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Pilot Study for Selection of Process Parameters During Joining of AISI 304 and Duplex 2205 using Gas Metal Arc Welding

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ABSTRACT

In automotive industries, Gas metal arc welding (GMAW) process is widely used for fabrication of different plates of metal. For fabrication process material of different thickness is used. Due to high input energy of GMAW and low stiffness of material suitable process parameters are selected for fabrication. In the present pilot study AISI 304 and Duplex 2205 of thickness 5 mm is used for joining two dissimilar metals. A pilot study is done to select the process parameters such as welding current, voltage, shielding gas, filler wire and gas flow rate for joining the plates. Effect of CO_2 as a double layer shielding gas is also considered in the present study. From the pilot study it has been concluded that too low value and too high value of process parameter selected results in poor weld bead so it is necessary to select process parameters in a proper range.

Keywords-- gas metal arc welding, process parameters, pilot study, double shielding gas, thin plates

I. INTRODUCTION

Gas metal arc welding is one of the mostly used fabrication process used in the industries for joining the two same or dissimilar metals. GMAW is a process in which coalescence is produces by heating the metals by using the wire as a filler material. any of the materials are joined by various processes in which some processes are easy to weld than other processes. So to compare these processes term 'weldability' is used. Weldability of a material depends upon the various factors like metallurgy of a material, gas absorption and evolution by the material, crack propagation of welded parts and extent of oxidation etc.

In the present pilot study AISI 304 and Duplex 2205 having thickness 5 mm is used for joining two dissimilar metals with GMAW. The process GMAW used in present study has high heat input energy and material having low stiffness. Due to high heat input and low stiffness a pilot study is done on material to select a suitable range of process parameters. Process parameters selected for the pilot study are welding current, voltage, filler wire, shielding gas, gas flow rate. Effect of CO2 gas as a outer layer shielding is also considered for the present pilot study.

A lot of research work has been done so far by researchers using different process parameters to get better results of welding. So our main focus in this research is to give an idea for new researchers to select the process parameters for joining upto 3 levels. Ramesh et al. [1] studied the effect of welding distortion on joining the two dissimilar material of AISI 304 and Duplex 2205 and concluded that with increase in welding current and voltage weld distortion increases. Ibrahim et al. [2] studied that the effects of different parameters on welding penetration, micro structural and hardness measurement in mild steel that having the 6mm thickness of base metal by using the robotic gas metal arc welding are investigated. Abbasi et al. [3] the effect of increased pressure on MIG welding has been investigated using automatic MIG welding machine using a mixture of argon and carbon dioxide as a shielding gas. Variation in parameters like feed rate, travelling speed, voltage and arc pressure were observed on penetration. Variation of penetration with different pressure has also been investigated. In this study all the above parameters are studied with different proportions of gas mixture of argon and carbon di oxide as a shielding gas. Lu et al. [4] proposed that He as the inner layer shielding gas and He + O2 as the outer layer shielding gas, and the weld efficiency from this process is increased compared with that of the common TIG welding process Cheaper than oxygen, CO2 gas is widely used in industry and can also decompose into oxygen in the welding process. Gulenc et al. [5] studied the effect of different proportions of the hydrogen in argon as a shielding. Influence of hydrogen is that it increases the

welding speed. It also influence that addition of hydrogen increases the volume of molten metal in the weld pool because of higher thermal conductivity of mixture of gases of hydrogen and argon. Kang et al. [6] studied the effect of alternate supply of shielding gas and mixture of shielding gas on the austenitic stainless steel using GTAW process and find the variations in welding distortion and welding speed with different shielding gases. Durgatlu [7] investigated the effects of hydrogen in argon as a shielding gas on the austenitic steel of 4mm thickness by using GTAW process with welding wire of same material. In this study he used three different gases as the shielding media, pure argon, 1.5% H2–Ar and 5% H2– Ar

II. EXPERIMENTAL PROCEDURE

AISI 304 and Duplex 2205 are used as work pieces material for joining dissimilar material having dimensions 100 mm x 50 mm x 5 mm. Chemical compositions of work piece materials as obtained by optical emission spectroscopy analysis (Spectroscopy Foundry Master, make: WAS, Germany) for austenitic stainless steel 304 is Fe 69.0%, C 0.05%, Si 0.33%, Mn 0.97%, Cr 20.2%, Ni 8.26%, Mo 0.16%, P 0.049%, S 0.008% and Cu is 0.382%. Dissimilar metal joining of AISI 304 is done with Duplex2205 with a chemical composition of Fe 66.2%, C 0.1%, Si 0.327%, Mn 1.46%, Cr 23.1%, Ni 4.92%, Mo 3.26%, P 0.020%, S 0.005% and Cu is 0.198%. Work pieces are ground filled and finalized for edge preparation (single-V joint). After this they are cleaned with acetone to remove oxide and surface contaminations. Equipment used for welding is metal active gas (MAG) semiautomatic welding machine (Torando 350, make: Ador, India) as shown in Fig. 1.

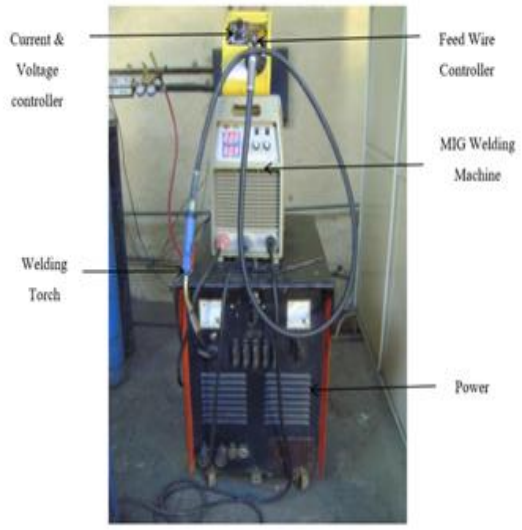

Figure 1: Gas metal arc welding setup

In order to select the proper range of parameters, process parameters selected are current, voltage, filler wire, gas flow rate and single or double layer shielding gas. For double shielding gas firstly a nozzle is prepared by fixing a second pipe around the periphery of a nozzle. CO_2 gas is passes through the outer pipe of nozzle. The purpose of CO_2 as a outer shielding is to protect welding arc and inner shielding gas from the atmospheric air. Prepared double shielding gas nozzle is shown in Fig. 2.

Figure 2: Prepared shielding gas nozzle

Shielding gas used for pilot study is pure argon, pure helium and a mixture of 70% Ar +30% He. Mixture of argon and helium is used as a shielding gas because pure helium is lighter gas and dispersed in air during welding and pure helium is also much expensive. Filler wire selected for welding purpose is AISI 304, AISI 316 and Duplex 2205. Three level of each parameter is selected for pilot study because we can use Taguchi technique to get the optimized results from these parameters.

III. RESULT AND DISCUSSION

Before finalized the process parameters trials are conducted on dissimilar metal joining using selected process parameters. Initially welding current and welding voltage is selected by conducting trials at different combination of welding current and voltage. During trials it was concluded that too much less and high current and voltage are not acceptable during joining 5 mm thick plates of work piece as shown in Fig 3 and Fig 4.

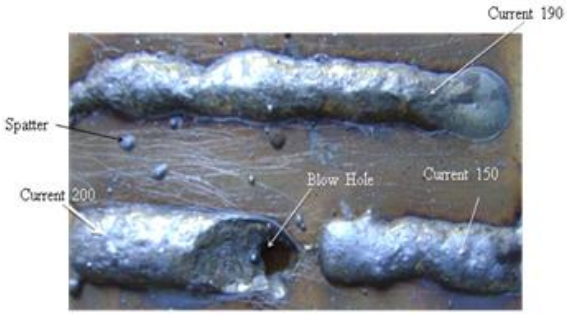

Figure 3: Pilot work on AISI 304

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Figure 4: Pilot work on Duplex 2205

From the Fig 3 and Fig 4 it has been concluded that when current of 150A is used narrow weld bead is formed and when we use 200A current problem of blow hole and spatter may occur as shown in Fig 3 and Fig. 6. For selection of proper welding voltage trials are also done on work piece as shown in Fig. 5.

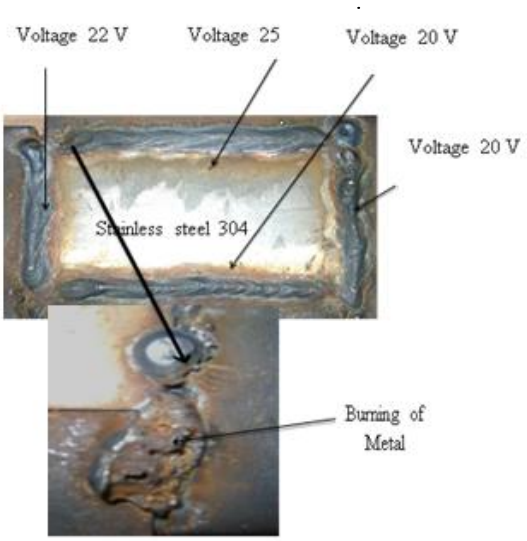

Figure 5: Blow hole in welding due to high voltage and current selected

Fig. 5 shows when combination of 200 A current and 22 V is selected for welding blow hole defects may occur on back face of work piece. Fig. 6 Shows the effect of shielding gas on work piece.

Another important parameter in GMAW is gas flow rate. Proper gas flow rate is necessary to get defect free welds. If gas flow rate is less than requirement porous bead is obtained and also if it is more than requirement than blowing of metal from the weld pool takes place (as shown in Fig. 6). If nozzle to work piece distance is more than more gas flow rate is required and if distance is less than less gas flow rate is required. Proper location of grounding is necessary to minimize the arc blow especially for ferromagnetic materials. So it is necessary to weld always away from the grounding of the work piece table.

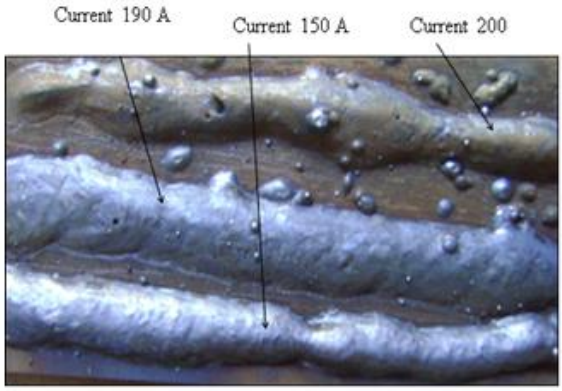

Figure 6: Weld bead using different shielding gas

After pilot study process parameters are finalized with three level each are shown as in Table 1.

S.NO	PARAMETER	UNITS	LEVELS		
			1	2	3
1	Welding current	A	160	180	200
2	Welding voltage	V	20	22	24
3	Shielding gas	-	Ar	He	70%Ar+30 %He
4	Gas flow rate	L/min	12	14	16
5	Filler wire	-	AISI 304	AISI 316	Duplex 2205
6	Single layer or double layer shielding	L/min	Single layer	Double layer with CO_2 8 L/min	Double layer with CO_2 8 L/min

Table: 1 Selected process parameters after trials

IV. CONCLUSION

Following results were concluded after conducting pilot study on process parameters.

- Too low value of welding current and voltage result in narrow bead of weld metal and sometime proper fusion of weld metal not take place.
- If value selected of welding current and voltage is too high it may result in spatter on the workpiece.
- If high voltage and high current is selected it may result in blow hole in the work piece.
- Carbon precipitation on the surface of weld metal takes place if only CO_2 is used as a shielding gas.

- If gas flow rate is less than 8 L/min than continous arc will not formed.
- Gas flow rate more than 16 L/min results in gas wastage.
- By using double layer shielding stability of welding arc takes place.

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