Experimental Analysis of GMAW Joint Strength by NDT Technique for SA 213

S.Yedu Krishnan[1], P.U.Akshay[2], P.D.Manuvel[3], K.R.Vivek[4], M.Ramakrishnan[5], M.Mohan[6], A.Balamurugan[7], A.Gowrishankar[8]

[1,2,3,4,] *UG Student, Department of Mechanical Engineering,Ganesh College of Engineering, Salem, Tamil Nadu - 636111, India.*

[5,6,7,8,] *Assistant Professor , Department of Mechanical Engineering, Ganesh College of Engineering, Salem, Tamil Nadu - 636111, India*

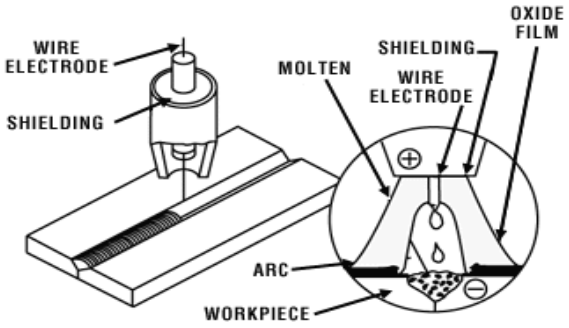
Abstract- **In large steel fabrication industries such as ship building, power plant and petrochemical Gas metal arc welding (GMAW) is the one of the most common method for joining of metals. It has various characteristics like high productivity, high mechanical properties, easy of automation, overall lower cost of production makes it first choice for many fabrication processes. Welding input parameters play a very significant role in determining the quality of a weld joint. The joint quality can be defined in terms of properties such as weld-bead geometry, mechanical properties and distortion. The main emphasis of this review is to study the effect of different input parameter of MIG welding on the weld quality. The research will be applied Taguchi Method on a SA213 pressure steel specimen of dimensions 40 mm tube diameter, Which have following interested parameters: various arc current, arc voltage and welding rotary drive speeds. The experiment was carried out in the following aspects: destructive and Nondestructive analysis. Finally we concluded that in this project investigation the AMPS-140, VOLT-18 & Rotary Drive Speed- 20 rpm is the best parameter for tube weld with 4mm wall thickness tube to obtain the good weldment state. According to the Taguchi optimization the optimized parameter value for Hardness 4mm wall thickness tube is AMPS-140, VOLT-18 & Rotary Drive Speed- 20 rpm.**

Index Terms- **Analysis, GMAW, NDT, SA213.**

I. INTRODUCTION

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.

GMAW is an important component in many industrial operations. It is easily found in any industry whose products require metal joining in a large scale. 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 base 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.



MIG WELDING PROCESS

II. MATERIALS USED

2.1 SA213

SA213 pipe is a kind of seamless medium-carbon steel boiler and super heater tube. It is produced according to the standard. SA213 steel pipe minimum carbon content is 0.27%. The seamless steel tube has minimum tensile strength of 415MPa, yield strength of 255MPa.The minimum elongation of SA213 pipe line is 30%. The steel pipe has excellent welding performance and toughness.

2.1.1 CHEMICAL PROPERTIES

Sl.No	Element	Composition In Weight % MIN	MAX
1	Carbon, C	0.35	0.27
2	Manganese, Mn	0.75	0.93
3	Silicon, Si	0.05	010
4	Sulphur &	0.015	0.035

2.1.3 MECHANICAL PROPERTIES

MATERIAL	SA213
Tensile Strength(Mpa)	≥ 415
Yield Strength(Mpa)	≥ 255
Elongation (%)	≥ 30

2.1.4 APPLICATIONS

SA213 seamless steel pipe is mainly used for high, middle, low pressure boiler and pressure purpose.

III. DESTRUCTIVE TEST & OPTIMIZATION

3.1 PROCESS PARAMETERS & LEVELS

Levels	Process parameters		
	Welding Current Amps	Arc Voltage Volt	Rotary Drive Speed (RDS) rpm
1	120	18	15
2	140	20	20
3	160	22	25

3.2 ORTHOGONAL ARRAY

Orthogonal array is designed by using minitab-16 software.

Amps	Volt	Rotary Drive Speed
120	18	15
120	20	20
120	22	25
140	18	20
140	20	25
140	22	15
160	18	25
160	20	15
160	22	20

3.3 S/N RATIOS VALUES FOR THE HARDNESS

Trial No.	Designation	Amps	Volt	RDS	Hardness	S/N Ratio
1	$A_1b_1c_1$	120	18	15	82	-38.2763
2	$A_1b_2c_2$	120	20	20	94	-39.4626
3	$A_1b_3c_3$	120	22	25	82	-38.2763
4	$A_2b_1c_2$	140	18	20	80	-38.0618
5	$A_2b_2c_3$	140	20	25	87	-38.7904
6	$A_2b_3c_1$	140	22	15	90	-39.0849
7	$A_3b_1c_3$	160	18	25	86	-38.6900
8	$A_3b_2c_1$	160	20	15	82	-38.2763
9	$A_3b_3c_2$	160	22	20	91	-39.1808

3.4 RESPONSE TABLE FOR SIGNAL TO NOISE RATIOS

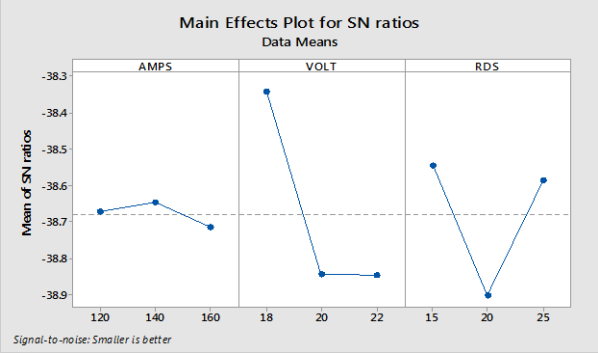
Smaller is better

Level	AMPS	VOLT	RDS
1	-38.67	-38.37	-38.85
2	-38.65	-38.89	-38.59
3	-38.72	-38.85	-38.59
Delta	0.07	0.50	0.36
Rank	3	1	2

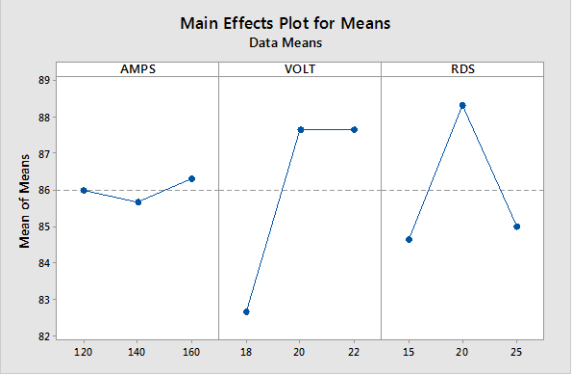
3.5 RESPONSE TABLE FOR MEANS

Level	AMPS	VOLT	RDS
1	86	82.67	84.67
2	85.07	87.67	88.13
3	86.33	87.67	85.00
Delta	0.67	5.00	3.67
Rank	3	1	2

3.6 MAIN EFFECTS PLOTFOR SN RATIO



3.7 MAIN EFFECT FOR MEANS RATIO



3.8 ANALYSIS OF VARIANCE FOR HARDNESS

Source	DF	SEQ SS	ADJ SS	F	P	% of Contribution
Amps	2	0.66	0.37	0.01	0.99	1
Volt	2	50	25.00	0.44	0.69	26
RDS	2	24.66	12.33	0.22	0.82	13
Error	2	114.66	57.33			60
Total	8	190.00				100

IV. NON DESTRUCTIVE TEST

4.1 LIQUID PENETRANT TESTING

This is used for non magnetic materials to find out surface defects. The non magnetic materials are Stainless steel, magnesium; aluminium and brass are tested by this method. Various defects like cracks, seams, porosity, inclusion and lack of fusion are identified in this method.

Procedure for penetrant testing

1. Surface cleaning
2. Application of penetrant
3. Remove excess penetrant
4. Application of developer

1. Surface cleaning:

Material surfaces are cleaned by acetone, Isoprophil alcohol and Methylene chloride. These are used to remove dirt, grease, scale, acids and chromates.

2. Application of Penetrant

Penetrant was applied to the material surfaces. Dwell time for this process is 5- 10 minutes.

3. Removable of excess Penetrant

Excess Penetrant Cleaning was done by water solvent.

4. Application of developer

Apply the developer the defects are visible either red or maroon color.

4.1.1 RESULT OF PENETRANT TEST

Some of plates rejected through penetrant test due to arc strike and spatter

Test plate	Problem	Accept	Reject
1	Arc strike	-----	Rejected
2	Spatter	Accepted	
3		Accepted	
4		Accepted	
5		-----	Rejected
6		Accepted	
7		Accepted	
8		-----	Rejected
9		Accepted	

4.2 RADIOGRAPHY TEST

The radiation used in radiography testing is a higher energy (shorter wavelength) version of the electromagnetic waves that we see as visible light. The radiation can come from an X-ray generator or a radioactive source.

Test plate	Problem	Accept	Reject
1		-----	Rejected
2	Excess	Accepted	
3		Accepted	
4		Accepted	
5		----------	Rejected
6		Accepted	
7		Accepted	
8		----------	Rejected
9		Accepted	

V. RESULT & CONCLUSION

TIG welding can be used successfully to join Tube of SA213. 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 it creates so many metallurgical defects and it is identified by using NDT testing. In our experiment we found out the input parameter value 160 AMPS, VOLT-18 Rotary drive speed 20 RPM is the best value and it does not create any major changes and failures in the testing process. Finally we concluded that in this project investigation the AMPS-140 VOLT-18 & Rotary Drive Speed-20rpm is the best parameter for tube weld with 4mm wall thickness tube to obtain the good weldment state. According to the Taguchi optimization the optimized parameter value for Hardness 4mm wall thickness tube is AMPS-140, VOLT-18 & Rotary Drive Speed-20 rpm.

REFERENCE

[1] J. Dutta Department of Mechanical Engineering, National Institute of Technology Karnataka, Surathkal, India, Experimental and analytical investigation of thermal parameters Developed in high carbon steel joints formed by GTAW.

[2] Vishnu V.S Numerical Analysis of Effect of Process Parameters on Residual Stress in a Double Side TIG Welded Low Carbon Steel Plate.IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE).

[3] M.Pal Pandi,et al Thermal Analysis on Butt Welded Aluminium Alloy AA7075 Plate Using FEM, International Journal of Engineering Research (ISSN:2319-6890)(online),2347-5013(print)Volume No.3, Issue No.2, pp : 116-120.

[4] M SUNDAR Assessment of residual stress and distortion in Welding by finite element method, proceedings of the International conference on mechanical engineering 2005.

[5] N. AKKUS Thermo mechanical Analysis of Arc Welded Joint by Finite Element Method International Conference on Advances in Welding Science and Technology for Construction, Energy and Transportation Systems (AWST - 2011) 24-25 October 2011, Antalya, Turkey

[6] FANRONG KONG Numerical and experimental study of thermally induced residual stress in the hybrid laser–GMA welding process Journal of Materials Processing Technology.

[7] LI YAJIANG Finite element analysis of residual stress in the welded zone of a high strength steel Key Laboratory of Liquid Structure and Heredity of Materials, Ministry of Education, Shandong University, Jinan 250 061, China.

[8] M.N.CHOUGLULE Experimental and analytical study of thermally induced residual stresses for stainless steel grade using GMAW process. 5th International & 26th All India Manufacturing Technology,Design and Research Conference (AIMTDR 2014) December 12th -14th, 2014, IIT Guwahati, Assam, India.

[9] S.KOU Welding Thin Plates of Aluminum Alloys A Quantitative Heat-Flow Analysis.

[10] ANCA 3d-thermo-mechanical simulation of welding process Mechanical Computacional Vol. XXIII, pp. 2301-2318 G.Buscaglia, E.Dari, O.Zamonsky (Eds.) Bariloche, Argentina, November 2004.

[11] L.A.JAMES, Fatigue-Crack Propagation Behavior of Several Pressure Vessel Steels and Weldments.

[12] A.D WILSON Properties and behaviours of modern A 387 cr-Mo steels.

[13] APPALA NAIDU Hot Corrosion Studies on Welded dissimilar Boiler steel in Power plant environment under cyclic condition. International Journal of Chem Tech Research CODEN (USA): IJCRGG ISSN: 0974-4290 Vol.6, No.2, pp 1325-1334, April-June 2014.

[14] A.RASOOL Influence of post welds heat treatment on the HAZ of low alloy steel weldments.The American society of Mechanical Engineers.