

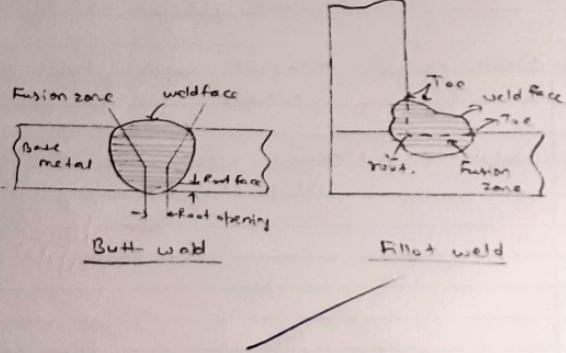
Experiment - 4

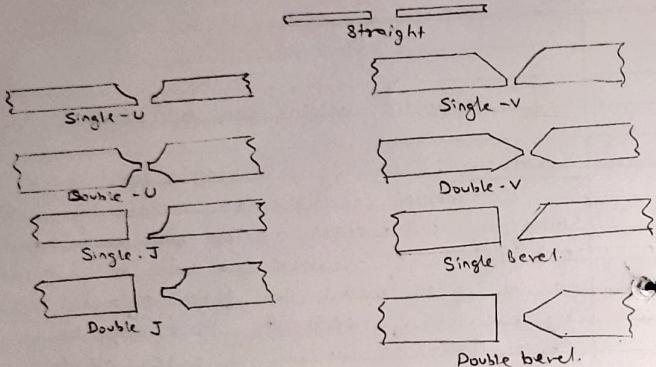
AIM Study the welding shop & its tools.

Introduction :- Welding is a process for joining two similar or dissimilar metals by fusion. It joins different metals, alloy, with or without the application of pressure and with or without the use of filler metal. The fusion of metal takes place by means of heat. The heat may be generated either from combustion of gases, electric arc, electric resistance or by chemical reaction. During some type of welding processes, pressure may also be employed, but this is not an essential requirement for all welding processes. It is therefore usually accompanied by post weld heat treatment for most of the critical components. The welding is widely used as a fabrication & repairing process in industries. Some of typical applications of welding include the fabrication of ships, pressure vessels, automobile bodies, offshore platforms, bridge, welded pipes, sealing of nuclear fuel, etc.

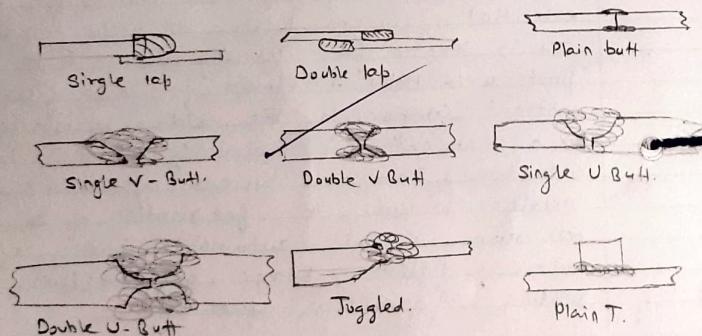
Terminological element of welding process :-

The terminological element of welding process used with common welding joints such as base metal, fusion zone, weld face, root face, root opening etc. are depicted in Fig.





Butt Joint Edge Preparation



Edge preparation: For welding the edges of joining surface metals are prepared first. Different edge preparations may be used for welding butt joints, which are given in Fig.

Welding Joints: Some common welding joints are shown in Fig. Welding joints are generally of two major kinds namely lap joints & butt joints. The main types are described as under.

Lap weld joint: (1) **Single Lap Joint:** This joint, made by overlapping the edge of the plate, is not recommended for most work. The single lap has very little resistance to bending. It can be used satisfactorily for joining two cylinders that fit inside one another.

(2) **Double Lap Joint:** This is stronger than the single lap joint but has the disadvantage that it requires twice as much welding.

(3) **Tee Fillet Weld:** This type of joint, although widely used, should not be employed if an alternative design is possible.

Advantage & Disadvantage of welding:-

* **Advantage -**

- i) welding is more economical & is much faster process as compared to other process (riveting, bolting, casting etc.)

Welding, if properly controlled results permanent joints having strength equal or sometime more than base metal.

Disadvantage

- (i) It results in residual stresses & distortion of the work pieces.
- (ii) Welded joints needs stress relieving & heat treatment.

* Classification of welding & Allied Processes:-

This is different welding ; brazing & soldering methods are being used in industries today. There are various ways of classifying the welding & allied processes. For example, they may be classified on the basis of source of heat, flame, arc, etc and the type of interaction i.e. liquid / liquid (fusion welding) or solid / solid (solid state welding). Welding processes may also be of welding & allied process is given as under-

(A) Welding Processes

- (i) Oxy-fuel gas welding processes
 - Air-acetylene welding
 - Oxy-acetylene welding
 - Oxy hydrogen welding
 - pressure gas welding.

(2) Arc welding Processes

(i) Carbon Arc welding

- Shielded Metal Arc welding.
- Submerged Arc welding.
- Gas Tungsten Arc welding.

(3) Resistance welding

- Spot welding
- Seam welding
- Projection welding
- Resistance Butt welding
- Percussion welding.

(4) Solid state welding Processes

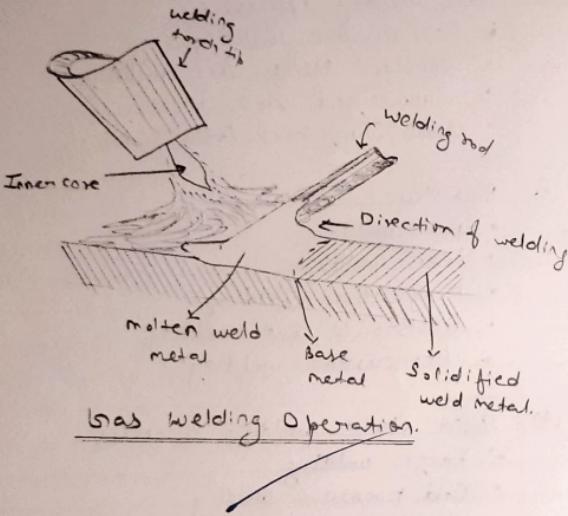
- Forge welding
- Cold pressure welding
- Friction welding
- Explosive welding
- Cold pressure welding.

(5) Thermit welding Process

- Thermit welding
- Pressure Thermit welding

(6) Radiant Energy welding Processes

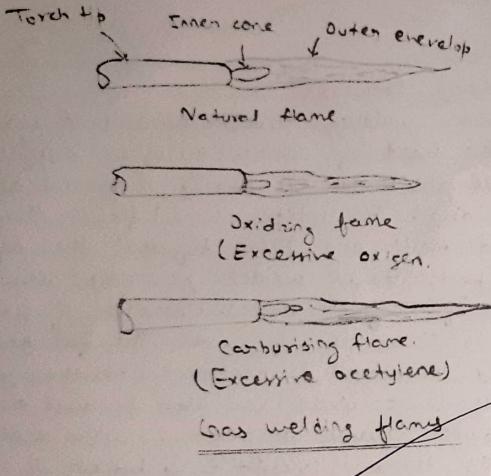
- Laser welding
- Electron Beam welding.



Gas welding processes :-

A fusion welding process which joint metals, using the heat of combustion of an oxygen/air and fuel gas mixture is usually referred as 'gas welding'. The intense heat (flame) thus produced melts and fuses together the edges of the parts to be welded, generally with the addition of a filler metal. Operation of gas welding is shown in fig. we The fuel gas generally employed is acetylene, however gases other than acetylene can also be used though with lower flame temperature. oxy-acetylene flame is the most versatile & hottest of all the flames produced by the combination of oxygen & other fuel gases.

* Oxy-Acetylene Welding - In this process, acetylene is mixed with oxygen in correct proportion in the welding torch & ignited. The flame resulting at tip of the torch is sufficient hot to melt & join the parent metal. The oxy-acetylene flame reaches a temp. at about 3000°C & thus can melt most generally added to the molten metal pool to build up the beam slightly for greater strength.



Types of welding Flames:- In Oxy-acetylene welding -

- Neutral welding flame (Acetylene to oxygen)
- Carburising welding flame (excess the acetylene)
- Oxidising welding flame (excess of oxygen)

(1) Neutral welding Flame:- A Neutral welding flame in oxy-acetylene welding has a balanced mixture of oxygen to acetylene. It is the most commonly used flame type for welding, as it produces a clean & steady flame without excess heat or chemical reactivity. The flame has two distinct parts: a bright inner core & a softer outer envelop, it ensures minimal effects of chemical change on the molten metal & therefore will not oxidize or carburize the metal. The neutral flame is commonly used for the welding of mild steel, stainless steel, cast iron, copper & aluminum.

(2) Carburising or reducing Welding Flame:- The carburising or reducing flame has excess of acetylene and can be recognised by acetylene feather, which exists between the inner core & usually much brighter in color. With iron to steel, carburising flame produces very hard, brittle substance known as iron carbide. A reducing flame may be distinguished from carburising flame by the fact that a carburising

flame contains more be distinguished from acetylene than a reducing flame. A reducing flame has an approximate temperature of 3038°C . It is used for welding with low alloy steel rods & for welding those metal that don't tend to absorb carbon. This flame is very well used for welding high carbon steel.

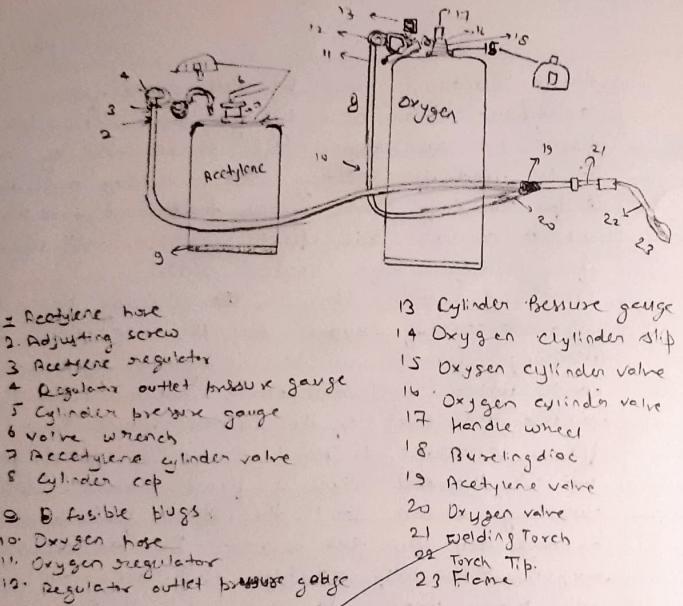
Oxidizing Welding flame:- The oxidizing flame has an excess of oxygen over the acetylene. An oxidizing flame can be recognized by the small cone, which is shorter, much bluer in color & more pointed than that of the neutral flame. The outer flame envelope is much shorter & tends to fan out at the end. Such a flame makes a loud roaring sound. It is the hottest flame produced by any oxy-fuel gas sources. But the excess oxygen especially at high temp. tends to combine with many metals to form hard, brittle, low strength oxides.

Moreover, an excess of oxygen causes the weld bead and the surrounding area to have a scummy or dirty appearance. For these reasons, an oxidizing flame is of limited use in welding. It is not used in the welding of steel. A slightly oxidizing flame is helpful when welding.

(i) Copper-base metals

(ii) Zinc base metals.

(iii) A few types of ferrous metals such as manganese steel & cast iron.



* Gas welding Equipments:-

Acetylene & oxygen gas is stored in compressed gas cylinders. These gas cylinders differ widely in capacity, designed and color code. However, in most of the countries, the standard size of these cylinders is 6 to 7 m³ (it is painted black for oxygen & maroon for acetylene. An acetylene cylinder is filled with some absorbative material, which is saturated with a decimal solvent acetone. Acetone has the ability to absorb a large volume of acetylene and release it as the pressure falls. If large quantities of acetylene gas are being consumed, it is much cheaper to generate the gas at the place of use with the help of acetylene gas generators. Acetylene gas is generated by carbide to water method.

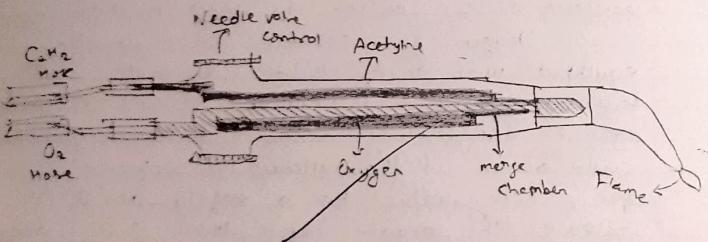
Oxygen gas cylinders are usually equipped with about 40 liters of oxygen at a pressure of about 154 kgf/cm² at 21°C. To provide against dangerously excessive pressure, such as could occur if the cylinder is exposed to fire, every valve has a safety device to release the oxygen before there is any danger of rupturing the cylinders. Fragile discs & fusible plugs are usually provided in the cylinders valves in case it is subjected to danger.

* Gas pressure regulators :- Gas pressure regulators are employed for regulating the supply of acetylene & oxygen gas from cylinders. A pressure regulator is connected between the cylinder & hose leading to welding torch. The cylinder to hose connections have left-handed threads on the acetylene regulator while these are right handed on the oxygen regulator. A pressure regulator is fitted with two pressure gauge, one for indication of the gas pressure in the cylinder & the other for indication of the reduced pressure at which the gas is going out.

Welding torch :- Figure shows the construction of the following welding torch. It is a tool for mixing oxygen & acetylene in correct proportion & burning the mixture at the end of a tip. Gas flow to the torch is controlled with the help of two hand-type needle valves in the handle of the torch. There are two basic types of gas welding torches:-

- Positive pressure (also known as medium or equal pressure)
- Low pressure or injector type.

The positive pressure type welding torch is the more common of the two types of oxy-acetylene torches. Torch tips :- It is the portion of the welding apparatus through which the gases pass just prior to their ignition & burning. A great variety of tips



Changeable welding tips differing in size, shape & construction are ~~variable~~ available commercially.

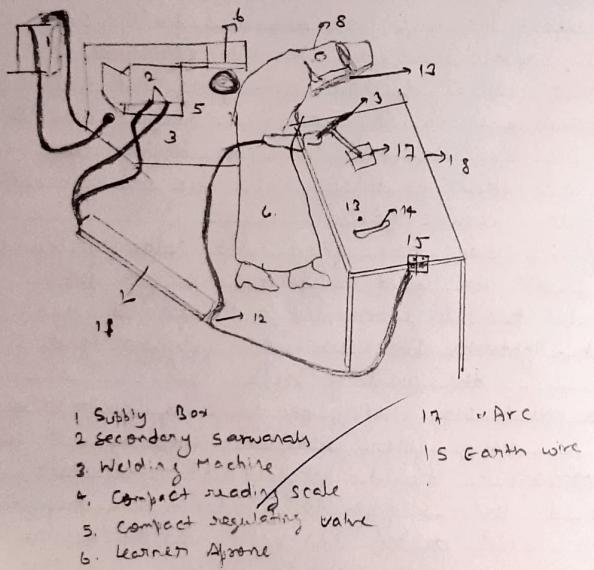
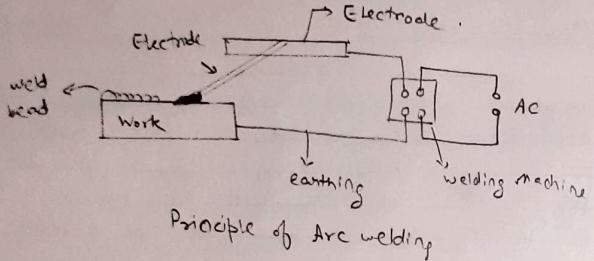
The tip sizes are identified by the diameter of the opening. The diameter of the tip opening used for welding depends upon the type of metal to be welded.

Hose pipes - The hose pipes are used for the supply of gases from the pressure regulators. The most common method of hose pipe fitting both oxygen & acetylene gas is the reinforced rubber hose pipe. Green is the standard color for oxygen hose, red for acetylene & black hose for other industrially available welding gases.

Goggles:- These are fitted with coloured lenses and are used to protect the eyes from harmful heat & ultraviolet and infrared rays.

Spark-lighter:- It is used for frequent igniting the welding torch.

Filler rods:- Gas welding can be done with or without using filler rod when welding with the filler rod, it should be held at approximately 90° to the welding tip. Metallurgical properties of the weld deposit can be controlled by the maximum optimum choice of filler rod. Most of the filler rods for gas welding also remain contain deoxidizers to control the oxygen content of metal pool.



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Fluxes:- Fluxes are used in gas welding to remove the oxide film and to maintain a clear surface.

These are usually employed for gas welding of aluminium, stainless steel, cast iron, brass & silicon bronze. They are available in the market in the form of dry powder, paste or thick solution hand masks to Apron. They are used to protect our body & hands from spark and flame which are produced while gas welding, they are made of leather.

Arc welding Process:- The process, in which an electric arc between an electrode and a work piece or between two electrodes is utilized to weld base metals, is called an arc welding process. The basic principle of the welding is shown in Figure (a). However, the basic elements involved in arc welding process are shown in Figure (b). Most of these processes use some shielding gas while other employ, coatings or fluxes to prevent the weld pool from the surrounding atmosphere. The various arc welding processes are:-

1. Carbon arc welding
2. Shielded Metal arc welding
3. Flux Cored arc welding
4. Gas Tungsten arc welding
5. Gas metal Arc welding
6. Plasma arc welding
7. Atomic arc welding
8. Electron beam welding
9. Stud Arc welding
10. Electro gas welding

Arc welding Equipment :- Arc welding equipment, setup and related tools and accessories are shown in Fig. However some common tools of arc welding are shown separately through figure. Few of the important components of arc welding setup are described as under.

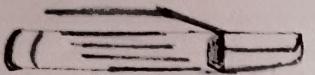
Welding Cable :- Welding cables are required for conduction of current from the power source through the electrode holder, the arc the work piece and back to the welding power source. These are insulated copper or aluminium cables.

Earthing Clamp :- Earthing clamp is also known as ground clamp and it is used to connect earth cable with job. Earth clamp are made of copper or copper alloy.

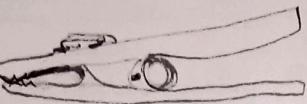
Electrode holder :- Electrode holder is used for holding the electrode manually & conducting current to it. These are usually matched to the size of the lead, which in turn matched to the amperage output of the arc welder. Electrode holders are available in sizes that range 150 to 500 Amp.

welding Electrodes :-

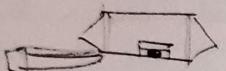
An electrode is a piece of wire or rod of a metal or alloy, with or without coating. An arc is set up between electrode are classified into following types -



Electrode holder



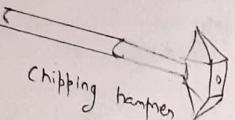
Fourth clamp



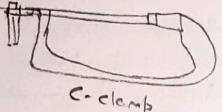
Hand screw



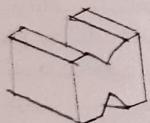
Wire brush



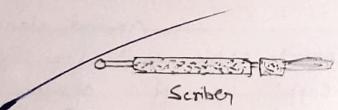
Chipping hammer



C-clamp



V-Block



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(i) Consumable Electrodes.

(a) Bare electrodes

(b) Coated electrodes

(ii) Non-consumable Electrodes

(a) Carbon or graphite electrodes

(b) Tungsten electrodes

Consumable electrode is made of different metals & their alloys. The end of this electrode starts melting when arc is struck between the electrode & work piece. Thus consumable electrode itself acts as a filler metal. Bare electrodes consist of a metal or alloy wire without any flux coating on them. Coated electrodes have flux coating which starts melting as soon as an electric arc is struck. This coating on melting performs many functions like prevention of joint from atmospheric contamination, arc stabilizers etc.

Non consumable electrodes are made up of high melting point materials like carbon, pure tungsten or alloy tungsten etc. These electrodes do not melt away during welding. But practically, the electrode length goes on decreasing with the passage of time, because of oxidation & evaporation of the electrode material during welding. The materials of non-consumable electrodes are usually copper coated carbon or graphite, pure tungsten, thoriated or zirconiated tungsten.

Hand screen:- Hand screen used for protection of eyes and supervision of weld bead.

Chipping Hammer:- Chipping hammer is used to remove the slag by striking.

Wire brush:- Wire brush is used to clean the surface to be weld.

Protective clothing:- Operator wears the protective clothing such as apron to keep away the exposure of direct heat to the body.

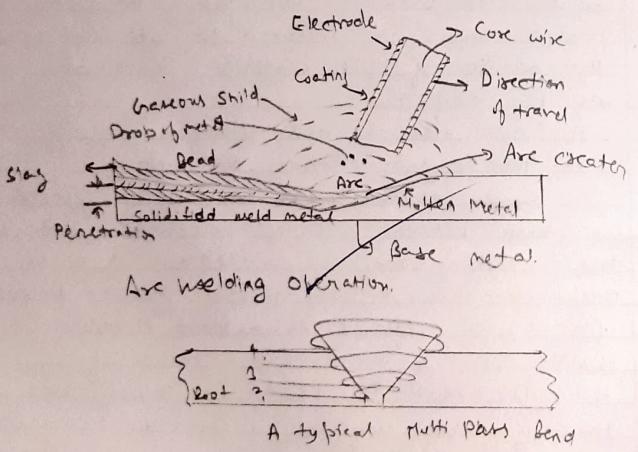
Carbon arc welding:- In this process, a pure graphite or baked carbon rod is used as a non-consumable electrode to create an electric arc between it and the work-piece. The electric arc produces heat and weld can be made with or without the addition of filler material. Carbon arc welding may be classified as-

- (i) Single electrode arc welding, and
- (ii) Twin carbon electrode arc welding.

In single electrode arc welding, an electric arc is struck between a carbon electrode and the work piece. Welding may be carried out in air or in an inert atmosphere. Direct current straight polarity (DCSP) is preferred to restrict electrode disintegration & the amount of carbon going into the weld metal. This process is mainly used for providing heat source for brazing, braze welding, soldering & heat treating as well as for repairing iron and steel castings. It is also used for welding

providing heat source for brazing, braze welding, soldering & heat treating as well as for repairing iron & steel casting. It is also used for welding of galvanized steel to copper.

In twin carbon arc welding the arc struck between two carbon electrodes produces heat to welds the joint. The arc produced between these two electrodes heats the metal to the melting temperature & welds the joint after saturation. The power source used is AC (Alternating Current) to keep the electrodes at the same temperature. Twin-electrode carbon arc welding can be used for welding in any position. This process is mainly used for joining copper alloys to each other or to ferrous metal. It can also be used for welding aluminium, nickel, zinc, lead alloys.



Shielded Metal Arc welding (SMAW) or Manual metal Arc welding (MM AW)

Shielded metal arc welding (SMAW) is a commonly used arc welding process manually carried by welder. It is an arc welding process in which heat for welding is produced through an electric arc set up. It is an arc welding process in which heat for welding is between a flux coated electrode & the work piece. The flux coating of electrode decomposes due to arc heat & serves many functions, like weld. The basic setup of a MMAW is depicted in Fig a),(b) & the configuration of weld zone is

is shown in Fig. If the parent metal is thick it may be necessary to make two or three passes for completing the weld. A typical multi pass bead in this case is shown in Fig.

Advantage

- (1) Shielded Metal Arc Welding (SMAW) can be carried out in any position with highest weld quality.
- (2) MMAW is the simplest of all the arc welding processes.
- (3) This welding process finds innumerable applications, because of the availability of a wide variety of electrodes.
- (4) Big range of metals & their alloys can be welded easily.
- (5) The process can be very well employed for hard facing & metal resistance etc.
- (6) Joints (between nozzles to shell in a pressure vessel) which because of their position are difficult to be welded by automatic welding machines can be easily accomplished by flux shielded metal arc welding.
- (7) The MMAW welding equipment is portable & the cost is fairly low.

Limitation:-

- (1) Due to flux coated electrodes, the chances of slag entrapment & other related defects are more as compared to MIG & TIG welding.

- (2) Due to fumes & particles of slag, the arc & metal transfer is not very clear & thus welding control in this process is a bit difficult as compared to MIG welding.
- (3) Due to limited length of each electrode & brittle flux coating on it, mechanization is difficult.
- (4) In welding long joints, as one electrode finishes, the weld is to be progressed with the next electrode. Unless properly cared, a defect (like, slag inclusion or insufficient penetration) may occur at the place where welding is restarted with the new electrode.
- (5) The process uses stick electrodes & thus it is slower as compared to MIG welding.

Application :-

- (1) Today, Almost all the commonly employed metals & their alloys can be welded by this process.
- (2) Shielded metal arc welding is used both as a fabrication process & for maintenance and repair jobs.
- (3) The process finds application in -
- Building & bridge construction.
 - Automotive & aircraft industry, etc.
 - Air receiver, tank, boiler & pressure vessel fabrication.
 - Ship building.
 - Pipes
 - Penstock Joining.

G 4 Part A

Object:- To prepare lap joint of given pieces with metal arc welding.

Material Requirement: Mild steel specimen.

Equipment Required:- Well insulated electrode holder, wire brush, cable & cable connector, hand shield, safety goggles, chipping hammer, Farthing clamp, cable lags, hand gloves, span etc.

Procedure :-

- Before carrying welding operation job pieces are cleaned.
- Job pieces are kept consider the type of job on welding table.
- Fix the electrode in the electrode holder considering the thickness of the job piece.
- Hold up the electrode holder which is ready for carrying operation.
- Do contact between electrode and job piece so that arc can be produce.
- Continuous arc can be maintained, keeping electrode slightly above the job piece.
- This is help to melt the part where to be jointed.
- It is kept for cooling to above side joint is prepared.

Safety Precaution:-

- Wearing appropriate safety, shop dress.
- Putting on goggles & also use hand shield.
- Required voltage must be checked so that required can be maintained.
- Hose pipe & leakages must be checked timely.
- Be alert at the of production arc

Part B

Object:- To prepare square butt joint of given pieces with metal arc welding.

Material Requirement:- Mild steel specimen.

Equipment Required:- Wall insulated electrode holder, wire, brush, cable, cable connectors, hand shield, safety goggles, chipping hammer, earthing clamp, cable lags, hand gloves, apron. etc

Procedure:- Before carrying welding operation, job pieces are cleaned.

- Job pieces are kept consider the type of job on welding table.
- Fix the electrodes in the electrodes holder considering the thickness of the job pieces.
- Hold up the electrodes holder which is ready for carrying operation.
- Do contact between electrode & job pieces so that arc can be produce.

- Continuous arc can be maintained, keeping ~~at the~~ electrode slightly above the job pieces
- This is help to melt parts where to be jointed.
- It is kept for cooling & above side joint is prepared.

Viva Question :-

Q1 Differentiate between fusion & solid state welding.

Ans Fusion welding - Metals are melted to form a joint, often uses filler material (ex. GRCs welding)

Solid state welding - Metals are joined without melting using pressure or heat below melting point, no filler needed.
ex. friction welding.

Q2 Define the types of joints.

Ans Butt joint - Two pieces are placed end to end in plane

Lap joint - One piece is overlapped over another.

Corner joint - Two piece meet at right angle to L shape

T-Joint - One piece is positioned perpendicular to other

Edge Joint - The edges of two or more parts (T) are placed side by side.

Q3 Give the name of components of gas & electric arc welding.

Ans For Gas welding → Oxygen cylinder, fuel gas (Acetylene) cylinder, pressure regulators, Hoses, Welding Torch

Electric arc Nozzle, spark lighter, safety equipment.

Electric Arc welding Components-

Power supply, electrode Holder, electrode, ground clamp, welding cables, welding machine / Transformer, welding Helmet & safety gear.

Q4

Explain different tools are used in welding.

Ans

Welding Machine - supplies electric current for welding

Electrode / Filler Rod - Fill the joint between metal pieces.

welding Helmet - Protects face & eyes from sparks & UV light.

welding Gloves - Protect hands from heat & sparks

chipping Hammer - Remove slag from welds

Wire brush - Clears the welded surface

Clamps - Hold metal pieces in place

Angle grinder - prepares & finishes metal surfaces.

Measuring tools - For accurate cutting & fitting.

Q5

Advantage & disadvantage of gas welding & arc welding.

Ans

Gas welding

Advantage - Portable

- No power needed

- cheap equipment

- used for thin metal

disadvantage - Slower

- Not for thick metal

- lower temperature

Q6

- uses flammable gases

Arc welding ~~Same~~ ^{8/1/25}

Advantage - Fast & efficient

- Strong welds

- Works on thick metals

- suitable for heavy duty

Disadvantage - Needs

- electricity

- costlier equipment

- less portable