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A Review on optimization of TIG welding process parameters using different method

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ABSTRACT

Over the past 25 years tungsten inert gas welding (TIG) has been widely used for fabrication and joint performance for its qualities such as it helps in better control of the weld. The weld produced by this welding resist corrosion, providing greater visibility during welding operations. TIG welding is often considered the strongest weld for reducing smoke and fume emissions because it generates extreme heat and its slow cooling rate results in high tensile strength and ductility. The impact of the ideal welding current, welding voltage, feed rate, gas flow rate, welding speed, etc. on variables like weld strength and weld pool is illustrated in this study. Tensile strength, DOP, and weld microstructure on various materials utilising various techniques. The optimal settings can be found for the desired quality through parameter optimization.

KEYWORDS: TIG Welding, Taguchi Method, RSM, GRA, ANOVA and Optimization

I. INTRODUCTION

Welding of new materials and components with higher thickness is considered a very important task nowadays in the manufacturing sector. However, the more modern welding techniques like TIG, MIG, PAW, EBW, and LBW have been developed by scientists because the gas flame welding that was once widely employed is no longer producing good results. There are many different welding techniques in that tungsten inert gas (TIG) welding is one of the most important for joining any material. Among these many different welding techniques, Tungsten Inert Gas (TIG) welding is considered to be by far the most important welding technique for joining any material. A non-consumable tungsten electrode, filler material, and inert gas shielding are used to combine metals in the fabrication technique known as tig welding. It is also known as tungsten arc/inert gas welding. It is one of the welding industry's most efficient metal fusing methods.

1. Working principle of TIG welding

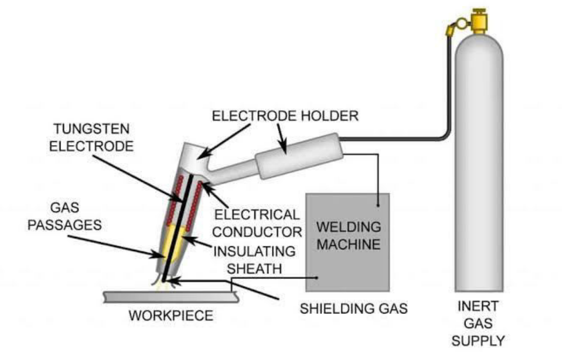

Fig.1 TIG Welding Setup

As per shown in above fig. 1, an arc is created between the workpiece that needs to be joined and the non-consumable tungsten electrode. By using filler metal, the extreme heat produced by the arc that results in melting of two metal pieces and fuse them together to make a strong weld. In order to protect the weld from air contamination, a shielding gas environment is used. The welding torch is coupled to a constant current welding power supply and a shielding gas source during the TIG welding procedure. To shield the weld from ambient impurities, a shielding gas (He or Ar.) is utilised. Shielding gas begins to spread towards the weld location as the arc is created, preventing the weld from mixing with ambient air and becoming contaminated.

2. Application of TIG welding

i. Tig welding is used in a wide range of industries to produce or repair metallic goods because of its extensive use with various metals and alloys.

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ii.Due to its excellent precision &strength, it is wid ely employed in numerous industries, including the sheet metal and aviation industries.

iii.This skill is frequently used in the automotive sector to prevent the rusting of important car components.

iv.The best welding method for producing &mainta ining packaging and equipment composedof stainle ss steel has been proven to be TIG welding.

3. TIG welding processes parameters

To achieve a defect free weld, process parameter influence is crucial.
In TIG welding, control variables are used to regulate the weld quality. TIG welding parameters such as current polarity, welding curren t, filler diameter, welding speed, shielding gas, mat erial thickness, welding voltage, weld shape, and ot hers have an impact on the overall weld quality.

i. Welding current

One of the most important parameters is weldingcu rrent. It affects the geometry of the weldments, the depth of fusion, and the rate of electrode burn off. The required current is determined by a number of variables, including the thickness of the material, the size, type, welding position and joint design.

ii. Shielding gas

It acts as a contaminant-prevention and protective gas for the atmosphere. The TIG welding procedure additionally improves weld quality because it is frequently carried out in a shielding gas environment. The distortion, residual stresses, heat affected zone (HAZ) and mechanical properties of the material to be welded are all strongly influenced by the shielding gas flow rate. The welded joint's bead geometry changes as gas flow increases, and this has a major impact on weld parameters including weld height and weld bead.

iii. Welding voltage

The shape of the fusion zone and weld reinforcement are determined by the welding voltage. It influences the microstructure and even the operation's success or failure. Welding voltage affects bead shape and weld deposit composition similarly to welding current. In accordance with the research report, higher arc voltages cause a lengthy arc length and a correspondingly wider, flatter bead with less penetration, whereas lower voltages cause a shorter arc length and a greater penetration.

iv. Welding Speed

It varies depending on bead width and weld penetration. Maximum weld penetration can be achieved only at a certain welding speed and becomes smaller as the speed increases.

v. Weld geometry

It is utilised for the selecting welding process. Different joints, such the butt, lap, fillet, or T-joint, are possible. A single-V, double-V, or U-shaped bevel is possible. Weld quality is directly impacted by weld geometry. Different welding positions, including flat, horizontal, vertical, or overhead, are possible. The most popular welding positions are vertical and horizontal. It becomes more difficult to achieve the appropriate weld quality if the welding position is challenging.

vi. Material thickness

Setting parameters and choosing a technique depend heavily on material thickness. The amount of heat input required and the rate of cooling are determined by the material thickness. Higher thickness results in faster cooling, which increases the heat affected zone (HAZ) and metal weld hardness.

II. LITERATURE REVIEW

Rishi Kumar et.al. conducted studies and presents the effects of welding parameters on ultimate tensile strength, including welding current, shielding gas flow rate, and current polarity, among others. Through the use of Response Surface Methodology, the parameters are optimised. To comprehend how input parameters affect the final tensile strength of the weldment an ANOVA analysis was performed. The author discovered that RSM is a useful tool for ANOVA analysis. Weldments are produced using the RSM mathematical model, which illustrates the link a parameter between the input and the output. [1]

Akash. B. Patel1 et.al. investigated the impact of each TIG welding parameter on the joint strength

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of the weld and then used the Taguchi method using L9 orthogonal array to identify the ideal parameters. Investigating the impact of activating flux on the mechanical characteristics of TIG-welded 321austenitic stainless steel was done using SiO2 and TiO2 oxide particles. According to the experimental findings, activating flux assisted TIG welding boosted weld penetration while tending to narrow the weld bead. The most observable effect was created by the SiO2 flow. Additionally, the welded junction had greater hardness and tensile strength. [2]

Parikshit Dutta et.al. investigate input-output linkages in the TIG welding process and conducted analysis based on complete factorial design of experiments (DOE) and two neural network-based methodologies (i.e., back-propagation algorithm and genetic-neural system). After evaluating the performance of the aforementioned methodologies on 36 randomly generated test cases, comparisons were made. From the aforementioned analysis, the authors deduce that the characteristics of the deviation function affected how well both BP-NN and GA-NN techniques performed. [3]

CHANDRESH. N. PATEL et.al. prepared all welds by using the MIG and TIG welding techniques. For this work, the author examined the Design of Experiment (Full Factorial) approach and used the experimental data to optimise using the grey relational analysis (GRA) technique. The analysis of variance (ANOVA) method and the grey relational analysis (GRA) optimization approach were employed by the author to determine the percentage contribution of each input parameter to achieving ideal conditions. He discovered through analysis that the most important parameter for MIG and TIG welding is the welding current. [4]

Sanjay Kumar et.al. research how to optimise the TIG joining technique's procedure parameters. As a base metal, the author chose AISI 304 materials. The total number of trials was 27, and they were created using the MINITAB-17 programme and the Taguchi L27 orthogonal array with four factors and three levels. He deduced from his research that the final weld quality is checked by the tensile strength test. [5]

M. Ravichandran et.al. presents experimental and numerical findings from TIG welding AA606. Four levels of parameters were used in the experimental testing, which used an L16 orthogonal array. ANOVA and Signal-to-Noise (SN) ratio were utilised by the author to assess the effectiveness of the experiment. The findings show that, the gas flow rate is the significant parameter on impact strength of weld joints, followed by welding speed and welding current. [6]

S. Kannan et.al. studied Tungsten inert gas (TIG) welding to join the disparate pieces. Using a zirconated tungsten electrode and the filler metal aluminium ER 2219, the mechanical and metallurgical characteristics of a tube-to-tube plate composed of commercial aluminium and Al 2025, respectively, are verified. The most significant process parameter that affects joint strength was identified by the author using a Taguchi L25 orthogonal array, and the percentage of contribution for each process parameter was calculated using an ANOVA approach to test both compression strength and hardness. He discovered that the welded sample's ideal joint strength was around 174.84 MPa and 131.36 Hv, respectively. [7]

III. DESIGN OF EXPERIMENT (DOE)

The wellbuilt statistical method of design of experiments
introduced by Ronald A. Fisher in the1920s, allows researchers to simultaneously
examine the effects of many different variables.
DoE approach is used in an experiment to find theo ptimal combination out of all potential combinations. Numerous components and their corresponding amounts are identified for this.
In order to determine the ideal level for that combination of factors to provide the intended practical output in products, it is essential to know which combination of variables in a process influences performance most.
Comparison of Variance To determine how each process variable will affect the response parameter, an ANOVA is utilised.
For ANOVA and DOE,"MINITAB" and "Design Expert" software are primarily utilised.
The relationship between the
input and output variables in the welding process is formed using a mathematical model. The impact of process factors on TIG welding have mostly been studied and optimised using the DoE methodologies listed below:

a.) Response Surface Methodology

b.) Taguchi Orthogonal Array

c.) Full Factorial technique

d.) Fractional Factorial technique

IV. CONCLUSION

1)According to this review of the literature, welding speed and voltage may have an impact on welding, but current is thec haracteristic that affects TIG welding the most.

2)There are many approaches for Design of Experiments, however Taguchi and RSM are ideal for optimization for more process parameters.

3)The study discovered that the response variables were affected in various ways by the control factors.

4)From the research paper study it was found that most of the studies used L9 orthogonal array and S/N ratio variance.

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