

Trade of Sheet Metalwork

Module 3: Thermal Processes

**Unit 1: Oxy-acetylene Welding -
Introduction**

Phase 2

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Document Release History

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04/09/06	First draft	
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Module 3 – Thermal Processes

Unit 1 – Oxy-acetylene Welding - Introduction

Duration – 7 Hours

Learning Outcome:

By the end of this unit each apprentice will be able to:

- Identify and safely assemble regulators, hoses, torch and cylinders
- Identify and understand the function of the component parts of the welding torch
- Select nozzle size, gas pressures, light and adjust flame and close down
- Select suitable filler rods
- Identify safety standards, precautions & hazards associated with the process

Key Learning Points:

Rk H	Gas cylinders - features, storage, handling and safety.
Rk	Types of regulators - flash back arrestors.
Rk	Hoses - colour coding.
Rk	The welding torch.
Rk	Nozzle selection, working gas pressures, filler materials.
Rk Sk	Assembly of equipment.
Rk Sk	Oxy-acetylene welding techniques - flame settings.
Rk H	Safety precautions and regulations - Hazards - Explosive gases.
Rk H	Protective clothing and equipment.
Sk	Heat and temperature heat and its effects, method of heat transfer. Temperature scales, Conversion between °C, °F, °K.

Training Resources:

- Oxy-acetylene welding equipment
- Hand-outs
- Safety clothing and equipment
- Videos
- BOC booklet “Safe Under Pressure”

Key Learning Points Code:

M = Maths **D** = Drawing **RK** = Related Knowledge **Sc** = Science
P = Personal Skills **Sk** = Skill **H** = Hazards

Identification, Care and Storage of Gas Cylinders

Cylinders containing gases are manufactured under strict government regulations. A colour code (B.S.349:1932) is used to indicate the contents of each cylinder.

Colour	Gas
Black	Oxygen
Maroon	Acetylene
Red	Coal gas and Hydrogen
Dark Grey with Black Neck	Nitrogen
Grey	Air

Table 1 - Cylinder Colour Code

To prevent the interchange of fittings between cylinders containing acetylene and oxygen gases, the valve outlets on acetylene gas cylinders are screwed left-handed and they will have a groove cut around the circumference as shown.

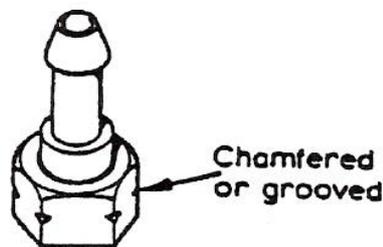


Figure 1 - Left-Hand Thread Combustible Gas i.e. Acetylene

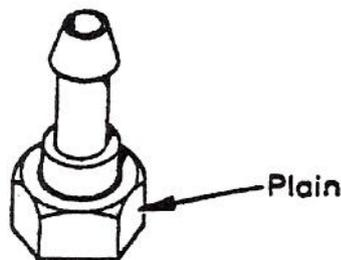


Figure 2 - Right-Hand Thread Non-Combustible Gas i.e. Oxygen

Cylinders of varying sizes are used to transport *acetylene*. The acetylene cylinder is made of steel with a concave bottom, which is protected from wear by a welded steel band. The illustration shows a cutaway view of a standard acetylene cylinder.

After the acetylene cylinder is built, a wet cement mixture of various materials, such as asbestos or charcoal, is packed into the cylinder. The cylinder is then baked, and the mixture forms a porous, sponge-like mass. Under pressure, dissolved acetylene is safe, but free acetylene over 15 psi pressure is unsafe. For safety, then, it becomes necessary to dissolve the acetylene.

Acetone initially dissolves about 25 times its own volume, and as the temperature increases, so does the amount of absorption. About 40% of the cylinder volume is filled with acetone, and, as the cylinder is charged with acetylene, the acetone absorbs the acetylene and swells up in the porous material.

The acetylene cylinder can be charged to 250 psi. In each cylinder are fuse plugs, consisting of steel bolts tapped into the cylinders. These are drilled and filled with a low melting alloy that melts between 203° and 207° F. In case of fire, the gas escapes through the melted fuse plugs, so a torch flame should be kept away from all cylinders. Most fuse plugs are on the top and/or bottom of the cylinder.

The cylinder should always be placed upright during use since the liquid acetone can run through the regulators and into the hoses if the tank were placed on its side.

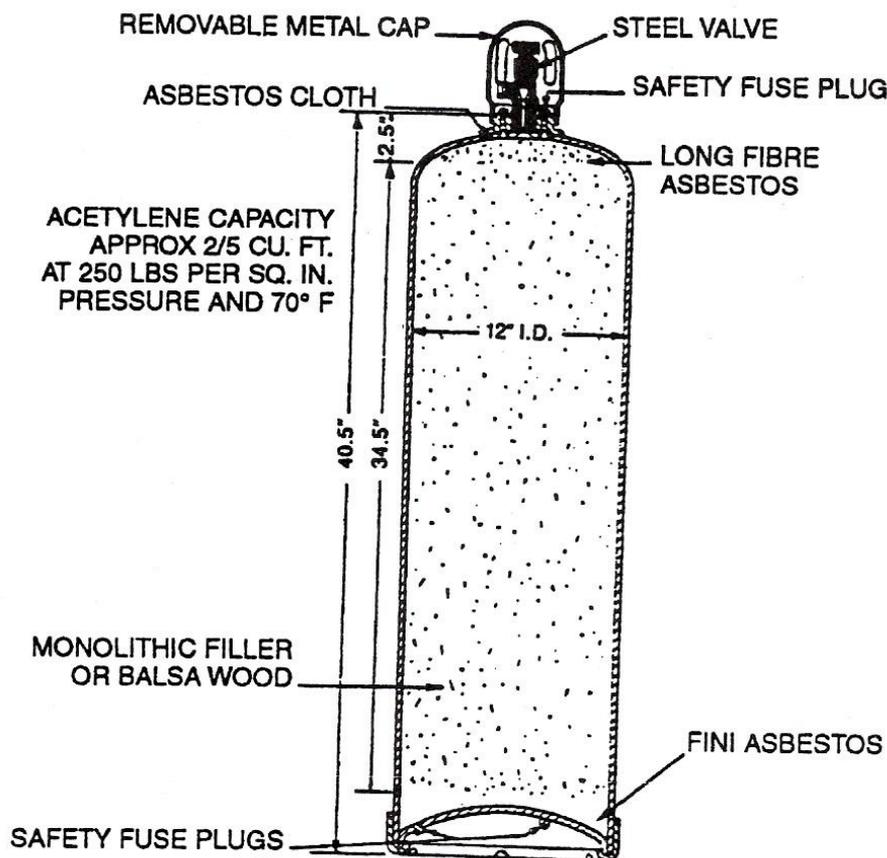
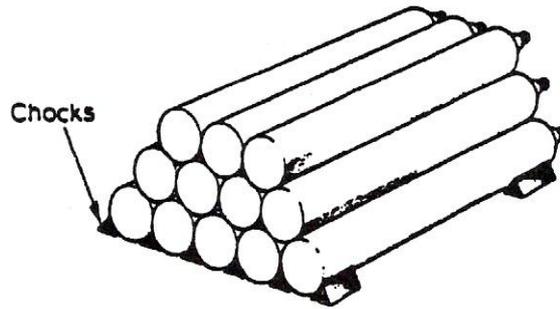
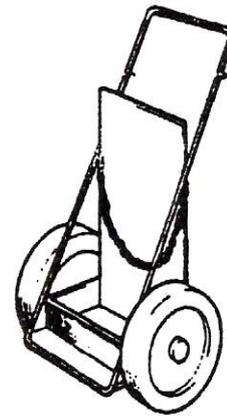


Figure 3 - Acetylene Cylinder Cutaway

Oxygen and acetylene cylinders should never be stored together. They should be stacked as in the diagram, with the bottom layer well chocked to prevent rolling, or stored upright with a securing chain to prevent them falling over. The full cylinders should be stored separately from empty ones and used up in rotation as received. The storage area should be cool and dry, protected from direct sunlight, frost, rain and corrosive conditions. There should be prominent signs indicating the presence of fire risk and *No Smoking* signs should be strictly observed.



Cylinders should never be handled roughly or allowed to fall from a height. When using cranes, etc., to lift cylinders, a protective mat or cradle should be used. Cylinders should never be used as rollers. If a cylinder has been damaged in any way it should be labelled accordingly, and the suppliers should be notified when it is collected. When moving cylinders that are in use and have regulator valves attached use a proper trolley. The cylinder valves should be turned off, using the correct key, before the cylinders are moved, and care must be taken to protect the regulators from knocks and bangs.



Portable Welding Trolley

Gauges

The pressure of the gases obtained from cylinders is much higher than the gas pressure used to operate the welding torch. Since the pressure of the gases must be reduced between the cylinder and the welding torch, special reducing valves called regulators are required.

Most regulators are constructed with two gauges. One gauge shows the pressure (amount) of gas in the cylinder and the other indicates the working pressure of the gas being delivered to the torch.

The pressure (amount) of gas in an oxygen cylinder is 1980 lb/in² and the pressure (amount) of gas in an acetylene cylinder is 225 lb/in².

Pressure readings on gauges are up to:	oxygen	30 lb/in ²
	acetylene	15 lb/in ²

1. Oxygen gauges

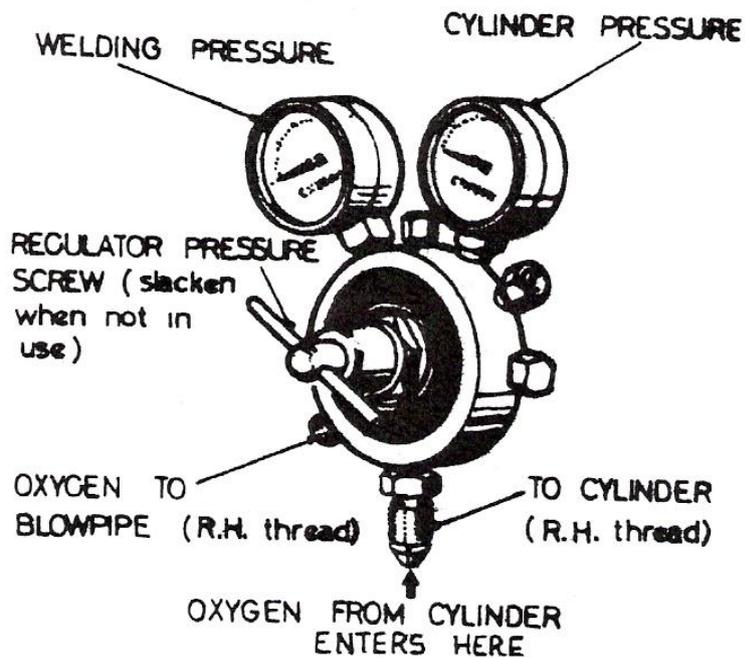


Figure 4 - Oxygen Gauges

2. Acetylene gauges

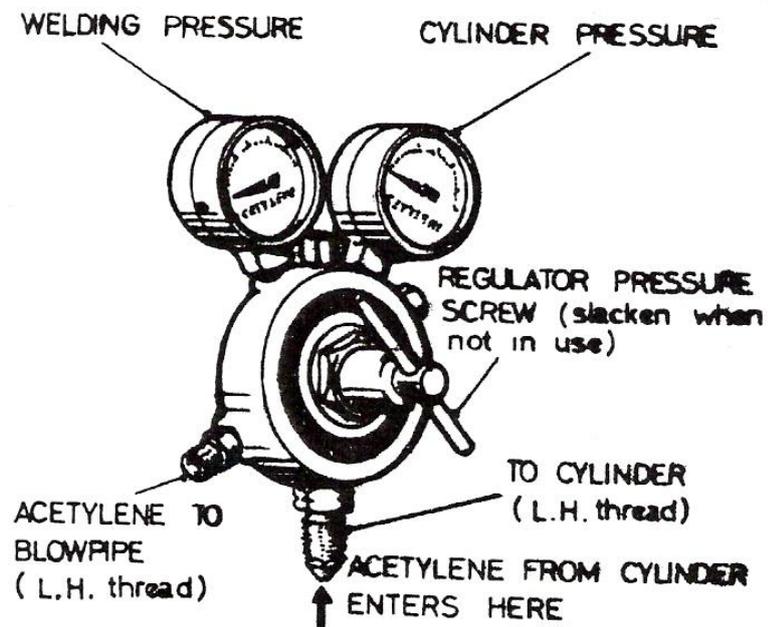


Figure 5 - Acetylene Gauges

Assessment

Write the answers to the following questions in your notebook. You may refer back in the notes if necessary.

1. Why are regulators fitted to cylinders?
2. Why are two gauges fitted to most regulators?
3. What is the pressure of gas in an oxygen cylinder?

Gas Pressure Regulator

Pressure regulators are precision manufactured instruments which, with correct use will provide reliable and trouble free service.

Before the Regulator is fitted to the Cylinder

Check that the cylinder valve outlet and the regulator inlets are free from oil, grease and damage.

Open the cylinder valve momentarily to eject any water or foreign matter from the seating (except in the case of hydrogen). Ensure that the blast is not directed at persons or naked flames.

Connecting to the Cylinder

Connect the regulator to the cylinder valve (left hand for acetylene and other combustible gases, right hand for oxygen and other non-combustible gases), using the correct spanner and ensure a gas tight seal. Do not use any form of jointing paste or tape between regulator and cylinder valve. Check that the pressure adjusting screw of the regulator is fully released (turned fully anti-clockwise).

Commencing Operation

Connect the downstream equipment and open the cylinder valve slowly. Check all joints for leaks using a 0.5% Teepol in water solution. The contents of the cylinder will register on the cylinder contents gauge and will decrease to zero as the cylinder empties. The contents are generally shown in the bars and lbf/in² (1 bar = 14.5 lbf/in²).

To set pressure, screw the pressure adjusting knob clockwise until the required outlet pressure registers on the outlet gauge. When gas is flowing, there may be a reduction in pressure, and adjustments should be made. Purge the gas line before lighting the equipment.

Finish of Operation

When work has stopped, close the cylinder valve, vent gas from the system and unscrew the pressure adjusting knob.

Flashback Arrestors

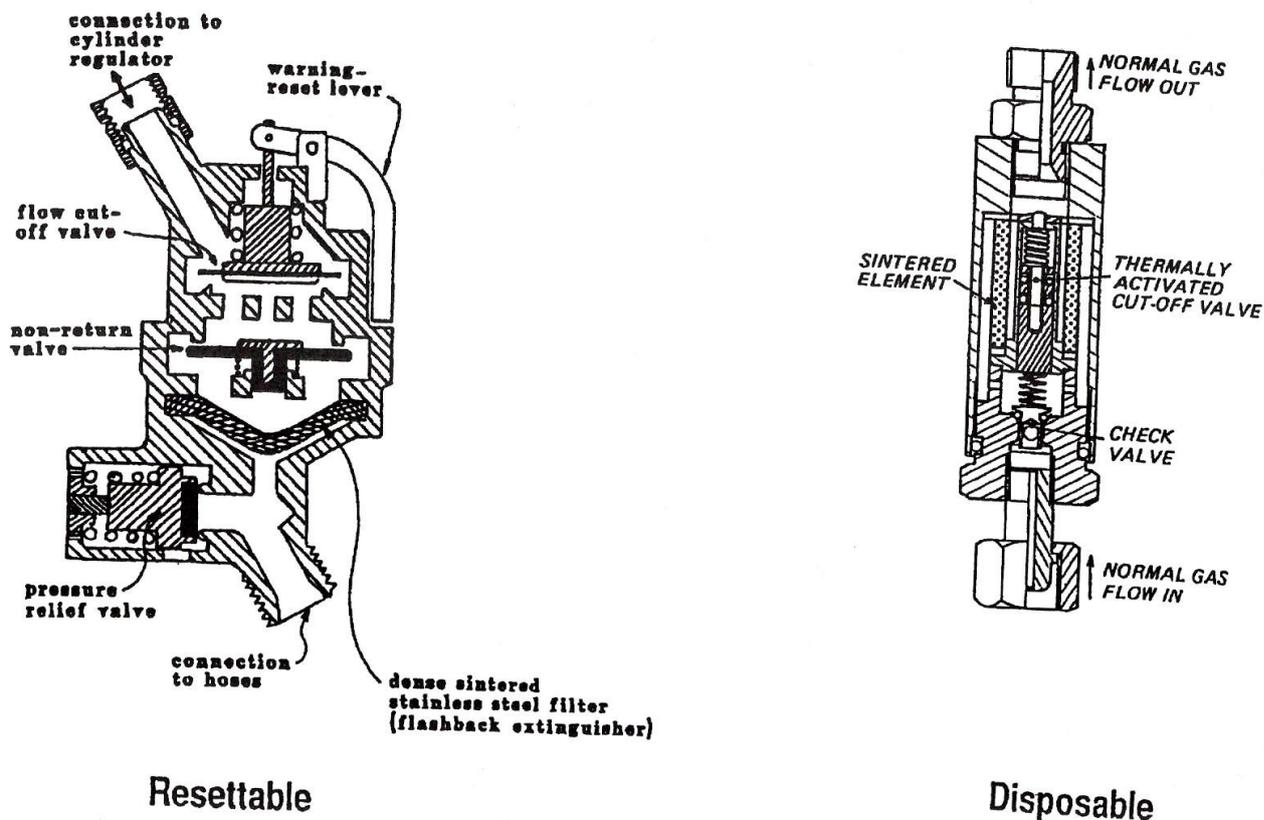


Figure 6 - Flashback Arrestors

Flashback arrestors are fitted to the regulators on both the oxygen and acetylene cylinders. The purpose of these is to prevent flames getting back into the cylinders in the event of a backfire or similar accident. There are two types of flashback arrestors - a disposable type and a re-settable type.

Hoses

These carry the gases from the regulators to the blowpipe. They are rubber, backed with canvas reinforcement. The oxygen hose is blue in colour with right-hand threads on all connections. The acetylene hose is red with left-hand threads on all connectors.

One end of the hose is connected to the flashback arrestor at the cylinder end, while the other end is connected to a hose check valve at the welding blowpipe end.

Hose Check Valves

Hose check valves, or hose protectors, are fitted between welding blowpipe and the hoses. They are marked "fit to blowpipe" or with a directional arrow to ensure that they cannot be fitted incorrectly. Should they be fitted incorrectly, i.e. attached to the regulator, no gas will flow through them. Basically they are spring loaded non-return valves designed to close in the event of a backfire taking place in the welding blowpipe.

The Blowpipe

There are several makes of gas welding blowpipes on the market all of which are supplied with detachable nozzles of different sizes. These numbered nozzles indicate the approximate consumption of gas in litres per hour. Usually they are numbered 1-2-3-5-7-10 etc. The greater the number the larger the hole size. Therefore the larger the nozzle the greater the amount of heat which can be achieved. The blowpipe is simply a mixing device to supply approximately equal volumes of oxygen and acetylene to the nozzle, and is fitted with regulating valves to vary the pressure of the gas, as required.

Ancillary Equipment

A spindle or bottle key is used to open the valves on both cylinders. Each valve should only be opened approximately $\frac{1}{2}$ turn and during use the key should be left in the position on the acetylene cylinder, so that it can be turned off immediately in the event of an emergency.

Spark lighters are used to ignite the gases. Do not use matches as these could constitute a hazard.

Welding Blowpipe/Torch

High pressure Blowpipe

This is designed to mix the gases and deliver them to the nozzle. As the two gases are delivered to the blowpipe at equal pressure the injection principle as used in the low pressure blowpipe is unsuitable for us on the high pressure system.

Flash Back

This is the appearance of a flame beyond the blowpipe and even into the regulator.

Back Fire

This is the appearance of a flame in the neck or body of the blowpipe.

Back fire may occur when there is:

1. A dirty nozzle tip
2. Wrong pressure for nozzle being used
3. Touching plate or weld pool with nozzle
4. Overheating of blowpipe (Cool down in water. Make sure that the gas is passing through nozzle)

Thickness		Nozzle Size	Regulator Pressure		Gas Consumption	
(mm)	(in)		(bar)	(lbf/in ²)	(l/h)	(ft ³ /h)
0.8	1/32	1	0.14	2	29	1
1.2	3/64	2	0.14	2	57	2
1.6	1/16	3	0.14	2	86	3
2.4	3/32	5	0.14	2	140	5
3.2	1/8	7	0.14	2	200	7
4.0	5/32	10	0.21	3	280	10
5.0	3/16	13	0.28	4	370	13
6.5	1/4	18	0.28	4	520	18
8.2	5/16	25	0.42	6	710	25
10.0	3/8	35	0.63	9	1 000	35
13	1/2	45	0.35	5	1 300	45
19	3/4	55	0.43	6	1 600	55
25	1	70	0.49	7	2 000	70
25+	1+	90	0.63	9	2 500	90

Table 2 - Nozzle Size, Working Pressure and Gas Consumption for Various Thicknesses of Mild Steel Plate

Note: These figures are an approximate guide and may be varied according to the flame setting, material etc.

Nozzle Size and Gas Velocity

The power of the blowpipe is measured by the amount of acetylene gas that is used per hour. Blowpipe manufacturers have various ways of showing this:

- (a) By the quantity of gas passed per hour, in litres.
- (b) By the diameter of the hole in the nozzle.
- (c) By a number corresponding to the plate thickness that can be welded by that nozzle.

It is most important when making a weld that the correct blowpipe power is used. The two factors that mostly affect this are the velocity and quantity of gas which passes through the nozzle.

Welding Techniques

Leftward Welding

In this method of welding, the blowpipe should be grasped firmly, ensuring that the wrist is free to move. The weld is commenced on the right-hand side of the seam; working towards the left-hand side, as shown in illustration (a) below. The blowpipe is moved forward with the flame pointing in the direction of the welding, with the filler rod being held in front of the flame. The angles of inclination of the blowpipe and filler rod are shown clearly in illustration (b). The blowpipe is given small sideways movements, while the filler rod is moved steadily across the weld seam.

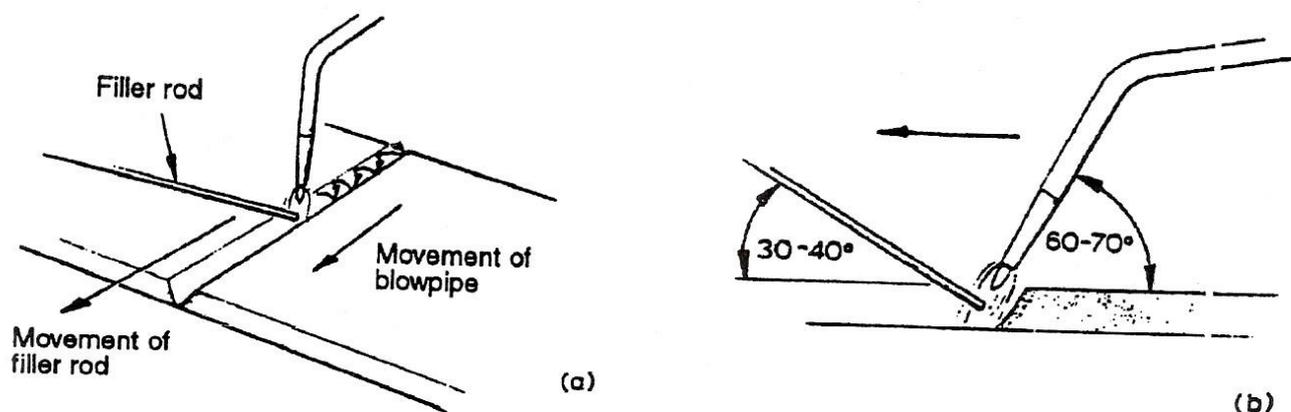


Figure 7 - Leftward Technique

The filler rod metal is added using a backward and forward movement of the rod, allowing the flame to melt the bottom edges of the plates just ahead of the weld pool. It is important that the filler rod is not held continuously in contact with the weld pool, or the heat from the flame cannot reach the bottom edges of the joint.

The disadvantages of this method are that the view of the joint edges is interrupted and it is necessary to remove the end of the rod, which slows down the welding process. Also, as the rod is removed, oxides form on the butt end, which are then deposited into the weld pool when recommencing the weld.

For welding plates over 3.2 mm (1/8 in.), it is usual to bevel the edges to approximately 40°, giving an included angle of approximately 80°. With plates over 8.2 mm (5/16 in.), it is usually necessary to use two or more passes. When welding plates 6.5 mm (1/4 in.) thick and over it is difficult to obtain complete firmness and even penetration at the bottom of the vee and if the welder is not highly skilled the quality of the weld decreases as the plate thickness increases. Also with an 80° vee the amount of filler metal used is quite considerable and can lead to problems due to the expansion and contraction that is produced. For these reasons it is considered that the maximum economical thickness of metal for this technique is 5 mm (3/16 in.).

Leftward Technique

Thickness of Plate (mm)(in)	Power of Blowpipe (gas consumption)		Diameter of Filler Rod		Rate of Welding		Distance between edges		Welding Rod used per metre per foot		Edge preparation
	(l/h)	(ft ³ h)	(mm)(in)	(mm)(in)	(m.h)	(ft.h)	(mm)(in)	(m)	(ft)		
0.9 1/32	28-57	1-12	1.6 1/16	1.6 1/16	6-7.6	20-25	— —	0.3	1	square	
1.6 1/16	57-86	2-3	1.6 1/16	1.6 1/16	7.6-9	25-30	1.6 1/16	0.53	1.75	square	
2.4 3/32	86-140	3-5	1.6 1/16	1.6 1/16	6-7.76	20-25	2.4 3/32	8.84	2.75	square	
3.2 1/8	140-200	5-7	3.2 1/8	3.2 1/8	5.4-6	18-20	3.2 1/8	0.50	1.65	square	
4.0 5/32	200-280	7-10	3.2 1/8	3.2 1/8	4.6-5.4	15-18	3.2 1/8	0.64	2.1	80° vee	
5.0 3/16	280-370	10-13	3.2 1/8	3.2 1/8	3.6-4.6	12-15	3.2 1/8	1.40	4.8	80° vee	

Table 3 - Leftward Technique

Rightward Welding

In this method, the welding is commenced on the left-hand side of the seam, working towards the right-hand side, as shown in the top illustration. The blowpipe points in the direction of the welded seam and moves in a straight line along the seam. The filler rod is held at an angle of $30/40^\circ$ (see second illustration) and describes a series of loops as it is moved forward.

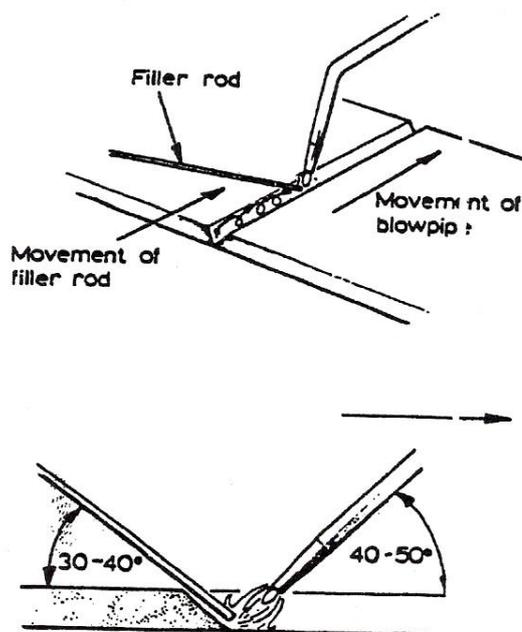


Figure 8 - Rightward Welding

When using this method it is not necessary to bevel the edges of the plates for thicknesses up to $5/16$ in., and for plates over this size a vee with an included angle of only 60° is required.

The differences in edge preparation, blowpipe direction and filler rod movement are the major factors to be considered when comparing the rightward and leftward techniques.

It is more common to use the rightward technique, in preference to the leftward, on mild steel plate over $3/18$ in., because: (a) less filler rod is used; (b) welding speed is greater; (c) gas consumption is less; (d) the mechanical properties of the welds are better, due to the annealing effect of the flame being directed on to the completed weld; (e) there is less risk of oxidation, due to the reducing flames of the oxyacetylene blowpipe.

Rightward Technique

Thickness of Plate (mm)(in)	Power of Blowpipe (gas consumption)		Diameter of Filler Rod (mm)(in)	Rate of Welding		Distance between edges (mm)(in)	Welding Rod used per metre per foot		Edge preparation
	(l/h)	(ft ³ h)		(m.h)	(ft.h)		(m)	(ft)	
5.0 $\frac{3}{16}$	370-520	13-18	2.4 $\frac{3}{32}$	3.6-4.6	12-15	2.4 $\frac{3}{32}$	1.03	3.4	no vee
6.5 $\frac{1}{4}$	520-570	18-20	3.2 $\frac{1}{8}$	3.0-3.6	10-12	3.2 $\frac{1}{8}$	1.03	3.4	no vee
8.2 $\frac{5}{16}$	710-816	25-30	4.0 $\frac{5}{32}$	2.1-2.4	7-8	4.0 $\frac{5}{32}$	1.03	3.4	no vee
10.0 $\frac{3}{8}$	1000-1300	35-45	5.0 $\frac{3}{16}$	1.8-2.1	6-7	3.2 $\frac{1}{8}$	1.22	4.0	60° vee
13.0 $\frac{1}{2}$	1300-1400	45-50	6.5 $\frac{1}{4}$	1.3-1.5	4.5-5	3.2 $\frac{1}{8}$	1.69	4.75	60° vee
16.2 $\frac{5}{8}$	1600-1700	55-60	6.5 $\frac{1}{4}$	1.1-1.33	7.5-4.25	3.2 $\frac{1}{8}$	2.05	6.75	60° vee
19 $\frac{3}{4}$	1700-2000	60-70	6.5 $\frac{1}{4}$	0.9-1.0	3-3.25	3.2 $\frac{1}{8}$	2.96	9.75	60° top, 80° bottom vee
25 1	2000-2500	70-90	6.5 $\frac{1}{4}$	0.6-0.7	2-2.25	3.2 $\frac{1}{8}$	5.08	16.75	60° vee 80° bottom vee

Table 4 - Rightward Technique

Oxy-Acetylene Welding Equipment

A complete oxy-acetylene welding set consists of the following:

1. An oxygen cylinder;
2. An oxygen regulator;
3. A blue oxygen hose;
4. An acetylene cylinder;
5. An acetylene regulator;
6. A red acetylene hose;
7. A blowpipe and set of interchangeable nozzles or tips;
8. A trolley to carry the cylinders;
9. Keys and spanners to fit the equipment;
10. Filler rods and fluxes;
11. Personal protection for the operator, i.e. gloves, goggles, apron, etc;
12. Flash back arrestors at regulators;
13. Hose check valves, see below.

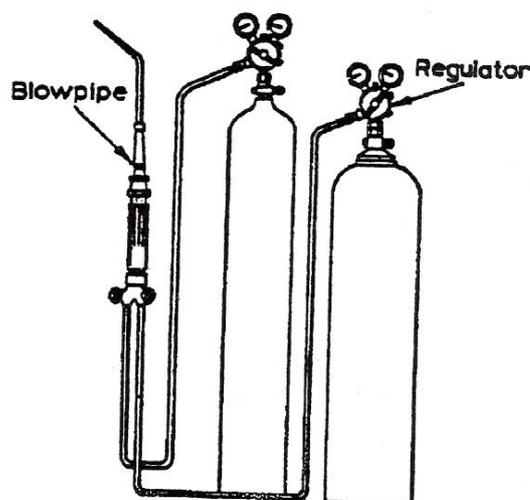


Figure 9 - Blue Oxygen Cylinder / Maroon Acetylene Cylinder

Flash Back Arrestor (Hose Protector)

This device which is fitted at the blowpipe of the hoses arrests any flame caused by backfire at the inlet connection of the blowpipe. It will also prevent the flow of the gases if they have been reversed during assembly.

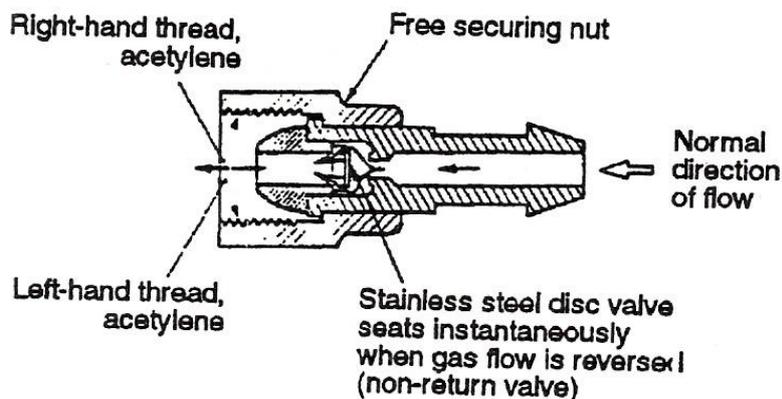
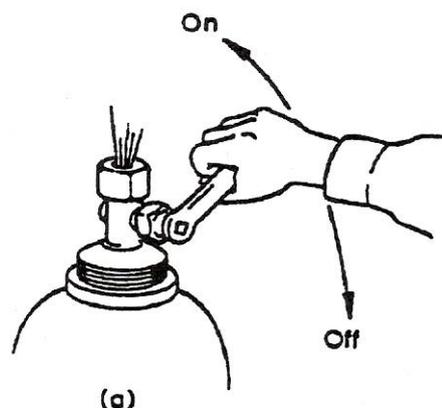


Figure 10 - Flash Back Arrestor

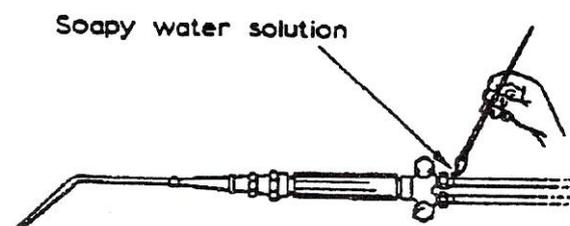
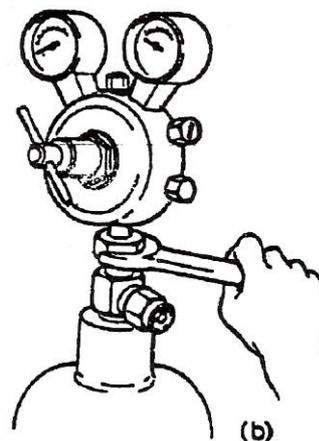
Assembly of the Equipment

1. Clean the valve seat on the cylinders by cracking open the valve momentarily (this will remove any dust or grit which would damage the valve seat), as shown in (a) on the left.
2. Select the correct regulator and screw it into the cylinder valve seat until it is finger-tight. Then, using the correct spanner, tighten up to obtain a gas-tight joint, as shown in (b). Slacken the pressure-control screw to relieve the pressure on the regulator diaphragm.



Never use oil or grease on the threads.

3. If new hoses are to be used they should be blown through to remove any dust or chalk.
4. Connect the hoses to the regulators **blue** hose for *oxygen*, **red** hose for *acetylene*. Make sure that the anti-flashback devices are fitted to the blowpipe end of the hoses.
5. Arrange the hoses so that they are not twisted.
6. Connect the hoses to the correct connectors on the blowpipe.
7. Open the blowpipe valves and turn on the gas supplies.
8. Adjust the regulators until the correct pressures are obtained. When these pressures have been set, the blowpipe valves are closed.
9. The system should now be tested for leaks, using a soapy water solution - see right.



Lighting Up

When the equipment is initially set up and before lighting up it should be checked for leaks. **Never use a naked flame to check for leaks.** The correct method is to use soapy water.

Only when the equipment is in a sound working condition can you proceed to the pressure adjustment, lighting up and flame setting required.

Before opening the cylinder outlet valves check that the regulator control screw is in the slackened position, i.e. turned fully in an anti-clockwise direction.

Slowly open the cylinder valve until gas is registered on the contents gauge. Turn the regulator adjusting screw in a clockwise direction until the recommended working pressure is indicated. When this procedure is applied to both cylinders the system is fully charged and ready for lighting up.

Slowly open the acetylene valve on the blowpipe. This allows acetylene gas to flow through the nozzle where it is ignited by means of a spark lighter. The acetylene flame should be adjusted until it ceases to smoke and there is no gap between the base flame and the welding tip. The oxygen valve is then opened and adjusted until a neutral flame is achieved. A neutral flame is a mixture of equal amounts of oxygen and acetylene gas and is used for all autogenous welding operations.

To extinguish the flame turn off the acetylene valve on the blowpipe. This will cause the flame to go out. The oxygen valve is then turned off. If the equipment is not to be used for a long period of time, i.e. lunch breaks etc., the valves on the cylinders should be closed. Both blowpipe valves should be opened fully until gas ceases to flow and then closed again.

The pressure adjusting screw on the regulators should be slackened by turning in an anti-clockwise direction.

Lighting and Adjusting the Flame

1. Open the blowpipe valves and turn on the gas supplies.
2. Adjust the regulators until the correct pressures are obtained. When these pressures have been set, the blowpipe valves are closed.
3. Open the acetylene valve on the blowtorch about three-quarters of a turn.
4. Allow the acetylene to flush the system through and then, using a spark lighter (or similar) - see illustration - light the gas.
5. Open the oxygen control valve and adjust until the required flame is achieved.

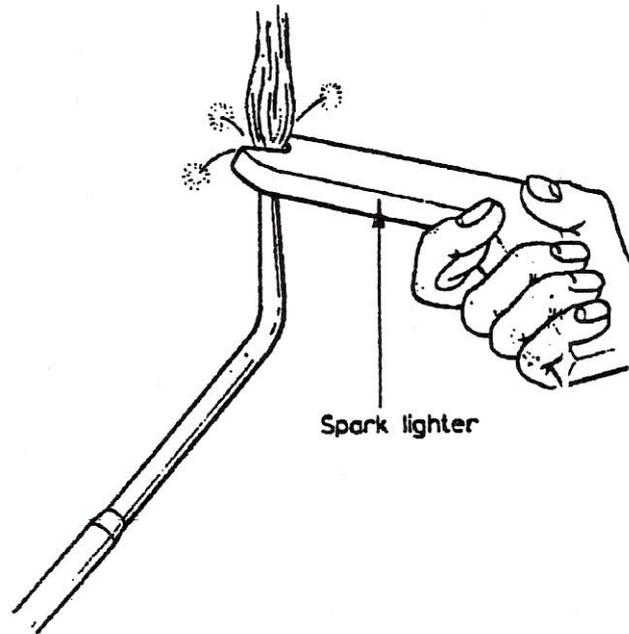


Figure 11 - Spark Lighter

Extinguishing the Flame

If the welding equipment is to be turned off for short periods the following procedure should be observed:

- (a) Close the acetylene control valve.
- (b) Close the oxygen control valve.

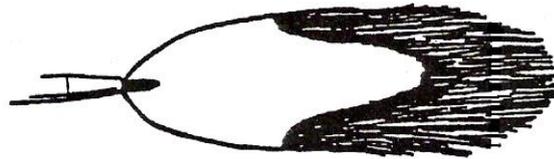
The Oxy-Acetylene Flame

It is most important when welding that the correct flame is selected to complete the welding process. Following are the three type of flame used by the welder:

Neutral Flame

This type of flame is produced when equal volumes of oxygen and acetylene are burnt together. In this flame there are two distinct zones: the inner white cone, which is clearly defined, and the outer envelope.

The neutral flame is used when welding steels, stainless steel, cast iron, copper and aluminium, etc.



Carburising Flame

If the volume of oxygen being supplied to the neutral flame is reduced, the resulting flame is rich in acetylene. It is rich in carbon and capable of yielding carbon to the steel being welded. Its effect is to reduce the melting temperature of the steel in the localised area of the weld. The carburising flame is recognised by the ragged bluish white feather surrounding the large central white cone.

The carburising flame is used for hard facing.



Oxidising Flame

If the neutral flame is adjusted until it burns with an excess of oxygen, the flame produced is called an oxidising flame. It can be recognised by the small white cone surrounded by the ragged bluish white feather. It tends to be hotter than the neutral flame.

The oxidising flame is used to weld brass.



Oxy-Acetylene Flame Types

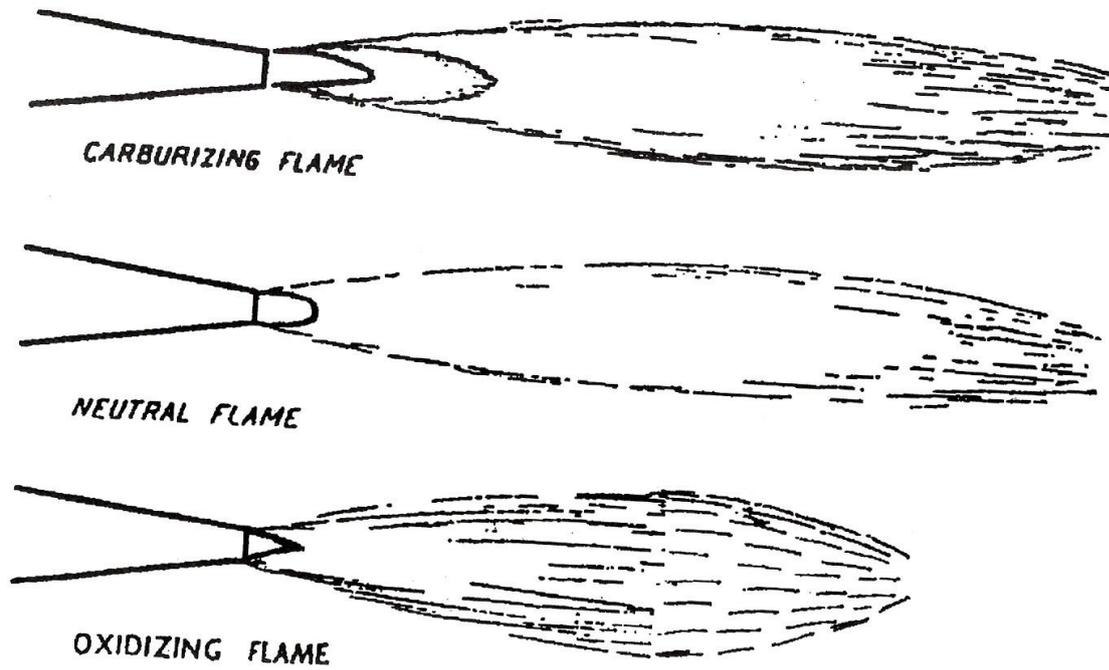
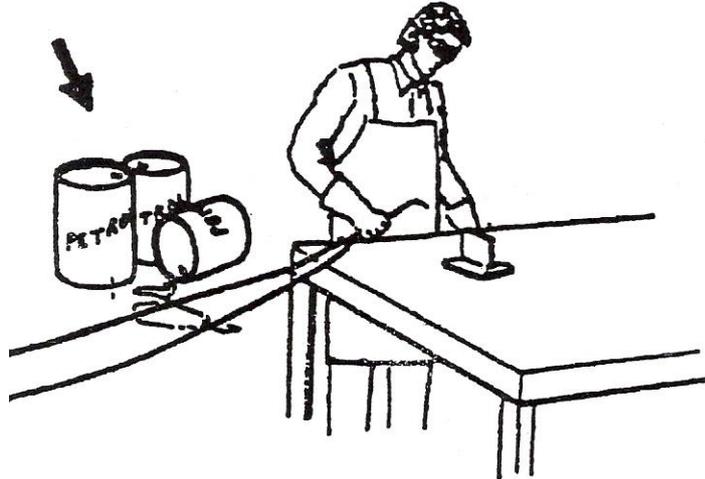


Figure 12 - Oxy-Acetylene Flame Types

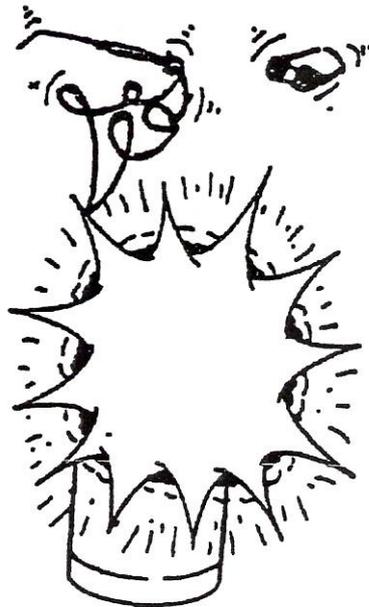
Safety Precautions

Before starting to weld, using the oxyacetylene torch, there are a number of safety precautions you should study and remember.

Never weld where there is an inflammable material in the vicinity.



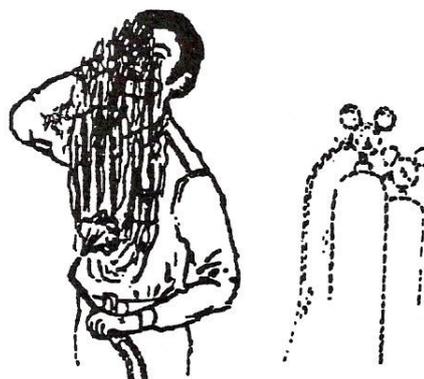
Never weld on containers (like a petrol can) which have held combustible materials.



Hazards

Oxygen

Oxygen cylinders and the fittings attached to them must never be greased or oiled. Even small quantities of oil and grease, when mixed with oxygen, can react and cause an explosion. Oxygen has no smell and does not itself burn, but it will support and speed up combustion. It should never be used for ventilating enclosed spaces or for blowing clothes or other combustible material (top illustration). Even a spark can, under these conditions, start a fire which may result in considerable damage or injury to personnel.

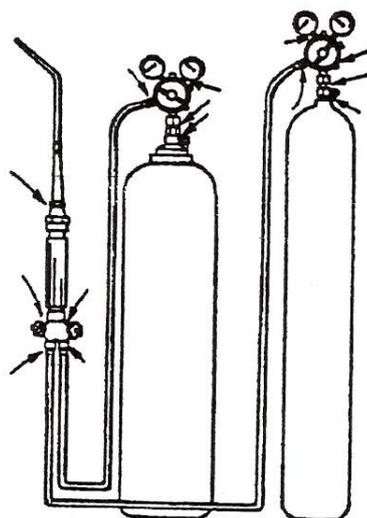


Never use oxygen to blow clothing clean

Acetylene

Acetylene gas has a noticeable smell, is highly inflammable and will ignite and burn very easily. Even a mixture of acetylene and air as low as 2% will give an explosive compound condition when in contact with metals and alloys, such as those containing copper and silver. Pippings and fittings made of copper should never be used with acetylene gas.

Take extra care with both oxygen and acetylene cylinders to ensure that there are no leakages when assembling the equipment. Dirt should be blown clear of the valve seats by cracking the valves momentarily before attaching the pressure regulator.

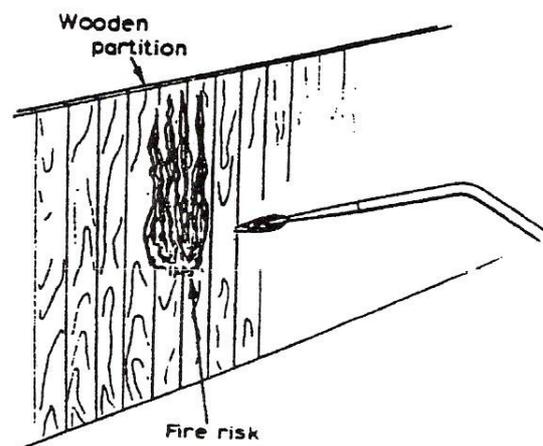


Test for leaks with soapy water not with a flame

NEVER: test for leakage with a flame. Soapy water should be brushed over the joint to test for leakage of gas (second illustration). Always check, on completion of the job that no glowing fragments or sparks are left.

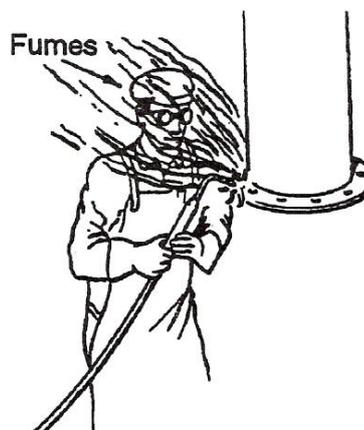
REMEMBER: that even at some distance away from the oxy-acetylene flame the temperature is still very high and capable of starting a fire (bottom illustration).

Do not use oil based detergent in testing of leaks.

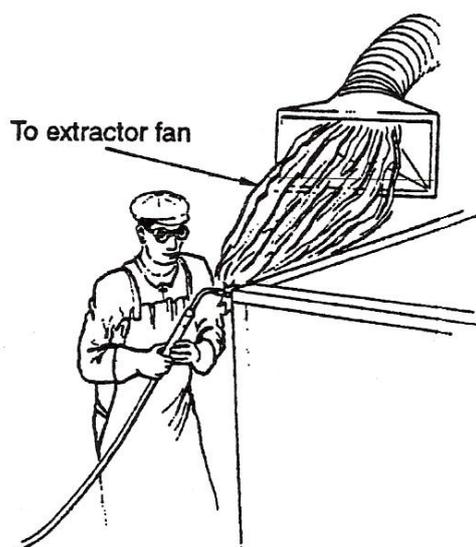


Dangers of Welding in Confined Spaces

When welding, fumes are given off which are dangerous to the health of the welder. It is therefore important to remove and dispose these fumes. This is particularly important when welding in confined spaces, such as inside boilers, tanks, ships compartments, etc.



When welding in confined spaces it is necessary to use some form of mechanical ventilation. This usually consists of an elongated hood attached to a flexible ducting, connected to an extraction fan. It is necessary to arrange the hood in such a position that it draws air across the face of the welder towards the welding. Forced ventilation not only reduces the fumes but also lowers the temperature in which the welder is working and increases his comfort.

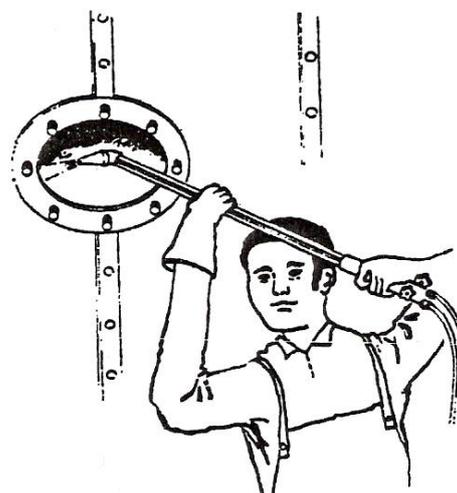


The fumes from welding consist of iron oxide particles which, when inhaled, will remain in the lungs causing damage to them. Arcing can also result in nitrous fumes (oxides of nitrogen) being formed. These give little warning of their presence and can cause serious damage to the lungs.

Oxygen should never be used to ventilate confined spaces.

Fatal accidents through workers' clothes becoming ignited have resulted from this practice.

The use of compressed air for forced ventilation is also an undesirable practice.



When welding is finished for a long time (during lunch or overnight) close the cylinder valves and then release all gas pressure from the regulators and hoses by opening the torch valves. Close the torch valves and release the pressure adjusting screws.

- In case of burns or accidents always turn off torch FIRST.
- Do not fool around with torch flame.
- Remember to wear goggles at all times when welding.
- Always blow out hoses before fitting.
- NEVER joint hoses with copper pipe.

Welding Safety

- Always wear protective clothing, i.e. flame retardant overalls.
- Always wear the correct eye goggles.
- Always have the spindle key in the acetylene cylinder valve.
- Always keep cylinders secured in an upright position.
- Always check for leaks with a soapy solution, NEVER with a naked flame.
- Never carry out makeshift repairs on welding equipment.
- Never allow oil or grease to come in contact with oxygen equipment.
- Never weld an enclosed vessel, i.e. petrol/oil drums until they have been thoroughly cleaned.
- Never work in an enclosed vessel on your own and always leave the cylinders outside. If working in an enclosure vessel, adequate ventilation should be provided and fire fighting equipment should be available.
- In the event of a serious flashback or backfire plunge the blowpipe in a bucket of cold water, leaving the oxygen running to prevent water entering the blowpipe.
- Should the hoses become damaged, turn off the supply of gas at the cylinder and inform your supervisor.
- Don't forget, this equipment, if misused or damaged can be dangerous. If in any doubt seek assistance and clarification from your supervisor.
- Always have flash back arrestors fitted and hose check valves.
- To convert Celsius to Fahrenheit use:

$$\mathbf{C = 5/9 (F - 32) \text{ and}} \\ \mathbf{F - 9/5 C + 32}$$

Conduction

Heat travels along metal objects. The heat given to the object is passed all along until the whole object has a uniform temperature. Heat conductivity varies with materials. Metals are good conductors while materials like asbestos and fibreglass resist the flow of heat. These may be called bad conductors of heat or good insulators.

Liquids such as water, petrol and oil are poor conductors of heat and gases are even poorer. Liquids and gases normally transfer their heat by convection which we will consider next.

Convection

When fluid is heated a movement takes place in the fluid. If water at a temperature above 4°C is heated, it expands, decreases in density and rises towards the surface. The same effect happens with other liquids and gases.

- Water gets hotter, expands, gets lighter and rises.

Radiation

This is heat transfer by rays which are similar to light rays. An example is the sun. The sun's rays are powerful and are capable of travelling through space. In a similar way the heat from any source can be felt when there is no interruption to the path of the rays. This radiant heat consists of invisible electro-magnetic waves which behave in a manner similar to light waves:

- they travel in a straight line;
- they can be reflected.

The rate of heat transfer depends on:

- temperature of the source;
- area of its source and nature of its surface.

The hotter the source, the greater will be the transfer. Increasing the area has the effect of 'spreading out' this hot surface and allows the heat to be given up more readily.

The nature of the surface is the finish. A dull dark finish radiates heat better and also absorbs heat better than a highly polished surface.

The Nature of Heat

A substance is made up of tiny particles called molecules and these consist of even smaller particles called atoms. Observations of these tiny particles shows that each one is vibrating; the amount of vibration depending on the 'hotness' of the substance. So:

- heat is internal energy and is capable of doing work.
- Heat flows from a hot to a cold surface.

A hot object placed beside a cold surface will cause the heat to 'flow' until the two things are at the same heat.

Temperature

The temperature of a body is "the degree of hotness". This is different to the heat contained in an object, e.g. more energy will be required to heat four litres of water than that to heat two litres to the same temperature.

Although terms like 'hot' and 'cold' give an indication of the temperature, they lack accuracy and can lead to misunderstanding, e.g. A hot day means something different to a hot engine. Temperature is measured by a thermometer.

Celsius Scale

Everyday temperature measurement uses this scale which is similar to that introduced in 1742 by the Swedish scientist Andreas Celsius. In this case the freezing point of water is marked 0°C and the boiling point 100°C; temperatures below zero are given negative values. For many years this scale was known as Centigrade but nowadays it is recommended that the name Celsius be used.

Fahrenheit Scale

To convert C to F we use:

$$F = 9/5 (C) + 32$$

A scale used in Britain until fairly recently. The upper fixed point was marked 212°F and the lower point as 32°F; the interval between divided into 180 degrees. To convert °F to °C the formula is:

$$C = (F - 32) \times 5/9$$

Kelvin Scale

The SI unit of temperature is the 'Kelvin'. This has the same size of degree or temperature interval as the Celsius scale, but has a zero about -273°C. To convert from Celsius to Kelvin add 273.

Self Assessment

Questions on Background Notes – Module 3.Unit 1

1. What is the function of a Flash Back Arrester?

2. When would an Oxidising Flame be used during oxy-acetylene welding?

3. When would the Rightward Technique be used while oxy-acetylene welding?

4. Why should the fittings used on oxygen cylinders never be oiled or greased?

5. What colour code is used for cylinders used to store acetylene and oxygen?

6. What methods are used to prevent the interchange of fittings used on cylinders containing acetylene and oxygen?

Answers to Questions 1-6. Module 3. Unit 1

1.

Flash Back Arrestor:

The purpose of a flash back arrestor is to prevent flames getting back into the cylinder in the event of a backfire or similar accident.

2.

An oxidising flame is used to weld brass.

3.

Rightward technique

Used on mild steel plate over 3/16 inches.

Less filler rod is used.

Welding speed is greater.

Gas consumption is less.

Mechanical properties of weld are better due to the annealing effect of the flame.

4.

The risk of explosion.

5.

Acetylene - Maroon

Oxygen - Black

6.

Acetylene

Acetylene fittings are screwed left handed i.e. anti clockwise.
They also have a chamber in them.

Oxygen

Oxygen equipment is the opposite with clockwise threaded fittings and no chamber.

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