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Experimental Analysis of joining two dissimilar metal using plasma arc & gas welding

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Abstract: Joining of dissimilar metals has found its use extensively in power generation, electronic, nuclear reactors, petrochemical and chemical industries The dissimilar metal joints of have been emerged as a structural material for various industrial applications which provides good combination of mechanical properties like strength, corrosion resistance with lower cost. Selections of joining process for such a material are difficult because of their physical and chemical properties. The 304 stainless steel and 1020 mild steel dissimilar material joints are very common structural applications joining of stainless steel and mild steel is very critical because of carbon precipitation and loss of chromium leads to increase in porosity affects the quality of joint leads deteriorate strength. The dissimilar metals is joining process is very difficult. Because two different materials to be welded not easy. The mild steel and stainless steel is used for welded process. The gas welding and plasma arc welded used this process .it is highly temp process used this process .thus the material reduce the corrosion resistance and increases the strength of metals
Keyword: Dissimilar metal welding, plasma Arc welding Gas welding, stainless steel ,mild steel

1. INTRODUCTION

Welding is a manufacturing process of creating a permanent joint obtained by the fusion of the surface of the parts to be joined together, with or without the application of pressure and a filler material. The materials to be joined may be similar or dissimilar to each other. The heat required for the fusion of the material may be obtained by burning of gas or by an electric arc. The latter method is more extensively used because of greater welding speed.

Welding is extensively used in fabrication as an alternative method for casting or forging and as a replacement for bolted and riveted joints. It is also used as a repair medium e.g. to reunite a metal at a crack or to build up a small part that has broken off such as a gear tooth or to repair a worn surface such as a bearing surface.

2. SELECTION OF MATERIAL & WELDING

2.1 304 STAINLESS STEEL

Steel Type 304 is a variation of the basic 18-8 grade, Type 302, with a higher chromium and lower carbon content. Lower carbon minimizes chromium carbide precipitation due to welding and its susceptibility to inter granular corrosion. In many instances, it can be used in the "as-welded "condition, while Type 302must be annealed in order to retain Adequate corrosion resistance.

Type 304 is an extra low-carbon variation of Type 304with0.03%maximum carbon content that eliminates carbide precipitation due to welding. As a result this alloy can be used in the "as-welded "condition, even in severe corrosive conditions.

Typical uses include architectural moldings and trim, kitchen equipment, welded components of chemical, textile, paper, pharmaceutical and chemical industry processing equipment

It often eliminates the necessity of annealing elements except for applications specifying stress relief. It has slightly lower mechanical properties than Type 304.

Table 1: Composition of 304 Stainless Steel

Fe	C	Si	Mn	S	P	Cr	Ni
71.433	0.058	0.35	1.32	0.007	0.032	18.52	8.28

The mechanical properties of 304 stainless steel

s.no	Mechanical properties	Metric
1	Density	0.289 lb/in³
2	Hardness, Brinell	123
3	Tensile Strength, Ultimate	505mpa
4	Poisson's Ratio	0.29
5	Modulus of Elasticity	193 - 200 GPa
6	Tensile Strength, Yield	215 MPa

2.2 Mild steel

AISI 1018 mild/low carbon steel has excellent weld ability and produces a uniform and harder case and it is considered as the best steel for carburized parts. AISI 1018 mild/low carbon steel offers a good balance of toughness, strength and ductility. Provided with higher mechanical properties,

AISI 1018 hot rolled steel also includes improved machining characteristics and Brinell hardness. Specific manufacturing controls are used for surface preparation, chemical composition, rolling and heating processes. All these processes develop a supreme quality product that are suited to fabrication processes such as welding, forging, drilling, machining, cold drawing and heat treating.

2.3 MILD STEEL CHEMICAL COMPOSITION

Mild steel contains-

Carbon - 0.16 to 0.18% (maximum 0.25 is allowable)
Manganese-0.70 to 0.90%
Silicon maximum-0.40%
Sulfur maximum -0.04%
Phosphorous maximum-0.04%
Mildest grade of carbon steel or mild steel contains a very low amount of carbon-0.05 to 0.26%

2.4 MILD STEEL MECHANICAL PROPERTIEs:

Mild steel contains -

Density – 0284ib/in
Hardness -126
Tensile strength (ultimate)- 440Mpa
Tensile strength (yield) -370Mpa
Modulus of elasticity -205Gpa
Bulk modulus- 140Gpa
Poisson ratio -0.290
Shear modulus-860Gpa

2.5 Plasma arc welding:

Plasma arc welding (PAW) is an arc welding process similar to gas tungsten arc welding (GTAW). The electric arc is formed between an electrode (which is usually but not always made of sintered tungsten) and the work piece the shielding gas envelope.

The plasma is then forced through a fine-bore copper nozzle which constricts the arc and the plasma exits the orifice at high velocities (approaching the speed of sound) and a temperature approaching 28,000 °C (50,000 °F) or higher. Just as oxy-fuel torches can be used for either welding or cutting, so too can plasma torches, which can achieve plasma arc welding or plasma is cutting. Arc plasma is the temporary state of a gas. The gas gets ionized after passage of electric current through it and it becomes a conductor of electricity. In ionized state atoms break into electrons (−) and cations (+) and the system contains a mixture of ions, electrons and highly excited atoms

2.6 Principle of operation

Plasma arc welding is a constricted arc process. The arc is constricted with the help of a water-cooled small diameter nozzle which squeezes the arc, increases its pressure, temperature and heat intensely and thus improves arc stability, arc shape and heat transfer characteristics.

Plasma arc welding processes can be divided into two basic types:

1. Non transferred arc process
2. Transferred arc process

2.7 Gas welding:

Gas welding is one type of welding process in which the edges of the metals to be welded are melted by using a gas flame. No pressure is applied during welding except pressure gas welding. The flame is produced at the tip of a welding torch. The welding heat is obtained by burning a mixture of oxygen and combustible gas .the flame only melts the metal. A flux is used during welding to prevent oxidation and remove impurities. Metal having 2mm to 50mm thick are welded by gas welding. Based on the type and combination of gases used for producing flame, there are three types of gas welding process used in industries such as

1. Air-acetylene welding
2. Oxy-acetylene welding
3. Oxy-hydrogen welding

2.8Oxy-Acetylene welding:

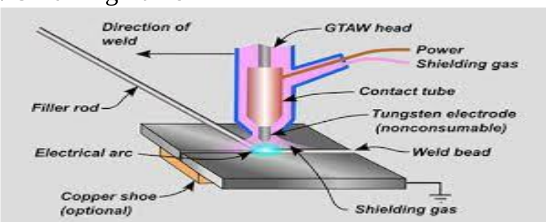
The most common form of gas welding is oxy-acetylene welding.it is a commonly used to permanently join mild steel. The use of oxygen and acetylene as welding gases dates back the 1890's..the combination of oxygen and acetylene produces a flame temperature above 3200◦c, making it ideal for welding and cutting. When the flame comes in correct in contact with steel it melts the metals the surface forming a molten pool and allowing to take place as shown. There are two types of oxy-acetylene system employed depending upon the manner in which acetylene is supplied for welding.

a) High-pressure system b) Low pressure system

<u>4.4 Flame characteristics</u>:

It is a very important to adjust the flame to suit the welding conditions. It is a done regulating the supply of oxygen and acetylene. By varying ratio of oxygen and acetylene the following three types can be obtained

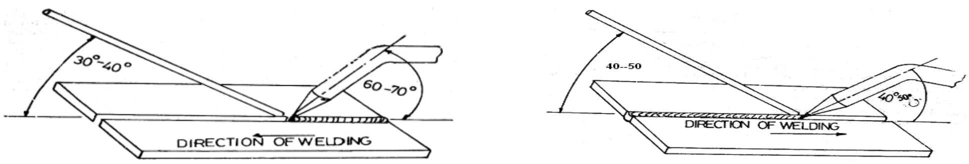
1. Neutral flame
2. Carburizing flame and
3. Oxidizing flame



2.10Gaswelding technique:

There are two techniques commonly used depending on the movement of torch along the weld

1. Leftward or forward welding
2. Rightward or backward welding



3. WELDING OF DISSIMILAR WELDING

3.1 Dissimilar welding:

Joining of dissimilar metals has found its use extensively in power generation, electronic, nuclear reactors, petrochemical and chemical industries mainly to get tailor-made properties in a component and reduction in weight. However efficient welding of dissimilar metals has posed a major challenge due to difference in thermo-mechanical and chemical properties of the materials to be joined under a common welding condition. This causes a steep gradient of the thermo-mechanical properties along the weld.

Plasma arc welding

Gas welding

A variety of problems come up in dissimilar welding like cracking, large weld residual stresses, migration of atoms during welding causing stress concentration on one side of the weld, compressive and tensile thermal stresses, stress corrosion cracking, etc. Now before discussing these problems coming up during dissimilar welding, the passages coming below throw some light on some of the causes of these problems.

In dissimilar welds, weld ability is determined by crystal structure, atomic diameter and compositional solubility of the parent metals in the solid and liquid states. Diffusion in the weld pool often results in the formation of intermetallic phases, the majority of which are hard and brittle and are thus detrimental to the mechanical strength and ductility of the joint.

The thermal expansion coefficient and thermal conductivity of the materials being joined are different, which causes large misfit strains and consequently the residual stresses results in cracking during solidification

4. TESTING PROCESS OF DISSIMILAR METALS

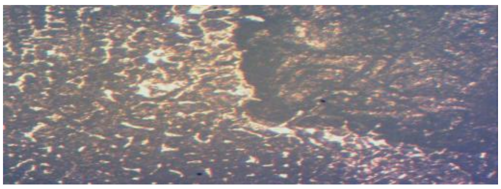
4.1 MICROSTRUCTURE

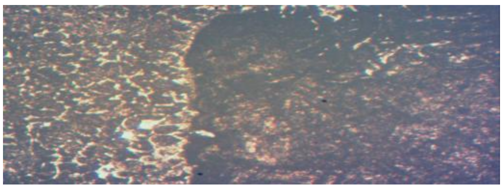
Microstructure is the small scale structure of a material, defined as the structure of a prepared surface of material as revealed by a microscope above 25× magnification.[1] The microstructure of a material (such as metals, polymers, ceramics or composites) can strongly influence physical properties such as strength, toughness, ductility, hardness, corrosion resistance, high/low temperature behavior or wear resistance. These properties in turn govern the application of these materials in industrial practice. Microstructure at scales smaller than can be viewed with optical microscopes is often called nanostructure

4.2Microstructure in plasma arc welding

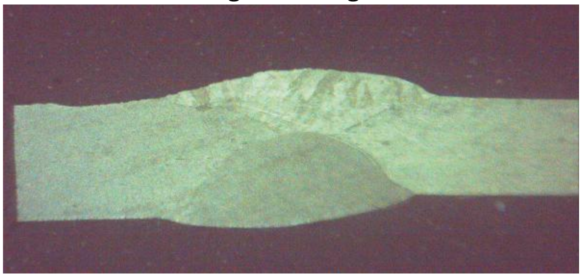
10×1

20×1





4.3microstructurein gas welding



10×1

20×1

4.4 Nondestructive testing

Nondestructive testing or non-destructive testing (NDT) is a wide group of analysis techniques used in science and technology industry to evaluate the properties of a material, component or system without causing damage.[1] The terms nondestructive examination (NDE), nondestructive inspection (NDI), and nondestructive evaluation (NDE) are also commonly used to describe this technology.[2]

4.5 Dye penetrant inspection (DPI), liquid penetrant inspection (LPI) OR penetrant testing (PT)

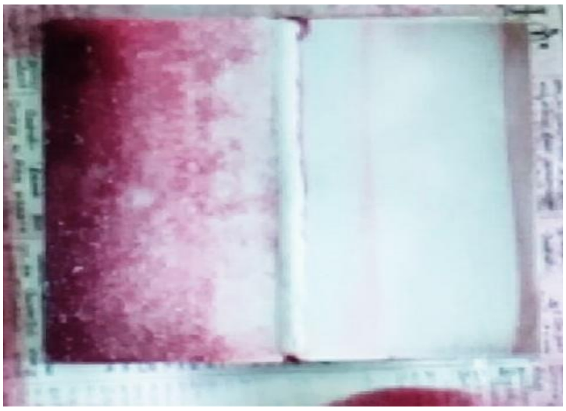
The penetrant may be applied to all non-ferrous materials and ferrous materials although for ferrous components magnetic-particle inspection is often used instead for its subsurface detection capability LPI is used to detect casting, forging and welding surface defects such as hairline cracks, surface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

4.6 Inspection steps

Below are the main steps of Liquid Penetrant Inspection:

1. Pre-cleaning .
2. Application of Penetrant
3. Excess Penetrant Removal
4. Application of Developer
5. Inspection
6. Post Cleaning

Penetrant test gas welding



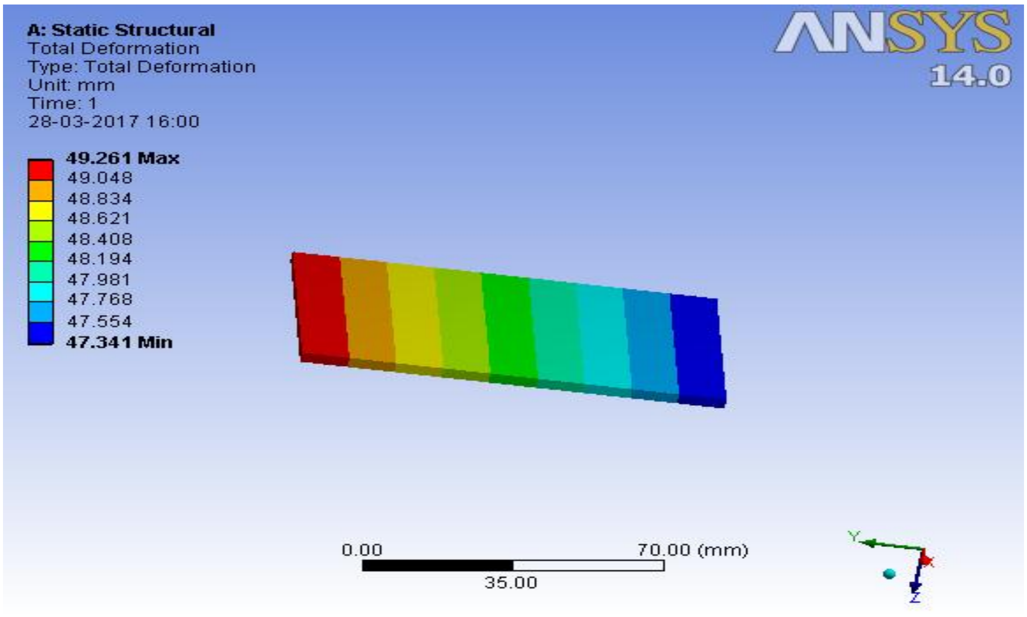
Penetrant test in plasma arc welding

4.7Finite Element Analysis

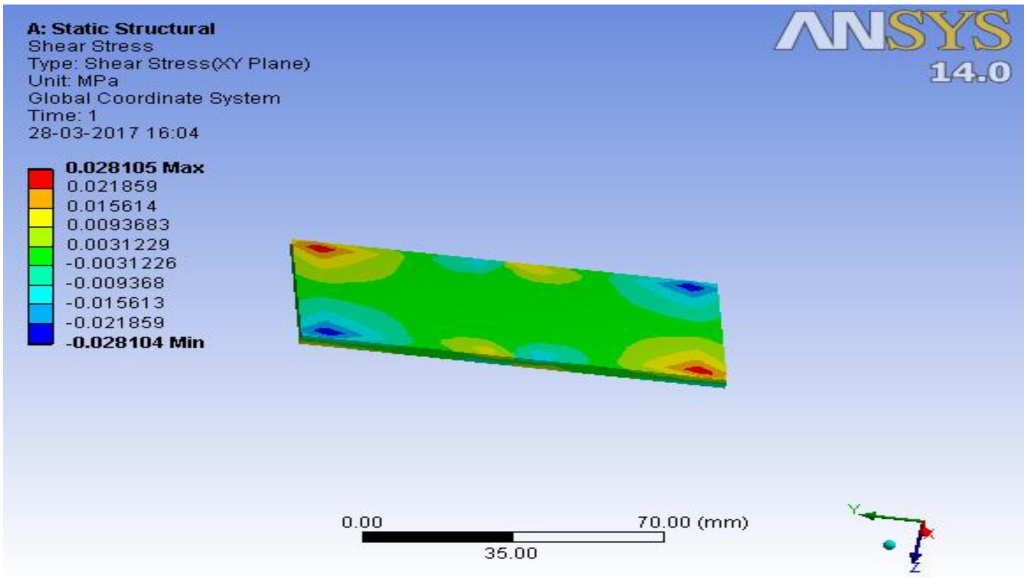
Finite Element Analysis (FEA) is a numerical method for solving problems of engineering and mathematical physics Useful for problems with complicated geometries, loadings, and material properties where

The total deformation result shows that tensile value in the weld joint to be 410 Mpa then the weld zone to be deformed. The total stress occurred in the center line of the weld joint analytical solutions cannot be obtained

Total deformation



Shear stress



5. Conclusion

The conclusions which can be made from the review paper are, plasma arc welding &gas welding of welding processes can be used in weld dissimilar metals. Study of the mechanical properties of the weld is very important because the main purpose of the welding is to strongly join the two metals together as the application of the welded structure may be at sensitive place the mild steel and stainless steel very difficult to joining to the metals. The dissimilar metals are mostly used from a high temperature place using from to the process. The mild steel and stainless steel in melting point high.so we can use from use highly critical area used from to thee process.

The boiler high temp process.so we have used from the type dissimilar metals used from process. Highly safe, long life used and more strength. Mostly high temp process used from to the process

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