Effect of Heat Input on Mechanical Properties of Aluminum Plate using MIG Welding

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Abstract*— The Aluminum alloy has wide range of industrial applications such as in aircraft and aerospace industries. Aluminum alloy has various properties like light in weight, corrosion resistance, high strength to weight ratio, and possesses excellent welding characteristics. MIG welding is commonly used for welding of aluminum alloys. A metal inert gas (MIG) welding process consist of heating melting and solidification of parent metal and a filler material in localized fusion zone by a transient heat source to form a joint between parent metals. MIG welding parameters are the most important factors affecting the quality, mechanical properties of welded joint. The alloy samples were welded at varying values of current, voltage and heat input after which mechanical test were perform on the welded sample. It was concluded that variation of current and voltage remarkably affect t he mechanical properties of aluminum *alloy

Index Terms—6063 Aluminum alloy, MIG welding, UTM machine, Ansys software.

I. INTRODUCTION

Aluminum (Al) is a light weight material which is used in many areas such as transportation industries, packaging, construction material and many more. Al is light, strong, corrosion resistant and easy to work with. Al can be alloyed with other elements to improve the properties, and the common Al-alloys have a number of useful properties. Al-alloys have several of advantages but in some cases, Al-alloys experience issues during welding. To understand more what happens when Al-alloys are welded, one has to study the alloy content and the connection between metallurgy and process. All Al-alloys are not weld able but there are many welding methods which could be useful in different cases. This report is going to focus on fusion welding such as MIG-welding (Metal inert gas). There are some phenomena that can occur after or during welding which cause poor quality of the weld material. The most commonly occurring phenomena are porosity, cracking, deformation and corrosion which are also going to be consider. All of these phenomena influence the material properties e.g. impact strength, hardness. To minimize the problems during welding there are several potential solutions but it depends on the welding method and the base material what could be used.

II. PROBLEM STATEMENT

In India also in world there is the number of process industries. After some life time there will be failure of weld joint. There are number of reasons for failure. If the strength is not proper then there is possibilities of early failure of joint. In metal joining process there are so many heat input parameters on which the strength of weld joint depends.
This project deals with the investigation of effect of welding heat input on tensile, hardness and impact strength at different heat input rate of the weld joint.

III. OBJECTIVE

- To study the heat input in butt weld joint to find the maximum tensile strength and hardness on plate welding.
- To suggest the suitable heat input for best hardness and best strength for particular application.

IV. WORKING PRINCIPLE

Mechanism of MIG welding:
Gas metal arc welding equipment consists of a welding gun, a power supply, a shielding gas supply and a wire-drive system which pulls the wire electrode from a spool and pushes it through a welding gun.
A source of cooling water may be required for the welding gun. In passing through the gun, the wire becomes energized by contact with a copper contact tube, which transfers current from a power source to the arc.
While simple in principle, a system of accurate controls is employed to initiate and terminate the shielding gas and cooling water, operate the welding contractor, and control electrode feed speed as required.

Work piece material use:
The strength analysis is carried out with aluminum alloy.
Parent Material**:**
The parent material used in this study was 6063 Aluminum alloy.
Experimental setup

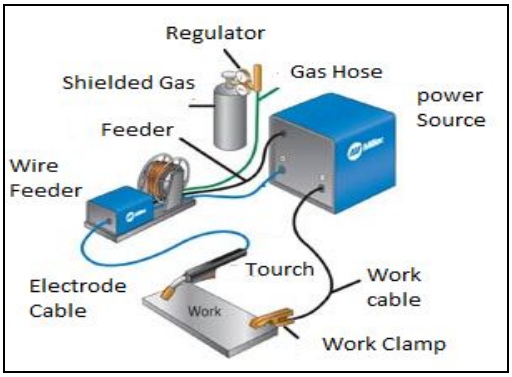


Figure1: experimental setup of MIG welding

Experimental Procedure:

Eighteen plates of 6063 Al alloy are machined on CNC machine. These plates are welded at chosen welding parameters at selected range of current, voltage and speed by using MIG welding. In this way nine plates are form. Each plate is cut into five equal piece i.e 45 pieces from nine plates. Dimension of each piece is 10*10*100 by ASTM E8/E8M-09 std . Nine samples from each set are use for tensile, nine for hardness, nine for microstructure and nine for impact test.

The selected Conditions for the welding operations are as follows:

Table1 : Range of heat input parameter

Sr No.	Welding current (A)	Voltage (V)	Speed (cm/min)
1	100	20	60
2	100	22	60
3	100	24	60
4	120	20	60
5	120	22	60
6	120	24	60
7	140	20	60
8	140	22	60
9	140	24	60

1.Tensile test :

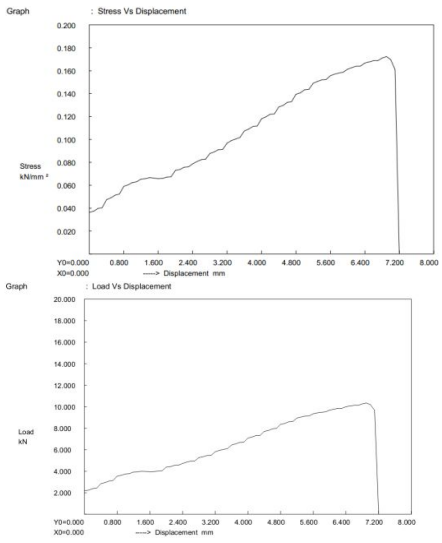
Figure2: UTM

Table2 : Tensile test reading

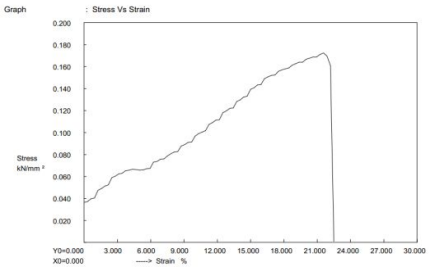
Specimen No.	Load (KN)	Disp. (mm)	Stress (KN/mm2)	Strain (%)
1	10	7.2	0.17	22.5
2	13	9.5	0.20	30
3	12	17.5	0.195	55
4	9.5	11.5	0.16	35.5
5	12	17	0.21	52
6	9.5	11	0.16	36
7	13	12	0.22	36
8	10	9.5	0.19	29
9	9.5	7.4	0.16	23

Before Test After Test

Figure3 : Tensile test specimen3



Graph2: Load Vs Disp.



Graph3: Stress Vs Strain

2. Hardness Test :
Type: Rockwell hardness test
Indentor: 1/8" Ball indentor
Scale: K

Figure4: Rockwell hardness tester

Table2: Hardness testing reading

Specimen No.	Hardness (RC)	Load (Kg)
1	67	60
2	70	60
3	74	60
4	74	60
5	73	60
6	70	60
7	73	60
8	76	60
9	74	60

Before Test

After Test

Figure5: Hardness test specimen

3. Impact Test:
Type: Charpy impact test

Figure6: Impact test machine

Table3: Impact test reading

Specimen No.	Impact Energy (J)
1	42
2	44
3	12
4	46
5	8
6	46.5
7	24
8	11
9	74

Before Test

After Test

Figure7: Impact test specimen

V. RESULT AND DISCUSSION:

Specimen No.	Ultimate tensile Strength (KN/mm^2)	% Elong-ation	Hardness (RC)	Impact Energy\ (J)
1	0.17	22.5	67	42
2	0.20	30	70	44
3	0.195	55	74	12
4	0.60	35.5	74	46
5	0.21	52	73	08
6	0.60	36	70	46.5
7	0.22	36	73	24
8	0.19	29	76	11
9	0.16	23	74	74

VI. CONCLUSION

In this study AL alloys 6063 were successfully welded by Butt joint.
Analysis of Strength –
1. The higher Ultimate tensile strength 0.60 KN/mm^2 obtained at current 120 A, 24 V, 60 cm/min speed.

2. Higher hardness value is 70 RC at Current 120 A, 24 V and 60 cm/min speed.

3. The higher Impact energy is 46.5 J at Current 120 A, 24 V and 60 cm/min speed.

VII. APPLICATION

Road transport, Rail transport, Shipbuilding. Aerospace, Industrial application.

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