WELDING

Chapter 1

Prepared by SUNIL KUMAR LECTURER in ME)

COMPETENCIES

- Identify the different types Consumable and Nonconsumable electrode welding processes
- Identify the flame characteristics associated with different types of gas welding
- Identify the unique characteristics for each type of arc welding
- List the advantages and disadvantages of gas and arc welding

WELDING

Soldering and brazing are adhesive bonds, whereas welding is a cohesive bond.

Joint Preparation

- Butt joints, vee joints, double-vee joints, tee joints, which require a fillet weld, and lap joints.
- Butt joints are used on metal that has a thickness of one-quarter inch or less.

Preparation for Weld Joints

- Surfaces to be joined must be ground to the weld specification.
- Any slag, corrosion, or other foreign material must be removed.

GAS WELDING

Oxygen-Acetylene Welding

- Oxygen tank (green)
- Acetylene tank (red, or black with a red top)
- Oxygen pressure valves have a right-hand internal thread
- Acetylene pressure valve has an external left-hand thread.
- An oxygen-acetylene flame is very hot, approaching 3500°F.

GAS WELDING

- **Fusion weld** is to place the two pieces against each other and melt their surfaces together.
- **Reducing flame** is used to melt low-melting-point metals and alloys because it does not oxidize or corrode the metals.
- **Neutral flame** is the hottest one possible and is the proper adjustment for welding.
- **Oxidizing flame** that can cause corrosion in the metal. It is only used for cutting flames or burning pieces of metal from a piece of stock. (Fig 14-9)

GAS WELDING

- Advantages of an oxy-acetylene weld
  - inexpensive
  - requires very little specialized equipment.
- Disadvantages
  - any traces of carbon left in the weld will weaken it.

GAS WELDING

Oxygen-Hydrogen Welding

- The oxygen-hydrogen torch can reach temperatures much higher than the oxy-acetylene torch.
- More expensive than oxy-acetylene welding and involves the flammability risk with hydrogen.

Plasma Welding

- Hydrogen plasma burns even hotter than hydrogen gas, permitting the welding of extremely high-melting-point metals.
- Very clean procedure that results in very little slag or foreign matter in the weld.

ELECTRICAL WELDING

- Resistance Welding – The two parts are pressed together and an alternating current (A/C) is passed through the contact zone.
- Spot welding – used extensively on sheet metals (holds handles on pots, car body together)
- Ribbon welding rollers. - parts to be welded are drawn between electrodes rollers while electricity is applied.

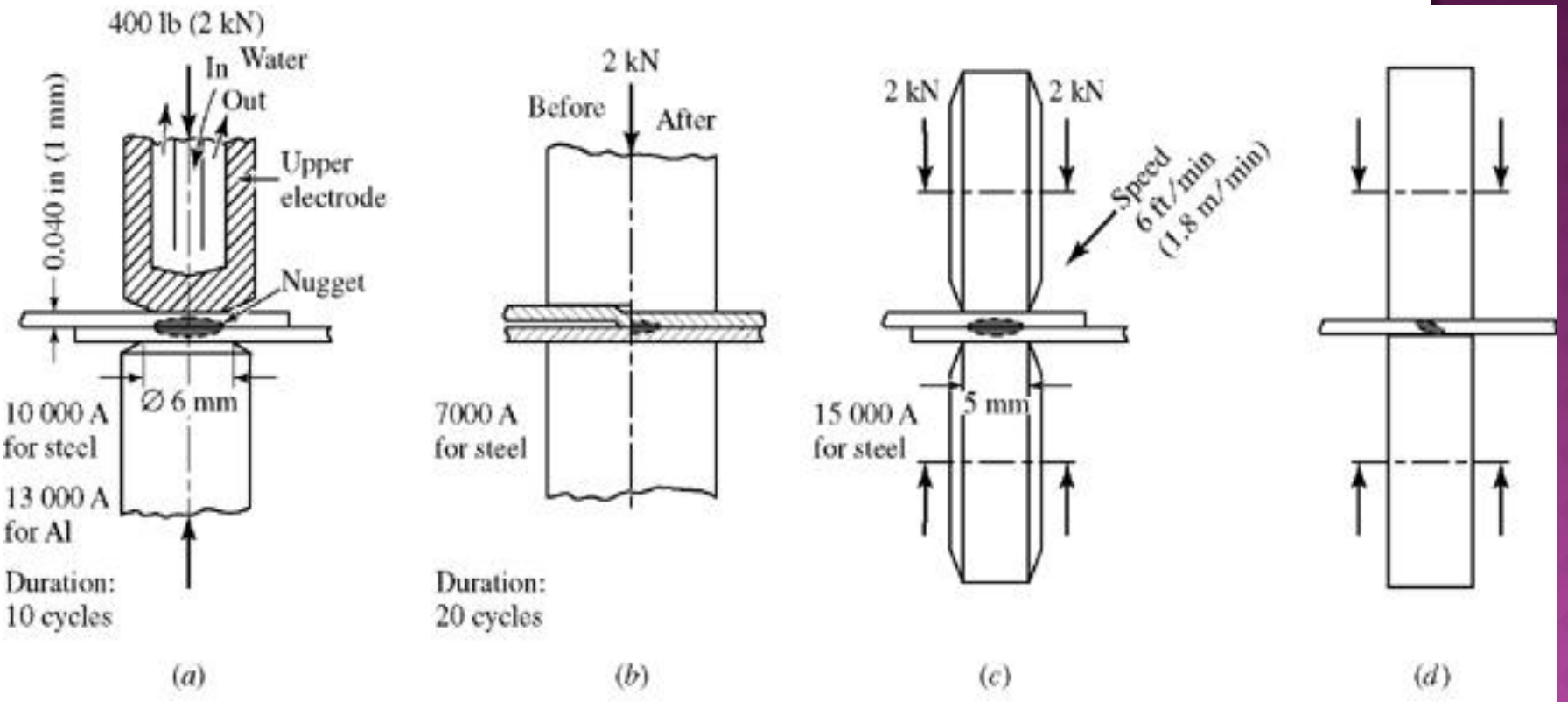

400 lb (2 kN)
In
Water
Out
0.040 in (1 mm)
Upper electrode
Nugget
Ø 6 mm
10 000 A for steel
13 000 A for Al
Duration: 10 cycles
(a)
2 kN
Before
After
7000 A for steel
Duration: 20 cycles
(b)
2 kN
2 kN
Speed 6 ft/min (1.8 m/min)
5 mm
15 000 A for steel
(c)
(d)

figure 18.15

ARC WELDING

A sustained arc generates the heat for melting the work piece and filler material.

- Consumable electrodes
- Non-consumable electrodes

CONSUMABLE ELECTRODES

- **Flux Core Arc Welding (FCAW)** developed in the early 1950s as an adaptation to SMAW to overcome limitation imposed by the use of a stick electrodes. Uses a spool of filler wire fed through the hand-piece. A core of flux is inside the wire
- Two versions
  - Self-shielded flux-cored arc welding – includes not only fluxes but also ingredients that generate shielding gases for protecting the arc.
  - Gas-shielded flux-cored arc welding – developed primarily for welding steels, obtains a shielding from externally supplied gases, similar to GMAW

CONSUMABLE ELECTRODES

- **Submerged Arc Welding (SAW)** – uses a continuous, consumable bare wire electrode, and arc shielding is provided by a cover of granular flux. Low-carbon, low alloy, and stainless steels can be readily welded by SAW.
- **Electrogas Welding (EGW) -** uses a continuous consumable electrode (either flux-cored wire or bare wire with externally supplied shielding gases) and molding shoes to contain the molten metal.
- **Shielded Metal Arc Welding (SMAW)** (stick) – arc is struck between the rod (shielded metal covered by flux) and the work pieces to be joined, the impurities rise to the top of the weld in the form of slag (18-19a, handout pg. 40)

A SUSTAINED ARC, SHIELDED BY MOLTEN SLAG, IS MAINTAINED IN CONSUMABLE-ELECTRODE WELDING BY THE (A) SHIELDED METAL-ARC, (B) SUBMERGED ARC, AND (C) ELECTROGAS METHODS.

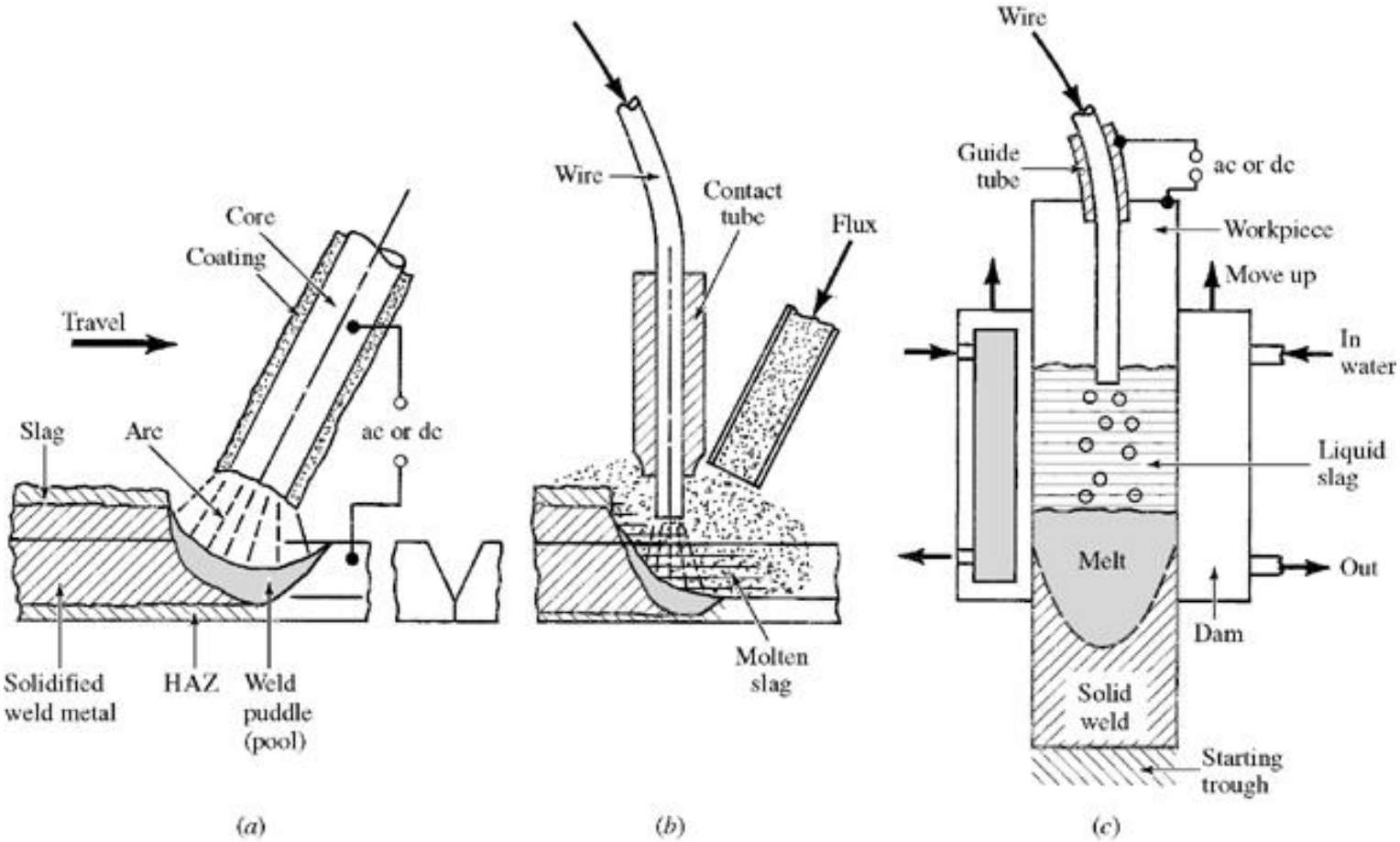


figure 18.19

SELECTION OF WELDING RODS

- Filler rod should have a tensile strength greater than the metal to be joined.
- Rod must also be compatible with the welded metal
- Welding positions required
- Welding current (ac or dc)
- Joint design (groove, butt, fillet, etc.)
- Thickness and shape of the base metal
- Service conditions and specifications
- Production efficiency and job conditions

WELDING ROD CLASSIFICATION (EX. E-6010)

- The E- stands for electrode.
- The first two numbers indicate the tensile strength
- The next-to-last number gives the welding positions
- The last digit of the weld rod number indicates the type of current for which the rod may be used (ac, dc straight, dc reverse), the penetration, and the type of flux around the rod.
- Example: E-6010 would have a tensile strength of 60,000 psi, could be used in all positions, has a cellulose-sodium flux, could give deep penetration, and must be used with dc reverse current. (p.270-272)

INERT GAS ARC WELDING

An inert gas is used to keep oxygen away from the hot metal during welding to prevent corrosion both on the surface and within the weld metal.

- **Gas metal arc welding (GMAW)** – (metal + inert gas) electrode is continuously fed through the welding gun and is shielded by an inert gas (figure 18-18c).
- Easily converted for
  - automatic welding machines, computer controlled welding machines, and robotics control.

THE ARC IS SHIELDED BY GAS IN THE (A) GAS TUNGSTEN-ARC, (B) PLASMA-ARC, AND (C) GAS METAL-ARC WELDING PROCESSES. NOTE THAT THE DEPTH OF PENETRATION INCREASES WITH INCREASING ARC TEMPERATURE.

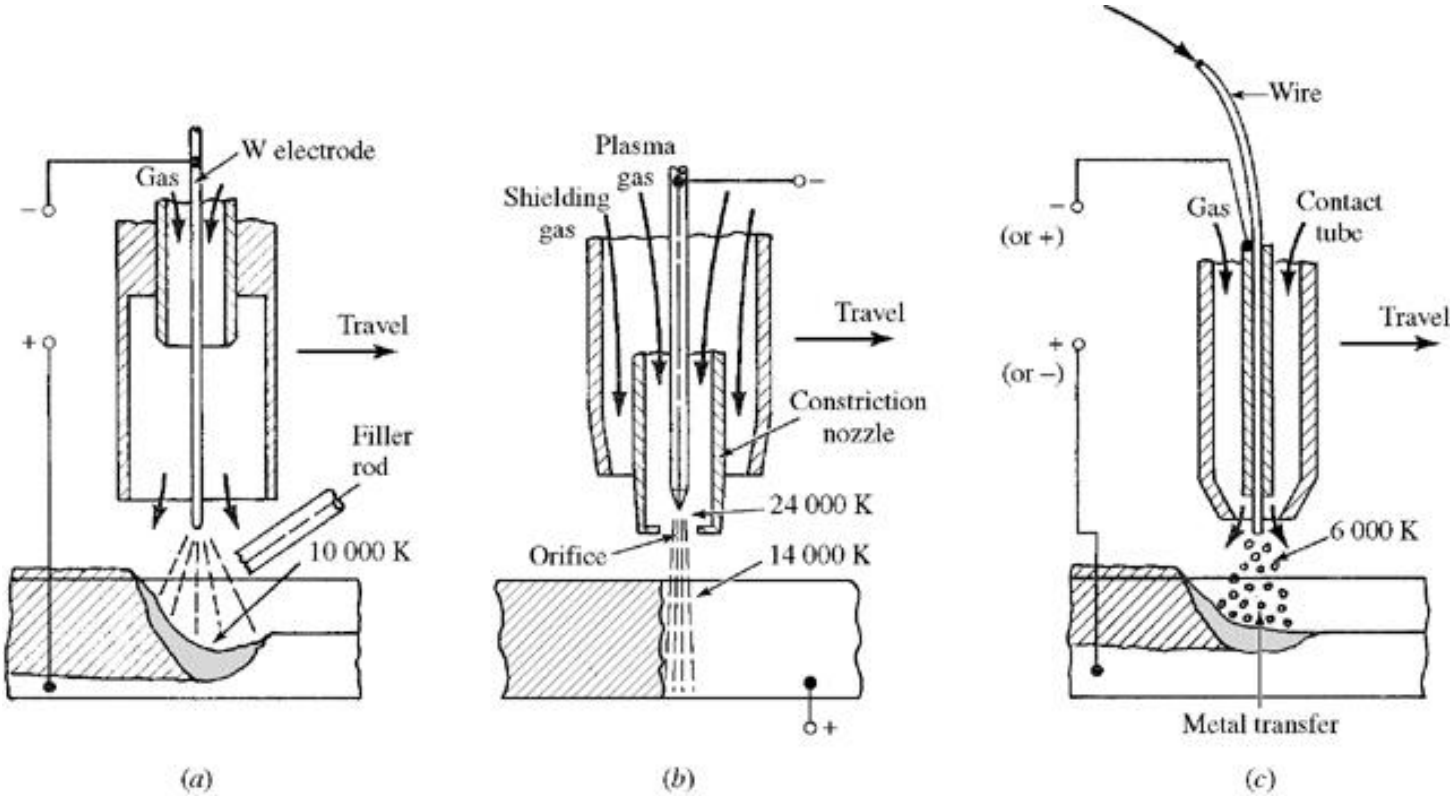


figure 18.18

NON-CONSUMABLE ELECTRODES

- **Gas Tungsten ARC welding - GTAW** (Tungsten inert gas, a.k.a. TIG) – Tungsten electrode not consumed, but surrounded by an inert gas and produces an arc.
  - Filler material is usually applied.
  - Gas tungsten arc welding does not produce as deep a penetration as stick or other types of welding.
  - GTAW is a slow method of welding, which results in an expensive product.
  - It can be used to weld aluminum, magnesium, titanium, and stainless steels.
- **Plasma-Arc welding (PAW)** – when an arc is created in a plasma (ionized) gas and a filler material may or may not be applied to the weld joint

OTHER WELDING TECHNIQUES

- **Electron beam welding (EBW)**
  - the electron gun melts the parent metal, and the molten metal flows to fill the gap
  - heat affected zone is very narrow
  - welds can be several inches deep, and leaves a very clean weld.
  - Welding must be done in a vacuum.
- **Laser beam welding (LBW) -** the heat from laser can be used to heat the surface of material or penetrate the entire depth of the joint (good for thin gauge metals). The major problems with the current lasers lie in the cost and bulk of the power source.

OTHER WELDING TECHNIQUES

- **Friction Welding**
  - Rubbing two pieces of metal or plastic together at a very high frequency.
  - It is simple, clean, quick, inexpensive, and effective.
  - Friction welds have thus far been used mainly for very small applications.
- **Chemical Welding**
  - Sheets of Lucite, Plexiglas, or acrylic can be fused by acetone or methyl ethyl ketone (MEK).
  - The chemical simply dissolves the surfaces of the plastic. When the solvent evaporates, the surfaces repolymerize to form a true weld.

BRAZING

A joining process in which filler metal is placed at or between the surfaces to be joined. The temperature is raised to melt the filler metal but not the workpiece.

- Braze melts between 840-2400 degrees F
- The filler material is in thin layers compared to base metal
- The filler penetrates the gap by capillary attraction
- Can connect dissimilar metals
- Most common braze defect is lack of braze or a void

SOLDERING

(400-840 degrees F) joints are usually of lesser strength than brazed but parts can be joined without exposure to excessive heat

- Used extensively in electronics industry because of heat sensitive components
- Surface preparation and the use of fluxes are most important

Fluxes –prevents oxidation and removes slight oxide films from work piece surfaces

THANKS

Gas Welding (Oxy-acetylene)

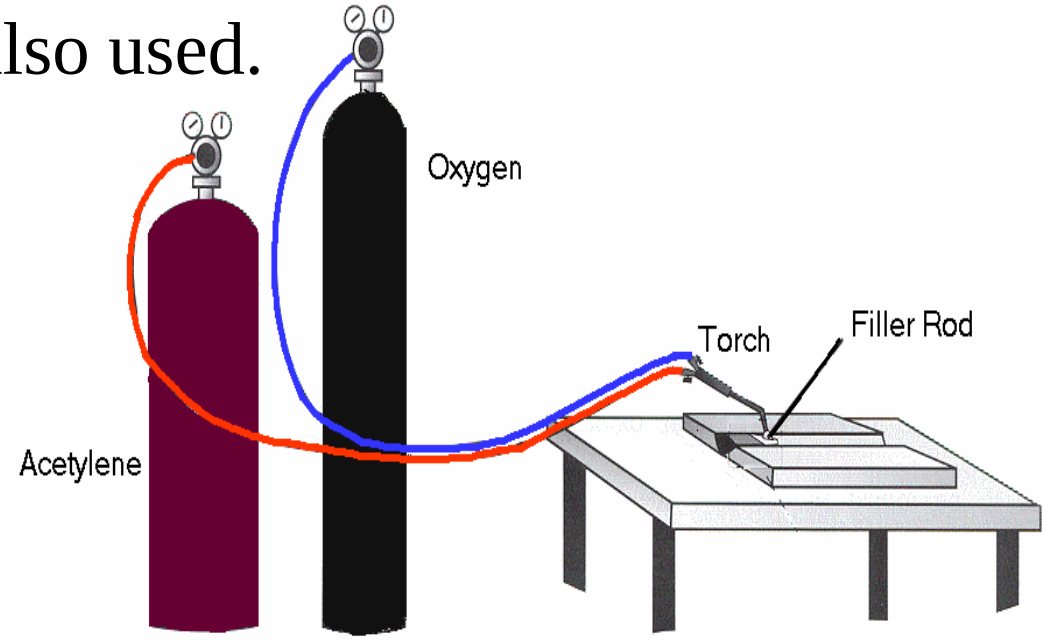
Engineering

A number of welding processes use a flame produced by burning a mixture of *fuel gas* and *oxygen*. The gas usually used is *Acetylene* but other gases are also used.

Separate cylinders and a hose pipe from each cylinder transports the gases to a torch.

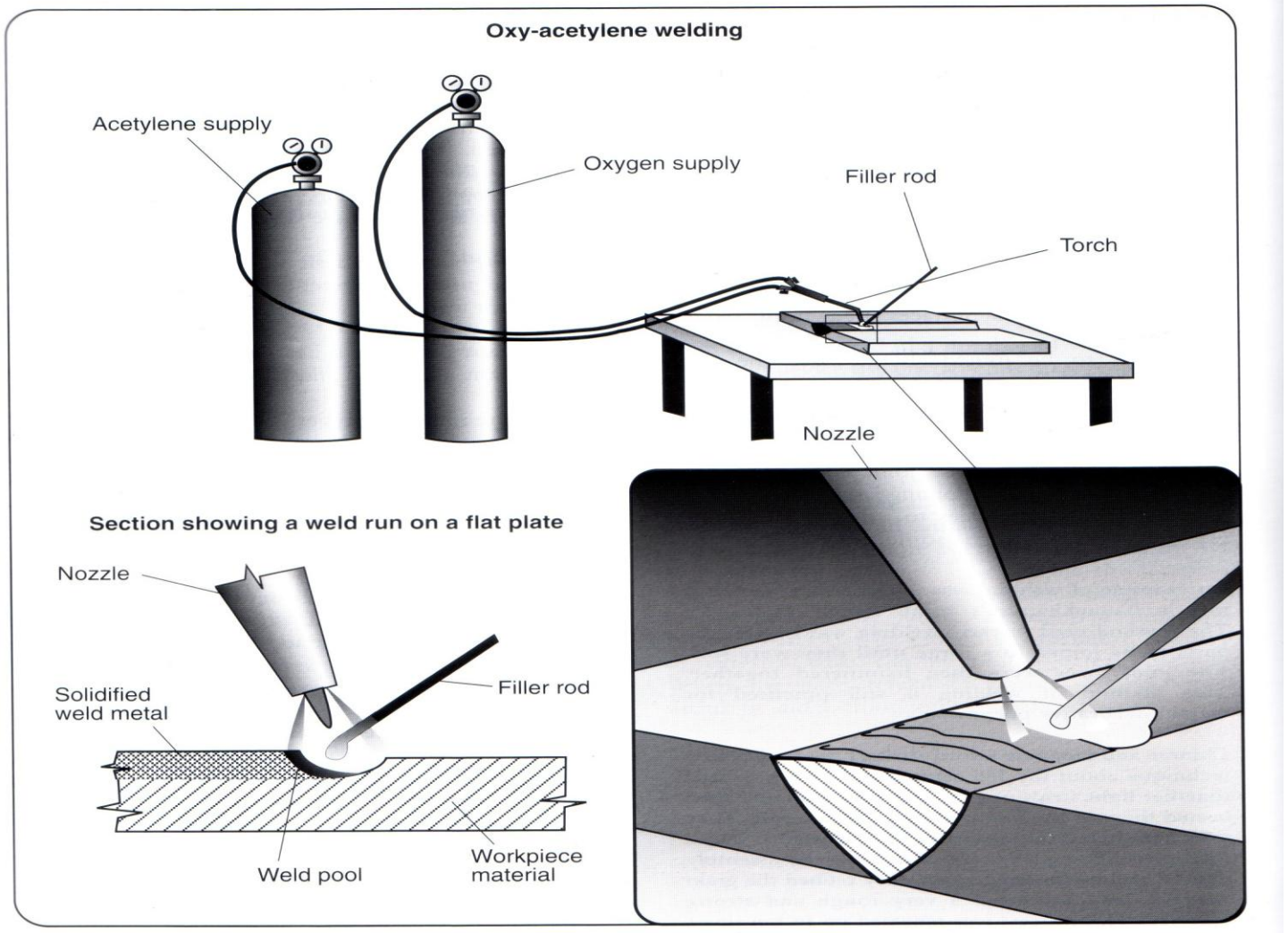
Gas and fuel mix in the torch

burns @ 3100°C.

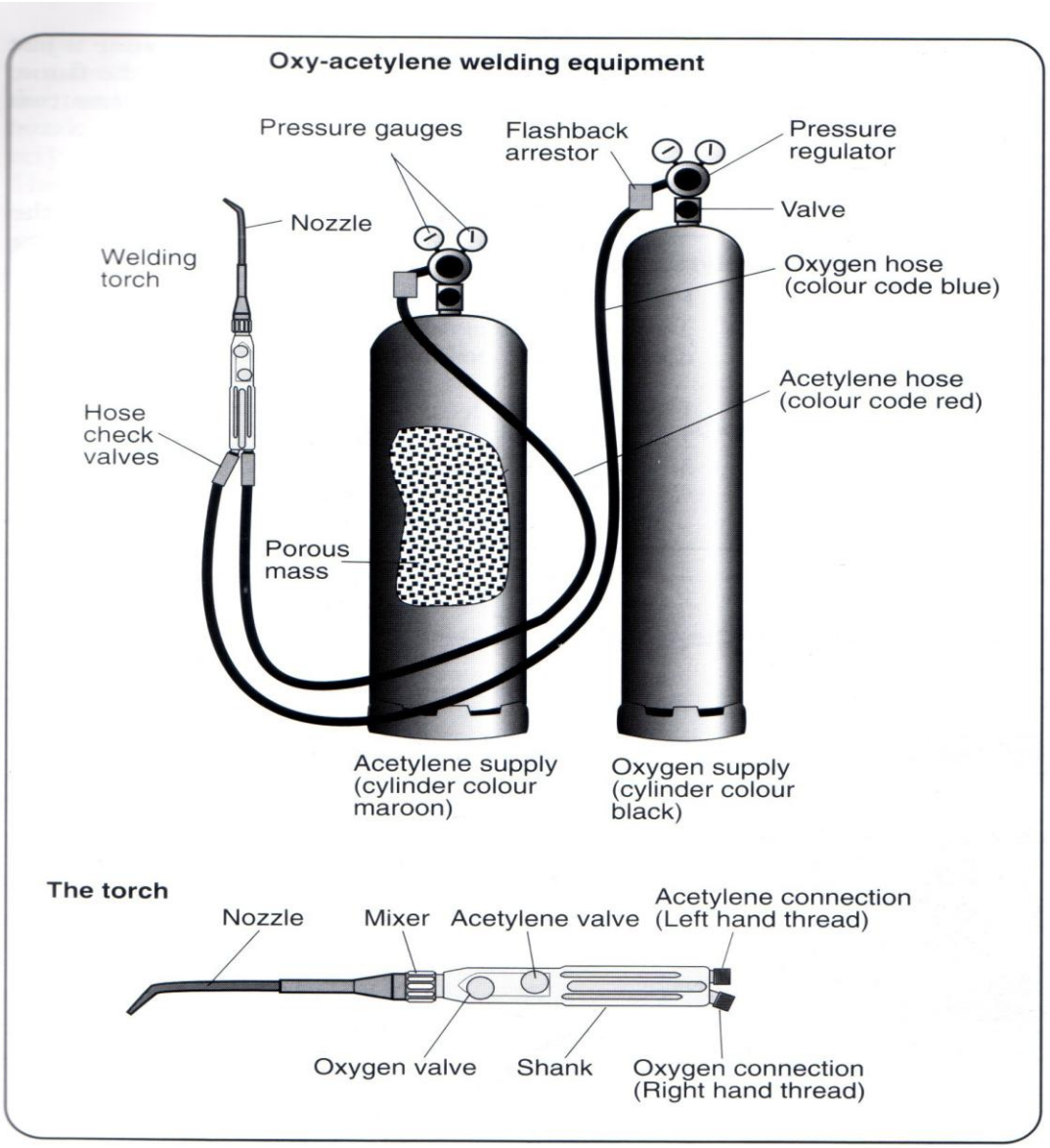


Gas Welding

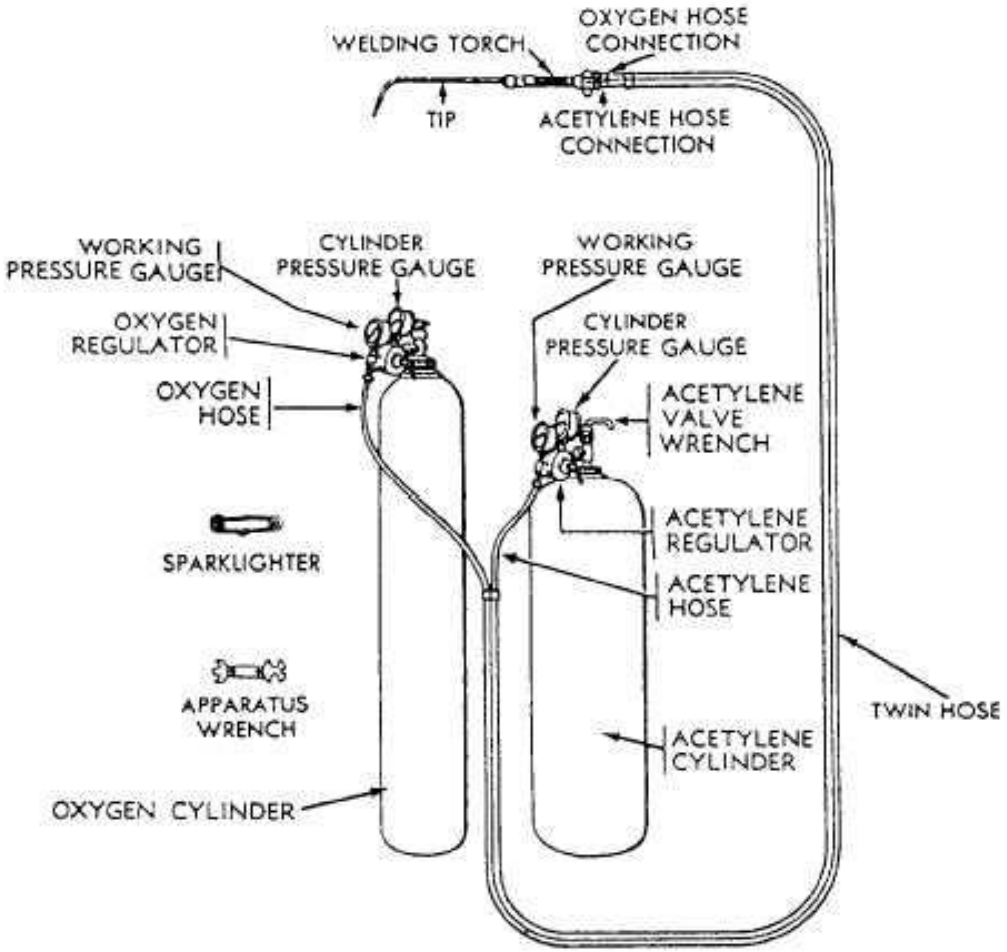
Engineering



Engineering



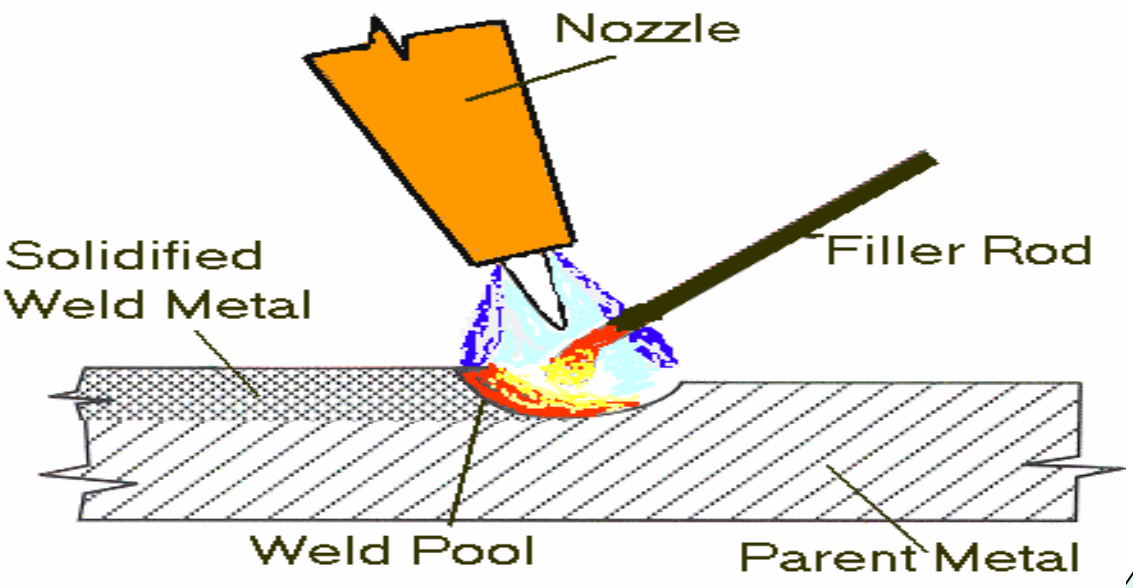
Engineering



Engineering

During the welding, heat from the flame is concentrated on the joint edges until the metal melts and starts to flow. When the molten metal from both sides melts it starts to fuse, when the metal cools down the two parts become *Permanently* joined

Additional *Filler Metal* is fed in by hand into the weld pool, at regular intervals where it becomes molten and joins with the parent metal.



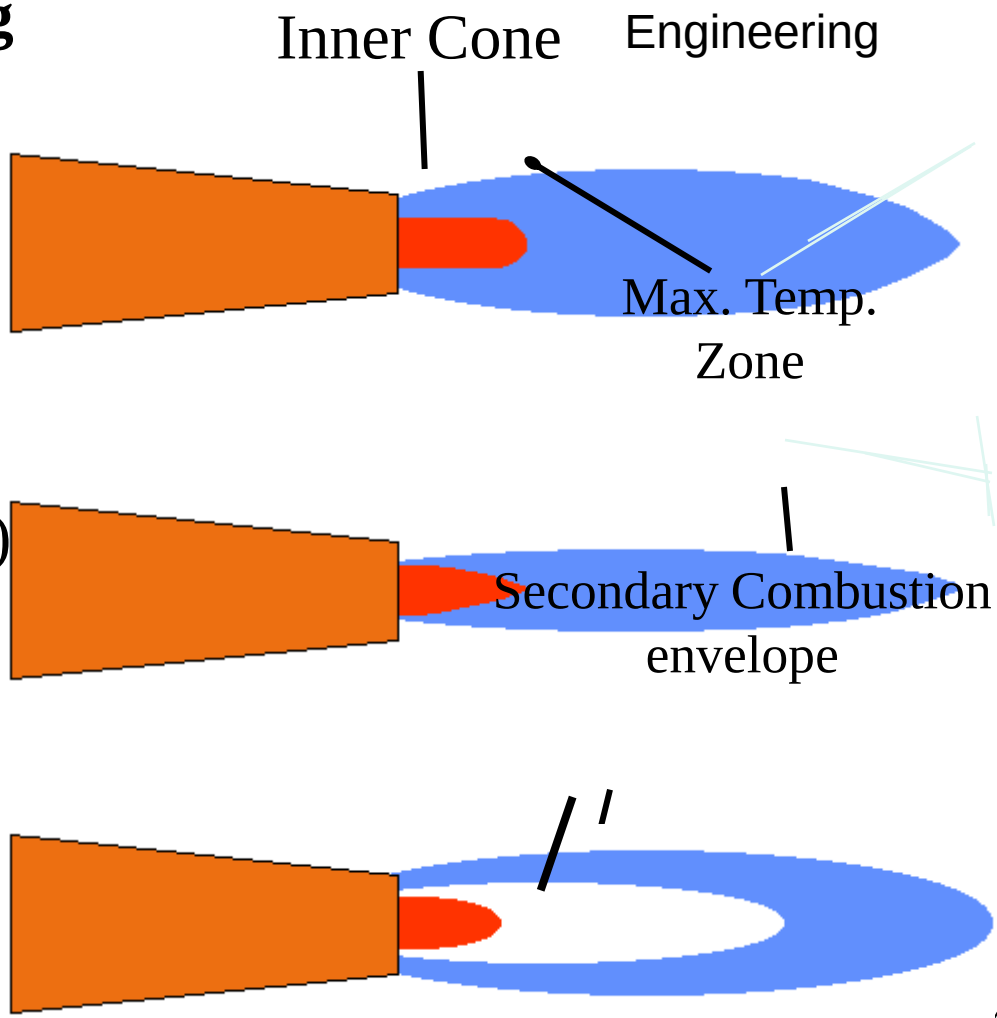
The Oxy-acetylene welding Flame

Engineering

Reducing or Carburizing
Excess acetylene (0.9:1)
(Alloy steels and
aluminium alloys)

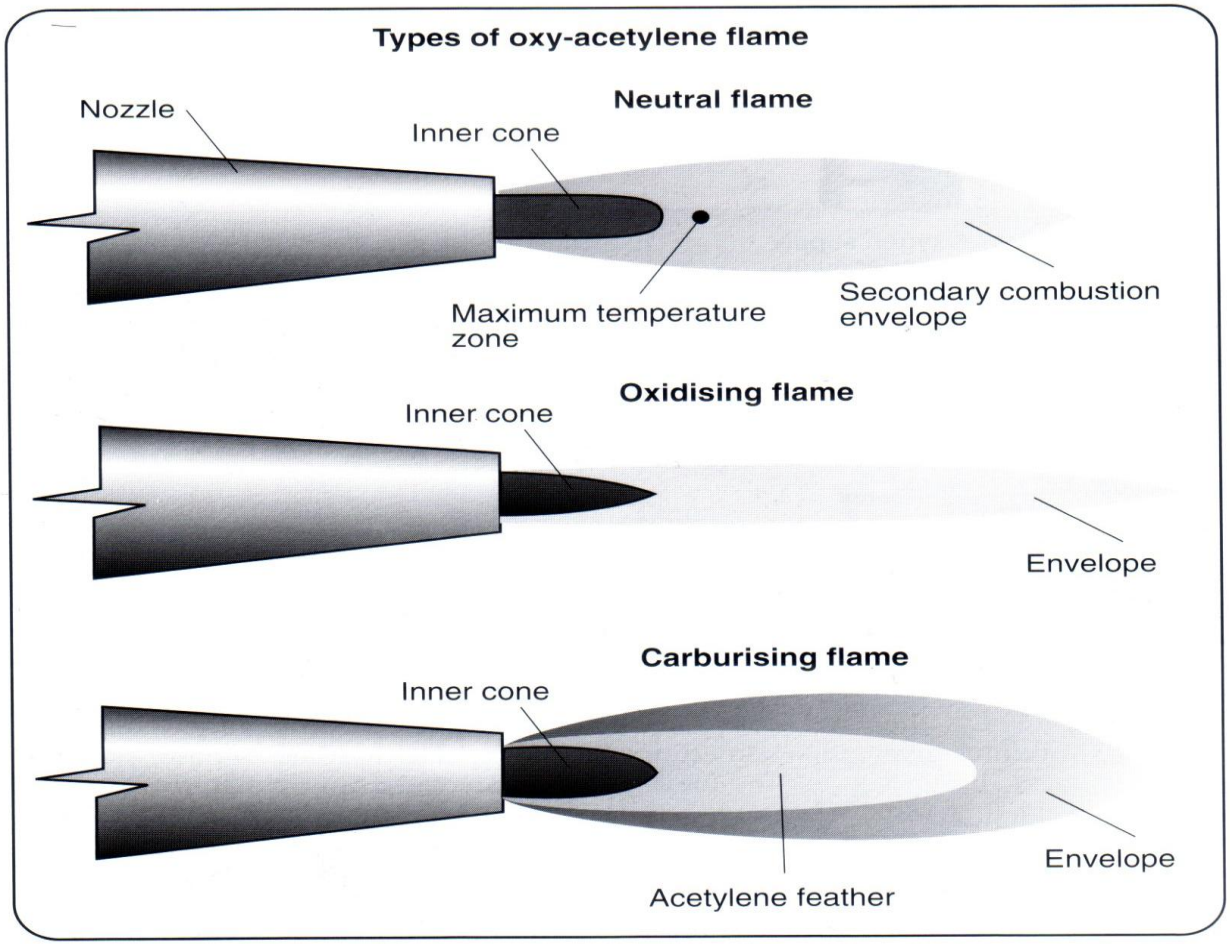
Oxidizing
Excess oxygen (1.5:1)
(Brasses, Bronzes, copper)

Neutral
Equal acetylene & oxygen
(low carbon steel, mild
steels).



Oxy-acetylene flames

Engineering



The Oxy-acetylene welding Flame

Engineering

Carburising

Neutral

Oxidising

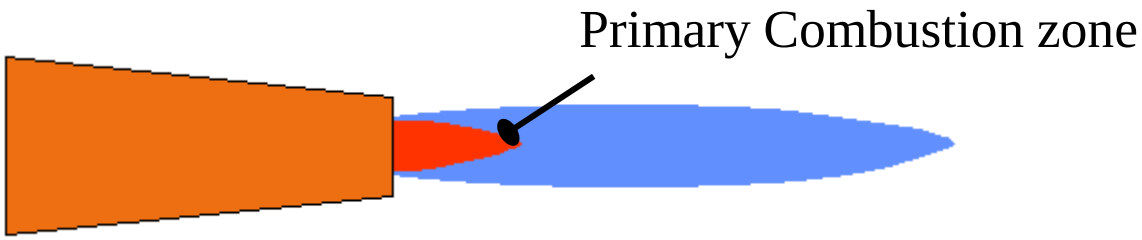
The Oxy-acetylene welding Flame

Engineering

The oxy-acetylene flame has two distinct zones.

The inner zone (Primary combustion Zone) is the hottest part of the flame. The welding should be performed so as the point of the inner zone should be just above the joint edges.

$$C_2H_2 + O_2 \longrightarrow 2CO + H_2$$

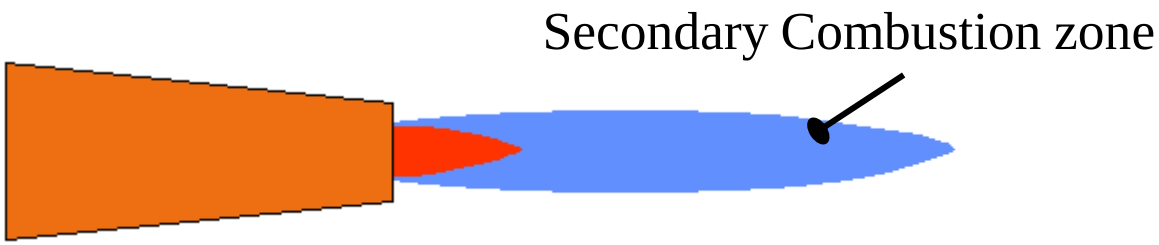


Engineering

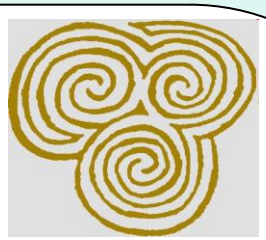
The outer zone the secondary combustion envelope performs two functions

- Preheats the joint edges
- Prevents oxidation by using some of the surrounding oxygen from weld pool for combustion and gives off carbon dioxide and water vapour

$$CO + H_2 + O_2 \longrightarrow CO_2 + H_2O$$



Equipment used in Oxy-Acetylene welding



Engineering

The oxygen and acetylene hose pipes

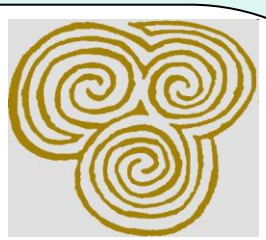
Gases used

Gas pressure Regulators

Flashback arrestor

Welding torch/Welding nozzle

Filler rods and fluxes



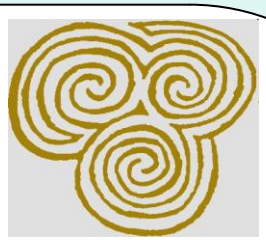
Engineering

The oxygen and acetylene hose pipes

Reinforced rubber hoses.

Acetylene hose has left hand thread couplings and colour coded red.

Oxygen hose has right handed thread couplings and colour coded blue



Engineering

Gases used

Oxygen extracted from air and compressed into cylinders at high pressure. Cylinder is black. Oil should never be brought into contact and should not be used on fittings

Acetylene (C_2H_2) is a fuel gas. Cannot be compressed directly as explodes at high pressures. Cylinders are packed with porous material which is filled with acetone. Acetone absorbs acetylene. Cylinder colour coded maroon

Gas Pressure Regulators

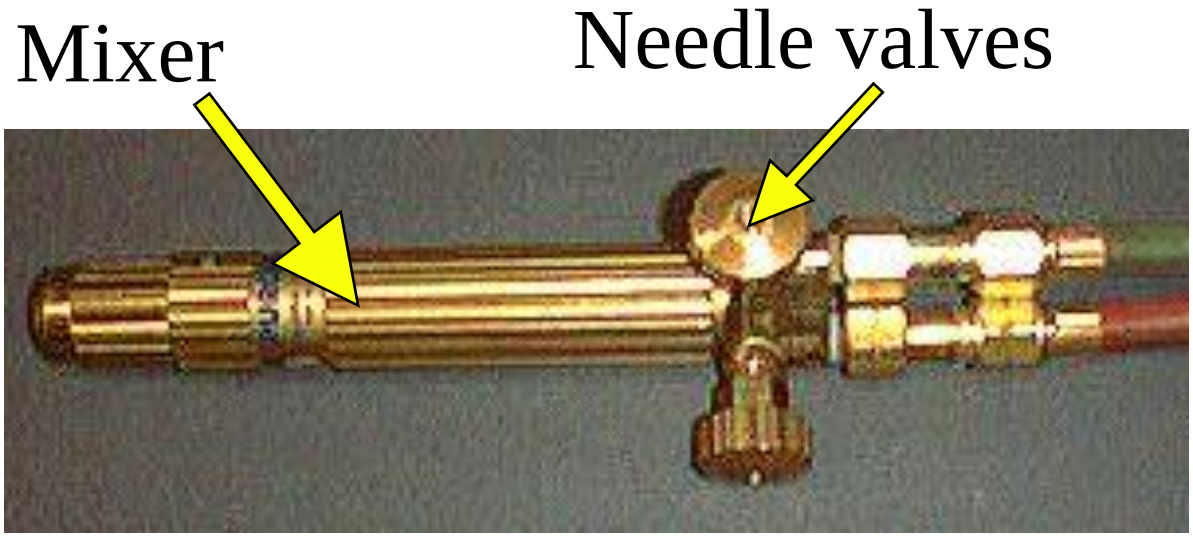
Engineering

One gauge indicates the pressure of the cylinder and the other indicates the pressure in the supply pipe to the torch.

Welding torch

Engineering

Oxygen and acetylene are delivered to the torch by separate hoses. Each gas is controlled by a valve on the torch. The two gases mix in the torch and after they are ignited burn at the nozzle.

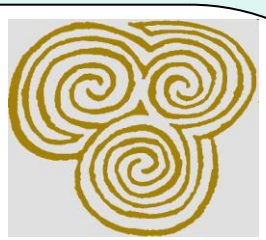


Flashback Arrestors

Engineering

These are positioned on both the fuel gas and oxygen supply between the hose and the regulator. Their purpose is to prevent the return of a flame through the hose into the regulator.

Filler Rods and fluxes



Engineering

Filler rods are used when additional filler metal is required in the weld area they come in different diameters.

Fluxes protect the weld pool from contamination by oxygen and nitrogen, they are normally in paste form placed on a heated filler rod before welding begins

2009 OL Q4

Question 4. (45 marks)

(a) Name the **three** types of oxyacetylene flame shown:

(b) Answer **any three** of the following in relation to **manual metal arc welding**:

(i) How is the heat produced for welding?

(ii) Why is a flux required at the joint?

(iii) What is the function for the earth clamp?

(iv) State **one** suitable safety precaution to be observed.

(c) Select **any three** from the following materials and identify the process used for making a permanent joint in **each** case.

(i) Tinplate, **(ii)** Mild steel plate, **(iii)** Acrylic, **(iv)** Light gauge aluminium.

(d) Give **two** reasons why goggles must be worn when gas welding.

2009 OL Q4 Ans

QUESTION NO. 4 Total 45 Marks

(a)

(i) Neutral flame **(ii)** Carburising flame **(iii)** Oxidising flame

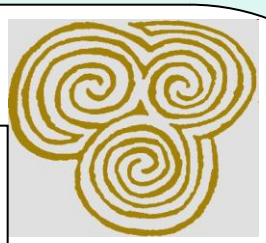
(b)

(i) Heat is produced by an electrical arc formed between the welding electrode and the metal being welded.

(ii) Flux is required at the joint to remove oxides, keep the weld pool clean from impurities and allow the weld to cool slowly by producing a slag covering.

(iii) The earth clamp is required to complete the circuit for current flow through
the metal being welded and back to the welding unit.

(iv) Leather gloves must be worn to protect the user from hot metal particles, UV
light and or high temperatures.



Engineering

(c) Any three:

(i) Tinplate - Soft solder

(ii) Mild steel plate - Gas welding / Spot welding

(ii) Acrylic - Adhesives / Plastic Welding

(iv) Light gauge aluminium - Pop rivets / Adhesives

(d) To protect the user from hot metal particles.

To protect the user from bright light produced by the gas flame.