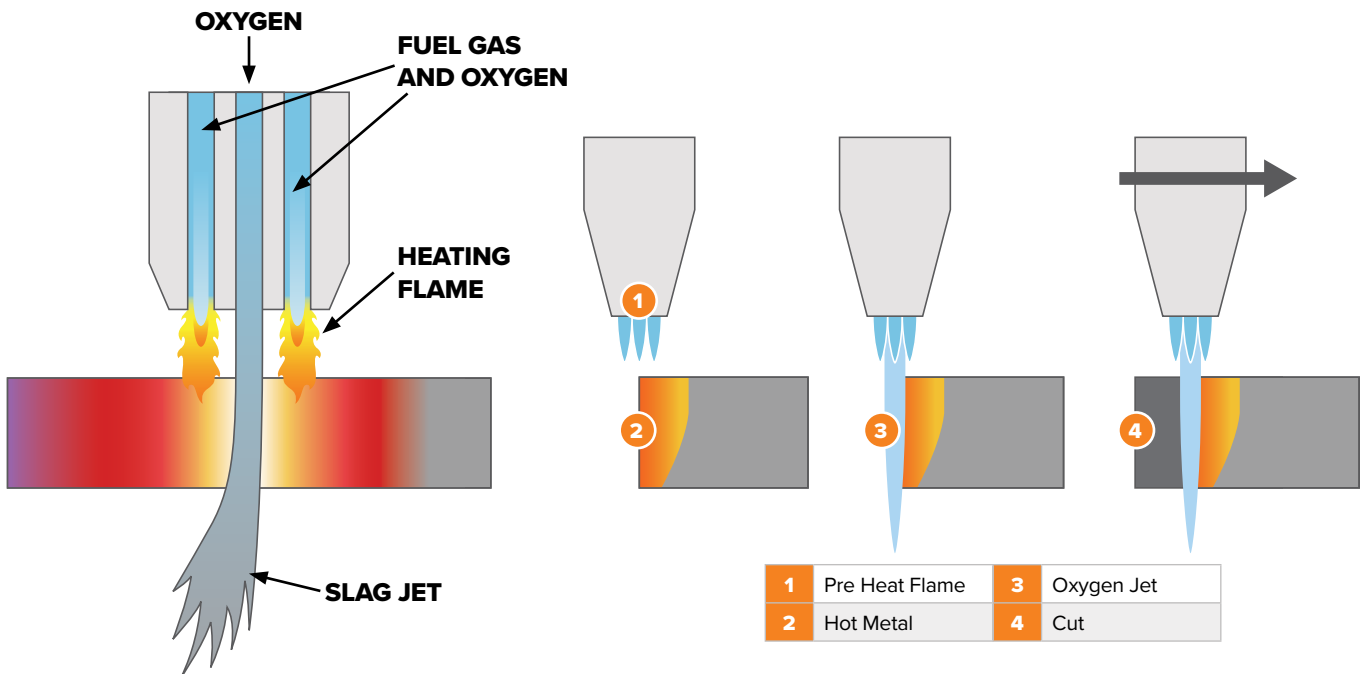
Gas cutting, most commonly referred to as oxy-cutting, is a method of cutting through ferrous metals using gas to produce a flame. It uses a mixture of oxygen and a fuel gas, generally acetylene or LPG, to rapidly oxidise the metal and cut through it.

Oxy-cutting only works on metal that contains iron because the cutting is done by oxidation. The metal must be preheated before it is cut, which is done using the same torch.

How Gas Cutting Works

Gas cutting works by using a combination of a preheating flame and a high-pressure stream of oxygen to oxidise and remove metal from the workpiece.

First, a flame, created by burning a fuel gas (commonly acetylene, LPG, or propane) mixed with oxygen, is used to preheat a localised area on the metal's surface to its ignition temperature. For steel, this is approximately 700-900°C, or a bright cherry red. This preheating flame softens the metal but does not melt it.



Once the metal is preheated, the lever on the cutting attachment is pressed, releasing a high-pressure jet of pure oxygen onto the heated area. The oxygen reacts with the hot steel in an exothermic oxidation reaction, forming iron oxide (slag) and generating additional heat.

The oxidation reaction (burning of iron) creates molten iron oxide (slag), which is blown away by the high-pressure oxygen jet, creating a cut through the metal. If the oxygen jet is not powerful enough, or if the torch moves too quickly, the slag may solidify in the cut, preventing a successful cut.

As the torch progresses along the cut line, more steel is continuously preheated, and the oxygen jet reacts with the steel, burning it away and creating the cut.

Preheat Flame

The preheat flame is created by the combustion of the preheat oxygen and fuel gas, which are combined either in the torch or the nozzle. The preheat flame serves three main purposes:

- Raises the metal to its ignition temperature.
- Compensates for heat losses caused by conduction into the bulk metal.
- Shields the cutting oxygen from atmospheric contamination, which could affect its performance.

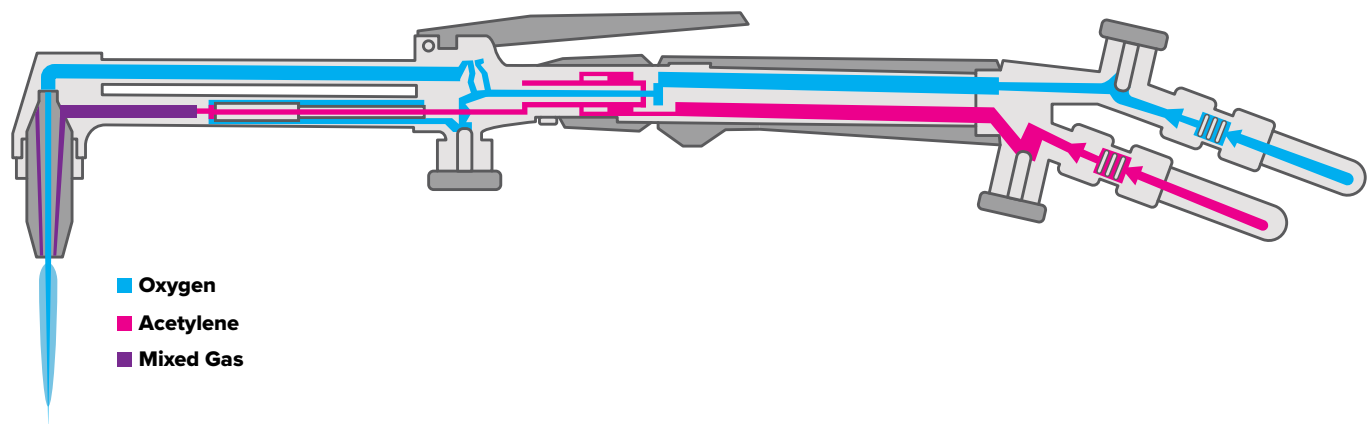
While the ignition temperature varies depending on the material being cut, the choice of fuel gas significantly influences how quickly the material reaches this temperature. For example, oxy-acetylene burns at a higher flame temperature (3,160°C) compared to oxy-propane (2,828°C). As a result, cutting can begin sooner when using oxy-acetylene, especially with thicker materials, where the difference becomes more pronounced.

The purity of the cutting oxygen is critical for efficient cutting. The preheat flame acts as a barrier, preventing nitrogen from the surrounding atmosphere from mixing with the cutting oxygen. If nitrogen reacts with the oxygen, it forms oxides of nitrogen, which can reduce cutting speeds and increase oxygen consumption.

Gas Cutting Attachment & Nozzles

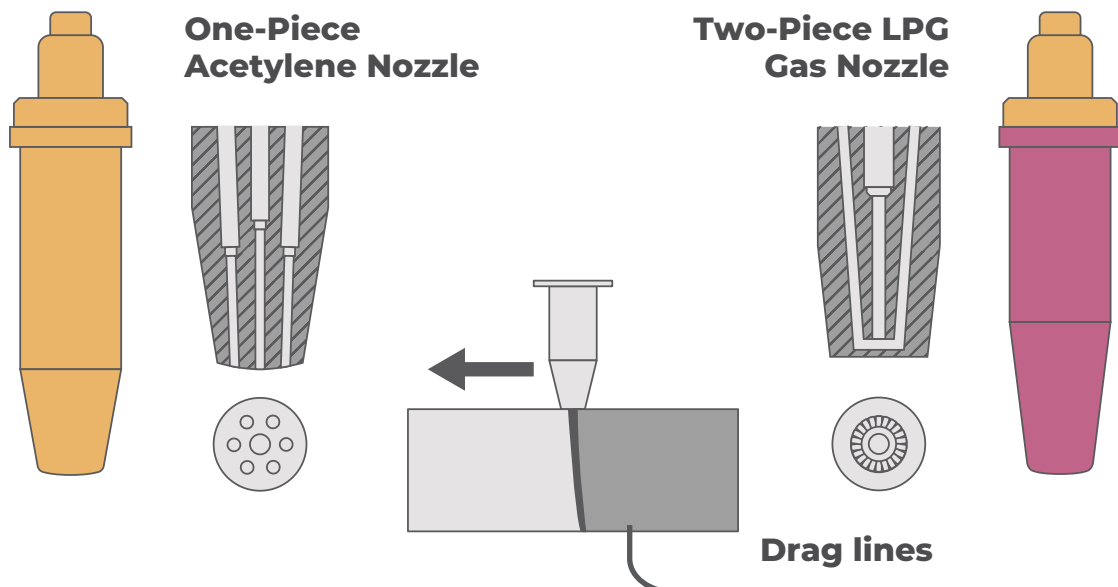
The cutting torch assembly consists of three main parts: the blowpipe handle, the cutting attachment, and the cutting nozzle.

The blowpipe handle is the same as that used for gas welding, with separate valves to control the flow of acetylene and oxygen into the cutting attachment.



The cutting attachment directs the preheat flame, formed by a mixture of oxygen and acetylene or LPG, which travels through a separate passage to the cutting oxygen.

The cutting oxygen is controlled by a lever located on top of the cutting attachment. When this lever is pressed, a high-pressure stream of oxygen flows through the cutting nozzle and onto the heated metal, initiating the cutting action.



Oxy-Acetylene

Type 41 High-Speed Cutting Nozzle Size	Steel Thickness (mm)	Acetylene Pressure (kPa)	Oxygen Pressure (kPa)	Cutting Speed (mm/min)	Acetylene Gas Flow (L/min)	Oxygen Gas Flow (L/min)
6	6-8	100	650	700	6	31
8	8-20	100	650	550-700	6	50
12	25-75	100	650	300-500	10	107
15	75-150	100	650	200-300	12	158
20	150-250	100	650	100-200	13	250
24	250-300	100	650	90	18	320

Oxy-LPG

Type 44 High-Speed Cutting Nozzle Size	Steel Thickness (mm)	LPG Pressure (kPa)	Oxygen Pressure (kPa)	Cutting Speed (mm/min)	LPG Gas Flow (L/min)	Oxygen Gas Flow (L/min)
6	6-8	100	650	550	5	45
8	8-20	100	650	500-550	5	64
12	25-75	100	650	300-500	6.5	122
15	75-150	100	650	200-300	7	173
20	150-250	100	650	100-200	8	267
24	250-300	100	650	90	12	350

Metal Preparation

Before a cut can be made, the base material needs to be clean of dirt, rust, paint, oil, grease or millscale. These can be removed using a wire brush or grinder.

Travel Angle & Distance

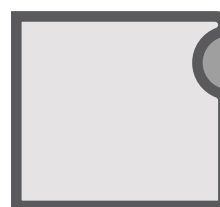
The inner cone of the preheating flame should be held 3-5mm above the edge of the plate until it is a bright cherry red colour.

If the nozzle is held too low, it can burn the top corners of the cut. The top edge becomes slightly rounded and heavily beaded. The cut face remains fairly square, with a relatively sharp bottom corner. When the nozzle is too low, it can hinder the oxidation reaction, producing a cut that looks like it was done too slowly.

If the nozzle is held too high, heat spreads along both sides of the cut, causing excessive melting and rounding at the top edge. it can result in undercut on the top side as it widens and 'bell-outs', and in extreme cases won't penetrate all the way through the metal.



TOO LOW



TOO HIGH

The gas nozzle should be held perpendicular (90°) to the base plate or inclined slightly forward in the direction of travel and pushed along the cut.

Where possible, the cut should be started on the edge of the plate. If this isn't possible, the cut can be started by piercing the plate.

Travel Speed

Travel speed is the rate that the torch is moved along the cut, and is determined by the material thickness being cut, as thicker materials require slower cutting speeds to ensure proper penetration.

If the travel speed is too slow, the top edges will be rounded and melted, while the lower half of the cut will be deeply fluted or badly gouged due to the molten steel scouring the cut surface. Hot metal and slag accumulate on the underside, and what remains on the bottom of the cut will be difficult to remove. These conditions can also be caused by too low an oxygen pressure.

If the travel speed is too fast, the top side of the cut may lack sharpness and be bearded, or it can be left with undercut. The excessive backward drag of the cut can also prevent it from penetrating all the way through the joint.



TOO SLOW



TOO FAST

6.4 Gas Cutting Troubleshooting

Problem	Recommended Actions
The base widens with excessive kerf	- Decrease the oxygen pressure. - Increase the travel speed.
The top edge melts or rounds	- Increase the travel speed. - The nozzle tip is too close to the plate, raise it. - The preheat flame is too large, reduce it. - Decrease the oxygen pressure.
Lack of penetration	Decrease the travel speed.
Undercut	The nozzle tip is too high above the plate, lower it.

6.5 Other Cutting Applications

Flame Gouging

Gouging, or flame gouging, enables the operator to use an oxy-acetylene cutting torch to create U-shaped grooves in metal. It is particularly useful for removing welds during demolition, preparation for rewelding and to remove excess metal.

Gouging nozzles are required to successfully gouge, along with a high-pressure oxygen regulator capable of delivering up to 650 kPa.

Gouging nozzles are specifically designed to deliver cutting oxygen at a lower velocity compared to standard cutting nozzles. This is achieved by using a larger oxygen orifice in the gouging nozzle, which allows for a more controlled and effective removal of metal.

Nozzle Size	Groove Width	Oxygen Pressure (kPa)	Acetylene Pressure (kPa)
13mm	8mm	400	50
19mm	11mm	500	50
25mm	13mm	550	55

7. Maintenance

Inspection and maintenance should be carried out on a routine basis for all items of gas and cutting equipment.

How often the gas equipment is used and the working environment it is in should both be considered when planning the frequency of maintenance. In severe conditions, maintenance should occur more frequently.

Proper operation of the equipment and regular preventive maintenance will help avoid failure, increase the life-span and ensure problem-free use.

 **Unplug the gas equipment from the cylinders before beginning any maintenance.**

Before each use, check your gas hoses, regulators, valves and cylinders are in good condition. Check that all connections are properly fastened. Any loose connections can inhibit performance and cause damage.

- Check that all covers and components are intact.
- Check for gas leaks on all regulators, valves and cylinders each time the equipment is set up.
- Check for 'creep' on regulators.

 **To check for 'creep' (pressure build up when the blowpipe valves are closed), close the blowpipe valves while the regulator is open and check for a continuing increase in pressure beyond the pressure that has been set. A pressure build up above 35 kPa is excessive.**

- Check the pressure gauges or indicators return to the stop position when the pressure is released.
- Check the regulator pressure indicator accuracy annually.
- Clean dirt and debris from the blowpipe, welding tips and cutting nozzles.

 **Drills should not be used to clean welding tips or cutting nozzles as any damage may promote the occurrence of flashback.**

- Check safety devices strictly according to the requirements in AS 4603.
- Check all O-rings for signs of damage regularly.

7.1 Maintenance Schedule

As outlined in AS 4839:2001, “The Safe Use of Portable and Mobile Oxy-Fuel Systems for Welding, Cutting, Heating and Allied Processes.”

Equipment	Weekly (if in constant use) or Before Every Use (performed by the operator)	Six Monthly/Yearly (performed by a technically qualified person)	Refurbishment or Replacement Intervals (equipment condition determines whether refurbishment or replacement)
Regulators (including integral protective devices)	- Visual check for serviceability (gas type, pressure rating, damage) - Check threads & sealing surfaces condition - Check for oil & grease contamination - Leak test all joints at working pressure	<i>Six Monthly</i> Functional test of internal components to ensure correct operation	Manufacturer or supplier recommendation, not exceeding 5 years
Flashback Arrestors & Other External Devices (including non-return valves)	- Visual check for serviceability (gas type, pressure rating, damage) - Check threads & sealing surfaces condition - Check for oil & grease contamination - Leak test all joints at working pressure	<i>Yearly as per AS 4603 or following a flashback</i> - Test non-return valves and flashback arrestors for proper function - For pressure-activated valves, check for no flow in the normal direction when the valve is tripped	Manufacturer or supplier recommendation, not exceeding 5 years
Hose Assemblies	- Visual check for serviceability (gas pressure rating, damage, cover condition) - Check threads & sealing surfaces of the fittings condition - Leak test all joints at working pressure	<i>Six Monthly</i> Check for cuts and wear by bending the hose in a tight radius to confirm the reinforcement isn't visible	Determined by the hose assembly condition.
Blowpipes, Mixers & Attachments	- Visual check for damage to the threads and sealing surfaces of the hose connections attachment connections - Leak test all joints at working pressure	<i>Six Monthly</i> - Test control valve function - Blank the attachment connections and leak test for internal malfunction	Manufacturer or supplier recommendation, not exceeding 5 years

i Regulator elastomers and seals will wear and deteriorate over time, both in service and while in storage. Any item that has been stored for 12 months or longer without use should be inspected in accordance with the annual maintenance schedule.

⚠ Only authorised service repair agents should carry out repairs and internal servicing.

For repairs, contact UNIMIG at unimig.com.au or contact your local dealer.

8. Gas Processes & Features Glossary

B

Backfire - The sudden return of the flame into the blowpipe, usually with a popping sound. The flame may be extinguished or re-ignite at the nozzle.

Brazing - A metal-joining process in which a filler metal with a melting point above 450°C but below the melting point of the base metals is melted and drawn into the joint by capillary action.

Braze Welding - A welding method where the metal parts are joined over a localised area using a nonferrous filler metal with a melting point above 450°C but below the melting point of the base metals. The filler is deposited to create a weld, resulting in a joint that externally resembles a traditional welded joint.

C

Carburising Flame - A carburising (or reducing) flame is produced when the acetylene content in the mixture is higher than the oxygen content.

F

Flame Heating - Flame heating uses a fuel gas and oxygen to create a flame to heat metals or other materials. It does not melt the base material; instead, it raises its temperature to facilitate tasks such as bending, shaping, straightening, or preheating.

Flame Gouging - A gouging process that uses a gas cutting torch to create U-shaped grooves in metal and is particularly useful for removing welds during demolition, preparation for rewelding and to remove excess metal.

Flashback - A severe condition where the flame travels back through the blowpipe and into the hoses, potentially reaching the regulators or even the gas cylinder. This can cause dangerous heating and decomposition of the gas contents.

Flux - Flux is a chemical compound used in gas welding and brazing to ensure clean, strong, and defect-free joints. It plays a critical role by removing and preventing the formation of oxides and other contaminants during the heating process.

G

Gas Cutting - A method of cutting through ferrous metals using gas to produce a flame. It uses a mixture of oxygen and a fuel gas, generally acetylene or LPG, to rapidly oxidise the metal and cut through it.

Gas Welding - A process of joining metals by heating them with a flame produced from the combustion of a fuel gas and oxygen.

N

Neutral Flame - A neutral flame is produced when the ratio of oxygen to acetylene in the mixture leaving the torch is approximately one-to-one and it has no chemical effect on the metal.

O

Oxidising Flame - An oxidising flame is produced when the oxygen content in the mixture exceeds the acetylene content.

P

Preheat Flame - The preheat flame is created by the combustion of the preheat oxygen and fuel gas and used to raise the metal to its ignition temperature, compensate for heat losses and shield the cutting oxygen from atmospheric contamination.

S

Soldering - Soldering is a low-temperature adhesion process that uses a filler metal, or solder alloy, with a melting point below 450°C wets into and spreads across the metal, and is drawn into the joint by capillary action.

Sustained Backfire - A sustained backfire occurs when the flame continues to burn inside the neck or handle of the blowpipe. It begins with a popping sound, followed by a hissing noise caused by internal burning.

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