© 2017 IJSRSET | Volume 3 | Issue 8 | Print ISSN: 2395-1990 | Online ISSN : 2394-4099
Themed Section: Engineering and Technology

A Review on Alloy Steel Welded by Plasma Arc Welding and Gas Tungsten Arc Welding for Comparative Study of Mechanical Properties

Harishkumar Parmar, Prof. Riddhish Thakore, Prof. Rajat Dave

Mechanical Engineering (Production), Shankersinh Vaghela Bapu Institute of Technology, Vasan, Gujarat, India

ABSTRACT

The austenitic stainless steel 304L are considered as High strength steel and high yield strength materials of interest for technology development, mainly for aeronautics and aerospace industries. For these purpose should increasing the welding speed, increasing the Penetration, decreasing the reject rate and reducing the pre and post welding machining. There are few studies of the process of GTAW and PAW of this material, making it important to study the feasibility of welding these steels. A comparison between the traditional welding processes (TIG-Tungsten Inert Gas and PAW-Welding Plasma Arc) and it was performed defining the influence of different process parameters. This paper mainly focus on the process parameter of the GTAW and PAW process for one to one comparison and evaluation of the process. This review study was performed for selection of the best material for the optimized comparison of two welding process.

Keywords : GTAW, PAW, SS 304L, Neural Network, Mechanical Properties, Microstructural Characterization

I. INTRODUCTION

Modern welding technology started just before the end of the 19th century with the development of methods for generating high temperature in localized zones. Welding generally requires a heat source to produce a high temperature zone to melt the material, though it is possible to weld two metal pieces without much increase in temperature. There are different methods and standards adopted and there is still a continuous search for new and improved methods of welding. As the demand for welding new materials and larger thickness components increases, gas flame welding which was first known to the welding engineer is no longer satisfactory and improved methods such as Metal Inert Gas welding, Tungsten Inert Gas welding, electron and laser beam welding have been developed.

In order to fulfill demands for quality and efficiency in the field of welding engineering, numerous works in research on the optimization of the welding processes are in progress. The aim of this work is to study a comparison between the traditional welding processes (TIG-Tungsten Inert Gas and PAW-Welding Plasma Arc) and this was performed defining the influence of different process parameters. The aims of this research are increasing the welding speed, increasing the Penetration, decreasing the reject rate and reducing the pre and post welding machining. To evaluate the mechanical properties were used tensile and hardness test and study about Elongation and the Tensile strength. Plasma arc welding has been increasingly considered as an alternative to traditional techniques to join the metals.

An increase in penetration depth and a reduction of possible welding defects is indeed achieved. There are many types of welding process available for welding, but we can choose Plasma Arc Welding and TIG welding because of this equipment is portable, it has non-consumable electrode. There are few studies of the process of Plasma arc welding and Gas Metal Arc Welding (TIG), making it important to study the mechanical property and microstructure of welding processes. Welding is a joining process in which coalescence produced between two metals by using heat, with or without use of pressure and with or without uses of filler metals and form uniform and homogeneous joint. Main two welding processes are TIG-Tungsten Inert Gas and PAW-Welding Plasma Arc.

Gas-tungsten arc welding (GTAW), also known as *tungsten inert gas* (TIG). Tungsten Inert Gas welding (TIG) is the old name for TIG welding process was developed in the late 1930s when a need to weld magnesium became apparent. The process now known as gas tungsten arc welding GTAW and the new name became popular in the technical books. The Gas Tungsten Arc Welding (GTAW) process is applicable when the highest weld quality is required. It can be used to weld almost all types of metals. The operator has excellent control of heat input, and vision is not limited by fumes or smoke from the process. TIG welding consist of Welding torch, non-consumable electrode, argon and helium as a shielding gas and its main application are Ferrous and various non-ferrous metal. Join various dissimilar metals together. Good for fabrication such as aircraft and race car frames, Used for welding thinner metal parts.

Arc welding process that produced coalescence metals by heating them with a constricted arc between electrode and work piece (transferred arc) or between electrode and water cooled constricting nozzle (non-transferred arc). Plasma: A gas mixture of positive ions, electrons and neutral gas molecules. Main objective of plasma arc welding To increase the energy level of the arc plasma in controlled manner. This is achieved by providing a gas nozzle around a tungsten electrode operating on DCEN. Main components of PAW are DC power supply, High frequency generator and current limiting resistors, Plasma Torch, Shielding gas. Application of PAW are in Aerospace industries, Cryogenics. Foodstuff and chemical industries, Machine and plant construction, Automobiles and railways, Ship construction, Tank equipment and pipe line construction.

II. LITERATURE REVIEW

Generally in industry there is none of specified welding technique among these two for the define weld job. Welder performs the technique arbitrary or self-define. Generally they adopt the technique as per their past experience or the availability of equipment. So it is required to define the technique for the welding job and this identification of technique for the job should be based on mechanical properties, Appearance and weld quality. Material welded by either PAW or GTAW but comparative study was not performed yet. So it will be very important to investigation in the field of welding.

Table 1. Literature Review

No	Title	Author	Pub. & Year	Journal Name	Welding Process	Conclusion
1	Disk-laser welding of Ti-6Al-4V titanium alloy plates in T-joint configuration	F. Caiazzoa F. Cardaropolia V. Alfieria V. Sergia P. Argenioa G. Barbierib	ELSEVIER 2017	Procedia Engineering 183 (2017) 219 – 226	LBM	Increse in tensile strength
2	Gas metal arc pulse welding with alternating current for lightweight materials	S. Brumm G. Bürkner	ELSEVIER 2015	Materials Today: Proceedings 2S (2015) S179 – S187	GTAW	Rised the welding speed decrese the penetration.
3	Comparison of Mechanical and Microstructural Characteristics in Maraging 300 Steel Welded by three different processes: LASER, PLASMA and TIG	Sakai,P.R. Lima,M.S.F. Fanton,L. Gomes,C.V. Lombardo,S. Silva,D.F. Abdalla,A.J.	ELSEVIER 2015	Procedia Engineering 114 (2015) 291 – 297	LBM PAW GTAW	Reduction in yield and tensile strength were lower than 5% with loss of about 20% in ductility

4	An Analysis of the Mechanical Behavior of AISI 4130 Steel after TIG and Laser welding process.	F. Souza Neto D. Neves O. M. M. Silva M. S. F. Lima A.J. Abdalla	ELSEVIER 2015	Procedia Engineering 114 (2015) 181 – 188	GTAW LBM	The hardness in the fusion zone is quite high The tempering applied after welding improved the ductility
5	The Effect of Welding Process Parameters on Pitting Corrosion and Microstructure of Chromium-Manganese Stainless Steel Gas Tungsten Arc Welded Plates	SUDHAKARA N. R, SIVASAKTHI VEL. P.S, NAGARAJA.S EAZHIL. K.M	ELSEVIER 2014	Procedia Engineering 97 (2014) 790 – 799	GTAW	The welding speed and shielding gas flow rate has strong positive effect on pitting corrosion
6	Experimental Investigation for Welding Aspects of Stainless Steel 310 for the Process of TIG Welding	V.Anand Raoa Dr.R.Deivanathanb	ELSEVIER 2014	Procedia Engineering 97 (2014) 902 – 908	GTAW	Strength of weld is proportionately increasing with the welding current The filler material 309L has produced better tensile and bending strength
7	Study on Weld Quality Characteristics of Micro Plasma Arc Welded Austenitic Stainless Steels	Kondapalli Siva Prasada Chalamalasetti Srinivasa Raob Damera Nageswara Raoc	ELSEVIER 2014	Procedia Engineering 97 (2014) 752 – 757	PAW	AISI 304L has highest tensile strength and hardness AISI 316L has attained lowest tensile strength AISI 321 has lowest hardness and grain size
8	Effect of heat input on the microstructure, residual stresses and corrosion resistance of 304L austenitic stainless steel weldments	Rahul Unnikrishnan, K.S.N. Satish Idury, T.P. Ismail, Alok Bhadauria, S.K. Shekhawat, Rajesh K. Khatirkar,*, Sanjay G. Sapate	ELSEVIER 2014	MATERIALS CHARACTERIZATION 93(2014)10–23	SMAW	thickness of the fusion boundary increased with the increase in heat
9	Effect of the plasma arc welding procedure on mechanical properties of DP700 steel	J. Piccini H. Svoboda	ELSEVIER 2012	Procedia Materials Science 1 (2012) 50 – 57	PAW	Obtaining full penetration defects-free joints HAZ becomes smaller without changing the mechanical properties.
10	Weldability of a 2205 duplex stainless steel using plasma arc welding	A. Urena E. Otero M.V. Utrilla C.J. Munez	ELSEVIER 2007	Materials Processing Technology 182 (2007) 624–631	PAW	Welds produced by keyhole PAW have higher penetration/ width ratios than welds produced in the melt-in mode. PAW enhance hardening in the fusion pool.

11	Comparison of Ti-5Al-5V-5Mo-3Cr Welds Performed by Laser Beam, Electron Beam and Gas Tungsten Arc Welding	T. Pasanga, J.M.Sánchez Amaya, Y. Tao, M.R. Amaya-Vazquez, F.J. Botana	ELSEVIER 2013	Procedia Engineering 63 (2013) 397 – 404	LBW EBW GTAW	strength of the welded specimen is lower than that of the Base Metal some ductility was maintained in terms of elongation.
12	Dislocation structure evolution in 304L stainless steel and weld joint during cyclic plastic deformation	Hao Wang, Hongyang Jing, Lei Zhao, Yongdian Han, Xiaoqing Lv, Lianyong Xu	ELSEVIER 2017	Materials Science & Engineering A S0921-5093(17)30259-9	GTAW	while the weld metal shows a short hardening within several cycles at first
13	Experimental and numerical analyses of residual stress distributions in TIG welding process for 304L stainless steel	S.A.A.Akbari Mousavi, R. Miresmaeili	ELSEVIER 2008	journal of materials processing technology 2 0 8 (2 0 0 8) 383–394	GTAW	50° u and v grooved specimens was examinedThe results showed that the magnitudes of the transverse residual stresses increased about threefold
14	Evaluation of Microstructure and Mechanical Properties in Dissimilar AusteniticSuper Duplex Stainless Steel Joint	Mehdi Rahmani, Abbas Eghlimi, and Morteza Shamanian	ASM International 2014	Journal of Materials Engineering and Performance Volume 23(10) October 2014—3745	GTAW	Both welded joints showed acceptable mechanical properties; the ultimate strength of the weldments was superior to that of the SDSS and ASS BMs.
15	Effect of repeated weld-repairs on microstructure, texture, impact properties and corrosion properties of AISI 304L stainless steel	Chun-Ming Lin, Hsien-Lung Tsai, Chun-Der Cheng, Cheng Yang	ELSEVIER 2012	Engineering Failure Analysis 21 (2012) 9–20	GTAW SMAW	Microstructures of the BM specimen and the HAZ regions of the two weld-repair specimens all consist of an austenite matrix with interspersed ferrite phases
16	Experimental Process of Tungsten Inert Gas Welding Of A Stainless steel plate	Ajay kumara, Pradeep Kumar, Srishti Mishra, R K Mishra, Tushar Srivastav, Sachin Mishra, Rajeev Kumar	ELSEVIER 2015	Materials Today: Proceedings 2 (2015) 3260 – 3267	GTAW	current and root face affects the deposition rate very significantly welding the stainless steel 304 on TIG welding as far the deposition rate is concerned

III. RESULTS AND DISCUSSION

There are few studies on the welding process of PAW and GTAW for SS 304L using the input parameter voltage, current, welding speed, and shielding gas flow rate on weld properties. Austenite stainless steels 304L have been widely applied in many fields, such as structural components in pressurized water reactors owing to their excellent combination of mechanical properties, better yield strength and very good oxidation and corrosion resistance properties while other material. 304L Austenite stainless steel material is easily welded by PAW and GTAW processes.

Both welding processes are compared for SS304L material and analysed. Generally in industry there is none of specified welding technique among these

two for the define weld job. Welder performs the technique arbitrary or self-define. Generally they adopt the technique as per their past experience or the availability of equipment. So it is required to define the technique for the welding job and this identification of technique for the job should be based on mechanical properties, Appearance and weld quality. Austenite stainless steels 304L welded by either PAW or GTAW but comparative study was not performed yet. So it will be very important to investigation in the field of welding.

An experiment on Welding of SS 304L material using the Gas Tungsten Arc Welding and Plasma Arc Welding process and analysis techniques used like Scanning Electron Microscopy (SEM), Micro and Macro Examination, Bend Test, Ultimate Tensile Test (UTS), Radiography etc. An investigation of the Weld penetration, HAZ elongation. To evaluate mechanical properties of material welded by GTAW and PAW. To study the effect of various process parameters like current, weld speed, gas flow rate on weld properties. Identify suitable process for various materials.

IV. CONCLUSION

From above literature review conclusion have been made as mention below.

- Austenitic stainless steel SS 304L has been selected for comparison of two welding process because of wide application, good weldability and cost effectiveness.
- GTAW and PAW are selected because of in industry there is none of specified welding technique among these two for the define weld job.
- Comparison of these processes is based on the mechanical properties and microstructural characterization. So it's a required to study about the tensile strength, weld penetration ratio, scanning electron microscopy and heat affected zone.
- Neural network is optimization algorithm which is use to define a regression model for the Best of two processes.

V. REFERENCES

[1]. F. Caiazzoa,*, F. Cardaropolia, V. Alfieria, V. Sergia, P. Argenioa, G. Barbierib, Disk-laser welding of Ti-6Al-4V titanium alloy plates in T-joint configuration

[2]. S. Brumm*, G. Bürkner, Gas metal arc pulse welding with alternating current for lightweight materials

[3]. Sakai, P.R.a, Lima, M.S.F.b, Fanton, L.a, Gomes, C.V.c, Lombardo, S.a, Silva, D.F.a, Abdalla, A.J.b, Comparison of Mechanical and Microstructural Characteristics in Maraging 300 Steel Welded by three different processes: LASER, PLASMA and TIG

[4]. F. Souza Netoa, D. Nevesb, O. M. M. Silva b, M. S. F. Limac, A.J. Abdallac, An Analysis of the Mechanical Behavior of AISI 4130 Steel after TIG and Laser welding process.

[5]. SUDHAKARAN. Ra*, SIVASAKTHIVEL. P.Sb, NAGARAJA.Sc and EAZHIL. K.Md, The Effect of Welding Process Parameters on Pitting Corrosion and Microstructure of Chromium-Manganese Stainless Steel Gas Tungsten Arc Welded Plates

[6]. V.Anand Raoa , Dr.R.Deivanathanb, Experimental Investigation for Welding Aspects of Stainless Steel 310 for the Process of TIG Welding

[7]. Kondapalli Siva Prasada*, Chalamalasetti Srinivasa Raob, Damera Nageswara Raoc, Study on Weld Quality Characteristics of Micro Plasma Arc Welded Austenitic Stainless Steels

[8]. Rahul Unnikrishnana, K.S.N. Satish Idurya, T.P. Ismaila, Alok Bhadauriaa, S.K. Shekhawatb, Rajesh K. Khatirkara,⋆, Sanjay G. Sapatea, Effect of heat input on the microstructure, residual stresses and corrosion resistance of 304L austenitic stainless steel weldments

[9]. J. Piccinia, H. Svobodaa,b, Effect of the plasma arc welding procedure on mechanical properties of DP700 steel

[10]. A. Ure˜na ∗, E. Otero, M.V. Utrilla, C.J. M´unez, Weldability of a 2205 duplex stainless steel using plasma arc welding

[11]. T. Pasanga,*, J.M.Sánchez Amayab, Y. Taoa, M.R. Amaya-Vazquezb, F.J. Botanab, J.C Sabolc, W.Z. Misiolekc, O. Kamiyad, Comparison of Ti-5Al-5V-5Mo-3Cr Welds Performed by Laser Beam, Electron Beam and Gas Tungsten Arc Welding

[12]. Hao Wang, Hongyang Jing, Lei Zhao, Yongdian, Han, Xiaoqing Lv, Lianyong Xu, Dislocation structure evolution in 304L stainless steel and weld joint during cyclic plastic deformation
[13]. S.A.A. Akbari Mousavi ∗, R. Miresmaeili, Experimental and numerical analyses of residual stress distributions in TIG welding process for 304L stainless steel
[14]. Mehdi Rahmani, Abbas Eghlimi, and Morteza Shamanian, Evaluation of Microstructure and Mechanical Properties in Dissimilar austeniticsuper Duplex Stainless Steel Joint
[15]. Chun-Ming Lin a,⇑, Hsien-Lung Tsai a, Chun-Der Cheng a, Cheng Yang b, Effect of repeated weld-repairs on microstructure, texture, impact properties and corrosion properties of AISI 304L stainless steel
[16]. Ajay kumara*, Pradeep Kumara, Srishti Mishra a, R K Mishraa Tushar Srivastava, Sachin Mishraa Rajeev Kumarb, Experimental Process of Tungsten Inert Gas Welding of A Stainless steel plate