EXPERIMENTAL INVESTIGATION & WELD CHARACTERISTICS OF GTAW WITH SS410

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Abstract - Scope of arc-welding has to be increased in the various engineering fields like aerospace, nuclear and underwater industries where complex geometry and hazardous environments necessitate fully automated systems. Even traditional applications of arc welding such as off-highway and automotive manufacturing have to be increased due to their demand in quality, cost, accuracy and volume to stay competitive. As a result process parameters are needed to improve the existing process of welding. Gas tungsten arc welding is a fusion welding process having wide applications in industry. In this process proper selection of input welding parameters is necessary in order to control weld distortion and subsequently increase the productivity of the process. In this research work experiments has to be carried out on SS410 stainless steel of 10 mm thick using gas tungsten arc welding (GTAW) process. The planned experiments are conducted in the TIG welding machine, Hardness and Impact test was carried out. The research will be applied Taguchi Method on an austenitic stainless steel specimen of dimensions 100 × 100 × 10 mm, which have the various parameters, such as current and torch angle. Image J software has to be used to find out the depth of penetration depending upon the temperature variation.

Keywords: Weld Characteristics, GTAW, SS410.

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1. TIG WELDING

TIG welding is an arc welding process that uses a non-consumable tungsten electrode to produce the weld. The weld area is protected from atmosphere by an inert shielding gas (argon or helium), and a filler metal is normally used. The power is supplied from the power source (rectifier), through a hand-piece or welding torch and is delivered to a tungsten electrode which is fitted into the hand piece. An electric arc is then created between the tungsten electrode and the work piece using a constant-current welding power supply that produces energy and conducted across the arc through a column of highly ionized gas and metal vapors. The tungsten electrode and the welding zone are protected from the surrounding air by inert gas.

The electric arc can produce temperatures of up to 20,000oC and this heat can be focused to melt and join two different part of material. The weld pool can be used to join the base metal with or without filler material. Schematic diagram of TIG welding and mechanism of TIG welding are shown in fig. 1 & fig. 2 respectively.

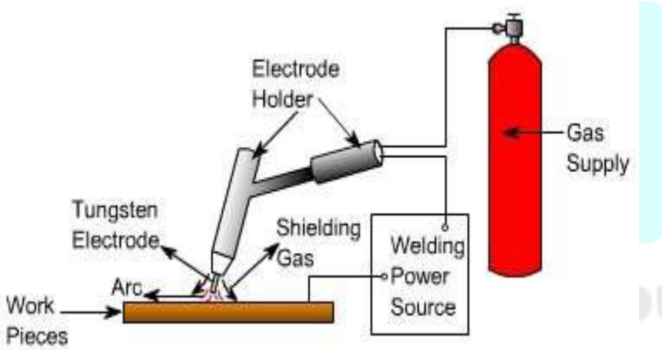


Fig 1.1: Schematic Diagram of TIG Welding.

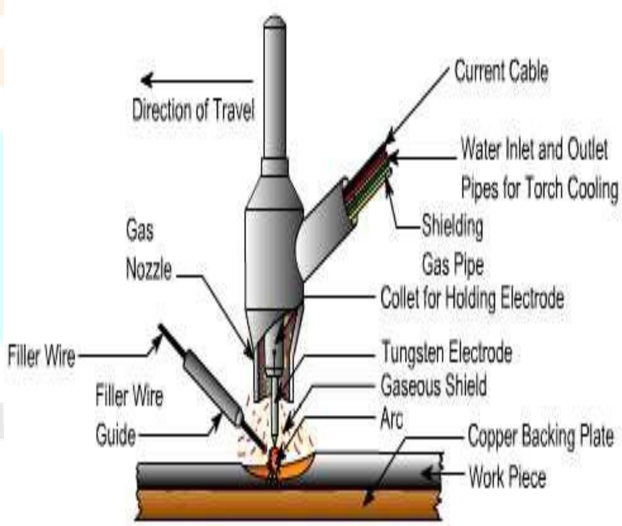


Fig. 1.2: Principle of TIG Welding.

Tungsten electrodes are commonly available from 0.5 mm to 6.4 mm diameter and 150 - 200mm length. The current carrying capacity of each size of electrode depends on whether it is connected to negative or positive terminal of DC power source. The power source required to maintain the TIG arc has a drooping or constant current characteristic which provides an essentially constant current output when the arc length is varied over several millimeters. Hence, the natural variations in the arc length which occur in manual welding have little effect on welding current. The capacity to limit the current to the set value is equally crucial when the electrode is short circuited to the work piece, otherwise excessively high current will flow, damaging the electrode. Open circuit voltage of power source ranges from 60 to 80 V.

2. MATERIALS USED

2.1 SS410

Grade 410is the basic martens tic stainless steel, like most non-stainless steels. It can be hardened by a "quench-and-temper" heat treatment. It contains a minimum of 11.5 per cent chromium, just sufficient to give corrosion resistance properties. It achieves maximum corrosion resistance when it has been hardened and tempered and then polished. Grade 410 is a general purpose grade often supplied in the hardened, but still machinable condition. The applications where high strength, moderate heat and corrosion resistance are required. Martens tic stainless steels are optimized for high hardness and other properties are to some degree compromised. Fabrication must be by methods that allow for poor weld ability and usually the need for a final heat treatment. Corrosion resistance of the martens tic grades is lower than that of the common austenitic grades, and their useful operating temperature range is limited by their loss of ductility at sub-zero temperatures and loss of strength by over-tempering at elevated temperatures.

2.1.1 Composition

Typical compositional ranges for grade 410 stainless steels are given below.

Grade		C	Mn	Si	P	S	Cr	Mo	Ni	N
410	min. Max.	- 0.15	- 1.00	- 1.00	- 0.040	- 0.030	11.5 13.5	-	0.75	-

3. EXPERIMENTAL RESULTS

3.1 HARDNESS VALUES (kgf/mm^2)

SAMPLES	S1	S2	S3	S4	S5	S6	S7	S8	S9
HRB VALUE	93	84	86	87	90	86	86	91	90

3.2 IMPACT STRENGTH

In our Project Impact Strength determined through impact testing machine by charpoy method. Specification of the machine and Size of the specimen

Energy Range = 0 – 300 J
Least Count (1 Division) = 1J
Specimen size = 10 X 10 X 55 mm
Notch = U NOTCH
Notch Depth = 5mm

Material	Test Plate	Average in joules/mm^2
SS410	S1	36
	S2	47
	S3	18
	S4	54
	S5	38
	S6	28
	S7	56
	S8	32
	S9	22

4. PROCESS PARAMETER OPTIMIZATION FOR TENSILE STRENGTH

After finding all the observation as given in table 3.2, S/N ratio and means are calculated and also various graphs for analysis is drawn by using Minitab-16 software.

4.1 Process parameters and their levels

Levels	Process parameters		
	Peak Current amps	Base Current amps	Torch angle
1	130	80	30
2	140	90	40
3	150	100	50

4.2 S/N Ratio Values:

Trial No.	Designation	Peak Current Amps	Base Current Amps	Torch Angle	Impact Strength	S/N Ratio
1	$A_1B_1C_1$	130	80	30	36	31.1261

2	$A_1B_2C_2$	130	90	40	47	33.4420
3	$A_1B_3C_3$	130	100	50	18	25.1055
4	$A_2B_1C_2$	140	80	40	54	34.6479
5	$A_2B_2C_3$	140	90	50	38	31.5957
6	$A_2B_3C_1$	140	100	30	28	28.9432
7	$A_3B_1C_3$	150	80	50	56	34.9638
8	$A_3B_2C_1$	150	90	30	32	30.1030
9	$A_3B_3C_2$	150	100	4	22	26.8485

4.3 Taguchi Analysis:

Taguchi Analysis: Impact Strength versus Peak Current (PC), Base Current (BC) & Torch Angle (TA).

4.3.1 Response Table for Signal to Noise Ratios - Larger is better

Level	PC	BC	TA
1	29.89	33.58	26.85
2	31.73	31.71	30.06
3	30.64	26.97	34.04
4			30.55
Delta	1.84	6.61	7.20
Rank	3	2	1

4.3.2 Response Table for Means

Level	PC	BC	TA
1	33.67	48.67	22.00
2	40.00	39.00	32.00
3	36.67	22.67	50.50
4			37.33
Delta	6.33	26.00	28.50
Rank	3	2	1

4.4 General Linear Model:

Method - Factor coding (-1, 0, +1)

Factor Information

Factor	Type	Levels	Values
PC	Fixed	3	130, 140, 150
BC	Fixed	3	80, 90, 100
TA	Fixed	4	30, 40, 50

Analysis of Variance

Source	DF	Ad SS	Ad MS	F-Value	P-Value
PC	2	109.2	54.58	0.45	0.726
BC	2	336.2	168.08	1.38	0.515
TA	3	225.6	75.20	0.62	0.707
Error	1	121.5	121.50		
Total	8	1443.6			

Model Summary

S	R-sq	R-sq (ad)	R-sq (pred)
11.0227	91.58%	32.67%	*

Coefficients

Term	Coef	SE Coef	T-Value	P-Value	VIF
Constant	36.04	4.36	8.27	0.077	
PEAK CURRENT					
130	-5.50	5.81	-0.95	0.517	1.67
140	0.83	5.81	0.14	0.909	1.67
BASE CURRENT					
80	9.50	5.81	1.64	0.349	1.67
90	-0.17	5.81	-0.03	0.982	1.67
TORCH ANGLE					
4	-9.4	14.2	-0.66	0.628	5.89
30	-4.04	6.26	-0.65	0.635	1.94
40	12.1	10.5	1.16	0.454	4.43

Regression Equation

IMPACT STRENGTH = 36.04 - 5.50 PC_130 + 0.83 PC_140 + 4.67 PC_150+ 9.50 BC_80 - 0.17 BC_90 - 9.33 BC_100 - 9.4 TA_4 - 4.04 TA_30 + 12.1 TA_40 + 1.29 TA_50

Fits and Diagnostics for Unusual Observations

Obs	IS	Fit	STD Resid	
1	36.0	0.0	*	X
5	38.0	0.0	*	X
9	22.0	- 0.0	*	X Unusual X

5. DEPTH OF PENETRATION

Inadequate weld bead dimensions such as shallow depth of penetration may contribute to failure of a welded structure since penetration determines the stress carrying capacity of a welded joint .To avoid such occurrences the input or welding process variables which influence the weld bead penetration must therefore be properly selected and optimized to obtain an acceptable weld bead penetration and hence a high quality joint. To predict the effect of welding process variables on weld bead geometry and hence quality researchers have employed different techniques.

Contents of Image folder:

ij.jar

This JAR (Java Archive) file is the platform-independent core of Image. It is the only file changed when you upgrade using the Help>Update Image command.

ImageJ.exe

This is the Image launcher for Windows.

Macros

This folder contains example macros. The StartupMacros.txt file in this folder contains macros and macro tools that are automatically installed when Image launches. To run a macro, drag and drop it on the Image window and run it by pressing ctrl-r (Macros>Run Macro).

Plugging

This folder contains a small sample of the hundreds of plugging available for Image. The plugging in this folder is installed in the Plugging menu when Image J starts.

Lust

This folder contains LUTs (Lookup Tables) that are installed at startup in the Image>Lookup Tables menu. Use the Image>Color>Display LUTs command to view all the LUTs in this menu.

VIEW OF TEST PLATE-1

VIEW OF TEST PLATE-2

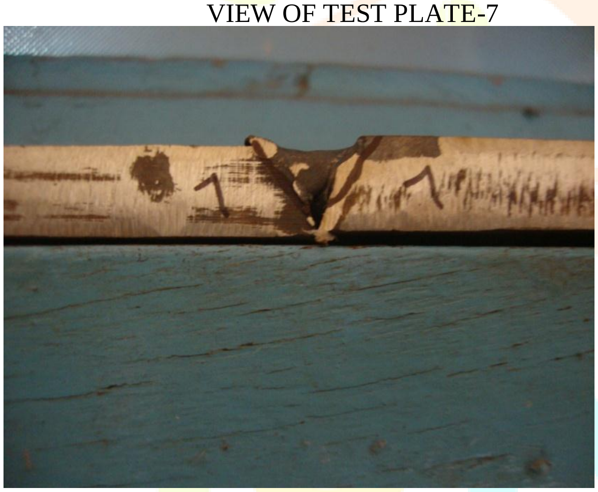
VIEW OF TEST PLATE-3

VIEW OF TEST PLATE-4

VIEW OF TEST PLATE-5

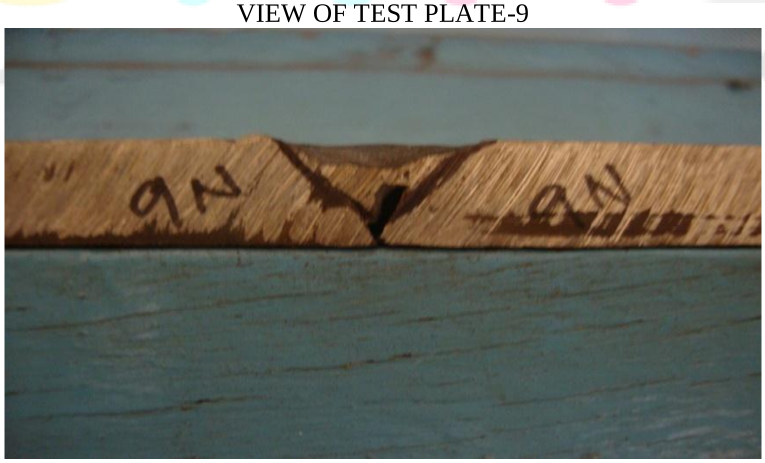
VIEW OF TEST PLATE-6

VIEW OF TEST PLATE-7



VIEW OF TEST PLATE-8

VIEW OF TEST PLATE-9



VARIOUS SIZES OF BEAD WIDTH, DEPTH OF PENETRATION OF WELDED PLATES

SAMPLES	Area	Mean	Min	Max	Angle	Length
T1	0.58	80.117	42.898	112.649	-1.206	12.836
	0.337	81.209	27.333	118.188	87.917	7.435
T2	0.797	73.064	38.333	140.333	0	17.696
	0.316	77.579	26.333	137	90	7.024
T3	0.775	77.542	51.21	182.43	-0.451	17.156
	0.434	82.459	25.516	158.667	90.807	9.592
T4	**0.775**	**83.717**	**32.667**	**140.664**	**-2.255**	**17.169**
	0.403	**84.475**	**15.788**	**138.01**	**90.868**	**8.917**
T5	0.726	109	31.364	123.328	-0.481	16.076
	0.391	72.039	8.208	139.203	89.105	8.647
T6	0.756	108.461	41.683	143.667	0.462	16.751
	0.416	100.08	4.98	164.716	91.685	9.19
T7	0.785	103.026	38	164.333	0	17.426
	0.422	46.736	16.362	71.609	88.34	9.325
T8	0.708	80.359	36.862	156.908	-1.975	15.679
	0.367	31.892	10.5	61.578	88.091	8.11
T9	1.133	100.798	33.086	125.667	-1.54	25.135
	0.58	56.592	6.667	117.491	88.191	12.84

5. CONCLUSION

TIG welding can be used successfully to join SS410. The processed joints exhibited better mechanical and metallurgical characteristics. The joints exhibited 90-95% of parent material's Hardness value. The specimen failures were associated depending upon the improper changes of heat value. In our experiment we found out the input parameter value 140 Peak current, Base Current 80 Amps and TORCH ANGLE 40º was the best value and it does not create any major changes and failures in the testing process. The toughness value of the TIG welded of SS410 steel was comparatively higher value (140 Peak current, Base Current 80 Amps and TORCH ANGLE 40º) than other value. It also induces high tensile strength. Finally we concluded that in this project investigation the value 140 Peak current, Base Current 80 Amps was the best parameter for SS410 steel for-10 MM thickness plate for obtain the good weldment state. According to the Taguchi's design and optimized parameter were value for Impact strength for-10 MM thickness plate value was 140 Peak current and Base Current 80 Amps and TORCH ANGLE 30º.

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