THERMAL AND WELDBEAD ANALYSIS OF DISSIMILAR GRADE ALUMINIUM BY GTAW

T. Rajkumar.M.E

Assistant Professor

Department of Mechanical Engineering ,

PRIST Deemed to be University,Madurai Campus

Tamil Nadu. India.

rajkumar291274@gmail.com

Abstract—

Welding is a joining process which is most widely used for permanent joining of two or more components. Welding results in a very complex thermal cycle which results in irreversible elastic plastic deformation and residual stresses in and around heat affected zone (HAZ). Residual stresses are produced in weldment due to mismatching and non-uniform distributions of plastic and thermal strains. The existence of residual stresses in structures affects the stress–strain relationship by lowering the proportional limit and thus reduces the buckling strength. The purpose of the present study is to investigate the residual stresses in heat affected zone of cruciform welded joint of dissimilar weld plate.. The variations in the process parameters affect the mechanical properties with great extent .In this project prediction of the metallurgical defect as well as predict the process parameter of TIG for getting maximum weldment, Good deposition and best mechanical properties and min HAZ. The planned experiments are conducted through ANSYS software tool

Keywords—GTAW; HAZ; thermal stress; weldment

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.

1.1 Gas Tungsten Arc Welding (GTAW) or Tungsten Inert Gas (TIG): GTAW or TIG welding process is an arc welding process uses a non consumable tungsten electrode to produce the weld. The weld area is protected from atmosphere with a shielding gas generally Argon or Helium or sometimes mixture of Argon and Helium. A filler metal may also feed manually for proper welding. GTAW most commonly called TIG welding process was developed during Second World War. With the development of TIG welding process, welding of difficult to weld materials e.g. Aluminium and Magnesium become possible. The use of TIG today has spread to a variety of metals like stainless steel, mild steel and high tensile steels, Al alloy, Titanium alloy. Like other welding system, TIG welding power sources have also improved from basic transformer types to the highly electronic controlled power source today.

1.2 BASIC MECHANISM OF TIG WELDING:

TIG welding is an arc welding process that uses a non-consumable tungsten electrode to produce the weld. The weld area is protected from atmosphere by an inert shielding gas(argon or helium), and a filler metal is normally used. The power is supplied from the power source (rectifier), through a hand-piece or welding torch and is delivered to a tungsten electrode which is fitted into the hand piece. An electric arc is then created between the tungsten electrode and the work piece using a constant-current welding power supply that produces energy and conducted across the arc through a column of highly ionized gas and metal vapours [1]. The tungsten electrode and the welding zone are protected from the surrounding air by inert gas. The electric arc can produce temperatures of up to 20,000oC and this heat can be focused to melt and join two different part of material. The weld pool can be used to join the base metal with or without filler material.

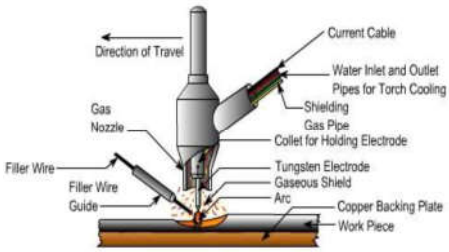


Figure 1. TIG Welding

1.3 PROCESS PARAMETERS OF TIG WELDING

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

a)WELDING CURRENT

Higher current in TIG welding can lead to splatter and work piece become damage. Again lower current setting in TIG 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.

b) WELDING VOLTAGE

Welding Voltage can be fixed or adjustable depending on the TIG 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.

c) INERT 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 TIG welding applications. For welding of extremely thin material pure argon is used. Argon generally provides an arc which operates more smoothly and quietly. Penetration of arc is less when Argon is used than the arc obtained by the use of Helium. For these reasons argon is preferred for most of the applications, except where higher heat and penetration is required for welding metals of high heat conductivity in larger thicknesses. Aluminium and copper are metals of high heat conductivity and are examples of the type of material for which helium is advantageous in welding relatively thick sections. Pure argon can be used for welding of structural steels, low alloyed steels, stainless steels, aluminium, copper, titanium and magnesium. Argon hydrogen mixture is used for welding of some grades of stainless steels and nickel alloys. Pure helium may be used for aluminium and copper. Helium argon mixtures may be used for low alloy steels, aluminium and copper.

d) WELDING SPEED:

Welding speed is an important parameter for TIG 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. Welding speed or travel speed is primarily control the bead size and penetration of weld. It is

interdependent with current .Excessive high welding speed decreases wetting action, increases tendency of undercut ,porosity and uneven bead shapes while slower welding speed reduces the tendency to porosity.

2.Experimental Work

The materials chosen for TIG welding are LM-6 and LM-25 (Grades of Aluminium). Commercial Aluminium plate of thickness 10 mm was selected as work piece material for the present experiment. Al plate was cut with dimension of 100 mm x 50 mm.TIG welding with Alternate Current (AC) was used in experiments as it concentrates the heat in the welding area. Zirconiated tungsten electrodes of diameter 3.4 mm was taken as electrode for this experiment. The end of the electrode was prepared by reducing the tip diameter to 2/3 of the original diameter by grinding and then striking an arc on a scrap material piece. This creates a ball on the end of the electrode. Generally an electrode that is too small for the welding current will form an excessively large ball, whereas too large an electrode will not form a satisfactory ball at all. For the first phase of experiment welding parameters selected are shown in table .Before performing the actual experiment a number of trial experiments have been performed to get the appropriate parameter range where welding could be possible and no observable efects like undercutting and porosity occurred.

Table1 Welding Parameters

SL.NO	AMPS	GAS PRESSURE Bar
1	55	4
2	70	4
3	85	4.5
4	100	4.5
5	115	5
6	130	5

After completing the welding Tests and analysis were conducted.

3.Testing and Analysis

3.1 Hardness test

Brinell Hardness Test is Conducted Before and After Welding. And best BHN Values Are given Below.

Table2. Hardness Test

Volt /Amps	**AVG BHN LM6**	**AVG BHN LM25**
125/100	25	23
150/120	24	20
175/130	22	23
200/140	27	19
250/150	24	19

300/160	24	21

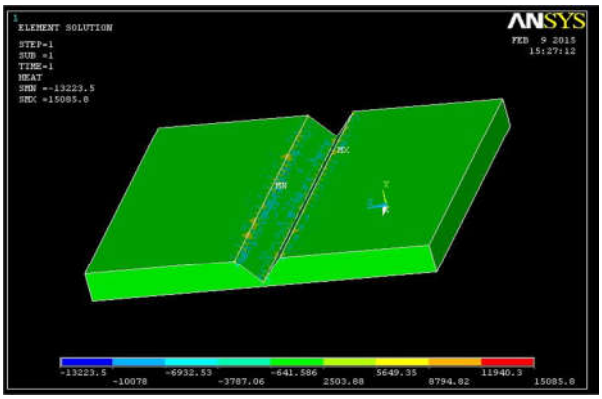
3.2 Ultrasonic test

Ultrasonic test also conducted to find out welded joint quality and proper penetration, slag ,porosity, undercut and two out of six samples got good weldments,two samples have low/excess penetration, one each in porosity and slug .

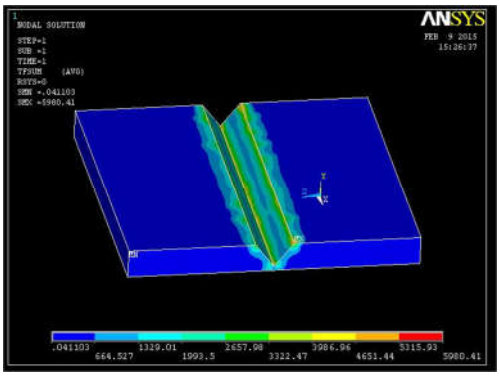
3.3 FEA to find HAZ

The HAZ was found out by using FEA and Heat Flow, Thermal Flux, Thermal Gradient images for temperature 600˚C were given below

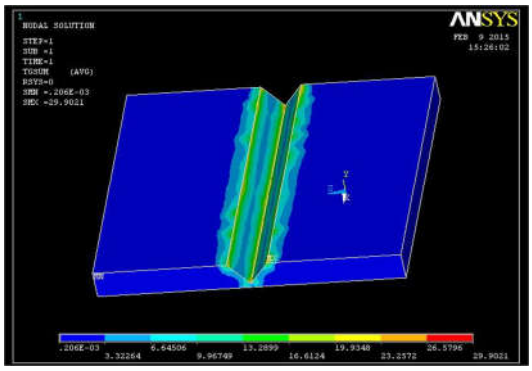
Heat Flow



Thermal Flow



Thermal Gradient



3.4 Depth of Penetration

Bead width and Depth of Penetration were found out and results are tabled below.

Table 3

TEST SAMPLE	Bead Width / Depth of Penetration	Area	Mean	Min	Max	Angle	Length
1	BW	0.441	188.788	99	215.91	-91.023	6.999
	DOP	0.882	177.664	129.333	196.33	0	14.121
2	BW	0.363	172.277	85.731	234.48	-91.102	6.118
	DOP	0.709	190.705	74.353	230.99	1.102	12.001
3	BW	0.458	186.538	42.778	219.04	90.796	8.091
	DOP	0.578	166.672	93.864	205.13	-0.63	10.225
4	DOP	0.312	177.714	56.667	208.19	-91.848	6.203
	BW	0.458	177.237	65.59	201	2.517	9.109
5	DOP	0.652	170.535	150.917	180.97	-0.597	11.163
	BW	0.433	175.529	86.667	208.33	-90	7.441
6	DOP	0.358	138.449	62	168	-90	6.874
	BW	0.662	125.34	48.667	148.33	0	12.706

5.731 34.487 91.102 .118

4.Conclusion

It is observed that at proper welding parameters good weldments and required depth of penetration can be achieved by joining dissimilar grade aluminium (LM6&LM25) using TIG welding at 175 Volts and 130 Ampheres.

Hardness also shows better after welding. Heat Affected Zone shows better results at 600˚C.Hence effective joining of dissimilar grade Aluminium by using TIG welding done and major advantages of both LM-6 and LM-25 Can be utilized effectively.

5. References

1. Milan Saga; Peter Kopas; Milan Uhricik - Modelling and Experimental Analysis of Aluminium Alloy Fatigue Damage in Case of Bending – Torsion Loading. - University of Zilina 599-606.
2. Casalino. G; Dal Maso,U; Angelastro,A;& Campanelli.S.L. – Hybrid Laser Welding: A Review -Daam International Scientific Book 2010 -413-430
3. Lasse Suominen; Mansoor Khurshid; Jari Parantainen. ‘Residual Stresses in Welded components following post-weld treatment methods’ 5th Fatigue Design Conference 2013

4. A.Ramkumar; Saji Varghese; M.Sivapragash- 'A Comparative Study of the Mechanical Properties of Single and Double Sided Friction Stir Welded Aluminium Joints'- Noorul Islam University -ICMOC 2012 – 3951-3961.
5. J.Babu; Abhijit Dutta,; A.Kumaraswamy.- 'Experimental Studies on Effect of Temperature And Strain Rate on Deformation Behaviour of Ti-6Al-4V using Taguchi Method- St.joseph College of Engg&Tech,Kerala-ICMPC 2014.1121-1130.
6. Mapelli.C, Manes ,A;Giglio.M.- Microstructural Investigation on an Al 6061T6 Alloy Subjected to ballistic impact - 2011-ICM11- 3447-3452.