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OPTIMIZATION OF GMAW PROCESS ON MILD STEEL

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Abstract: Quality of weld depends on a big extent on the beadgeometry which is largely influenced by various process parameters in the process. Meagreness of weld bead dimensions may lead to failure of the welded structure. This paper is a study of optimization of process parameters. Experiments were conducted based on central composite Face Centred Cubic design and mathematical models were developed correlating the important controllable GMAW process parameters like Voltage (V), welding speed (S) and gas flow rate (G) with weld bead penetration. Gas metal arc welding is a fusion welding process having wide applications in industries. Gas metal arc welding is one of the conventional and traditional methods to join materials. The present study is to investigate the influence of welding parameters on the penetration. The optimization for Gas metal arc welding process parameters (GMAW) of Martensitic Stainless steel work piece mild steel using Taguchi method is done. Twenty seven experimental runs (L27) based on an orthogonal array Taguchi method were performed. This paper presents the effect of welding parameters like welding speed, welding current and wire diameter on penetration. The ANOVA is applied to identify the most significant factor and predicted optimal parameter setting. Experiment with the optimized parameter setting, which have been obtained from the analysis, are giving valid the results. The confirmation test is conducted and found the results closer to the optimize results. These results showed the successful implementation of methodology.

KeyWords: GMAW, welding, Argon gas, ANOVA etc.

I. INTRODUCTION

Welding is a manufacturing process of creating a permanent joint obtained by the fusion of the surface of the parts to be joined together, with or without the application of pressure and a filler material. The materials to be joined may be similar or dissimilar to each other. The heat required for the fusion of the material may be obtained by burning of gas or by an electric arc. The latter method is more extensively used because of greater welding speed. Welding is extensively used in fabrication as an alternative method for casting or forging and as a replacement for bolted and riveted joints. It is also used as a repair medium e.g. to reunite a metal at a crack or to build up a small part that has broken off such as a gear tooth or to repair a worn surface such as a bearing surface.

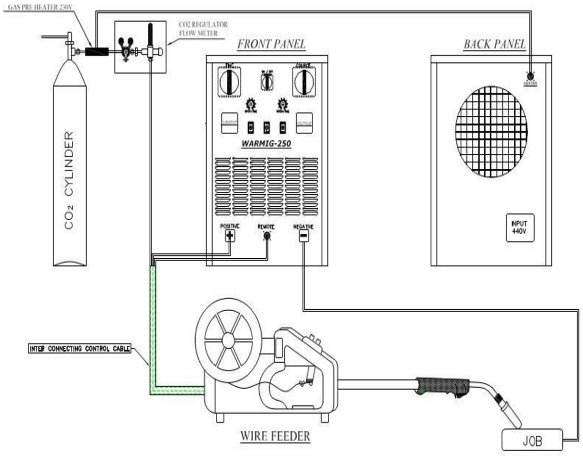

Figure1.1Gas Metal Arc Welding (GMAW orMIG)

II. METHODOLOGY

2.1 Experimental Setup

From the literature survey of past researchers it is shown-that the material selection in manufacturing process is most important thing as per process availability and customer's requirement. There is number of material used in modern industry but steel have corrosion resistive property and high strength, so it is widely use in modern industry. The material used to carry out experiment is mild steel. The filler material use for the experiment is copper coated MS material electrodes with size of 1.20 mm diameter.

Shielding gas composition for experiment is as shown in table

Table 2.1shilding gas composition

Type of gases	CO2	Argon
A	0%	100%
B	20%	80%
C	100%	0%

Mild steel plates with the dimensions of 150×200×8 mm are prepared with the bevel heights of 8 millimeter, bevel angle of 45. These specimens are then welded with a root gap distance 1 millimeter. Figure shows the single V groove butt joint preparations.

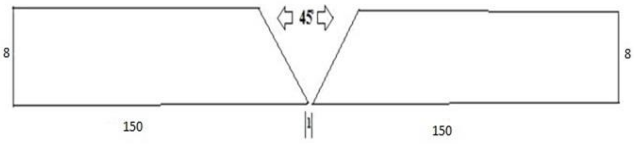

Figure 2.1 Sample specimen with bevel angle of 45°

After preparation, plates are placed on the workbench. In each placement, distance between the nozzle and work piece and the electrode extension were 20 and 10 millimeter, respectively. The welding electrode is held perpendicular to the welding surface. Welding is started and the flow rate of shielding gas is adjusted by using knob. The plates were welded at single pass.

Figure: 2.2 Universal testing machineUTE-40

2.2 Taguchi method

Design of experiment: Each experimenter may design a different set of fractional factorial experiments. Taguchi simplified and standardized the fractional factorial designs in such a way to engineers conducting tests thousands of miles apart, will always use similar designs and tends to obtains similar results. Taguchi developed a family of fractional factorial experiments matrices which can be utilizes in various situations. These matrices reduce the experiments numbers but still obtain reasonably rich information. In Taguchi methodology specially design table known as “orthogonal arrays” are used. The use of this table makes the design of experiments vary easy and consistent.

Table2.2-ParameterandtheirLevels

Process parameter	Level1	Level2	Level3
GasMixture CO2&Argon	100%CO2	80%Ar&20% CO2	100%Ar
Current (Amp)	120	150	180
Travel speed (mm/min)	130	150	170

III. RESULTS OF DOE –FULL FACTORIAL METHOD

Obtain results are shown in table 3.1.

Table3.1–Experimental Results of Full factorial Method

SrNo.	GasMixture	Current	Travel speed	Ultimate Tensile strength	Breaking point
1	100 %CO2	120	130	513.316	BOW
2	100 %CO2	120	150	508.734	BOW
3	100 %CO2	120	170	496.364	BFW
4	100 %CO2	150	130	499.321	BOW
5	100 %CO2	150	150	487.604	BFW
6	100 %CO2	150	170	482.316	BFW
7	100 %CO2	180	130	492.584	BOW
8	100 %CO2	180	150	460.991	BFW
9	100 %CO2	180	170	496.735	BFW
10	80%Ar&20 % CO2	120	130	551.035	BOW
11	80%Ar&20 % CO2	120	150	545.027	BOW
12	80%Ar&20 % CO2	120	170	539.521	BOW
13	80%Ar&20 % CO2	150	130	537.016	BOW
14	80%Ar&20 % CO2	150	150	519.037	BFW
15	80%Ar&20 %CO2	150	170	526.038	BFW
16	80%Ar&20 % CO2	180	130	534.032	BOW
17	80%Ar&20 %CO2	180	150	522.631	BFW
18	80%Ar&20 %CO2	180	170	485.062	BFW
19	100 %Ar	120	130	492.069	BOW
20	100 %Ar	120	150	486.164	BFW
21	100 %Ar	120	170	481.742	BFW
22	100 %Ar	150	130	479.106	BOW
23	100 %Ar	150	150	460.035	BFW
24	100 %Ar	150	170	471.019	BFW

25	100 %Ar	180	130	475.368	BOW
26	100 %Ar	180	150	459.032	BFW
27	100 %Ar	180	170	463.025	BFW

Test for bending stress

For the same parametric values, root bend and fae bends are checked for bending strength optimization.

Table3.2–Experimental Results of Bending strength test

Sr No.	GasMixture	Current	Travel speed	Rootbend	Facebend
1	100 %CO_2	120	130	Satisfactory	Satisfactory
2	100 %CO_2	120	150	Satisfactory	Satisfactory
3	100 %CO_2	120	170	Not satisfactory	Not satisfactory
4	100 %CO_2	150	130	Satisfactory	Satisfactory
5	100 %CO_2	150	150	Satisfactory	Satisfactory
6	100 %CO_2	150	170	Not satisfactory	Not satisfactory
7	100 %CO_2	180	130	Satisfactory	Satisfactory
8	100 %CO_2	180	150	Satisfactory	Satisfactory
9	100 %CO_2	180	170	Not satisfactory	Not satisfactory
10	80%Ar&20 % CO_2	120	130	Satisfactory	Satisfactory
11	80%Ar&20 %CO_2	120	150	Satisfactory	Satisfactory
12	80%Ar&20 %CO_2	120	170	Satisfactory	Satisfactory
13	80%Ar&20 %CO_2	150	130	Satisfactory	Satisfactory
14	80%Ar&20 %CO_2	150	150	Not satisfactory	Not satisfactory
15	80%Ar&20 %CO_2	150	170	Satisfactory	Not satisfactory
16	80%Ar&20 %CO_2	180	130	Satisfactory	Satisfactory
17	80%Ar&20 %CO_2	180	150	Not satisfactory	Not satisfactory
18	80%Ar&20 %CO_2	180	170	Satisfactory	Not satisfactory
19	100%Ar	120	130	Satisfactory	Satisfactory
20	100 %Ar	120	150	Not satisfactory	Not satisfactory
21	100 %Ar	120	170	Satisfactory	Not satisfactory
22	100 %Ar	150	130	Satisfactory	Satisfactory
23	100 %Ar	150	150	Not satisfactory	Not satisfactory
24	100%Ar	150	170	Satisfactory	Not satisfactory
25	100 %Ar	180	130	Satisfactory	Satisfactory
26	100 %Ar	180	150	BFW	Not satisfactory
27	100 %Ar	180	170	BFW	Not satisfactory

3.2Analysis of Variance (ANOVA)

ANOVA was used to determine the significant parameters influencing surface finish and wall thickness in the forming of AA1100. Table 4.3 shows summery of ANOVA results for ultimate tensile strength and wall angle. In this study analysis was level of significance as 5% and level of confidence as 95%.

Table3.3–ANOVA Results for ultimate tensile strength

Source of Variation	DOF	Sum of Squares (SS)	Mean Square (MS)	Variance Ratio (F)	Probability(P)	Percentage Contribution %C
Gas mixture	2	13862	6930.80	73.63	0.000	69.70%
Current	2	2920	1460.08	15.51	0.000	14.68%
Travel speed	2	1223	611.28	6.49	0.007	6.15%
Error	20	1883	94.14			9.47%
Total	26	19887				100%
S=9.70235 R-Sq =90.53%						

MAIN EFFECT PLOTS ANALYSIS

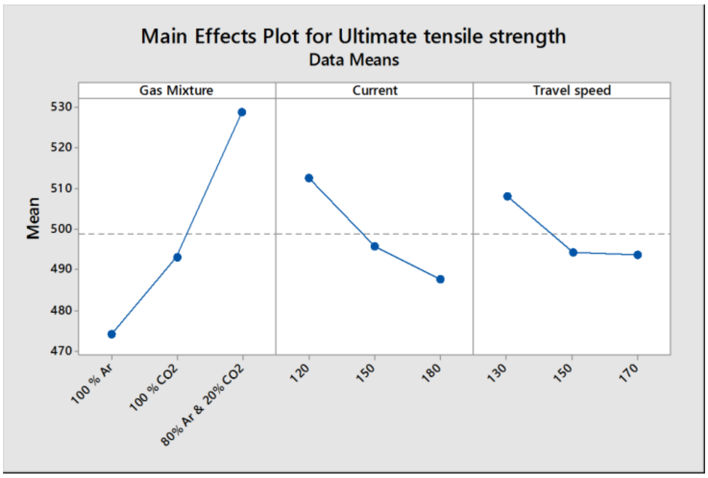

Figure 3.1 ANOVA results

From the above ANOVA results it is clear that ultimate tensile strength depends on gas mixture by 69.70% and current by 14.68%. For achieving better strength we need to control these two parameters only. Optimum values can be Gas mixture at level 3 (80% Ar& 20% CO2), Current at level 1 (120 Amp) and Travel speed at level 1 (130 mm/ min).

IV. CONCLUSIONS

From above experiments, its concluded that individual effect of gases are not so impressive compared to when they are used in mixture. For better results, its optimized that mixture of both gases should be well maintained in prescribed ratio achived from said experimental analysis.

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