"EFFECT OF ARC VOLTAGE, WELDING CURRENT AND WELDING SPEED ON TENSILE STRENGTH, IMPACT ENERGY AND HARDNESS OF AA6063 JOINTS PRODUCED BY MIG WELDING"

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ABSTRACT

Metal Inert Gas welding is one of the widely used techniques for joining ferrous and nonferrous metals. MIG welding process offers several advantages like joining of unlike metals, low heat effected zone, absence of slag etc compared to TIG welding. Metal inert gas (MIG) welding, in which argon, helium Co2 are used as shielding gas. The accuracy and quality of welded joints largely depends upon type of power, welding speed, type of inert gas used for shielding,heat input. This study deals with the investigation of effect of welding heat input on the mechanical properties of the welded joint. Experiments are conducted on specimens of single v butt joint. The material selected for preparing the test specimen is Aluminium AA6063 Alloy. The strength of the welded joint is tested by a universal tensile testing machine and the results are evaluated.

Keyword - *MIG welding, welding, V butt welds, Welding Speed, Tensile Strength, Shielding gas*

1. INTRODUCTION

In this project we are going to study of weld joint microstructures and mechanical properties using MIG welding process. Aluminium is the second important after steel usage because of its characteristic which is high strength stiffness to weight ratio, good corrosion resistance, good formability better conductor of heat and electricity. It has been the best candidate to replace heavier material like steel and copper in automobile because it has the recycling potential. The choice of material is influenced by the requirement to improve the economy of fuel and also the energy consumption.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 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 shows strong bond in the joint. 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.

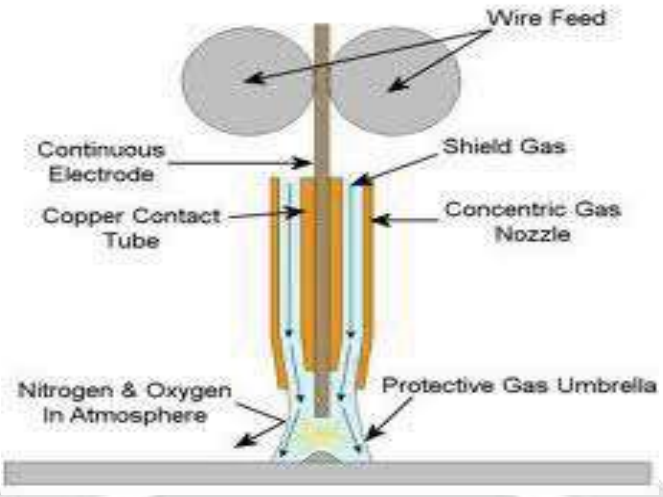


Fig. 1.1: Working principle of MIG welding

1.1 Properties and advantages of Al:
Aluminium is a very light weight metal (specific weight of 2.7 g/cm3). Use of aluminium in automobile and aerospace reduces dead-weight and energy consumption. Strength of Aluminium can be improved as per the required properties for various applications by modifying the composition of its alloys. Aluminium is a highly corrosion resistant material.

2. Process Parameters of MIG Welding

The parameters that affect the quality and outcome of the MIG welding process are given below.

2.1 Welding Current
Higher current in MIG welding can lead to splatter and work piece become damage. Again lower current setting in MIG welding lead to sticking of the filler wire. Sometimes larger heat affected area can be found for lower welding current, as high temperatures need to applied for longer periods of time to deposit the same amount of filling materials. Fixed current mode will vary the voltage in order to maintain a constant arc current.

2.2 Welding Voltage
Welding Voltage can be fixed or adjustable depending on the MIG welding equipment. A high initial voltage allows for easy arc initiation and a greater range of working tip distance. Too high voltage, can lead to large variable in welding quality.

2.3 Shielding Gases

The choice of shielding gas is depends on the working metals and effects on the welding cost, weld temperature, arc stability, weld speed, splatter, electrode life etc. It also affects the finished weld penetration depth and surface profile, porosity, corrosion resistance, strength, hardness and brittleness of the weld material. Argon or Helium may be used successfully for MIG welding applications. For welding of extremely thin material pure argon is used. Argon generally provides an arc which operates more smoothly and quietly.

2.3 Welding Speed
Welding speed is an important parameter for MIG welding. If the welding speed is increased, power or heat input per unit length of weld is decreases, therefore less weld reinforcement results and penetration of welding decreases.

2.3 Heat input
In arc welding, energy is transferred from the welding electrode to the base metal by an electric arc. When the welder starts the arc, both the base metal and the filler metal are melted to create the weld. This melting is possible

because a sufficient amount of power (energy transferred per unit time) and energy density is supplied to the electrode. Heat input is a relative measure of the energy transferred per unit length of weld. It is an important characteristic because, like preheat and inter pass temperature, it influences the cooling rate, which may affect the mechanical properties and metallurgical structure of the weld and the HAZ . Heat input is typically calculated as the ratio of the power (i.e., voltage x current) to the velocity of the heat source (i.e., the arc) as follows

Heat Input(Q)=(V*I*60)/ *v*

Where,

Q=Heat input in J/mm

V=arc voltage in volts

I=welding current in ampere,

v =speed of welding in mm/min.

3. Material Selection for Work piece

3.1 Aluminium Alloys

The typical alloy in elements usually consist of copper, magnesium, manganese, silicon ,zinc ,etc.Aluminium alloy is classified into two principal namely casting alloys and wrought alloys that consist of the heat-treatableandnon-heat-treatable.About85% of aluminium used for wrought products.

Base Material Selection Aluminium Alloy (AA6063)

The experimental work is to be carried out to investigation of finding optimum MIG welding for tensile test, hardness and Impact Strength of V grooves butt weld joint of aluminium alloy(AA6063) material. Focus of this project work to identify strength of welded joint by changing the welding current and voltage.Aluminium is not just a single material, but a family of a variety of alloys grouped according to the alloy elements added and that provide the best combination of properties for a particular application. Alloy requirements may include strength, corrosion resistance enhancement, ductility, ease of welding, formability or combinations of some of these properties.

Table -1: Chemical Compositions of Aluminium alloy (AA6063) in Wt. %

Si	0.42	Pb	0.0005
Mg	0.40	Mn	0.31
Fe	0.53	Al	Balance
Ti	0.02	Ni	0.002
Cu	0.10	Sn	0.0001
Zn	0.07	Cr	0.01

Material Selection for Filler Metal

Aluminium Alloy (AA5356)

Due to high importance, welding assemblies were prepared from AA6063 aluminium alloy. ER5356 wire electrode having 1 mm diameter was used as filler metal.

Table -2 Chemical composition of the filler metal (ER5356)

Elements	Al	Mn	Si	Fe	Mg	Cu	Zn	Ti	Cr
Wt. (%)	Balance	0.125	0.25	0.4	5	0.1	0.1	0.13	0.125

Process Parameters

Table -3 Welding parameters were used during to the welding

Cylinder pressure (bar)	145
Cylinder outlet pressure (l/min)	14
Nozzle opening (mm)	10
Electrode stick out (mm)	19.2
Arc length (mm)	3
Nozzle-to-work distance (mm)	20.2
Contact tip-to-work distance (mm)	22.2
Arc voltage (V)	20, 22, 24
Welding current (A)	100,120, 140

the values of the selected process parameters, three parameters with three levels. All these values are selected on the basis of literature review, machine specification.

Table -4 Process Parameters for MIG Welding

Sr No	Welding Current (A)	Voltage(V)	Speed(cm/min)	Heat Input (J/mm)
1	100	20	60	200.0
2	100	22	60	220.0
3	100	24	60	240.0
4	120	20	60	240.0
5	120	22	60	264.0
6	120	24	60	288.0
7	140	20	60	280.0
8	140	22	60	308.0
9	140	24	60	336.0

Experimental Setup

Sample Preparation for tensile test-

All the welds were performed in plates rolled to 10 mm thick perpendicular to the rolling direction in a butt joint arrangement with straight edge preparation. Plates of 100 mm x 50 mm x 10 mm were welded along their long edge. The fig. 1 & 2 shows weld geometry is used in welding process.

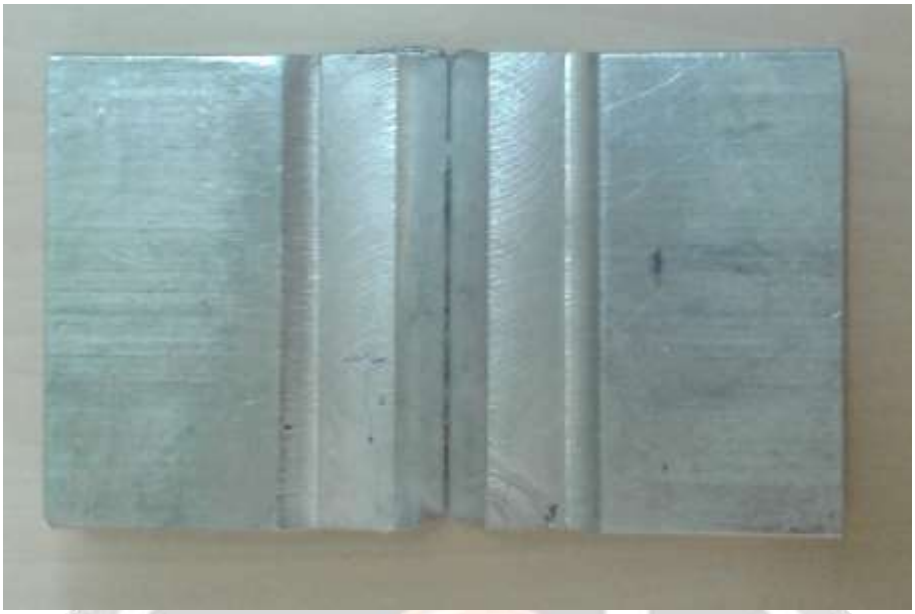
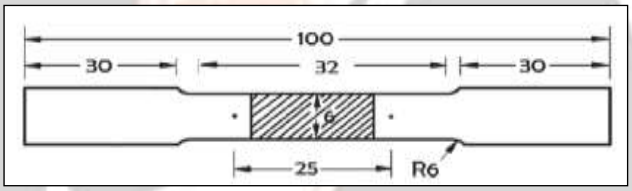


Fig -1: **Aluminium plate Machined sample**



Hardness Test

Fig.3 Micro Hardness samples

Impact Test-

Fig.3 Impact Test samples

Results of Experiments

Specimen. No	Current (A)	Voltage(V)	Speed (M/min)	MIG Weld Result		
				UTS (KN/mm^2)	Rockwell Hardness (RC)	Impact Test (J)
1	100	20	60	0.175	76	42
2	100	22	60	0.210	74	44
3	100	24	60	0.200	74	44
4	120	20	60	0.160	72	46
5	120	22	60	0.210	73	46
6	120	24	60	0.160	70	48
7	140	20	60	0.230	73	46
8	140	22	60	0.170	76	44
9	140	24	60	0.160	78	41

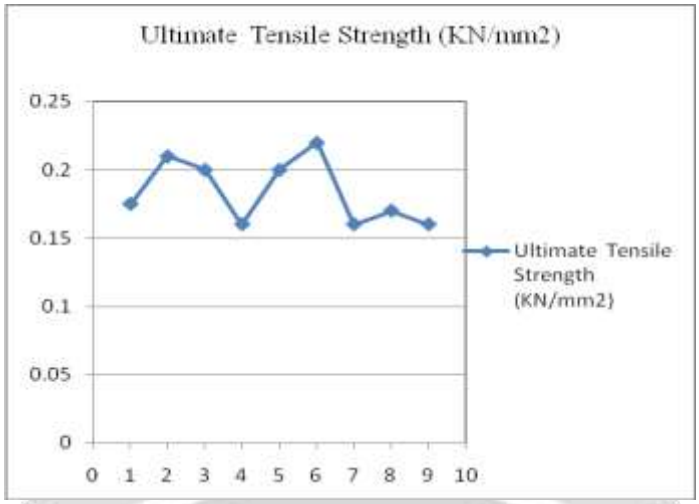


Chart -1: Ultimate Tensile Strength Vs Specimen

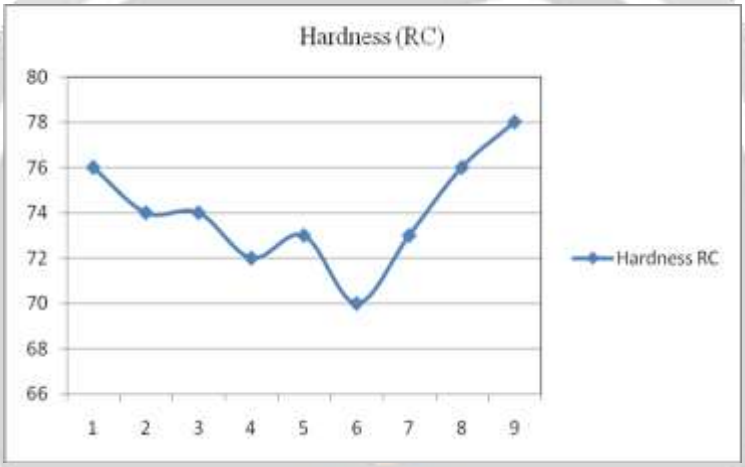


Chart -2: hardness Vs Specimen

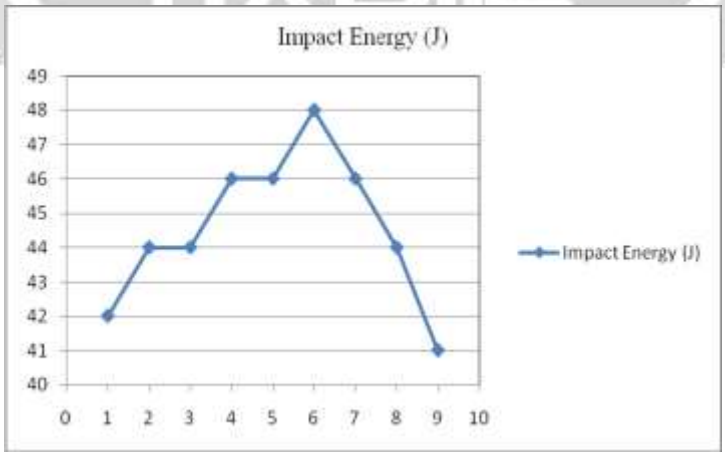


Chart -3: Impact energy Vs Specimen

4. CONCLUSION

- The higher ultimate tensile strength 0.22 KN/mm^2 produced at 120A Current, 24V Voltage, 60Cm/min Speed with heat input is 2880.
- The higher micro hardness 78RC produced at 140A Current,24V Voltage,60Cm/min Speed in MIG Welding and Lower micro hardness 70RC produced at 120A Current, 24V Voltage, 60Cm/min Speed.In the aluminium hardness should be because if hardness increased then material becomes brittle in nature.
- The higher Impact Energy 48J produced at 120A Current,24V Voltage, 60Cm/min Speed in MIG Welding.
- The MIG welding process shows good result at 120A Current, 24V Voltage, 60cm/min Speed. So this is best suitable parameter to weld Aluminium alloy (AA6063) with filler material (AA5356) with MIG Welding process.

6. REFERENCES

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