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TIG Welding on Dissimilar Metals SS-316 and SS-304 : A Short Review

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Abstract:

Gas Tungsten Arc Welding (GTAW), also called Tungsten Inert Gas welding (TIG) is one of the main welding methods which have been widely used in industries for the welding of stainless steel, titanium alloy, and other nonferrous metals for its high weld quality and lower equipment investment. In today's world, of heavy competition companies are striving hard to increase their production. This paper represents a review on ATIG Welding Process. Gas tungsten arc welding is essential in industries where weld bead shape and metallurgical properties must be controlled. However, when compared to other arc welding processes, TIG welding's shallow penetration limits its ability to weld thick structures in a single pass, resulting in low productivity and the need for skilled welders. Grade 304 and 316 stainless steel is the most versatile and widely used stainless steel, available in a wider range of products and forms than any other types of steel. It has excellent forming and welding characteristics. Post-weld annealing is not required when welding thin sections. It has excellent corrosion resistance in a wide range of atmospheric environments and many corrosive media.

Keywords: ***Gas Tungsten Arc Welding, Tungsten Inert Gas welding, SS304, SS316***

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I. INTRODUCTION

Welding is a procedure of joining two comparative or unique metals with the use of heat or pressure or both with or without utilization of filler metal. It is a changeless joining process used to join various materials like plastics, alloys or metals together at their reaching surfaces by utilization of heat and additionally pressure or both. In welding method, the work-pieces to be combined are melted at the mating boundary and after solidification process a permanent joint can be accomplished. Russel Meredith established Tungsten inert gas (TIG) welding method in year 1941 by for welding magnesium, as its oxides have high melting point than parental metal, it is also called GTAW(Gas tungsten arc welding). Currently it is widely used for welding metals.Gas tungsten arc welding (GTAW), also called tungsten inert gas welding (TIG), is one of the main welding methods which has been widely used in industry for the welding of stainless steel, titanium alloy, and other non ferrous metals for its high weld quality, lower sensitivity to the joint fitting and welding parameters, and lower equipment investment (Heiple and Ropper, 1982). This process uses a non consumable tungsten

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electrode to produce the weld. The weld area is protected from atmospheric contamination by a shielding gas (usually an inert gas such as argon), and a filler metal is normally used. The filler metal is not used in Autogenously TIG welds. A constant current welding power supply produces energy which is conducted across the arc through a column of highly ionized gas and metal vapors known as plasma. The area surrounding the molten metal, electrode and the arc are protected from atmospheric contamination by an envelope of inert gas during heating and subsequent cooling. The TIG welding has been widely used in industry for the welding of stainless steel, titanium alloy, and other nonferrous metals for its high weld quality, lower sensitivity to the joint fitting and welding parameters, and lower equipment investment (Lu et al. 2008).

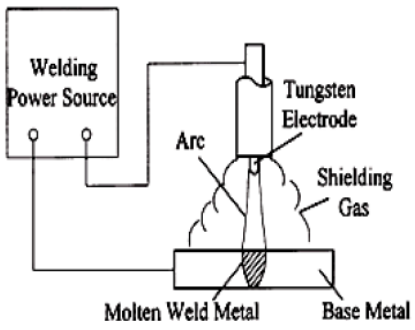

Figure 1: Sketch of the GTAW process [4]

II. LITERATURE REVIEW

Singh et.al 2017 [1] utilized Activated Flux TIG (ATIG) welding process for joining of P91 Steel (Ferrite Steel) plates. Initiating transition (a meagre layer) is applied along the line on the outside of the material where the welding is to be completes in this procedure. The ATIG procedure helps to expand the weld infiltration in thick materials. In the current investigation, ATIG was done on P-91 steel. Tungsten Inert Gas welding (TIG) gives great quality welds, however the infiltration got in such welding is as yet requesting. This Paper Shows that utilization of transitions improved weld dot entrance twice to threefold when contrasted with ordinary TIG welding. It likewise looked at weld dab entrance utilizing different transitions (Br2O3, V_2O_5, MgO) and Br_2O_3 has most extreme infiltration.

Jadon et.al 2017 [2] carried out bead on plate welds for Mild Steel and AISI 409 plates utilizing Gas tungsten arc welding (GTAW) technique. The input parameters were taken as welding current (I), welding voltage (V) and gas pressure (P) and estimates ultimate tensile strength (UTS)as output parameter and check the parametric variations. Taguchi method was considered for optimization by a L27 orthogonal array to create Design of Experiment (DOE). The MINITAB-17 was used for checking the usefulness of various by Analysis of variance (ANOVA). Finally, the confirmation tests were done. The effect of parameter on Ultimate tensile strength (UTS) can be ranked in decreasing order as-Voltage>current>pressure (UTS more affected by voltage and current).

Sharma et.al 2017 [3] In this paper optimization of TIG welding process parameters on Stainless Steel 347, 321 Stainless Steel by using various optimization methods like analysis of variance (ANOVA), Response surface methodology (RSM) etc. have been reviewed and categorized under three categories i.e. optimization on TIG welding, optimization on steel and optimization on RSM. Input Process parameters were optimized using Response surface methodology (RSM)for tensile strength and hardness. Optimization of GTAW welding parameters like voltage, current and gas flow rate by RSM technique. This paper shows current, speed, root gap has influence on tensile strength, it found that lower welding speed strength is more; increases in current tensile strength of weld joint increases.

Kanaiya et.al 2017 [4] this paper gives an overall view of the orbital welding process and its equipment. This research work presented here for having an all-inclusive report on orbital welding specially uses a U type closed orbital welding head in a specific area of welding where by arc from tungsten electrode is rotated mechanically through 360° or 180° theoretically but in practically it

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rotates about 410° around static work piece. In orbital welding process parameter of GTAW like welding current, deposition rate, depth of penetration, voltage, arc length, current density, flux, tip angle, shielding gas, electrode, pulse current, standoff distance etc. are of special importance so far as the quality of weld is concerned.

Hussein et.al 2016 [5] this exploration researches the procedure properties relationship of welded tube of mild steel (MS) with unique thickness by utilizing Metal Inert Gas (MIG) orbital welding. This examination work contemplated the impacts of weld current and jigs rotational speed to the malleable properties of welding tubes. MIG welding was utilized to weld divergent diameter of MS pipes. The mechanical properties were tried utilizing Universal Tensile Machine (UTM). Design of Experiment (DoE) was utilized to plan the test just as to examine the information of analyses. It was discovered that expanding of welding current controllable properties of welded tubes increment then again expanding in jigs rotational speed diminishes the malleable properties of the welded tubes. This examination shows that welding current is the most critical boundary which influenced the tractable properties of welded mellow steel tubes by MIG orbital welding contrasted with dance rotational speed.

Karthikeyan et.al 2016 [6] This paper has presented the optimization of process parameter of Orbital Tungsten Inert Gas welding (OTIG) of stainless steel 304 L for satellite system Design of Experiment (DOE) using Taguchi method. and optimize the signal to noise ratio(output) by current, rpm and standoff distance (input). L27 Orthogonal array is used as design of experiment is followed for minimum of 27 (three parameters and three levels=3×3=27) samples for this experiment. This proposed procedure recognizes the ideal boundaries for welding and draws out the essentialness of the individual boundary, blend of any of the two boundaries (connection impact) utilizing Taguchi technique by linear regression of Signal to Noise (SN) ratio and means verses input parameters (current, rpm and standoff distance). At the point when ideal boundaries are shown up, detailed experimentations were done and further these are tested by Universal testing machine to find out the strength needed for intended application. In this study he most important parameter affecting the responses have been identified as Current over all input parameter so keeping good control over the weld current is the key action which decides the weld strength and its quality.

Singh et.al 2016 [7] presented a review of the study about the optimal process parameters for TIG welding. By the different scientific research in TIG welding to find the best parameter with help of Taguchi technique with various different process parameters (different gas, electrode diameters, different compositions of filler rods) can be taken for welding 309 stainless to study the effects of parameters on impact strength, tensile strength, hardness of weld joint residual stress heat affected zone of butt weld joint on different grove angles.

Joshi et.al 2015 [8] the fundamental ideas of the orbital welding and the historical backdrop of the orbital are depicted this paper welding. The issues identified with the orbital welding with that the answers for the issues where recommended in the paper. Still there are prerequisite of progress in this procedure identified with the nature of weld, proficiency, the efficiency, effortlessness. The review of this innovation considering every single above factor is considered in this paper. Enhancing the welding procedure improves weld quality; speeds up, and decrease scrap and revise costs. By accomplishing these objectives, the organizations can understand the lower cost per item with a decent quality and least conveyance time. The orbital welding strategy with assistance of PC programming the control on the utilization of anode, input material, and shield on can be accomplished without any problem.

Singh et.al 2015 [9] in this article the investigation is generally focused to control the weld bead shape and its metallurgical characteristics. Welding penetration can be increases by reducing the weld bead width. Depth to width ratio also increases as the expanse of reduced hardness. Activated TIG welding uses various fluxes like: Cr_2O_3, Mgo, Cao, Al_2O_3 are used to improve the performance of mild steel weld. Cr_2O_3 flux gives a higher penetration

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rate. Flux provides a developed weld quality and also increases hardness of weld structure. Flux also increases the depth to width ratio of the activated tungsten inert gas welding structure

Kumar et.al 2015 [10] This paper investigated the performance of stainless steel 304 using GTAW process by design of experiment method and optimized by L-18 orthogonal array design matrix was followed. And Taguchi`s method was used to analyze the results. Mechanical testing- Tensile testing, micro hardness testing and microstructures was carried out to check the performance of the welded joints. The output parameter depth to width ratio, tensile strength, micro hardness (VHN) optimized by various input parameter (travel speed gas flow rate, current voltage. This paper show that by using flux SiO2 changes in welding current directly changes the heat input &pattern of convection.

Ravindra et.al 2015 [11] the purpose of this paper was to optimize the welding process parameters & find out their optimized value with help of Optimization (Taguchi) method of three level and three factors was considered. ANOVA technique of Experimentalanalysis. Tensile & hardness testing of welding sample are calculated as output parameter. this paper shows the influence of welding current, arc voltage & gas flow rate (input) on tensile strength and hardness (output) of material during welding of 202 Stainless steel, Mild steel plates

Mohan et.al 2014 [12] in this thesis to improve welding quality of aluminium (Al) plate an automated TIG welding system has been developed. Welding of Al plate has performed in 2 phases (1st phase one side welding performed & 2nd phase both side welding performed on Al plate by changing the process parameter. Welding strength of weld joint depends on welding parameter. This work performed without any filler material and experimentation done using Taguchi method with three levels (welding current, voltage and welding speed) with three factor and two response tensile strength and hardness of welded pieces. L-9 orthogonal array is used for design of experiment.

Bharath et.al 2014 [13] In this examination work the ANOVA strategy is utilized to distinguish the impact of the welding speed, ebb and flow, cathode, root hole on the quality of the material and the goal of this exploration is utilized to decide the impact of different welding boundaries on the weld dot, rigidity and twisting quality of AISI 316 welded joint. It is seen that current is to be utilized is the most affecting variable to get higher elasticity and Speed is most impacting component to have most noteworthy curve quality and current, speed, root hole has some effect on the rigidity and the twisting Strength of the material.

Ravisankar et.al 2014 [14] in this article describes the temperature distribution and residual stresses for a TIG circumferential butt joint of AISI 304 from experimentation. To achieve proper weld penetration and heat effected zone an optimum heat input value is chosen. Increase in weld speed and power causes to increase temperature distribution and longitudinal and circumferential residual stress.

Kumar et.al 2014 [15] depicts the streamlining of TIG welding process boundaries like voltage, beat off time and weld speed, gas stream, current, stalemate separation, beat on an ideal opportunity to improve weld quality is done on an of treated steel 304 plate. In This paper advancement is finished utilizing Taguchi strategy is utilized to get the ideal boundaries L27 symmetrical cluster is utilized for experimentation then test esteems and the different settings of the procedure boundaries are taken care of as contribution to Taguchi and consequently the S/N proportion esteems are gotten. Weld speed and info current are seen as the hugest boundaries in TIG welding finally, the quality of the weld is approved by elastic and twisting test.

Sharma et.al 2013 [16] investigate the influence of various process parameter like welding current, gas flow rate, welding speed, in mechanical properties in stainless steel. Hardness and tensile strength are investigated in this paper. Analysis of variance (ANOVA) is used to designate the level of input parameter. Among all the process parameter effect of current is more in performance parameter

Singh et.al 2013 [17] This paper investigated influence welding parameters welding current, gas flow rate & welding speed (input) are taken into account during TIG welding of 5083 Aluminum

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alloy and found increase in weld heat energy (output) on work surface by increasing the welding current which result as increasing the front & back width (output) of weld joint linearly & decreases linearly with increase welding speed

Kim et.al 2013 [18] This paper about the orbital TIG welding of stainless-steel pipe for robot system which travels on the guide rail installed on the pipe and weld and tracks the pipe seam using the LVS (laser vision sensor) joint. This study gives a relationship b/w welding travel speed and wire feed speed with input parameter is welding speed and output is surface finish.

Satish et.al 2012 [19] The aim of this paper is welding of dissimilar metals (carbon steel and stainless steel) by GTAW process .Taguchi method is used to formulate the experimental layout to rank the welding input parameters(gas flow rate, current ,bevel angle) which affect the quality of weld and HAZ (output).Heat input for the welded specimen were calculated which influence of mechanical properties
(Hardness, tensile strength)

Neelamagam et.al 2012 [20] Activated – flux tungsten inert gas welding, a variant of TIG welding has been developed in house to increase the depth of penetration in single pass welding. Effect of welding process parameters like current, voltage and torch speed on weld bead shape like depth of penetration, bead width, heat affected zone were simulated using genetic algorithm.

III. CONCLUSION

From the literature review, it is found that welding of pipes is a big challenge by conventional arc welding process. Again, repeatability of welding depends on its control of welding speed and other processing parameters.

- TIG welding is most effective way of for Stainless steel welding dissimilar joint in now a day.
- Only few researchers have developed optimization model and simulation procedure for welding process.
- No one has attempted Optimization of process parameters using RSM Method.

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