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COMPARATIVE EVALUATION OF MANUAL METAL ARC WELDING AND MAG-CO_2 WELDING ON BASE OF HARDNESS PROPERTIES AND ITS WELD QUALITY FOR CARBON STEEL ALLOY"

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ABSTRACT: *Comparative Evaluation of Manual Metal Arc Welding and MAG –CO_2 Welding were studied in this paper. All welds were prepared by MMAW technique in flat position and MAG Welding techniques in same position. The welding currents were chosen as variable input parameter. The welding currents were chosen as 100,140 &, 180 A, arc voltage was chosen as 24 V for all experiments. Material taken for our experiment is AISI 1020 or C20 of 5 mm plate thickness several experiments have performed to investigate the mechanical properties and weld quality.*

1. INTRODUCTION

MMAW and MAG-CO_2 processes are an important component in industrial operation. These processes are versatile; since they can be applied for all position welding; can be easily automated. These advantages features of these processes have attracted many researchers to study on them. Arc welding, the molten weld pool is contained by the surrounding solid metal, which means that a liquid – solid interface is always present at the weld fusion boundary. This interface provides an ideal nucleation site. Hence during the solidification of weld – metal, there is no homogeneous nucleation and super cooling id negligible. As the nucleating grains grow, some of them are pinched off, causing fewer but larger grains in the weld-metal. The resulting grain size has marked effect on mechanical properties. The welding parameters for the both process are the most important factors affecting the quality, productivity and cost of welding joint in this study we have chosen first order parameter like welding current. Because among all control parameters welding current has the strongest effect on weld bead size, geometry and depth of penetration [1]. Investigation into the relationship between the welding process parameters and bead geometry began in the mid 1900s. Raveendra and Chandel showed that arc current has the greatest influence on bead geometry and that mathematical model derived from experimental results can be used to predict bead geometry shown in figure 1 accurately [2].

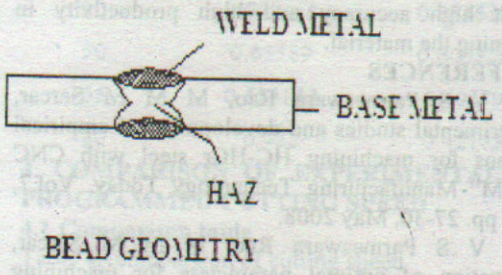

Figure 1 Bead Geometry

2. GENERAL DESCRIPTION OF MMA WELDING

It is an arc welding process wherein coalescence is produced by heating the work piece. With an electric arc set up between fluxes coaled electrode and the work piece. The flux covering decomposes due to arc heat and performs many functions, like arc stability, weld metal protection, etc. The electrode itself melts and supplies the necessary filler metal. Heat required for welding is obtained from the arc struck between a coated electrode and the work piece. The arc temperature and thus the arc heat can he increased or decreased by employing higher or lower arc currents. A high current arc with smaller arc length produced a very intense heat. The arc melts the electrode end and the job. Material droplet arc transferred from the electrode to the job, through the arc, and are deposited along the joint to be welded. The flux coating melts produces a gaseous and shield to prevent atmospheric contamination of the molten weld metal. A process sketch is shown in figure.2 [3].

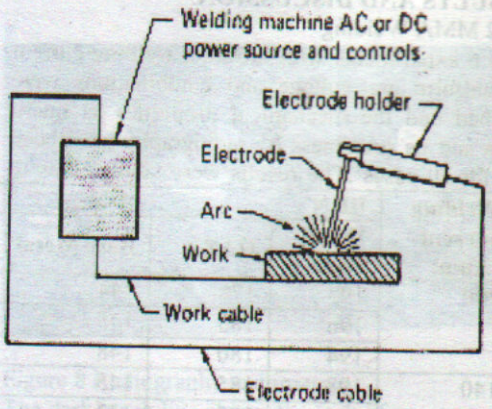

Figure 2 MMA Welding Machine

3. GENERAL DESCRIPTION OF MAG-CO_2 WELDING

MAG stands for metal-active-gas arc welding. This is a variation of MIG welding, in which identical equipment is used but the inert gas is replaced by carbon dioxide, which is chemically active The American Welding Society refers to the process as Gas Metal Arc welding and has given it the letter designation GMAW.

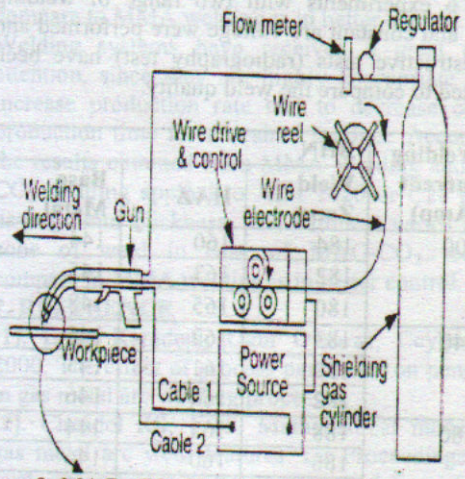

Figure 3 MAG- CO_2 Welding Machine

All the major commercial metals can be welded by the MAG- CO_2 process, including carbon steels, stainless steels, aluminum, copper, titanium, zirconium and nickel alloys. Gas metal arc welding (GMAW or MIG welding) is an electric arc welding process which joins metals by heating them with an arc established between a continuous filler metal (consumable) electrode and the work. Shielding of the arc and molten weld pool is obtained entirely from an externally supplied gas or gas mixture. A process sketch is shown in figure.3 [3].

4. EXPERIMENTAL SET UP

The experimental set-up is as shown figure 4 for MMA welding, while figure 5 for MAG-CO_2 welding experiment set up. The welding machine we used for MMA welding is as shown in figure 4. Its make and specifications were as-

Make - Modern Electrical Industries, AB'ad
KVA-12
Volts-440
Current Amp-300
Cycles-50

Welding electrodes we used for our experiments for the MMA welding technique were an extruded retile based and heavy coated electrodes of standard (AWS:E6013,IS: ER 4221X) And that were maker of GEE Ltd.

Figure 4 Welding Machine for MMA welding

While for the MAG-CO_2 welding our welding machines specifications were as-

Make-ESAB
Code-AUTO K 400
Volatge-17-34 volts
Curent-100-350 Amp DCEP
Electrode-1.2mm makes GEE Ltd.
Standard-AWS/SFA 5.18: ER 70 S-6
Mild steel copper coated

Figure 5 Welding Machine for MAG-CO2 welding

In our experiment we had used 16-bit microcontroller for welding installation. The experiments are performed under reverse-polarity (wire-anode, work piece-cathode) direct Current in the constant current mode. The specimen we have used had 5mm plate thickness .The welding torch was fixed on a table that can be displaced manually in vertical direction, in

order to adjust the distance between the contact-tip and the metal [4].

Table 1 Chemical composition of specimens, wt%

	C	Mn	Si	S	P	Al	N
Base-Metal Carbon Steel Alloy	0.123	0.9	0.045	0.008	0.13	0.004	0.005
MIG-Wire electrode AWS/SFA 5.18: ER 70 S-6	0.077	1.9	0.66	0.028	0.002	0.028	0.008
MMA- Wire electrode AWS:E6013,IS: ER 4221X)	0.077	1.4	0.86	0.012	0.014	0.018	0.001

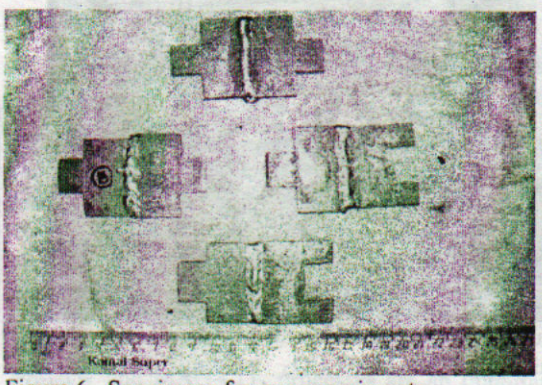

Figure 6 Specimens for our experiments

The gas was provided by bottle of industrial gas. During this study, we used carbon dioxide gas. Mass flow meters make MISATU allow measurement and control of gas output. Pressure gauge ranges were 0-100psi (0-7bar).All Experiments had performed at the pressure of 2 – 2.4 bar. The anode wire used in our experiments is GM-70 MIG wire (AWS/SFA 5.18: ER 70 S-6) mild steel copper coated. The welded specimens were look like as shown in figure 6.

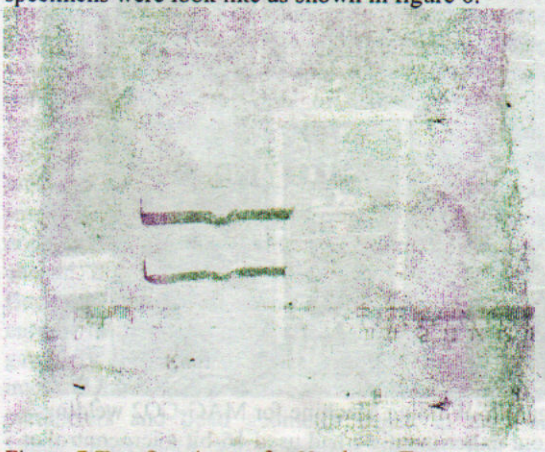

Figure 7 Test Specimens for Hardness Test

And figure 7 shows the test specimens for the hardness test which were taken for hardness testing on Vickers's Hardness Machine at Divine Laboratory, Ahmadabad.

5. RESULTS AND DISCUSSION

Table 2 MMA Welding

Totally 6 experiments with different welding current and uniform arc voltage and combinations were performed and the mechanical properties as micro harness and its soundness by radiography have been tested for all cases .The results were tabulated as in table 2 and in table 3. For our experimental work we have taken input parameter as welding current and as output hardness are measured with the vicker's hardness machine.

Welding current (Amp)	BHN		
	Weld Zone	HAZ	Base Metal
100	195	178	144
	196	185	145
	194	180	148
140	198	185	145
	196	182	143
	206	173	146
180	199	180	144
	205	189	146
	207	187	142

Table3 MIG Welding

Totally 6 experiments with two range of welding current, and constant arc voltage were performed and Non destructive tests (radiography test) have been conducted to compare the weld quality.

Welding current (Amp)	BHN		
	Weld Zone	HAZ	Base Metal
100	184	160	144
	182	163	145
	180	165	148
140	183	162	145
	180	161	143
	182	160	146
180	188	162	144
	186	160	146
	190	167	142

While among these 6 experiments 2 jobs each from both welding techniques, were carried for Non destructive testing i.e. radiography test at Radio Tech, Ahmedabad. The results are shown in figure 8.

6. CONCLUSION

By physical inspection of both specimens, we can easily conclude that surface finish of MAG-CO_2 welding gives better smoothness than MMA welding. As shown in figure.8 mark A is of MMA welding while mark B made on the job which is prepared by MAG-CO_2 welding technique. Both jobs have same process parameters and that are 100 Amp weld current, arc voltage 24 V.

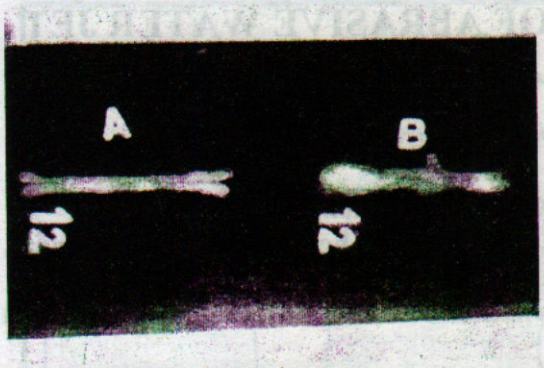

Figure 8 Radiography test images

The dark black line shows the lack of penetration and white images shows the fusion. As from result we concluded that in mark A black line is continuous comparing with mark B job. It shows that there is much lack of penetration in MMA welding comparing to MAG-CO_2 welding. And also the fusion in the weld joint is good in case of MAG-CO_2 welding with respect to MMA welding.

According to the results obtained for hardness values of MMA Welding and MAG-CO_2 welding applied to having 5mm thickness, the hardness varies in three zone of weld in case of MAG-CO_2 technique compare to MMA welding is in better control.

Welding systems have received a great deal of attention, since they are highly appropriate both to increase production rate and to decrease cost and production time for a desired product. According to the results obtained from MMA Welding and MAG-CO_2 welding applied to AISI 1020 or C20 material having 5mm thickness. The hardness varies in three zone of weld in case of MAG-CO_2 technique compare to MMA welding is in better control.

7. REFERENCE

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