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Study The Influence of TIG Welding Parameters On Weld Characteristics Of 5083 Aluminum Alloy

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Abstract - The welding parameters play vital role in joining the work pieces by TIG welding for 5083 aluminum alloy. This paper presents the investigated influence of welding parameters on the weld bead geometry such as front width and back width of weld joint. Welding current, gas flow rate and welding speed are taken into account during experimentation and found increase in heat energy on work piece surface by increasing the welding current which results as increasing the front width and back width of weld joint linearly. Front width and back width of weld joint decreases linearly with the increment of welding speed, but increasing the depth of penetration. Front width and back width of weld joint increases or decreases alternatively with increasing of gas flow rate. The mechanical properties of weld joint also affected greatly with the variation of welding parameters.

***Keywords* - TIG welding, Weld bead geometry, AA5083 and welding parameters.**

I. INTRODUCTION

Aluminum alloy has excellent performance so used in aerospace industry, aviation, marine industry, automobile, defense and others [1-3]. Tungsten Inert Gas (TIG) welding process is used for welding the materials with the coalescence of heat generated by an electric arc established between a non-consumable tungsten electrode and the metal [4]. Most commonly, Argon, helium and their mixture are preferred to use as a shielding gases for better welding because of does not chemically react or combine with each other. The main purposes of shielding gas: i) shield the welding area from air, preventing oxidation, ii) transfer the heat from electrode to metal and iii) helps to start and maintain a stable arc due to low ionization potential [5]. Heat input parameter influences the cooling rate; weld bead size and mechanical properties of the weld [6]. TIG weld quality is strongly characterized by the weld pool geometry because the weld pool geometry plays an important role in determining the mechanical properties of weld [7-8]. The weld quality was strongly characterized by weld bead geometry because the weld pool geometry plays an important role in determining mechanical properties of weld [9-11]. Maximum quality can be achieved with control of welding parameters and material used must be cleaned [12]. The weld bead geometry of weld repaired aluminum alloy was similar as cast aluminum alloy in appearance but different in micro-structure [13]. If welding speed decreases beyond an optimum value, depth of penetration decreases due to the pressure of electric arc on weld pool [14]. Less depth of penetration was obtained for low gun angle because of less pre-heating of base metal [15].

II. EXPERIMENTATION

Experimentation is a way of conducting an experiment in a sequence to achieve the desired goals on the basis of selected input and output parameter discussed below in detail as:

A. Experimental material

Experimental material is 5083 Al-alloy of 5 mm thickness, welded by TIG welding process. The chemical compositions of 5083 Al-alloy stated by producer are shown in table 1 below:

Al	Mg	Mn	Si	Fe	Cu	Zn	Cr	Ti
92.4- 95.6	4.0 – 4.9	0.40 – 1.0	Max. 0.40	Max. 0.40	Max. 0.10	Max. 0.25	0.05 – 0.25	Max. 0.15

Table 1: Chemical composition of 5083 Al-alloy

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Physical and mechanical properties of 5083 Al-alloy stated by producer are such as: Density of 2.66 g/cc, Tensile Strength of 317 MPa, Brinell Hardness of 85 BHN, Yield Strength of 228 MPa, Modulus of Elasticity 71 GPa.

The filler wires used to transfer the extra material to fill the gap b/w the joints of same composition of base metal. There are different types of filler wires such as 5183, 5356, 5554, 5556 and 5654 available in the market on the basis of base metal compositions of 5083 Al-alloy. In this study, the filler metal of 5356 graded is used for welding the specimens because of its good physical and mechanical properties for obtaining the best joint such as: Density of 2.657 g/cc, Melting range of 1060 – 1175 ^{o}F, Hardness of 105 BHN and excellent Corrosion resistance. The chemical compositions of 5356 filler wire stated by producer are shown in table 2 below:

Si	**Fe**	**Cu**	**Mn**	**Mg**	**Cr**	**Zn**	**Ti**	**Al**
0.25	0.40	0.10	0.05-0.20	4.5-5.5	0.05-0.20	0.10	0.06-0.20	remaining

Table 2: Chemical composition of 5356 filler wire

B. Experimental method

Experimental trials are performed to identify the working range of welding parameters of welding current, welding speed and gas flow rate after specimen preparation. Fifty four specimens with dimension of 50 mm x 30 mm x 5 mm are prepared for conducting experiments for each welding input parameters. The experiments are conducted within the working range of welding parameters for all specimens. The welding joint occurs for current of 205 ampere, gas flow rate of 11 Lt/min and speed of 81 mm/min. The welding current range is selected at constant gas flow rate of 13 Lt/min for work piece thickness of 5 mm shown below in table 3.

	Specimens ID								
Welding current (amps)	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**
	205	210	215	220	225	230	235	240	245

Table 3: Working range of welding current

The working range of shielding gas flow rate at constant current of 230 amps is selected for conducting the experiments shown in table 4.

	Specimens ID								
Shielding gas flow (Lt.min)	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**
	11	11.5	12	12.5	13	13.5	14	14.5	15

Table 4: Working range of gas flow rate

Similarly, the working range of welding speed at constant current of 230 amps is selected for conducting the experimental trials shown in table 5.

	Specimens ID								
Welding speed (mm/min)	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**
	81	84	87	91	92	95	97	99	102

Table 5: Working range of welding speed

After conducting the experimental trials for all specimens within working range of welding parameters, measure the various results of weld bead geometry such as front and back width of joint with the use of traveling microscope are listed in table 6 to 8. But the measurements are done on three points of weld bead for front and back width and record the average readings.

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Specimens ID	Welding current (amps)	Gas flow rate (Lt/min)	Front width (mm)	Back width (mm)
A	205	13	6.31	3.60
B	210	13	6.43	3.87
C	215	13	7.49	4.10
D	220	13	7.54	4.21
E	225	13	8.21	3.84
F	230	13	8.04	4.67
G	235	13	8.83	5.26
H	240	13	8.55	5.48
I	245	13	9.77	6.19

Table 6: Results of experiments with variation of welding current

Specimens ID	Welding current (amps)	Gas flow rate (Lt/min)	Front width (mm)	Back width (mm)
A	230	11	8.33	5.10
B	230	11.5	7.56	4.86
C	230	12	8.67	5.41
D	230	12.5	8.49	5.63
E	230	13	8.91	5.50
F	230	13.5	8.59	5.23
G	230	14	8.70	5.30
H	230	14.5	8.38	5.43
I	230	15	7.89	5.07

Table 7: Results of experiments with variation of gas flow rate

Specimens ID	Welding current (amps)	Welding speed (mm/min)	Front width (mm)	Back width (mm)
A	230	81	9.13	6.31
B	230	84	9.75	6.13
C	230	87	8.51	5.44
D	230	91	8.79	5.26

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E	230	92	8.64	4.63
F	230	95	8.17	3.84
G	230	97	7.54	4.21
H	230	99	7.43	4.10
I	230	102	6.81	3.87

Table 8: Results of experiments with variation of welding speed

III. RESULTS AND ANALYSIS

Results and analysis of the collected data describes the influence of welding input parameters on the output parameters such as front and back width of 5083 Al-Alloy welded joints. The effect of welding input parameters on weld characteristics of the weld joint is discussed below in detail:

A. Effect of welding current on weld characteristics of weld joint

Figure 1 describe the effect of welding current variations on weld bead geometry of weld joint at constant gas flow rate of 13 Lt/min. It is clear from figure that the front width and back width changes across the weld bead for different values of welding current. It is observed that the front width and back width deviate in increasing order with the variation in welding current.

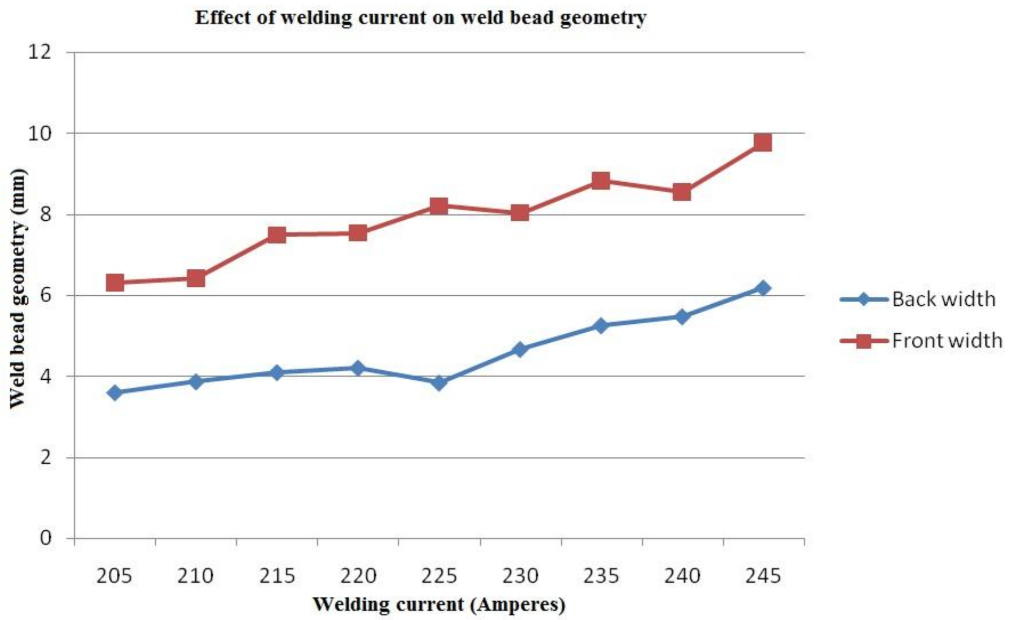

Fig 1: Welding current Vs weld bead geometry

B. Effect of Gas flow rate on weld characteristics of weld joint

The weld bead geometry of weld joint is affected by change in shielding gas flow rate values at constant welding current of 230 amps. It is clear from figure 2 that the front width and back width changes as increase or decrease alternatively by changing the values of gas flow rate in increasing order.

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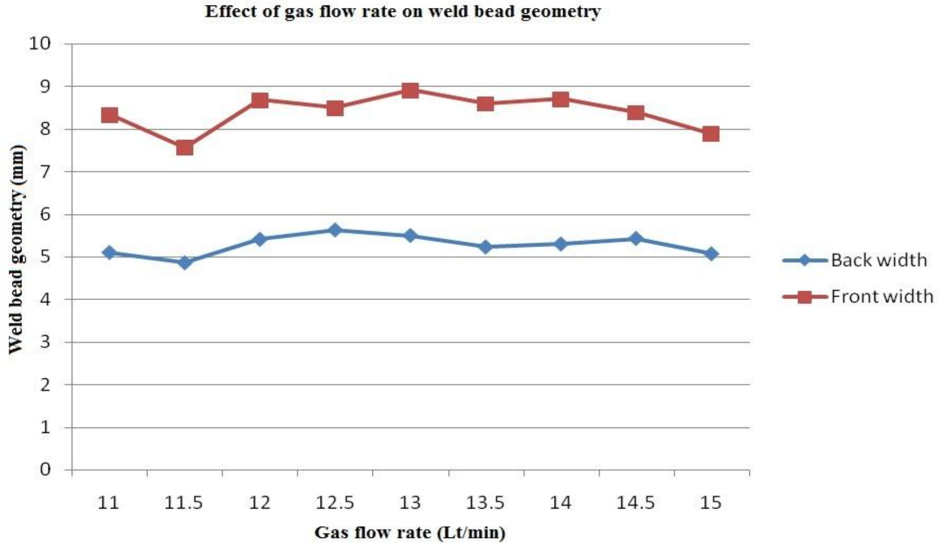

Fig 2: Gas flow rate Vs weld bead geometry

C. Effect of welding speed on weld characteristics of weld joint

The effect of the different values of welding speed on weld bead geometry of weld joint at constant welding current of 230 amps shown below in figure 3. It is observed that as the welding speed increases at constant current, the front width and back width decreases linearly, but increases the depth of penetration.

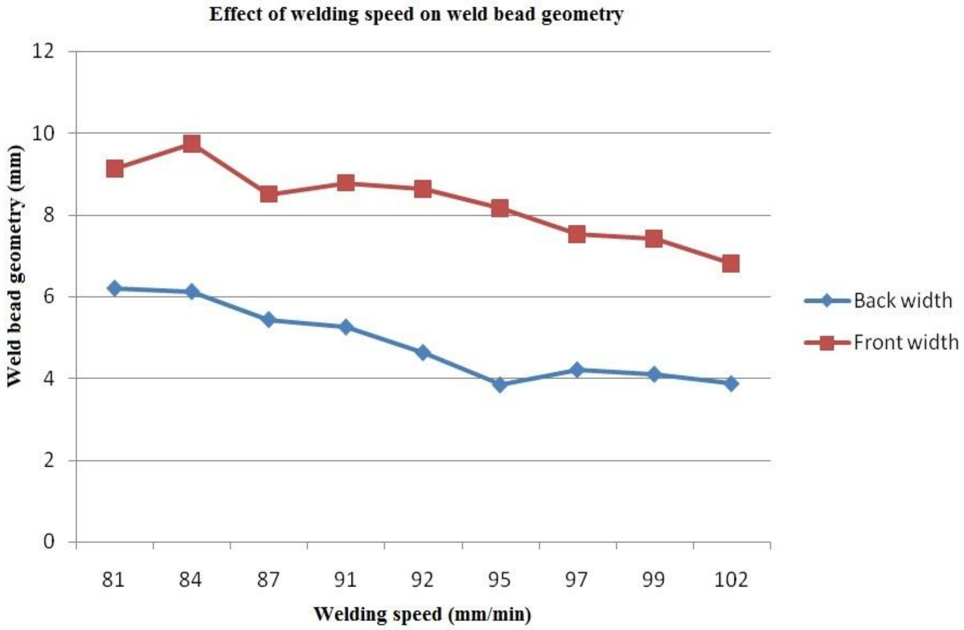

Fig 3: Welding speed Vs weld bead geometry

IV. CONCLUSION

From analysis of all experimental trials, it is found that the great effect of welding parameters such as welding current, gas flow rate and welding speed on weld bead geometry (front and back width) of weld joint. It is clear from the results phase that the following conclusions are drawn from the analysis of collected data of input and output parameters:-

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1. The front width and back width of weld bead increases linearly for different values of welding current when gas flow rate is kept constant.
2. The front width and back width increases or decreases alternatively by changing the values of gas flow rate in increasing order when welding current is kept constant.
3. As the welding speed increases at constant current, the front width and back width decreases linearly, but increases the depth of penetration.

The future scope of the study is discussed in steps such as shown below:

1. In the present study, welding current, gas flow rate and welding speed are taken into account as input parameters. The other welding parameters such as arc voltage, heat input, stand of distance can be investigated on same as well as different alloys of aluminum.
2. Further post weld heat treatment can be applied on same or different materials to achieve better results.

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