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An Experimental Investigation on the Effect of MIG Welding parameters on the weld joint using Taguchi method

Shreyash Patel[1]

[1]*M. Tech. Scholar, Mechanical Engineering Department, Rajasthan technical University, Rajasthan, India,*
Srp.ngpp.@gmail.com

Abstract: *In my study determine the effect of MIG welding parameters on welding joint with Taguchi orthogonal array method. A welding mild steel plate is IS 2062 E 250 grebe A by means of the filler metal diameter of wire is 1.2 mm and its grade is ER 70S6 and inert gas is 100% carbon dioxide.*

In this work the variable parameters are weld current, weld voltage and weld wire rate moreover stable input parameters are weld arc time, and gas flow time is 17lit/hr. to investigation of the tensile strength and hardness of the welding joint are examine in an experimentally. They have chosen three constraints were change at three levels. Designing the nine experiments were stage base on L9 orthogonal array of Taguchi technique. It consisting of three input variables are welding current, voltage and wire feed rate respectively. Finding the single to noise ratio(S/N ratio) and analysis of variance (ANOVA) based on S/N ratio of employed of mini tab 17 software, which is investigated that the wire feed rate maximum effect on tensile strength go after welding current and arc voltage. And the arc voltage has maximum effect in hardness go after wire feed rate and welding current.

Keywords: *Mig, Gmaw, Mild Steel, Taguchi Method*

I. INTRODUCTION

GMAW is generally identified as Metal Inert Gas welding and it is less generally known as Metal Active Gas welding Gas Metal Arc welding process (GMAW) has been the majority usually used welding method for the ferrous and non ferrous materials in engineering world. In a GMAW a electric power source, a welding torch, shielding gas & a wire pool drive control. The welding process is very simple. GMAW process can be employ to weld thick metal plate with high output. The protecting gas is used to protect the weld pond from oxidization.

The protecting gas used is either inert gas or carbon dioxide. Gas Metal Arc Welding Is a semi-automatic or automatic Arc weld process in which a constant and consumable wire electrode and a protecting gas are feed through a handgun.

A steady voltage, direct current power source is most commonly used with GMAW, but steady current systems, as well as alternating current, can be used. The function of GMAW usually requires direct current reverse polarity to the electrode. In non-standard terminology, in any case, the GMAW processes lend itself to weld a broad range of both hard carbon steel and tubular metal-cored electrodes. The alloy material variety for GMAW includes: medium carbon steel, stainless steel, aluminum, magnesium, copper and alloys steel. The GMAW process lends itself to semiautomatic, robotic computerization and hard mechanization welding applications. Now a day's GMAW welding process is widely used industries atmosphere causes of good strength, penetration and weld reliability GMAW is most applicable in automobile industries, machine structural components, agriculture equipment's, aerospace industries marine industries etc.

II. LITERATURE REVIEW

Ajit Hooda Ashwani Dhingra and Satpal Sharma (2013)

In this study work a try was made to develop a response surface model to calculate tensile strength of inert gas metal arc welded AISI 1040 medium carbon steel joints. The process parameters such as welding voltage, current, wire speed and gas flow rate were studied. The experiments were conducted based on a four-factor, three-level, face centered composite design matrix. The experiential relationship can be used to predict the yield strength of inert gas metal arc welded AISI 1040 medium carbon steel. Response Surface Methodology (RSM) was applied to optimizing the MIG welding process parameters to attain the maximum yield strength of the joint

Gautam kochera, Sandeep kumarb, Gurcharan Singh (2013)

MIG butt welds of IS 2062 E250 mild steel plates to be welded using CO 2 as protecting gas. Welding speed is select as process variable while arc voltage, welding current, wire feed rate distance between the nozzle and the plates are fixed in this experiment. The effect of weld speed on the weld bead profile is been discussed with the effect of weld speed on the fusion angle and wetting angle. They are effect of weld speed on the weld bead dilution i.e. penetration area and reinforcement area also be discussed.

Jatinder Gill, bJagdev Singh (2013)

The effect of welding speed and heat input rate on stress concentration factor of butt welded joint of IS 2062 E 250 A steel plates by gas metal arc welding (GMAW) were studied. For this series of experiments were carried out at fixed wire feed rate, welding current , arc voltage ,distance between gas nozzle and plate, gas pressure and the vertical angle of welding. Thus Different samples were obtained by employing arc voltage of 20V, welding current of 110A, wire speed of 5.918m/min and welding speeds of 94.83, 109.90, 120.00, 131.25, 140, 150 and 169.76 mm/min .The findings indicate that the weld bead geometry i.e. width of reinforcement, height of reinforcement, flake angle, and radius of notch get effected with the welding speed and heat input rate, thus the stress concentration factor also affected. The results shows that with increase in the welding speed, flank angle and weld bead width, reinforcement height decreases whereas notch radius increase thus stress concentration factor decreases. At the same time with increase in the heat input rate, flank angle and weld bead width, reinforcement height increases whereas notch radius decreases thus stress concentration factor increases.

III. DESIGN OF EXPERIMENTS

The experiment were performed on a semi automatic pulse MIG welding machine employ direct current electrode positive the pulse MIG welding machine model is ELECTRO DIGNO SYSTEM,MIG (EDS 400 TURBO). Pulsed spray transfer has a steady stream of metal droplets crossing the welding arc. The pulsed power source supplies the welding arc with two types of welding current.

Figure.1 Pulse MIG welding machine

The test piece size is 100×100×6mm IS 2062 E250A mild steel plate is used were cut down by power Hacksaw machine. The consumable electrode ER70S6 diameter is 1.2mm. Gas is 100% Co_2 are employ. They have chemical composition of electrode and parent metal shown in table.

Table 1 Chemical Composition of consumable electrode

Chemical Composition of Filler Wire					
E70S6					
C	Si	Mn	Cu	P	S
0.19	0.98	1.63	0.025	0.025	0.025

Table 2 Chemical Composition of parent metal

IS 2062 E250A specification of mild steel for general structural purpose					
Chemical composition					
C	Si	Mn	N	P	S
Max 0.22	0.40	1.50	Max 0.012	Max 0.045	Max 0.045

The sample cut in same size and their pictorial view is shown in figure number 2. A single "V" grove of 60 degree was made on each specimen employ power grinding machine. The sample piece is as shown in figure number 3.

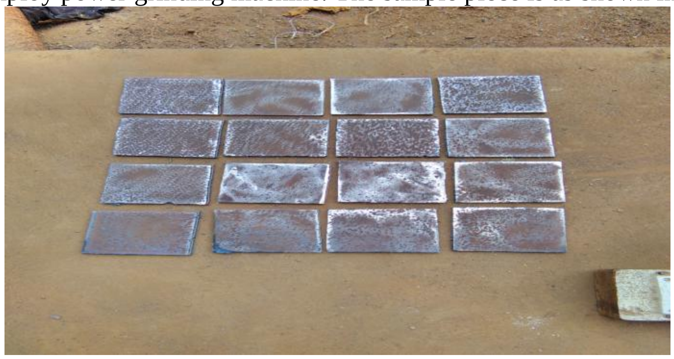

Figure.2 Sample piece of welding specimen

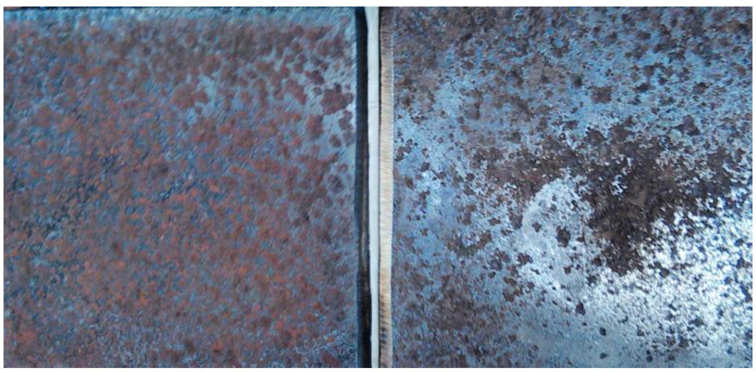

Figure.3 single V grove of specimen

IV. DESIGN MATRIX

In this experiment there are three variable parameters are selected which is development of design matrix employ Taguchi method using mini tab 17 software. The variable parameter respectively i.e voltage current and wire feed rate. The variable parameters three level are shown in table.

Table 3 Three levels of variable parameters

Level	Variable		
	Voltage (V)	Current (A)	Wire speed (M/MIN)
1	23	180	200
2	24	190	250
3	25	200	300

The design matrix is produce Taguchi orthogonal array, level is L9 design were selected in the design matrix. The following table displays the L9 Taguchi design (orthogonal array). L9 means 9 runs. 3^3 means 3 factors with 3 levels each. This array is orthogonal; factor levels are weighted equally across the entire design.

The table columns represent the control factors, the table rows represent the runs (combination of factor levels), and each table cell represents the factor level for that run.

Table 4 L9 orthogonal array Taguchi design matrix

Sr.no.	Voltage (V)	Current (A)	Wire speed (M/MIN)
1	23	180	200
2	23	190	250

3	23	200	300
4	24	180	250
5	24	190	300
6	24	200	200
7	25	180	300
8	25	190	200
9	25	200	250

After the design matrix prepared using mini tab 17 software, the MIG machine parameter is set as per the requirements. The MIG machine is semiautomatic set the welding voltage, current and welding wire speed are set manual the run of experiment is start carefully with prescribe variable parameter. Each and every specimen gives the numbers for further procedure. A welded pictorial view is shown in figure.

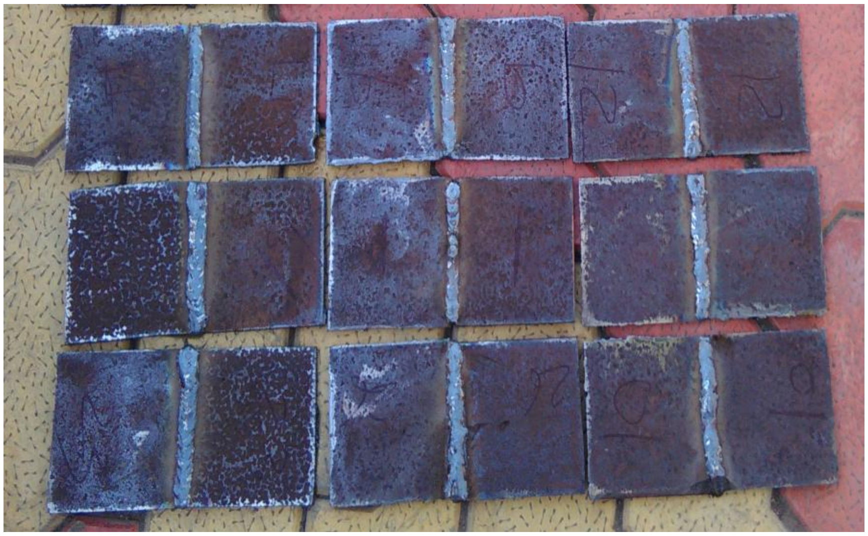

Figure 5 weld specimen

V. ANALYSIS OF RESULTS BASED ON TAGUCHI METHOD

5.1 Tensile Test

Tensile strength find experimentally then after finding the single to noise ratio using mini tab 17 software, it is represent desire value means mean of output characteristics. And noise represents the undesirable value means squared deviation of the output characteristics.

According to value engineering the characteristics class as higher the best for tensile strength and for hardness nominal is best. The finding the analysis of variance based on S/N ratio. The main purpose of ANOVA analysis is to finding the design parameters and specifies which parameters are considerably touching the output parameters. Table 5 Result for tensile test (UTS)

Sr. no.	Voltage (V)	Current (A)	Wire speed (M/MIN)	Tensile Strength (Mpa)	S/N Ratio
1	23	180	200	512.3	54.1905
2	23	190	250	382.3	51.6481
3	23	200	300	390.1	51.8235
4	24	180	250	360.8	51.1453
5	24	190	300	350.3	50.8888

6	24	200	200	370.6	51.3781
7	25	180	300	479.6	53.6176
8	25	190	200	490.2	53.8075
9	25	200	250	308.6	49.7879

The most favorable process parameters have been calculated by analysis of s/n ratio. From main effect plot shown in figure, its accomplished that the voltage (23) current (180) and wire speed (200) give higher tensile strength .however optimal parameters is 23 volt, 180 current and wire speed rate 200 m/min.

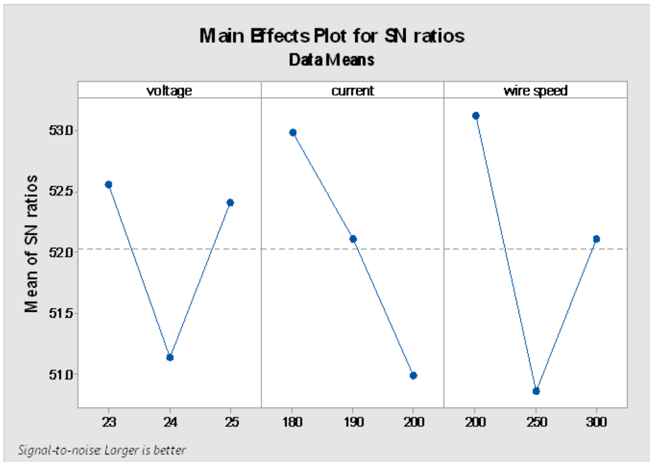

Figure 6 Main effect plot for UTS

ANOVA analysis shown in table below and is accomplished that wire speed is the most efficient factor which effect on tensile strength maximum. The percentage contribution of 43% cover welding wire speed with percentage contribution 33% welding current and voltage with percentage contribution 20% and total error is 4%

Table 6 ANOVA based on S/N ratio

Source	DF	Adj SS	Adj MS	F-value	P-value	PC (%)
Voltage	2	3.6343	1.8171	4.80	0.173	20
Current	2	5.9588	2.9794	7.87	0.113	33
Wire speed	2	7.7221	3.8611	10.19	0.089	43
Error	2	0.7576	0.3788			04
Total	8	18.0728				

The response values for S/N ratio for each level of celebrated factors have been shown in table which shows factor level values of each factor and their ranking. The response for S/N ratio larger is better shown in table.

Table 7 Response table for S/N ratio for UTS

Level	Voltage (V)	Current (A)	Wire speed (M/MIN)
1	52.55	52.98	53.13
2	51.14	52.11	50.86
3	52.40	51.00	52.11
Delta	1.42	1.99	2.26
Rank	3	2	1

5.2 Hardness test

The test samples from all the 9 run the specimen use for measuring hardness are cleaning with emery paper on the parent metal, heat affected zone and welding zone. The pyramid shape diamond indenter use on the Hardness testing. The full load applied on specimen is usually 10-15 second.

All specimens were taking three reading of each respective area and taking an average reading of the parent metal, heat affected zone and welding zone respectively. Every reading is taking carefully at atmospheric temperature range. There are three indention of each zone and taking average of all reading for the precise work.

Table 8 Result for hardness

Hardness WZ Hv10	Hardness PM Hv10	Hardness HAZ Hv10	S/N Ratio
163.5	139.5	170.0	19.83.72
156.0	131.5	138.0	20.9651
156.5	134.5	140.5	22.0401
131.5	131.5	145.0	24.8353
186.5	176.5	180.5	31.1246
190.5	179.5	200.5	21.3277
153.5	145.5	140.5	26.9821
180.5	170.5	190.0	25.3405
190.0	174.5	180.0	27.2712

The most favorable process parameters have been calculated by analysis of S/N ratio. From main effect plot shown in figure, it's accomplished that the voltage (23) current (180) and wire speed (200) give optimal condition of hardness .however optimal condition of parameters is 23 volt, 180 current and wire speed 200 m/min.

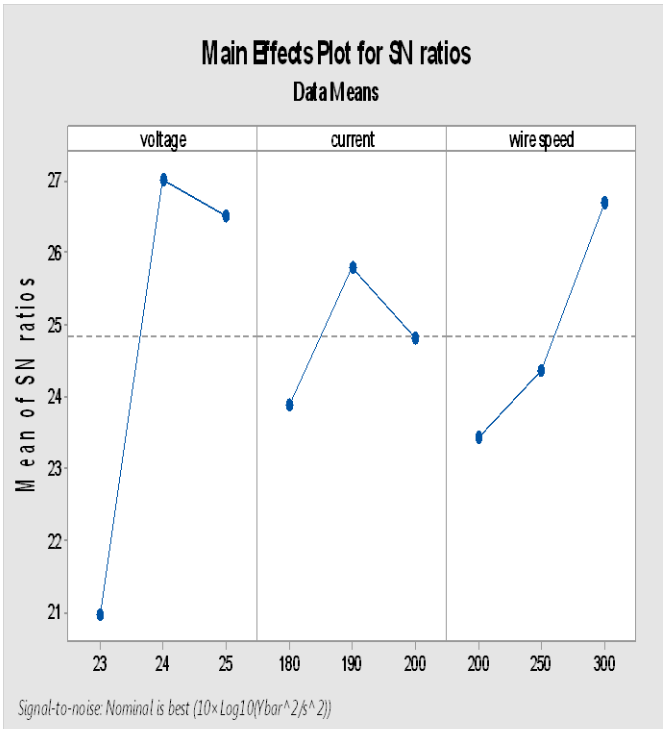

Figure 7 Main effect plot for hardness

After that determine the S/N ratio of hardness and main effect plot, the contribution factor determine based on S/N ratio. The analysis of variance ANOVA purpose is to determine which parameters are large contribution, the results of ANOVA is shown in table below that accomplished the voltage is the most efficient factor which effect on hardness. The percentage contribution of 53% cover welding voltage with percentage contribution 02% welding current and wire feed rate with percentage contribution 36% and total error is 08%

Table 9 ANOVA based on S/N ratio

Source	DF	Adj SS	Adj MS	F-value	P-value	PC (%)
Voltage	2	68.537	34.269	9.74	0.093	69
Current	2	5.561	2.780	0.79	0.559	6
Wire speed	2	17.096	8.548	2.43	0. 292	17
Error	2	7.035	3.517			08
Total	8	98.229				

The response values for S/N ratio for each level of celebrated factors have been shown in table which shows factor level values of each factor and their ranking.

Table 10 Response table for S/N ratio for hardness

Level	Voltage (V)	Current (A)	Wire speed (M/MIN)
1	20.95	23.88	23.44
2	27.04	25.81	24.36
3	26.53	24.82	26.72
Delta	6.09	1.93	3.27
Rank	1	3	2

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