Micro Structure analysis of TIG Welded SS 301 Alloy

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Abstract: *This work deals with micro structure analysis of TIG welding SS 301 plates of dimension 200*75*6 mm were taken, the. The input parameters are root gap, current, electrode diameter and gas flow rate. The main effects plots were plotted using Minitab software .the analysis is done with analysis software.*

Keywords: TIG welding, SS, Hardness, root gap, S/N Ratio.

1. INTRODUCTION

GTAW welding is an electric arc welding process, in which the fusion energy is produced by an electric arc burning between the work piece and the tungsten electrode. During the welding process the electrode, the arc and the weld pool are protected against the damaging effects of the atmospheric air by an inert shielding gas. By means of a gas nozzle the shielding gas is lead to the welding zone where it replaces the atmospheric air. TIG welding differs from the other arc welding processes by the fact that the electrode is not consumed like the electrodes in other processes such as MIG/MAG and MM. Stainless steel is widely used in sheet metal fabrication, especially in automotive, chemical and rail coach manufacturing, mainly due to its excellent corrosion resistance and better strength to weight ratio. Stainless steel is a generic name covering a group of metallic alloys with chromium content in excess of 10.5 percent and a maximum carbon content of 1.2 percent (according to European Standard EN 10088) and often includes other elements, such as nickel and molybdenum. Due to formation of a passive layer, this is 1 to 2 nanometers thick; this metal exhibits excellent corrosion resistance. The passive layer is self-healing, and therefore chemical or mechanical damages to it re-passivity in oxidizing environments. Stainless steel has been widely used for rail vehicle body shell design for many years owing to its corrosion resistance, low life-cycle cost, and high strength-to weight ratio and fire resistance.

1.1 Working Principle of TIG Welding Operation

TIG is an arc welding process, as shown in Fig. Wherein coalescence is produced by heating the work piece with an electrical arc struck between a tungsten electrode and the job. The electrical discharge generates a plasma arc between the electrode tip and the work piece to be welded. It is an arc welding process wherein coalescence is produced by heating the job with an electrical arc struck between a tungsten electrode and the job. The arc is normally initialized by a power source with a high frequency generator. This produces a small spark that provides the initial conducting path through the air for the low voltage welding current. The arc generates high-temperature of approximately 6100 C and melts the surface of base metal to form a molten pool. A

welding gas (argon, helium, nitrogen etc) is used to avoid atmospheric contamination of the molten weld pool. The shielding gas displaces the air and avoids the contact of oxygen and the nitrogen with the molten metal or hot tungsten electrode. As the molten metal cools, coalescence
occurs and the parts are joined. The resulting weld is smooth and requires minimum finish.

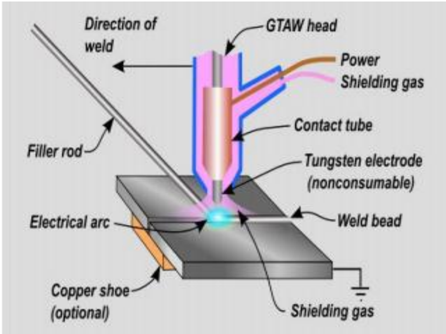


Figure 1 working principle of tig welding

2.EXPERIMENTAL PROCEDURE

In this work, SS 301 alloy of dimension 200*75*6mm was taken and the number of pieces were 18.Tig was performed the number of experiments were 9, the process parameters are Root gap, Current, Electrode and Gas flow rate

2.1 SS 301 chemical composition

Carbon	0.0582%
Chromium	16.0600%
Iron	72.6000%
Manganese	1.9300%
Nickel	6.5600%
Phosphorus	0.0649%
Silicon	0.3670%
Sulphur	0.005%

2.2 Common Applications of 301 Stainless Steel

- Aircraft structural parts
- Trailer bodies
- Architectural (roof drainage/door frames, etc.)
- Auto body trim and wheel covers
- Utensils and table wear
- Conveyor parts

Table 2.1 experimental setup

Experiment	Root gap (mm	Current (amperes)	Electrode Diameter(mm)	Gas flow (liters/ minute)
1	1	100	1.6	2
2	1	150	2.5	4
3	1	170	3	5
4	2	100	2.5	5
5	2	150	3	2
6	2	170	1.6	4
7	2.5	100	3	4
8	2.5	150	1.6	5
9	2.5	170	2.5	2

3. EXPERIMENTAL SPECIMENS

Figure.3.1: Specimen to conduct experiments

4. MICRO STRUCTURE SPECIMENS

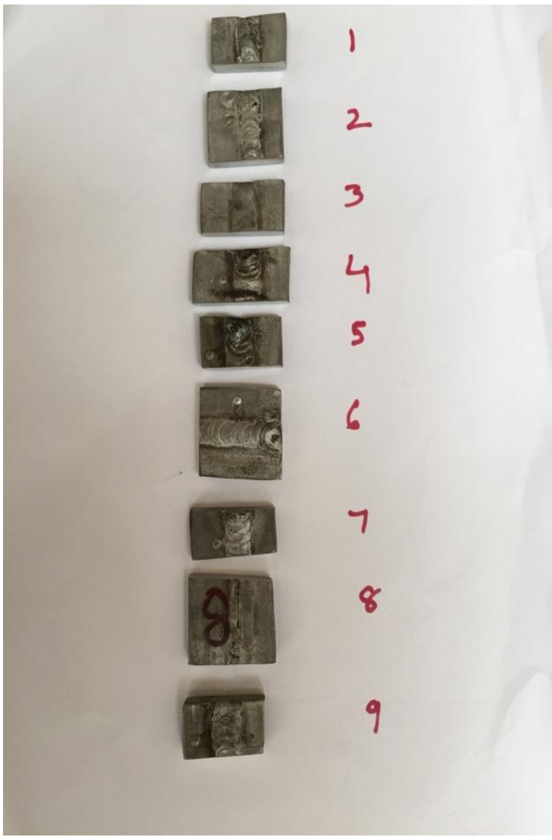
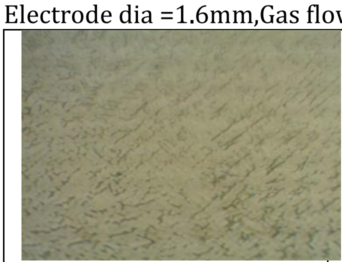
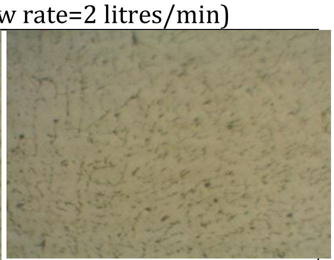


Figure 4.1 micro structure analysis

4.1Micro structure

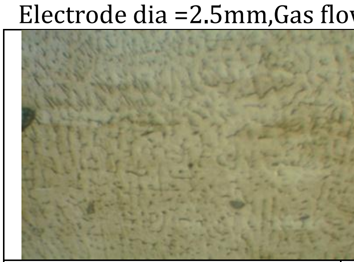
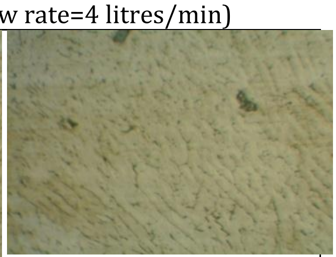
Experiment 1 (Root gap=1mm,current =100 Amps, Electrode dia =1.6mm,Gas flow rate=2 litres/min)

WELD ZONE	HEAT AFFECTED ZONE

Figure 4.1(a)

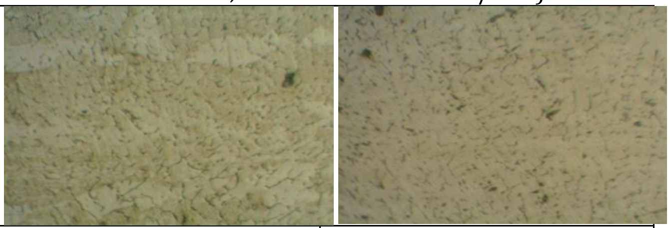
EXPERIMENT 2(Root gap=1mm,current =150 Amps, Electrode dia =2.5mm,Gas flow rate=4 litres/min)

WELD ZONE	HEAT AFFECTED ZONE

Figure 4.1(b)

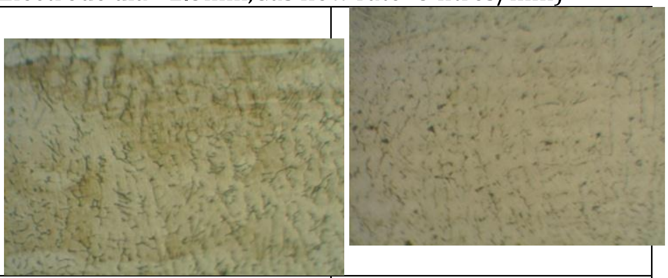
EXPERIMENT 3(Root gap=1mm,current =170 Amps, Electrode dia =3mm,Gas flow rate=5 litres/min)



WELD ZONE	HEAT AFFECTED ZONE

Figure 4.1(c)

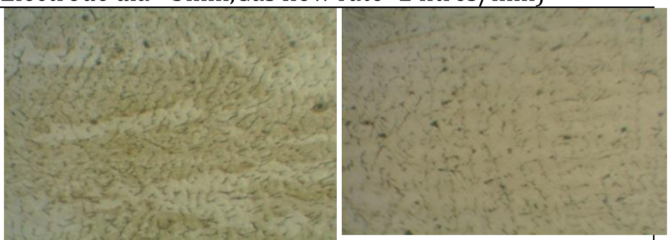
EXPERIMENT 4(Root gap=2mm,current =100 Amps, Electrode dia =2.5mm,Gas flow rate=5 litres/min)



WELD ZONE	HEAT AFFECTED ZONE

Figure 4.1(d)

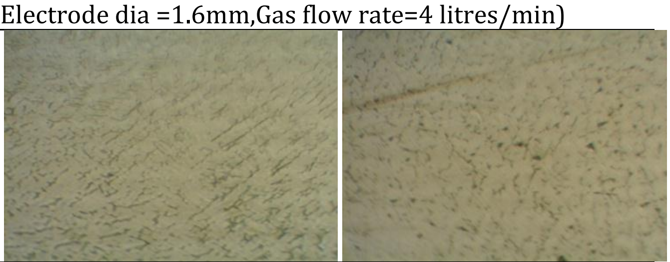
EXPERIMENT 5(Root gap=2mm,current =150 Amps, Electrode dia =3mm,Gas flow rate=2 litres/min)



WELD ZONE	HEAT AFFECTED ZONE

Figure 4.1(e)

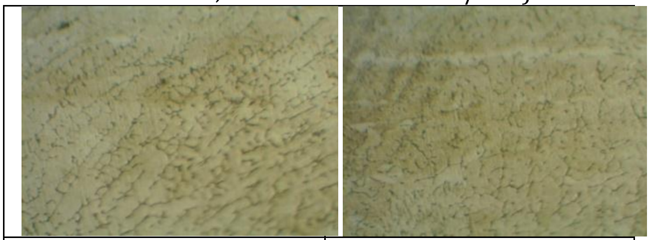
EXPERIMENT 6(Root gap=2mm,current =170 Amps, Electrode dia =1.6mm,Gas flow rate=4 litres/min)



WELD ZONE	HEAT AFFECTED ZONE

Figure 4.1(f)

EXPERIMENT 7(Root gap=2.5mm,current =100 Amps, Electrode dia =3 mm,Gas flow rate=4 litres/min)



WELD ZONE	HEAT AFFECTED ZONE

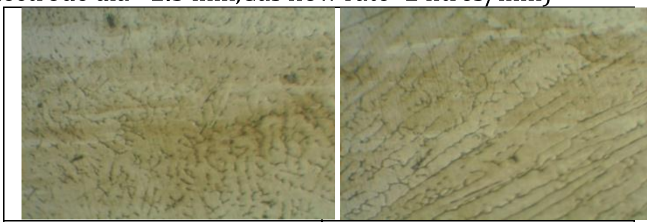
Figure 4.1(g)

EXPERIMENT 8(Root gap=2.5mm,current =150 Amps, Electrode dia =1.6 mm,Gas flow rate=5 litres/min)

WELD ZONE	HEAT AFFECTED ZONE

Figure 4.1(h)

EXPERIMENT 9(Root gap=2.5mm,current =170 Amps, Electrode dia =2.5 mm,Gas flow rate=2 litres/min)

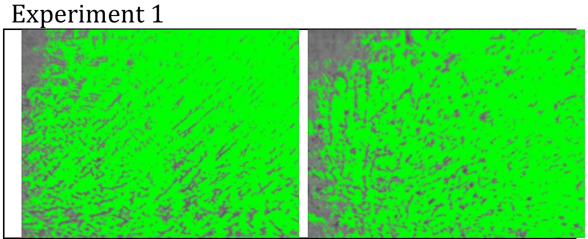


WELD ZONE	HEAT AFFECTED ZONE

Figure 4.1(i)

4.2 Software Analysis pictures of Micro structure

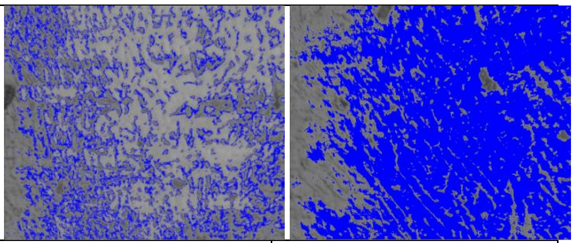
Experiment 1



weld zone	Heat affected zone
Austenite 25.09%	Austenite 28.81%
Ferrite 77.36%	Ferrite 74.38%

Figure 4.2(a)

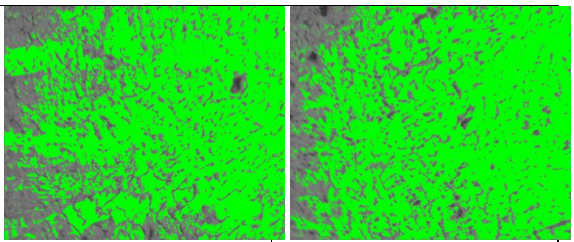
Experiment 2



weld zone	Heat affected zone
austenite 67.60%	Austenite 34.44%
ferrite 34.98%	Ferrite 68.18%

Figure 4.2(b)

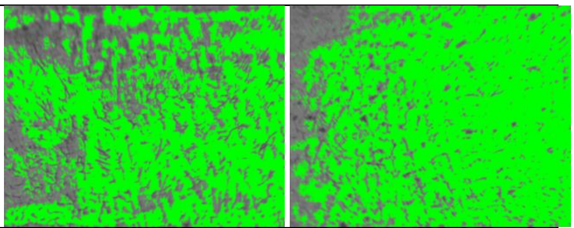
Experiment 3



Weldzone	Heat affected zone
Austenite 38.10%	Austenite 31.15%
Ferrite 64.56%	Ferrite 71.79%

Figure 4.2(c)

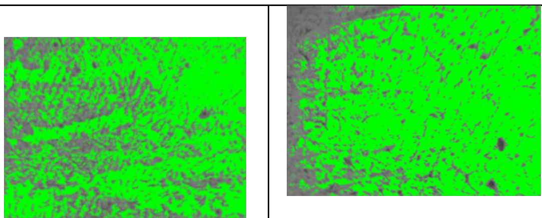
Experiment 4



Weldzone	Heat affected zone
Austenite 43.60%	Austenite 27.58%
Ferrite 58.93%	Ferrite75.12%

Figure 4.2(d)

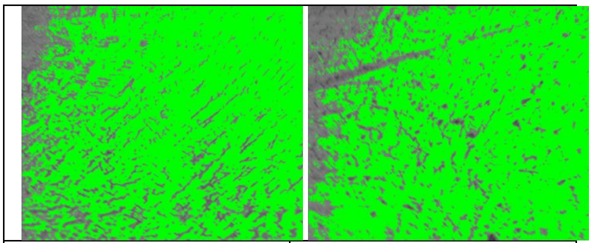
Experiment 5



weld zone	Heat affected zone
Austenite 42.42%	Austenite31.84%
Ferrite 60.55%	Ferrite 70.98%

Figure 4.2(e)

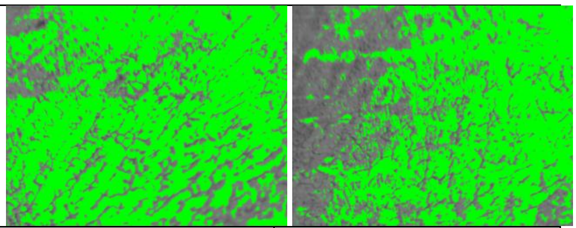
Experiment 6



weld zone	Heat affected zone
Austenite 25.09%	Austenite 25.29%
Ferrite 77.36%	Ferrite 77.18 %

Figure 4.2(f)

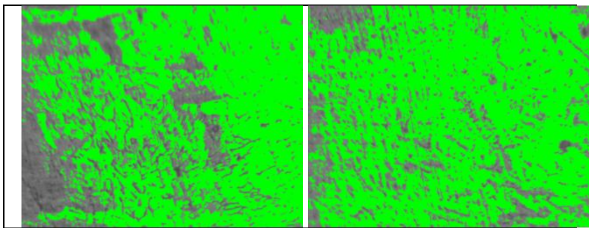
Experiment 7



weld zone	Heat affected zone
Austenite 32.06**%**	Austenite 45.89%
Ferrite 70.53%	Ferrite 56.91%

Figure 4.2(g)

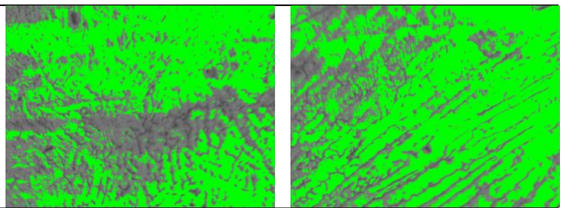
Experiment 8



weld zone	Heat affected zone
Austenite 37.58**%**	Austenite 29.86**%**
Ferrite 64.86 %	Ferrite 73.53%

Figure 4.2(h)

Experiment 9



weld zone	Heat affected zone
Austenite 47.36**%**	Austenite 38.04**%**
Ferrite 55.50%	Ferrite 64.79 %

Figure 4.2(i)

5.MAIN EFFECT PLOTS

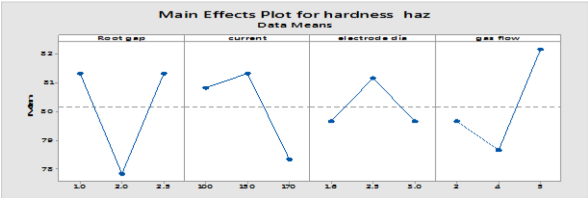


Figure 5.1: hardness

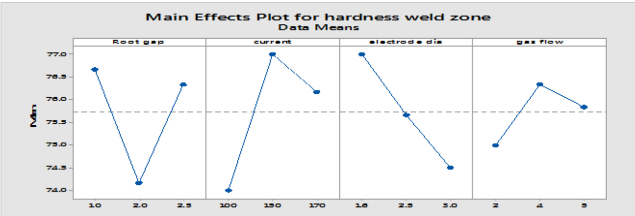


Figure 5.2: hardness weld zone

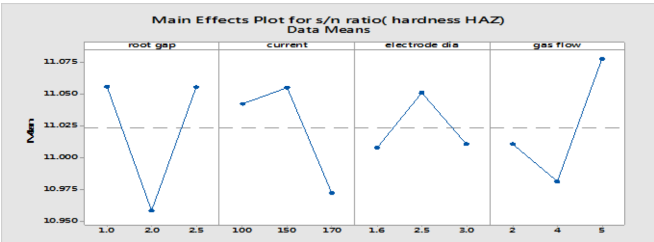


Figure 5.6:S/N Ratio for hardness HAZ

6. RESULTS AND DISCUSSION

1. Hardness in heat affected zone was more than hardness in weld zone and base metal
2. Austenite %was more in weld zone than Haz in most cases Ferrite %was more in HAZ zone Austenite % was higher in weld zone because austenite requires high temperature for its formation approx(300-375degree celsius)
3. From the graphs it was observed that,when root gap increases,angular distortion increases When electrode dameter was increased hardness first increased then decreased
4. In most cases,Base metal hardness was more than weld metal hardness
5. Ferrite% was higher in heat affected zone because the ferrite contains only a small amount of carbon which means untransformed austenite will become more enriched with carbon as temperature decreases and more ferrite is formed
6. For minimum value of root gap,current,electrode diameter angular distortion was minimum,when current and electrode diameter are increased,hardness first increases and then it stabilized

7. CONCLUSION

Heat affected zone region had higher hardness compared to weld zone and base metal.

8. ACKNOWLEDGMENTS

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BIOGRAPHIES

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