Investigation of Mild Steel Mechanical Properties Welded by Gas Metal Arc Welding

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Abstract— In global environment, welding plays a major important role in manufacturing technology. Gas Metal Arc Welding process (GMAW) dominates other welding processes. The selection of shielding gas is a big challenge in industries. The usages of shielding gases have been increased towards better productivity, good weld quality and better mechanical properties. In this study, the shielding gases like pure CO2 and pure Argon + pure CO2 are used and experimented. The multipass welding is used in this method by four passes procedure. The mechanical properties like tensile strength, impact energy and hardness values were tested in parent metal since it was widely used for most of applications like marine, machine tools and structural applications. The welds produced by the shielding gases pure Argon + pure CO2 gives the better mechanical properties compared to welds produced by the pure CO2 shielding gas.

Key words: Gas Metal Arc Welding, Mechanical Properties, Multipass Welding

I. INTRODUCTION

Gas metal arc welding (GMAW) is a welding process in which an electric arc forms between a consumable wire electrode and the work piece, which heats the work piece metal, influencing them to melt & join. Through with the electrode wire, a shielding gas is passed along with the welding gun. And the contaminants in the air are shielded by using the shielding gas [1]. The shielding gas composition in GMAW plays major role because which is used to protect the weld pool from the atmospheric contamination, to achieve a good weld quality and also for a safety purpose [2].

Compare to other welding process GMAW are time consuming welding process. The base metal was welded with help shielding gas mixture which gives good weld penetration and mechanical properties. The thickness of the base metal is high the welding process uses the multipass welding [3]. The multipass welding gives some good mechanical properties on weld metal. The pure CO_2 were result in weld defect as increase in spatter rate but they can achieve deeper penetration. But with the mixture Ar+CO_2 the spatter rate is reduced and they able to achieve good mechanical properties of weld metal [4]. They experimented with oxygen also mixes with argon it gives good arc stability and reduces the surface tension in the weld metal but the oxygen level is increases in the mixtures shows more defects than other mixing process. A chromium carbide and tungsten carbide perception increases the strength and hardness values [5].

II. MATERIALS AND METHODS

Mild steel is used in all type ofindustries for example in automobile, structural and others public sectorunits. In this research, plates of mild steel IS2062 having dimensions 150mm length, 150mm width and 10mm thickness has been used as a work piece material. The welding was performed by a Gas Metal Arc Welding (GMAW) process in an enclosed chamber. The Shielding gases pure argon and pure carbon dioxide was supplied through the nozzle at the constant flow rate. At first sample was welded under the following parameters are pure CO_2 was supplied as a shielding gas flow through the welding torch at a flow rate of 10 l/minute for 4 passes. Welding was performed using a welding current of 160 Amps and welding voltage approximately 24V and an arc length of 2mm has to been maintained. The sample was represented as S1. In the second condition pure Argon (pass 1), pure CO_2 (pass 2), pure Argon (pass 3) & pure CO_2 (pass 4) were supplied as a shielding gas flow through the welding torch at a flow rate of 10 l/minute. Welding was performed using a welding current of 160 Amps and welding voltage approximately 24V and an arc length of 2mm has to been maintained. The sample was represented as S2. The process parameters are shown in the Table 1.

S.NO.	PROCESS PARAMETERS	VALUES
1	Electrode type	ER70SG
2	Electrode Diameter(mm)	1.2
3	Gas Flow Rate(LPM)	10
4	Metal Thickness (mm)	10
5	Wire feed rate (mm/min)	2
7	Welding Current(A)	160
8	Welding Voltage(V)	24

Table 1: The Process Parameters for Welding

After the welding processes are finished, the specimens are undergone to the mechanical property testing like tensile, hardness and impact tests.

III. RESULTS AND DISCUSSIONS

A. Hardness Test:

The test is evaluated to determine the hardness value of weld metal and compare the results with base metal. The hardness test was performed on the transverse cross-section of the Gas Metal Arc Welding zone using a load of 1839.375 N, which was applied for duration of 20 s. Measurements in each zone (base material, Heat Affected Zone (HAZ) and weld Zone) were taken at regular intervals. The test can be conducted on Brinell hardness testing machine. The hardness values of welded specimens are shown in the Table 2 and Table3.

Base metal	HAZ	Weld metal
166	187	207

Table 2: Hardness Values for sample 1 GMAW Process under pure CO_2

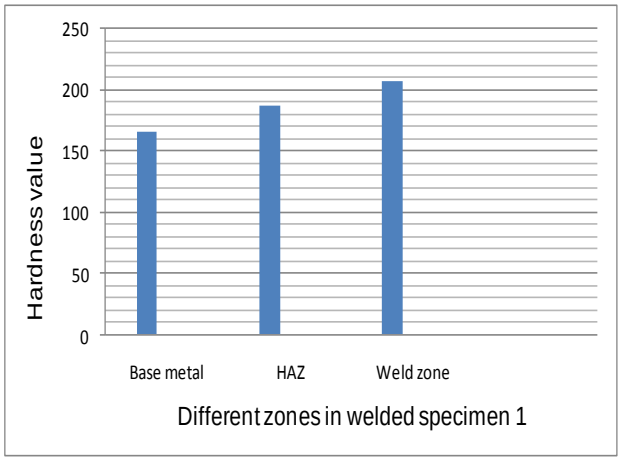

Fig. 1: Comparison of hardness values for specimen 1

Base metal	HAZ	Weld metal
166	192	288

Table 3: Hardness Values for sample 2 GMAW Process under pure CO_2 + pure Ar

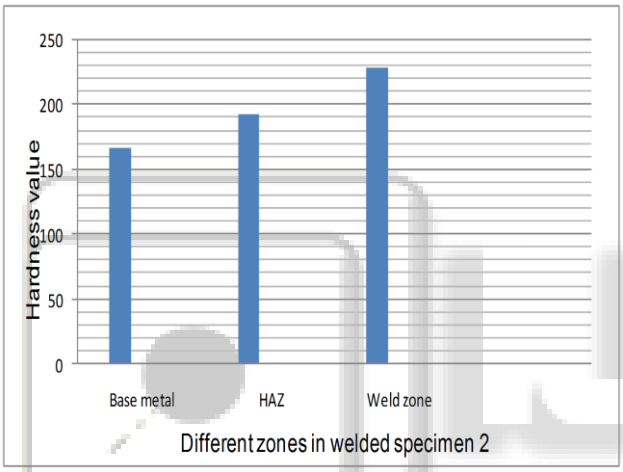

Fig. 2: Comparison of hardness values for specimen 2

The results are clearly noted that the hardness value of weld zone is higher than the base metal and HAZ. Among the specimen 1 & specimen 2, the specimen 2 supply shielding gas of pure argon and pure carbon dioxide will give the better hardness value when compared to pure CO_2 specimen 1 in GMAW process.

B. Impact Test:

The test is evaluated to determine the impact energy of weld metal and compare the results. The impact test was performed on the transverse cross-section of the Gas Metal Arc Welding zone. The test can be conducted on Charpy impact testing machine. The impact energy values of welded specimen 1 & 2 are shown in the Table 4.

Weld specimen	Shielding gases	Impact energy (Joules)
Specimen 1	Pure CO_2	74
Specimen 2	Pure CO2+Pure Argon	79

Table 4: Impact Energy Values for sample 1 & 2 GMAW Process under pure CO_2 and pure CO_2+pure Ar

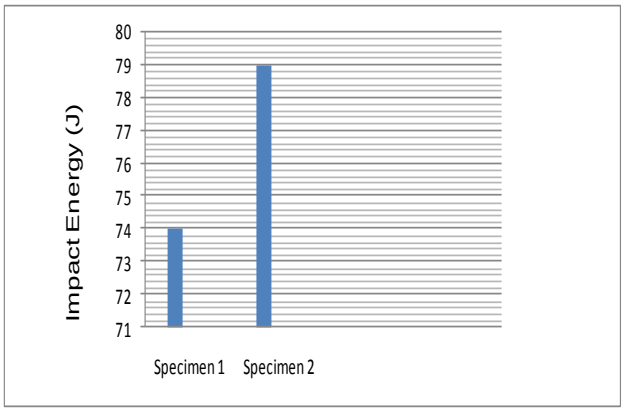

Fig. 3: Comparison of impact energy values for specimen 1 & 2

The results are clearly noted that the impact energy value of shielding gas pure argon and pure carbon dioxide welded specimen 2 is higher than the shielding gas of pure carbon dioxide welded the specimen 1 in GMAW process.

C. Tensile Test:

The test is evaluated to determine the tensile strength and percentage of elongation of weld metal and compare the results with base metal. The tensile test was performed on the transverse cross-section of the Gas Metal Arc Welding zone. The test can be conducted on universal testing machine. The tensile properties of welded specimen are shown in the Table 5.

S. No.	Weld Specimen	Ultimate strength N/mm^2	% of elongation	Fracture position
1	Specimen 1	384	15	Weld area
2	specimen 2	388	25	Weld area

Table 5: The tensile properties of welded specimen 1 & 2

The results are clearly noted that the ultimate strength & elongation of specimen 2 is higher than specimen 1. Among the specimen 1 & specimen 2, the specimen 2 supply shielding gas of pure argon and pure carbon dioxide will give the better tensile properties when compared to pure CO_2 specimen 1 in GMAW process.

IV. Conclusion

A 'V' butt joint specimen is developed to make analysis of mechanical properties for different shielding gas mixtures. The test specimens were prepared as per the ASTM E8M-04 standard for experimental analysis.

- The hardness of sample 2 is better than sample 1 in an analysis of experimental work.
- The sample 1 is lesser impact energy than sample 2. Also, the higher O_2 perception in the sample 1 reduces the impact energy.
- Sample 2 is higher strength than sample 1 while applying shielding gases with pure argon and carbon dioxide in the tensile test investigation.

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