Introduction to welding process

Introduction

Welding is a process in which two or more parts are joined permanently at their touching surfaces by a suitable application of heat and/or pressure. Often a filler material is added to facilitate coalescence. The assembled parts that are joined by welding are called a weldment. Welding is primarily used in metal parts and their alloys.

Welding processes are classified into two major groups:

1. Fusion welding: In this process, base metal is melted by means of heat. Often, in fusion welding operations, a filler metal is added to the molten pool to facilitate the process and provide bulk and strength to the joint. Commonly used fusion welding processes are: arc welding, resistance welding, oxyfuel welding, electron beam welding and laser beam welding.

2. Solid-state welding: In this process, joining of parts takes place by application of pressure alone or a combination of heat and pressure. No filler metal is used. Commonly used solid-state welding processes are: diffusion welding, friction welding, ultrasonic welding.

Arc welding and similar processes

Arc welding is a method of permanently joining two or more metal parts. It consists of combination of different welding processes wherein coalescence is produced by heating with an electric arc, (mostly without the application of pressure) and with or without the use of filler metals depending upon the base plate thickness. A homogeneous joint is achieved by melting and fusing the adjacent portions of the separate parts. The final welded joint has unit strength approximately equal to that of the base material. The arc temperature is maintained approximately 4400°C. A flux material is used to prevent oxidation, which decomposes under the heat of welding and releases a gas that shields the arc and the hot metal.The second basic method employs an inert or nearly inert gas to form a protective envelope around the arc and the weld. Helium, argon, and carbon dioxide are the most commonly used gases.

Shielded-Metal Arc (SMAW) or Stick Welding

This is an arc welding process wherein coalescence is produced by heating the workpiece with an electric arc setup between a flux-coated electrode and the workpiece. The electrode is in a rod form coated with flux. Figure M6.1.1 illustrates the process.

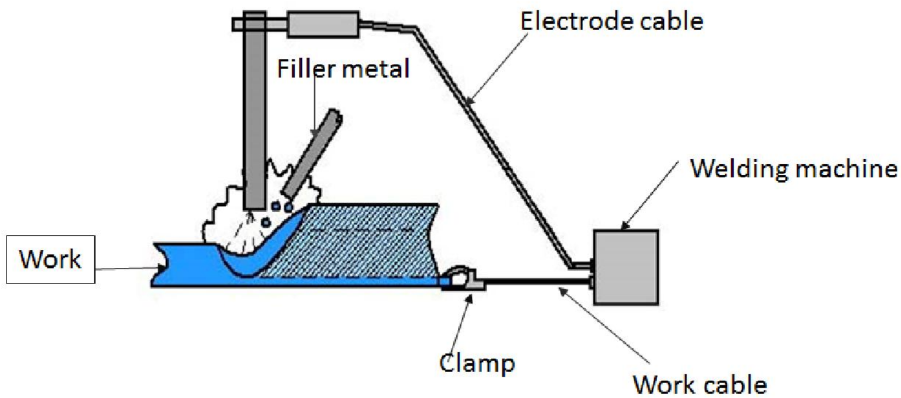

Figure M6.1.1: Shielded-Metal Arc (SMAW)

Submerged Arc Welding (SAW)

This is another type of arc welding process, in which coalescence is produced by heating the workpiece with an electric arc setup between the bare electrode and the work piece. Molten pool remains completely hidden under a blanket of granular material called flux. The electrode is in a wire form and is continuously fed from a reel. Movement of the weld gun, dispensing of the flux and picking up of surplus flux granules behind the gun are usually automatic.

Flux-Cored Arc Welding (FCAW)

This process is similar to the shielded-arc stick welding process with the main difference being the flux is inside the welding rod. Tubular, coiled and continuously fed electrode containing flux inside the electrode is used, thereby, saving the cost of changing the welding. Sometimes, externally supplied gas is used to assist in shielding the arc.

Gas-Metal Arc Welding (GMAW)

In this process an inert gas such as argon, helium, carbon dioxide or a mixture of them are used to prevent atmospheric contamination of the weld. The shielding gas is allowed to flow through the weld gun. The electrode used here is in a wire form, fed continuously at a fixed rate. The wire is consumed during the process and thereby provides filler metal. This process is illustrated in Figure M6.1.2.

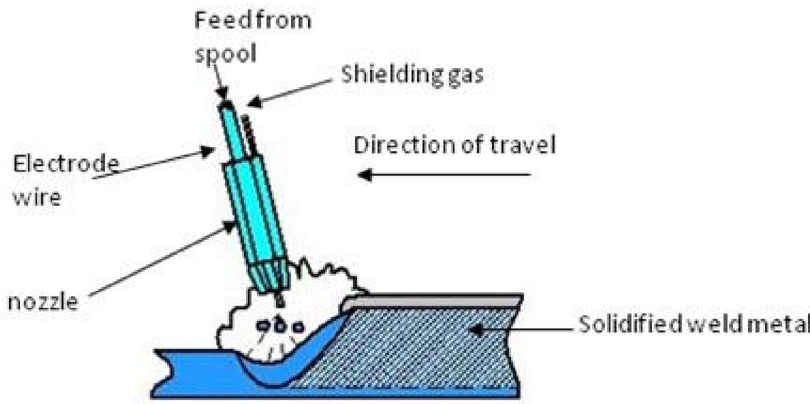

Figure M6.1.2: Gas-Metal Arc Welding

Gas-Tungsten Arc Welding (GTAW)

This process is also known as tungsten–inert gas (TIG) welding. This is similar to the **Gas-Metal Arc Welding** process. Difference being the electrode is non consumable and does not provide filler metal in this case. A gas shield (usually inert gas) is used as in the GMAW process. If the filler metal is required, an auxiliary rod is used.

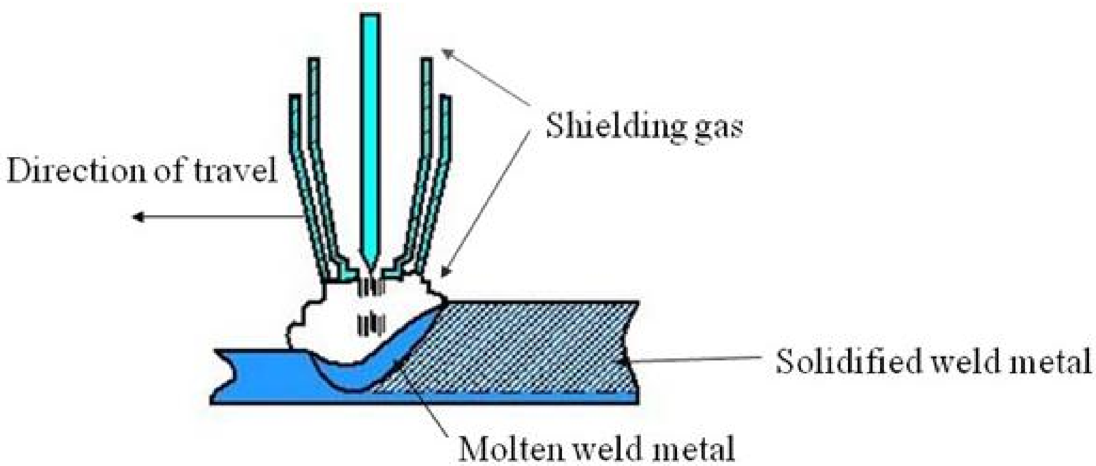

Figure M6.1.3: Plasma Arc Welding (PAW)

Plasma Arc Welding (PAW)

This process is similar to TIG. A non-consumable electrode is used in this process. Arc plasma is a temporary state of gas. The gas gets ionized after the passage of electric current and becomes a conductor of electricity. The plasma consists of free electrons, positive ions, and neutral particles. Plasma arc welding differs from GTAW welding in the amount of ionized gas which is greatly increased in plasma arc welding, and it is this ionized gas that provides the heat of welding. This process has been illustrated in Figure M6.1.3.

Oxyfuel Gas Welding (OFW)

This process is also known as oxy-acetylene welding. Heat is supplied by the combustion of acetylene in a stream of oxygen. Both gases are supplied to the torch through flexible hoses. Heat from this torch is lower and far less concentrated than that from an electric arc.

Resistance welding

Resistance welding is a group of welding process in which coalescence is produced by the heat obtained from the resistance of the work to the flow of electric current in a circuit of which the work is a part and by the application of pressure. No filler metal is needed in this process.

Electron-Beam Welding (EBW)

Electron beam welding is defined as a fusion welding process wherein coalescence is produced by the heat obtained from a concentrated beam of high velocity electron. When high velocity electrons strike the workpiece, kinetic energy is transformed into thermal energy causing localized heating and melting of the weld metal. The electron beam generation takes place in a vacuum, and the process works best when the entire operation and the workpiece are also in a high vacuum of 10^{-4}torr or lower. However, radiations namely-ray, infrared and ultraviolet radiation generates and the welding operator must be protected.

Laser Beam Welding (LBW)

Laser beam welding is defined as a fusion welding process and coalescence is achieved by utilizing the heat obtained from a concentrated coherent light beam and impinging upon the surface to be joined. This process uses the energy in an extremely concentrated beam of coherent, mono-chromatic light to melt the weld metal. This process is illustrated in Figure M6.1.4.

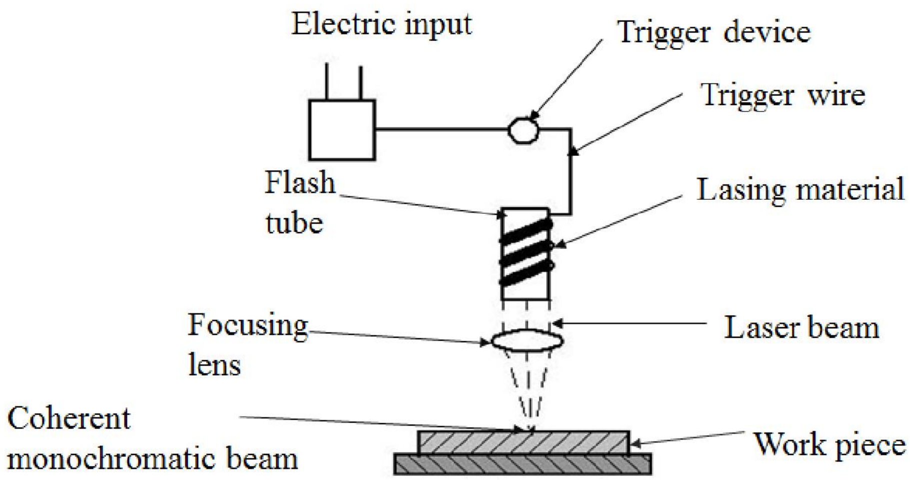

Figure M6.1.4: Laser-beam welding.

Friction Welding (FRW)

In friction welding (solid state welding process) coalescence is produced by utilizing the heat obtained from the mechanically induced rotating motion between the rubbing surfaces. When the temperature at the interface of the two parts is sufficiently high, the rotation is stopped and increased axial force is applied. This fuses the two parts together. The rotational force is provided through a strong motor or a flywheel. In the latter case the process may be called inertia welding.

Other Welding Processes

Other processes used in the industry are following:

1. Diffusion bonding (DB): Parts are pressed together at an elevated temperature below the melting point for a period of time.

2. Explosion welding (EXW): The parts to be welded are driven together at an angle by means of an explosive charge and fuse together from the friction of the impact.

3. Ultrasonic welding (USW) for metals: This process utilizes transverse oscillation of one part against the other to develop sufficient frictional heat for fusion to occur.

4. Electro slag (ESW) and Electro gas (EGW) processes: In these processes a molten pool of weld metal contained by copper "shoes" is used to make vertical butt welds in heavy plate.