Parametric Analysis of Weld Characteristics for a Single Pass Tig Welding

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Abstract---Tungsten Inert Gas welding is one of the most widely used techniques for joining ferrous and non-ferrous metal. In which the arc is generated between a nonconsumable tungsten electrode and work-piece, and the molten metal is protected from the atmosphere by using the shielding of inert gas argon. In this study, SS304 sheet material having 3 mm thickness were welded using TIG welding. The welding process parameter namely welding current, welding voltage Gas flow rate considered for weld quality. The Full Factorial Design advocated the use of experiment.
Keywords: Welding Current , Welding Voltage , Gas Flow Rate , Front Width , Back Width.

I. INTRODUCTION

TIG welding is one of most popular electric arc welding process in which the fusion Energy is produced by an electric arc burning between the work piece and the tungsten electrod. During the welding process the electrode , the arc and the weld pull are protected againts the damaging effects of the atmospheric air by an inert shielding gas like argon or helium. By means of a gas nozzle the shielding gas is lead to the welding zone where it replaces the atmospheric air.

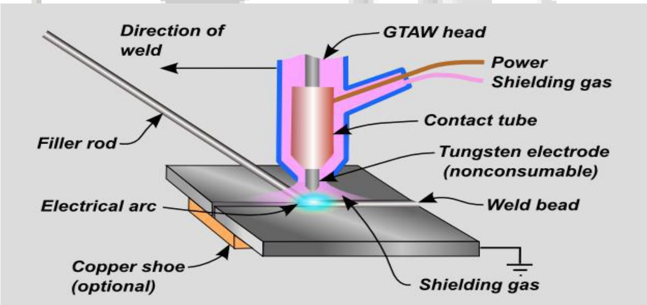

Fig.1: Tig Welding Setup

II. LITERATURE REVIEW

A. *Sreejith S Nair(3, July 2013)*

Tungsten Inert Gas (TIG) welding is a widely applied manufacturing process. The weld distortion is one of the major constraints which can not be completely avoided irrespective of material type and thickness. The present paper reports the optimization of weld process parameters for the transverse distortion control applied to MS structures of 3 mm thickness with TIG weld process. The base material used for the experiments was pure 1100 aluminum with a plate thickness of 1.6mm. ANOVA is applied for the optimization of weld parameters control. In this study the transverse distortion of TIG, welding process was evaluated using weld current, root gap, Argon gas flow rate and the weld speed as the main parameters. A L8 orthogonal array was selected for the design of experiments towards the distortion optimization caused by butt welding. It was found from these experiments that Root gap has a major contribution of 43% and Weld current of 36% influence on distortion. Robust design is possible by controlling these parameters and identifying their criticality in process with respect to pooled errors in experiments. Pooled errors include effect of parameters which do not have appreciable contribution towards distortions. The TIG welding process parameters are selected by using Taguchi method of experimentation with minimum number of experiments. . L8 orthogonal array was selected and factors with two levels were used in the design of experiments. ANOVA is developed and implemented for the experimental data for control of selected parameters. This is the simplest case for the weld distortion analysis for optimum TIG process parameters control with lowest number of experiments. In addition critical contribution of weld process parameters is further analysed with Pooled ANOVA. The experiments on distortion control of weld parameters for TIG welding for MS structures have resulted with effect of each parameter contributions as following manner. Root gap contributes 43 %. Weld current contributes 37%. Weld speed contributes 14 %. Parameter Gas flow rate and Interaction of current and gas flow rate has no major effect and are combined with the error and the pooled error is about 6 %. This procedure can be effectively used to reduce weld distortion in the design of structures with TIG welding process and the optimization with the various input parameters.

B. *G. Lothongkum, E. Viyanit, P. Bhandhubanyong(24 Nov.2000)*

The TIG pulse welding parameters of AISI 316L stainless steel plate of 3 mm thickness at the welding positions of 6-12 h were investigated. The studied parameters were welding speed, pulse/base currents, pulse frequency, and % on time. Preliminary welding results at the 6 h welding position showed that the appropriate parameters were: base current of 61 A, pulse frequency of 5 Hz, and 65% on time. With these constant parameters the effects of welding speeds of 2-8 mm/s and nitrogen contents of 0-4 vol.% in argon shielding gas on pulse currents. The maximum welding speed of 5 mm/s is found for the welding positions of 8, 9, 10 h, but the welding speed of 6 mm/s is not applicable because of incomplete filled groove. The welding parameters for TIG pulse welding of AISI 316L stainless steel plate of 3 mm thickness at 6, 8, 9,10 and 12 h welding positions are experimented. The initial experiments showed that the base parameters: current of 61 A, pulse frequency of 5 Hz and 65% on time should be kept constant at all welding positions. The relations of welding speed pulse currents and shielding gas compositions were then investigated.

III. DESIGN OF EXEPERIMENT

DOE is a technique of defining and investigating all the possible combinations in an experiment involving multiple factors and to identify the best combination. In this, different factors and their levels are identified. Design of experiments is also useful to combine factors at appropriate levels, each within the respective acceptable range to produce the best results and yet exhibit minimum variation around the optimum results. The design of experiment is used to develop a layout of the different conditions to be studied. An experiment design must satisfy two objectives: first the number of trails must be determined and second the conditions for each trail must be specified. Before designing an experiment, the knowledge of the product/process under investigation is prime importance for identifying the factors likely to influence the outcome. The Design of Experiments (DOE) is a method to identify the important factors in a process, identify and fix the problem in a process, and also identify the possibility of estimation interactions.

A. *Factorial design*

Factorial design allows simultaneous study of effect that several factors may have on a process. When performing an experiment, varying the level of factor simultaneously rather than one at a time is efficient in terms of time and cost, and also allow for the study of interaction between the factors. Interaction is the driving force in many times processes. Without the use of factorial experiments, important interaction remains undetected

B. *Process Parameters*

Input Parameter:

1. Factor A: Welding Current
2. Factor B: Welding Voltage
3. Factor C: Gas Flow Rate

Constant parameter:

Work Piece Thickness

Output Parameter:

1.Front Width
2.Back Width

Thickness	Parameters	Level1	Level2	Level3
3mm	Welding Current	110	120	140
	Welding Voltage	20	22	24
	Gas Flow Rate	3.5	5.5	7.5

Table.1: Process Parameter Level

Ex. No.	Welding Current	Welding Voltage	Gas Flow Rate	Plate Thick Ness
1.	110	24	7.5	3
2.	140	22	5.5	3
3.	110	22	7.5	3
4.	120	20	7.5	3
5.	120	24	7.5	3
6.	140	24	3.5	3
7.	140	22	3.5	3
8.	110	24	3.5	3
9.	140	20	5.5	3
10.	120	22	7.5	3
11.	140	24	7.5	3
12.	110	22	3.5	3
13.	120	20	3.5	3
14.	140	22	7.5	3
15.	120	22	5.5	3
16.	140	20	3.5	3
17.	140	24	5.5	3
18.	140	20	7.5	3
19.	120	20	5.5	3
20.	120	22	3.5	3
21.	110	20	5.5	3
22.	110	20	7.5	3
23.	110	20	3.5	3
24.	110	24	5.5	3
25.	110	22	5.5	3
26.	120	24	3.5	3
27.	120	24	5.5	3

Table.2: Full Factorial Design Factor

IV. EXPERIMENATAL WORK

A. *Equipment*

- DC or AC / DC Power Source
- TIG Torch
- Work Return Welding Lead
- Shielding gas supply line

B. *TIG welding machines specifications are as*

- Make-HALLMARK
- Code- TIG 200A
- Volatge-230 V AC
- Curent-25-200 A
- Electrode-Tungsten

Fig. 2: TIG Welding Machine set-up

C. *Welding Torch*

Specifications of the welding torch which is used for these experiments are Forced Air cooled cooling system Collets for 0.8-1.6. Φ electrode.

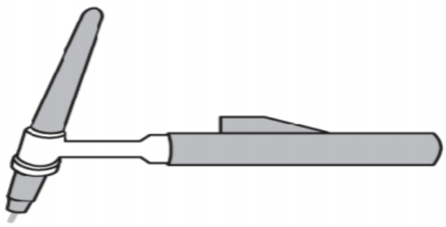

Fig.3: Welding Torch

D. Material selection

Material selected for welding trials and experiments is SS304. Austenitic Cr-Ni tainless steel has Better corrosion resistance than Type 302. High ductility, excellent drawing, forming, and spinning properties. Essentially non-magnetic, becomes slightly magnetic whencold worked. Low carbon content means less carbide precipitation in the heat-affected zone during welding and a lower susceptibility to intergranular corrosion.

Chemical	3mm
%C	0.057
%Cr	18.350
%Ni	8.100
%Mo	0.470

Table. 3: Chemical Composition

E. Work piece detail

For study SS304 is selected, as it has a very large scale application in the process industry. The material selected thicknesses as 3mm.The specimen size selected is 25mm X 50mm as per ASTM standards.

Fig.4: Thicknesses of work piece material of SS304

F. Welding performance of tig welding machine

Fig.5: Welded Job

After welding the work pieces, penetration is checked by visual observations. Specimens with improper penetration are rejected. The effect of welding parameters on Bead Geometry is studied by measuring front width and back width by using Travelling microscope

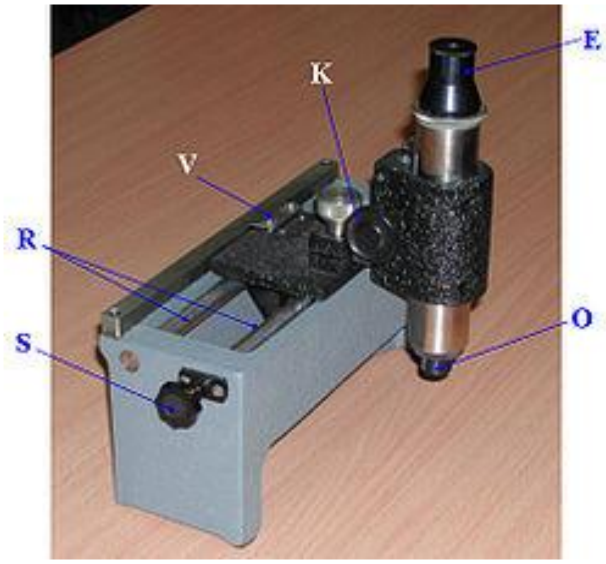

Fig.6: Travelling Microscope

E- eyepiece V- Vernier
O- objective R- rail
K- knob of focusing S- screw

Ex. No.	Welding Current	Welding Voltage	Gas Flow Rate	Plate Thick Ness	Front Width	Back Width
1	110	24	7.5	3	6.40	3.55
2	140	22	5.5	3	7.50	5.67
3	110	22	7.5	3	6.28	3.42
4	120	20	7.5	3	6.90	4.59
5	120	24	7.5	3	6.97	4.67
6	140	24	3.5	3	7.50	4.70
7	140	22	3.5	3	7.58	4.73
8	110	24	3.5	3	5.01	4.60
9	140	20	5.5	3	7.38	5.53
10	120	22	7.5	3	7.02	4.68
11	140	24	7.5	3	8.04	6.33
12	110	22	3.5	3	5.12	4.69
13	120	20	3.5	3	6.99	5.10
14	140	22	7.5	3	8.07	6.38
15	120	22	5.5	3	6.72	5.15
16	140	20	3.5	3	7.53	4.67
17	140	24	5.5	3	7.41	5.60
18	140	20	7.5	3	7.99	6.25
19	120	20	5.5	3	6.68	5.08
20	120	22	3.5	3	6.90	5.00
21	110	20	5.5	3	5.60	4.65
22	110	20	7.5	3	6.30	3.45
23	110	20	3.5	3	5.20	4.80
24	110	24	5.5	3	5.62	4.68
25	110	22	5.5	3	5.58	4.62
26	120	24	3.5	3	7.10	5.18
27	120	24	5.5	3	6.82	5.12

Table. 4: Exeperiment

V. CONCLUSION

In present study parametric analysis has been carried out for front width and back width on SS304 material. Experiments are carried out using Full Factorial Method by varying welding current, welding voltage and gas flow rate for 3mm thickness of SS304 material. Minitab 15 software was used for analyze the experimental data.

We have concluded that at welding current(140A),welding voltage(22V) and gas flow rate(7.5LPM), we measure the maximum F.W.(8.07mm) and welding current(110A),welding voltage(24V) and gas flow rate(3.5LPM), we measure the minimum F.W.(5.01mm).and at the welding current(140A), welding voltage(20V), gas flow rate(7.5LPM), we measure the maximum B.W.(6.25 mm) and welding current(110A), welding voltage(22V), gas flow rate(7.5LPM), we measure the minimum B.W.(5.42 mm)

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