Analysis Of Arc Welding-Gas Welding And Adhesive Joint In Mild Steel Plate

Sutharsan.M[1], Suruthi.K[2], Palanivel.G[3] , Manikandan.M[4]

[1,2,3,4] Assistant Professor, Department of Mechanical Engineering, IFET College of Engineering, Villupuram 605108 Tamil nadu, India

Abstract- *To analysis of welding properties in arc welding, gas welding and adhesive joints in mild steel plate. During the welding process many defects affects the strength of welding. The defects find by using nondestructive joints then strength of welding is finding by using destructive testing. We realize the importance of nondestructive testing as a means to control materials and fabrication to prevent failure, provide consumer safety, and to assure product reliability and quality levels. The aim of my project is reduce cost for joining the metals and reduce the defects during the metal joining process. Then increase strength in metal joining process and reduces the cost for metal joining process. Importance of adhesive joining process, components required for making adhesive bond.*

Withstand temperature of adhesive bond joining in metal plates also explain in my project. During the metal joining process in the arc welding, gas welding and adhesive joining method without defective method is finding by nondestructive testing. Then destructive test is used to find the strength of welding in the above three methods (Keywords: Arc welding, gas welding, adhesive joint)

Keywords: Display device, Load Cell, PIC, XLP Technology.

I. INTRODUCTION

A. *Purpose of Project*

The purpose of the project is to improve the quality of metal joining process. In the erection work many defects are affect metal joining places. The more time spend for find quality of welding the more materials are rejected during the welding process. In field quality engineers feel that the components will not serve the purpose for which they are built. Such number of components is rejected every year that it causes financial loss in construction work.

The aim of my project is to reduce defects in metal joining process, number of components rejected for quality non-conformance. i.e to increase the quality of metal joining.

B. *About Project*

- Mild steel plate
- Arc welding
- Gas welding
- Adhesive joining
- Nondestructive testing
- Destructive testing

C. *Mild steel plate*

Mild steel is a type of steel that only contains a small amount of carbon and other elements. It is softer and more easily shaped than higher carbon steels. It also bends a long way instead of breaking because it is ductile. It is used in nails and some types of wire, it can be used to make bottle openers, chairs, staplers, staples, railings and most common metal products. Its name comes from the fact it only has less carbon than steel

D. *Arc welding*

Arc welding is a type of welding that uses a welding power supply to create an electric arc between an electrode and the base material to melt the metals at the welding point. They can use either direct (DC) or alternating (AC) current, and consumable or non-consumable electrodes.

The welding region is usually protected by some type of shielding gas, vapor, or slag. Arc welding processes may be manual, semi-automatic, or fully automated. First developed in the early part of the 20th century, arc welding became commercially important in shipbuilding during the Second World War. Today it remains an important process for the fabrication of steel structures and vehicles.

E. *Gas welding*

Oxy-fuel welding (commonly called oxyacetylene welding, oxy welding, or gas welding in the U.S.) and oxy-fuel cutting are processes that use fuel gases and oxygen to weld and cut metals, respectively.

Oxy-fuel is one of the oldest welding processes. Still used in industry, in recent decades it has been less widely utilized in industrial applications as other specifically devised technologies have been adopted. It is still widely used for welding pipes and tubes, as well as repair work. It is also frequently well-suited, and favored, for fabricating some types of metal-based artwork.

F. Adhesive joining

Adhesives are incredibly strong and quite easy to use. Composed of two liquid components that require mixing prior to use. To developed this type of adhesive to accommodate applications that require impact-resistant structural bonds on metal, plastic composites or wood. They have been developed with a wide temperature range, high shear strength, and a resistant to most chemicals.

G. Nondestructive testing

Non-destructive testing (NDT) is a wide group of analysis techniques used in science and industry to evaluate the properties of a material, component or system without causing damage.

- Magnetic testing
- Ultrasonic inspection
- Liquid Penetrant examinations
- Radiographic test

H. Destructive testing

Destructive weld testing, as the name suggests, involves the physical destruction of the completed weld in order to evaluate its characteristics. This method of testing is used frequently for a number of applications. Some of these applications include welding procedure qualification and welder performance qualification testing, sampling inspection of production welds, research inspection, and failure analysis work. A number of destructive weld testing methods are used to determine weld integrity or performance.

Typically they involve sectioning and/or breaking the welded component and evaluating various mechanical and/or physical characteristics. We shall briefly examine some of the more common methods of this type of welding inspection. We shall consider the macro etch test, the fillet weld break test, the transverse tension test, and the guided bend test. We shall consider how they are used, and what types of weld characteristics they are designed to determine. We shall examine their advantages over other inspection methods and their limitations.

Methods:

- Macro Etch Testing
- Fillet Weld Break Test
- Transverse Tension Test
- Guided Bend Test
- Hardness

Hardness Testing Method Indenter

(a) Brinell hardness Steel ball
(b) Vickers hardness

- Notch-toughness

I. MATERIAL USED

A. Mild Steel

Mild steel is a type of steel that only contains a small amount of carbon and other elements. It is softer and more easily shaped than higher carbon steels. It also bends a long way instead of breaking because it is ductile. It is used in nails and some types of wire, it can be used to make bottle openers, chairs, staplers, staples, railings and most common metal products. Its name comes from the fact it only has less carbon than steel.

B. Mild steel properties

Carbon, Max. - 0.16
Manganese, Min - 0.30
Silicon, Max. - 0.25
Sculpture, Max.- 0.030
Phosphorous, Max. - 0.030
Aluminum, Min - 0.02
Mild steel density - 7.85 gm./cm3
Stiffness is around - 210,000 MPa.

C. Some mild steel properties and uses:

- Mild steel has a maximum limit of 0.2% carbon. The proportions of manganese (1.65%), copper (0.6%) and silicon (0.6%) are approximately fixed, while the proportions of cobalt, chromium, niobium, molybdenum, titanium, nickel, tungsten, vanadium and zirconium are not.
- A higher amount of carbon makes steels different from low carbon mild-type steels. A greater amount of carbon makes steel stronger, harder and very slightly stiffer than a low carbon steel. However, the strength and hardness comes at the price of a decrease in the ductility of this alloy. Carbon atoms get trapped in the interstitial sites of the iron lattice and make it stronger.
- What is known as mildest grade of carbon steel or 'mild steel' is typically low carbon steel with a comparatively low amount of carbon (0.16% to 0.2%). It has ferromagnetic properties, which make it ideal for manufacture of many products.
- The calculated average industry grade mild steel density is 7.85 gm/cm3. Its Young's modulus, which is a measure of its stiffness, is around 210,000 MPa.
- Mild steel is the cheapest and most versatile form of steel and serves every application which requires a bulk amount of steel.

- The low amount of alloying elements also makes mild steel vulnerable to rust. Naturally, people prefer stainless steel over mild steel, when they want a rust free material. Mild steel is also used in construction as structural steel. It is also widely used in the car manufacturing industry.

D. Mechanical properties of mild steel

Steel is made up of carbon and iron, with much more iron than carbon. In fact, at the most, steel can have about 2.1 percent carbon. Mild steel is one of the most commonly used construction materials. It is very strong and can be made from readily available natural materials. It is known as mild steel because of its relatively low carbon content.

E. Chemistry

Mild steel usually contains 40 points of carbon at most. One carbon point is .01 percent of carbon in the steel. This means that it has at most .4 percent carbon. Most steels have other alloying elements other than carbon to give them certain desirable mechanical properties. 1018 steel, a common type of mild steel, contains approximately .6 percent to .9 percent manganese, up to .04 percent phosphorus, and up to .05 percent sulphur. Varying these chemicals affects properties such as corrosion resistance and strength.

II. WELDING PROCESS

Arc Welding

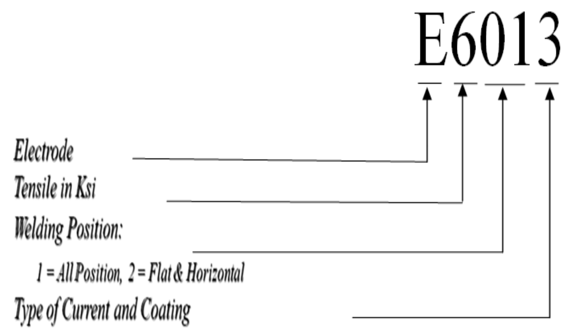
Arc welding is a type of welding that uses a welding power supply to create an electric arc between an electrode and the base material to melt the metals at the welding point. They can use either direct (DC) or alternating (AC) current, and consumable or non-consumable electrodes. The welding region is usually protected by some type of shielding gas, vapor, or slag. Arc welding processes may be manual, semi-automatic, or fully automated. First developed in the early part of the 20th century, arc welding became commercially important in shipbuilding during the Second World War. Today it remains an important process for the fabrication of steel structures and vehicles.

Arc Welding Specification

Fig.3.1 Electrode

BASE METAL: MILD STEELFILLER METAL: E6013 Electrode Diameter of electrode: 2.6mm

About Electrode



Welding technique

- Selection of the correct electrode
- Selection of the correct size of the electrode for the job
- Correct welding current
- Correct arc lengths
- Correct angle of electrode to work
- Correct travel speed
- Correct preparation of work to be welded

Correct Work Preparation

The method of preparation of components to be welded will depend on equipment available and relative costs. Methods may include sawing, punching, shearing, machining, flame cutting and others. In all cases edges should be prepared for the joints that suit the application. The following section describes the various joint types and areas of application.

Power supplies

To supply the electrical energy necessary for arc welding processes, a number of different power supplies can be used. The most common classification is constant current power supplies and constant voltage power supplies. In arc welding, the voltage is directly related to the length of the arc, and the current is related to the amount of heat input.

This is important because in manual welding, it can be difficult to hold the electrode perfectly steady, and as a result, the arc length and thus voltage tend to fluctuate. Constant voltage power supplies hold the voltage constant and vary the current, and as a result, are most often used for automated welding processes such as gas metal arc welding, flux cored arc welding, and submerged arc welding. In these processes, arc length is kept constant, since any fluctuation in the distance between the wire and the base material is quickly rectified by a large change in current. For example, if the wire and the base material get too close, the current will rapidly increase, which in turn causes the heat to increase and the tip of the wire to melt, returning it to its original separation distance.

Electrode Selection

As a general rule, the selection of an electrode is straight forward, in that it is only a matter of selecting an electrode of similar composition to the parent metal. However, for some metals there is a choice of several electrodes, each of which has particular properties to suit specific classes of work. Often, one electrode in the group will be more suitable for general applications due to its all-round qualities. The table below shows just a few of the wide range of electrodes available from BOC, with their typical areas of application.

Electrode Size

The size of the electrode generally depends on the thickness of the section being welded, and the thicker the section the larger the electrode required. In the case of light sheet, the electrode size used is generally slightly larger than the work being welded. This means that, if 2.0mm sheet is being welded, 2.5mm diameter electrode is the recommended size. The following table gives the maximum size of electrodes that may be used for various thicknesses of section

Quality of weld depends on the following factors

- Undercutting is caused by high amperage.
- Porosity is caused by fast travel or dirty material surfaces.
- Slag included in bead is caused by low amperage and short arc.
- Lack of fusion is caused by low amperage and improper edge preparation.
- Overlap is caused by electrode shaking

ELECTRODE ANGLE

The angle that the electrode makes with the work is important to ensure a smooth, even transfer of metal. The recommended angles for use in the various welding positions are covered later.

CORRECT TRAVEL SPEED

The electrode should be moved along in the direction of the joint being welded at a speed that will give the size of run required. At the same time, the electrode is fed downwards to keep the correct arc length at all times. As a guide for general applications, the table below gives recommended run lengths for the down hand position. Correct travel speed for normal welding applications varies between approximately 100 and 300mm per minute, depending on electrode size, size of run required and the amperage used.

Excessive travel speeds lead to poor fusion, lack of penetration etc, while too slow a rate of travel will frequently lead to arc instability, slag inclusions and poor mechanical properties.

A. TYPES OF JOINTS

BUTT WELDS

A butt weld is a weld made between two plates so as to give continuity of section. Close attention must be paid to detail in a butt weld to ensure that the maximum strength of the weld is developed.

Failure to properly prepare the edges may lead to the production of faulty welds, as correct manipulation of the electrode is impeded. Two terms relating to the preparation of butt welds require explanation at this stage.

They are:

- Root Face: the proportion of the prepared edge that has not been beveled (Land).
- Root Gap: the separation between root faces of the parts to be joined.
- Various types of butt welds are in common use and their suitability for different thickness of steel

SQUARE BUTT WELD

The edges are not prepared, but are separated slightly to allow fusion through the full thickness of the steel. Suitable for plate up to 6mm in thickness.

SINGLE 'V' BUTT WELD

This is commonly used for plate up to 16mm in thickness and on metal of greater thickness where access is available from only one side.

DOUBLE 'V' BUTT WELD

Used on plate of 12mm and over in thickness when welding can be applied from both sides. It allows faster welding and greater economy of electrodes than a single 'V' preparation on the same thickness of steel and also has less tendency to distortion as weld contraction can be equalized.

BUTT WELD WITH BACKING MATERIAL

When square butt welds or single 'V' welds cannot be welded from both sides, it is desirable to use a backing bar to ensure complete fusion.

SINGLE 'U' BUTT WELD

Used on thick plates as an alternative to a single 'V' preparation. It has advantages in speed of welding. It takes less weld metal than a single 'V', there is less contraction and there is, therefore, a lessened tendency to distortion. Preparation is more expensive than in the case of a 'V', as machining is required. This type of joint is most suitable for material over 40mm in thickness.

DOUBLE 'U' BUTT WELD

For use on thick plate that is accessible for welding from both sides. For a given thickness it is faster, needs less weld metal and causes less distortion than a single 'u' preparation.

Horizontal Butt Weld

The lower member in this case is beveled to approximately 15° and the upper member 45°, making an included angle of 60°. This preparation provides a ledge on the lower member, which tends to retain the molten metal. General notes on butt Welds the first run in a prepared butt weld should be deposited with an electrode not larger than 4.0 mm. The angle of the electrode for the various runs in a butt weld is shown below.

It is necessary to maintain the root gap by tacking at intervals or by other means, as it will tend to close during welding. All single 'V', single 'u' and square butt welds should have a backing run deposited on the underside of the joint, otherwise 50% may be deducted from the permissible working stress of the joint. Before proceeding with a run on the underside of a weld, it is necessary to back-gouge or grind that side of the joint. Butt welds should be overfilled to a certain extent by building up the weld until it is above the surface of the plate. Excessive reinforcement, however, should be avoided.

Fillet Welds

A fillet weld is approximately triangular in section, joining two surfaces not in the same plane and forming a lap joint, tee joint or corner joint. Joints made with fillet welds do not require extensive edge preparation, as is the case with butt welded joints, since the weld does not necessarily penetrate the full thickness of either member. It is, however, important that the parts to be joined be clean, close fitting, and that all the edges on which welding is to be carried out are square. On sheared plate, it is advisable to entirely remove any 'false cut' on the edges prior to welding.

B. DEFECTS CAUSED IN WELDING

Slag Inclusions

Slag inclusions occur when slag particles are trapped inside the weld metal, which produces a weaker weld. These can be caused by:

- erratic travel speed
- too wide a weaving motion
- slag left on the previous weld pass
- too large an electrode being used
- letting slag run ahead of the arc.
- This defect can be prevented by:
- a uniform travel speed
- a tighter weaving motion
- complete slag removal before welding
- using a smaller electrode
- keeping the slag behind the arc, which is done by shortening the
- arc, increasing the travel speed or changing the electrode angle

Wagon tracks

Wagon tracks are linear slag inclusions that run the longitudinal axis of the weld. They result from allowing the slag to run ahead of the weld puddle and by slag left on the previous weld pass. These occur at the toe lines of the previous weld bead,

Undercutting

Undercutting is a groove melted in the base metal next to the toe or root of a weld that is not filled by the weld metal. Undercutting causes a weaker joint and it can cause cracking. This defect is caused by:

- excessive welding current
- too long an arc length
- excessive weaving speed
- Excessive travel speed.

On vertical and horizontal welds, it can also be caused by too large an electrode size and incorrect electrode angles.

This defect can be prevented by:

choosing the proper welding current for the type and size of electrode and the welding position holding the arc as short as possible pausing at each side of the weld bead when a weaving technique is used using a travel speed slow enough so that the weld metal can Completely fill all of the melted out areas of the base metal.

Lack of Fusion

Lack of fusion is when the weld metal is not fused to the base metal. This can occur between the weld metal and the base metal or between passes in a multiple pass weld.

Causes of this defect can be:

- excessive travel speed
- electrode size too large

- welding current too low
- poor joint preparation
- Letting the weld metal get ahead of the arc.

Lack of fusion can usually be prevented by:

- reducing the travel speed
- using a smaller diameter electrode
- increasing the welding current
- better joint preparation
- Using a proper electrode angle.

Overlapping

Overlapping is the protrusion of the weld metal over the edge or toe of the weld bead. This defect can cause an area of lack of fusion and create a notch, which can lead to crack initiation.

Overlapping is often produced by:

- Too slow a travel speed, which permits the weld puddle to get ahead of the electrode
- An incorrect electrode angle.

C. GAS WELDING

Fuels

Oxy-fuel processes may use a variety of fuel gases, the most common being acetylene. Other gases that may be used are propylene, liquified petroleum gas(LPG), propane, natural gas, hydrogen, and MAPP gas. Many brands use different kinds of gases in their mixes.

Note: there is not a single gas called "oxyacetylene".

Acetylene

Acetylene is the primary fuel for oxy-fuel welding and is the fuel of choice for repair work and general cutting and welding. Acetylene gas is shipped in special cylinders designed to keep the gas dissolved. The cylinders are packed with porous materials (e.g. kapok fiber, diatomaceous earth, or (formerly) asbestos), then filled to around 50% capacity with acetone, as acetylene is acetone soluble. This method is necessary because above 207 kPa (30 lbf/in²) (absolute pressure) acetylene is unstable and may explode.

There is about 1700 kPa (250 psi) pressure in the tank when full. Acetylene when combined with oxygen burns at a temperature of 3200 °C to 3500 °C (5800 °F to 6300 °F), highest among commonly used gaseous fuels. As fuel acetylene's primary disadvantage, in comparison to other fuels, is high cost.

As acetylene is unstable at a pressure roughly equivalent to 33 feet/10 meters underwater, water submerged cutting and welding is reserved for hydrogen rather than acetylene.

Gasoline

Oxy-gasoline, also known as oxy-petrol, torches have been found to perform very well, especially where bottled gas fuel is not available or difficult to transport to the worksite. Tests showed that an oxy-gasoline torch can cut steel plate up to 0.5 in (13 mm) thick at the same rate as oxy-acetylene. In plate thicknesses greater than 0.5 inch the cutting rate was better than oxy-acetylene; at 4.5 in (110 mm) it was three times faster.

The gasoline is fed from a pressure tank whose pressure can be hand-pumped or fed from a gas cylinder. Another low cost approach commonly used by jewelry makers in Asia is using air bubbled through a gasoline container by a foot-operated air pump, and burning the fuel-air mixture in a specialized welding torch.

Hydrogen

Hydrogen has a clean flame and is good for use on aluminium. It can be used at a higher pressure than acetylene and is therefore useful for underwater welding and cutting. It is a good type of flame to use when heating large amounts of material. The flame temperature is high, about 2,000 °C for hydrogen gas in air at atmospheric pressure, and up to 2800 °C when pre-mixed in a 2:1 ratio with pure oxygen (oxyhydrogen).

Hydrogen is not used for welding steels and other ferrous materials, because it causes hydrogen embrittlement.

For some oxyhydrogen torches the oxygen and hydrogen are produced by electrolysis of water in an apparatus which is connected directly to the torch.

Types of this sort of torch:

- The oxygen and the hydrogen are led off the electrolysis cell separately and are fed into the two gas connections of an ordinary oxy-gas torch. This happens in the water torch, which is sometimes used in small torches used in making jewelry and electronics.
- The mixed oxygen and hydrogen are drawn from the electrolysis cell and are led into a special torch designed to prevent flashback. See oxyhydrogen.

D. Oxy-fuel welding and cutting

Oxy-fuel welding (commonly called oxyacetylene welding, oxy welding, or gas welding in the U.S.) and oxy-fuel cutting are processes that use fuel gases and oxygen to weld and cut metals, respectively. French engineers Edmond Fouché and Charles Picard became the first to develop oxygen-acetylene welding in 1903.[1] Pure oxygen, instead of air (20% oxygen/80% nitrogen), is used to increase the flame temperature to allow localized melting of the work piece material (e.g. steel) in a room environment.

Oxy-fuel is one of the oldest welding processes. Still used in industry, in recent decades it has been less widely utilized in industrial applications as other specifically devised technologies have been adopted. It is still widely used for welding pipes and tubes, as well as repair work. It is also frequently well-suited, and favored, for fabricating some types of metal-based artwork.

In oxy-fuel welding, a welding torch is used to weld metals. Welding metal results when two pieces are heated to a temperature that produces a shared pool of molten metal. The molten pool is generally supplied with additional metal called filler. Filler material depends upon the metals to be welded. In oxy-fuel cutting, a torch is used to heat metal to its kindling temperature. A stream of oxygen is then trained on the metal, burning it into a metal oxide that flows out of the kerf as slag. Sometimes called a "Gas Axe".

Torches that do not mix fuel with oxygen (combining, instead, atmospheric air) are not considered oxy-fuel torches and can typically be identified by a single tank (Oxy-fuel cutting requires two isolated supplies, fuel and oxygen). Most metals cannot be melted with a single-tank torch. As such, single-tank torches are typically used only for soldering and brazing, rather than welding.

Apparatus

The apparatus used in gas welding consists basically of an oxygen source and a fuel gas source (usually cylinders), two pressure regulators and two flexible hoses (one of each for each cylinder), and a torch. This sort of torch can also be used for soldering and brazing. The cylinders are often carried in a special wheeled trolley.

There have been examples of ox hydrogen cutting sets with small (scuba-sized) gas cylinders worn on the user's back in a backpack harness, for rescue work and similar.

In short, oxy-fuel equipment is quite versatile, not only because it is preferred for some sorts of iron or steel welding but also because it lends itself to brazing, braze-welding, metal heating (for annealing or tempering, bending or forming), rust or scale removal, the loosening of corroded nuts and bolts and is a ubiquitous means of cutting ferrous metals.

III. ADHESIVE METAL JOINING

Adhesives are incredibly strong and quite easy to use. Composed of two liquid components that require mixing prior to use. To developed this type of adhesive to accommodate applications that require impact-resistant structural bonds on metal, plastic composites or wood. They have been developed with a wide temperature range, high shear strength, and a resistant to most chemicals.

Features

- Long bonding range.
- Excellent initial strength.
- High heat resistance.

Produce an adhesive for your specific needs

Methacrylate Adhesives, also known as acrylic adhesives are incredibly strong and quite easy to use. Composed of two liquid components that require mixing prior to use. Methacrylate adhesive manufacturers have developed this type of adhesive to accommodate applications that require impact-resistant structural bonds on metal, plastic composites or wood. They have been developed with a wide temperature range, high shear strength, and a resistant to most chemicals.

Obviously, the majority of end users will mostly be commercial or industrial users, although there may be instances where methacrylate adhesives would be useful for personal use in construction projects.

Like other types of adhesives, epoxies, or urethanes, methacrylate adhesives have a lot of advantages. All are reasonably cost effective, so most of these adhesives are not cost prohibitive for use in various industries. As compared to epoxy, both are very good gap fillers, but unlike epoxy, methacrylate maintains its viscosity during the curing process. Epoxy can be extremely strong, but does not perform very will at low temperatures nor does it have the impact strength of methacrylate adhesives. Epoxies generally perform poorly on thermoplastics and require careful cleaning or surface preparation on metals and composites. Methacrylate is essentially unaffected by the cleanliness of the surfaces to be bonded.

As compared to urethanes, methacrylate is very effective on a wide range of substrates. Flexibility at low temperatures is a characteristic that both posses, but methacrylate is much more tolerant of high temperatures and will perform much better in this environment. Urethanes have good adhesion to metals and composites; however do not perform as well as methacrylate adhesive on thermoplastics without the use of primers.

Unlike the techniques normally used for two component adhesives, twin cartridges directly applying the hardener to the resin, the two components of a methacrylate adhesive can each be applied separately to each of the substrates. The actual curing reaction doesn’t begin until the two substrates come together. This process avoids having to mix difficult mixing ratios. It also creates a greater length of time for you to work with the substrates and make necessary adjustments

Composition of Methyl Methacrylate adhesive

Methacrylate refers to derivatives of methacrylic acid. These derivatives include the parent acid ($CH_2C(CH_3)CO_2H$), salts (e.g., $CH_2C(CH_3)CO_2^-Na^+$), esters (e.g. $CH_2C(CH_3)CO_2CH_3$, or methyl methacrylate) and the polymers of these species. Methacrylates are common monomers in polymer plastics, forming the acrylate polymers. Methacrylates easily form polymers because the double bonds are very reactive. They are used as the monomer resin in some windscreen repair kits, and as bone cement for fixing prosthetic devices in orthopaedic surgery.

Methyl methacrylate is an organic compound with the formula $CH_2=C(CH_3)COOCH_3$. This colourless liquid, the methyl ester of methacrylic acid (MAA) is a monomer produced on a large scale for the production of poly(methyl methacrylate) (PMMA).Methyl methacrylate adhesive is a compound which is manufactured from butylene’s, ethylene or propylene. It is primarily made to join different items together and form structural bonding by creating strong and non-reversible bonds in both light and heavy applications.

Methyl methacrylate adhesive is usually formulated with modifiers to provide tough bond lines that reduce stresses or impacts and resist peels hence making it appropriate to be used in places that are exposed to high intensity pressure that would otherwise likely reverse the bond created. The adhesive can also withstand temperatures ranging from negative fifty degrees centigrade to ninety five degrees centigrade, thus making it ideal to be used in situations that might be exposed to extreme temperatures. Furthermore, the compound is insensitive to situations and applications that contain certain amounts of grease or oils.

Methyl methacrylate adhesive is used in diverse industries to facilitate various operations. Commonly the adhesive is used in the food production, stationery items, and toys industries, the primary application being for packaging.

The compound is also an integral part of various heavy industries processes where it is used in various roles such as; assembling machines’ spare parts, machine branding, providing protective coating during painting, and providing uniform distribution of stress in the structure which it is being applied. Many industrial operators prefer this adhesive since unlike other methods of conjoining and bonding various structures, Methyl methacrylate adhesive does not require any drilling consequently saving time and reducing operation costs.

Small quantities of the adhesive are also used for medical purposes in surgical bone implants and dental restorations. The compound is preferred in medical fields because it has minimal reactions with the body and it also creates a permanent bond which does not require other subsequent surgeries. This means when a patient is treated using methacrylate adhesive, there is a very high likelihood that the treatment will remain intact for long periods.

Excessive exposure to Methyl methacrylate adhesive can cause various health issues. Therefore people who work with the compound for long periods of time are advised to wear protective clothing and take the necessary precautions to reduce their exposure. The compound can also evaporate if left exposed to air, it should therefore be kept in tightly sealed containers.

Table: 4.1 Physical Properties

Color	Straw
Chemistry	Methacrylate Ester
Appearance	Liquid
Specific Gravity (g/ml)	1.03
Viscosity (cps)	50,000 - 80,000
Time to Handling Strength (min)	0.5 to 2
Full Cure Time (hr)	24

Requiring High Metal-to-Metal Bond Strengths

Metal goods are significantly vulnerable to friction, vibrations and other stresses, use mechanical fasteners that may loosen over time, or use adhesives bonding that becomes ineffective with time. This is the reason many bonded metal goods may be dismantled or even be disassembled relatively easily. Ineffectual bonding creates a dire need for metal bonding adhesive products that promise long-lasting and firm adhesion.

Many metal objects, substrates or surfaces may come apart or separate, if handled roughly, or are exposed to severe pressures, thermal cycling or vibrations. Hence, it is critically essential that the meal-bonding adhesive that is used possess traits that have the potential to penetrate into the solid metal molecules of the surfaces being bonded.

Metal bonding adhesives such as methacrylate adhesive from Adhesive Systems, Inc., are engineered to strengthen mechanical fastening or to replace spot welds and rivets for metal lap joints or substrate bonding. All of our metal adhesives and methacrylates feature high-bonding capacities and tough bonds providing exceptional peel and shear strength once cured. Our metal bonding adhesives resist fatigue, cracking, thermal shock and vibration. Additional they maintain creep, and are resistant to moisture and corrosion in most applications. The best part is that these are wholly reactive compounds and do not possess ingredients, diluents and solvents that are hazardous under normal usages Material Safety Data Sheets are available for our products.

Surface Preparation

Surface Preparation For high strength structural bonds, paint, oxide films, oils, dust, mold release agents and all other surface contaminants must be completely removed. The amount of surface preparation depends on the required bond strength and the environmental aging resistance desired by user.

Handling/Curing Information

Directions For Use

- For high strength structural bonds, paint, oxide films, oils, dust, mold release agents and all other surface contaminants must be completely removed. The amount of surface preparation depends on the required bond strength and the environmental aging resistance desired by user. Wiping with solvent such as Methyl Ethyl Ketone (MEK) will aid in preparing the surface for bonding.

- Use gloves to minimize skin contact with adhesive.
- This product consists of two parts. Mix thoroughly by weight or volume in the proportions specified in the Uncured Properties Section. Mix approximately 15 seconds after a uniform color is obtained.
- For maximum bond strength, apply product evenly to both surfaces to be joined.
- Application to the substrates should be made within 45 minutes. Large quantities and/or higher temperatures will reduce this working time.
- Join the adhesive coated surfaces and allow to cure at 60°F (16°C) or above until
- firm Up to 200°F (93°C), will speed curing.
- The following times and temperatures will result in a full cure
- Keep parts from moving until handling strength is reached. Contact pressure is necessary. Maximum shear strength is obtained with a 3-5 mil bond line.

Curing (chemistry)

Curing is a term in polymer chemistry and process engineering that refers to the toughening or hardening of a polymer material by cross-linking of polymer chains, brought about by chemical additives, ultraviolet radiation, electron beam or heat. In rubber, the curing process is also called vulcanization.

Resin curing

Despite the wide variety of thermoset resin formulations (epoxy, vinyl ester, polyester, etc.), their cure behavior is qualitatively identical. The resin viscosity drops initially upon the application of heat, passes through a region of maximum flow and begins to increase as the chemical reactions increase the average length and the degree of cross-linking between the constituent oligomers. This process continues until a continuous 3-dimensional network of oligomer chains is created – this stage is termed gelation.

In terms of process ability of the resin this marks an important watershed: before gelation the system is relatively mobile, after it the mobility is very limited, the micro-structure of the resin and the composite material is fixed and severe diffusion limitations to further cure are created. Cure monitoring methods give a significant insight to the chemical process and define process actions towards achieving specific quality indices of the cured resin systems.

Cure Temperature and Time

75°F (24°C) 7 days

150°F (67°C) 120 minutes

200°F (93°C) 30 minutes

Drying Time

The adhesive dries in about 10 minutes. High humidity will slow drying-high temperatures speed the drying. This adhesive has a bonding range of approximately 30 minutes when applied to both bond surfaces under conditions of 70°F (21°C) and 35% R.H. If the adhesive becomes too dry, apply another thin coat of adhesive to one surface, allow to become slightly tacky, and bond. Relative humidity above 50% can cause blushing (condensation of moisture on surface) and a false bond. To avoid this, we recommend a force drying temperature of 180-220°F (82-104°C). Force drying will also help remove the solvent more rapidly.

IV. NON-DESTRUCTIVE TESTS (NDT)

Non-destructive testing (NDT) is a wide group of analysis techniques used in science and industry to evaluate the properties of a material, component or system without causing damage.

- Magnetic testing
- Ultrasonic inspection
- Liquid Penetrant examinations
- Radiographic test

5.1.1 Magnetic particle inspection

Magnetic particle inspection (MPI) is a non-destructive testing (NDT) process for detecting surface and slightly subsurface discontinuities in such as iron, nickel, cobalt, and some of their alloys.

Fig. 5.1.Magnetic particle inspection

The process puts a magnetic field into the part. The piece can be magnetized by direct or indirect magnetization. Direct magnetization occurs when the electric current is passed through the test object and a magnetic field is formed in the material. Indirect magnetization occurs when no electric current is passed through the test object, but a magnetic field is applied from an outside source.

The magnetic lines of force are perpendicular to the direction of the electric current which may be either alternating current (AC) or some form of direct current (DC) (rectified AC). The presence of a surface or subsurface discontinuity in the material allows the magnetic flux to leak, since air cannot support as much magnetic field per unit volume as metals. Ferrous iron particles are then applied to the part. The particles may be dry or in a wet suspension.

Fig. 5.2 Magnetic particle inspection (defect)

If an area of flux leakage is present the particles will be attracted to this area. The particles will build up at the area of leakage and form what is known as an indication. The indication can then be evaluated to determine what it is, what may have caused it, and what action should be taken.

A popular name for magnetic particle inspection is or used to be magna fluxing.

Ultrasonic testing

In ultrasonic testing (UT), very short ultrasonic pulse-waves with center frequencies ranging from 0.1-15 MHz and occasionally up to 50 MHz are launched into materials to detect internal flaws or to characterize materials. A common example is ultrasonic thickness measurement, which tests the thickness of the test object, for example, to monitor pipe work corrosion.

Fig. 5.3 Ultrasonic testing

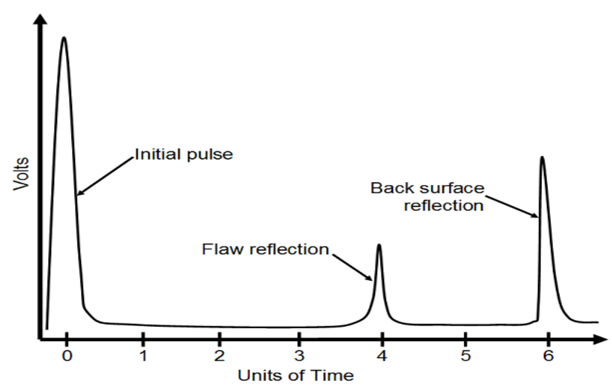


Fig.5.4 Ultrasonic testing output curve

Ultrasonic testing is often performed on steel and other metals and alloys, though it can also be used on concrete, wood and composites, albeit with less resolution. It is a form of non-destructive testing used in many industries including aerospace, automotive and other transportation sectors.

Liquid Penetrant examinations

Dye penetrant inspection (DPI), also called liquid penetrant inspection (LPI) or penetrant testing (PT), is a widely applied and low-cost inspection method used to locate surface-breaking defects in all porous materials (metals, plastics, or ceramics).

Fig. 5.5Liquid Penetrant examinations

The penetrant may be applied to all non-ferrous materials and ferrous materials; although for ferrous components magnetic-particle inspection is often used instead for its subsurface detection capability. LPI is used to detect casting, forging and welding surface defects such as hairline cracks, surface porosity, leaks in new products, and fatigue cracks on in-service components.

Radiographic examinations

Radiography is a nondestructive examination method that uses invisible X-ray, or Gamma radiation to examine the interior of materials. It gives a permanent film record of defects that is relatively easy to interpret. Although this is a slow and expensive method of nondestructive examination, it is a positive method for detecting porosity, inclusions, cracks, and voids in the interior of castings, welds, other structures. X-ray generated by electron bombardment of tungsten, and gamma rays emitted by radioactive elements are penetrating radiation whose intensity is modified by passage through a material.

TRIAL NO	LOAD IN 'N'	LOADING DEFLECTION IN MM	UNLOADING DEFLECTION IN MM	AVERAGE DEFLECTION
1	**500**	**21.5**	**22**	**21.75**
2	**1000**	**42**	**43**	**42.5**
3	**1500**	**64**	**64**	**64**

The amount of energy absorbed by a material depends on its thickness and density. Energy not absorbed by the material will cause exposure of the radiographic film. Those area will be dark when the film is developed. Areas of material where the thickness has been changed by discontinuities, such as porosity or cracks, will appear as dark outlines on the film. All discontinuities are detected by viewing shape and variations in the density of the processed film.

V. DESTRUCTIVE TESTING

Destructive weld testing, as the name suggests, involves the physical destruction of the completed weld in order to evaluate its characteristics. This method of testing is used frequently for a number of applications. Some of these applications include welding procedure qualification and welder performance qualification testing, sampling inspection of production welds, research inspection, and failure analysis work.

A number of destructive weld testing methods are used to determine weld integrity or performance. Typically they involve sectioning and/or breaking the welded component and evaluating various mechanical and/or physical characteristics. We shall briefly examine some of the more common methods of this type of welding inspection. We shall consider the macro etch test, the fillet weld break test, the transverse tension test, and the guided bend test. We shall consider how they are used, and what types of weld characteristics they are designed to determine. We shall examine their advantages over other inspection methods and their limitations.

A. GUIDED BEND TEST

This is a test method in which a specimen is bent to a specified bend radius. Various types of bend tests are used to evaluate the ductility and soundness of welded joints. Guided bend tests are usually taken transverse to the weld axis and may be bent in plunger type test machines or in wrap-around bend test jigs.

Table.6.1. Arc welding Bend Test Report

TRIAL NO	LOAD IN 'N'	LOADING DEFLECTION IN MM	UNLOADING DEFLECTION IN MM	AVERAGE DEFLECTION
1	500	21.5	22	21.75
2	1000	42	43	42.5
3	1500	64	64	64

Face bend tests are made with the weld face in tension, and root bend tests are made with the weld root in tension. When bend testing thick plates, side bend test specimens are usually cut from the welded joint and bent with the weld cross section in tension. The guided bend test is most commonly used in welding procedure and welder performance qualification tests. This type of testing is particularly good at finding liner fusion defects, which will often open up in the plate surface during the testing procedure.

Table.6.2 Gas welding Bend Test Report

TRIAL NO	LOAD IN 'N'	LOADING DEFLECTION IN MM	UNLOADING DEFLECTION IN MM	AVERAGE DEFLECTION
1	500	20	21	20.5
2	1000	40	42	41
3	1500	64	64	64

Table.6.3 Adhesive joint Bend Test Report

TRIAL NO	LOAD IN 'N'	LOADING DEFLECTION IN MM	UNLOADING DEFLECTION IN MM	AVERAGE DEFLECTION
1	500	23	24	23.5
2	1000	42	44	43
3	1500	63	63	63

Fig 6.1 *Guided Bend Test*

B. HARDNESS

Hardness is regarded as the resistance of a material to indentations and scratching. This is generally determined by forcing an indenter on to the surface. The resultant deformation in steel is both elastic and plastic. There are several methods using which the hardness of a metal could be found out. They basically differ in the form of the indenter, which is used on to the surface. Hardness number is related to the ratio of the applied load to the surface area of the indentation formed.

The testing procedure involves forcing the indenter on to the surface at a particular road. On removal, the size of indentation is measured using a microscope. Based on the size of the indentation, hardness is worked out. For example, Brinell hardness (BHN) is given by the ratio of the applied load and spherical area of the indentation

Hardness Testing Method Indenter

(a) Brinell hardness Steel ball

(b) Vickers hardness

Table. 6.4 Hardness test report

MATERIAL	LOAD IN Kgf	INDENTOR SCALE	TRAIL NUMBER			RHN
MILD STEEL ARC WELDING	100	DIAMOND	64	64	72	67
MILD STEEL GAS WELDING	100	DIAMOND	72	70.5	66	69.5
MILD STEEL ADHESIVE JOINT	100	DIAMOND	73	74	73	73

C. Notch – toughness report

There is always a possibility of microscopic cracks in a material or the material may develop such cracks as a result of several cycles of loading. Such cracks may grow rapidly without detection and lead to sudden collapse of the structure.

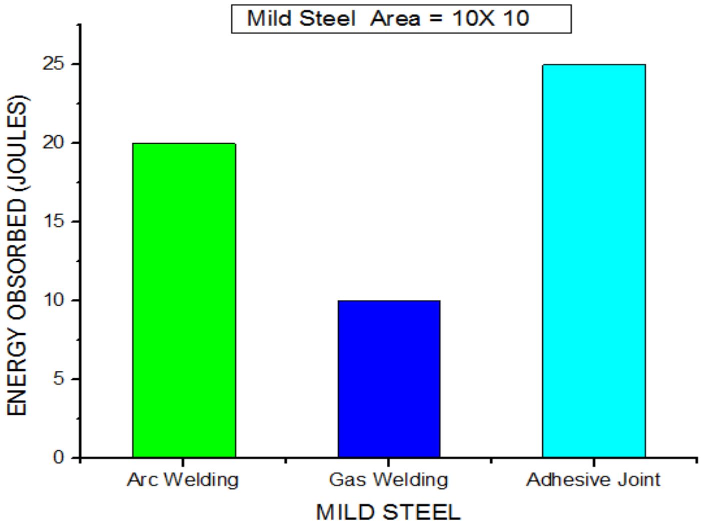


Fig: 6.5 Notch – toughness report

To ensure that this does not happen, materials in which the cracks grow slowly are preferred. Such steels are known as notch-tough steels and the amount of energy they heavy pendulum as in Izod and Charpy tests. absorb is measured by impacting a notched specimen with a heavy pendulum as in Izod and Charpy tests.

VI. CONCLUSION

The Experiment analyze the quality and strength of components in arc welding, gas welding and adhesive joining. Defects are reduced and strength is increase in adhesive joining process and rejection is reduced to zero.

The successfully analyze defect, strength analysis in mild steel components and reduce the defects in mild steel joining process.

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