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EXPERIMENTAL INVESTIGATION OF MICROSTRUCTURE AND MECHANICAL PROPERTIES OF TIG WELDED DISSIMILAR ALUMINUM ALLOY AA6061/AA6063 AT DIFFERENT WELDING CURRENT

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ABSTRACT

Aluminium combinations are notable for its applications in manufacturing industries. TIG welding is the widely used technique for the joining of both ferrous and non-ferrous metals. The present work focuses the study of Micro-structural and mechanical properties of the welded joints of 6 mm thick Aluminium plate of grade AA-6061 andAA-6063, using Tungsten Inert Gas welding by using Filler wire of grade AA-4043 with welding current as varying parameter and also to investigate the influence of the process parameters. A single V-butt joint configuration (bevel angle 60˚ and root gap 1.5 mm) of plates was used for welding.The accuracy and quality of welded joints largely depends upon type of power supply, welding speed, type of inert gas used for shielding and also the gas flow rate. Welding speed and current were the most influencing process parameter for controlling the hardness of HAZ and tensile strength of the welds. Results have shown that optimum weld current out of the three weld currents used (75A, 85A and 95A) is 75A.Better microstructure and mechanical properties were found in the welded joints for the weld current 75A.

Keywords: AA6061, AA6063, Aluminum alloys, TIG welding, Mechanical properties, Microstructure.

1. INTRODUCTION

Aluminium is an environmental friendly and green material as it can be easily and efficiently be recycled infinitely. Due to its high specific strength, stiffness and good corrosion and oxidation resistance aluminium becomes an important substitute material to most of the engineering materials including steel.

Thus aluminium fits for vast application in aerospace industries, high speed and light weight vehicles, marine and other engineering sectors for various structural applications. For fabrication of complex structures and equipment, fusion welding is mostly used as it is least expensive, fast, easy to use and reliable process. Welding of aluminium alloys is not only challenging due to high thermal conductivity,oxide layer formation but also has adverse effect on mechanical properties of welds on account of various defects and metallurgical changes. Porosity, voids,loss of alloying elements, distortion, development of residual stress, hot cracking, localized strength reduction, formation of Heat Affected Zone (HAZ) are some main problems associated with fusion welding of aluminium alloys. Formation of Al_2O_3solid inclusion was also reported in literature. These problems become more crucial while performing welding of dissimilar aluminium alloys because of different chemical composition, mechanical and thermal properties. The adverse effect of fusion welding on aluminium alloy can be reduced by controlling the heat input which can be governed by process parameter. Friction stir welding have some advantages over fusion weld but also have its own characteristic demerits .The prediction of weldment strength become more difficult when dissimilar alloys having different melting point and thermal conductivity are to be welded by fusion welding techniques.There are many studies present in literature on the effect of process parameter on tensile properties and microstructure of welded joints of similar or dissimilar aluminium alloy.

2. EXPERIMENTAL WORK

We have selected the material as aluminum alloy of grade AA-6061 T-651 and cut the pieces in the rectangular form of the size as 200 mm x 150 mm x 6 mm. For the welding of aluminum alloy AA-6061 and AA-6063 we have selected the filler wire of grade as AA-4043 having the diameter as 1.5 mm. After the cutting of the pieces we have to use the TIG welding on pieces at the different values of welding current for the experimental procedure. Before the welding the pieces are we have to prepare the pieces for the welding. The grinding was being done on the edges of the pieces to provide them a better smoothness for a proper welding joint. After that we have used the grit emery paper for the removal of the any kind of external material from the surface of the plate. TIG welding was carried out by varying the welding current (75, 85 & 95 Amps), with a shielding gas flow rate (10, 11, & 12 L/min). The voltage and all other welding parameters were kept constant during the process. From the study, the factors which are having significant impact on the performance of TIG welding has identified as, welding current (Amps), Welding speed, gas flow rate (L/min) and these factors were controlled during the welding

Table 1

Sample	Voltage (V) Volt	Current (I) Amps	Root gap (R) mm	Gas flow rate (G) litre/mins
1	40	75	1.5	10
2	40	85	1.5	11
3	40	95	1.5	12

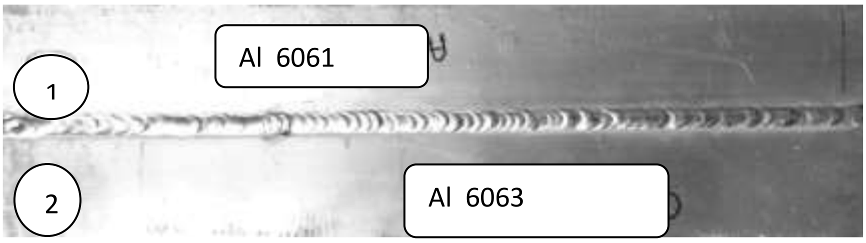

Figure 2.1 TIG welded Al 6061 / Al 6063 Plates

3. RESULTS & DISCUSSION

After the welding the welded specimen are passed through the microstructure testing and micro-hardness testing of the base material and of the welded portion. The micro-structural testing takes place by using the optical microscopy and micro-hardness examined by using the Vickers hardness tester. Specimens are to be cut in the lab with hand hacksaw for the testing having the size as 50 mm x 10 mm x 6 mm as shown in figure. After cutting the pieces these are to be passed through the different operations such as grinding, polishing with grit size emery paper and finally the etching process with the etching liquid solution.

Microstructure of the welded part of aluminium alloy AA-6061/ AA-6063 welded at the current 75 ampere

The microstructure of the welded part (as shown in the fig.) consists of interdendritic network of aluminium silicon in matrix of aluminium solid solution.

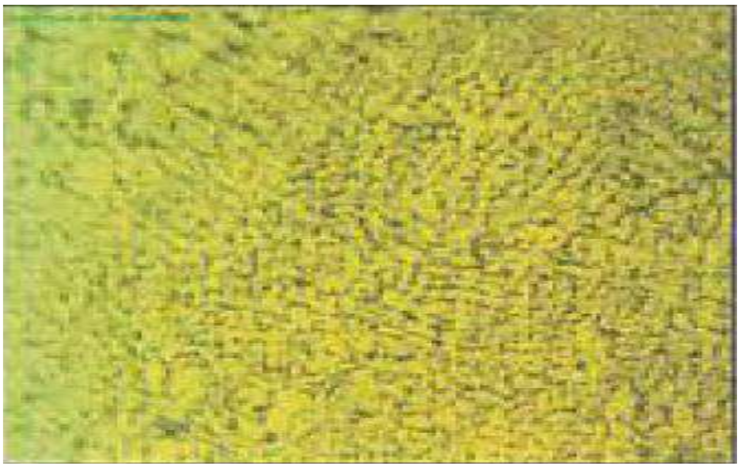

Figure 3.1 Microstructure of the welded part at welding current as 75 ampere

MICRO HARDNESS TEST

In General, both AA6061 and AA6063 alloys have exhibited decrease in micro hardness in the weld as compared to their corresponding base material. This is mainly because of coarsening, dissolution caused by TIG thermal cycle.

Micro Structure of Base material of aluminum alloy AA-6061

The testing method used for the microstructure testing was ASM 9, 2004. The microstructure of the base material specimen was captured on the microscope at 200 X magnification with help of camera along the weld. The grain size of the particles of the aluminium alloy AA-6061 was 0.005-0.010 mm in the microstructure. Oxide/Inclusions were negligible on the surface of the base material. Only few sports of porosity (up to .02 mm) were present. Primary Silicon was not present in the microstructure of the base material

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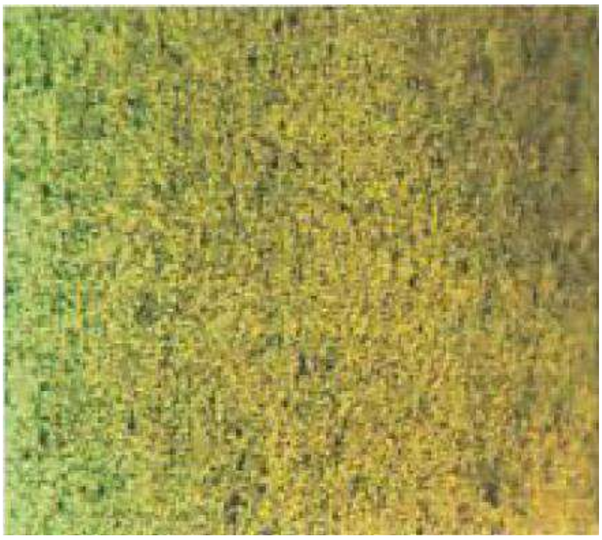

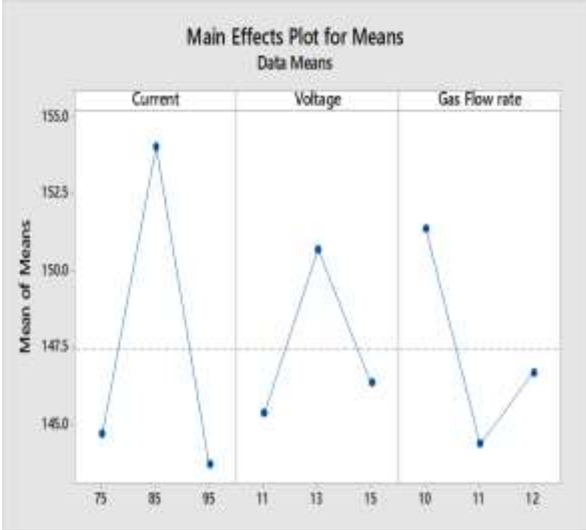

Figure 3.2 Microstructure of base material **Figure 3.3 –** Main Effects plot for Means

In this main effect plot for mean it shows the mean effect for different level of current, gas flow rate and are compared to evaluate the relative strength of the effect on various factors.

4. CONCLUSIONS

Aluminium plates of two dissimilar grade AA-6061 and AA-6063, of 6 mm thick was welded by using Tungsten Inert Gas welding by using Filler wire of grade AA-4043

with welding current and Gas flow rate as varying parameter to study the Micro-structural and mechanical properties of the welded joint.The accuracy and quality of welded joints largely depends upon type of power supply, welding speed, type of inert gas used for shielding and also the gas flow rate. Welding speed and current were the most influencing process parameter for controlling the hardness of HAZ and tensile strength of the welds. Both AA6061 and AA6063 alloys have exhibited decrease in micro hardness in the weld as compared to their corresponding base material. This is mainly because of coarsening, dissolution caused by TIG thermal cycle. There is the alternative change in the micro-hardness value with the increasing of welding current during this experiment. The base material microstructure has the closely packed molecules atomic structure. Results have shown that optimum weld current out of the three weld currents used (75A, 85A and 95A) is 75A, keeping Voltage as a constant parameter and varying Gas flow Rates (10, 11, & 12 L/min). Better microstructure and mechanical properties were found in the welded joints for the weld current 75A.

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