Optimization of TIG Welding Process Parameters: A Review

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Abstract **- The main objective of this review paper is to find the most important process parameters and also the output parameters which have a vast effect on the TIG welding and from various papers it has been studied that many of the researchers had mainly worked on the parameters which affect the TIG welding Process like Current, Voltage, Gas Flow Rate, Welding Speed, Arc Length etc. are taken as input parameters and Tensile Strength, Impact Strength, Hardness, Depth of Penetration. Heat Affected Zones etc. are taken as output Parameters and various optimization techniques are also applied for optimization of results like Taguchi, RSM, ANOVA and Grey Relation Analysis.**

Index Terms - Tungsten Inert Gas Welding (TIG), Taguchi Method, Physical Parameters

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I. INTRODUCTION

TIG welding is a welding process which is done manually it requires skilled welding personnel to perform this welding Process. It is different from another welding process in the way the arc is produced and filler material is applied. In this welding process both hands are used for welding in one palm the welder holds TIG torch while the other palm is used for holding filler material. TIG welding is a very difficult welding procedure but also it is an ingenious process for different materials. It is a very high-quality yielding process when performed nicely but it runs with a lower rate. It is mainly used for difficult welding joints and for materials such as SS, Aluminum, Inconel alloys, etc.

TIG welding system constitutes of various components such as suitable power source, argon gas cylinder, welding torch connected to a power supply, Shielding gas tube and water tube for cooling torch.

II. PROCESS AND WORKING AND CONSTRUCTION OF TIG WELDING

Gas Tungsten Arc Welding (GTAW) commonly known as Tungsten Inert Gas (TIG) welding is a type of arc welding having non-consumable electrode for producing a weld. The electrode and weld area is isolated by Argon or Helium which is also known as a Shielding gas in TIG welding. It is applied with a constant current power supply which is used for producing arc in a region of highly ionized gas and metal vapors known as plasma. The job to be welded is first cleaned in order to get a good quality of weld dirt such as grease, other oxides for strengthening weld joint.

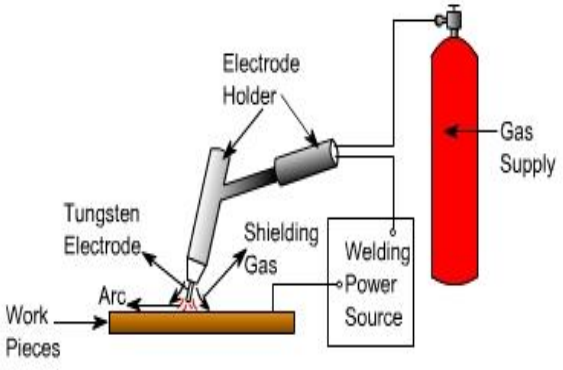

Fig. 1 Schematic Diagram of TIG Welding

Ref. No	Authors	Year	Material	Optimization Technique	Parameters	Responses	Findings
[1]	Wichen Chuaiphan, Loeshpahn Srijaroenpramong	2018	AISI 304, AISI 201 SS	Design of Experiment	Current, Voltage, Speed(mm/s), Arc Length, Nozzle Size, Tungsten Electrode, Diameter, Flow Rate of Shielding Gas, Flow Rate of Balking Gas	Tensile Strength	Tensile strength increases as the current increase.
[2]	Asif Ahmad, Shah Nawaz Alam	2018	S30430SS	Taguchi Philosophy and Minimum HAZ	Current, Arc Length, Speed	Bead width, DOP, HAZ Geometry	Good bead geometry means good tensile strength
[3]	Ganesh S Mudaliyar Priyank B Patel, J D Patel, Ayesha M Doi	2018	AISI 304I SS	Taguchi Approach	Current, Arc Pulse Freq., Speed	Weld penetration, bead width, angular distortion	the lowest value of speed and the highest value of current and arc length
[4]	S Arulselvan, S Harish Shiva, M Muruganandham, E Vinoth Kumar, K.Vijaya Kumar	2018	SS 304, High Carbon Steel IS2062	Taguchi	Current, Voltage, Speed, Gas Flow Rate	Hardness, penetration depth	Hardness and depth of penetration are very much Appreciable on welded joints
[5]	Ashutosh Patel, Shabana Naz Siddique	2018	Alloy Steel Grade 22	ANOVA	Current, Root Gap, Gas Flow Rate	Tensile Strength	Tensile strength increases as the current increase
[6]	M. Ravichandran, A Naveen Sait and U. Vignesh	2017	2205 Duplex Stainless Steel	ANOVA	Current, Gas Flow Rate, Speed	Impact strength, hardness	Hardness and impact both are at a higher level at a different level of process parameter
[7]	Kamal Kant Sharma, Indraj Singh	2017	SS 347, SS 321	ANOVA, RSM	Literature Review	Literature Review	Current, Root gap, Speed are some important process parameters
[8]	I.J Rohit, R. Ajithraj and M. Dev Anand##	2017	SS 304	Adaptive Neuro-Fuzzy Inference System	Current, Voltage, Speed, Gas Flow Rate	Tensile strength	Use of artificial intelligence tool is verified by using a neuro-fuzzy inference system
[9]	Dhananjay Kumar, Dharamveer Mangal	2017	SS 304L		Current, Voltage, Speed, Gas Flow Rate	Angular distortion	Double side TIG weld shows lower angular distortion as compared to one side welding
[10]	Sanjay Kumar, Praveen K Singh, D Patel, Shashi B Prasad	2017	AISI SS 304	ANOVA RSM	Current, Voltage, Root Gap, Gas Flow Rate	Hardness, bending strength	For hardness, voltage is the most effective process parameter and for bending strength, current plays a vital role

[11]	Anmoljeet Singh, Rutash Mittal	2017	SS304, SS 202	ANOVA	Current, Speed, Gas Flow Rate	Impact toughness, bending strength	Gas flow rate is most significant followed by current and speed resp.
[12]	Kumar Rahul Anand, Vijay Mittal	2017	SS 316	Taguchi Technique	Current, Voltage, Gas Flow Rate	Tensile strength, hardness	Tensile strength increases as the current increase
[13]	P Shashidhar, P Laxminagaprasad, U Anil Kumar	2017	SS	Taguchi ANOVA	Current, Gas Flow Rate, Filler rod	Ultimate load	Ultimate load directly depends on current and filler rod
[14]	Qazi T Z, Shahin Ansari	2017	SS 316	ANOVA	Literature Review	Literature Review	A review is done on various process parameters like current, voltage gas flow rate, etc.
[15]	Ravi Shanker Vidyarthi, Dheerendra Kumar Dwivedi, Vasudevan Muthukumaran	2017	Ferrite SS	Response Surface Methodology	Current, Speed, Flux Coating Density	Depth of penetration, bead width, the welded area	DOP, BW, and D/W and WA directly depends on flux coating density
[16]	Urvish Patel, Diveyesh Patel, Priyesh Santoki	2017	SS 316	Taguchi Method	Current, Voltage, Gas Flow Rate	Depth of penetration on various factors	Increase in current increases depth of penetration
[17]	Gurdev Singh, Aman Bansal	2016	SS 316	Taguchi, ANOVA	Current, Voltage, Gas Flow Rate	Tensile strength	Welding voltage has the most significant influence on tensile
[18]	M Manapparai, A Elango	2016	AISI 310, 321 Austeniti c SS	Taguchi Method	Current, Gas Flow Rate, Bevel Angle, Root Gap	Tensile strength	Tensile strength increases as the current increase, it decreases with increase in root gap
[19]	Vijay Gohel, Jatin Makwana, Ritesh Kumar Ranjan	2016	SS 304	Taguchi, ANOVA	Current, Voltage, Gas Flow Rate	Tensile strength, hardness	Tensile strength, hardness increases as the current increase
[20]	Arpita N Bhavsar, Vikram A Patel	2016	SS304L	ANOVA	Current, Groove Design, Filler Rod	Tensile strength, hardness	Hardness, Tensile strength increases as the current increase
[21]	Jeya Jeevahan, G Britto Joseph, G Mageshwaran, N Manikandan	2016	SS 316	Design of Experiment	Current, Voltage, Gas Flow Rate	Impact strength, hardness	It concludes that an increase in welding current, voltage, and gas flow rate increase in impact strength
[22]	M Prabandha, Prasad Rayala	2016	SS Plate	Taguchi, ANOVA	Current, Gas Flow Rate, Filler Rod dia.	Tensile strength, hardness	Tensile strength increases with an increase in current, both side welding is equivalent to base material strength.
[23]	Hiren M Bopaliya, Manhar S Kagthara, Dr. G D Acharya	2016	SS 304	Taguchi	Literature Review	Impact strength, hardness	Ranking of tensile strength has been derived in order V<GFR<I

[24]	M Pandi Krishnan, A Naveen Sait	2015	SS 301	Taguchi	Pressure, Speed, Temperature	Tensile load, tensile stress	Tensile strength increases as the Pressure increase
[25]	Shekhar Rajendra Gulwade, R R Arkerimath	2015	Austeniti c SS	ANOVA	Current, Voltage, Gas Flow Rate	Hardness	Hardness is directly proportional to all parameters
[26]	A Devraju	2015	Duplex SS, AISI 316L SS	Design of Experiment	Current, Voltage, Welding Speed, Gas Flow Rate	X-ray, microstructural analysis, impact, hardness, tensile strength	X-ray has no effect, impact test shows weld at an acceptable level, tensile strength, hardness found improved, bending test also acceptable at given parameters
[27]	Joby Joseph, S Muthukumaran	2015	AISI 4135	Taguchi, Genetic Algorithm Simulated Annealing	Current, Voltage, Welding Speed, Gas flow rate	Tensile strength	Tensile strength increases as the current, voltage, GFR increase
[28]	V Gopinath, T Manojkumar, I Sirajudeen, S Yogeshwaran, V Chandran	2015	SS 202	Response Surface Methodology (RSM)	Current, Speed, Filler Dia.	Tensile load, tensile strength	Tensile strength increases as the current increase
[29]	Prasad Mehul Kumar Anil, Nirav B Patel	2015	S31603	Genetic Algorithm, ANOVA	Current, Gas Flow, Filler Rod Dia.	Aspect ratio's	It concludes that change in welding current, filler rod dia., and gas flow rate improves the weld quality
[30]	Akash B Patel, Prof. Satyam P Patel	2014	SS 321	ANOVA	Current, Gas Flow Rate, Flux Proportion	Heat affected zones	HAZ Directly proportional to Current, and GFR
[31]	Balaji Chandrakanth, S V Abinesh Kumar, S Ashwin Kumar, R Satish	2014	SS316L	ANOVA	Current, Bevel Angle, Gas Flow	Tensile strength	Tensile strength increases as the current increase
[32]	Venkateshan M V, Murugan N	2014	409 M Ferite SS	Design of Experiment	Current, Speed, Voltage, Gas Flow Rate	Bead geometry, distortion	Increase in bead width increase in angular distortion, bowling distortion decrease with a decrease in root penetration
[33]	Sreejith S Nair	2013	SS	RSM	Rod Dia, Current	Tensile strength, hardness, penetration	Increase in current increase in Tensile strength and hardness
[34]	Ajit Khatter, Pawan Kumar, Manish Kumar	2013	SS 304	Taguchi	Current, Voltage, Gas Flow	Tensile strength	Increase in current increase in Tensile strength
[35]	Dheeraj Singh, Vedansh Chaturvedi, Jyoti Vimal	2013	SS	Taguchi Method, Grey Relation Analysis	Current, GFR, WS, Gun Angle	Tensile load, area of penetration, bead width, bead height, penetration	Tensile Strength Increases with increase in gun angle.

VII. CONCLUSION

The Current paper helps us to determine the study of optimization of parameters of TIG welding. From the previous researches, we have concluded that a lot of research has been done on factors such as Current, Voltage, GFR, and WS finding out various parameters like Tensile Strength, Hardness, penetration, HAZ studies from above papers the various conclusions can be derived.

1. Parameters such as Gas different filler rod material are taken in account for welding of SS 304 by Taguchi method.
2. The parameters such as Tensile Strength, Impact Strength, etc. are calculated on butt joint welds on different groove angle.
3. The most preferred parameters are Tensile Strength, Hardness, HAZ, DOP.
4. The Taguchi approach has been built on the traditional design of experimental methods to improve the design of products and processes.
5. The interactions of current and voltage greatly influence the tensile strength of the material

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