EXPERIMENTAL INVESTIGATION AND WELD CHARACTERISTICS OF GMAW WITH EN 8 AND SS 409

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Abstract - The dissimilar metal joints have been emerged as a structural material for various industrial applications which provides good combination of mechanical properties like strength, corrosion resistance with lower cost. Selections of joining process for such a material are difficult because of their physical and chemical properties. The stainless steel and mild steel dissimilar material joints are very common structural applications. Joining of stainless steel and mild steel is very critical because of carbon precipitation and loss of chromium leads to increase in porosity affects the quality of joint leads deteriorates strength. Gas metal 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 order to obtain a good quality weld and control weld distortion, it is therefore, necessary to control the input welding parameters. In this research work experiments has to be carried out on EN 8 & SS409 stainless steel of 4 mm thick using gas metal arc welding (GMAW) process. The research will be applied Taguchi Method on an austenitic stainless steel specimen of dimensions 100 × 100 × 10 mm, which have following interested parameters: various arc current arc voltage and welding torch angle. The experiment has to be done in following aspects: Ultimate tensile strength. The main objective of the experimental factors affecting to mechanical property of dissimilar steel with semi automatic Gas Metal Arc Welding (GMAW) through various welding parameters.

Keywords: Weld Characteristics, GMAW, SS409, EN 8.

1. GAS METAL ARC WELDING PROCESS

Gas metal arc welding (GMAW) is the most widely used fusion welding process in industries. It has extensive application, particularly, in the automotive industry. For vehicle chases, load and suspension applications, GMAW provides high joint efficiency in volume production and light weight designs by welding thin plates of high strength steels with various thicknesses to create complex assemblies (Long et al. 2009). GMAW is an important component in many industrial operations (Erdal Karadeniz et al 2005). It is easily found in any industry whose products require metal joining in a large scale (Correia et al 2004). It establishes an electric arc between a continuous filler material electrode and weld pool, with shielding from an externally supplied gas, which may be an inert gas, an active gas or a mixture. The heat of the arc melts the surface of the VOLT metal and the end of the electrode. Molten metal from the electrode is transferred through the arc to the work where it becomes the deposited weld metal.

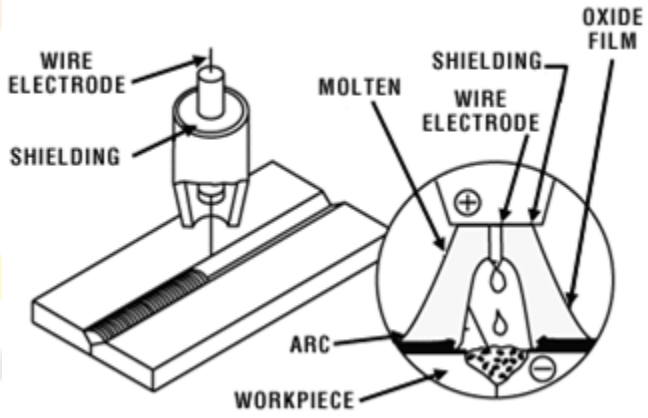


Fig.1: GMAW Process

2. MATERIALS USED

2.1 SS409

Grade 409is the basic martensitic 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 409 is a general purpose grade often supplied in the hardened, but still machinable condition, for applications where high strength and moderate heat and corrosion resistance are required.

Martensitic stainless steels are optimised for high hardness, and other properties are to some degree compromised. Fabrication must be by methods that allow for poor weldability and usually the need for a final heat treatment. Corrosion resistance of the martensitic 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.

2.2 EN 8

EN8 is a medium carbon steel usually supplied untreated. EN8 has good tensile strength and is often used in applications such as: shafts, gears, stressed pins, studs, bolts, keys etc.EN8 is a very popular grade and is readily machinable in any condition. It can be further surface-hardened to produce components with enhanced wear resistance, typically in the range 50-55 HRC through induction processes. It is also available in free-machining versions, EN8DM and EN8M (212A42).

3. EXPERIMENTAL RESULTS

3.1 ROCKWELL HARDNESS TEST

1. Rockwell Hardness systems use a direct readout machine determining the hardness number Volt upon the depth of penetration of either a diamond point or a steel ball. Deep penetration indicated a material having a low Rockwell Hardness number.
2. However, a low penetration indicates a material having a high Rockwell Hardness number. The Rockwell Hardness number is Volt upon the difference in the depth to which a penetrator is driven by a definite light or "minor" load and a definite heavy or "Major" load.
3. The ball penetrators are chucks that are made to hold 1/16" or 1/8" diameter hardened steel balls. Also available are ¼" and ½" ball penetrators for the testing of softer materials.
4. There are two types of anvils that are used on the Rockwell hardness testers. The flat faceplate models are used for flat specimens. The "V" type anvils hold round specimens firmly.
5. Test blocks or calibration blocks are flat steel or brass blocks, which have been tested and marked with the scale and Rockwell number. They should be used to check the accuracy and calibration of the tester frequently.

Using the "B" Scale;
a. Use a 1/16 indenter
b. Major load: 100 Kg, Minor load: 10 Kg
c. Use for Case hardened steel titanium, tool steel.
d. Do not use on hardened steel

Table 1: HARDNESS VALUE-HRB VALUE

SAMPLES	S1	S2	S3	S4	S5	S6	S7	S8	S9
SS409	82	90	86	82	87	90	84	89	87
EN8	90	95	87	90	94	92	95	87	89

3.2 IMPACT TEST

Impact strength testing is an ASTM standard method of determining impact strength. A notched sample is generally used to determine impact strength. Impact is a very important phenomenon in governing the life of a structure. In the case of aircraft, impact can take place by the bird hitting the plane while it is cruising, during take - off and landing there is impact by the debris present on the runway an arm held at a specific height (constant potential energy) is released. The arm hits the sample and breaks it. From the energy absorbed by the sample, its impact strength is determined. The North American standard for Izod Impact testing is ASTM D256. The results are expressed in energy lost per unit of thickness (such as ft-lb/in or J/cm) at the notch. Alternatively, the results may be reported as energy lost per unit cross-sectional area at the notch (J/m^2 or $ft\text{-}lb/in^2$). In Europe, ISO 180 methods are used and results are Volt only on the cross-sectional area at the notch (J/m^2).
The dimensions of a standard specimen for ASTM D256 are 4 x 12.7 x 3.2 mm (2.5" x 0.5" x 1/8"). The most common specimen thickness is 3.2 mm (0.125"), but the width can vary between 3.0 and 12.7 mm (0.118" and 0.500").
The Izod impact test differs from the Charpy impact test in that the sample is held in a cantilevered beam configuration as opposed to a three point bending configuration.

IMPACT STRENGTH

In our Project Impact Strength determined through impact testing machine by charpy 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 = V NOTCH
Notch Depth = 2mm

TABLE 2: Impact Test

Amps	volt	Gas Pressure Kg/cm^2	Energy Observed in Joules
160	18	4	60
160	20	5	22
160	22	6	18
180	18	5	26
180	20	6	25
180	22	4	42
200	18	6	18
200	20	4	26
200	22	5	26

3.2.1 PROCESS PARAMETER OPTIMIZATION FOR IMPACT STRENGTH

After finding all the observation as given in table 2, S/N ratio and means are calculated and also various graphs for analysis is drawn by using Minitab-16 software.

3.2.2 Process parameters and their levels

Table 3: Process parameters and their levels

Levels	Process parameters		
	AMPS	VOLT	GAS Pressure(GP)
1	140	18	4
2	160	20	5
3	180	22	6

3.2.3 IMPACT SRENGTH (ANALYSIS OF RESULT)

HARDNESS AND S/N RATIOS VALUES FOR THE EXPERIMENTS

Trial No.	Designation	AMPS	VOLT	GAS Pressure(GP)	Impact Strength(IS)	S/N Ratio
1	$A_1B_1C_1$	160	18	4	60	37.8419
2	$A_1B_2C_2$	160	20	5	22	30.6296
3	$A_1B_3C_3$	160	22	6	18	26.8485
4	$A_2B_1C_2$	180	18	5	26	29.5424
5	$A_2B_2C_3$	180	20	6	25	28.2995
6	**$A_2B_3C_1$**	**180**	**22**	**4**	**42**	**32.0412**
7	$A_3B_1C_3$	200	18	6	18	37.1466
8	$A_3B_2C_1$	200	20	4	26	35.2686
9	$A_3B_3C_2$	200	22	5	26	39.4626

3.2.4 IMPACT RESPONSE FOR EACH LEVEL OF THE PROCESS PARAMETER

Response Table for Signal to Noise Ratios
Larger is better

Level	AMPS	VOLT	GP
1	29.17	29.66	32.11
2	29.57	27.70	27.82
3	27.23	28.62	26.06
Delta	2.34	1.95	6.05
Rank	2	3	1

Response Table for Means

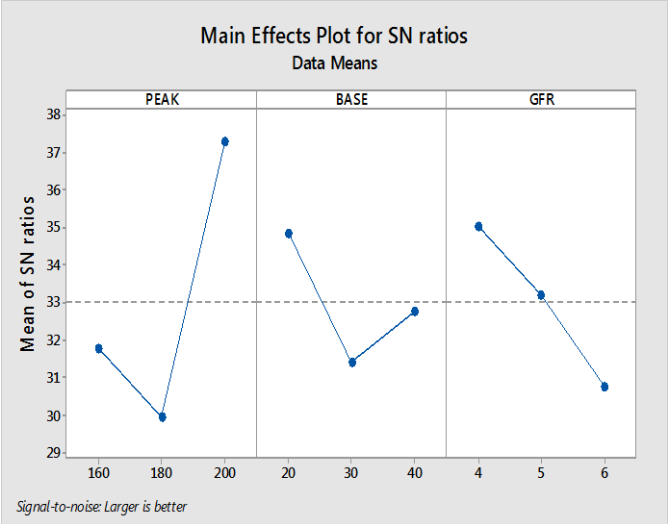
Level	AMPS	VOLT	GP
1	33.33	34.67	42.67
2	31.00	24.33	24.67
3	23.33	28.67	20.33
Delta	10.00	10.33	22.33
Rank	3	2	1

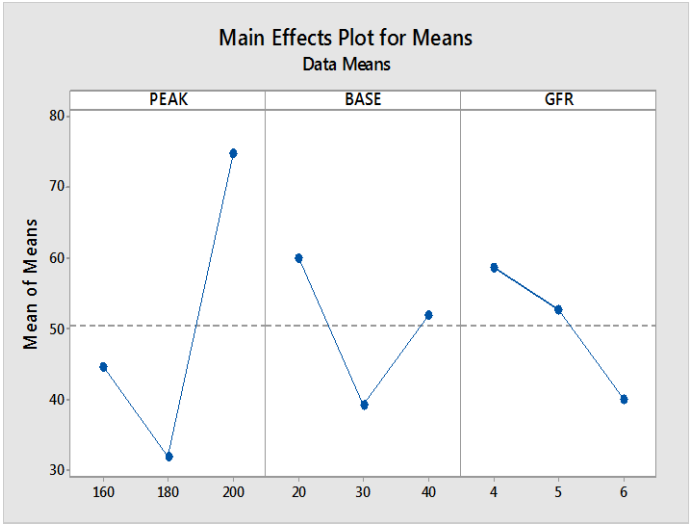
General Linear Model: IS versus AMPS, VOLT, GP

Factor	Type	Levels	Values
AMPS	fixed	3	140,160,180
VOLT	fixed	3	18,20,22
GP	fixed	3	4,5,6

Analysis of Variance for IS, using Adjusted SS for Tests

Source	DF	Seq SS	Adj SS	F	P	% of Contribution
AMPS	2	164.2	82.11	0.55	0.643	11
VOLT	2	161.6	80.78	0.55	0.647	11
GP	2	841.6	420.78	2.84	0.260	57
Error	2	296.2	148.11			21
Total	8	1463.6				100





General Linear Model: IS versus AMPS, VOLT, GAS PR

Method

Factor coding (-1, 0, +1)

Factor Information

Factor	Type	Levels	Values
AMPS	Fixed	3	140, 160, 180
VOLT	Fixed	3	18, 20, 22
GP	Fixed	3	4, 5, 6

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
12.1701	79.76%	19.04%	0.00%

Coefficients

Term	Coef	SE Coef	T-Value	P-Value	VIF
Constant	29.22	4.06	7.20	0.019	
AMPS					
140	4.11	5.74	0.72	0.548	1.33
160	1.78	5.74	0.31	0.786	1.33
VOLT					
18	5.44	5.74	0.95	0.443	1.33
20	-4.89	5.74	-0.85	0.484	1.33
GP					
4	13.44	5.74	2.34	0.144	1.33
5	-4.56	5.74	-0.79	0.510	1.33

Regression Equation

IS=29.22+ 4.11 AMPS_140+ 1.78 AMPS_160 -5.89 AMPS_180+ 5.44 VOLT_18 - 4.89 VOLT_20- 0.56 VOLT_22 + 13.44 GP_4 - 4.56 GP_5 - 8.89 GP_6

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 ImageJ folder:

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

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This is the ImageJ 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 ImageJ launches. To run a macro, drag and drop it on the ImageJ window and run it by pressing ctrl-r (Macros>Run Macro).

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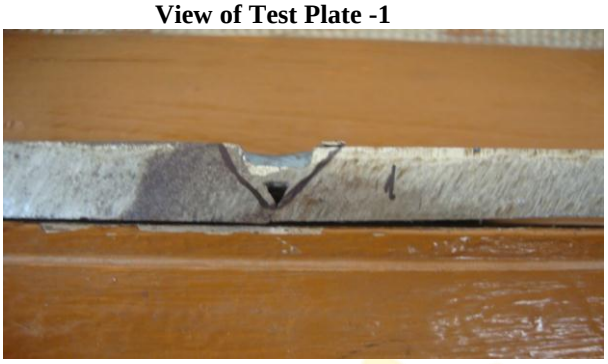
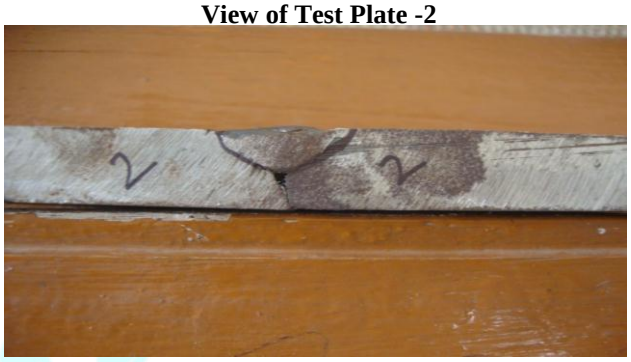
View of Test Plate -1



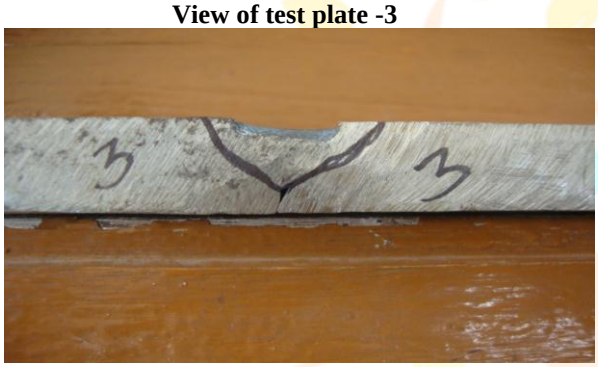
Amps -160, Volt-18, Gas Pressure-4

View of Test Plate -2



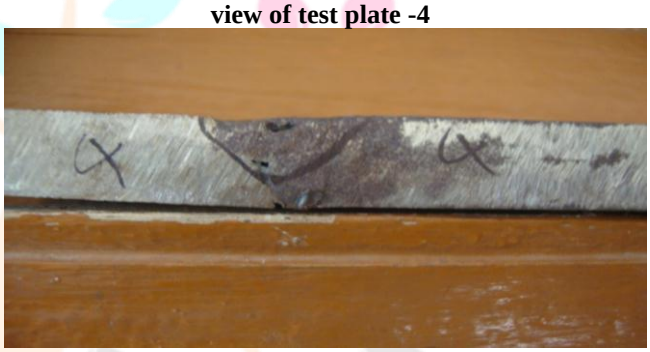
Amps -160, Volt-20, Gas Pressure-5

View of test plate -3



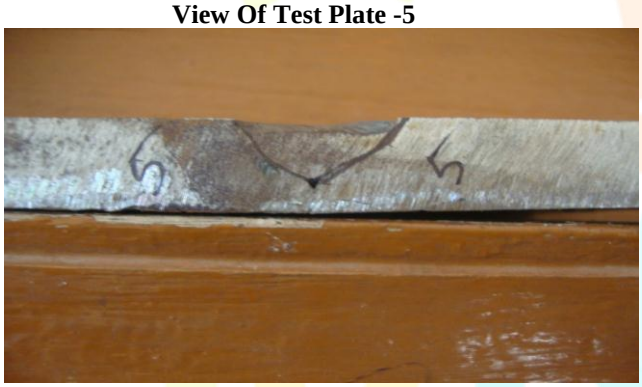
Amps -160 , Volt-22, Gas Pressure-6

view of test plate -4



Amps -180 , Volt-18, Gas Pressure-5

View Of Test Plate -5



Amps -180 , Volt-20, Gas Pressure-6

View Of Test Plate -6

Amps -180 , Volt-22, Gas Pressure-4

View of Test Plate -7

Amps -200 , Volt-18, Gas Pressure-6

view of Test Plate -8

Amps -200, Volt-20, Gas Pressure-5

View of Test Plate -9

Amps -200, Volt-22, Gas Pressure-4

5.1 VARIOUS SIZES OF BEAD WIDTH, DEPTH OF PENETRATION AND HEAT AFFECTED ZONE

SAMPLES	Area	Mean	Min	Max	Angle	Length
S1	0.324	134.242	100	219.403	-3.814	11.451
	0.199	109.493	16.104	220.538	87.93	7.029
S2	0.346	120.162	68.333	193	0	12.272
	0.146	109.675	27.333	158.492	86.248	5.174
S3	0.484	139.458	66.636	234.127	-2.834	17.117
	0.228	122.811	15.667	194.34	88.191	8.044
S4	0.43	121.378	97.667	152	0	15.235
	0.221	103.425	44.345	148.262	86.269	7.803
S5	0.426	123.478	81	167.764	-0.644	15.066
	0.189	119.86	32.333	166.755	88.55	6.688
S6	0.402	124.589	68.25	195.222	0.682	14.22
	0.166	97.603	68.845	136.188	88.34	5.842
S7	0.342	136.446	84	229.387	-0.801	12.104
	0.204	115.131	19.047	184.553	90.674	7.195
S8	**0.369**	**116.998**	**84.108**	**167.316**	**-0.744**	**13.035**
	0.244	**110.263**	**28.775**	**161.863**	**88.315**	**8.637**
S9	0.433	139.547	87.006	230.932	-1.266	15.323
	0.199	149.758	68.775	235.165	87.93	7.029

5. CONCLUSION

FCAW welding can be used successfully to join SS 409&EN24. 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 In our experiment we found out the input parameter value 200 AMPS VOLT-20 GAS PRESSURE-4Kg/cm^2.is the best value and it does not create any major changes and failures in the testing process. The toughness value of the MIG welded dissimilar steel was comparatively satisfied value (200 AMPS VOLT-20 GAS PRESSURE-4Kg/cm^2.) than other value. It also induces high tensile strength. Finally we concluded that in this project investigation the 200 AMPS VOLT-20 GAS PRESSURE-4Kg/cm2 is the best parameter for SS 409& EN8 -10 MM thickness plate for obtain the good weldment state. According to the Taguchis design and optimized parameter is value for Impact strength the 10 mm plate of SS 409& EN8 -10 MM steel is 180 AMPS VOLT-22 GAS PRESSURE-4Kg/cm^2.

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