Non Destructive Testing on MIG Welding of Dissimilar Materials By Using Different Filler Rods

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Abstract- *The dissimilar joining of Aluminum to stainless steel was performed by gas tungsten arc welding process using different filler materials. The results indicated the formation of defect free joint by using Aluminum filler material. But, the presence of some defects like solidification crack and lack of fusion caused decreasing tensile strength of other joints. Aluminum and stainless steel were lap-welded by using Metal Inert Gas (MIG) welding with aluminum filler (Group 1) and stainless steel filler (Group 2). The effects of the welding voltage and type of filler metals used on the weld joints were studied. Nondestructive testing or Non-destructive testing (NDT) is a wide group of analysis techniques used in science and industry. Because NDT does not permanently alter the article being inspected, it is a valuable technique that can save both money and time in product evaluation, and research. Testing methods include ultrasonic, magnetic-particle, liquid penetrant, radiographic, remote visual inspection (RVI), eddy-current testing, and low coherence interferometry. Nondestructive testing is a tool in forensic engineering, mechanical engineering, electrical engineering, civil engineering, systems engineering, aeronautical engineering, medicine and art.*

Keywords- gas tungsten arc welding; Aluminum; stainless steel; dissimilar joint; microstructure, NDT testing.

I. INTRODUCTION

Nondestructive testing rely on use of electromagnetic radiation, sound and inherent properties of materials to examine samples. This includes some kinds of microscopy to examine external surfaces in detail, although sample preparation techniques for metallography, optical microscopy and electron microscopy are generally destructive as the surfaces must be made smooth through polishing or the sample must be electron transparent in thickness.Sound waves are utilized in the case of ultrasonic testing. Contrast between a defect and the bulk of the sample may be enhanced for visual examination by the unaided eye by using liquids to penetrate fatigue cracks.

MIG welding is abbreviated for the phrase Metal Inert Gas, and MAG is abbreviated as Metal Active Gas. Some shielding gases mainly carbon dioxide and oxygen will react with the welding arc and puddle and help make the weld. So these are called active gases. But gases like argon and helium do not have any effect on the actual welding arc and therefore that's why they are called inert gases.

It is much faster than TIG or Stick welding and it can be adapted to robots and used in high end production facilities where part after part is repetitively manufactured. Usually a filler metal is, however, melted into the welding seam, or weld, either using a wire feeder through the welding gun (MIG/MAG welding) or by using a manual-feed welding rod.

II. TYPES OF NDT METHODS

Broadly ndt methods are classified into the five main types as

1. Visual inspection
2. Liquid penetrant inspection
3. Magnetic particle testing
4. Radiographic inspection
5. Ultrasonic testing.

III. OBJECTIVES

The objectives of this project are to;

i. Investigate the weld quality and defects using optical devices.
ii. Investigate the effects joining stainless –aluminum with various filler materials.
iii. Investigate of welding defects by NDT methods the results of experiment.

IV. LITERATURE REVIEW

Welding has become one of the most important metal working processes as almost everything made of the metal is welded. Products of the welding industry include automobiles, airplanes and jet engines. It is attracting attention nowadays, due to its many advantages, such as low manufacturing cost and the ability to reduce working operations.

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V. EXPERMENTIAL

It is fact that there are inherent flaws in materials due to crystal lattice imperfections and dislocations however microscopic they may be. Manufacturing processes such as welding, casting, forging, surface treatment, etc. may cause further flaws or defects. Materials are used under various conditions of stress, fatigue and corrosion, which may create additional defects or aggravate present ones. It has been established that most material failures occur because these defects reach dangerous proportions such that remaining parts of the materials could not withstand the stress they are subjected to, thus become ductile or brittle.

Various NDT methods have been developed, each one having advantages and limitations making it more or less appropriate for a given application. With the variety of NDT methods available, it is important to select the method that will provide the necessary results. A combination of different NDT tests may be applied to provide assurance that the material or component is fit for use.

RADIOGRAPHY TESTING

The method of radiographic testing involves the use of a source of radiation from which the radiations hit the test specimen, pass through it and are detected by a suitable radiation detector placed on the side opposite to that of the source. While passing through the test specimen the radiations are absorbed in accordance with the thickness, physical density and the internal defects of the specimen and the detector system therefore receives the differential radiations from different parts of a defective specimen which are recorded onto the detector.

Radiography Testing (RT), or industrial radiography is NDT method of inspecting materials for hidden flaws by using the ability of short wavelength electromagnetic radiation (high energy photons) to penetrate various materials Radiographic Testing Method is nothing but to take the shadow picture of an object onto a film by the passage of X-ray or Gamma ray through it. It is the same as the medical radiography (X-ray).

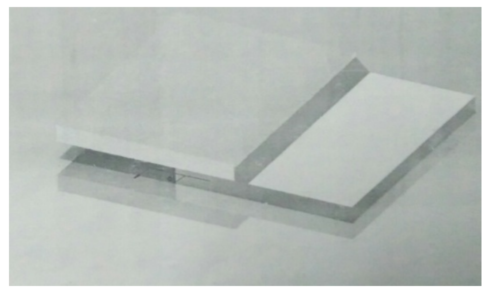

Figure 1. Diagram of MIG Welding

In MIG welding process the arc is maintained between a consumable electrode and the work piece in an inert gas atmosphere. The coiled electrode wire is fed by drive rolls as it melts away at the tip. Except for aluminum, a DC source is used with the consumable electrode as the positive terminal. For welding steel, a shielding is provided by CO2 for lowest cost. Normally, a high current density in the electrode (of the order of 10,000 amp/cm2) is used so that projected types of metal transfer results. The welding current is in the range 100-300 amp. The process is primarily meant for thick plates and fillet welds. MIG welding process is one of the most employed to weld aluminum alloys.

MATERIALS USED

Pure aluminium does not meet the demands made on modern construction materials for high yield stress and high rechrystallisation temperature, so that increase of strength is not lost at increased working temperatures and processing temperatures. It is possible to some extent to meet these demands by means of alloying and heat treatment. Mg, Cu, Si, Mn and Zn are the most important alloying elements. Other alloying elements are Fe, Ni, Cr, Co, Ti, Pb, Sb and Bi. The strength of aluminium, especially the ternary (triple) alloys Al-

Cu-Mg, Al-Si-Mg and Al- Zn-Mg, can be increased considerably by means of secondary hardening.

Iron and the most common iron alloy, steel, are from a corrosion viewpoint relatively poor materials since they rust in air, corrode in acids and scale in furnace atmospheres. In spite of this there is a group of iron-base alloys, the iron-chromium-nickel alloys known as stainless steels, which do not rust in sea water, are resistant to concentrated acids and which do not scale at temperatures up to 1100°C. It is this largely unique universal usefulness, in combination with good mechanical properties and manufacturing characteristics, which gives the stainless steels their raison d'être and makes them an indispensable tool for the designer. The usage of stainless steel is small compared with that of carbon steels but exhibits a steady growth, in contrast to the constructional steels. Stainless steels as a group is perhaps more heterogeneous than the constructional steels, and their properties are in many cases relatively unfamiliar to the designer. In some ways stainless steels are an unexplored world but to take advantage of these materials will require an increased understanding of their basic properties.

Table 1. Chemical composition of base plate and weld material (mass fraction, %)

Chemical Names	Stainless Steel 304	Aluminium 5083
Al		Rem -
Si		0.40
Ti		0.15
Fe		0.40
Cu		0.10
Mn		0.40- 1.00
Mg		4.00- 4.90
Cr		0.05- 0.25
Zn		0.25

Table 2. Table 1. Chemical composition of base plate and weld material (mass fraction, %)

Parameters	values
Welding current/ A	200
Shielding gas	Co2
Gas flow	12
Plate thickness	6mm
Filler diameters	0.8mm

In order to join AA5083 to 304 austentic Stainless steel by MIG welding process, plates with dimension is (100mmx300mmx6mm) and shown in fig.1 were cut from rolled plates. Lap joint design was selected in order to concentrate heat flow on the plates to compensate heat loss due to its high thermal conductivity. Then MIG welding were performed using different filler materials. Table 1 lists the chemical composition of the plates and filler materials. Also, the welding conditions and parameters are listed in Table 2.

The plates are 304 Stainless Steel were machined to the required dimensions (100mmx300mmx6mm). Lap joint configuration, as shown in Fig.2, was prepared to fabricate MIG welded joints. The initial joint configuration was obtained by securing the plates in position using tack welding for MIG welds. All necessary care was taken to avoid joint distortion, and the joints were made with suitable clamps. Single pass welding was used to fabricate the joints. SS 304 grade filler rod and wire were used for MIG welding processes, respectively. High purity (99.99%) Co2 gas was the shielding gas.

The plates are AA5083 were machined to the required dimensions (100mmx300mmx6mm). Lap joint configuration, as shown in Fig.3, was prepared to fabricate MIG welded joints. The initial joint configuration was obtained by securing the plates in position using tack welding for MIG welds. All necessary care was taken to avoid joint distortion, and the joints were made with suitable clamps. Single pass welding was used to fabricate the joints. AA5083 grade filler rod and wire were used for MIG welding processes, respectively. High purity (99.99%) Co2 gas was the shielding gas.

VI. RESULTS AND DISCUSSIONS

ULTRASONIC TESTING

The factors that affect the sensitivity of flaw detection in radiographic testing are the type of specimen, its geometry, shape, thickness and physical density; type, location and orientation of defects with respect to the direction of the beam of radiation; exposure conditions such as energy of radiation, scattering, source-to-film distance, object-to-film distance, source size, filters if used, intensifying screens, etc.; type of film used and the film processing conditions; film viewing conditions and the operator's eye sight, qualifications, skill and experience.

Figure 2. Scan plate 1

Figure 3. Scan plate 2

The formation of defect may be due to the high cooling rate of the fusion zone because of the presence of base material with high thermal conductivity and entrapment of welding gases such as co2 into weld metal.

On the other hand, high thermal expansion of the austentic stainless steel and the presence of low melting temperature phase between the grain boundaries led to the formation of solidification cracks in the Aluminium side.

WELDING DEFECTS

A welding defect is any flaw that compromises the useful of a weld ment. The Improper welding parameters, base metal and selection of method introduce in the weld metal. So, the defective weld causes failure in service conditions and damages to the properties the defects in weld depending on thickness, load, size and environment of the weld.

1. Lack of Fusion

Lack of fusion is the poor adhesion of the welded beat to the base metal. The parameter mainly affects thee welding current. If the current is very low, it is not sufficient to heat the metal all over the place. The wrong design of the weld also causes defects.

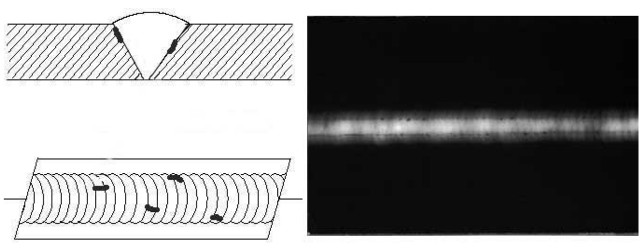

Figure 4. Lack of Fusion

2. Porosity

It is a small voids in weld metal formed by gases entrapped during solidification. It is caused by inclusions of atmospheric gases, sulfur in weld metal or surface contaminates.

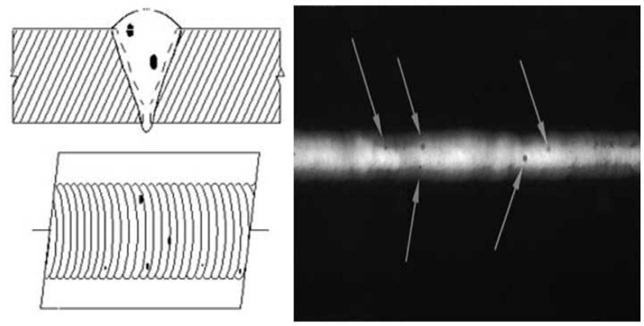

Figure 5. Porosity

It is due to presence of gases in the solidifying metal are producing porosity. The gases are; oxygen, nitrogen and hydrogen.

3. Cavity

Cavities are formed by shrinkage during solidification.

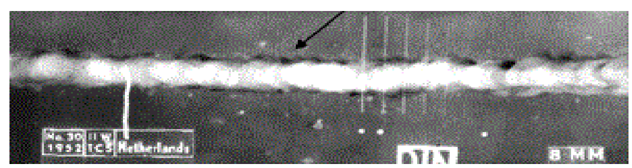

Figure 6. Cavity

VII. CONCLUSION

In this project, it is found that the great effect of welding parameters such as welding current, gas flow rate and welding speed on weld bead geometry (front and back width) of weld joint. Dissimilar materials are used to different filler rods to the testing of radiography and ultrasonic testing.

Radiography testing on Stainless Steel filler rods in welding is done and are having low defects. But the same time another testing on Aluminium filler rods in welding is not applicable for the dissimilar materials. Ultrasonic testing is not applicable for both the filler rods because they having lots of defects in the welding and the dissimilar materials is not suitable for this welding process.

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