Materials joining methods

Two methods used to join of materials permanent and semi-permanent, Different materials can be joined in many different ways depending on the joint needs to be permanent or semi-permanent. They are (Welding, Brazing, Soldering, Riveting, Adhesives, Nuts and bolts and washers, Screws).

• *Permanent: This term refers to arc welding, brazing, soldering and adhesive bonding. In these processes a permanent joint between the parts is formed and cannot be separated easily, if separate these parts are damage.*

• *Semi-permanent: this type of joint is a method of joining that is designed to be permanent, this term refers to nuts and bolts and washers, however, it can be disassembled without damage.*

Conventional Welding Classification

Welding processes usually divided into three main groups, solid state, liquid state welding, but there are third type namely solid/liquid state. With three types the materials are joined together with these methods cannot separate easily and achieved by pressure, pressure and heat, or heat only.

1- Solid-state Welding Processes; In solid state welding such as friction welding, forge welding, explosion welding, etc. *The surfaces to be joined are brought into close proximity by heating the surfaces without causing melting and applying normal pressure. Then, providing relative motion between the two surfaces, after stop the motion is applying high pressure without heating*. In these processes the materials remain in solid state and welding is achieved through the application of heat and pressure, or high pressure only.

2- Liquid State (Fusion) Welding Processes; arc welding, resistance welding, oxy fuel gas welding, etc. *There are two inherent problems with fusion welding, effect of localized heating and rapid cooling on the microstructure of the parent metals and effect of residual stresses developed in the parent metals due to expansion or contraction*.

3- Solid / Liquid State Bonding; *In this state, low temperature joining methods are used when the metal to be joined cannot withstand to high temperature, or complex sections are to be joined, or dissimilar metals are to be joined, or weldability of material is poor.* Also in these methods, the gap between the metal pieces to be joined is filled with molten filler material after

heating the base metal. Melting point of filler material is much lower than base metals, the bonding is doing without melting of parent metal.

Electric Arc Welding

Electric Arc Welding provides the heat required for melting the parent as well as filler material.

Mechanism of Arc welding

The workpiece and the electrode are connected to the power source (*The electrode is an electrical conductor used to make contact between (cathode and anode) to fuse or melt of workpiece*). The arc is started with touching the electrode to the workpiece, then withdrawing it to a short distance (a few mm) from the workpiece. When the electrode and workpiece are in contact the current is flows. The arc is generated by the electrons emitted form cathode and moving towards anode and the arc changes electrical energy into heat and light.

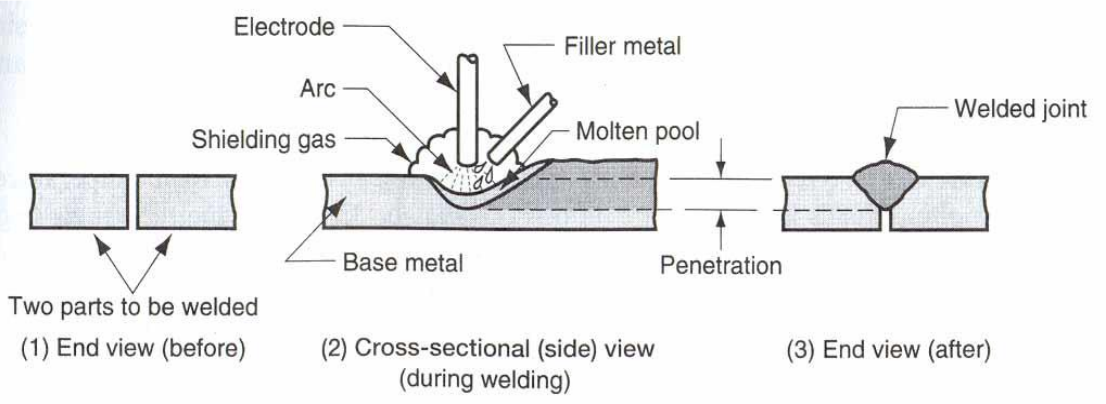

Fig.27: **Electric Arc Welding**

About 70% of the heat emitted due to the flux of electrons at anode raises the anode temperature to high values up to 5,000 °C or more. This heat melts the base metal as well as the tip of the electrode in the area surrounding the arc. A welding is formed when the mixture of molten base and the electrode metal solidifies in the welding area.

The electrode also reacts to slag, which is a liquid and lighter than the molten metal. *The slag is rising and floating on the surface and by solidification, forms a protective covering over the hot metal. This also slows down the rate of cooling of the weld.* The slag layer can be removed by light chipping or small hammering on the slag cover.