WELDING

Introduction

Welding, in engineering, any process in which two or more pieces of metal are joined together by the application of heat, pressure, or a combination of both. Most of the processes may be grouped into two main categories: pressure welding, in which the weld is achieved by pressure; and heat welding, in which the weld is achieved by heat. Heat welding is the most common welding process used today. Brazing and soldering are other means of joining metals.

With the development of new techniques during the first half of the 20th century, welding replaced bolting and riveting in the construction of many types of structures, including bridges, buildings, and ships. It is also a basic process in the motor and aircraft industries and in the manufacture of machinery. Along with soldering and brazing, it is essential in the production of virtually every manufactured product involving metals.

The welding process best suited to joining two pieces of metal depends on the physical properties of the metals, the specific use to which they are applied, and the production facilities available. Welding processes are generally classified according to the sources of heat and pressure used.

The original pressure process was forge welding. Forge welding was practiced for centuries by blacksmiths and other artisans. The metals are brought to a suitable temperature in a furnace, and the weld is achieved by hammering or other mechanical pressure. Forge welding is used rarely in modern manufacturing.

The welding processes most commonly employed today include gas welding, arc welding, and resistance welding. Other joining processes include Thermit welding, laser welding, and electron-beam welding.

Gas Welding

Gas welding is a nonpressure process using heat from a gas flame. The flame is applied directly to the metal edges to be joined and simultaneously to a filler metal in wire or rod form, called the welding rod, which is melted to the joint. Gas welding has the advantage of involving equipment that is portable and does not require an electric power source. The surfaces to be welded and the welding rod are coated with flux, a fusible material that shields the material from air, which would result in a defective weld.

Arc Welding

Arc-welding processes, which have become the most important welding processes, particularly for joining steels, require a continuous supply of either direct or alternating electrical current. This current is used to create an electric arc, which generates enough heat to melt metal and create a weld.

Arc welding has several advantages over other welding methods. Arc welding is faster because of its high heat concentration, which also tends to reduce distortion in the weld. The most widely used arc-welding processes are shielded metal arc, gas-tungsten arc, gas-metal arc, and submerged arc.

Shielded Metal Arc

In shielded metal-arc welding, a metallic electrode, which conducts electricity, is coated with flux and connected to a source of electric current. The metal to be welded is connected to the other end of the same source of current. By touching the tip of the electrode to the metal and then drawing it away, an electric arc is formed. The intense heat of the arc melts both parts to be welded and the point of the metal electrode, which supplies filler metal for the weld. This process, developed in the early 20th century, is used primarily for welding steels.

Gas-Tungsten Arc

In gas-tungsten arc welding, a tungsten electrode is used in place of the metal electrode used in shielded metal-arc welding. A chemically inert gas, such as argon, helium, or hydrogen, is used to shield the metal from oxidation. The heat from the arc formed between the electrode and the metal melts the edges of the metal. Metal for the weld may be added by placing a bare wire in the arc or the point of the weld. This process can be used with nearly all metals and produces a high-quality weld. However, the rate of welding is considerably slower than in other processes.

Gas-Metal Arc

In gas-metal welding, a bare electrode is shielded from the air by surrounding it with argon or carbon dioxide gas or by coating the electrode with flux. The electrode is fed into the electric arc, and melts off in droplets to enter the liquid metal that forms the weld. Most common metals can be joined by this process.

Submerged Arc

Submerged-arc welding is similar to gas-metal arc welding, but in this process no gas is used to shield the weld. Instead, the arc and tip of the wire are submerged beneath a layer of granular, fusible material formulated to produce a proper weld. This process is very efficient but is generally only used with steels.

Resistance And Thermit Welding

In resistance welding, heat is obtained from the resistance of metal to the flow of an electric current. Electrodes are clamped on each side of the parts to be welded, the parts are subjected to great pressure, and a heavy current is applied briefly. The point where the two metals meet creates resistance to the flow of current. This resistance causes heat, which melts the metals and creates the weld. Resistance welding is extensively employed in many fields of sheet metal or wire manufacturing and is particularly adaptable to repetitive welds made by automatic or semi-automatic machines.

In Thermit welding, heat is generated by the chemical reaction that results when a mixture of aluminium powder and iron oxide, known as Thermit, is ignited. The aluminium unites with the oxygen and generates heat, releasing liquid steel from the iron. The liquid steel serves as filler metal for the weld. Thermit welding is employed chiefly in welding breaks or seams in heavy iron and steel sections. It is also used in the welding of rail for rail tracks.

New Processes

The use of electron beams and lasers for welding has grown during the second half of the 20th century. These methods produce high-quality welded products at a rapid rate. Laser welding and electron-beam welding have valuable applications in the motor and aerospace industries.