Unit Five: Welding Technology

1. Introduction

Welding is a process for joining two similar or dissimilar metals by fusion. It joins different metals/alloys, with or without the application of pressure and with or without the use of filler metal.

Weldability may be defined as property of a metal which indicates the ease with which it can be welded with other similar or dissimilar metals.

2. Welding joints

Some common welding joints are shown in Fig. 17.3. Welding joints are of generally of two major kinds namely lap joint and butt joint.

2.1. Lap weld joint

1. **Single-Lap Joint:** This joint, made by overlapping the edges of the plate, is not recommended for most work. The single lap has very little resistance to bending.
2. **Double-Lap Joint:** This is stronger than the single-lap joint but has the disadvantage that it requires twice as much welding.

2.2. Butt weld joint

1. **Single-Vee Butt Weld:** It is used for plates up to 15.8 mm thick. The angle of the vee depends upon the technique being used, the plates being spaced approximately 3.2 mm.
2. **Double-Vee Butt Weld** It is used for plates over 13 mm thick when the welding can be performed on both sides of the plate. The top vee angle is either 60° or 80°, while the bottom angle is 80°, depending on the technique being used.

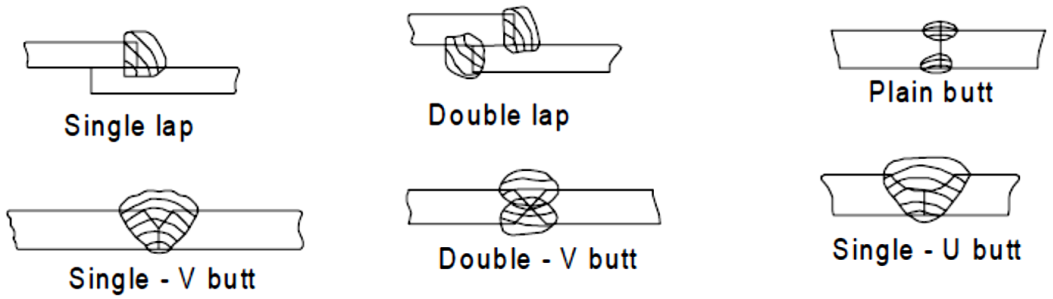

Fig. 4.1 lap and butt-welding joints

3. Welding Positions

There are four types of welding positions, which are given as:

1. Flat or down hand position
2. Horizontal position
3. Vertical position
4. Overhead position

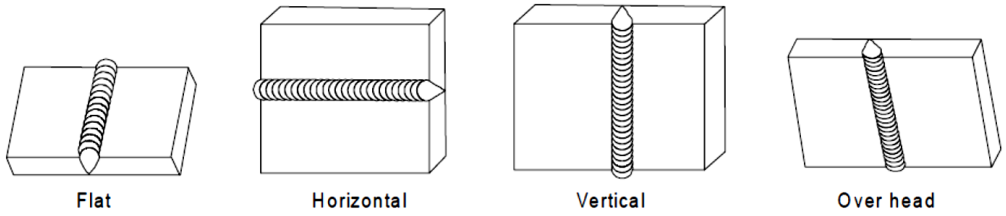

Fig. 4.2 Kinds of welding positions

4. CLASSIFICATION OF WELDING PROCESSES

1. Oxy-Fuel Gas Welding Processes
    a. Air-acetylene welding
    b. Oxy-acetylene welding
2. Arc Welding Processes
    a. Shielded Metal Arc Welding
    b. Gas Metal Arc Welding
    c. Gas Tungsten Arc Welding
    d. Submerged Arc Welding
    e. Plasma Arc Welding
3. Resistance Welding
    a. Spot Welding
    b. Seam Welding
4. Solid-State Welding Processes
    a. Forge Welding
    b. Friction Welding
    c. Explosive Welding
5. Thermit Welding Processes
6. Radiant Energy Welding Processes
    a. Laser Welding
    b. Electron Beam Welding

4.1. Oxy-Acetylene Welding

In this process, acetylene is mixed with oxygen in correct proportions in the welding torch and ignited. The flame resulting at the tip of the torch is sufficiently hot to melt and join the parent metal. The oxy-acetylene flame reaches a temperature of about 3300°C and thus can melt most of the ferrous and non-ferrous metals in common use. A filler metal rod or welding rod is generally added to the molten metal pool to build up the seam slightly for greater strength.

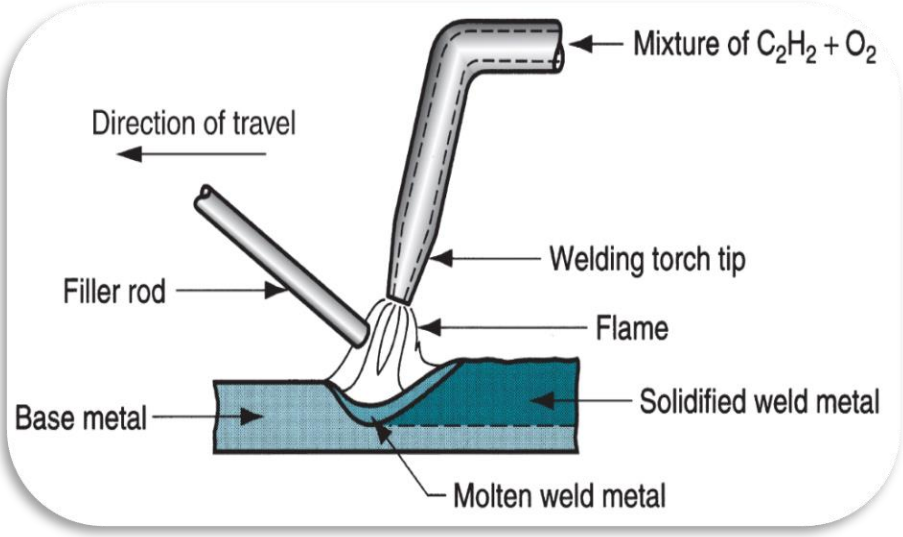

Fig. 4.3 Gas welding operation

4.2. Arc Welding Processes

4.2.1. Shielded Metal Arc Welding (SMAW)

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 between a flux coated electrode and the workpiece. The flux coating of electrode decomposes due to arc heat and serves many functions, like weld metal protection, arc stability etc. Inner core of the electrode supplies the filler material for making a weld. SMAW can be carried out in any position with highest weld quality and is the simplest of all the arc welding processes.

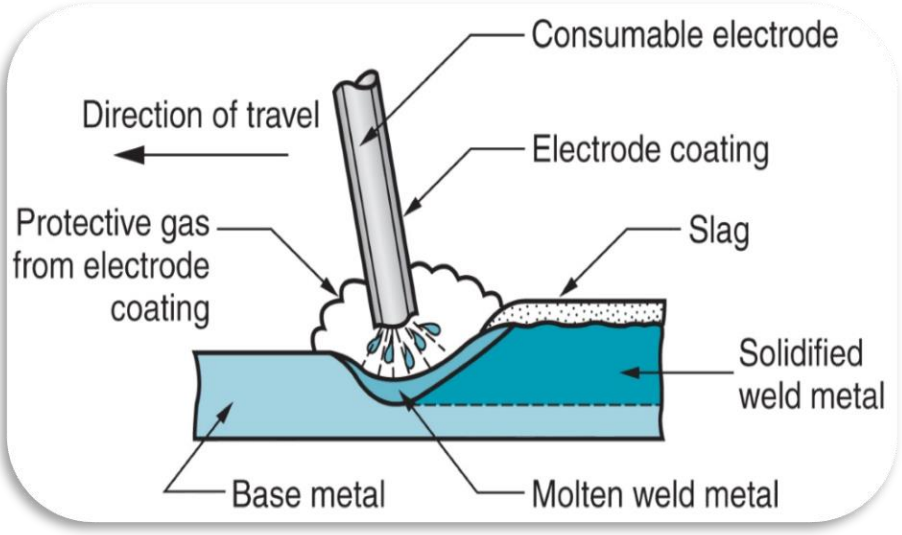

Fig. 4.4 Schematic SMAW Process

4.2.2. Gas Metal ARC Welding (GMAW) or Metal Inert Gas Welding (MIG)

Metal inert gas arc welding (MIG) or more appropriately called as gas metal arc welding (GMAW) utilizes a consumable electrode. The typical setup for GMAW or MIG welding process is shown in Fig. 4.5. The consumable electrode is in the form of a wire reel which is fed at a constant rate, through the feed rollers. The welding torch is connected to the gas supply cylinder which provides the necessary inert gas. The electrode and the work-piece are connected to the welding power supply. The power supplies are always of the constant voltage type only.

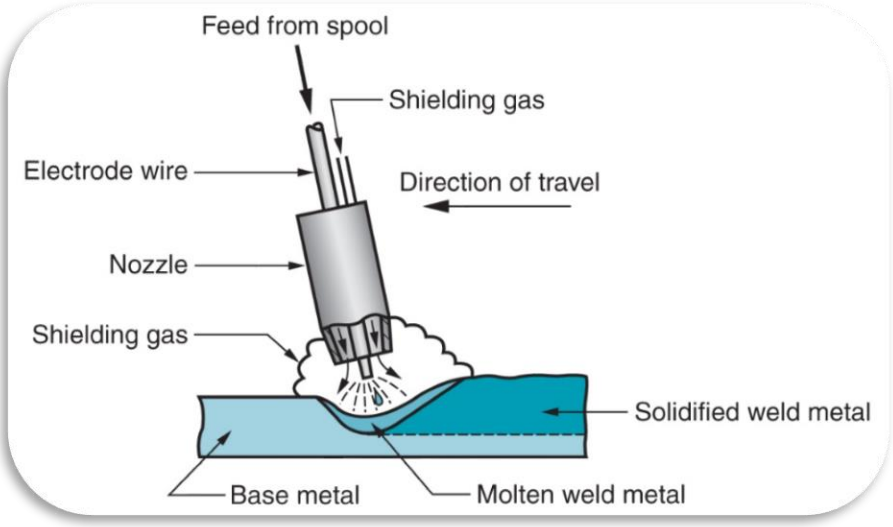

Fig. 4.5 Gas metal arc welding (GMAW) set up

4.2.3. Tungusten Inert Gas Welding (TIG)

In this process a non-consumable tungsten electrode is used with an envelope of inert shielding gas around it. The shielding gas protects the tungsten electrode and the molten metal weld pool from the atmospheric contamination. The shielding gases generally used are argon, helium, or their mixtures. Typical tungsten inert gas welding setup is shown in Fig. 5.5.

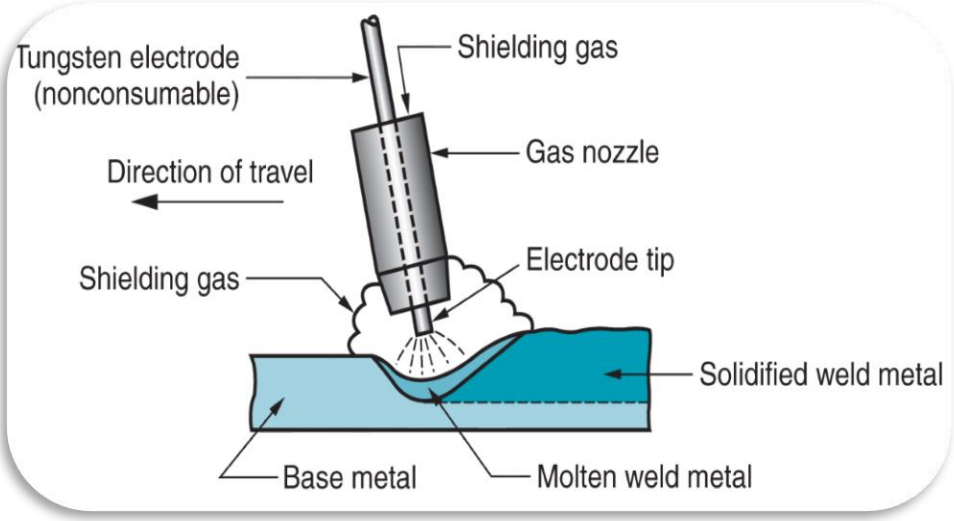

Fig. 5.5 Tungsten inert gas welding setup

4.2.4. Submerged Arc Welding

Schematic submerged arc welding process is shown in Fig. 5.6. In this welding process, a consumable bare electrode is used in combination with a flux feeder tube. The arc, end of the bare electrode and molten pool remain completely submerged under blanket of granular flux. The feed of electrode and tube is automatic, and the welding is homogenous in structure. No pressure is applied for welding purposes. This process is used for welding low carbon steel, bronze, nickel, and other non-ferrous materials.

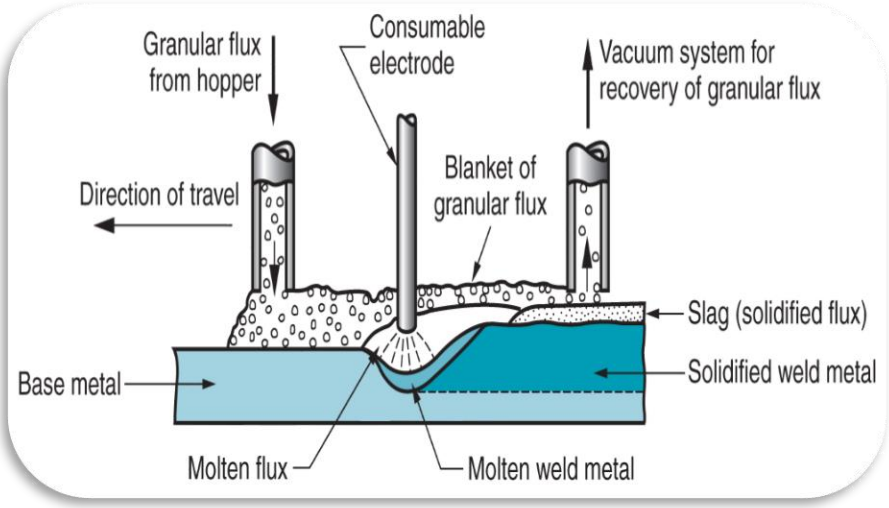

Fig. 5.6 Schematic submerged arc welding process

4.3.RESISTANCE WELDING

In resistance welding the metal parts to be joined are heated by their resistance to the flow of an electrical current. The process applies to practically all metals and most combinations of pure metals and those alloys, which have only a limited plastic range, are welded by heating the parts to fusion (melting).

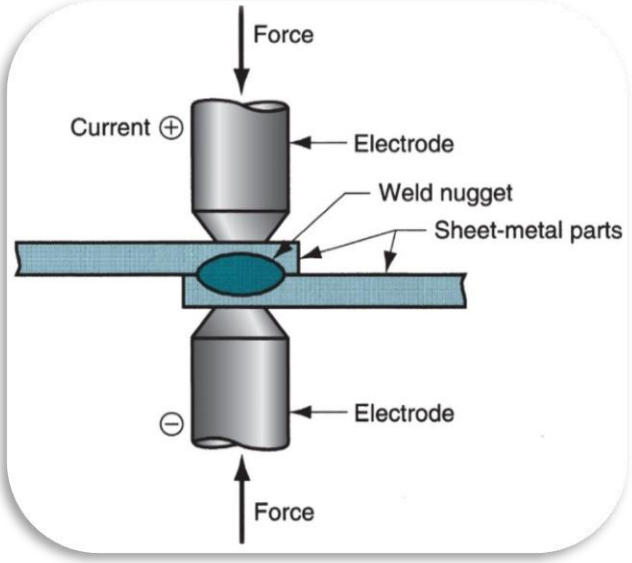

Fig. 5.7 Resistance spot welding machine

4.4.SOLID STATE WELDING PROCESSES

4.4.1. Friction Welding

In this process, the heat for welding is obtained from mechanically induced sliding motion between rubbing surfaces of workpieces as shown in Fig. 5.8. In friction welding, one part is firmly held while the other (usually cylindrical) is rotated under simultaneous application of axial pressure. As these parts are brought to rub against each other under pressure, they get heated due to friction. When the desired forging temperature is attained, the rotation is stopped, and the axial pressure is increased to obtain forging action and hence welded joint. Most of the metals and their dissimilar combinations such as aluminum and titanium, copper and steel, aluminum and steel etc. can be welded using friction welding.

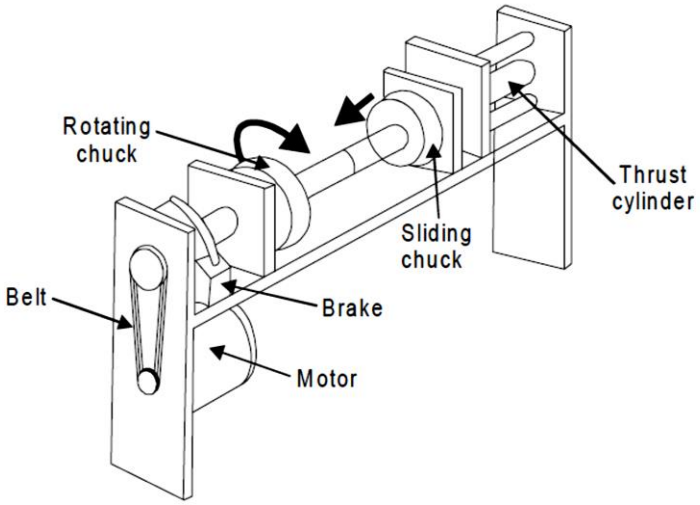

Fig. 5.8 Friction welding process

YouTube: https://youtu.be/IGgIgb6qDR0