

WELDING PROCESS

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Abstract:

The term joining is generally used for welding, brazing, soldering, and adhesive bonding, which form a permanent joint between the parts—a joint that cannot easily be separated. The term assembly usually refers to mechanical methods of fastening parts together. Some of these methods allow for easy disassembly, while others do not. We begin our coverage of the joining and assembly processes with welding. *Welding* is a materials joining process in which two or more parts are coalesced at their contacting surfaces by a suitable application of heat and/or pressure. Many welding processes are accomplished by heat alone, with no pressure applied; others by a combination of heat and pressure; and still others by pressure alone, with no external heat supplied. In some welding processes a filler material is added to facilitate coalescence. The assemblage of parts that are joined by welding is called a weldment.

Key Words: welding, materials, accuracy, quality.

1. INTRODUCTION

Welding is most commonly associated with metal parts, but the process is also used for joining plastics. Our discussion of welding will focus on metals. Welding is a relatively new process (Historical Note 29.1). Its commercial and technological importance derives from the following: 1- Welding provides a permanent joint. The welded parts become a single entity. 2- The welded joint can be stronger than the parent materials if a filler metal is used that has strength properties superior to those of the parents, and if proper welding techniques are used. 3- Welding is usually the most economical way to join components in terms of material usage and fabrication costs. Alternative mechanical methods of assembly require more complex shape alterations (e.g., drilling of holes) and addition of fasteners (e.g., rivets or bolts). The resulting mechanical assembly is usually heavier than a corresponding weldment. 4- Welding is not restricted to the factory environment. It can be accomplished “in the field.” Although welding has the advantages indicated above, it also has certain limitations and drawbacks (or potential drawbacks): 1- Most welding operations are performed manually and are expensive in terms of labor cost. Many welding operations are considered “skilled trades,” and the labor to perform these operations may be scarce. 2- Most welding processes are inherently dangerous because they involve the use of high energy. 3- Since welding accomplishes a permanent bond between the components, it does not allow for convenient disassembly. If the product must occasionally be disassembled (e.g., for repair or maintenance), then welding should not be used as the assembly method. 4- The welded joint can suffer from certain quality defects that are difficult to detect. The defects can reduce the strength of the joint.

9.1 OVERVIEW OF WELDING

TECNOLOGY Welding involves localized coalescence or joining together of two metallic parts at their faying surfaces. The faying surfaces are the part surfaces in contact or close proximity that are to be joined. Welding is usually performed on parts made of the same metal, but some welding operations can be use to join dissimilar metals.

2. TYPES OF WELDING PROCESSES

Some 50 different types of welding operations have been cataloged by the American Welding Society. They use various types or combinations of energy to provide the required power. We can divide the welding processes into two major groups: (1) fusion welding and (2) solid-state welding

2.1-Fusion Welding

Fusion-welding processes use heat to melt the base metals. In many fusion welding operations, a filler metal is added to the molten pool to facilitate the process and provide bulk and strength to the 2 Welded joint. A fusion-welding operation in which no filler metal is added is referred to as an autogenous weld. The fusion category includes the most widely used welding processes, which can be organized into the following general groups (initials in parentheses are designations of the American Welding Society).

2.2 Arc welding (AW):

Arc welding refers to a group of welding processes in which heating of the metals is accomplished by an electric arc, as shown in **Figure 1**. Some arc welding operations also apply pressure during the process and most utilize a filler metal. **Resistance welding (RW)**. Resistance welding achieves coalescence using heat from electrical resistance to the flow of a current passing between the faying surfaces of two parts held together under pressure. included spot welding and seam welding, two joining methods widely used today in sheet metal working.

2.3 Oxyfuel gas welding (OFW)

These joining processes use an oxyfuel gas, such as a mixture of oxygen and acetylene, to produce a hot flame for melting the base metal and filler metal, if one is used. Although Davy discovered acetylene gas early in the 1800s, oxyfuel gas welding required the subsequent development of torches for combining acetylene and oxygen around 1900. During the 1890s, hydrogen and natural gas were mixed with oxygen for welding, but the oxyacetylene flame achieved significantly higher temperatures. These three welding processes—arc welding, resistance welding, and oxyfuel gas welding—constitute by far the majority of welding operations performed today.

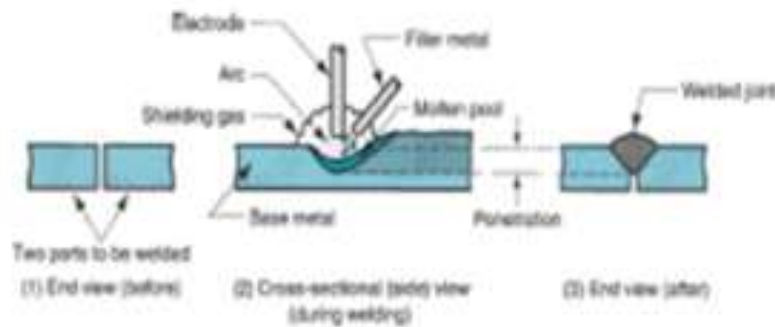


Fig.1.Basics

Figure 1 Basics of arc welding: (1) before the weld; (2) during the weld (the base metal is melted and filler metal is added to the molten pool); and (3) the completed weldment. There are many variations of the arc-welding process. Other fusion-welding processes. Other welding processes that produce fusion of the metals joined include electron beam welding and laser beam welding. Certain arc and oxyfuel processes are also used for cutting metals.

2.4. Solid-State Welding :

Solid-state welding refers to joining processes in which coalescence results from application of pressure alone or a combination of heat and pressure. If heat is used, the temperature in the process is below the melting point of the metals being welded. No filler metal is utilized. Representative welding processes in this group include: Diffusion welding (DFW). Two surfaces are held together under pressure at an elevated temperature and the parts coalesce by solid-state diffusion. Friction welding (FRW). Coalescence is achieved by the heat of friction between two surfaces.

2.5. Ultrasonic welding (USW):

Moderate pressure is applied between the two parts and an oscillating motion at ultrasonic frequencies is used in a direction parallel to the contacting surfaces. The combination of normal and vibratory forces results in shear stresses that remove surface films and achieve atomic bonding of the surfaces.

3. WELDING AS A COMMERCIAL OPERATION

The principal applications of welding are (1) construction, such as buildings and bridges; (2) piping, pressure vessels, boilers, and storage tanks; (3) shipbuilding; (4) aircraft and aerospace; and (5) automotive and railroad . Welding is performed in a variety of locations and in a variety of industries. Owing to its versatility as an assembly technique for commercial products, many welding operations are performed in factories. However, several of the traditional processes, such as arc welding and oxyfuel gas welding, use equipment that can be readily moved, so these operations are not limited to the factory. They can be performed at construction sites, in shipyards, at customers' plants, and in automotive repair shops. Most welding operations are labor intensive. For example, arc welding is usually performed by a skilled worker, **called a welder**, who manually controls the path or placement of the weld to join individual parts into a larger unit. In factory

operations in which arc welding is manually performed, the welder often works with a second worker, called a *fitter*. It is the fitter's job to arrange the individual components for the welder prior to making the weld. Welding fixtures and positioners are used for this purpose. **A welding fixture** is a device for clamping and holding the components in fixed position for welding. It is custom fabricated for the particular geometry of the weldment and therefore must be economically justified on the basis of the quantities of assemblies to be produced.

A welding positioner is a device that holds the parts and also moves the assemblage to the desired position for welding. This differs from a welding fixture that only holds the parts in a single fixed position. The desired position is usually one in which the weld path is flat and horizontal. The Safety Issue Welding is inherently dangerous to human workers. Strict safety precautions must be practiced by those who perform these operations. The high temperatures of the molten metals in welding are an obvious danger. In gas welding, the fuels (e.g., acetylene) are a fire hazard. Most of the processes use high energy to cause melting of the part surfaces to be joined. In many welding processes, electrical power is the source of thermal energy, so there is the hazard of electrical shock to the worker. Certain welding processes have their own particular perils. In arc welding, for example, ultraviolet radiation is emitted that is injurious to human vision. A special helmet that includes a dark viewing window must be worn by the welder. This window filters out the dangerous radiation but is so dark that it renders the welder virtually blind, except when the arc is struck. Sparks, spatters of molten metal, smoke, and fumes add to the risks associated with welding operations. Ventilation facilities must be used to exhaust the dangerous fumes generated by some of the fluxes and molten metals used in welding. If the operation is performed in an enclosed area, special ventilation suits or hoods are required. Automation in Welding Because of the hazards of manual welding, and in efforts to increase productivity and improve product quality, various forms of mechanization and automation have been developed. The categories include machine welding, **automatic welding, and robotic welding**. Machine welding can be defined as mechanized welding with equipment that performs the operation under the continuous supervision of an operator. It is normally accomplished by a welding head that is moved by mechanical means relative to a stationary work, or by moving the work relative to a stationary welding head. The human worker must continually observe and interact with the equipment to control the operation. If the equipment is capable of performing the operation without control by a human operator, it is referred to as automatic welding. A human worker is usually present to oversee the process and detect variations from normal conditions. What distinguishes automatic welding from machine welding is a weld cycle controller to regulate the arc movement and work piece positioning without continuous human attention. Automatic welding requires a welding fixture and/or positioner to position the work relative to the welding head. It also requires a higher degree of consistency and accuracy in the component parts used in the weldment. For these reasons, automatic welding can be justified only for large quantity production. A typical robotic arc welding cell consists of two welding fixtures and a human fitter to load and unload parts while the robot welds. In addition to arc welding, industrial robots are also used in automobile final assembly plants to perform resistance welding on car bodies.

29.2 THE WELD JOINT

Welding produces a solid

connection between two pieces, called a weld joint. **A weld joint** is the junction of the edges or surfaces of parts that have been joined by welding. This section covers two classifications related to weld joints: (1) types of joints and (2) the types of welds used to join the pieces that form the joints.

4. TYPES OF JOINTS

There are five basic types of joints for bringing two parts together for joining. The five joint types are not limited to welding; they apply to other joining and fastening techniques as well. With reference to **Figure 2**, the five joint types can be defined as follows: **(a) Butt joint**. In this joint type, the parts lie in the same plane and are joined at their edges. **(b) Corner joint**. The parts in a corner joint form a right angle and are joined at the corner of the angle. **(c) Lap joint**.

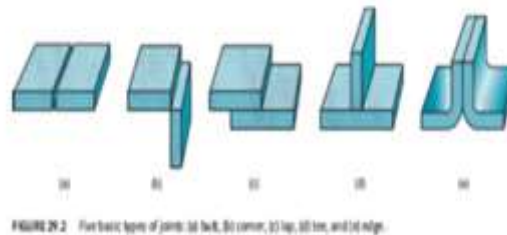


Fig.2. Types of joints

This joint consists of two overlapping parts. **(d) Tee joint**. In a tee joint, one part is perpendicular to the other in the approximate shape of the letter “T.” **(e) Edge joint**. The parts in an edge joint are parallel with at least one of their edges in common, and the joint is made at the common edge(s).

5. TYPES OF WELDS

Each of the preceding joints can be made by welding. It is appropriate to distinguish between the joint type and the way in which it is welded—the weld type. Differences among weld types are in geometry (joint type) and welding process. **A fillet weld** is used to fill in the edges of plates created by corner, lap, and tee joints, as in **Figure 3**.

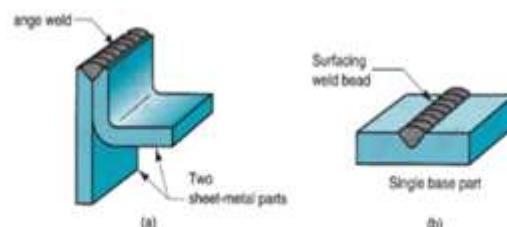


Fig.3.Types of weld

Filler metal is used to provide a cross section approximately the shape of a right triangle. It is the most common weld type in arc and oxyfuel welding because it requires minimum edge preparation—the basic square edges of the parts are used. Fillet welds can be single or double (i.e., welded on one side or both) and can be continuous or intermittent (i.e., welded along the entire length of the joint or with unwelded spaces along the length). Groove welds usually require that the edges of the parts be shaped into a groove to facilitate weld penetration. The grooved shapes include square, bevel, V, U, and J, in **Figure 2** Five basic types of joints: (a) butt,

(b) corner, (c) lap, (d) tee, and (e) edge. **Figure 3** Various forms of fillet welds: (a) inside single fillet corner joint; (b) outside single fillet corner joint; (c) double fillet lap joint; and (d) double fillet tee joint. Dashed lines show the original part edges. Single or double sides, as shown in **Figure 4**. Filler metal is used to fill in the joint, usually by arc or oxyfuel welding. Preparation of the part edges beyond the basic square edge, although requiring additional processing, is often done to increase the strength of the welded joint or where thicker parts are to be welded. Although most closely associated with a butt joint, groove welds are used on all joint types except lap. Plug welds and slot welds are used for attaching flat plates, as shown in **Figure 5**, using one or more holes or slots in the top part and then filling with filler metal to fuse the two parts together. Spot welds and seam welds, used for lap joints, are diagrammed in **Figure 6**. A spot weld is a small fused section between the surfaces of two sheets or plates. Multiple spot welds are typically required to join the parts. It is most closely associated with resistance welding. A seam weld is similar to a spot weld except it consists of a more or less continuously fused section between the two sheets or plates.

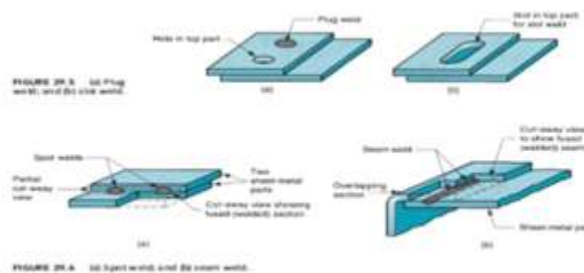


Fig.4.Types of joints

There are two heat transfer mechanisms at work, both of which reduce the amount of generated heat that is used by the welding process. The situation is depicted in **Figure 8**. The first mechanism involves the transfer of heat between the heat source and the surface of the work. This process has a certain heat transfer factor f_1 , defined as the ratio of the actual heat received by the workpiece divided by the total heat generated at the source. The second mechanism involves the conduction of heat away from the weld area to be dissipated throughout the work metal, so that only a portion of the heat transferred to the surface is available for melting. This melting factor f_2 is the proportion of heat received at the work surface that can be used for melting. The combined effect of these two factors is to reduce the heat energy available for welding as follows: $H_w = f_1 f_2 H$ (3) where H_w = net heat available for welding, J (Btu), f_1 = heat transfer factor, f_2 = the melting factor, and H = the total heat generated by the welding process, J (Btu). The factors f_1 and f_2 range in value between zero and one. It is appropriate to separate f_1 and f_2 in concept, even though they act in concert during the welding process. The heat transfer factor f_1 is determined largely by the welding process and the capacity to convert the power source (e.g., electrical energy) into usable heat at the work surface. Arc-welding processes are relatively efficient in this regard, while oxyfuel gas-welding processes are relatively inefficient. The melting factor f_2 depends on the welding process, but it is also influenced by the thermal properties of the metal, joint configuration, and work thickness. Metals with high thermal conductivity, such as aluminum and copper, present a problem in welding because of the rapid dissipation of heat away from the heat contact area. The problem is exacerbated by welding heat sources with low energy densities (e.g., oxyfuel welding) because the heat input is spread over a larger area, thus facilitating conduction into the work. In general, a high power density combined with a low conductivity work material results in a high melting factor.

CONCLUSION

Let me conclude that, The fusion zone consists of a mixture of filler metal and base metal that have completely melted. This zone is characterized by a high degree of homogeneity among the component metals that have been melted during welding. The mixing of these components is motivated largely by convection in the molten weld pool. Solidification in the fusion zone has similarities to a casting process. In 8 significant difference between solidification in casting and in welding is that epitaxial grain growth occurs in welding. The reader may recall that in casting, the metallic grains are formed from the melt by nucleation of solid particles at the mold wall, followed by grain growth. In welding, by contrast, the nucleation stage of solidification is avoided by the mechanism of epitaxial grain growth, in which atoms from the molten pool solidify on preexisting lattice sites of the adjacent solid base metal. composition is therefore identical to that of the base metal. The third zone in the typical fusion weld is **the heat-affected zone (HAZ)**. The metal in this zone has experienced temperatures that are below its melting point, yet high enough to cause microstructural changes in the solid metal. The chemical composition in the heat-affected zone is the same as the base metal, but this region has been heat treated due to the welding temperatures so that its properties and structure have been altered. The amount of metallurgical damage in the HAZ depends on factors such as the amount of heat input and peak temperatures reached, distance from the fusion zone, length of time the metal has been subjected to the high temperatures, cooling rate, and the metal's thermal properties. The effect on mechanical properties in the heat-affected zone is usually negative, and it is in this region of the weld joint that welding failures often occur. As the distance from the fusion zone increases, the **unaffected base metal zone** is finally reached, in which no metallurgical change has occurred. Nevertheless, the base metal surrounding the HAZ is likely to be in a state of high residual stress, the result of shrinkage in the fusion zone.

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Biography:

Author Was Born In Omakuppam Village, Tamilnadu In India, In 1996. He Is Interested In Material Science And Engineering. He Was Participated In The State Level Historical Essay Competition-2007-08.Now ,He Is Studying Mechanical Engineering At Kingston Engineering College. He Was Member In Sae India In 2014-16.Also He Is Member In Indian Welding Society And International Association Of Engineers. Also He Is A Marathon Player. Then He Was Participated Many National Level Symposium And He Got First And Second Place At P.S.V College Of Engineering And Technology And Pallavan College Of Engineering In 2016.