WELDING

1. INTRODUCTION

Welding is a process by which metals are joined by heating them to a suitable temperature with or without the application of pressure and addition of filler materials. Welding processes are employed in most of the modern fabrication works and industries.

2. CLASSIFICATION OF WELDING PROCESSES

Welding processes are broadly classified under two main headings:-

i) Pressure welding or Plastic welding processes

ii) Non Pressure welding or Fusion welding processes

i) Pressure welding or Plastic welding : - In this process, the ends of metal pieces to be joined are heated to plastic state and are joined together by applying pressure on them. No additional filler material is used.

eg: Blacksmith welding, Resistance welding, Cold pressure welding etc.

ii) Non Pressure welding or Fusion welding:- here the material at the joint is heated to molten state (fusion state) and allowed to solidify. Thus the two parts are joined together without the application of any pressure. It uses a filler material such as an electrode.

eg: Gas welding, Arc welding, Thermit welding etc.

3. ARC WELDING

Arc welding is a fusion welding process in which welding is done by producing heat from an electric arc between the work and electrode. Both D.C. and A.C. electric supply are used for this. The arc between the two terminals produces heat to melt the metal. If two pieces of metal that are to be joined are placed so that they touch or almost touch one another and the arc from the electrode is directed at this junction, the heat generated by the arc (approx. 3500^{o}C) causes a small section of the edges of both pieces to melt. These molten portions along with the molten portions of the electrode flow together. As the arc column is moved, the molten puddle solidifies joining the two pieces of metal with a combinmation of electrode and base metal.

There are different methods of arc welding in practice as listed below:

i) Metal Arc Welding

ii) Carbon Arc Welding

iii) Atomic Hydrogen Arc Welding

iv) Tungsten inert gas Arc Welding (TIG)

v) Metal inert gas Arc Welding (MIG)

vi) Submerged Arc Welding

vii) Plasma Arc Welding

3.1 Metal Arc Welding

The commonly used arc welding method is metal arc welding. In this process a metal electrode is used. The metal electrode itself melts and acts as a filler material.

An arc welding circuit consists of the following essential items:

a) The power source ie the Welding machine
b) Welding lead cable and electrode holder
c) Welding return cable and clamp
d) Welding earth

3.2 Arc Welding Machines

There are three types of welding machines in use:

i) Welding transformer
ii) Welding generator
iii) Welding rectifier

i) Welding transformer

It is used to change the voltage and current to the desired range suitable for welding. Normally low voltage high current (high amperage) supply is preferred for welding. The welding transformer operates on A .C. supply only and it has no rotating parts. It is a step down transformer which reduces the main supply voltage (220 or 440 V) to the welding supply open circuit voltage between 40 and 100 V.

ii) Welding generator

It is used to generate D.C supply for arc welding. It may be driven by an A.C. motor or driven by a petrol or diesel engine. It can be used anywhere in the field work, away from the electric lines.

iii) Welding rectifier

It is used to convert A.C. into D.C welding supply and does not have any rotating parts. It is basically a transformer, but the output of which is connected with a rectifier to change the A.C in to D.C

3.3 Welding Electrode

Electrode is a conductor from which an arc struck. The arc melts electrode and parent metal. They join together to form a good weld when solidifies. The electrode is a core, coated with a solid flux acts as a filler material and is consumed during welding by keeping a constant arc length. The flux when melts produces a slag which floats on the metal pool, protects the weld from oxidation. The flux of electrode mainly contains cellulose (burns and produces a gaseous shield around the arc), calcium carbonate and calcium fluoride (impart fluidity to the slag), Iron powder (for higher penetration and deposition), Titania (for stabilising the arc), asbestos etc.

Electrodes are available in different standard lengths of 450, 350, 300and 200 mm. A core length of 25mm from one end is left uncoated for holding in the electrode holder. It is mainly specified by its core diameter.

Electrode size in mm	Gauge No.(SWG)	Current range in ampere (A)
1.6	16	40-60
2.5	12	50-80
3.2	10	90-130
4.0	8	120-170
5.0	6	130-270
6.0	4	300-400

4. GAS WELDING

Oxy-fuel welding, commonly referred to as oxy welding or gas welding is a process of joining metals by application of heat created by gas flame. The fuel gas commonly acetylene, when mixed with proper proportion of oxygen in a mixing chamber of welding torch, produces a very hot flame of about 3150 - 3300 ^{o}C .

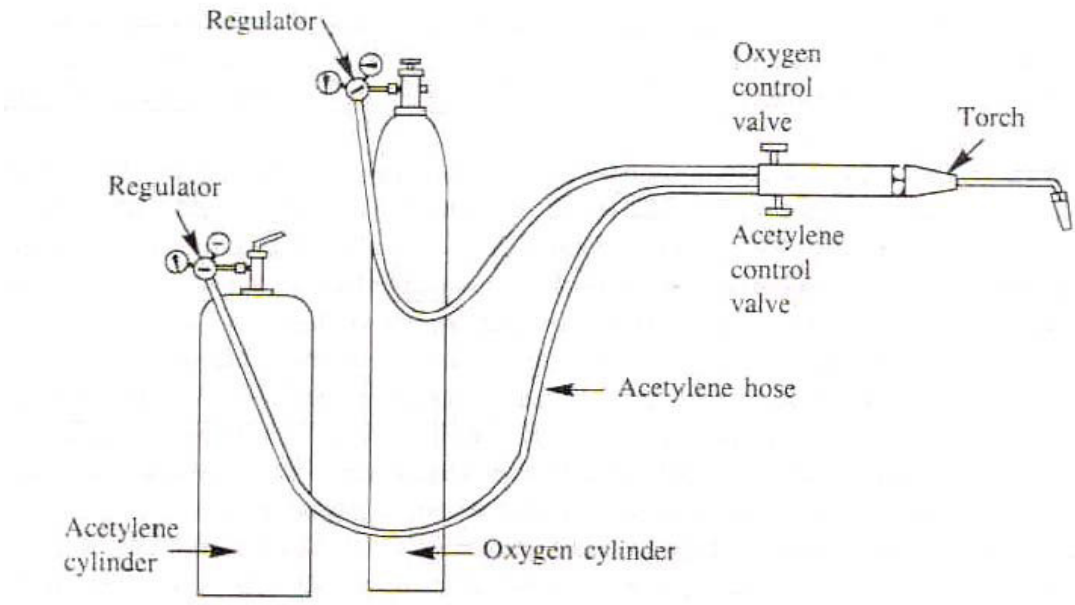
Different gases suitable for welding and cutting are Acetylene, hydrogen, LPG, Methane etc.

4.1 Oxy- Acetylene Gas Welding

The oxy-acetylene welding process uses a combination of oxygen and acetylene gas to provide a high temperature flame. The high temperature flame melts the metal faces of the work-pieces to be joined, causing them to flow together. A filler metal alloy is normally added and sometimes used to prevent oxidation and to facilitate the metal union.

OXY-ACETYLENE GAS WELDING APPARATUS

Oxy-fuel apparatus consists of two cylinders (one oxygen and one acetylene) equipped with two regulators, pressure gauges, two lengths of hose, and a blow torch. The regulators are attached to cylinders and are used to reduce and maintain a uniform pressure of gases at the torch. The gases at reduced pressure are conveyed to the torch by the hoses. The regulators include high pressure and low pressure gauges to indicate the contents of the cylinder and the working-pressure on each hose. When the gases reach the torch they are there mixed and combustion takes place at the welding tip fitted to the torch.



The basic equipments used to carry out gas welding are:

1. Oxygen gas cylinder (coloured in black) with valve made of brass having right hand threads
2. Acetylene gas cylinder (coloured in maroon/red) with valve having left hand threads
3. Oxygen pressure regulator
4. Acetylene pressure regulator
5. Oxygen gas hose(Black)
6. Acetylene gas hose(Red/maroon)
7. Welding torch or blow pipe with a set of nozzles and gas lighter
8. Trolleys for the transportation of oxygen and acetylene cylinders
9. Set of keys and spanners
10. Filler rods and fluxes
11. Protective clothing for the welder (e.g., asbestos apron, gloves, goggles, etc.)

WELDING TORCH (BLOW PIPE)

A welding torch mixes oxygen and acetylene in the desired proportions, burns the mixture at the end of the tip, and provides a means for moving and directing the flame.

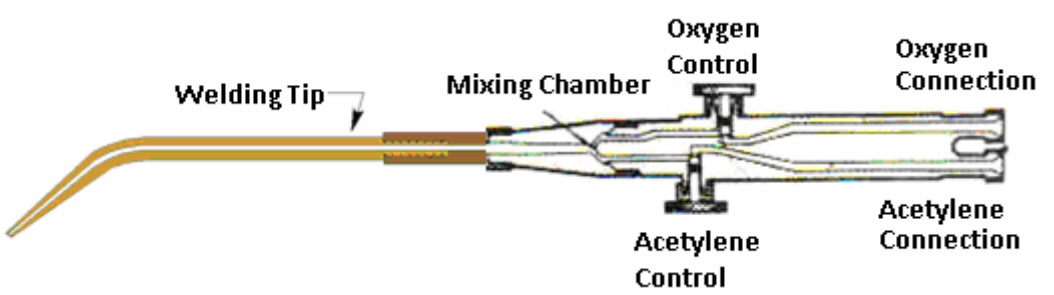


Fig : Welding Torch

There are two types of welding torches, namely:

a) High pressure (or equal pressure) type

b) Low pressure (or injector) type

High pressure blowpipes or torches are used with (dissolved) acetylene stored in cylinders at a pressure of 117 psi. Low pressure blowpipes are used with acetylene obtained from an acetylene generator at a pressure of 8 inch - head of water (approximately 0.3 psi).

To change the power of the welding torch, it is only necessary to change the nozzle tip (size) and increase or decrease the gas pressures appropriately.

4.2 Types of Gas Welding Flames

In oxyacetylene welding, flame is the most important tool. All the welding equipment simply serves to maintain and control the flame. The flame must be of the proper size, shape and condition in order to operate with maximum efficiency. Three distinct types of flames are possible on adjusting the proportions of acetylene and oxygen:

1. Neutral Flame (Acetylene oxygen in equal proportions)
2. Oxidizing Flame (Excess of oxygen)
3. Reducing Flame (Excess of acetylene)

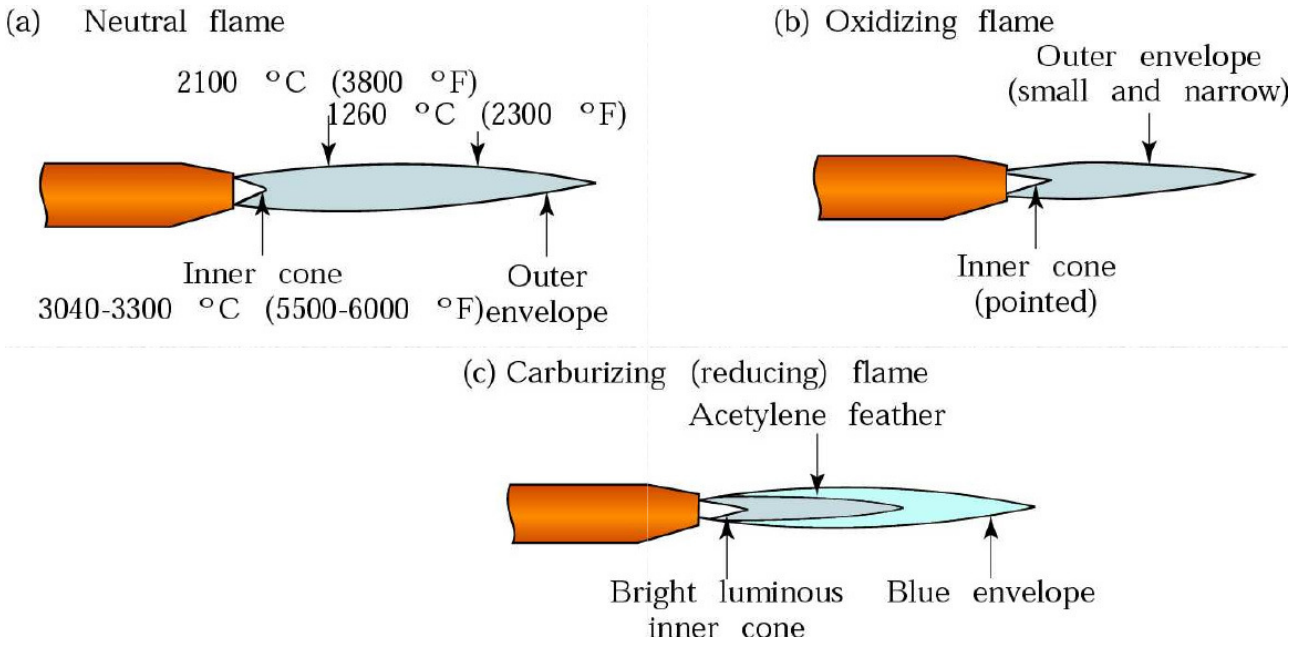


Fig : Types of Welding Flames

5. TOOLS AND ACCESSORIES USED IN WELDING SHOP

i) Flat file

A file is a hardened piece of high grade steel with slanting rows of teeth and is used for removing excess material to smooth or fit metal parts. Files are generally forged out of high carbon steel or tungsten steel followed by cutting of teeth, hardening and tempering.

iii) Hack saw

The hack saw is used to cut metals of different sections. The main parts are frame, handle and a replaceable blade. The blades are available in standard lengths 225, 250 and 300mm.

iv) Try square

Try square is mainly used for checking the squarness of surfaces or edges which are adjacent, flatness of a filed surface and for marking out lines on workpieces. It consists of a blade and stock which are made of steel fixed rigidly at 90^o to each other.

v) Steel rule/ Brass rule

The steel rule consists of a hardened steel strip having line graduations etched or engraved in it. They are usually 150mm or 300mm long and is used to take linear measurements to an accuracy of 1mm or 0.5mm. The brass rule is similar to steel rule, but it is made of brass. Since the brass possess low coefficient of linear expansion, its dimensional accuracy will be more reliable in heated regions.

vi) Ball peen hammer

Hammer is a hand tool made of tool steel, largely used for striking on the metals. A hammer is named by its peen. The ball shaped peen hammer is known as ball peen hammer. The peen and face are hardened.

vii) Punches

Punches are percussion tools and are manufactured from tool steel. They are used on any scribed lines by indentations. Tips are tapered, hardened and tempered. The shanks are knurled for easier handling and gripping. The punch whose tip is tapered at an angle of 90^o is known as centre punch used to mark centres to be drilled or to mark centre of an edge. A dot punch with tip tapered at 60^o is used to punch a chain of dots on a scribed line.

viii) Chipping hammer

It is a welding tool used to remove slag from the weldment

ix) Electrode holder

It is used to hold the electrode properly. Its mouth grips the electrode and passes current to the electrode through the welding cable connected at the other end of the holder. It should be well insulated.

x) Tongs

They are used to handle the hot metal (welding job) for positioning or while cleaning.

xi) Wire brush

It is used for cleaning the surface of the metal as well as for the slag from the welds. The wire brush is made of steel wires fitted on a wooden piece.

xii) Apron

It protects the welder's body and clothes from heat and sparks. Usually leather apron is employed.

xiii) Face shield / eye shield (Welding screen)

It is used to prevent direct rays of arc, weld spatter and slag and protects the operator's eyes and face. It consists of a cover slag and a dark filter glass. The filter glass absorbs the ultra violet rays radiated by the arc.

xiv) Hand gloves

Mainly leather gloves are used to protect arm from welding spark and heat.

xv) Earth clamp

It is used to connect the return lead firmly to the work piece or to the welding table.

6. POSITIONS OF WELDING

All welding can be classified according to the position of the workpiece or the position of the welded joint on the plates or sections being welded.

There are four basic welding positions, which are illustrated in figure below

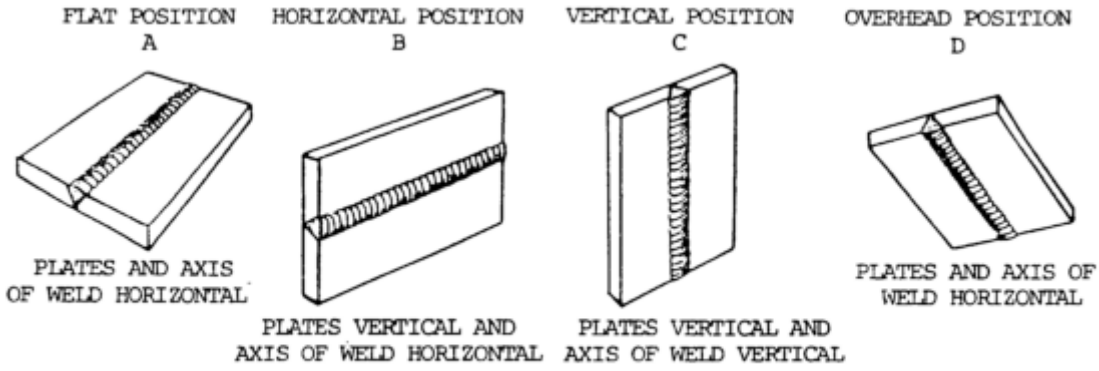


Fig : Positions of welding

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