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Research Paper

ANALYSIS OF HEAT AFFECTED ZONE OF MILD STEEL SPECIMEN DEVELOPED DUE TO MIG WELDING

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The Gas Metal Arc Welding is the most widely used for long continuous welds also it is versatile in nature as spot welds can also be per formed by GMAW. Process requires relatively simple and lesser skilled labors, so it is mostly automated and once welding parameters established it should be possible to produce repeatable welds. It is also called as MIG welding. As there is a great influence of welding conditions on behavior of heat affected zone (HAZ) so the present work investigates the effect of welding condition according to mechanical properties of mild steel and presents the optimum welding condition through the evaluation about the weld ability of mild steel by the welding conditions such as the welding passes, voltage variation, current, variation, and change in thickness of mild steel flats. In order to find out optimum welding condition by the mechanical properties mild steel (0.134% carbon) was selected as a specimen having thickness 5, 8,16mm were prepared for experiment. Specimens were welded in the range of 20-24 Volt, 130-150Amp and test pieces out of theses for test of tension, impact and hardness and micro structure have been extracted. The experimental result revealed that with increase in voltage there is increase in penetration so using the parameters further welding was performed. Results show that with increase in current there is increase in hardness of HAZ and ultimate tensile strength.

Keywords: Heat affected zone, Mild steel specimen, MIG welding

INTRODUCTION

Selection of the Work Material and Electrode

Metal inert gas welding is the most versatile welding and commonly used for making long and continuous weld as it can be easily auto mated. Metal arc welding was used for experimentation. The chemical composition of the material used is shown in the Table No. 1.

For welding mild steel work-pieces Copper-coated mild steel (MIG) electrode having specifications **IS 6419, (AWS A/SFA 5.18)** manufactured by Ador welding limited was selected which has diameter 1.2 mm. It provides stable arc and minimum spatter

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Table 1: Chemical Composition of Materials (wt %)									
Material	**Fe%**	**C%**	**Si%**	**Mn%**	**P%**	**S%**	**Cr%**	**Al%**	**Cu%**
Mild Steel	99.2	0.134	0.074	0.404	0.056	0.022	0.16	0.002	0.009

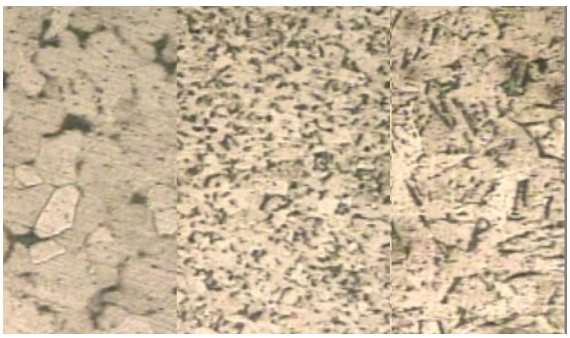
under optimum welding conditions. Normally recommended with CO_2 shielding and can be used with Ar- CO_2 mixtures also. It is all position electrode meant for MIG welding. Composition of wire is C-0.07-0.14, S-0.025max, Mn-1.40-1.60, O-0.025max, Si-0.80-1.0, Cu-0.5max (% age by weight), mechanical properties of all welded with 100% CO_2 are UTS-500-550 MP and YS-420-480MP a also it leaves metal free of slag and oxide inclusions and produces sound welds.

Micro Structural Examination

Micro structural Examination was carried out on Leitz metallurgical microscope. The photograph of different zones of welded specimen was taken for study. A micro structural photograph of heat affected zone was taken at 100 magnifications.

The different zones of welded specimen of mild steel can be seen in Figure 4.12 below.

Figure 1: Different Zones of Welded Specimen of Mild Steel



Parent Metal Heat Affected Zone Weld metal Zone

Linear intercept method can be used for grain size determination from micro structural photographs. Length parameter is the mean intercept length.

$$L = \frac{L_T}{P \times M}$$

Where

L = Grain size in mm LT = Total test line length in mm M = Magnification factor

P = The number of grain boundaries intersecting test line

Mechanical Testing of the Test Specimens

Hardness Testing:-The Vickers and knoop tests make relatively small indentations and are thus well suited for hardness measurement of the various regions of the HAZ for fine scale traverses. In Vickers hardness test a know load (P) from 1 to 120 kg depending on the material to be tested is applied for specified time to the surface of the material through a square base diamond indenter or pyramid having 136° between opposite faces. The two diagonal of the resulting square indentation on the test piece are measured with a micrometer microscope and averaged D mm is use for calculation of hardness. The Vickers hardness number is calculated as by following equation.

$$VHN = \frac{1.854P}{D^2}$$

RESULTS

This deals with the results of the experimental findings of welded joints prepared at different voltages, current, number of pass and effect of variation of specimen.

Effect of Voltage on Penetration

Specimens were welded at varying Voltage of 20V, 22V and 24V keeping other conditions are constant like current=130, wire speed, shielding gas pressure and welding speed etc. By visual observations it was found that with increase in voltage there was also increase in penetration as shown below in figures 5.1, 5.2 and 5.3.

Figure 2: Specimen Welded at 20Volts

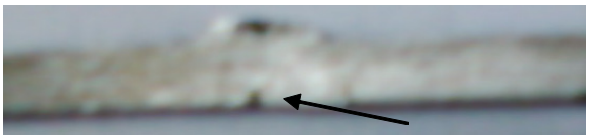


Figure 3: Specimen Welded at 22Volts

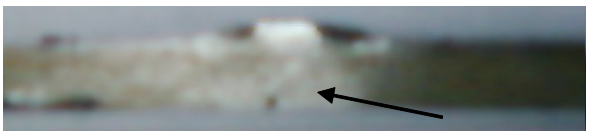
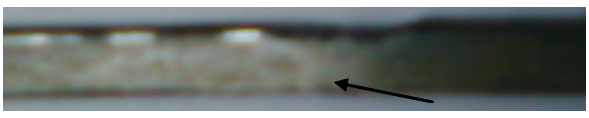


Figure 4: Specimen Welded at 20Volts



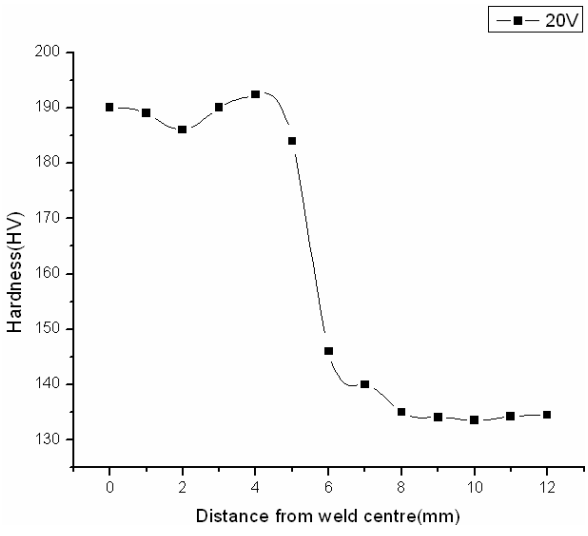
Specimen welded at 24volts shows full penetration for 1.5 mm face width and it gives best results in terms of penetration.

So by observing the above results the conditions for welding multiple passes used are 24V and 130Amp, with electrode wire speed 22.2mm/sec and welding speed of 1to2 mm/sec.The specimens were further tested for hardness.

Effect of Voltage on Hardness

As we can see from the graph between distance from the weld centre and hardness there is nearly constant variation of hardness but suddenly the parent metal next to weld metal i.e. HAZ there is increase in hardness because there is a thermal gradient between welding heat and atmospheric temperature due to this sudden quenching by air there is formation of martensitic structure in HAZ causing increase in hardness. As we can see there is increase in HAZ hardness with decrease in voltage.

Figure 5.4: Effect of Voltage Variation With Hardness



Effect of Variation of Thickness on Hardness of HAZ

For similar conditions like current of 130Amp, 24 voltage, welding speed and wire electrode speed the following results are obtained.

Figure 5: Effect of Voltage Variation with Hardness

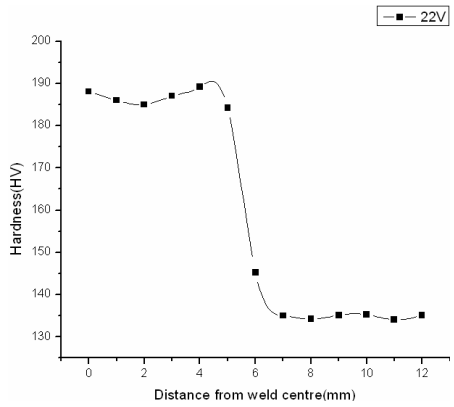


Figure 6: Effect of Voltage Variation with Hardness

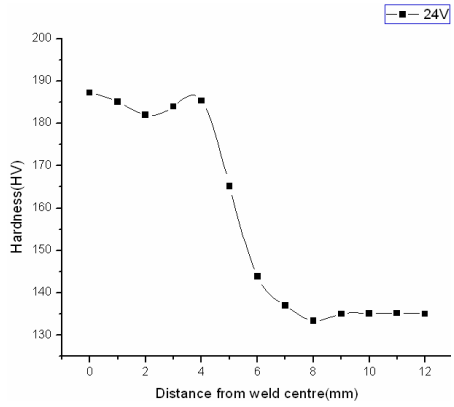


Figure 7: Effect of Voltage Variation with Hardness

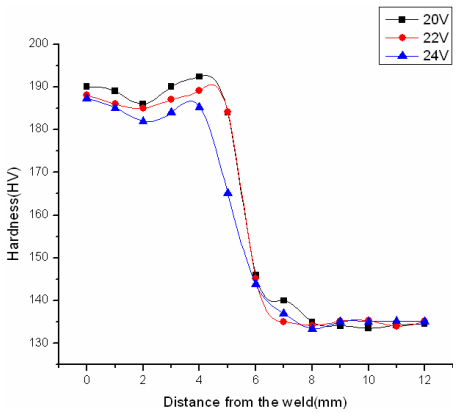


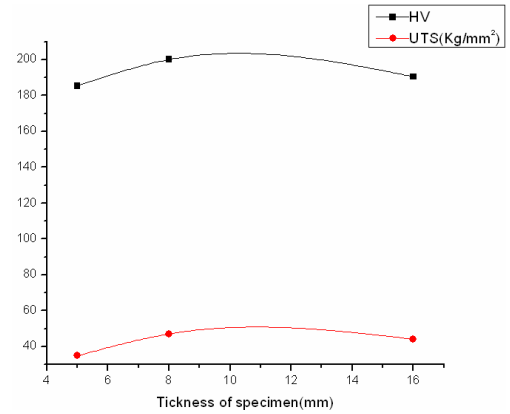
Table 2: Variation of Hardness with Voltage

Distance from weldbead center (mm)	Hardness (HV) Voltage=20	Hardness (HV) Voltage=22	Hardness (HV) Voltage=24
0	190	188.1	187.2
1	189	186	185.1
2	186	185	182
3	190	187	184
4	192.4	189.2	185.3
5	184	184.2	165.1
6	146	145.2	143.8
7	140	135	136.9
8	135	134.2	133.4
9	134.1	135.1	135
10	133.5	135.3	135.1
11	134.2	134	135.2
12	134.5	135.1	135

Table 3: Effect of Variation of Thickness on Hardness of HAZ

Specimen Thickness (mm)	Maximum HAZ Hardness (HV)	Maximum UTS (Kg/mm2)
5	185.3	34.8
8	200.1	47.15
16	190.5	44.2

Figure 8: Effect of Variation of Thickness on Hardness of HAZ



CONCLUSION

By visual inspection it was observed that for increase in voltage there is increase in penetration and there is slight increase in HAZ hardness with respect to increase In Current. So it may be concluded that using higher voltage of 24V better penetration can be obtained. Also the increase penetration has forced to perform rest of multiple pass welding with 24 V and 130Amp current. So 24V and 130Amp current is recommended for welding the specimens.

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