FUSION WELDING

Concept of Welding:

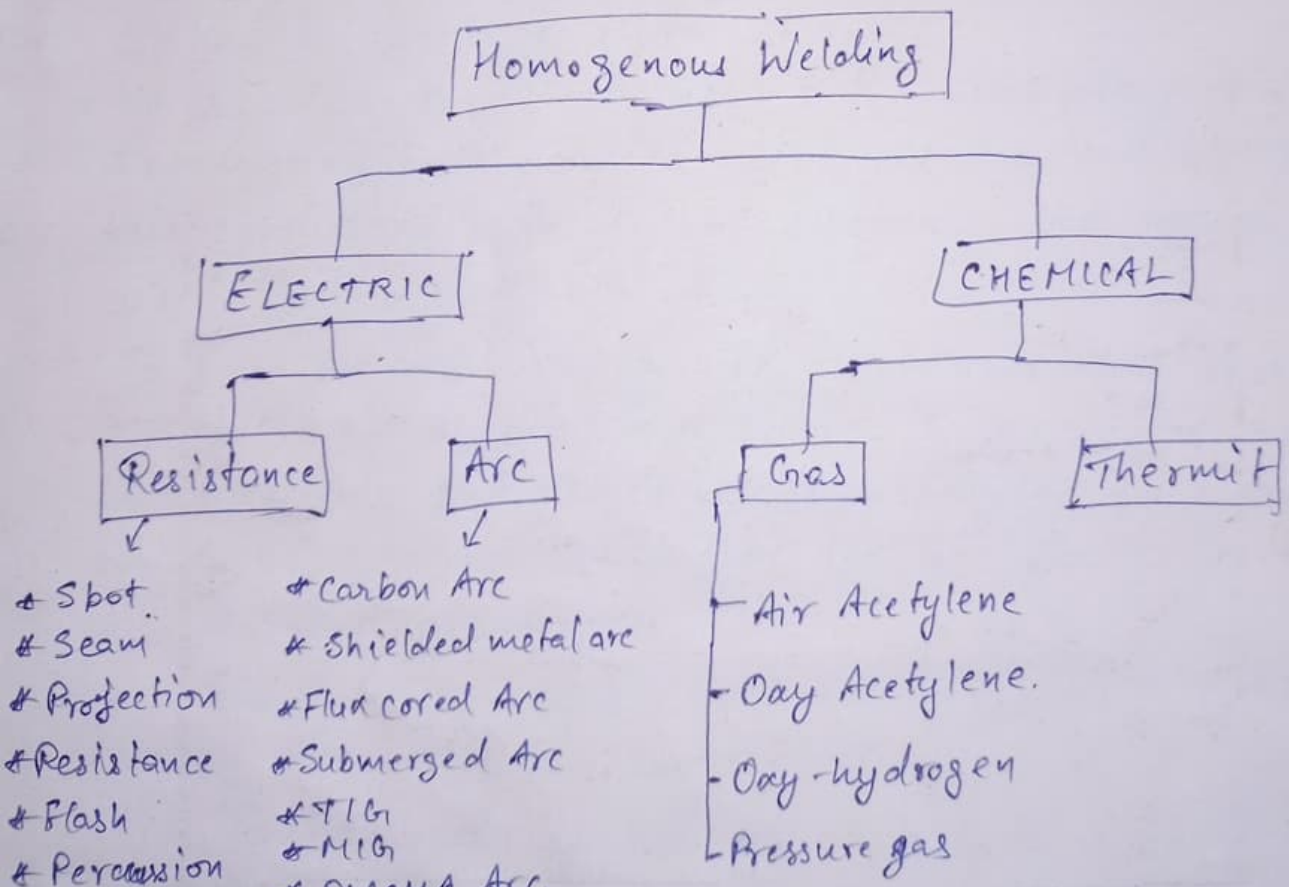
In fusion welding, a source of high density heat energy raises the temperature of the surfaces enough to cause localized melting.

If the heat density is too low, the heat is conducted away as fast as it is added and melting does not occur.

$$\text{Heat Density} = \frac{\text{Power}}{\text{Surface area}}.$$

Homogenous Welding:

The process of joining similar metals with the help of filler rod of the same metal is called homogenous welding.



ARC WELDING

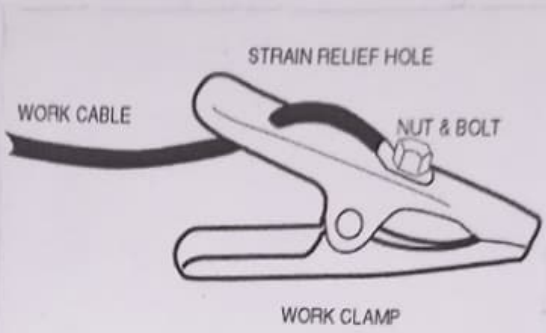
- Arc welding is used for joining the metal parts. Heat is produced with an electric arc or arc, mostly without the application of pressure and with or without the use of filler metal.

Principle:

- Arc is generated between the positive pole of Direct current (DC) called anode and the negative pole of DC called cathode.
- When these two poles are brought together, the electron from the electrode while moving towards the workpiece ionizes the air.
- The ionize air further forms a gas cloud which changes into an ionized gas column, called plasma. It has tempreture upto 30,000°C.
- As soon as the electrons hit the workpiece it forms a conducting path between electrode tip and workpiece. this conducting path full of electrons and ionized air is called arc.
- To form an arc, initially we touch electrode and workpiece due to which a spark is generated, after this electrode and workpiece is separated for a small distance (1.5 to 3mm) such that the arc flow constantly, this is called arc length.
- the kinetic energy of electrons are converted into heat energy that melts the workpiece;
- the kinetic energy of positive charge is converted into heat energy that melts the electrode.

ARC WELDING EQUIPMENT

1. A.C. or D.C. power supply source.
2. Electrode holder.
3. Electrode.
4. Cable, cable connectors.
5. Cable lug.
6. Chipping hammer.
7. Earthing clamps.
8. Wire brush.
9. Helmet.
10. Safety goggles.
11. Hand gloves.
12. Apron, sleeves etc.



Arc welding Equipments


Welding Transformer


Electrode


Electrode Holder

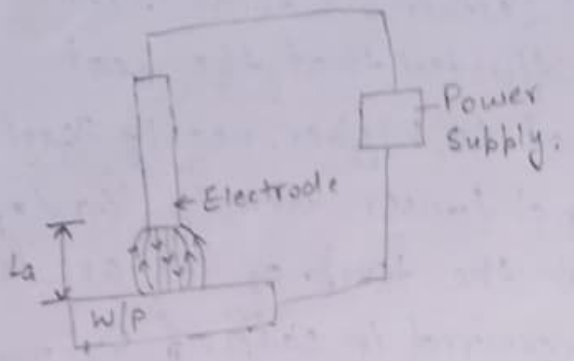

Workpiece clamp


Chipping hammer


Wire brush


Protective shield

Alternating Current (AC) Welding.



Depending upon the application, A.C. or D.C. machines are used in arc welding, but in some cases either of them can be used. D.C. supply is usually obtained from generators driven by electric motor or if no electricity is available then diesel engine can be used. D.C. welding is mostly used for heavy work and at sites where electricity is not available.

where mains supply are available, an A.C. source transformers are used. The function of transformer is to step down the voltage from 440 volts to the normal open circuit welding voltage (80-100 volts). There is no fixed polarity at the terminals when using A.C. and they interchange in every cycle. Also the alternating current acquires zero value twice in each cycle with the result, at these particular moment the potential difference b/w the terminals is also zero and hence a higher voltage is required to maintain the arc at this moment.

Direct Current (DC) Welding:

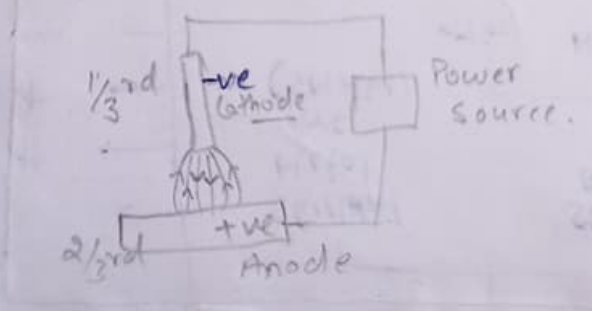
In DC welding the electrode acts as one terminal and the job the other terminal (either +ve or -ve). The potential difference can be so adjusted that the heat developed at the positive terminal is higher, nearly 2/3rd and that on the negative terminal lower, nearly 1/3rd of the total heat evolved. Here again the temp. of the arc is 3700°C to 4000°C. The voltage required in case of D.C. welding is 60-80 volts striking the arc and 15 to 25 volts for maintaining the arc.

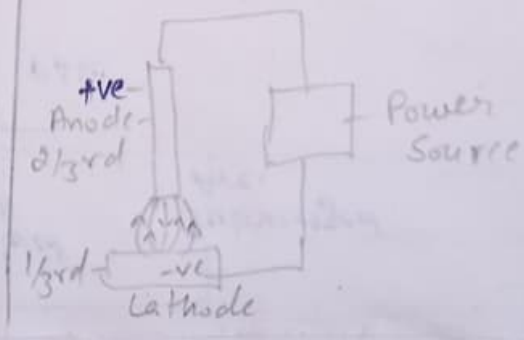
Polarity is very significant factor in all DC working. This polarity can be of two types:

(1) Straight polarity: In this, the electrode forms the negative terminal and the workpiece positive.

(2) Reverse polarity: In this, the electrode forms the positive terminal and the workpiece negative.

Straight polarity	Reverse polarity
(1) DCSP, DCEN	(1) DCRP, DCEP
(2) Electrode (-ve), w/p (+ve)	(2) Electrode (+ve), w/p (-ve)
(3) More heat will be on the w/p when compared to electrode.	(3) More heat will be on the electrode when compared to w/p.
(4) Used for welding of high thickness high melting point materials.	(4) Used for welding of less thickness low melting point materials.
(5) Depth of penetration is more	(5) Depth of penetration is less.
(6) Welding deposition rate, Welding speed — Less	(6) Welding deposition rate, welding speed — More.



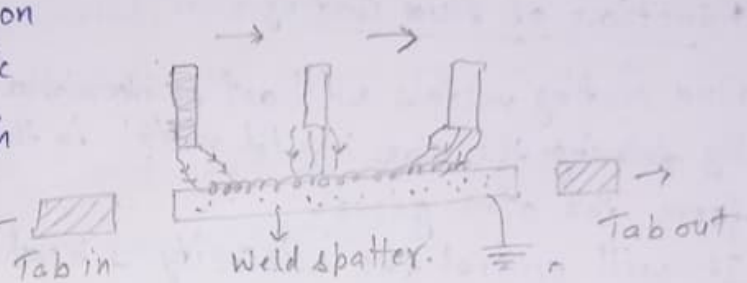


Arc Crater:

Because of the penetration of electric arc into the parent metal, small depression will be formed in the parent metal around which molten metal is piled up, known as the arc crater. Its depth depends on the thickness of the parent metal.

Arc Blow:

- Arc blow is the phenomenon of deflection of the electric arc from its intended path towards the w/p at the begining and end.



- It occurs in D.C. welding.
- When a current flows in any conductor, a magnetic field is formed around the conductor in direction right angle to the current, this magnetic field tends to bend the arc from its path.
- The magnetic field is produced by electromagnetic forces which attracts the arc towards its forces, this effect is called Pinch effect.
- In DC welding, there is fixed polority, so the induced magnetic fields are constant in one direction but in A.C. welding polority is not fixed.
- Due to Arc blow extra heat is produced which melts the metal more than required, the molten metal splashes on the clean surface of w/p, these particles after solidification becoming solid forms, called weld spatter.

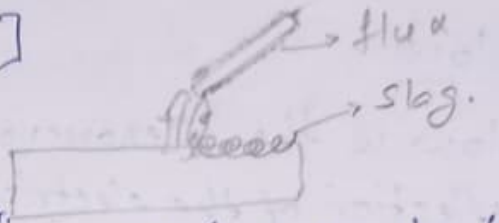
Remedies

- Provide extra material at extreme ends of the w/p, known as Tab in & Tab out.
- Use small arc length at the begining & end of the w/p.
- Provide flux coatings on the electrode.

ELECTRODES

The electrodes are used for providing heat input in arc welding. Electrodes can be classified on the following basis:

1) Consumable
   Non-Consumable [Carbon, graphite or Tungsten]
2) Bare electrode.
   Coated Electrode. [Flux coating]



Function of flux Coating

* Flux coating metals will act as deoxidizer.
* By forming the slag liquid metal in the weld pool can be protected form the atm gases.
* It will control the viscosity & heat transfer losses of the liquid metal in the weld pool.
* By reducing the arc blow, it increases the stability of the arc.
* Strength of the joint can be increased by adding alloying elements.
* It will increase the heat concentration of arc on w/p by reducing the heat transfer losses.

Flux Coating Materials:

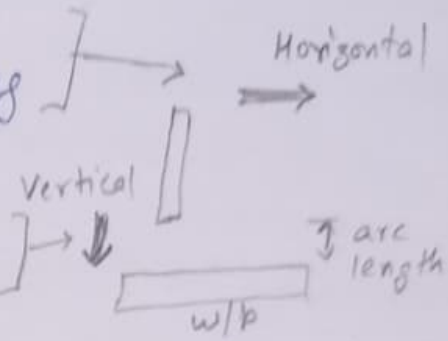
(1) De-Oxidising Elements: Graphite, Aluminium (Al_2O_3), ferrosilicon and ferromageness.
(2) Gas forming: Organic matters (starch, cellulose etc.)
(3) Slag forming: Iron oxide, Titanium oxide, silicon dioxide, silica flour and calcium flouride.
(4) Arc Stabilizers: Calcium oxide, Sodium oxide & Potassium Silicate.
(5) Alloying Elements: Chromium, Nickel, Cobalt & Vanadium.
(6) [weld strengthener]
Viscosity forming compound: CaF_2, TiO_2.

WELDING TECHNIQUES:

There are two movements for the electrode.

1) Linear movement of the electrode, w.r.t the w/p, known as the linear welding speed.

2) Downward movement of the electrode w.r.t to maintain constant arc length.



Manual Arc Welding : Movement controlled manually. (Horizontal, Vertical)

Semi Automatic : one movement manually, other by machine.

Automatic : Both movement of the electrodes are controlled by machines.

Specification of Electrode (BIS):

E 1 2 1 423 P

1.) Type of electrode manufacturing [E means by extrusion]

2) Types of flux coating [1 means high cellulose, 2 means high titanium]

3.) Position of the electrode.
0 → F, U, H, D, O.
1 → F, H, U, D.
2 → F, H.

Acc. to ISI system, an electrode is specified by six digits with a prefix 'M' [Metal arc Welding]

4.) Polarity
1 → D+ [Direct current electrode positive]

5.] Strength of the electrode
4 means tensile strength.
2 means Yield strength.
3 means % of elongation.

6.] Specific information regarding the electrode
P: Deep penetration.