International Journal of Innovative Research in Computer Science & Technology (IJIRCST)
ISSN: 2347-5552, Volume-10, Special Issue-4, April-2022
Young Researchers' Conference on Indian Literatures, 2022
Organized by Presidency University, Bangalore, India

A Brief Introduction about Welding Process

Mr. Medikeranahalli Santhosh
Assistant Professor, Department of Civil Engineering, Presidency University, Bangalore, India,
Email Id-santhoshmb@presidencyuniversity.in

ABSTRACT:
A common connecting method used in all sectors to permanently fuse materials is welding. The concepts, techniques, and applications of the welding process are briefly covered in this chapter. The main goal of welding is to join two or more materialsusually metals or thermoplasticsin a way that is sturdy and long-lasting. It entails melting the basic components or adding a filler to produce a molten pool, which cools and solidifies to form a junction. There are many different welding techniques used, including arc welding, gas welding, resistance welding, and laser welding, each having its distinct properties and applicability for different purposes. Preparation, assembly, choice of welding technique, application of heat source, and post-welding processes including inspection and testing are all crucial aspects of the welding process. The right joint design, the right choice of welding settings, clean and aligned surfaces, and precise preparation are all necessary for successful welding. Numerous sectors, including construction, automotive, aerospace, shipbuilding, manufacturing, and infrastructure development, find widespread use for welding. It is utilized for the construction, upkeep, and repair of various structures and parts, from complex industrial gear to sensitive electronic equipment. The ability to combine materials quickly and affordably using welding allows for the construction of intricate and durable systems.

KEYWORDS:

Acetylene, Arc, Electrode, Gas, Metal, Oxygen, Pressure, Welding.

I. INTRODUCTION

A fundamental technique for fusing two or more pieces of metal is welding. This procedure is crucial in the production of a wide range of goods, including vehicles, structures, bridges, and ships as well as electrical devices and medical equipment. In the current world, welding is essential because it makes it possible to create intricate structures and assemblies that are otherwise not possible. By applying heat, metal parts are melted and fused during the welding process. Arc welding, gas welding, resistance welding, and laser welding, among other techniques, can all be used to accomplish this. The technique will vary depending on the application, the thickness of the metal, and the type of metal being welded [1], [2].

The adaptability of welding is one of its main benefits. A variety of metals, including steel, aluminum, copper, brass, and titanium, can be joined by welding. Additionally, metals of various thicknesses and forms can be joined via welding. This makes welding an essential procedure in a variety of sectors, such as manufacturing, aerospace, and construction. Both manual and automated welding techniques are viable options. An experienced operator manipulates the welding torch or electrode to produce the desired weld when manual welding is being done. On the other hand, automated welding is carried out by robotic devices that are programmed to weld particular product components. To increase productivity and uniformity in high-volume production settings, automated welding is frequently used When welding, safety is a crucial factor to take into account. If the heat and light produced by welding are not carefully regulated, they can hurt people. To shield themselves from the heat and light, welders must put on safety gear such as welding helmets, gloves, and clothing. To avoid breathing in dangerous gases, they must also make sure the workspace is adequately ventilated [3], [4].

One of the most popular types of welding is arc welding. The metal components are fused by melting them together in an electric arc. Between an electrode and the workpiece, an electric arc is produced, which produces heat and melts the metal to form the weld. The majority of metals, including steel, aluminum, and titanium, may be joined together using arc welding. On the other hand, gas welding entails melting the metal parts together with a flame. Fuel gas and oxygen are burned to produce the flame, which heats up and melts the metal. It is common practice to utilize gas welding to combine thin metals, including sheet metal. Another widely used technique for welding is resistance welding, which produces heat by employing electric resistance. In the automobile sector, this technique is frequently used to weld sheet metal and other thin materials. On the other hand, laser welding is a high-precision welding technique that melts the metal parts together using a laser beam.

The medical device and electronics industries frequently employ this technique. Finally, welding is a vital procedure in contemporary manufacturing that makes it possible to create intricate structures and components. Arc welding, gas welding, resistance welding, and laser welding are some of the techniques that can be used to melt and fuse metal parts using heat. Steel, aluminum, copper, and titanium can all be joined using the flexible joining technique of welding. Safety is a key concern during welding, which can be done manually or with the aid of automated technologies. Welding will continue to be a key component of the industrial sector for many years to come thanks to its versatility in joining metals of various forms, thicknesses, and sizes. By utilizing intense heat to melt the components together and then allowing them to cool, which results in fusion, welding is a fabrication method that unites materials, typically metals or thermoplastics. Welding is separate from lower-temperature processes that don't melt the base metal parent metal, such as brazing and soldering [5], [6].

The base metal is normally melted first, followed by the addition of filler material to create a pool of molten metal the weld pool, which cools to form a joint that, depending on the welded design butt, full penetration, fillet, etc., may be stronger than the base metal. To create a weld, pressure can either be applied alone, in combination with heat, or both. To prevent contamination or oxidation of the filler metals or molten metals during welding, a shield is also necessary. Welding can be done with a variety of energy sources, such as gas flames chemical, electric arcs electrical, lasers, electron beams, friction, and ultrasound. Welding can be done in a variety of settings, including the open air, underwater, and in space, even though it is frequently an industrial activity. Welding is a risky activity, thus safety measures must be taken to prevent burns, electric shocks, visual impairment, inhalation of toxic fumes, and exposure to strong ultraviolet radiation.

II. DISCUSSION

Gas Welding Process

The heat source in this process is the burning of acetylene gas. The oxyacetylene flame, which burns at a temperature above 3250°C and can melt most metals and alloys, is produced by the chemical interaction of acetylene and oxygen. In demand for oxyacetylene welding are two systems:

High-Pressure System

In this system, acetylene and oxygen gases are taken from cylinders that are under high pressure and are kept there.

Low-Pressure System

In this system, acetylene gas is produced on-site at low pressure while oxygen gas is still received from a cylinder as before. In a container that is sealed, water is applied to calcium carbide drop by drop to create acetylene gas. According to need, this acetylene gas is pulled for oxyacetylene welding.

Equipment Needed for Gas Welding

The apparatus for high-pressure oxyacetylene welding comprises two enormous steel cylinders. A long, narrow cylinder that is typically painted black and filled with oxygen at a high pressure of 125–140 kg/sq cm. In the other cylinder, which is shorter but slightly larger and colored maroon, at a pressure of 16–21 kg/sq cm, acetylene gas is dissolved in acetone in diameter. The D.A. cylinder should be handled carefully because acetylene is an ignitable gas and should be kept as vertical as possible. These two cylinders are both equipped with valves that are typically kept in the closed position. D.A. stands for dissolved acetylene. Each cylinder has a pressure regulator with two gauges so that gas can be drawn from it. The pressure regulator's job is to lower the gas's pressure before distributing it [7], [8].

The two gauges show both the internal cylinder pressure and the lower gas pressure following the pressure regulator stage. Rubber hose pipes are used to transport the gases from the pressure regulator to the welding torch also known as the blowpipe. To prevent confusion, the pressure regulator and hose line attached to the oxygen cylinder are black, while those connected to the acetylene cylinder are maroon. Different oxygen and acetylene gas tubes make up a welding torch. Pin valves manage the supply of these gases. Then, these two gases are let combined in a mixing chamber before being forced out through the blow pipe's opening. These varying-sized orifices can be screwed onto the blowpipe. depicts the entire assembly of the cylinders, regulator, etc. The two cylinders are often transported in a cart, which is not depicted in Figure 1. The following protective attire is worn by a gas welding operator:

- **(i)** Covers his eyes with blue goggles.
- **(ii)** Covers his person with a leather or canvas apron.
- **(iii)** Covers his hands with leather gloves.

He has a stock of flux and metal welding rods. He also has a spark lighter, a wire brush, and a chipping hammer. Opening the pin valve in the welding torch that regulates the flow of acetylene gas and using a spark lighter to burn the gas are the steps in the process of starting a flame. The burning of acetylene gas produces a lot of smoke. The desired type of flame is then obtained by opening and adjusting the oxygen supply valve.

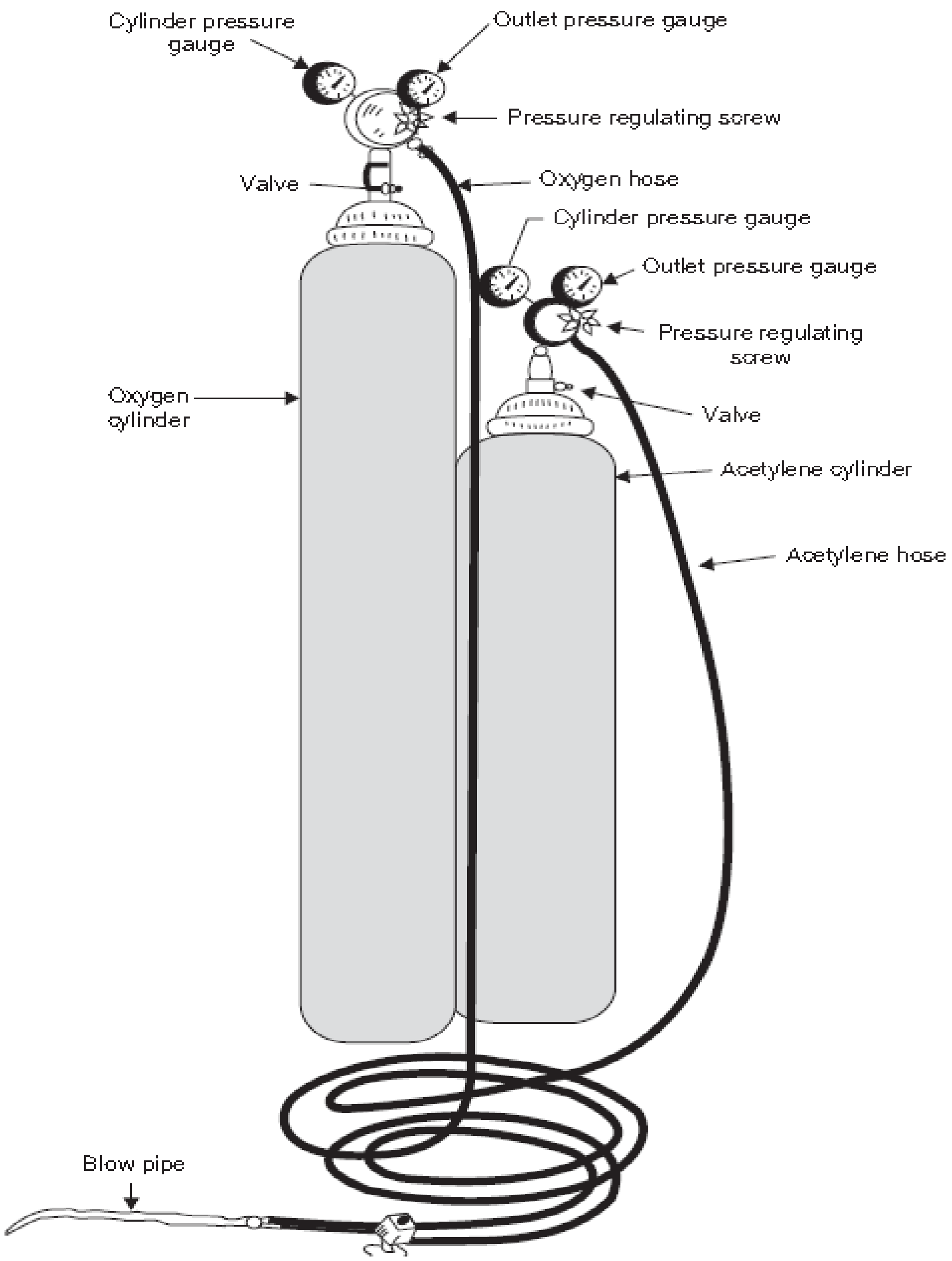

Figure 1: Represting the High-pressure welding equipment

Types of Flames

The gas welding apparatus is capable of producing three different types of oxyacetylene flames. The chemical equation 2 C_2H_2 + 5 O_2 4 CO_2 + 2 H_2O describes the reaction between acetylene gas and oxygen. One volume of acetylene requires two and a half liters of oxygen gas to burn completely. When the flame burns, one volume of oxygen is extracted from the cylinder and 112 volumes are given by the atmosphere. The flame is referred to as a neutral flame when oxygen is given in this ratio. However, if there is a lack of oxygen, the flame is known as a decreasing flame because it contains some unburned carbon. If there is an excess of air or oxygen, the flame turns into an oxidizing flame. With careful inspection, these three types of flames can be identified from one another. Figure. 2 depicts these flames.

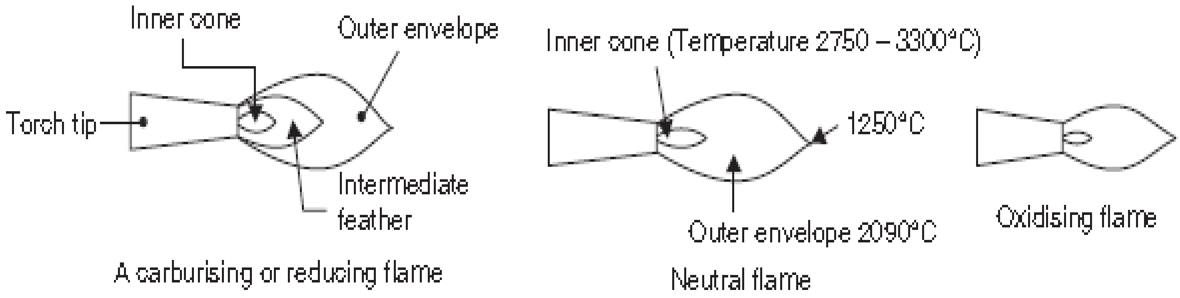

Figure 2: Represting the Types of oxyacetylene flames

Three separate zonesthe inner cone, intermediate feather, and outside envelopemake up a carburizing or reducing flame. The intermediate feather progressively vanishes as the oxygen supply rises, leaving the inner cone and the outer envelope as the only two cones. The acetylene and oxygen at this time Gases are in chemical equilibrium, and a neutral flame is present. The inner cone shortens, loses its shape, and emits a harsh hissing sound if the oxygen supply is raised further. The flame is currently oxidizing. The flame temperature in such flames is the highest. For welding all types of steel and cast iron goods, the neutral flame is employed. For welding brass, bronze, and copper goods as well as Chromium-Ni and manganese steels, a mildly oxidizing flame is used. The welding of high-carbon steel, aluminum, and nickel goods uses a light carburizing flame.

Welding Operation

Setting up the task involves cleaning the parts that will be welded and preparing the joint. The thickness of the work components determines how the joints are prepared. An edge or flange junction can be used to attach thin sheets. A lap or fillet joint may occasionally be employed. The maximum thickness of a sheet that can be welded is 4.5 mm. without any joint preparation, having a butt joint. many types of joints frequently employed in welding are depicted. Thorough joint preparation is required for sound welding of plates that are thicker than 4.5 mm. The edges of the two plates that are going to be welded together are beveled, creating a V-shaped groove between them. The borders of the two plates are not permitted to meet; instead, there is a space between them that is roughly 2-3 mm. If the plates are even thicker, a double V-joint is used in place of a single V-joint.

Use of Filler Rods and Fluxes

Every time welding is performed, additional metal may need to be added to the pool of molten metal. In gas welding, filler rods with continuously melting ends provide the excess metal. The filler rod's metal composition should, ideally, match that of the work piece's metal. During the welding process, some metals may oxidize. These metal oxides are dissolved and eliminated using flux. The most popular types of flux are borax and mixtures of fluorides and sodium, potassium, and lithium chlorides. Slag, which is lighter than the molten metal pool and is produced when the flux reacts with metallic oxides, floats on top of it. A chipping hammer and wire brush are used by the welder to remove the flux once it has solidified.

Oxyacetylene Cutting

A steel plate can also be sliced using an oxyacetylene flame. This is accomplished with a specialized cutting torch that has three passagestwo for oxygen and acetylene gas and an additional path for high-pressure oxygen. Oxy cutting, often known as flame cutting, is essentially an oxidation procedure. When it is red hot, high-pressure oxygen is allowed to impinge on the area where a cut is to be formed. The area is heated with the welding flame. Because iron oxides have a lower melting point than steel, they are easily melted. The molten iron oxides are removed by the oxygen jet, revealing more steel underneath. This, in turn, becomes oxidized, and the steel plate quickly has its thickness sliced throughout. The oxyacetylene flame is moved gradually. Any profile can be cut from the steel plate in this way. This procedure has one restriction. Either the steel plate's edge must be cut, or a pilot hole must be bored in the plate to serve as the cut's starting point.

Arc Welding

An electric arc serves as the heat source during arc welding. An electric arc can reach temperatures as high as 5500°C. If an electric circuit that is carrying current is mistakenly destroyed, a spark is created. A persistent spark produced by a gap between welding electrodes is known as an electric arc. and the project. The quality of the weld generated by an electric arc is significantly higher than that of a gas weld due to the higher heat output and less oxidation. Arc welding can be done with a power supply that is either A.C. or D.C. A transformer-style equipment is used to supply current for A.C. An open circuit voltage of roughly 75–80 V is needed for A.C. However, the current demand is very strict, and the welding equipment needs to be able to deliver 100 to 300 Amps. The +ve and -ve terminals define the characteristics of a D.C. supply. With D.C., an arc can be struck with an open circuit voltage of 70–75 volts, which is a little lower. Typically, the workpiece is linked to the +ve terminal and the electrode to the -ve terminal. D.C. straight polarity DCSP is the name given to such a configuration. In this configuration, around two-thirds of the heat is produced on the end of the workpiece and one-third on the electrode end. It is preferable to use a DC reverse polarity DCRP configuration in some situations, such as overhead welding. In this configuration, the workpiece is linked to the -ve terminal and the electrode to the +ve terminal.

Striking an Arc

The electrode must be touched to the work to shorten it and create an arc. A very large current begins to flow through the circuit at the point of contact, and the voltage lowers. Now, the electrode is gently raised to maintain a space between the electrode tip and the workpiece of 2-3 mm. The intensity of the amperage decreases while the voltage across the arc increases to roughly 15-20 volts. The metal electrode's tip begins to melt as a result of the heat produced by the arc, widening the gap. The arc will end unless the electrode is advanced slowly towards the work while maintaining a gap of 2-3 mm at the same rate as the electrode tip is melting. The machine voltage won't be able to keep the arc going if the gap widens too much.

The arc produces a lot of heat as well as bright light. The workpiece at the site of the arc is also melted, maintaining a pool of molten metal, in addition to the electrode tip. If not protected in some way, this metal will oxidize. Therefore, a layer of coating is applied to the metal electrodes over their entire length except around 35–40 mm at the stub end, where the metal core of the electrode is exposed and maintained in the electrode holder. This coating at the electrode's tip vaporizes when heated, enveloping the molten metal pool in a gaseous shield that protects it from oxidation. Flux, which forms slag when it combines with impurities, is another component of the electrode coating that aids in stabilizing the arc. Coatings come in a variety of varieties. The molten metal pool solidifies to form a joint as the electrode is progressively pushed across it. This method results in junctions that are frequently more durable than the parent metals being connected. There are several different sizes of electrodes. The diameter of the core metal wire in mm determines the electrode's size. The thickness of the components to be linked determines the size of the electrode. Thick plates must be welded using thicker electrodes. The size of the utilized electrode affects the current. Therefore, 100 to 120 Amp is the optimum value of current for electrodes with a 3.15 mm diameter.

Heat Affected Zone

A molten pool forms in the arc area as a result of the high heat output that occurs during the arc welding process. Additionally, heat is transferred into the region of the joint on both sides. Although the material's temperature on each side of the weld bead may not be as high as the metal's melting point, is quite near it. The temperature of the metal may decrease as we get farther away from the junction or weld bead. The heated metal cools as quickly as it heated as the electrode passes over the joint and goes away. We can therefore infer that heat treatment was performed on the metal near the weld bead. When welding steel, the rapid heating and cooling may cause martensitic and other structures to form, which may be more brittle and hard. Heat Affected Zone refers to the area of welding that is so impacted.

III. CONCLUSION

A crucial method for bringing materials together across several sectors is welding. Here are some important details about how the welding process ends. Welding is a universal joining technique that is used in many industries to permanently fuse materials. In this chapter, the principles, methods, and applications of the welding process are briefly discussed. The primary objective of welding is to unite two or more materialstypically metals or thermoplasticsstrongly and durably. Melting the fundamental elements or adding a filler creates a molten pool, which then cools and solidifies to create a junction. Arc welding, gas welding, resistance welding, and laser welding are just a few of the many diverse welding processes that are utilized. Each has unique qualities and uses. The welding process involves several important steps, including preparation, assembly, welding technique selection, application of heat source, and post-welding operations including testing and inspection.

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