Study and Optimization of Parameter in TIG Welding Process

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ABSTRACT : Tungsten inert gas (TIG) welding which uses a non-consumable tungsten electrode and an inert gas for arc shielding, is an extremely important arc welding process. Argon is used as shielding gas.To improve welding quality of SS 304 plate an TIG welding system has been used , by which welding speed can be control during welding process. Welding of SS 304 plate has been performed in One phases. During single side welding performed over SS 304 plate by changing different welding parameters. Effect of welding speed and welding current on the tensile strength of the weld joint has been investigated for weld joint.Optical microscopic analysis has been done on the weld zone to evaluate the effect of welding parameters on welding quality. Hardness value of the welded zone has been measured at the Tensile test of the welded zone.

Keywords:-welding process,TIG welding,MIG welding,hardness,tensilestrength

I. Introduction

Welding is a permanent joining process used to join different materials like metals, alloys or plastics, together at their contacting surfaces by application of heat and or pressure.During welding, the work-pieces to be joined is melted at the interface and after solidification a permanent joint can be achieved. Sometimes a filler material is added to form a weld pool of molten material which after solidification gives a strong bond between the materials. Weld ability of a material depends on different factors like the metallurgical changes that occur during welding, changes in hardness in weld zone due to rapid solidification, extent of oxidation due to reaction of materials with atmospheric oxygen and tendency of crack formation in the joint position.

Principle of TIG Welding Process

TIG welding is an arc attachment method that uses a non-consumable metal electrode to produce the weld. The weld space is protected against atmosphere by an inert shielding gas (argon or helium), and a filler metal is generally used. the ability is provided from the power source (rectifier), through a hand-piece or welding torch and is delivered to a tungsten electrode that is fitted into the hand piece. an electrical arc is then created between the tungsten electrode and also the work piece employing a constant-current welding power offer that produces energy and conducted across the arc through a column of extremely ionized gas and metal vapours [1]. The metal electrode and also the welding zone ar protected against the surrounding air by inert gas. the electrical arc will turn out temperatures of up to twenty,000oC and this heat are often targeted to melt and be a part of 2 completely different part of material. The weld pool are often used to be a part of the base metal with or while not filler material. Schematic diagram of TIG fastening and mechanism of TIG welding ar shown in fig. one & fig. a pair of severally.

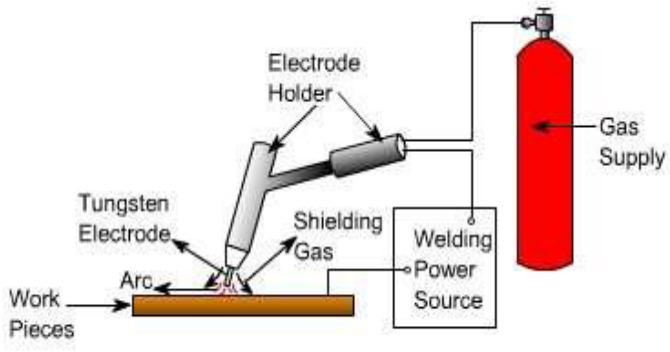

Figure 1: Schematic Diagram of TIG Welding System

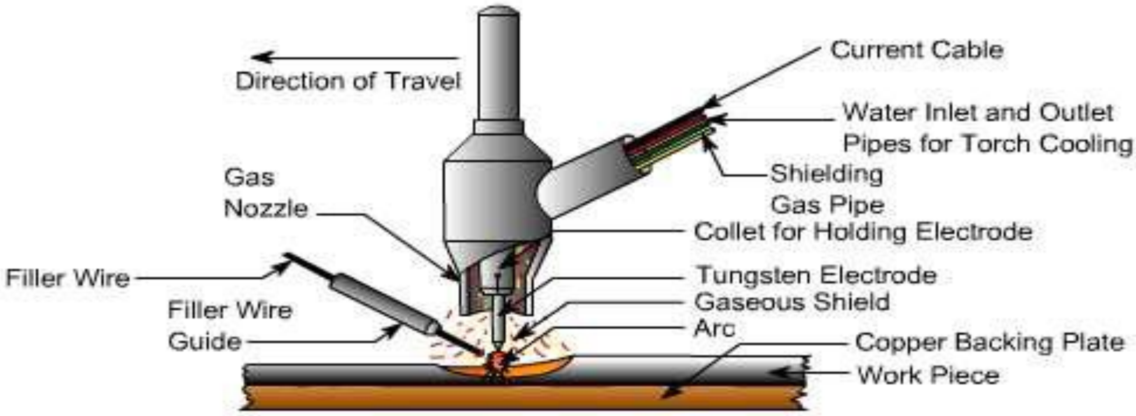

Figure 2: Principle of TIG Welding.

Tungsten electrodes are usually on the market from zero.5 mm to 6.4-millimetre diameter and 150 - 200 mm in length. the current carrying capability of every size of the electrode depends on whether or not it's connected to the negative or positive terminal of DC power supply. The power supply needed to keep up the TIG arc contains a drooping or constant current characteristic that provides a primarily constant current output once the arc length is varied over many millimetres. Hence, the natural variations within the arc length that occur in manual welding have very little impact on welding current. The capability to limit the current to the set value is equally crucial once the electrode is briefly circuited to the workpiece, otherwise excessively high current can flow, damaging the electrode. open circuit voltage of power source ranges from sixty to eighty V.

II. Advantages of TIG welding

TIG welding process has specific advantages over other arc welding process as follows -

i. Narrow concentrated arc
ii. Able to weld ferrous and non-ferrous metals
iii. Does not use flux or leave any slag (shielding gas is used to protect the weld-pool and tungsten electrode)
iv. No spatter and fumes during TIG welding

III. Applications of TIG Welding

The TIG welding method is best fitted to the metal plate of thickness around 5- 6 millimetre. The thicker material plate may also be welded by TIG using multi passes which end in high heat inputs and resulting in distortion and reduction in mechanical properties of the base metal. In TIG attachment top quality welds are often achieved because of the high degree of control in heat input and filler additions individually. TIG welding is often performed in all positions and also the method is helpful for tube and pipe joint. The TIG welding could be a highly manageable and clean method needs little or no finishing or typically no finishing. This welding method is often used for each manual and automatic operations. The TIG welding method is extensively utilized in the supposed high-tech industry applications like

I. Nuclear ind
II. Aircraft
III. Food processing ind
IV. Maintenance and repair work
V. Precision manufacturing ind
VI. Automobile ind

IV. Literature Review

[1] Sanjeev kumar et. al attempted to explore the possibility for welding of higher thickness plates by TIG welding. Aluminium Plates (3-5mm thickness) were welded by Pulsed Tungsten Inert Gas Welding process with welding current in the range 48-112 A and gas flow rate 7 -15 l/min. Shear strength of weld metal (73MPa) was found less than parent metal (85 MPa). From the analysis of photomicrograph of welded specimen it has been found that,weld deposits are form co-axial dendrite micro-structure towards the fusion line and tensile fracture occur near to fusion line of weld deposit.

[2] Sathiya Paulraj Investigated Taguchi L9 array with grey relational analysis hasbeen used to optimize the multiple performance characteristics such as ultimate tensile strength and yield strength (room temperature,750 °C) and impact toughness. An optimum combination of three test parameters of grey relational grade for quality weld joints was found to be welding current of 110 A, voltage of 12V and welding speed of 1.5 mm/s. Based on the ANOVA results of GRG, it was observed that the welding current (58%) exerted a significant influence on multiple responses followed by welding speed (30%) and voltage (12%). The mechanical properties were correlated with the metallurgical characteristics.

[3] Akhilesh Kumar Singh investigated methods used to increase the penetration of weld penetration as well as improvement in TIG welding process has been described properly. According to literature review, Most of the experimental studies are reviewed to improve TIG welding process and their mechanical properties.ATIG(Activated flux TIG) welding achieves significant improvement in penetration compared to conventional TIG. Flux used in the process probably make arc narrow in the molten weld pool and thus reduce the weld bead width by half compared to that ofconventional TIG welding and thereby increase the weld penetration.FBTIG (Flux Bounded TIG) welding also generatesfull penetration. The drawback of this process is that if distance between the flux paints on top of the plates across the weld joint increase, then the weld penetration decreases vice-versa.

[4] Srinivasa Reddy Vempati investigated The present work is able to establish a best combination of parameters for output response and results variation is small from desired value. Confirmation experiment was also conducted and the efficiency of Taguchi optimization method was verified. The experimental value of ultimate tensile strength that is observed from optimal level of welding parameters as 1040 N/mm2 and the improvement in S/N ratio is 0.957. It is observed that welding parameters like current, voltage are considerably significant on tensile strength Where as travel speed or welding speed as insignificant effect.

[5] Sreehari R. Nair investigated the ATIG welding process parameters were optimized for ASTM/UNS S32205 DSS joints to obtain desirable aspect ratio, and the results were analysed in detail.We can draw the following conclusions. The electrode gap is the predominant factor that affects the aspect ratio of DSS welds fabricated using ATIG welding process. The optimum welding parameters are found to be electrode gap of 1 mm, travel speed of 130 mm/min, current of 140 A, and voltage of 12 V. The confirmation experimental results for aspect ratio is in good agreement with the data analyzed by the Taguchi method. The aspect ratio is found to be 1.24 for the joints fabricated using the optimized process parameters and is well within the acceptable range to avoid solidification cracking.

[6] K. Anand invesigated this study, an artificial neural network for friction welding of Incoloy 800H has been optimized through a proper selection of the training algorithm. Different ANNs, trained with standard or incremental back propagation(IBP), batch back propagation (BBP), quick propagation (QP),Levenberg Marquardt back propagation (LM) and Genetic Algorithm(GANN), have been evaluated with respect to their predictive ability. A robust comparison of the performances of the above five algorithms was made employing standard statistical indices.Artificial neural network models were used to establish the input
output relationships and optimization of input parameters of this process. The friction welding of the Incoloy 800H, its input output modelling were carried out successfully in both forward & reverse directions, and optimization of process parameters were carried out successfully.

[7] Dongjie Li performed Weld pool shape variations under two different TIG welding methods were investigated on a ZG0Cr13Ni5Mo martensite stainless plate. The effects of welding parameters (speed, arc length and current) on weld pool shape are discussed under both the doubleshielded TIG and traditional TIG processes. Two typical weld pool shapes, wide-shallow and narrow-deep,were investigated with respect to the mechanism of formation.
Marangoni convection was considered to be the main factor controlling fluid flow in the liquid pool. Inward Marangoni convection eads the heat flux to transfer from the edges of the weld pool to the centre and form a deep and narrow weld pool shape.

[8] Bolarinwa Johnson Kutelu performed Welding parameters have influence on the mechanical properties (tensile,hardness, impact) of GTA welded joints; Corrosion behaviours of GTA welded joints are influenced by welding parameters in varied degrees; High quality GTA welded joint depends primarily on optimized welding parameters arrangement. Better economy, improved efficiency and high profitability are some notable derivable advantages obtainable through proper welding input parameters selection.

[9] Indira Rani et. al investigated the mechanical properties of the weldments of AA6351 during the GTAW /TIG welding with non-pulsed and pulsed current at different frequencies. Welding was performed with current 70-74 A, arc travel speed 700-760 mm/min, and pulse frequency 3 and 7 Hz. From the experimental results it was concluded that the tensile strength and YS of the weldments is closer to base metal. Failure location of weldments occurred at HAZ and from this we said that weldments have better weld joint strength.

[10] Ahmed Khalid Hussain et. al investigated the effect of welding speed on tensile strength of the welded joint by TIG welding process of AA6351 Aluminium alloy of 4 mm thickness. The strength of the welded joint was tested by a universal tensile testing machine. Welding was done on specimens of single v butt joint with welding speed of 1800 -7200 mm/min.From the experimental results it was revealed that strength of the weld zone is less than base metal and tensile strength increases with reduction of welding speed.

[11] Tseng et. Al investigated the effect of activated TIG process on weld morphology, angular distortion, delta ferrite content and hardness of 316 L stainless steel by using different flux like TiO_2, MnO_2, MoO_3, SiO_2 and Al_2O_3. To join 6 mm thick plate author uses welding current 200 Amp, welding speed 150 mm/min and gas flow rate 10 l/min. From the experimental results it was found that the use of SiO_2 flux improve the joint penetration, but Al_2O_3 flux deteriorate the weld depth and bead width compared with conventional TIG process.

[12] Narang et. al performed TIG welding of structural steel plates of different thickness with welding current in the range of 55 - 95 A, and welding speed of 15-45 mm/sec. To predict the weldment macrostructure zones, weld bead reinforcement, penetration and shape profile characteristics along with the shape of the heat affected zone (HAZ), fuzzy logic based simulation of TIG welding process has been done.

[13] Karunakaran et. al performed TIG welding of AISI 304L stainless steel and compare the weld bead profiles for constant current and pulsed current setting. Effect of welding current on tensile strength, hardness profiles, microstructure and residual stress distribution of welding zone of steel samples were reported. For the experimentation welding current of 100-180 A, welding speed 118.44 mm/min, pulse frequency 6 Hz have been considered. Lower magnitude of residual stress was found in pulsed current compared to constant current welding. Tensile and hardness properties of the joints enhanced due to formation of finer grains and breaking of dendrites for the use of pulsed current.

[14] Raveendra et. Al done experiment to see the effect of pulsed current on the characteristics of weldments by GTAW. To weld 3 mm thick 304 stainless steel welding current 80-83 A and arc travel speed 700-1230 mm/min. More hardness found in the HAZ zone of all the weldments may be due to grain refinement. Higher tensile strength found in the non-pulsed current weldments. It was observed that UTS and YS value of non-pulsed current were more than the parent metal and pulsed current weldments.

[15] Sakthivel et.al Studied creep rupture behaviour of 3 mm thick 316L austenitic stainless steel weld joints fabricated by single pass activated TIG and multi-pass conventional TIG welding processes. Welding was done by using current in the range of 160-280 A, and welding speed of 80-120 mm/min. Experimental result shows that weld joints possessed lower creep rupture life than the base metal. It was also found that, single pass activated TIG welding process increases the creep rupture life of the steel weld joint over the multi-pass TIG weld joints.

[16] Norman et. al investigated the microstructures of autogenous TIG welded Al-Mg-Cu-Mn alloy for a wide range of welding conditions. Welding was done with current in the range 100-190 A and welding speed 420 1500 mm/min. The fine microstructure was observed at the centre of the weld which was form due to higher cooling rate at the weld centre compared to the fusion boundary. It was observed that as the welding speed increases, the cooling rate at the centre of the weld also increases, producing smaller size dendrite structure.

[17] Song et. al successfully joined dissimilar metals of 5A06 Al alloy and AISI 321 stainless steel of thickness 3 mm by TIG welding-brazing with different filler materials. TIG welding– brazing was carried out by AC-TIG welding source with welding current 135 A, arc length 3.0–4.0mm, welding speed 120 mm/min and argon gas flow rate 8–10 lit/min. It was found hat addition of Si preventing the build-up of the IMC layer, minimising its thickness. The author also investigated (Song et. al 2009) spreading behaviour of filler metal on the groove surface and microstructure characteristics for butt joint. For the experimentation welding current in the range of 90-170 A and welding speed in the range of 100-220 mm/min, were used for 2 mm thick plate.

[18] Wang et. al studied the influences of process parameters of TIG arc welding on the microstructure, tensile property and fracture of welded joints of Ni-base super-alloy. For welding plate width of 1.2-1.5 mm, welding current in the range of 55-90 A, with variable welding speed in the range 2100-2900 mm/min was used. From experimental result it was observed that, the heat input increases with increase of welding current and decrease of welding speed.

[19] Kumar and Sundarrajan performed pulsed TIG welding of 2.14 mm AA5456 Al alloy using welding current (40-90) A, welding speed (210-230) mm/min. Taguchi method was employed to optimize the pulsed TIG welding process parameters for increasing the mechanical properties and a Regression models were developed. Microstructures of all the welds were studied and correlated with the mechanical properties. 10-15% improvement in mechanical properties was observed after planishing due to or redistribution of internal stresses in the weld.

[20] Preston et.al developed a finite element model to predict the evolution of residual stress and distortion dependence on the yield stress-temp for 3.2 mm 2024 Al alloy by TIG welding.

[21] Akbar Mousavi et.al analysed the effect of geometry configurations on the residual stress distributions in TIG weld from predicted data and compared it with data obtained by Xray diffraction method. Attempts were made to analyse the residual stresses produced in the TIG welding process using 2D and 3D finite element analysis. For welding of 10 mm thick 304 grade stainless steel welding current in the range 80-225 A, voltage 15 V, and welding velocity in the range of 90-192 mm/min were employed.

[22] Ahmet durgutlu et.al investigated the effect of hydrogen in argon as shielding gas for TIG welding of 316L austenitic stainless steel. They used current 115 A, welding speed 100 mm/min and gas flow rate 10 l/min for welding of 4 mm thick plate. For all shielding media,hardness of weld metal is lower than that of HAZ and base metal. Penetration depth, weld bead width and mean grain size in the weld metal increases with increasing hydrogen content.The highest tensile strength was obtained for the sample welded under shielding gas of 1.5%H_2–Ar.

[23] Wang Rui et. al investigated the effect of process parameters i.e. plate thickness, welding heat input on distortion of Al alloy 5A12 during TIG welding. For welding they used current (60-100) A, welding speed (800-1400) mm/min and thickness of w/p (2.5-6) mm. The results show that the plate thickness and welding heat input have great effect on the dynamic process and residual distortion of out-of-plane.

[24] Dongjie Li et.al proposed a double-shielded TIG method to improve weld penetration and compared with the traditional TIG welding method under different welding parameters i.e welding speed, arc length and current. They used gas flow rate 10 l/min, welding speed (90-300) mm/min, current (100-200) A and thickness of w/p 10 mm. The results show that the changes in the welding parameters directly impact the oxygen concentration in the weld pool and the temperature distribution on the pool surface.

V. Conclusion

Based on what has been discussed in this study, it can be concluded that the selection of the parameters is a key factor in producing the optimal surface roughness of weld bead.The accurate selection of parameters is also very important in the success. Variable parameters such as ampere, travel speed and filler rod feed rate are major factors in producing the best welding surface, Parameters such as current, CFH, arc gap and other parameters must be taken as a constant parameter when setup is done based on the type and dimensions of the work piece. The next chapter will explain in detail how the project research work was conducted.

VI. ACKNOWLEDGMENT

I express my cavernous sense of obligation and gratitude to my guide Prof.Nilam S Patel and Prof.Varun H. Patel for his genuine guidance and constant encouragement throughout this projectwork. I am highly obliged as my honourable guide have devoted his valuable time and sharedhis expertise knowledge. I am thankful to our Head of Department, Department of Mechanical Engineering and Principal, Ipcowala Institute of Engineering & Technology, Dharmaj for providing me such an opportunity to do my project work. I pay my profound gratefulness to the Mechcrop Private Limited for their support for raw material, cutting of plates, tool manufacturing, tool, Instrument respectively. Further I am thankful to my friends, particularly, Viral Patel, Krunal Patel, Daxesh Padya and MineshVaghela for their continuous support during my project work.At last but not in the least, I pay my sincere thanks to my family for their financial support through my dissertation work.

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