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Materials Today: Proceedings XX (2016) XXX–XXX

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PMME 2016

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Mechanical Properties and Microstructure of Al-5083 by TIG Welding

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Abstract

The current study deals with the parametric and microstructural analysis and of Al5083 welded specimen with an automated TIG set up. TIG provides one of the most precise and quality welding fastest welding speed can be used in marine, aerospace and ship industries. Welding speed, current, gas flow rate are the important parameters which are directly affecting the tensile strength of welded specimen and plays an important role in metallurgical changes. Wire EDM cutting is used to cut the welded specimen as per ASTM standard. Tensile strength increases by increasing welding speed till an optimum value and further decreases by increasing the welding speed. Micro-Structural changes are investigated by X-ray diffraction (XRD) and Scanning electron microscopy (SEM) and Energy dispersive spectroscopy (EDS).

Selection and Peer-review under responsibility of International Conference on Processing of Materials, Minerals and Energy (July 29th – 30th) 2016, Ongole, Andhra Pradesh, India.

Keywords: TIG welding, Al-5083,Tensile Strength,Micro-Structure

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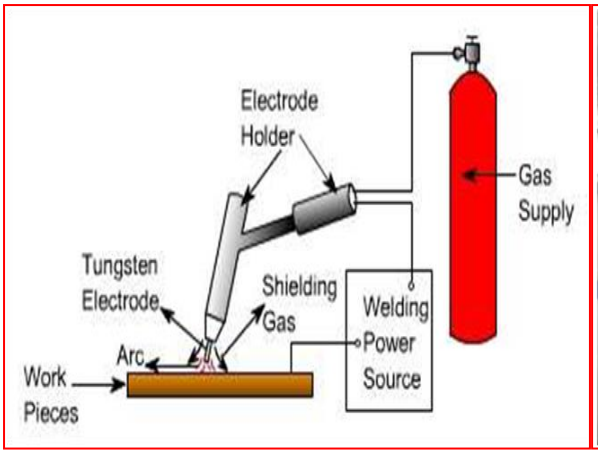
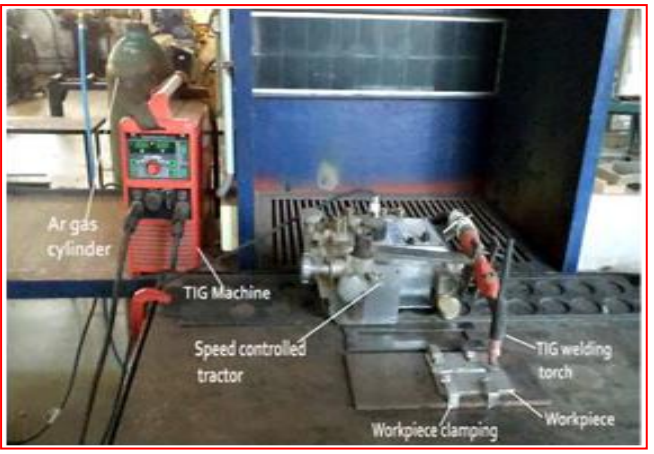
1. Introduction

Many welding processes like Tungsten inert gas welding (TIG), Gas metal arc welding (GMAW), and Gas Tungsten arc welding (GTAW) are used for various applications in industry to weld light weight materials, aluminum, magnesium and its alloy. TIG welding process uses non consumable electrode to produce weld and welded area is shielded by Helium (He) and Argon (Ar) gases [1]. This investigation focuses to make a crystal clear understanding of changes in mechanical properties by the change in microstructures. A well controlled experiment of three sets and each set contains three sample shows a pattern of tensile strength with the three parameters gas flow rate, current, welding speed effect. It is suggested that caution should be exercised when using TIG method for Al5083 in HSTs where such welding technique is adopted [2]

Nomenclature

He, Ar	Helium, Argon
A	Ampere





[Figure-1& 2 Schematic Diagram of TIG welding and Experimental Set-up of TIG welding]

2.0 Experimental Set up-

Welding of Al 5083 series plate (100x20x3) mm has been done at various parameters like welding speed and welding current and gas flow rate in the set up by TIG welding shown below figure-1. Chemical compositions of Al-5083 Physical and mechanical properties are listed below in Table-1. The welding parameter ranges taken into account for welding are welding current of 118– 134 amps, gas flow rate of 6 –7 Lt/min and welding speed of 90– 105 mm/min. Welded specimen is cut by wire EDM as per ASTM standard and performed tensile test on UTM machine First point.

Table 1. Mechanical Properties of Al-5083

Density	Brinell Hardness	Tensile Strength	Yield Strength	Elasticity modulas
2.66 g/cc	85 HB	317 MPa	228 MPa	71 GPa

3.0-Result and Discussion

After an Exhaustive analysis of welded sample the investigation in able to represent the influence of input parameters at Tensile strength of Al-5083.

I-After cutting the sample by wire EDM as per ASTM standard tensile test carried on at UTM machine for nine successive specimens. Minimum tensile strength of specimen C is observed and maximum is observed in specimen H of welded joint. We can see a clear picture of highest tensile strength is achieved at welding current of 134 amp followed by gas flow rate 7 liter/minute and corresponding welding speed is 100 mm/minute.

A-Influence of welding current at Tensile strength

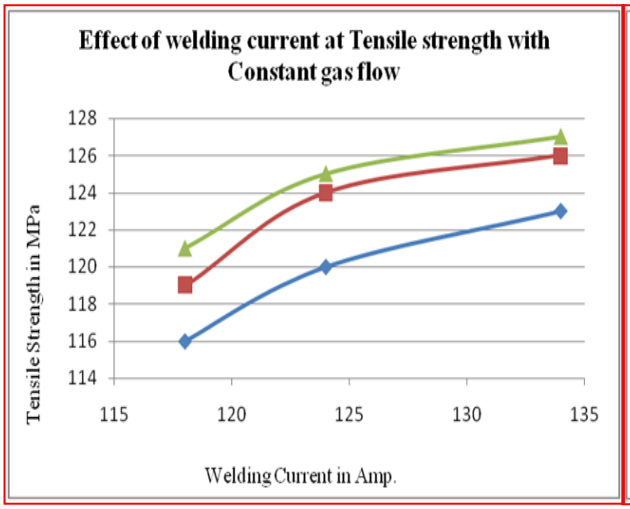
Effect of current as a input parameters reveals that among the three stages of current such as 118 amp, 124 amp and 134 amp is recorded and their mechanical properties is analyzed. Figure-3A shows the effect of current at tensile strength of welded joint. Conclusion drawn by the figure-3A tensile strength increases as the current increases at a constant gas flow rate till an optimum value of 134 amp current that shows the maximum tensile strength of 127MPa of the joint.

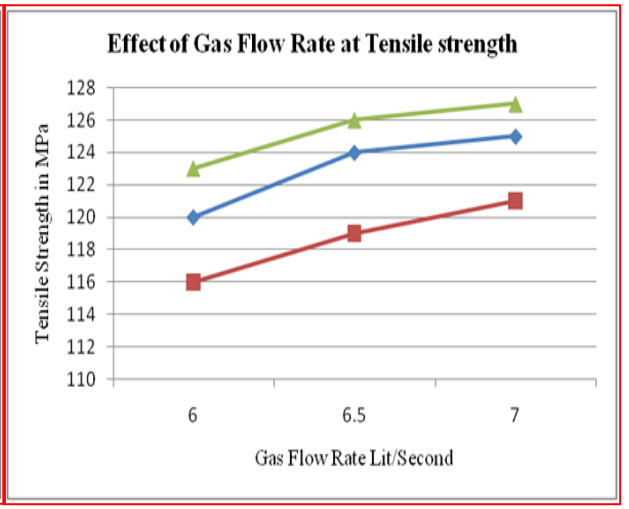
B-Effect of Gas Flow Rate on Tensile Strength

Effect of shielding gas flow rate as input parameters shows three different levels effect at tensile strength of welded joint is described at 6 liter/minute, 6.5 liter/minute, and 7 liter/minute. Figure-3B shows the effect of shielding gases at a constant current of three samples. Tensile strength increases by change of shielding gas to an optimum value of 7litre/minute and corresponding tensile strength is 127MPa of sample.

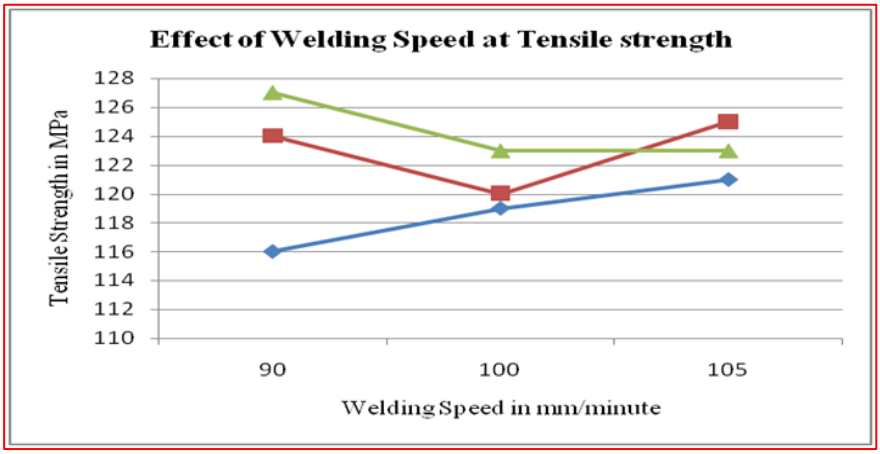
C-Effect of Welding Speed on Tensile Strength

Effect of welding speed as input parameters shows the effect on mechanical properties of weld joint such as tensile strength. Effect of welding speed can be observed in Figure-3C.At a constant current three sample has been analyzed and reveals that tensile strength increases by increasing the welding speed till optimum value of 100 mm/min at current of 134 amps that shows the maximum tensile strength of 127 MPa of weld joint. After that tensile strength starts to decrease by further increment of welding speed.





[Figure-3 (A)-Tensile strength Vs Welding current][Figure-3 (B)-Tensile strength Vs Gas flow rate]



[Figure-3 (C)-Tensile strength Vs welding speed]

II-Micro-structural Analysis-

To characterize the fracture of welded specimen and mechanical properties with the above discussed parameters, micro-structural characteristics were analyzed. In order to better explanation weld characteristics along with change welding speed, welding current, gas flow rate were investigated in detail. From micro-structural observations, we see that grains in TIG weldments are finer but not showing uniform melting of materials and grain boundaries which can increase the strength of welded area of Al 5083; there is not proper fusion between both the plates of aluminum that might be due to low value of current.

We observed in figure-4(b) that there is not complete transition in the eqiaxed grain from columnar, In addition there is some amount of porosity in the weldment.grains are showing better bonding comparatively microstructure shown in figure-4(a) at low current of 118 Amp and this better distribution is helping to increase the tensile strength with increase in current. As we can see in figure-4(c) that there is minimum porosity because welding speed is comparatively high that is 134 Amp. It was also reported by Yao Liu et.al.(2012) that porosity is decreasing with increase in welding speed[2].figure-4(c) is showing the microstructure of refined grain because the pulses in welding process causes to rapid solidification of the weld pool, and welding seams are fused well and the structure is tight so we are getting highest tensile strength of 127 MPa.

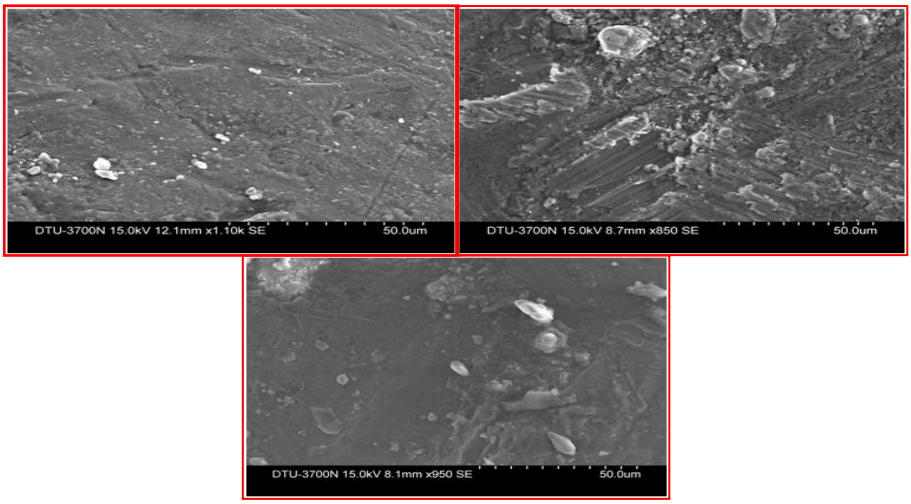


Figure-4 (a) &(b) Microstructure of fracture sample at 118A and 124A current, Figure-4 (c) Microstructure of fracture sample at 134 A current

Conclusions

After Exhaustive trials of welding strength at various parameters we are able to conclude some points.

(I) Tensile strength of AL plate increases with the increase in welding speed and showing some optimization value of current 134 Amp and further tensile strength decreases b y increasing welding current.

(II) Maximum welding tensile strength is obtained at 134 Amp with flow rate of 7 lt/min and welding speed of 98 mm/minute.

(III) Evaluated optimum parameters range as 134 Amp and welding current, 7 lt/min of flow rate of gas and 98 mm/min of welding speed by which efficient weld can be produced and better tensile strength can be achieved.

(IV) Microstructure of weld pool is showing in shape refined grain because the pulses in welding process causes to rapid solidification of the weld pool, and welding seams are fused well and the structure is tight so we are getting highest tensile strength of 127 MPa.

Acknowledgements

We would like to express our sincere gratefulness to our department of Mechanical Engineering, KEC Ghaziabad, for giving me the opportunity to work in lab and also providing excellent guidance, encouragement, moral support and continuous assistance.

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