Welding Technology

UNIT-3

Gas Welding Process

Introduction

- It is a fusion welding in which strong gas flame is used to generate heat and raise temperature of metal pieces localized at the place where joint is to be made.
- In this welding metal pieces to be joined are heated.
- The metal thus melted starts flowing along the edges where joint is to be made.
- A filler metal may also be added to the flowing molten metal to fill up the cavity at the edges.
- The cavity filed with molten metal is allowed to solidify to get the strong joint.
- Different combinations of gases can be used to obtain a heating flame.
- The popular gas combinations are oxy-hydrogen mixture, oxygen-acetylene and etc. different mixing proportion of two gases in a mixture can generate different types of flames with different characteristics.

3.1 Oxy-acetylene welding

- Oxy-acetylene welding can be used for welding of wide range of metals and alloys.
- Acetylene mixed with oxygen when burnt under a controlled environment produces large amount of heat giving higher temperature rise.
- This burning also produces carbon dioxide which helps in preventing oxidation of metals being welded. Highest temperature that can be produced by this welding is $3200^{o}C$.
- The chemical reaction involved in burning of acetylene is

$$2C_2H_2 + 5O_2 = 4CO_2 + 2H_2O + Heat$$

- On the basis of supply pressure of gases oxy-acetylene welding is categorized as high pressure welding in this system both gases oxygen and acetylene supplied to welding zone are high pressure from their respective high pressure cylinders.
- The other one is low pressure welding in which oxygen is supplied from high pressure cylinder but acetylene is generated by the action of water on calcium carbide and supplied at low pressure. In this case high pressure supply of oxygen pulls acetylene at the welding zone.

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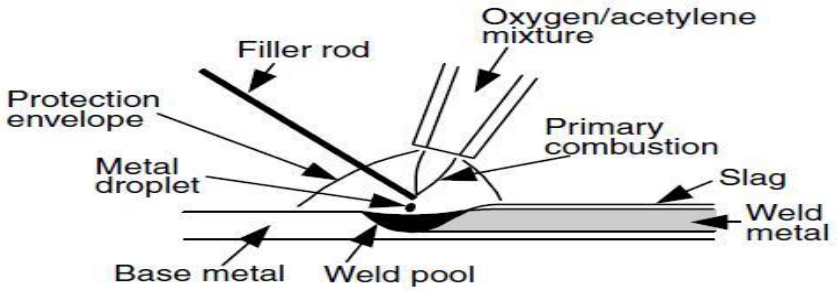

Fig 3.1 OXY- Acetylene Gas Welding

3.2 Principle of operation

- This uses a mixture of oxygen and acetylene gas to create a flame that will burn at a temperature of around 3200 degrees Celsius at the hottest point. This will clearly be sufficient to melt mild steel at the joint allowing the melting of a filler rod to fuse the joint edges together.

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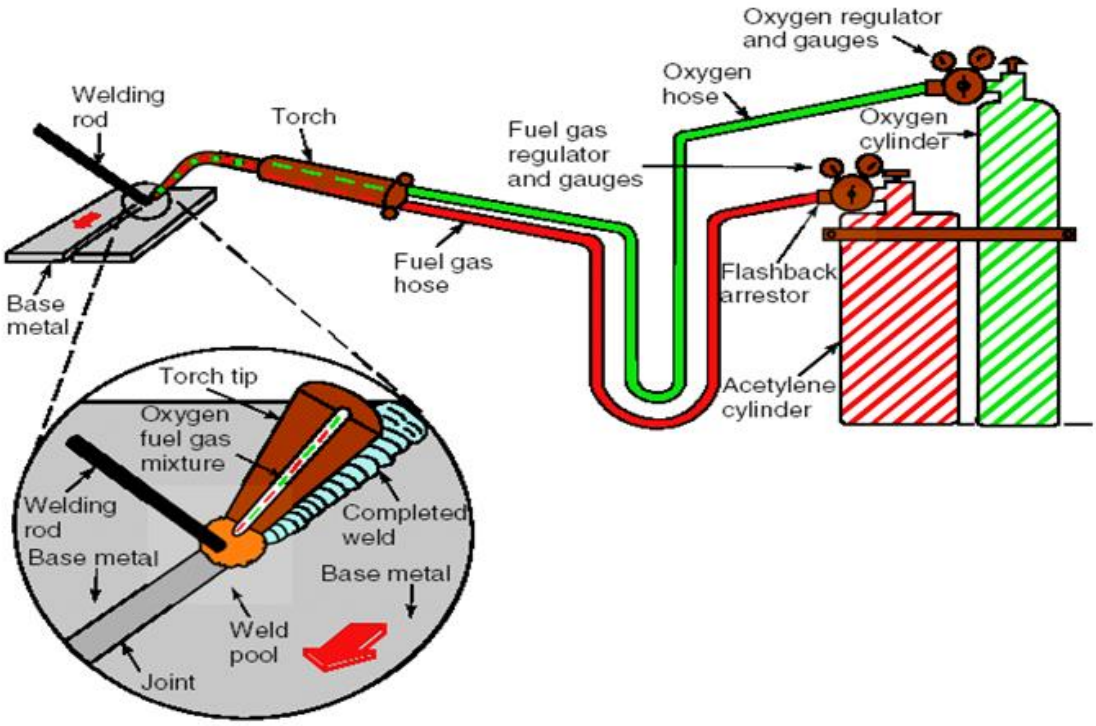


Fig: 3.2 Typical Oxy – Acetylene Gas Welding Work Station

3.3 Types of welding flames

- Flame is established by burning (controlled) of the two gases mixture at the outlet of blow pipe or torch.
- The proportion of gasses in the mixture is controlled by controlling the flow rate of each of the two gasses.
- Here, it should be clear that burning of acetylene generates heat and oxygen only supports acetylene in burning..
- Insufficient supply of oxygen leaves acetylene un burnt in atmosphere creating pollution and adding cost of waste acetylene
- A general nomenclature of the flame established in oxy-acetylene welding is given in Figure 3.3.
- The flame can be divided in to three zones.
- Zone '1' is very near to the outlet of torch, where oxygen reacts with acetylene and burning of two gases takes place.
- Zone '2' produces carbon monoxide and hydrogen in ratio 2 : 1 by volume. This zone gives the highest temperature of the flame. This zone is supposed to **Welding and** consume the oxygen available here and contribute reducing properly to the flame.
- Zone '3' is the outermost zone of the flame. Temperature of this zone is comparatively low. This zone converts CO to CO_2 and H_2O vapours.

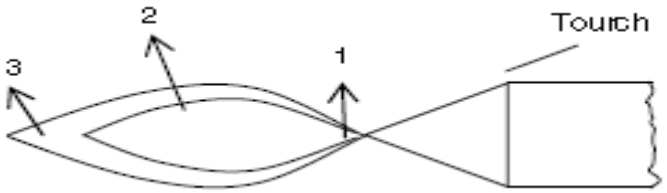


Fig :3.3 : Gas Welding Flame Zones

- On the basis of supply proportion of acetylene and oxygen, flames can be divided into three categories, **neutral flame, carburizing flame and oxidizing flame**. These are described here

Neutral Flame

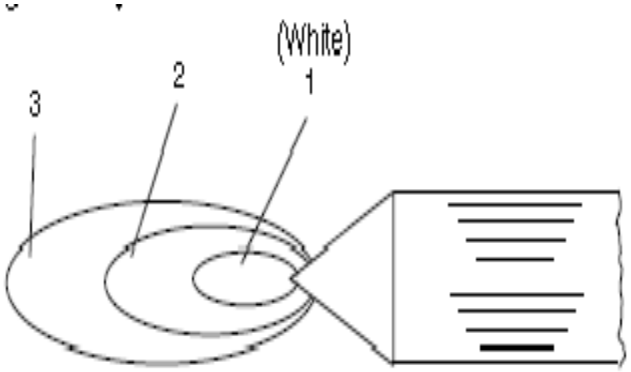
- If the ratio of oxygen to acetylene is about 1 : 1 to 1.15 : 1, all reactions are carried to completion and a neutral flame is produced.
- The flame consists of two sharply defined zones inner white flame cone outer envelope of blue colour as shown in Figure 3.4.
- In this flame none of two gasses is supplied in excess.
- This flame is of white cone.
- Most welding is done with a neutral flame. It is chemically neutral and neither oxidizes or carburizes the metal being welded.

Carburizing Flame

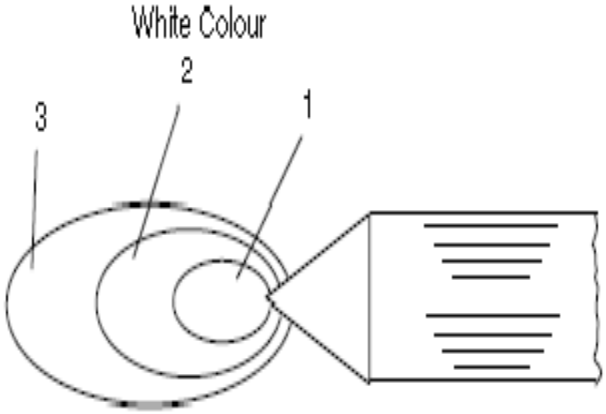
- This flame is obtained when excess of acetylene is supplied than which is theoretically required.
- This flame is identified by three zones the inner cone which is not sharply defined, an outer envelope as same in case of neutral flamed and middle zone surrounds inner one extended to outer envelope as shown in figure 3.4.
- It is white in colour due to excess acetylene.
- Larger the excess of acetylene larger will be its length.
- To get a neutral flame a systematic procedure is to make carburizing flame first and then increase oxygen supply gradually till the excess acetylene zone disappears. The resulting flame will be a carburizing flame.
- Its temperature generation range is $3100^{o}C$ to $3300^{o}C$.
- It is used for the welding of metals where risk of oxidation at elevated temperature is more like aluminium, its alloys and lead and its alloys.
- Flames of this type are also used in welding Monel (a nickel-copper alloy), high-carbon steels, and some alloy steels, and for applying some types of hard-facing material.
- The metals which have tendency to absorb carbon should not be welded by carburizing flame as they become brittle localized.

Oxidizing Flame

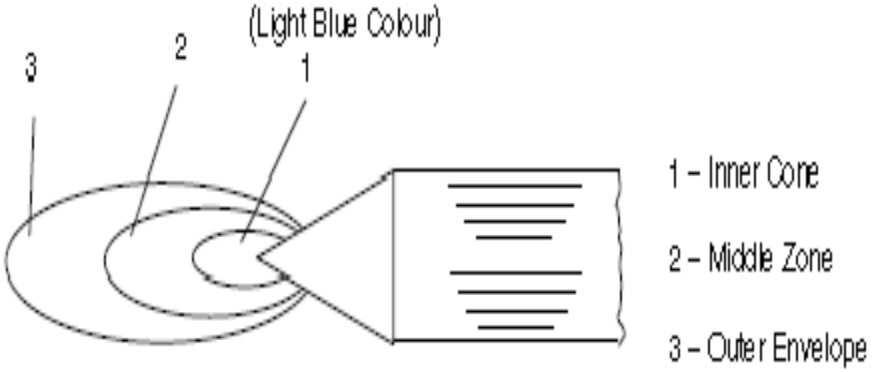
- This flame as an excess of oxygen over that required for a neutral flame.
- The ratio $O_2 : C_2H_2 = 1.15$ to 1.50.
- To have this flame set carburizing flame first convert it to neutral flame and then reduce the supply of acetylene to get oxidizing flame.
- Its inner cone is relatively shorter and excess oxygen turns the flame to light blue colour as shown in figure 3.4
- It burns with a harsh sound.
- Used when welding copper and copper alloys but harmful when welding steel because the excess oxygen reacts with the carbon, decarburizing the region around the weld



Neutral Flame



Carburizing or Reducing Flame



Oxidizing Fame

Fig.3.4 : Welding Flames

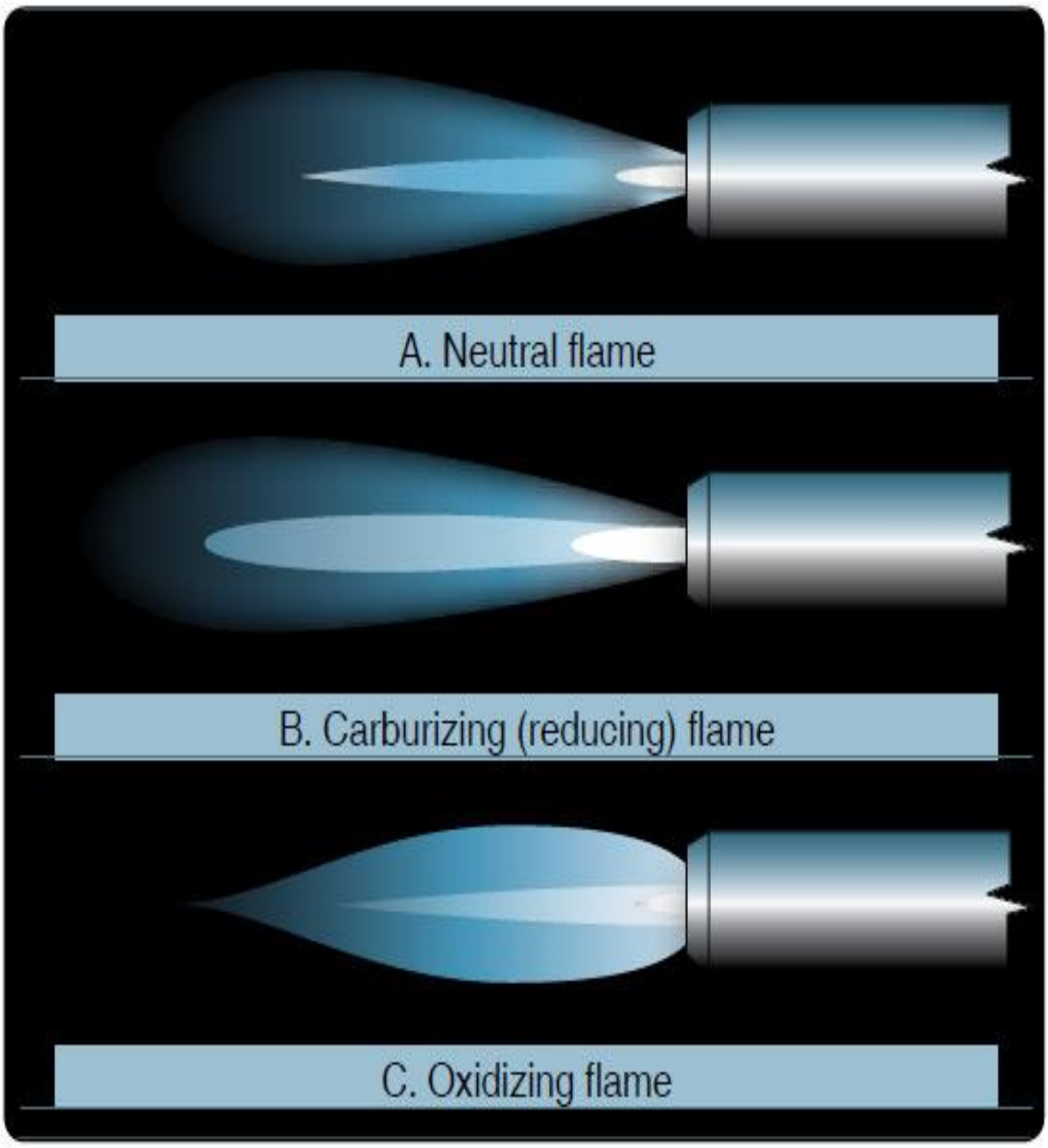


Fig 3.5 : Welding Flames

3.4 Filler metals and fluxes

Filler metals

- Filler metals are used to supply additional material to the pool to assist in filling the gap (or groove) and it forms an integral part of the weld.
- Filler rods have the same or nearly the same chemical composition as the base metal and are available in a variety of compositions (for welding different materials) and sizes. Some typical filler metals with their applications have been shown below.
- These consumable filler rods may be bare, or they may be coated with flux.
- Most rods are furnished in 36-inch lengths and a wide variety of diameters, ranging from 1/32 to 3/8 inch.

Table 3.1 : Filler Rods Used for Different Materials

S.No.	Material to be weld	Filler rod material
1.	Ferrous metals	Steel rods with high carbon, silicon and magnese.
2.	Alloy steels	Steel rods with chromium and vanadium.
3.	Stainless steels	18/8 Chromium-nickel rod.
4.	Copper	Drawn copper rod.
5.	Brass	Phosphor branz rod.
6.	Grey cast iron	Special cast iron rods.
7.	Aluminium sheets and its alloys	Pure aluminium rods.
8.	Aluminium castings	Aluminium rod with 12 percent silicon.
9.	Magnesium alloys	Same composion as base material.

Fluxes

- During the welding operation, the temperature of molten metal is high enough. The so hot metal has a tendency to react with oxygen and nitrogen present in the atmospheric air and to form oxides and nitrides.
- The oxides formed have higher melting temperature than that of base metal. They also disturb the movement of welding rod.
- A substance that prevents formation of oxides and other contaminants in welding, or dissolves them and facilitates removal is known as **Flux.**
- Fluxes are available in several forms, such as dry powders, a paste, liquids, or coatings on welding rod.

Flux performs following functions

- Provides protective atmosphere for welding
- Stabilizes arc
- Reduces spattering

Properties of Fluxes

- It should have low melting temperature than the base metal.
- It should easily and readily react with metallic oxides and form a low melting temperature fusible slag to float on the top of the weld.
- It should be easily chipped-off after solidification.
- It should also act as better cleaning agent.
- It should not adversely affect the base metal.
- It should not chemically react with the base metal.
- It must not cause corrosion on the finished weld.

Different fluxes are used for welding of different metals.

- For the welding of **copper and its alloy** sodium nitrate; sodium carbonates are used as flux.
- For welding of **aluminium or its alloy** chloride of sodium, potassium, lithium or barium are used.
- Borax is used for Mild Steel and low carbon Steel.

- Cast Iron Flux is used with cast iron, high carbon steel , ferrous silicon, and silver steel

3.5 Gas welding equipment

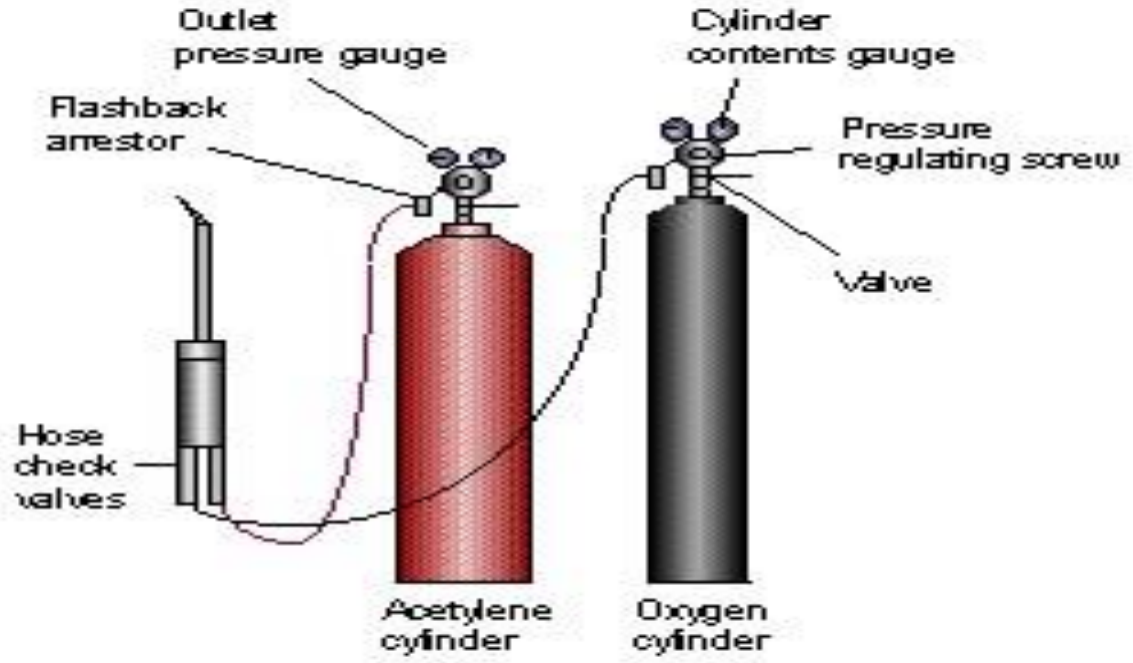


Fig 3.6 : Oxy- Acetylene Welding Equipment

It consists of two large steel cylinders; one containing oxygen at high pressure and other dissolved acetylene also at high pressure. In addition to tools and equipment's some consumables are also used in gas welding. Major tools and equipment and consumables are listed
below followed by their brief description.

Tools and Equipment
(a) Gas cylinders (two)
(b) Hose pipes and valves
(c) Cylinder pressure gauge
(d) Outlet pressure gauge
(e) Pressure regulators
(f) Blow pipe or torch and spark lights
(g) Welding screens
(h) Goggles, screens, gloves and apron
(i) Wire brush, trolley, chipping hammer.

Consumables
(a) Oxygen gas
(b) Acetylene gas
(c) Filler metal (rod or wire)
(d) Fluxes.

Gas Cylinders
Two large steel cylinders, capable to withstand high pressure are needed to keep oxygen and acetylene separately. Cylinders are painted with different colours : oxygen cylinder in black colour and acetylene cylinder in maroon or red colour. Oxygen is filled at pressure to 2000 pound per square ich (PSI). Large weight of acetylene is kept dissolved in acetone. Acetylene cylinder should not be exposed to higher temperature for safety reasons.

Pressure Regulators
Each of the cylinders should be equipped with pressure regulator at the top. Pressure regulator maintains supply pressure at a constant value which has to be much less than the pressure at which gas has been filled in the cylinder. This way supply pressure can be controlled and maintained to different values as per the requirement. Value of supply pressure depends upon inside diameter of outlet nozzle, supply flow rate of gas.

Pressure Gauge
Pressure gauge measures the pressure with respect to the atmospheric pressure. Two pressure gauges are mounted on each of the cylinders. One for knowing pressure of gas inside the cylinder which is the measure of gas content inside the cylinder. Second gauge is used to know the supply pressure of the gas to below pipe. Former gauge is called cylinder pressure gauge and later one is called outlet pressure gauge.

Hose Pipes and Values
Hose pipes are used to carry gases from their respective cylinders to blow pipe. Hose pipes are made of rubber with long life. Each value is mounted at the top of each cylinder along with the pressure value is mounted at the top of each cylinder along with the pressure gauge. This value can stop flow of gas from cylinder to hose pipe. One valve is mounted on the each hosepipe where these are connected to blow pipe. These valve can stop the flow and control the flow of oxygen and acetylene independently to get carburizing, oxidizing or neutral flame.

Blow Pipe and Spark Lighter
Blow pipes are used in welding or cutting. These are made in different design and size to suit the work. Both the gases are mixed in a chamber of blow pipe and then driven out through the orifice of the blow pipe nozzle and burnt by spark lighter. Blow pipes are classified as high pressure torch used in gas cutting and low pressure torch used in gas welding. In case of high pressure blow pipe acetylene is supplied at high pressure as compared to low pressure blow pipe.

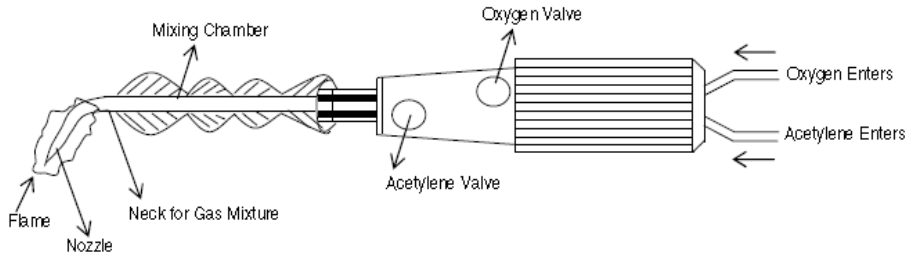


FIG 3.7 : Blow Pipe Used in Gas Welding

Safety Hammer
Goggles, welding screens, gloves and apron are the part of the safety kit used gas welding. Glaze produced by the flame and spirals can damage the hammer beings so safety kit elements are used for protection.

Chipping Hammer
Chipping hammer is a simple hammer having sharp edge at one of its end and sharp point at its outer end. It is used to remove the adhering layer of slag on the weldment. A brush having hard wires is used for cleaning of weldments after the use of chipping hammer. Trolley is used to carry gas cylinders and other related tools of welding from one place to another. In addition to the above there are some more material used in gas welding as consumable material, which are describe below.

Welding Rods
These are also called filler metals. Filler metal is typically in the form of rod, 90 mm long and diameter ranging from 1.6 mm to 9.5 mm. Composition of filler metal must be same as that of base metal. Two types of welding rods are generally available. One is coated welding rods, which have coating of flux. Others are bare welding rods having no coating of flux. Different types of welding rods are used for welding of different metals.