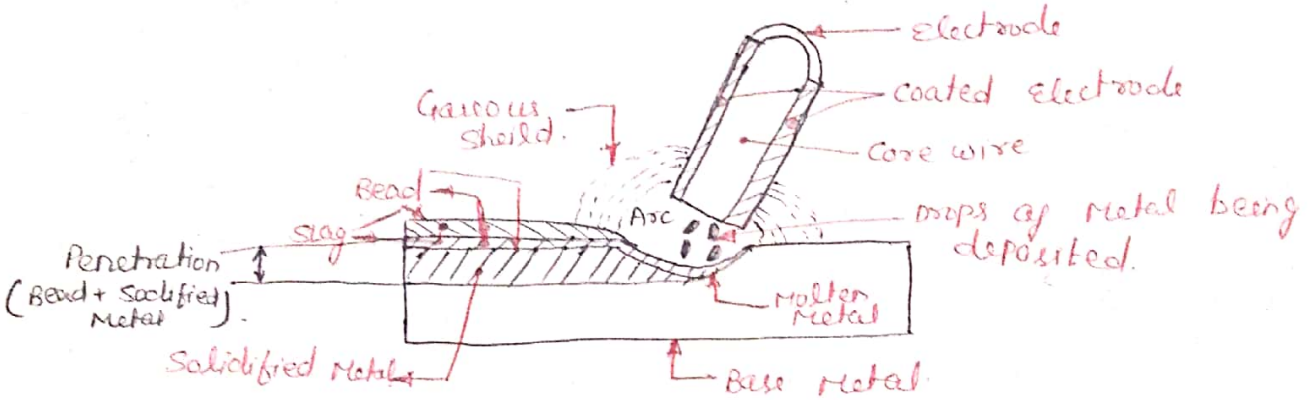
ARC WELDING :—

The arc welding is a fusion welding process in which the welding heat is obtained from an electric arc between the work (or base metal) and an electrode. The electric arc is produced when two conductors of an electric circuit are touched together and then separated by a small distance, such that there is sufficient voltage in the circuit to maintain the flow of current through the gaseous medium (air). The temperature of heat produced by the electric arc is of the order of 6000°C to 7000°C.



Basic principal of Arc welding

The most common method of arc welding is with the use of a metal electrode which supplies filler metal. The welding is done by first making contact of the electrode with the work (the electrode act as one conductor and the work as second conductor) and then seperating the electrode to a proper distance to produce an arc. When the arc is obtained, intense heat so produced quickly melts the work under the arc forming a pool of molten metal which seems to be forced out of the pool by the blast from the arc. A small depression is formed in the work and the molten metal is deposited around the edge of this depression, which is called the arc crator.

the slag is brushed off after the joint has cooled. The arc, once started, should be advanced at a uniform speed along the desired line of welding. the meeting should reach to a sufficient depth below the original surfaces of the metal pieces to be joined to obtained the desired weld. this is known as obtaining proper penetration.

Both the direct current (DC) and Alternating current (AC) are used for arc welding. the direct current supply for arc welding is usually obtained from a generator driven by either an Electric motor or petrol or diesel Engine.

the alternating current supply for arc welding is obtained from a step down transformer which receives current from the supply mains at 200 to 440 volts and transforms it to the voltage actually required (i.e 80 to 100 volts) for striking the arc only. In order to maintain the arc, a still lower voltage say about 30 to 40 volts is required. The voltage required in case of D.C. welding is 60 to 80 volts for striking the arc and 15 to 25 volts for maintaining the arc.

Polarity in Arc welding :-

(i) **Straight polarity :-** when the work is connected to the positive terminal of a D.C. welding machine and the negative terminal to an electrode holder. the welding set up is said to have straight polarity. straight polarity is preferable for some welds. when it is desired to have more heat liberated at or near the work, straight polarity is used. because the heat develop at +ve terminal is higher (60 to 75% of total heat evolved) then -ve terminal Temp of arc (3500°C to 4000°C)

Reversed polarity :-

when work is connected to negative and electrode to a positive terminal, then the welding set up is said to have reversed polarity. In most of the reversed polarity is used. In reversed polarity electron metal melts and fill the spacing to form the weld.

when alternating current is used, there is no fixed polarity at the terminals and they interchange in every cycle. the A.C also requires zero value twice in each cycle. thus at these particular moments, the potential difference b/w the terminal is zero and hence a high voltage is required to maintain the arc at this moment.

Types of arc welding :-

thus are of two types :-

1. **Un-shielded arc welding :-**

when a large electrode or filler rod is used for welding, it is said to be un-shielded arc welding. In this case, the deposited weld metal while it is hot will absorb oxygen and nitrogen from the atmosphere the effect of oxygen is to produce inclusions and blow holes in weld and nitrogen promotes hardness and brittleness. this decreases the strength of weld metal, lowers its ductility and resistance to corrosion.

2. Sheilded Arc welding :-

when coated welding electrode for welding are used, then it is called sheilded arc welding. The weld made with coated rods are free from blow holes and produce much stronger welded joints.

Arc welding Equipments :-

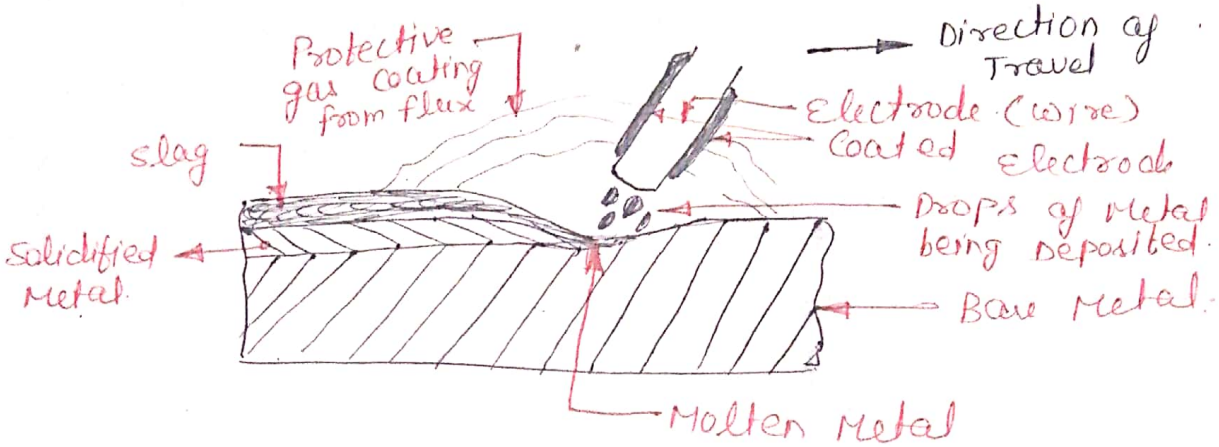
The Equipment commonly used for welding consists of the following :

1. Alternating Current (A.C) or Direct Current (DC)
2. Electrode 3. Electrode holder (insulated) 4. Cables.
5. Cable Connectors (6) Cable lugs (7) chipping hammer
8. Earthing clamps 9. wire brush 10. Helmet or hand sheild
11. safety goggles 12. Hand gloves 13. Aprons, sleeves Etc.

Metal Arc welding proces :-

In metal Arc welding proces, the arc is produced between the flux coated metallic Electrode and the workpiece. The electrode is consumable so supplies the necessary filler metal. the covering of the electrode serve the purpose of flux.

During the welding proces, the metal Electrode is melted by the heat of the arc and fuses with the workpiece. the temperature produced by the heat is about 2400°C to 2700°C. The arc temperature and thus the arc heat can be increased or decreased by Employing higher or lower arc Currents. A high Current arc with small arc length produce a very intense heat.



Flux sheilded Metal Arc welding

Advantages :—

The welding Equipment ei simple, less costly and portable.

2. welding can be carried out in any position with highest weld qualities.
3. wide varieties of electrodes are available.
4. Total welding cost ei less.

Disadvantages :— The length of each electrode ei limited and when new electrode ei used, proper cleaning has to be done which decreases the welding speed.

2) welding control ei difficult as compared to MIG welding.
3) if the covering absorbs moisture, the moisture causes Porosity defect.
4) Because of flux coating, chances of slag Entrapment are more.

Applications :—

① It ei used both as a fabrication proces and for maintenance and repair jobs.

2. It ei also used in ship buildings, Pipe lines, buildings & bridges construction, tanks, boilers, Automotive & aircraft industries

CARBON ARC WELDING :-

Carbon arc welding is an arc welding process in which welding heat is obtained from an electric arc between a carbon electrode and the work.

In this welding the electrode is non-consumable so less heat is required at the electrode so electrode is made (-ve) negative terminal and job is (+ve) positive since the polarity is fixed, D.C. is usually used for welding. Though graphite electrodes are costlier than carbon electrode, they are preferred as they have longer life, more current carrying capacity and lesser electrical resistance.

Carbon arc welding can be done by using single carbon electrode system or by using two carbon electrode system. In twin carbon electrode arc welding, the arc is maintained between two carbon electrode and the workpiece. In heavy welds, a filler rod is melted by the arc and deposited in the weld.

In carbon arc welding, a current of 20 to 800 Amperes is used which depend upon the thickness of metal to be welded and diameter of electrode. Most of the arc welding is done with automatic welding Equipment where the arc voltage and current, rate of travel and rate of feeding the filler rod all are properly controlled.

NOTE:- The size of the arc depends upon the distance b/w electrode tip, electrode diameter and the welding current. An A.C is used for generating arc in twin carbon arc welding in order to generate heat at both the electrodes.

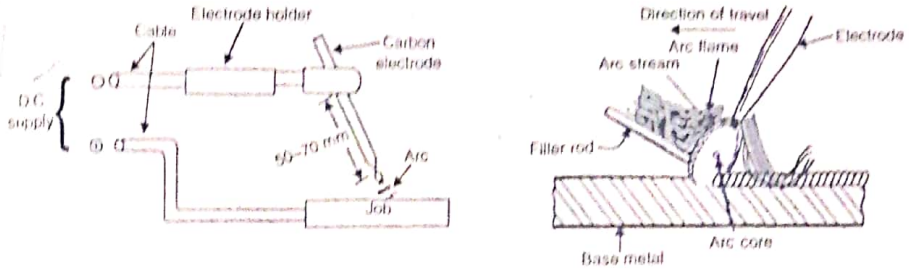


Fig. 21.4. *Principle of Carbon Arc Welding.*

Advantages :-

1) Process is simple so less time is required to have a good skill.
2) Process can be easily mechanized.
3) welding heat source and filler metal source are seperate. So better heat control is possible.
4) total welding cost is less.

Disadvantages :-

1) Since D.C is usually used in single electrode carbon arc welding so there are more chances of arc blow which give poor welds with blow holes and porosity.
2) If carbon is transferred from electrode, it causes a harder weld deposit in case of ferrous materials.

Applications :-

1) The carbon arc welding is used for welding Cast Iron, steel, copper, bronze, galvanized iron, Aluminium and for rough cutting of metal.
2) It can also be employed for brazing, Beheating and post heating of the welded joints.

—

SUBMERGED ARC WELDING:—

In this welding, a consumable bare electrode wire is fed, continuously and automatically, from a roll of wire into the welding zone. Electric arc is produced b/w the electrode and the workpiece and the whole weld remains covered under a blanket of granular flux. The welding zone and arc remain submerged under the flux and hence it is called submerged arc welding.

No protective shield is required in this case because welding zone and arc are not visible. There is also no need of any shielding gas because welding is done under the blanket of granular flux. After the process is over the unfused flux can be recovered and reused.

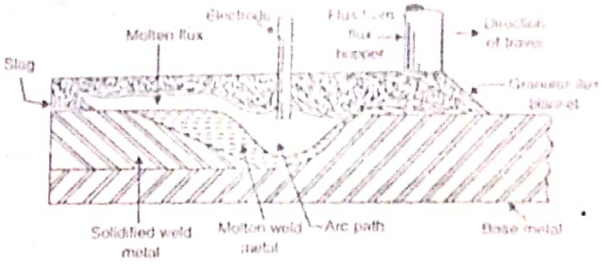


Fig. 21.12(a). Principle of Submerged Arc Welding

Submerged arc welding is restricted to weld only the joints having horizontal orientation and thicker plates (more than 5mm).

This welding is used for doing faster welding jobs. It is possible to use large welding electrodes, (12mm), no. of electrodes, and very high current (4000A) so that very high metal deposition rates of the order of 20kg/hr or more can be achieved with this process. Also very high welding speeds (5m/min) are possible in SAW. These machines are able to weld plates of thickness as high as 75mm in but joint in single pass but it is more economical for larger welds only.

Advantages :-

① operator is not exposed to metal spatter and can work without helmet and other safety equipments.
② It is much faster.
③ No edge preparation is required.
④ very neat appearance and smooth weld shape can be obtained.

Disadvantages :-

① It is limited to welding in flat position only
② Flux consumption is very much.
③ Cast Iron, Al alloys, Mg alloys cannot be welded by this process.
④ It is not economical for thin pieces and for small weld.
⑤ Since the arc, end of the electrode remains completely hidden so jigs, fixtures, accessories, and pointer are require to ensure proper welding at the joint.

Applications :-

① welding metals like mild steel, low alloy steels etc.
② shipbuildings, automotive industries, Nuclear Power industries etc.
③ welding of bridge girders, railroads, structural shapes, pressure vessels, Pipes and structure of railway coaches & locomotives.

TUNGSTEN INERT GAS (TIG) OR GAS TUNGSTEN ARC WELDING:—

In this process, welding heat is produced from an electric arc established b/w the tungsten electrode and the job. A shielding gas (Argon, helicum, Nitrogen etc.) is used to avoid atmospheric contamination of the molten weld pool. Filler metal, if required is fed seperately.

The gas nozzle surrounds the tungsten electrode, when the gas leaves the nozzle, it completely envelops the tip of the electrode and the weld take place under it.

In this process, either D.C. or A.C. may be used, the selection depend upon the type of metal to be welded. The direct current with straight polarity is used for welding copper alloys and stainless steel, whereas the reverse polarity is used for magnesium. The alternating current is more versatile in its application and is used for steel, cast iron, Aluminium and Magnesium.

This process is capable of making clean sound weld in Aluminium without the use of corrosive fluxes. Though any metal can be welded by this process, yet it is best suited for the welding of relatively thin pieces of metal. The tungsten inert gas welding may be done either by a manual process or by the automatic machine welding. When it is manual, the weld can be made in any position.

Polarities:-

DCSP (Direct current Straight polarity):-

Tungsten electrode (-ve), work (+ve) used for mild steel, stainless steel, Copper and titanium.

DCRP (Direct current Reverse polarity):-

Tungsten electrode (+ve), work (-ve) used for welding Aluminium and heavily oxidized aluminium castings.

ACHF (Alternating Current High Frequency):-

It is used for Al and Mg. High frequency also helps in oxide cleaning actions.

Advantages:-

① No flux is used so no danger of flux entrapment.
② clear visibility of the arc, so better control.
③ weld can possible in all positions.
④ High quality welding of thin material (as thin as 0.125 mm).
⑤ Unlike metals can be welded to each other like mild steel to stainless steel, brass to Copper etc.

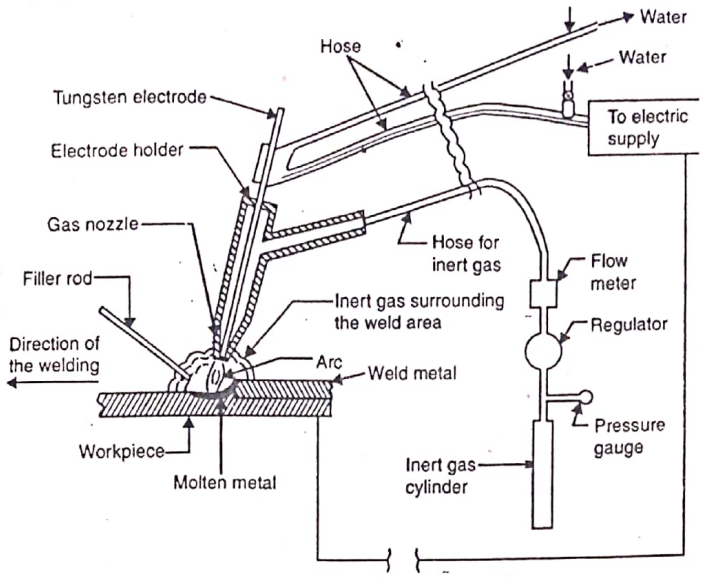
Disadvantages:-

1. Tungsten, if transfers can contimate the weld pool.
2. Electrode is non-consumable, so seperate fillers rod is needed, so there is decrease in welding speed.
3. Filler rod end if by chance comes out of the inert gas shield can cause weld metal contamination.

Applications:-

1) welding of Carbon steel, stainless steel, Aluminium, Magnes, brass, Copper, bronze, titanium etc.

2. Welding of sheet metal and thinner sections.
3. Used in aircrafts, rocket motor chambers, transistor cans and instrument industries.



METAL INERT GAS (MIG) ARC WELDING :—

In metallic inert gas arc welding is similar to tungsten inert gas welding except the electrode is consumable. In this process, filler metal wire (from 0.75mm to 1.5mm diameter) of desired composition is automatically and continuously fed from a reel at a speed ranging from 250 to 750 cm per minute. The filler metal is deposited by the arc which is completely surrounded by inert gas.

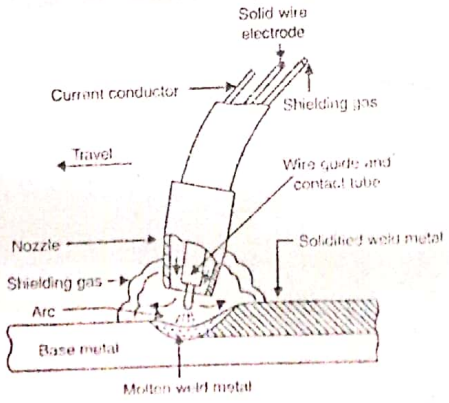


Fig. 21.8(a). *Principle of Metal Inert Gas Welding (MIG).*

Advantages :- ① continuous welding at higher speed and in all positions with deeper penetration is possible.
② Thin and thick both types of workpiece can be welded effectively.
③ No flux is used so more visibility, Neat new, cleanliness.

Disadvantages :- 1. The metallurgical and mechanical properties of the joint may be affected due to high cooling rate.
② Process variables are more.
③ Difficult to weld in small corners.

Applications :- It is suitable for welding variety of ferrous and non ferrous metals.
② Metal fabrication industries, shipbuilding, Automobiles, Pressure vessel industries etc.
③ welding tool steels and dies.

ATOMIC HYDROGEN WELDING (ARC WELDING)

In this welding, the arc is obtained b/w two tungsten Electrode (non-consumable), in an atmosphere of hydrogen, which also act as a shielding gas. As the hydrogen enters the arc, the high temperature break up the molecules of hydrogen (Converting of two atoms) into single atoms. In doing so a large amount of heat is required and absorbed by the hydrogen. These single hydrogen atoms then have a strong tendency to recombine, especially when they approach the relatively cool surfaces of the workpiece. when the atoms combine, the heat which was absorbed is liberated, producing a temperature of about 3000°C at the work piece. Since the arc is independent of the work. the heat input of the weld can be controlled by varying the distance of the arc from the weld. Filler metal may be used when needed.

ADVANTAGES:-

① The main advantage of the process is its ability to provide high heat concentration. In addition to this, the hydrogen also act as a shielding gas to protect the electrodes and molten metal from oxidation.

② Since under the atomic hydrogen arc, the molten metal becomes extremely fluid, therefore the metal should be confined and welds should be made in flat position.

Disadvantages:-

① welding speed is less compared to MIG welding.

② operating cost is higher.

③ The process can not be used for depositing large quantities of metals.

Applications:-

① Used for welding of thin pieces of Aluminium, stainless steels etc.

② This process is widely used in the repair of steel moulds and dies.

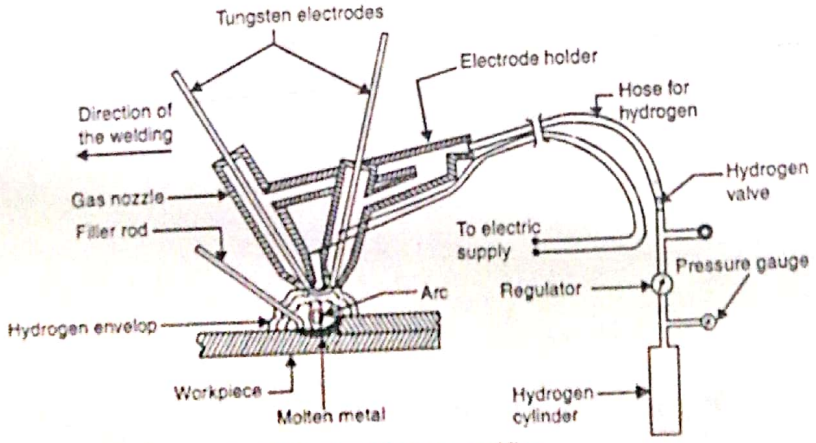


Fig. 15.19. Atomic hydrogen welding.