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Evaluation and Optimization of Process Parameters of Tig Welding

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Abstract:

Tungsten inert gas welding is an advanced technique for bringing conjoins between ferrous and non-ferrous metals. TIG welding has abundant benefits in joining of dissimilar metals while considering certain parameters such as zone with low heat, Min slag. The intension was to investigate the effect of TIG welding parameters acting along the surface of Aluminium-6061. The Taguchi method used to conduct the experiments. The voltage, current, stand-off distance and gas flow rate were the attributes considered for the process. The Joints of the samples were tested by the Universal Testing Machine and welded joints were tested for hardness using the Rockwell Hardness testing machine. The experiments were conducted with an intension to optimize the welding conditions so as to maximize the hardness and tensile strength

Keywords: Tungsten inert gas, Aluminium alloy 6061, Process parameters

Introduction

Fabrication of structure can be brought about by different phases. The different phases can be cutting bending assembling, joining and finishing operations.it must be accomplished with at most concern to meet the design specifications and satisfy the factor of safety.

A component manufactured largely depends on satisfying the specifications of the design and the stability in the product. This can be achieved by engaging in modern level of technologies, as today's world is off modern tools and manufacturing. This version of manufacturing has definitely been a boon in processing the raw materials right from exposing it to high temperature so that it can be melted and allowing it to fuse so as to bring a joint between the components. The revolution in manufacturing has helped several organizations in adapting the recent technologies to ensures less rejections and repairs. Thereby making the component sturdy and strong. This ensures that that the joint thus welded or joined through any metal joining technique will have a strong bond. Thus, it very important for the structed that go through these ensures that it has been processed through these techniques and has adopted modern methods

Experimental Setup And Fabrication

Material :Aluminium Alloy AA 6061

The Aluminium alloy AA 6061has a property that it can withstand medium to high strength when compared Aluminium Alloy 6005A. it possess an impotent property to resist corrosion and provided a stable weldability. It has been chosen not only based on these factors but also because of its fatigue strength and cold formability up to T4

Fabrication

The procured metals weremachined according to the 2D drawing. The machining was carried out at **Metal Extrusions, Peenya, Bangalore.** The machining was done according to the dimensions required, while following the American Weld Society (AWS) standards. The standard states that the "minimum diameter of the hole for the plug weld must be no less than the thickness of the part containing it." and "the distance between the two holes must be 4 timesthe diameter of the hole."

The plug welding was carried out using TIG welding technique. Tungsten inert gas welding(TIG), sometimes referred to as Gas Tungsten Arc Welding is a welding process that has the formation of electric arc between the tungsten electrode and work piece (AA 6061) used. This heats the work piece metals and the electrode to fuse. Along with this, a shielding gas (75% Argon and 25%CO2) is fed through the welding gun which shields the whole process from atmospheric contamination. The equipment's that are used for the process of TIG Welding are a TIG welder, welding face shield, C-clamps, and a metal brush. Safety equipment play a major role alongside the tools used for performing welding. They are sunscreen, safety goggles, gloves, protection leather boots, long sleeve shirts and pants.

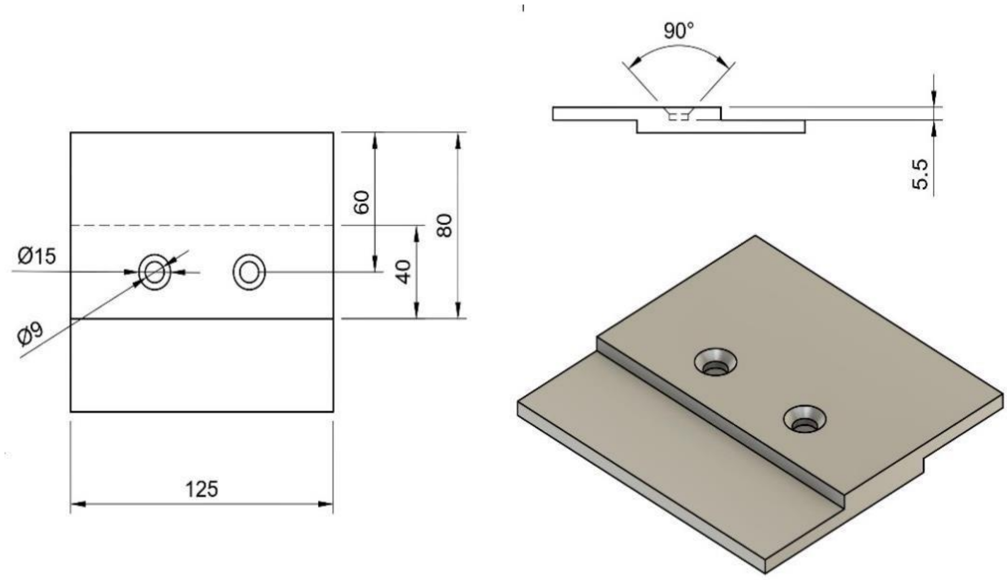


Figure 1: 2D drawing of Aluminium plates

The welding was done taking into consideration three parameters, Weld Current, Gas Flow Rate and Base Current. Welding current is the term used to describe the electricity that jumps across the arc gap between the end of the electrode and the metal being welded. Gas flow rate is the rate at which argon gas flows into the welding region in liters per minute. Base Current – (0-200 Amps) – sets the low amperage for each pulse.

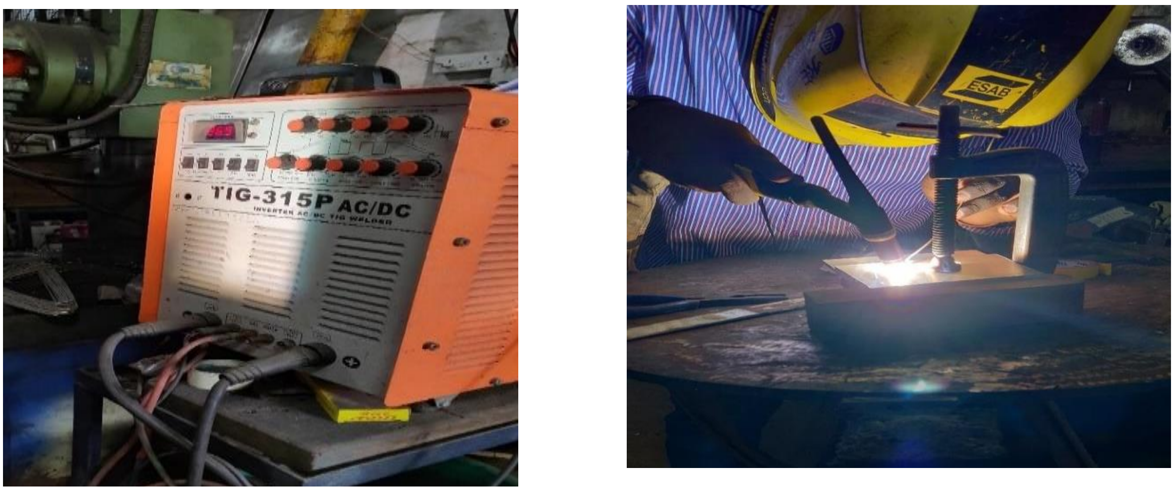


Figure 2: TIG welding process

Figure 3: Welded plates- Top View

Figure 4: Welded Plates of different parametric inputs

Figure 5: Plug weld- Side View

Table II: Parametric values taken for welding operation

Specimen no.	Weld Current (A)	Flow Rate(lpm)	Arc Pulsing
1	260	10	OFF
2	260	10	ON
3	270	10	OFF
4	270	10	ON
5	280	10	OFF
6	280	10	ON
7	260	13	OFF
8	260	13	ON
9	270	13	OFF
10	270	13	ON
11	280	13	OFF
12	280	13	ON
13	260	16	OFF

14	260	16	ON
15	270	16	OFF
16	270	16	ON
17	280	16	OFF
18	280	16	ON

Hardness Test

Rockwell Hardness test was conducted on welded samples to find the hardness of the alloyat the welded region. A load of 100 kgF was applied at the welded region randomly at arbitrary points. The indenter used is a diamond ball indenter of 1/16" diameter is used foraluminium material.

Table III: Rockwell Hardness test results

Specimen No	Rockwell Hardness Value (HRB)	Specimen No	Rockwell Hardness Value (HRB)
1	35	10	15
2	20	11	78
3	91	12	13
4	22	13	28
5	19	14	30
6	95	15	55
7	21	16	54
8	17	17	65
9	18	18	40

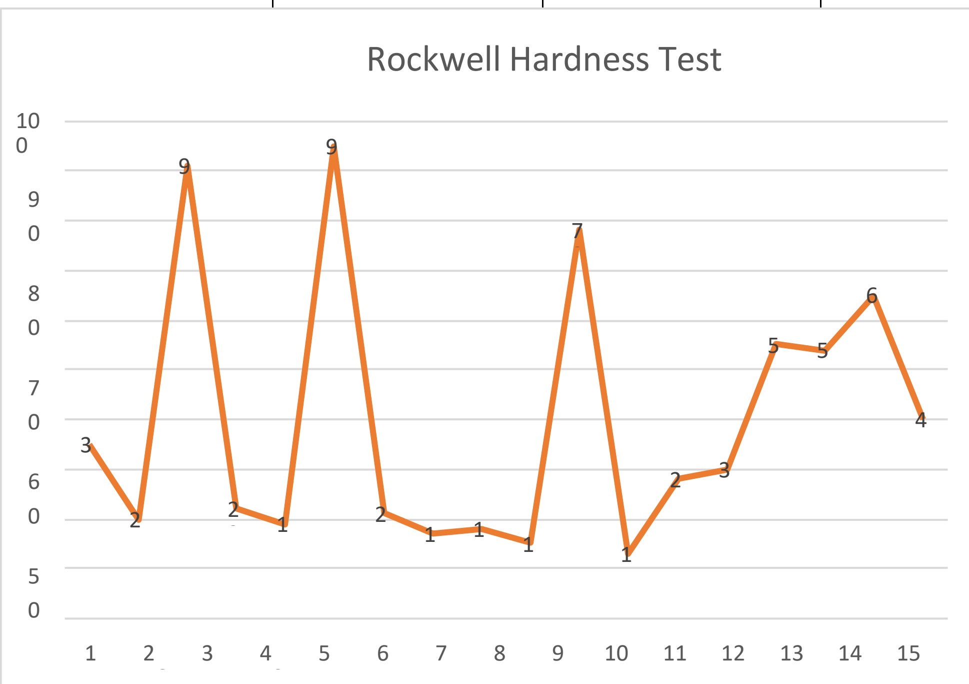


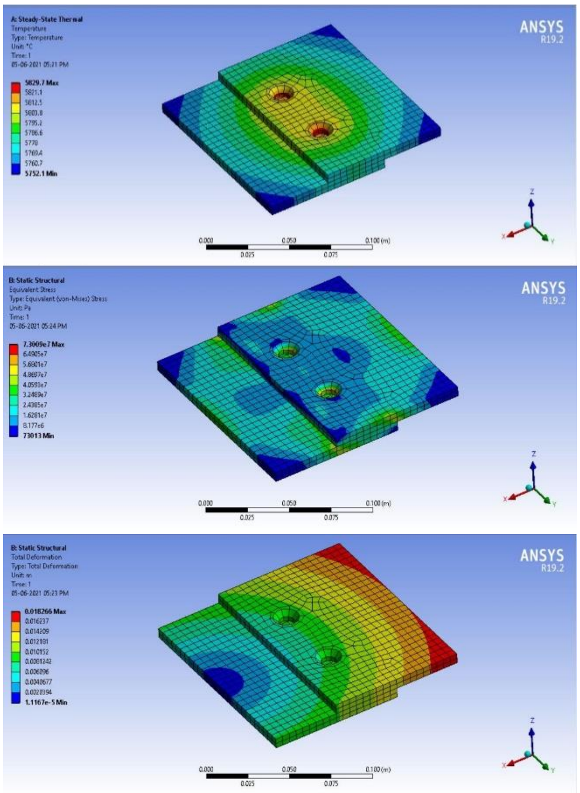
Figure 6: Rockwell Hardness graph

ANSYS Simulation

The results for the ANSYS simulation are obtained as follows:

Table IV: Simulation results

Voltage (V)	Current (I)	Temparature (C)		Total Deformation (mm)		Equivalent Stress (MPa)	
		Max	Min	Max	Min	Max	Min
10	60	5829.7	5752.0	18.266	0.01110	73.009	0.073
10	70	6797.0	6706.5	21.308	0.01300	85.176	0.0853
10	80	7764.3	7660.8	24.350	0.01490	97.344	0.0975
15	60	8731.6	8615.2	27.392	0.01675	109.51	0.1095
15	70	10182.0	10047	31.955	0.01950	127.76	0.1281
15	80	11633.0	11478	36.518	0.02230	146.02	0.1460



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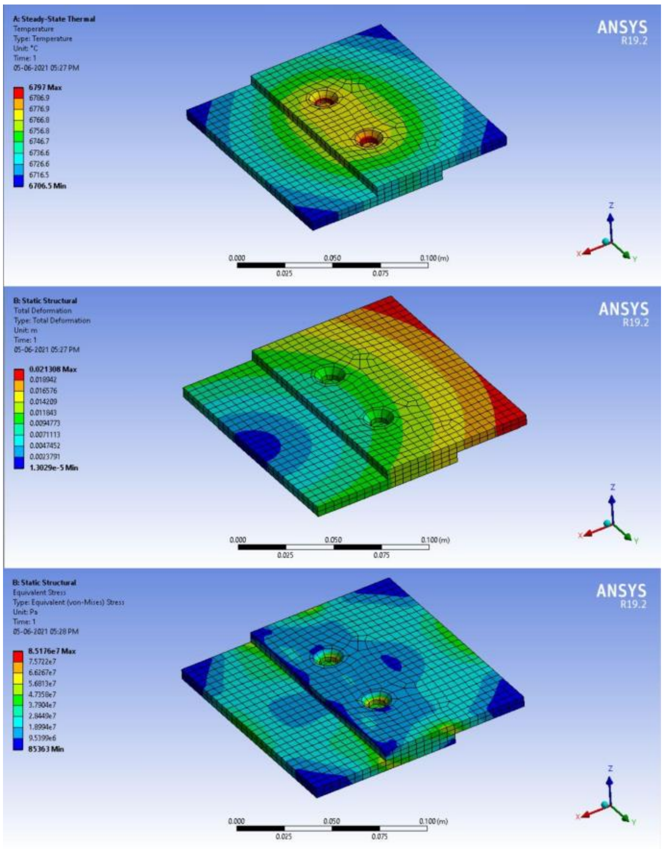
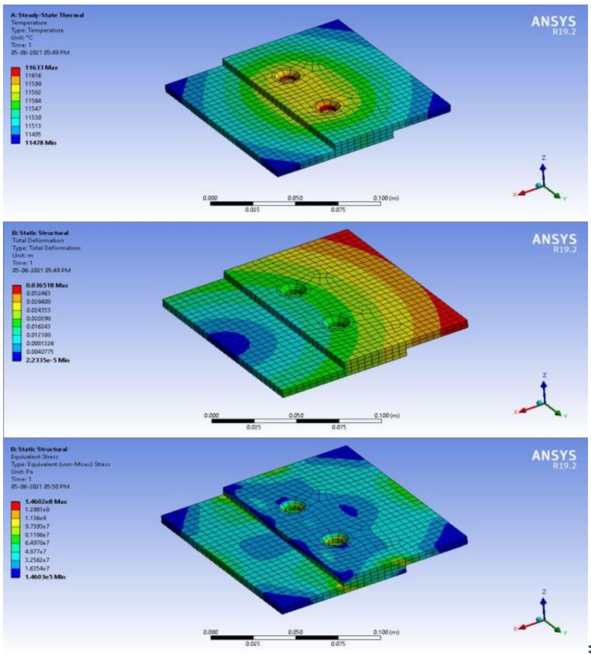


Figure 7 :Voltage = 10V, Current = 60A

Figure 8 : Voltage



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10V, Current = 70A

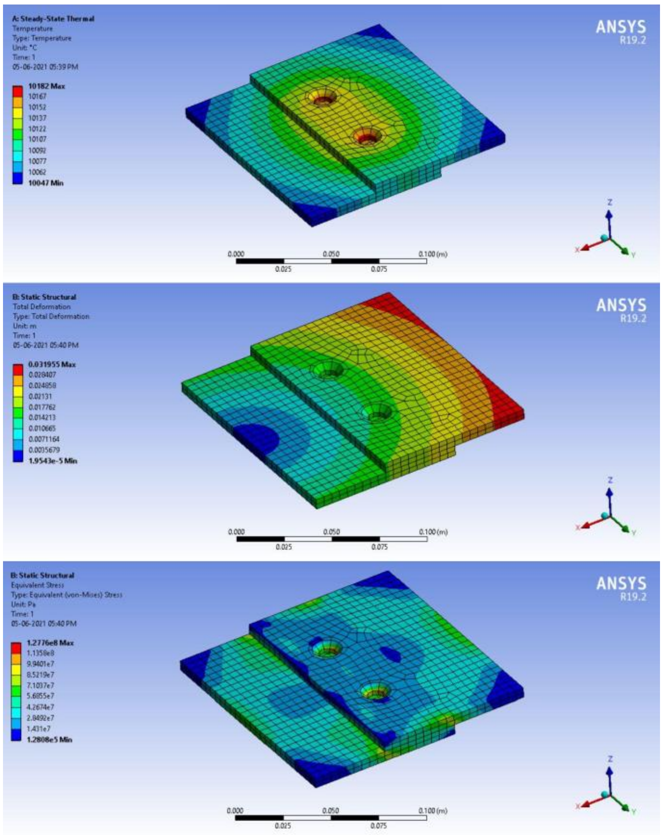
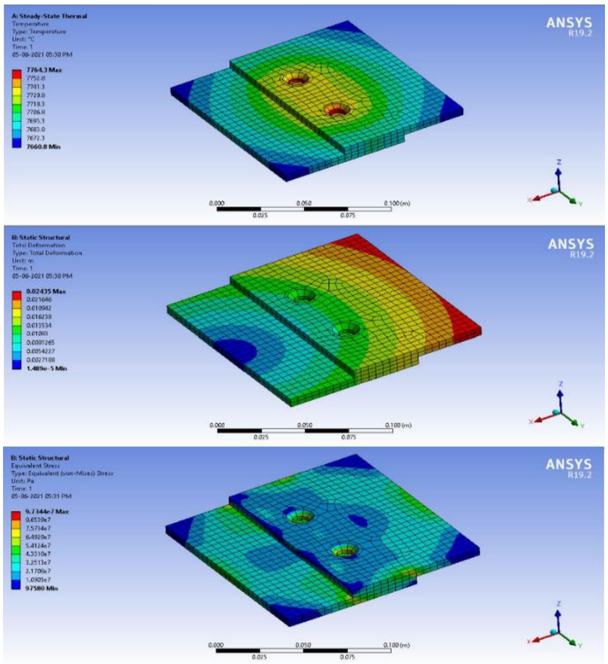
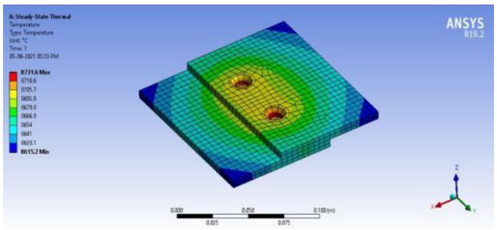
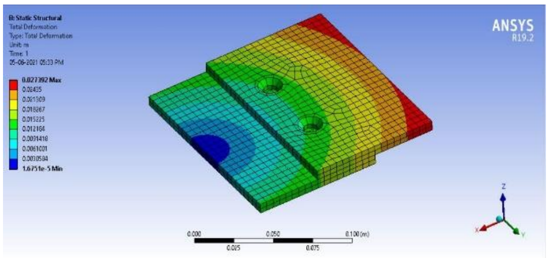


Figure 11: Voltage = 15V, Current = 80A

Figure 12: Voltage = 15V, Current = 70A







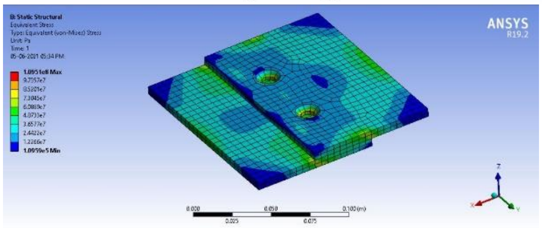


Figure 9 :Voltage = 10V, Current = 80A **Figure 10: Voltage = 15V, Current = 60A**

Conclusion

The simulation results show that welding voltage and current are directly proportional to the equivalent stresses and heat developed in the alloy. We also see that the maximum stresses are experienced in the welded joints of the metal samples and this is exactly wherethe metal fractures.

Excessive gas flow creates turbulence and swirling currents that pull in unwanted airbornecontaminants (and it can cause arc wandering). Generally, on the lower gas flow rate ensures proper shielding coverage without turbulence. TIG welding at welding current greater than 150 A produced the higher ultimate tensile strength. The hardness values of the welded samples were greater than the base material. The weld joint efficiency increasesas the current was increased. Strength with in the weld was achieved with higher pulsing rates that as well as increase agitation. Tig welding has influenced as it minimizes scrap and requires minimum finishing process

Hence, quite clearly the specimen with the highest current, 280 A, the lowest gas flowrate 10 lpm, and pulsing turned on resulted in the best hardness value of 95 HRB. Hardness ofa material is proportional to its tensile strength as the harder material is the stronger materialand stronger the material, better the weld quality. Finally, it can be concluded that the weldquality is proportional to the weld current and arc pulsing while inversely proportional to gas flowrate. The process parameters – weld current, gas flowrate and arc pulsing are successfully optimized to give best weld quality for TIG welding operation on AluminiumAlloy 6061.

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