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Evaluation of Mechanical and Metallurgical Properties of TIG Welded Aluminium Alloy Joint

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Abstract – *Aluminium alloys are alloys in which aluminium is the predominant metal. The typical alloying elements copper, magnesium, manganese, silicon, tin and zinc. Al and aluminium alloys plays an important role in engineering and metallurgy field because of fabrication and formability. TIG welding technique is one of the precise and fastest process used in aerospace industries, ship industries, automobile industries, nuclear industries and marine industries. TIG welding is a high quality welding process used to weld the aluminium. Gas Tungsten arc welding (GTAW) for surfacing are high reliability, all position capability, ease of use, low cost and high productivity. Due to high strength, good welding properties, increased wear and corrosion resistance and high strength-to weight ratio, Aluminium 5083 is widely used in Ship building, Rail cars, Vehicle bodies, Tip truck bodies, Pressure vessels. The welding parameters such as welding current, Gas flow rate and different diameters are taken into account which influences the properties of material at welded area. The effect of welding process parameters is analyzed by conducting of micro hardness, tensile test and microstructure on weld joint.*

Key Words: **AA5083, Pulsed TIG welding, Specimen, Filler rod, Gas Flow Rate.**

1. INTRODUCTION

Welding is a permanent joining process used to join different materials like metals, alloys or plastics, together at their contacting surfaces by application of heat and or pressure. During welding, the work-pieces to be joined are melted at the interface and after solidification a permanent joint can be achieved. Sometimes a filler material is added to form a weld pool of molten material which after solidification gives a strong bond between the materials. Weld ability of a material depends on different factors like the metallurgical changes that occur during welding, changes in hardness in weld zone due to rapid solidification, extent of oxidation due to reaction of materials with atmospheric oxygen and tendency of crack formation in the joint position. Aluminium alloys are widely used to produce aerospace components with high specific strength.

1.1 TIG WELDING

TIG welding processes, the arc is struck from a consumable electrode to the work piece and metal has been melted from electrode, transferred across the arc and finally incorporated into the molten pool. TIG process employs an electrode, made from high melting point metal, usually a type of tungsten, which is not melted. The electrode and the molten pool are shielded from the atmosphere by a stream of inert gas which flows around the electrode and is directed onto the work piece by a nozzle which surrounds the electrode. In TIG welding, the primary functions of the arc are to supply heat to melt the work piece and any filler metal which may be necessary. TIG welding was, like MIG/MAG developed during 1940 at the start of the Second World War. TIG's development came about to help in the welding of difficult types of material, e.g. aluminium and magnesium. The use of TIG today has spread to a variety of metals like stainless mild and high tensile steels. GTAW is most commonly called TIG (Tungsten Inert Gas).The development of TIG welding has added a lot in the ability to make products that before the 1940's were only thought of. Like other forms of welding, TIG power sources have, over the years, gone from basic transformer types to the highly electronic power source of the world today

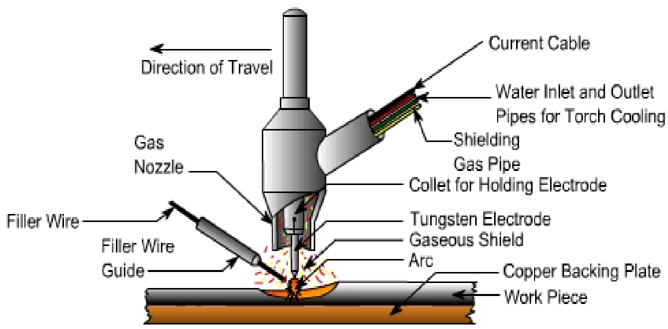

Figure 1.1- TIG Welding

2. LITERATURE REVIEW

[1] Swapnil Verma, Sidharth Singh, Shubham Govil, Neha Bhadauria (Feb 2017)

It is observed that TIG welding is one of the best welding techniques for aluminium alloy. Filler material also plays a very important role in determining the yield strength as it was obtained that larger yield strength.

[2] Sunil M. Pawar1, Prof. Vivek V. Kulkarni (may2015)

After welding, the ductility of weld zone is higher due to low strength filler wire. So the ultimate tensile strength and yield strength of the specimen are higher.

[3] B. RAVINDAR, 2K. GURURAJ

Micro hardness and Vickers hardness with changes of welding current, gas flow rate and filler rod diameter by using pulsed tungsten inert gas welding technique is investigated. Hardness value of the weld zone changes with the distance from the center due to change of microstructure.

3. ANALYTICAL WORK

In the present work, tensile test analysis of a welded joint specimen is conducted in a virtual environment. The material used for the analysis is AA5083 aluminium alloy, whose composition is listed in Table 1.

Table -1: Chemical composition of AA5083

ELEMENT	WEIGHT %
Aluminium	94.7
Manganese	0.7
Magnesium	4.3
Chromium	0.15
Silicon	0.5
Copper	0.1
Titanium	0.15

Table -2: Mechanical Properties

Property	Value
Tensile strength(MPa)	330
Shear strength(MPa)	185
Elongation	17
Hardness Vickers(HV)	95

4. EXPERIMENTAL WORK

The aluminum alloy AA5083 is welded by TIG welding with suitable filler rod, welding current, gas and gas flow rate then the material is machined to get required shape. The machined material is then subjected to various test before doing the test the material is machine to fit in the testing machine then the following test are taken micro hardness, tensile test and microstructure on the welded area.

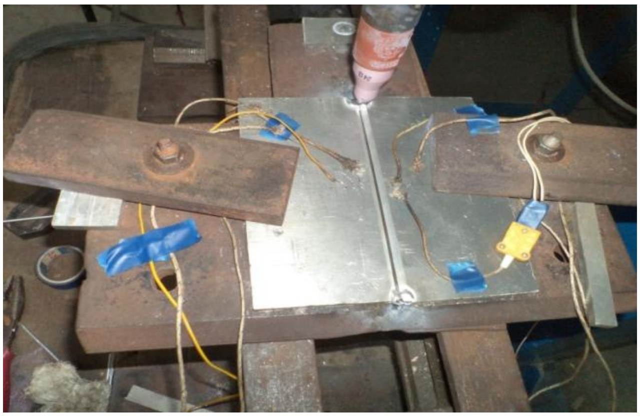

Figure 4.1- Welding process

Then the tested component is compared to base metal with the old value and the welded value to know the changed properties of the metal after welding process

Tensile material after testing

Figure 4.2- After tensile test

5. FINAL ANALYSIS

5.1 Microstructure

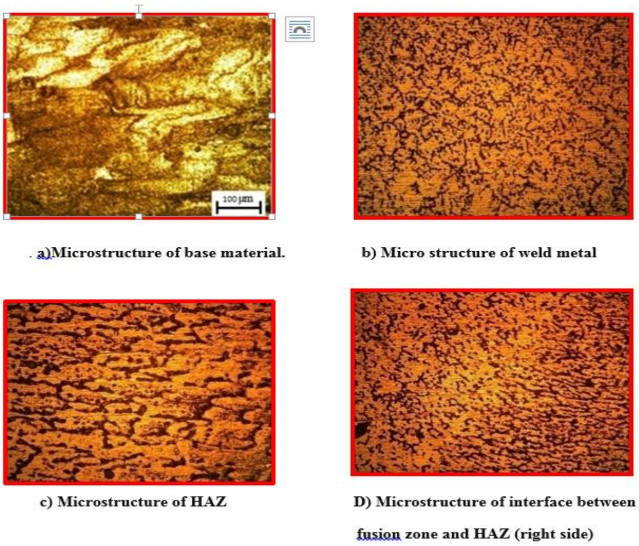

Figure 5.1- Microstructure

The micro structure of base material is shown in Fig. (a).The matrix shows severely worked grains of primary phase and the particles of Mg-Al_2 and some insoluble Al_6 (Fe, Mn). The solubility of Mg in aluminum is lower and hence the particles of Mg-Al_2 are present and formed a banding along the direction of rolling. The particles in aluminum solid solution have fragmented and partially elongated with primary phase. However, the size and distribution of strengthening precipitates are different in GTA welded joints. From the micrographs, it was observed that there was an appreciable difference in grain size of the weld zone and HAZ regions. The matrix shows bigger particles appeared and the dissolved particles grown to bigger size. This may be due to the rapid cooling induced by good thermal conductivity and low thermal capacity of aluminium. The grain size of the fusion zone and HAZ are influenced by the heat input of the welding process. In the HAZ, the grains next to the fusion boundary were found to be grown larger due to the intense heat and high temperature experienced during welding. The weld zone of GTAW welded joints contain dendritic structure and this may be due to fast heating of base metal and fast cooling of molten metal due to welding heat. The optical micro graphs of weld metal and heat affected zone (HAZ) are shown in Fig. (b) and Fig.6 (c) respectively. Figure (d) shows the interface between weld metal and HAZ.

5.2 Micro Hardness

Table 3: Micro hardness test result

S.No	Sample Piece	Observed Value			Average Value
		1	2	3	
1	TIG welded aluminium alloy	83	82	83	83

5.3 Tensile Test

Tensile test for Base Material

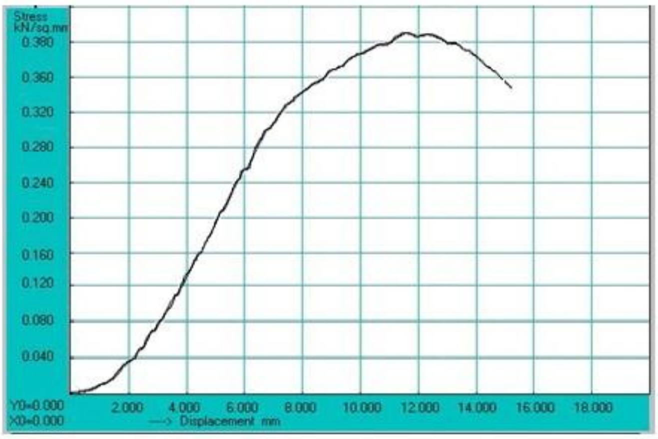

Chart 5.3.1- Tensile test for base material
Tensile test Before Welding is **385 MPa**

Tensile test for welded material

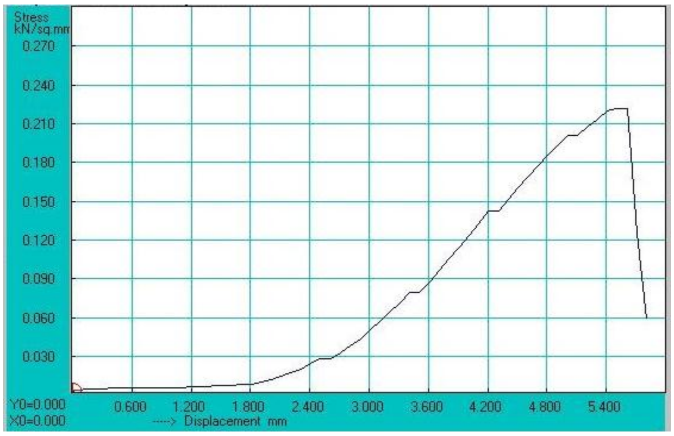

Chart 5.3.2- tensile test for welded material
Tensile test after welding is **225 MPa**

6. CONCLUSION

In this paper, the effect of GTAW of AA 5083 aluminium alloy has been analyzed by experimental approach. Due to welding the mechanical properties of aluminium AA5083 will be changed the changed values will be compared to the base metal. Finally it is observed that TIG welding is one of the best welding techniques for aluminium alloys.

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