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Review of TIG Welding Process Parameters

Lalit Narwar[1], Dr. K K Jain[2]

[1]*M.E Student, NITTTR Bhopal – 462002, INDIA*

[2]*Associate Professor, Department of Mechanical Engineering, NITTTR Bhopal – 462002, INDIA*

Abstract-- **Tungsten Inert Gas Welding performance is generally evaluated on the basis of Tensile Strength, Bead Geometry, Depth of Penetration, Aspect Ratio (Width–to-Depth Ratio) and Hardness. The important TIG machining parameters affecting to the performance measures of the process are voltage, current, welding speed, shielding gas flow rate, electrode gap, root gap and filler materials . A considerable amount of work has been reported by the researchers on the measurement of TIG performance on the basis of Tensile Strength, Bead Geometry, Depth of Penetration, Aspect Ratio and Hardness for various materials. A number of approaches are proposed in the literature to solve the problems related with optimization of these parameters. It is felt that a review of the a variety of approaches developed would help to compare their main features and their relative advantages or restrictions to allow choose the most suitable approach for a particular application and also throw light on aspects that needs further consideration. In view of above, this paper presents a review of development happened in optimization of TIG welding related process parameters.**

Keywords-- **TIG Welding, Voltage, Current, Welding speed, Electrode gap, Root gap, Shielding gas flow rate, Tensile Strength, Depth of penetration, Aspect Ratio**

I. INTRODUCTION

Welding technology is used in every branch of manufacturing. To consistently produce high quality welds, arc welding requires experienced welding personnel to avoid distortion. In TIG quality of a weld depends on welding input parameters. Optimum ranges of welding parameters are required for better economy and for improving efficiency and profitability. This can be achieved by conducting experiments and mounting the mathematical relationships between input and output process parameters. The problem that has been faced by the industry is to control the process input parameters for obtaining a good welded joint with required weld quality. Initially to study the weld input parameters for welded joint with the required quality a time-consuming trial and error method is required. Then welds are examined whether they meet the requirement or not. Finally the weld parameters can be chosen to produce a welded joint that strongly meets the joint qualities.

Also, what is not achieved or often considered is an optimized welding parameters arrangement, since welds can often be formed with very different parameters. In other words, there is frequently a more ideal welding input parameters combination, which can be used.

GTAW is also called as Tungsten Inert gas Welding (TIG) is an arc welding process, wherein coalescence is produced by heating the work piece with an electrical arc struck among a tungsten electrode and the job. The electrical discharge generates a plasma arc stuck between the electrode tip and the work piece to be welded. The arc is normally initialized by a power source with a high frequency producer. This produces a small spark that provides the initial conducting path through the air for the small voltage welding current. The arc generates high-temperature of approximately 6100 C and melts the surface of base metal to structure a molten pool. A welding gas (argon, helium, nitrogen etc) is used to avoid atmospheric contamination of the molten weld puddle. The shielding gas displaces the air and avoids the contact of oxygen and the nitrogen with the molten metal or hot tungsten electrode. As the molten metal cools, coalescence occurs and the parts are joined. The resulting weld is smooth and requires minimum finishing. To get best welding parameters for a particular metal combination optimization is required.

II. EXISTING RESEARCH EFFORTS

S.C Juang, et.al [1], considered quality attributes of weld pool geometry in the choice of procedure parameters, the altered Taguchi system is embraced to break down the impact of every welding procedure parameter on the weld pool geometry, and afterward to decide the procedure parameters with the ideal weld pool geometry. Trial results are given to represent the proposed approach.

C.V. Gonçalves, et.al [2] displayed an examination between two systems to study warm wonder that happens in the base metal amid welding operations. The procedures consolidate streamlining systems, for example, the mimicked strengthening (SA) and gold area, in two diverse physical models.

The main warm model considers a semi stationary warmth conduction in the inside plate, while the second one uses the general transient mathematical statement of warmth dispersion with stage change. In both cases, the warmth flux produced by the welding procedure is assessed, and, starting here, worldwide warm productivity and combination proficiency are likewise evaluated. Additionally, the utilization of the SA system with the numerical model permits the weld pool geometry distinguishing proof.

Parikshit Dutta, et.al [3], did traditional relapse examination on some test information of a tungsten inactive gas (TIG) welding procedure to discover its input–output connections. One thousand preparing information for neural systems were made aimlessly, by shifting the data variables inside of their separate extents and the reactions were computed for every blend of data variables by utilizing the reaction comparisons got through the above routine relapse examination. The exhibitions of the customary relapse examination approach, a back-proliferation neural system (BPNN) and a hereditary neural framework (GA-NN) were looked at on some arbitrarily created experiments (exploratory), which are not quite the same as the preparation cases.

T. Senthil Kumar, et.al [4], describes the influence of pulsed current TIG welding parameters on tensile properties of AA 6061 aluminium alloy weldments. . In the case of single pass TIG welding of thinner section of this alloy, the pulsed current has been found beneficial due to its advantages over the conventional continuous current process. The use of pulsed current parameters has been found to improve the mechanical properties of the welds compared to those of continuous current welds of this alloy due to grain refinement occurring in the fusion zone.

M. Balasubramanian, et.al [5], created scientific models to anticipate grain size and hardness of argon tungsten beat current bend welded titanium composite weldments. Four elements, five level, focal composite, rotatable outline grid is utilized to improve the required number of investigations. The numerical models were created by reaction surface technique (RSM). The sufficiency of the models was checked by ANOVA system. By utilizing the created scientific models, grain size and hardness of the joints can be anticipated with 99% certainty level.

S. Mishra, et.al [6], report an experimental and modeling investigation of gas tungsten arc butt welding of stainless steel plates containing different sulfur concentrations. The main variables studied were sulfur concentrations in the two plates, welding current and welding speed. The results show significant shift of the fusion zone toward the low sulfur steel.

The asymmetric fusion zone profile with respect to the original joint interface could be quantitatively explained through numerical modeling of heat transfer and fluid flow considering a bead shift observed experimentally.

A.Kumar, et.al [7], depicted the change of mechanical properties of AA 5456 Aluminum amalgam welds through beat tungsten idle gas (TIG) welding procedure. Taguchi strategy was utilized to streamline the beat TIG welding procedure parameters of AA 5456 Aluminum composite welds for expanding the mechanical properties. Examination of change was utilized to check the ampleness of the created models. Microstructures of the considerable number of welds were concentrated on and corresponded with the mechanical properties.

D.S. Nagesh, et.al [8], clarified an incorporated strategy with another methodology utilizing test outline lattice of test plans system on the exploratory information accessible from ordinary experimentation, use of neural system for foreseeing the weld globule geometric descriptors and utilization of hereditary calculation for advancement of procedure parameters. An endeavor has been made to foresee the dot shape parameters utilizing back-engendering neural system. To improve the procedure parameters for the fancied front tallness to front width proportion and back stature to back width proportion, hereditary algorithmic methodology has been connected.

Cristiene Vasconcelos Gonçalves, et.al [9], describes a technique used to estimate the heat flux is based on solution of an inverse three-dimensional transient heat conduction model with moving heat sources. The thermal fields at any region of the plate or at any instant are determined from the estimation of the heat rate delivered to the workpiece. The direct problem is solved by an implicit finite difference method. The system of linear algebraic equations is solved by Successive Over Relaxation method (SOR) and the inverse problem is solved using the Golden Section technique. The golden section technique minimizes an error square function based on the difference of theoretical and experimental temperature. The temperature measurements are obtained using thermocouples at accessible regions of the workpiece surface while the theoretical temperatures are calculated from the 3D transient thermal model.

Jing-Shiang Shih, et.al [10], discribed Principal component analysis (PCA) coupled with Taguchi methods for multiple quality characteristics optimization of metal inert gas (MIG) arc welding aluminum foam plates. The quality characteristics investigated are the micro-hardness and the bending strength of the weldments.

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Eight control factors selected are the type of filler material, MIG current, welding speed, MIG gas flow rate, workpiece gap, MIG arcing angle, groove angle, and electrode extension length.

M. Aghakhani, et.al [11], used Taguchi's method of design of experiments a mathematical model was developed using parameters such as, wire feed rate (W), welding voltage (V), nozzle-to-plate distance (N), welding speed (S) and gas flow rate (G) on weld dilution. After collecting data, signal-to-noise ratios (S/N) were calculated and used in order to obtain the most favorable levels for every input parameter. Subsequently, using analysis of variation the significant coefficients for each input factor on the weld dilution were determined and validated. Finally a mathematical model based on regression analysis for predicting the weld dilution was obtained. Results shows that wire feed rate (W) , arc voltage (V) have increasing effect while nozzle-to-plate distance (N) and welding speed (S) have decreasing consequence on the dilution whereas gas Flow rate alone has almost no effect on dilution but its interaction with other parameters makes it quite important in increasing the weld dilution.

A. Razal Rose, et.al [12], set up an exact relationship to foresee rigidity of the PCTIG welded AZ61A magnesium amalgam by joining procedure parameters, for example, beat present, base current, beat recurrence and heartbeat on time. Measurable apparatuses, for example, configuration of trials, examination of fluctuation, and relapse investigation are utilized to add to the connections. The created observational relationship can be viably used to anticipate the elasticity of PCTIG welded AZ61A magnesium compound joints at the 95% certainty level. The outcomes show that the beat current has the best impact on elasticity, trailed by beat on time, beat recurrence and base current.

Fei Liu, et.al [13], Gas tungsten arc butt welding of Mg–Al filling with Zn filler metal without and with Al foils in different thicknesses was carried out. Additional Al element was introduced into the fusion zone to accurately adapt microstructure and composition of the welding seam. Microstructures and mechanical properties of the welded joints were examined. Results show that the addition of appropriate quantity of Al element increases the substance of Al-based solid solution in the fusion zone near the Mg base metal. The solid solution can remove the stress concentration and hinder crack propagation, so the tensile strengths of the joints are improved. However, the flattering quantity of Al element will lead to the formation of partially Al-rich zones and deteriorate the mechanical property of the joints.

V. Subravel, et.al [14], studied the effect of welding speed on tensile and microstructural characteristics of pulsed current gas tungsten arc welded (PCGTAW) AZ31B magnesium alloy joints. Five joints were fabricated using different levels of welding speeds (105-145 mm/min). It was found that the joints fabricated using a welding speed of 135 mm/min yielded superior tensile properties compared to other joints. The formation of fine grains and uniformly distributed precipitates in the fusion zone are the main reasons for the superior tensile properties of these joints.

A. Ravisankar, et.al [15], evaluated the temperature distribution and residual stresses for a GTAW circumferential butt joint of AISI 304 stainless steel using numerical simulation. For evaluation of weld induced residual stresses, the analysis of heat source fitting was carried out with heat inputs ranging from 200 to 500 J/mm to arrive at optimal heat input for obtaining proper weld penetration and heat affected zone (HAZ). For this chosen heat input, the influence of different weld speeds and powers on the temperature distribution and the residual stresses is studied. The heat source analysis revealed the best choice of heat input as 300 J/mm. The residual stresses on the inner and outer surfaces, and along the radial direction were computed. Increase in temperature distribution as well as longitudinal and circumferential residual stresses was observed with the increase in weld speed and power. The validity of the results obtained from numerical simulation is demonstrated with full scale shop floor welding experiments.

III. CONCLUSION

In the present work, various optimization techniques used for TIG process parameters are studied and effects of these parameters on the output parameters have been reviewed. The aim of this work is to study the output of various conventional and nonconventional optimization techniques on TIG welding process so as to allow choose the most suitable approach for a particular application. The summary of research work performed shows that conventional techniques like Taguchi , ANOVA, RSM and nonconventional techniques like ANN, GA, simulated annealing are successfully used in optimization of TIG process parameters for Stainless steel, carbon steel, magnesium alloy, Aluminum alloy, Titanium Alloy etc. The above observations can be utilized as a guideline document for further research in carrying out optimization of TIG welding parameters.

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