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THE USE OF AN ARC WELDING PROCESS TO INVESTIGATE WELD PROPERTIES ON LAP JOINT

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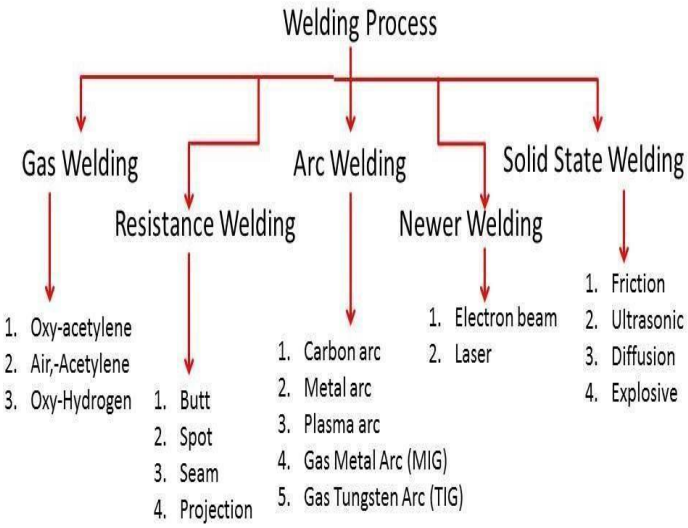
Abstract - The main objective of shielded metal arc welding is to perform arc welding using a covered metal electrode to shield the weld joint, welding is one of the most popular ways to combine two metal parts into one and to observe the influence of pre-welded heat treat mention heat affected zone when joining heavy thickness plates while performing SMAW.in this process the pre-welded heat input strongly affected the HAZ. Micro structure and hardness
This work on the principle of heat produced by the electric arc the electrode used in the process is consumable the current type used in the process either AC or DC depending on base metal. The parameters of this process weld process are current, length of the arc, angle. SMAW arc welding uses the arc heat to melt the base metal and tip of a consumable electrode. The electrode and base metal are part of the electric circuit or welding circuit. The welding starts when the tip of the electrode and the base metal come to contact and here should be some distance between the base metal and electrode. The heat melts the tip and the surface of the work. Tiny globlues of molten metal form on the electrode tip then to the arc into the metal pool. Filler is deposited as the electrode is consumed. The flux coating disintegeres and gives off vapour's that serve as a shielding gas and provides a protective layer of slag. After chipping and cleaning the destructive and non-destructive testing is done.
This process is widely used in many industrial applications due to its versatility, simplicity and indoor and outdoor applicability. SMAW process is commonly used across range of including aerospace, automotive, energy and construction among others.
***Key Words*:** Welding, SMAW, Butt joint, Lap joint, T joint, speed of weld, shielding gas.

1.INTRODUCTION

WELDING:

Welding is a fabrication process that joins materials, usually metals or thermoplastics, by using high heat to melt the parts together and allowing them to cool, causing fusion.

Classification of welding process:



Weld joint: Weld joint is a point or edge where two or more pieces of metal are joined together. They are formed by welding two or more work pieces according to a particular geometry

Types of weld joints:

- **Butt joint:**

A butt joint or butt weld is a joint where two pieces of metal are placed together in the same plane and the side of each metal is joined by welding.

- Square
- Single bevel
- Double bevel
- Single J
- Double J
- Single U
- Double U

- **Lap joint:**

Lap welding joints are essentially a modified version of the butt joint. They are formed when two pieces of metal are placed in an overlapping pattern on top of each other.

- Fillet welding
- Spot welding
- Plug welding
- Slot welding
- Bevel groove welding
- Flare bevel groove welding
- J-groove welding

- **Edge joint:**

In this, both the metal plate surfaces are placed together, that they are adjacent and generally parallel in position at the point of welding. It is known as edge joint welding.

- U-groove
- V-groove
- J-groove
- Corner-flange
- Bevel-groove Square-groove

- **Corner joint:**

The corner joint welding is used to join two members that are located at approximately right angle to each other in the form of a "L".

- Fillet weld
- Closed
- Half-open
- Fully open

- **T-joint:**

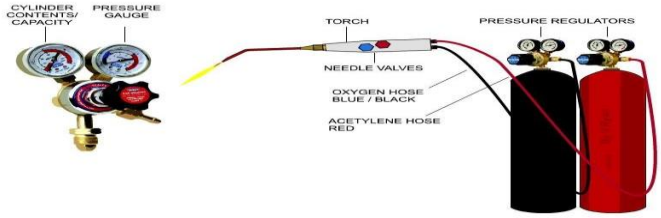
T-joint is formed, when the two metal plates are intersected to an angle of 90 degree with on plate is lie on the center of the other plate like a "T" shape.

- Fillet welding
- Plug welding
- Slot welding
- Bevel groove welding
- Flare bevel groove welding
- J-groove welding

GAS WELDING:

- **OXY-ACETYLENE WELDING :**

Oxyacetylene welding, commonly referred to as gas welding, is a process which relies on combustion of oxygen and acetylene. When mixed together in correct proportions within a hand-held torch or blowpipe, a relatively hot flame is produced with a temperature of about 3,200 degree celcius.



Oxy Acetylene Welding

Advantages:

- It is simple in construction, no huge parts and equipment are used in its installation like Arc Welding.
- It is easy to operate and no need for highly skilled technicians to operate it.
- Not only for welding but also oxy acetylene is used to separate or cut the materials into pieces.
- This type of Welding is cheaper.
- As Oxy Acetylene uses the gases like oxygen and acetylene, it can be used to weld ferrous and even non-ferrous metals.
- The intensity of the flame can be adjusted to high and less by using the valve.
- It can be used for high melting metals and even for low melting metals.

Disadvantages :

- The temperature of the flame is less when compared to the are welding.
- As like are welding, the oxy acetylene does not have a high flux shield over the weld.
- It is suitable for thin materials and medium thin materials whereas it is not suitable for thick materials.

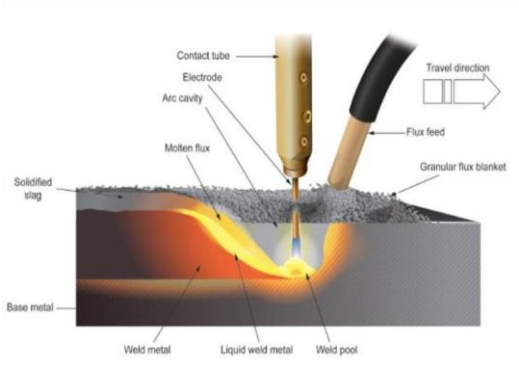
Applications :

- It is used in the industries like metal joining and metal cuttings.
- It is used in the Automobile repairs to join the damaged parts.
- Fabricating Workshops and industries.
- For polishing in glass companies.
- It is used in jewelry designing for the purpose of water welding,

Submerged Arc Welding (SAW):

Submerged-arc welding (SAW) is a common arc welding process that involves the formation of an arc between a continuously fed electrode and the work piece. A blanket of powdered flux generates a protective gas shield and a

slag (and may also be used to add alloying elements to the weld pool) which protects the weld



Submerged Arc Welding{SAW} Advantages

2.LITERATURE SURVEY

Chandel presented theoretical predictions of the effect of current, electrode polarity, electrode diameter and electrode extension on the melting rate, bead height, and bead width and weld penetration in Tungsten Arc Welding. They indicated that the melting rate in TIG can be increased by using

(1) higher current

(ii) straight polarity

(iii) a smaller diameter electrode and

(iv) a longer electrode extension.

The percentage difference in melting rate, bead height, bead width and bead penetration has been found to be affected by the current level and polarity used. They have concluded that when a smaller diameter electrode is used, the increase in the current level does not make a significant effect on the percentage change in the weld bead geometrical parameters.

Chandel and Seow presented the mathematical prediction of the effect of current, polarity used, electrode diameter and its extension on the melting rate, bead height, bead width and weld penetration in SAW. They concluded that for a given current (heat input) the melting rate can be increased by using electrode negative polarity, longer electrode extension, and smaller diameter electrodes. There are two other ways to increase the deposition rate without increasing the heat input; these are:

(1) using a twin-arc mode

(2) adding metal powders.

Gunaraj and Murgan developed analytical models to establish a relationship between process parameters and weld bead volume in SAW of pipes. They also carried out the optimization of weld bead volume using the optimization module available in the MATLAB software

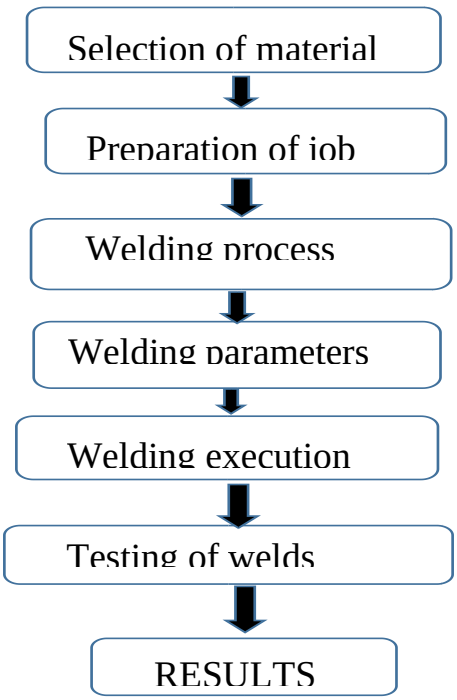
Mostafa and Khajavi described the prediction of weld penetration as influenced by Flux Cored Arc Welding process parameters like welding current, arc voltage, nozzleto-plate distance, electrode-to-work angle and welding speed. The optimization result shows penetration will be maximum when welding current, arc voltage, nozzle-to-plate distance and electrode-to- work angle is at their maximum possible value and welding speed is at its minimum value. Increase in welding current (1) increases the depth of penetration (P). Increase in welding speed (S) causes a decrease in depth of penetration(P). Increase in arc welding voltage (V) resulted in an increase in depth of penetration (P), Increase in electrodeto-work angle from 90° to 120° (i.e. for normal to backhand) had resulted in increase of depth **ErdalKaradeniz** have investigated the effects of various welding parameters on weld penetration in Erdemir 6842 steel of 2.5 mm thickness welded by Robotic Gas Metal Arc Welding Process. The welding current, are voltage and welding speed have been chosen as variable process parameters. The depths of penetration have been measured for each specimen after the welding operations and the effects of these welding process parameters on penetration have been determined. The welding currents in step of 95A, 105A and 115 A, Are voltages in steps of 22V, 24V and 26 V and welding speeds in steps of 7,10 and 14 mm/s have been used for all experiments. It has been found that increase in current; substantially increases the depth of penetration while increase in voltage, very slightly increases the penetration. The highest penetration has been observed at 10mm/s welding speed.

Gupta and Parmar developed mathematical models by using fractional factorial technique to predict the weld bead geometry and shape relationship for Submerged Arc Welding of micro alloyed steel in the medium thickness range of 10-16 mm. The response factors namely bead penetration, weld width, reinforcement, dilution, weld penetration shape factor (WPSF), weld reinforcement form factor (WRFF) as affected by wire feed rate, open circuit voltage, nozzle-to-plate distance, welding speed and work material thickness have been investigated and analyzed.

Ravindran and Parmar developed mathematical models by using fractional factorial techniques to predict weld bead geometry and shape relations for CO2 voltage, current, welding speed, nozzle-to-plate distance and gun angle**.**

3.METHODOLOGY

following flowchart describes the methodology



Two thicknesses of MS metal plate and stainless steel are selected for Gas Tungsten Are

Welding. Thickness of plates is 2mm and 4mm. Prepare the area to be v-grooved and weld. Remove all flammable materials on the work piece and find a good surface to weld on.

First using shield metal are welding machine for welding process. Set up weld parameters to weld the metal piece. Clean the work piece before welding, it is done by brushing with a wire brush or grinder. Start the welding on the first and second plates, maintain 1.6mm to 2.4mm distance between non consumable electrode and metal plates and keep the torch at 90 degrees of angle. Start moving the weld pool across the metal. Clean the slag by using chipping hammer to break the slag. Use the wire brush to clean the unwanted material on weld. Allow the metal piece to be getting cool.

A filler metal (ER 70S-2) is used to join the two metal pieces together. As the spark is struck, the filler metal is inserted in the cavity, and due to intense heat, the filler metal melts and fills the cavity between the two metal pieces and forms a strong weld. Examine the weld piece for testing the weld like dye penetration test, tensile test and bending test.

4.EXPERIMENTATION

MATERIALS

- In a shield metal are welding and gas tungsten are welding 2 mm &4 mm MS plates are used for welding.
- Sizes -150x150x6mm.

PROPERTIES FOR MATERIAL

• Properties of mild steel and stainless steel

RECTIFIER

Through a pipe in one direction, most welding power sources are capable of welding with DC output. They accomplish this with internal circuitry that changes or rectifies the AC into DC.

Rectifier

INERT GASES

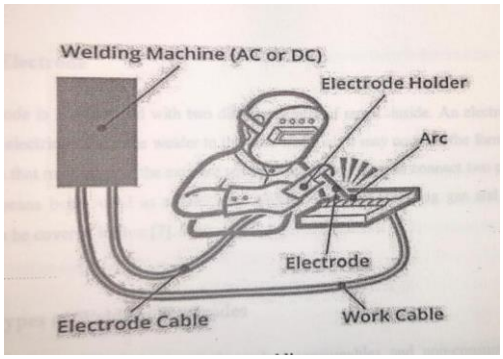
The mostly commonly used shielding gases are argon and helium for developing high quality weld joints of reactive and ferrous metal. Small amount of hydrogen on helium is often added in argon to increase the penetration capability and welding speed.

- **REGULATOR**

The function of the gas regulator is to reduce bottle pressure gas down to lower pressure and deliver it at a constant flow. The constant flow of gas flows down through the TIG torch lead to the TIG torch nozzle and around the weld pool. Generally, 3.5kg of argon gas cylinder in TIG welding. During the welding the flow rate of argon gas is 121/ht.

Arc welding experiment

Arc welding is a type of welding process using an electric arc to create heat to melt and join metals. A power supply creates an electric arc between a consumable or no consumable electrode and the base material using either direct (DC) or alternating (AC) currents. It is a fusion welding process used to join metals. An electric arc from an AC or DC power supply creates an intense heat of around 6500°F which melts the metal at the join between two work



Arc Welding Experimental setup

The arc can be either manually or mechanically guided along the line of the join, while the electrode either simply carries the current or conducts the current and melts into the weld pool at the same time to supply filler metal to the join. Because the metals react chemically to oxygen and nitrogen in the air when heated to high temperatures by the arc, a protective 6 shielding gas or slag is used to minimize the contact of the molten metal with the air. Once cooled, the molten metals solidify to form a metallurgical bond.

Different polarities used in arc welding

- Direct Current Straight Polarity-occurs when electrode is made negative and base plates are made positive. Thus electrons flow from electrode tip to base plates.
- Direct Current Reverse Polarity-occurs when electrode is made positive and base plates are made negative. Thus electrons flow from base plates to electrode.Alternating Current Polarity-if power source provides AC current then above two case swill occur one after another in every cycle. In one half of the cycle, electrode will be negative (so base plates will be positive) and in the next half, electrode will be positive (so base plate will be negative). Number of cycles per second depends on frequency of supply. For example, with a 60Hz supply, 60 cycles occur in every second

PROCEDURE

➢ **mm thick MS plate & stainless steel**

- Select two 6 mm MS Plate and stainless steel.

Ms plate and stainless steel

• mark the specimen as per the required shape on 4mm metal plates using hammer & pointer.

Cut the tensile specimen shape as per the mark by using plasma cutting.

Weld current

Higher current in TIG Welding can be led to splatter and work piece become damage. Again, lower current setting in TIG Welding leads to sticking of the filler wire sometimes larger heat effect area can be sound for lower welding current, if high temperatures need to apply for longer periods of time to deposit the same amount of filling materials.

Weld Voltage

Welding voltage can be fixed or adjustable depending on the TIG welding equipment. A high initial voltage allows for easy are imitation and a greater range on working tip distance. Too high voltage, can leads to large variable in welding quality.

Weld Speed

Welding speed is an important parameter for TIG Welding If the welding speed is increased, power or heat input per unit length of weld is decreases, therefore less weld reinforcement result and penetration of welding decreases. Welding speed is primarily controlling the size of bead and penetration. To travel Imm of weld time required is of Isec.

Distance between Tungsten Electrode and Work piece. The gap between tungsten and work piece should be maintained at between 1.6 mm to 2.4 mm.

5. TESTING OF WELD JOINTS

TESTING AND TYPES OF WELD JOINTS

1.Non-destructive type

2. Destructive type

NON-DESTRUCTIVE TYPE

Non-destructive type field is mostly very broad. In inter-disciplinary field it plays a major role in inspecting the structural component and its systems perform their function

in a reliable fashion. NDT defines the use of noninvasive techniques to determine the integrity of materials, components or structure. Alternatively, NDT can also be defined is quantitative measure to measure certain characteristics of an object, the French words far as NDT concerned is that inspect or measure without causing any harm to the structure. This method can be performed on metals, plastics, ceramics, composites, cremates, and coatings in order to detect cracks, internal voids, surface cavities, DE-laminations in complete c defective welds and any type of flaw that could.. leads to premature failure. Commonly used NDT test methods can be seen. These are universal NDT test methods are Dye penetration test, magnetic particle test, radiography test, ultrasonic test, hardness test, gamma test, visual test.

5.2.1 Dye penetration test

Dye penetration test is one of the most popular non-destructive testing methods in the industry. Dye penetration test is economical, versatile, and required minimal training when compared to other NDT methods. In this test, it checks for the material flaws which are open to the surface are flowing very thin liquid into the flaw and then drawing the liquid out with a chalk like developer. Welds are the most common items but sheets, plates, bars, pipes, castings and forgings are also most commonly inspected using dye penetration test.

These methods are an in expensive and convenient technique for surface defect inspection. The limitations of liquid penetrate technique includes the inability to inspect the sub surface flaws and loss of resolution on pours materials.

Dye Penetration Test

There are the seven basic steps to follow when using the dye penetration solvent

- Pre cleaning-removing surface contaminants.
- Application of penetrate by spraying.
- Dual time.

1. Removals of excess penetrate.
2. Developing- applying developer to absorb penetrate back to
3. Post cleaning-removing penetrate or developer trace from the surface.

Pre cleaning: This can be ranges from grinding and wire brushing to merely wiping the specimen with a rag moistens with the cleaner. The surface of the specimen needs to be free of dirt, rust, scale, paint, oil, grease and be smooth enough to wipe of the penetrate without leaving the residue.

DESTRUCTIVE TEST

5 Tensile test

Tensile properties of the weld joints namely yield and ultimate strength and ductility (% age elongation, % age reduction in area) can be obtained either in ambient condition or in special environment (low temperature, high temperature, corrosion). Depending upon the requirement of the application, using tensile test usually conducted at constant strain rate (ranging from 0.0001 to 10000 mm/min). Tensile properties of the weld joint are obtained in two ways,Taking specimen from transverse direction of weld joint consisting base metal-heat affected zone-weld metal-heat affected zone-base metal and All weld metal specimen as shown in Fig. Tensile test results must be supported by respective engineering stress and strain diagram indicating modulus of elasticity,elongation at fracture, yield and ultimate strength.

UTM Machine

TEST

Brinell hardness machine

we have placed the specimen on the anvil and by rotating the hand wheel the penetrate comes contact with the specimen and the indicator moves to zero while in complete contact between the specimen and the penetrate then we applied the load on the the specimen with the help of the penetrate after waiting for the 20 secs of time after load applied we removed the load applied on the specimen then the indicator in the dial face moves onto the certain value that should noted in the notebook so we have taken 15 positions on the specimen by applying the load we have noted the values for the plotting the graph to understand where it has the greater strength on specimen after completion of the hardness test we have moved on to the torsion test.

RESULTS

We have performed two tests on the welded specimen they are

1.Test

2 Destructive test

NON-DESTRUCTIVE TEST

Dye penetration test

After performing dye penetration test, we have found that they have been very flaws like porosities in weld joints.

DESTRUCTIVE TEST

Tensile test

It can be absorbed that 6mm plate (welded using electrode 6013) as broken at the point near to the edge of the base metal as weld bead is stronger.

CONCLUSION

The joints fabricated by ARC Welding process exhibits high strength value. The strength exhibited by the weld quality by ARC Welding compared to other source of welding like are welding SMA welding is higher. One of the conclusions is that the hardness of the weld zone is grater then the hardness of the non-welded zone that is parent metal. Hardness of the weld zone increases as the velocity of arc movement decreases and it decreases as the velocity of are movement increases. This happens due to the metal flowing rate. If our objective is used to compare the weld quality strength on tensile test then ARC Welding welding has better quality than the other welding. Defects in gas tungsten are welding is less.

If our objective is used to compare the weld quality strength on hardness test then ARC welding has better quality than the other welding. The weld quality of SMAW and ARC welding is weaker compared to that of ARC Welding welding. That results in the breakage of sheet at uneven point. This is due to the poor welding on the sheets. If our objective is used to compare the weld quality strength on bending test then ARC Welding has better quality.

Future scope

In present work welding is performed without any filler material. A filler rod/wire feeding system can be included in the system so that by using filler rod/wire thicker plate can be welded. Welding setup can also be used for welding of some other materials.

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