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Analyzing Effects of Weld Parameters for Increasing the Strength of Welded Joint on Mild Steel Material by using the TIG Welding Process

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Abstract

In Manufacturing the Mechanical Components, joining is the most requisite process. Welding is one such permanent type of joining methods which can join two or more different or same material parts. Among different types of welding processes, TIG welding is the most widely used for joining the parts as it has significant advantages as compare with other welding processes. So this Research Paper is based on how to increase the strength of Welding joints by applying the TIG Welding process. To achieve the best possible solution we have conducted series of experiments using Mild Steel (IS 2062) by applying varying welding parameters like voltage, current, welding speed etc.
Keywords: Tungsten Inert Gas (TIG), Heat Affected Zone (HAZ), American Society of Mechanical Engineers (ASME), Ultimate Tensile Strength (UTS), Brinnel Hardness Number (BHN), Direct Current Electrode Positive (DCEP)

I. INTRODUCTION

TIG welding is a welding process in which a non consumable tungsten electrode to produce the weld. To strike the welding arc, a high frequency generator provides an electric spark. which is a conductive path for the welding current through the shielding gas and allows the arc to be initiated while the electrode and the work piece are separated, typically about 1.5–3 mm apart. The arc is struck, the welder moves the torch in a small circle to create a welding pool, the size of which depends on the size of the electrode and the amount of current. While maintaining a constant separation between the electrode and the work piece, the operator then moves the torch back slightly and tilts it backward about 10–15 degrees from vertical. Filler metal is added manually to the front end of the weld pool as it is needed. Nowadays TIG is widely used to weld all kinds of metals& metal alloys like stainless steel, nickel, titanium, aluminium, magnesium. The quality of weld ments made by TIG is markedly affected by the welding parameters set by a welder like welding current, welding voltage, travel speed, weld joint position, electrode angle.

A. *Welding Current*

Welding Current used in TIG has the greatest effect on the deposition rate, weld bead size, shape & penetration. In TIG welding metals are generally welded with DCEP (Direct current electrode positive) because it provides the max. heat input to the work & therefore relatively deep penetration can be obtained. When all other welding parameters are held constant, increasing the current will increase the depth and the width of weld penetration & the size of weld bead. If the current is too high, the size of weld bead is large and excessive deep penetration that wastes the filler metal causes burn through &undercut. Too high or too low welding current also affects the strength of weld metal and tensile strength.

B. *Welding Voltage*

In TIG, the arc voltage has a decided effect upon the penetration bead reinforcement & bead width .By increasing the arc voltage the weld becomes flatter & wider, the penetration increases until an optimum value of the voltage is reached, at which time it begins to decrease. High and low voltage cause an unstable arc on mild steel. Excessive voltage causes the formation of excessive spatter & porosity in fillet welds, it increases undercut and produces concave fillet welds subject to cracking. Low voltage produces narrower beads with greater convexity but an excessive low voltage may cause porosity and overlapping at the edges of the weld bead.

C. *Travel Speed*

The travel speed is the rate at which arc travels along the workpiece. For a constant given current, slower travel speeds proportionally provide larger beads and higher heat input to the base metals because of the longer heating time. If the travel speed is too slow unusual weld build up occurs which causes poor fusion, lower penetration, porosity, rough uneven bead. Increasing the travel speed shows opposite effects: less weld metal gets deposited with lower heat input that produces a narrower bead with less penetration. Excessively high speed cause high spatter & undercutting and the beads show an irregular form because of very little weld metal deposit per unit length of weld.

Material Composition: Mild Steel: IS 2062

1) *Chemical Composition:*

Table - 1
Chemical composition of IS 2062

Carbon %	*Manganese Max %*	*Sulphur Max %*	*Phosphorous Max %*	*Silicon Max %*	*Carbon Equivalent*
0.23	*1.50*	*0.045*	*0.045*	*0.40*	*0.42*
Tolerance +0.02	*+0.05*	*+0.005*	*+0.005*	*+0.03*	

2) *Mechanical Properties*

Table – 2
Mechanical properties of IS 2062

Tensile Strength, Min , MPa	*Yield Stress, Min, MPa*		
mm	*<20 mm*	*20-40 mm*	*>40 mm*
410	*210*	*205*	*190*

II. EXPERIMENTAL SETUP

In this study, the effect of various welding parameters on the weldability of Mild Steel – IS 2062 specimens having dimensions 300mm×300mm×10 mm welded by TIG welding were investigated. The welding current, arc voltage, welding speed are chosen as welding parameters.

Welding Process: TIG Welding.
Welding Parameters - Welding Current, Arc Voltage & Welding Speed.
Dimension: 300mm×300mm×10mm.
Parent Material Grade: IS 2062.
Electrode Wire Specification: Flux Cored Wire AWS A5-20 E-71T-1
Electrode Wire Diameter: 1.2 mm.
Shielding Gas - Carbon-Dioxide CO_2
Equipment:

- TIG Welding torch
- Power Supply
- Tungsten Arc Welding System Set up..

Fig. 1: GTAW torch with various electrodes, cups, collets and gas diffusers

Fig. 2: Power Supply in TIG Welding

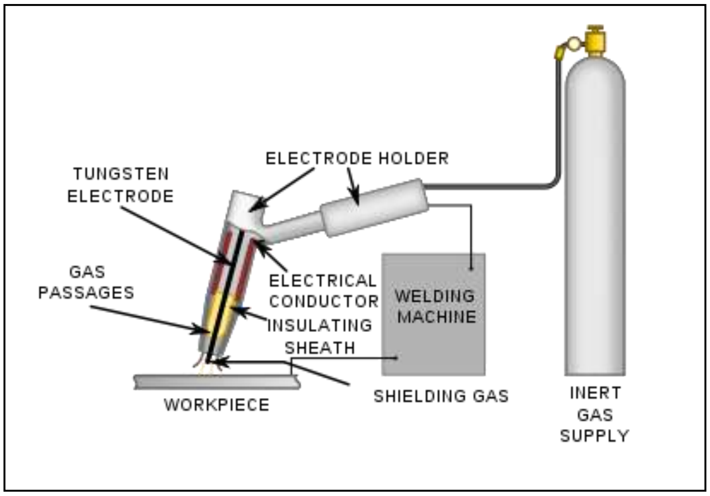

Fig. 3: Tungsten Arc Welding System set up

A. *Experimental Procedure*

First all we had analyzed readings of welding parameters which is currently being used in premier engineering limited. Then we had applied the various varying welding parameters for increasing the strength of welding joints in TIG welding. Sample marked as '7' mentioned in the 'Experimental Result' table is being used by premier engineering limited. The readings mentioned in table for sample '1-6' are carried by ourselves under proper welding standard and as per our experimental setup. Various readings for 'Sample 1-6' (as mentioned in experimental results table) were carried by varying Welding Current, Arc Voltage and Welding Speeds. The effect of each parameter on the welding joint was scrutinized by keeping the rest two parameters constants (though welding speed solely depends on the welder and can't be held constant). For carrying out experimental analysis the dimensions of Weldments were chosen as 300mm×300mm×10mm according to 'Test Method - ASME SEC 9 ASTM A370 . Two pieces of dimensions 300mm×150mm×10mm were welded together and such seven samples were prepared. The range for the selection of Welding Current and Arc Voltage were chosen by referring to 'Manufacturing Technology Volume-1' by 'P.N. Rao'. For the preparation of each sample, welding was carried out in three passes and a back-chip .For each pass , the readings for Welding Current , Arc Voltage and Welding Speed were noted down and checked the Hardness and U.T.S. of the specimen.

B. *Experimental Results*

Table – 3
Experiment result table

Sample No.	*Sr. No.*	*Welding Current*	*Welding Voltage*	*Welding Speed*	*Ultimate Tensile Strength (Mpa)*	*Hardness in BHN*		
								Average
1.	*1.*	*159*	*24.4*	*211.86*	*496.24*	*Parent*	*167,169,167*	*167.66*
	2.	*165*	*24.8*	*295.27*		*Weld*	*228,222,232*	*227.33*
	3.	*159*	*25.8*	*272.72*		*HAZ*	*185,176, 180*	*180.33*
2.	*1.*	*146*	*24.8*	*144.02*	*464.12*	*Parent*	*165,165,176*	*168.66*
	2.	*155*	*24.8*	*295.27*		*Weld*	*195,202,200*	*199*
	3.	*158*	*25.7*	*264.78*		*HAZ*	*156,162,165*	*161*
3.	*1.*	*136*	*26.4*	*192.79*	*474.35*	*Parent*	*159,161,162*	*160.66*
	2.	*145*	*26.8*	*246.71*		*Weld*	*216,226,228*	*223.33*
	3.	*148*	*27.7*	*250*		*HAZ*	*162,165,169*	*165.33*
4.	*1.*	*136*	*22.4*	*180.07*	*468.75*	*Parent*	*139,137,141*	*139*
	2.	*145*	*22.8*	*206.89*		*Weld*	*198,195,201*	*198*
	3.	*148*	*23.7*	*225.56*		*HAZ*	*152,155,155*	*154*
5.	*1.*	*136*	*24.4*	*106.53*	*478.46*	*Parent*	*148,151,151*	*150*
	2.	*145*	*24.8*	*191.57*		*Weld*	*225,228.225*	*226*
	3.	*148*	*25.7*	*195.69*		*HAZ*	*176,183,185*	*181.33*
6.	*1.*	*136*	*24.4*	*133.33*	*449.40*	*Parent*	*144,147,150*	*147*
	2.	*145*	*24.8*	*197.88*		*Weld*	*195,198,199*	*197.33*
	3.	*148*	*25.7*	*233.82*		*HAZ*	*145,140,145*	*143.33*
7.	*1.*	*136*	*24.4*	*196.07*	*445.96*	*Parent*	*159,161,162*	*160.66*
	2.	*145*	*24.8*	*145.13*		*Weld*	*205,203,208*	*205.33*
	3.	*148*	*25.7*	*204.08*		*HAZ*	*153,155,158*	*155.33*

Fig. 4: Specimen after welding

Fig. 5: Final weld sample

Fig. 6: samples after tensile test

III. RESULTS & DISCUSSION

- As compared with sample "7" (company's own setup), if we increases the welding speed then hardness increases and ultimate tensile strength also increases as this can be shown from sample no.1(experiment result table).
- If welding speed increases, and voltage decreases then hardness is going to decreases. This can be shown in sample no.4 as compared with company's own setup.
- If current kept constant and voltage increases along with increase in welding speed, then hardness increases. (sample no.3 and sample no.7)

IV. CONCLUSION

- Since from the above results we have concluded that with increasing the welding speed with constant welding voltage and current, hardness increases.
- For increasing the efficiency of welded joint, we have to increase the two parameters keeping remaining one constant.
- If Voltage decreases and welding Speed increases hardness decreases. If Voltage increases, Current increases and welding speed decreases then hardness decreases**.**

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