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EFFECT OF A-TIG WELDING PROCESS PARAMETERS ON PENETRATION IN MILD STEEL PLATES

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Abstract:- TIG welding is mostly used to weldthin sections for high surface finish. A major drawback in the processis having very small penetration as compare to other arc welding process. The problem can be avoided by using active flux in conventional TIG welding. In the present study investigate theoptimization of A-TIG welding process on mild steel for an optimal parameter by using Taguchi technique. Theeffect of various process parameters (welding current (I), welding speed (V), active flux) .IN the present study efforts were made to increase the weld penetration by appling the active flux and to optimize the process parameters.

***Key words**- A-TIG, Active flux used on mild steel, Tio2 and Sio2 flux used*

I. INTRODUCTION

TIG welding is widely used in modern industry due to good weld bead surface finish obtained. It is applied in almost all categories of ferrous and nonferrous metals, but Conventional Tungsten Inert Gas (TIG) arc welding suffers from the following disadvantages: (a) low productivity; (b) relative shallow penetration; and (c) the high sensitivity of the surface condition and chemical composition of the base metal. When a thin layer of activating flux is used on the surface of the plate before welding then process is called A-TIG welding or also called active flux TIG welding. The advantage of active flux TIG welding is increase the depth of penetration as compare to conventional TIG welding. The researchers find the mechanisms by which active fluxes increase the penetration of conventional TIG welds are reviewed. The most dominant mechanism for increased penetration is considered to be arc constriction rather than a change in the surface tension of the molten pool[1].Some researchers observe the depth/width ratio of the weld pool was closely related to the oxygen content in the pool. As the oxygen content in the weld metal is in a certain range of 70–300ppm, the depth/width ratio increases to 1.5 to 2.0 times[2].Specific activated flux has been developed for enhancing the penetration performance of the TIG welding process for welding of type 304 LN and type 316LN stainless steels. A significant increase in penetration of over 300% has been observed in single pass TIG welding[3].The researchers applied active flux on TIG welding process, oxide powders (Al_2O_3, Cr_2O_3, TiO_2, SiO_2 and CaO) was applied on a type 304 stainless steel through a thin layer of the flux to produce a bead on plate welds.The experimental results indicated that the increase in the penetration is significant with the use of Cr_2O_3, TiO_2, and SiO_2 [4]. Some researchers find When multi-component flux AF305 is used as surface activating flux for an aluminum alloy, the weld penetration of activating flux-tungsten inert-gas welding is over two times more than that of conventional TIG welding[5].The investigate the effect of Cr_2O_3 flux used in tungsten inert gas (TIG) welding on the weld morphology, retained ferrite content, welding residual stress, and hot cracking susceptibility when welding 5 mm thick type 316L stainless steel plates. The results showed that Cr_2O_3 flux assisted TIG welding can create a high depth-to-width ratio weld[6].Some researchers observe that an activated flux assisted TIG welding of type 316L stainless steel was investigated. SiO_2-TiO_2 mixed powder was selected as the activated flux. The results showed that TIG welds surface produced with flux contributed to the formation of residues. The 80% SiO_2+ 20%TiO_2 mixture can produce the greatest improvement function in TIG penetration [7].

EXPERIMENTAL PROCEDURE

The experiments were designed using Taguchi technique and based on a three-factor-three-level. In taguchi technique larger the batter technique is used to find the result.

Larger the better

$$\left(S/N\right)_{HB} = -10 \log(MSD_{HB})$$

$$MSD_{HB} = \frac{1}{R}\sum_{j=1}^{R}(1/y_j^2)$$

In full factorial design, the number of experimental runs exponentially increases as the number of factors as well as their level increases. This results huge experimentation cost and considerable time. Experiments have been conducted with the process parameters given in Table 1, to obtain welding on 8 mm thickness mild steel plate with 35 mm × 150 mm dimensions by TIG welding process.

Table 1- Process Parameters

Parameters	Notation	Unit	Levels of factors		
			1	2	3
Current	I	A	100	130	160
Travel speed	V	mm/min	135	165	200
flux	flux	-	Sio_2	Tio_2	w/o

These experiments were conducted as per the design matrix using L_9. The experiments were conducted according to the design matrix at random order to avoid systematic errors infiltrating the system. Weld beads were laid on t mild steel plate (150×35×8 mm) using bead on plate technique. The experimental set up was designed and used to control the linear movement of the torch using a fixture which mounted on the submerge arc welding. The fixture is having one hole and one slot in diagonal position hole for position hold and slot for giving the angle to weld nozzle. The weld beads were used cutting process to produce specimens for examining the depth of penetration and width of weld bead. After making the specimens grinding process was down on the face. These specimens were prepared by the usual metallurgical polishing methods and etched with etching reagent methanol and nitric acid in 3:1 combination. Penetration was checked for each cross section using Stereo Zoom Trinocular microscope.

Table 2 shows the selected design matrix based on Taguchi L9 orthogonal array consisting of 9 sets of coded conditions and the experimental results for the responses of penetration and width of weld bead. All these data have been utilized for analysis and evaluation of optimal parameter combination required to achieve desired quality weld in terms of bead geometry within the experimental domain.

Table 2- Design Matrix

Sr no.	Current (A)	Travel speed (mm/min)	flux	Penetration (mm)			S/N Ratio
				R1	R2	R3	
1	100	135	Sio_2	2.38	2.32	2.38	7.4582401
2	100	165	Tio_2	1.72	1.68	1.72	4.6429741
3	100	200	w/o	1.1	1.16	1.12	1.0359089
4	130	135	Tio_2	2.08	2.1	2.2	6.5539885
5	130	165	Sio_2	1.88	1.86	1.95	5.5598202
6	130	200	w/o	1.62	1.56	1.6	4.0461328
7	160	135	w/o	2.12	2.16	2.09	6.5403636
8	160	165	Sio_2	2.74	2.78	2.7	8.7550113
9	160	200	Tio_2	2.3	2.34	2.36	7.3595357

Results and Discussion- In Table 2 R1, R2, R3 represents depth of penetration value for three repetitions of each trial. Theimprovement in penetration for s/n ratio & average value of raw data at three levels L1, L2, L3 for each parameter shown in table 3 & 4.

Table 3-Response Table for S/N

LEVEL	current	travel speed	flux
L1	-4.713	-7.337	-6.767
L2	-5.517	-6.773	-6.503
L3	-8.023	-4.144	-4.982
L2-L1	-0.803	0.564	0.264
L3-L2	-2.507	2.629	1.520
DIFFERENCE	-1.703	2.063	1.256

Where L1,L2 and L3 denotes the avg. value of S/n data at levels 1,2 & 3 of parameters.L2-L1 is the avg. main effect when the corresponding parameter changes from level 1 to level 2. L3-L2 is the avg. main effect when the parameter changes from level 2 to level 3.

Table 4-Response Table for Raw Data

LEVEL	current	travel speed	flux
L1	1.802	2.333	2.235
L2	1.902	2.211	2.122
L3	2.524	1.684	1.871
L2-L1	0.1	-0.122	-0.113
L3-L2	0.622	-0.526	-0.251
DIFFERENCE	0.522	-0.404	-0.137

L1,L2 and L3 denotes the avg. value of raw data at levels 1,2 & 3 of parameters.L2-L1 is the avg. main effect when the corresponding parameter changes from level 1 to level 2. L3-L2 is the avg. main effect when the corresponding parameter changes from level 2 to level 3.

Figure Effect of process parameters on depth of penetration for both S/N data & RAW data.

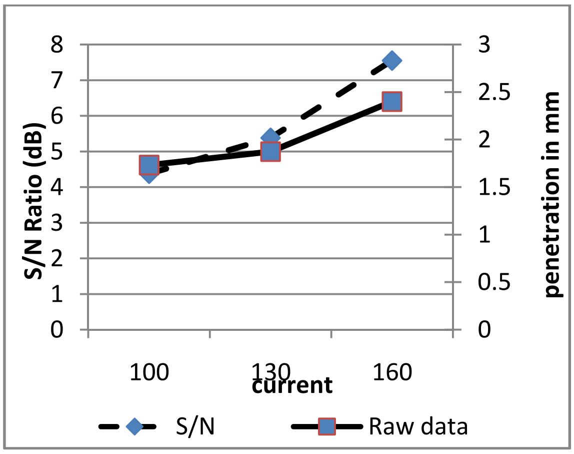

Figure 1 Effect current on S/N data & RAW data

From the fig 1shows the direct effect of welding current on depth of penetration. Figure illustrates that when the welding current increases, the heat input increases. The increase in heat input results in preheating of the work piece during forward welding. This results in more melting of base metal. Hence there is an increase in depth of penetration as welding current increases.

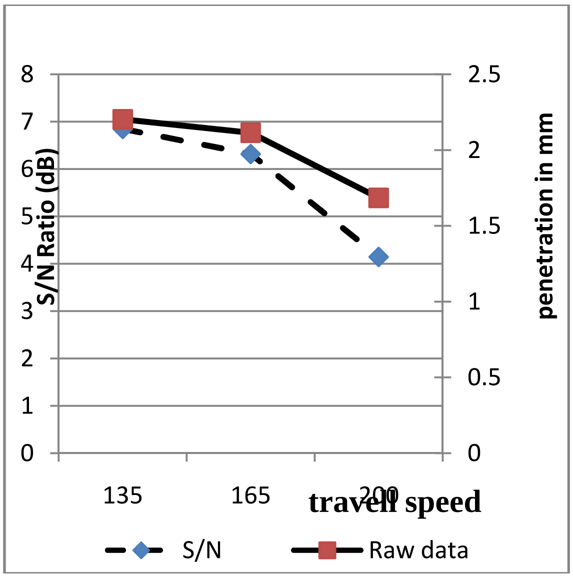

Figure 2- Effect travel speed on S/N data & RAW data

Fig2, shows the direct effect of welding speed on depth of penetration. Welding speed is one of the main factors that control heat input and bead width.

The bead width and dimensions of the heat affected zone decreases with the increase in welding speed. This is because heat input is inversely proportional to welding speed. Due to the above factors the depth of penetration decreases with the increase in welding speed

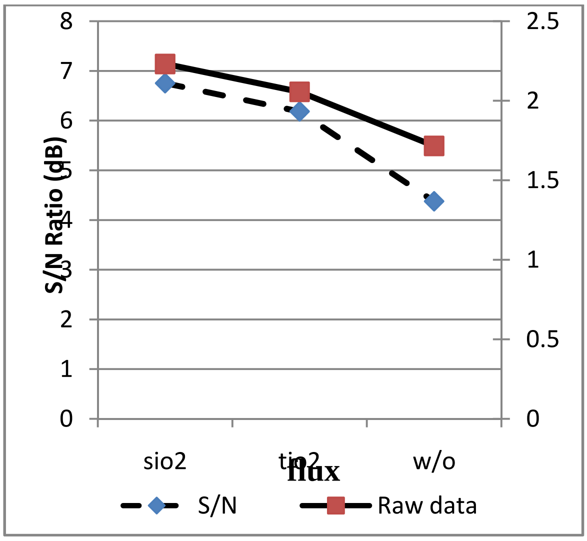

Figure 3- Effect flux on S/N data & RAW data

From figure 3we can observe that diffrent flux have deffrent effect on depth of penetration in case of with flux as compare to without flux depth of penetration increase.sio_2 have more effect as compare to tio_2 as shown in figure analyzed by researchers the reasion for increase the penetration for using the active flux ins following

1) Arc constriction -The temp of arc is higher than decompositiontemp. of molecules at the center in the lower part of thearc where shielding gas and the atom of flux are ionized to electrons and positive ions .the materials evaporated still exist as molecules and decomposed atoms in the outer reasion of the arc.decomposed atomes absorb electrons to form charged particles to cause the decrease of main conducting materials, then the cnducting ability decreasesand arc constricts[8].

2) Generally, surface tension gradients decrease with increasing of temp. In pure metal and many alloys, fluid flow from low suface tension reasion to high surface tension resion. Weld pool center is having high temp.so the surface tension near the center is low as compare to outer resion. So flid folwwidth of bead is higher and penetration is less . surface active elements such as oxygen and sulfur can change the direction of the fluid flow in weld pool. when plate with coating activating flux fluid flow width of beas less and penetratio is more.

In the table5significant parameter is shown and also show the contribution of all parameter in penetration.

CONCLUSION

from the experimental result we can observe that

a) The penetration improve could be increase in the weld current and contribution of welding current to improve penetration is 40.09 %.

b) we find that depth of penetration is inversely prepositional to travel speed. The contribution of welding current to improve penetration is 24.92 %.

c) If we used the active flux the depth of penetration is increase more effect is down by the sio_2 as compare to the tio_2. The contribution of welding current to improve penetration is 22.24%.

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