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# Optimization of TIG Welding Parameters on Strength Basis: A Review

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**Abstract:- A higher grade of Super steel, a kind of stainless, offers a number of attractive characteristics, including resistance to acid attack, rust, pitting, and crevice corrosion. These advantages can be linked to the higher concentrations of specific alloying elements. This special alloy was utilised in a number of demanding environmental applications, including nuclear energy plants, aircraft, and chemicals processing plants. Employing correct welding processes was equally critical for maintaining the characteristics of super austenitic stain-less steel. This study examines several welding methods for connecting highly austenitic steel may be joined using a variety of techniques, including welding processes, arc welding welding, friction joining, laser joining, tungsten inert gas joining, active tungsten inert gas joining, and hybrid laser joining.**

***Keywords***:- *TIG, Welding, Optimization, Taguchi Approach, SS 304L.*

## I. INTRODUCTION

A non-consumable electrode and the metal being worked on generated heat during the technique of tungsten-gas arc welding, sometimes referred to as tig welding. This is illustrated in Figure 1. A weld pool is created when the base metal melts due to the arc's heat. In contrast to standard stick welding, gtaw protects the weld region with an inert gas to keep the weld from being contaminated by air. The heat-affected zone close to the weld bead, the molten steel puddle, and the tungsten electrode are all present. protected from oxidation by this shielding gas. Steel are tall steels built just on Fe-Cr, Ar y, and Fe-Cr-Ni groups. These steels, which are required be stainless, must have a minimum of 10.5% carbon by weight.

Stainless (ss) was a material that was often used in a variety of industrial applications, including pressure vessels, valve bodies, and pipes for reactor coolant. because of its great ability to withstand oxidation and high temperatures qualities, it was also employed in the chemical, process, and petrochemical industries. Due to its widespread availability, low cost, and ease of fabrication, 1,2 carbon steel (cs) was another material that was frequently employed in big facilities. ability to be heated, etc. Numerous industrial applications need the connecting of cs to stain-free steel. Due of their technological and financial possibilities, welding of dissimilar metals became an area of study. In power production applications, low temperature and much less corrosive environments allow the boilers and heat exchangers to operate, whereas the super warmers and re-heaters must operate at higher temperatures.

## II. LITERATURE REVIEW

**S. ANSARI et.al [1]:** In order to improve mechanical properties and reduce production costs, tig welding was improved utilising Taguchi's experimental approach for optimization. The final tensile and impacts strength, as well as the bending strength of weld joints, were maximised by using welding settings such a weld power at 170 amps, welder speeds of 12.7 mm, and gas flow of 15 lit/min. The ideal circumstances are provided by the Taguchi technique of optimization, which was made relevant by achieving remarkable results in confirmatory testing. The optimal parametric combination was discovered using median effect size plots and s/n ratio plots.

**A. SHARMA et.al [2]:** Industries frequently employ tungsten arc welded plates. Dissimilar metal welding is especially helpful in structural applications. The best method for handling these problems that occur when welding base metals is TIG welding. This essay examines stainless and mild metal plates that have been TIG welded. In this research ,the impact of TIG welder on mild steel and stainless metal sheets was investigated, with different welding speeds, welding current, voltage, and other parameters influencing the outcomes. TIG welding was used to link plates of mild steel with stainless steel. Comparing to other welding methods,TIG welding stainless with mild steel results in improved properties.

**A. RAMAKRISHNA et.al [3]:** The microstructure and mechanical properties of a dissimler Metal Inert gas (Tg) welded AISI 304 are the subject of the experimental examination. Gas turbines, heat exchangers, chemical industries, and the automotive industry all frequently use austenitic stainless steel. Austenitic stainless steels can also be formed and manufactured with ease. The Brinell testing procedure has demonstrated that,when compared to base metal and the heat affected.

**K. T. SUNNY et.al [4]:** In this review paper they study properties of stainless steel that is austenitic and its application because of higher concentration among all alloy elements. They found out properties of austenitic SS with proper method of welding. They had used many welding methods such as For combining various SS plates, several

welding techniques are used, including metal inert gas, shielding metal electric arc, resistance welding, laser ablation, tungsten inert riveting, active tungsten inert gases soldering, and hybrid laser welding. Argon as a shielding gas will increase the bead quality, and RSA may be utilised to optimise Gas metal arc welding parameters. and In TIG welding adding 2% Nitrogen would increase mechanical properties of TIG welded metal.

**D. VARSHNEYet.al [5]:** In this review paper the objective was to study the aluminum used, application and parameters.The method used for these was literature review technique for optimization and period used was 2008-2019. Aluminum alloy used in this review paper was 6061 because it was least explored aluminum alloy. The main aim was to understand maximum penetration, mechanical properties and rust behavior used with TIGW on aluminum alloy 6061.

**M. KUMARI et.al [6]:** In the work done, TIG welding was done on AISI 304 metal of 5 mm thickness. The purpose of the work was to analyze the micro structure, hardness, the use of to measure the weld's penetration depth Taguchi method. The welding parameter used was welding current range (130-160) Amp, shielding gas, weld speed Consequently, it was discovered that increasing the welding speed, the DOP decreases when the current is constant.

**SUNIL PATIDAR et.al [7]:**Because the two materials had differing mechanical and chemical qualities, the joining process was challenging; making the best use of the process parameters became crucial. Ultimate tensile strength served as the main criterion for the optimization process. The mechanical joints that were produced were also contrasted with one another based on tests for ultimate tensile strength and hardness.. Generally, in different applications like industry, homes, different metals have to be welded together, which is more difficult than welding the same metal plate.

**M. SHRIVASTAVA et.al [8]:** In this paper he had examined which parameters should be taken for analysis in stainless steel plate 304 and in this important factor aimed to attain the deepest possible penetration and minimum distortion in weld. They had taken four The effects on distortions and the depth of penetration of the welding parameters welder intensity, flow rate, root face, and arc voltage were examined.Welding speeds best for distortion and the parameters valued was found welding current was 90 A, 10 LPM gas flow, 1 mm root face, 31.578 mm/min welding speed, and 2.3996 mm as the ideal response value.. and the obtained valued was examined by Taguchi method. Welded distortion error percentage was in range of expected value and calculated valued.

**D. MISHRA et.al [9]:** To create strong welds, two distinct 310 and 304 stainless steel sheet metal grades—with a thickness of 3 mm are subjected to shield metal (SM) and gaseous tungsten (GT) arc welding. The research will be useful for selecting an effective welding method .For practical usage, a method for butt welding There have been produced many stainless steel alloys having single or double "V" edges in grades 310 or 304. Two distinct stainless grades, 310 and 304, are joined together using the GT and SM arc welding techniques. On the welded object, tension and toughness tests are conducted. specimens. Any form of weld flaw is not seen during the dye penetrant inspection.

**M. V. RAMANA et.al [10]:** The goal of this effort was to investigate the impact of parameters in TIGW with Response surface method as to increase impact strength. The parameters must be improved in order to increase impact strength of weld joints. current is By the Taguchi technique, the power is 180 A, and wire process parameters is 0.82 mm/min, as well as the speed is 0.08 mm/min. It was shown that the impact strength is significantly influenced by the wire feed. The test's outcome under perfect circumstances is 54.0 J, whereas a regression model's estimation of the impact strength under ideal circumstances came out at 56.96 J. The impact resistance of the confirmatory test result has been found to be within the permitted range.. Impact strength is significantly influenced by the spool wire feed (56.3%), weld current, and travelling speed by ANOVA. Method.

**S. KUMAR et.al [11]:** In the given paper ANOVA is used in an experimental study to examine how welding factors affect TIG welded connections. Which had the following goal: The TIG welding process's welding parameters need to be improved in order to increase the weld structure's mechanical qualities and lower production costs. The current analysis concentrated on the method parameter optimization for the tig joining procedure. As a base metal, Aisi 304 materials were chosen. The specimen's dimensions were 200 mm, 50 mm, and 3 mm. The tig welding process was used to butt-weld the specimen. Based on their major impact on the mechanical characteristics of the weld structure, input parameters were chosen.

**G. SHANMUGASUNDAR et.al [12]:** In this work AISI 304L was joined with the help of TIG welding. Its primary goal was to use the Taguchi technique to improve the TIG welding settings. The computation for this challenge was done using an ANOVA. The welding parameters, such as welding speed, gas flow rate, and distance from the nozzle to the plate were taken. Finally, the best result was found at parameter (110-amp, 10 l/min, 15 mm).

**A. SIVANANTHAM et.al [13]:** In this work, dissimilar TIG welding was used to join stainless-steel plates of 3 mm thickness (Iso 304L especially in industry, AISI 430 ferritic) without the use of filler material (argon). With the aid of the Taguchi approach, the work's goal was to comprehend the tensile strength test of welding while maintaining certain crucial variables, such as tig welding, welding speed, and gas flow rate, in mind. The welding parameter of 140 amps, 110 mm/min, and 15 litres per minute produced the best UTS result (606 MPa).

**C. A. SOMANI et.al [14]:** For welding austenitic stainless steels, the current work is an experiment investigation of the hybrid TIG-MIG welding procedure.The

idea of combining two distinct welding techniques to get the benefits of both procedures and to eliminate the drawbacks of both welding methods is tested.Using Design Expert software, an attempt is made to statistically analyse and improve control parameters. Based on major control factors, a statistical model is created. The essay offers a framework for assessing both direct and indirect impacts in the intricate phenomena of TIG-MIG hybrids welding. The TIG-MIG hybrid welding technology offers faster welding at a desirable level of quality.

• The final tensile strength in such a range under consideration is directly impacted by welding current.To achieve high quality, a process is optimised between a set of control parameter values.

**M. F. BENLAMNOUAR ET AL et.al [15]:** With the aid of the Taguchi experiment, the goal was to investigate the characteristics of welded joints. Its function was to weld the 304L austenitic stainless steel and X70 low alloy steel, both of which have high strength. and examined the mechanical properties of various metals. and the L9 array was made using the Taguchi technique.. He discovered that some welding parameters need to be chosen before TIG welding. He explained that the primary factors that influence tungsten arc welding (TIG). For welding (speed-8 L/P), welding speed (70 m/min), and welding current, gas flow rate is a crucial factor (70A).

**V. CHAUDHARI et.al [16]:** The objective was to study the parameters of With the use of the Taguchi technique, it is possible to enhance a process' performance without having to carry out a lot of trials. This cuts down on experimentation costs and saves time. This method has been used to carry out robust process and product design as well as to address several important issues in the manufacturing sectors.

**B. DENKENA ET AL et.al [17]:** Turbine engines are using more and more blade integrated discs (Blisks). These integrally machined parts have advantages in terms of performance to weight. However, partial substitution is not an option in the event of failure. For greater sustainability, the Blisk must be completely replaced or restored utilising regenerative techniques. The TIG+SiC welds displayed greater processes loads as well as a twice as large deflection when recontouring the various specimens. As a result, it might be necessary to reduce the process parameters or instal more clamping mechanisms Additionally, a simulation of material removal will take into account the weld properties to anticipate Process forces for efficient re-contouring activity planning.

**S. C. BODKHE et.al [18]:** Finding the ideal set of procedure parameters to increase the penetration depth (DOP) when The objective of the current study is to A-TIG weld stainless (SS) alloy 304L. After an ANOVA was utilised to determine the applicability of the process parameters, welding current was discovered to be the most significant input variable affecting DOP. RSM may be used to analyse a number of performance parameters and improve process variables while A-TIG welding SS 3041. Process variables such welding power, torch velocity, the arc spacing have been explored for A-TIG welder of SS 304L. Power, torched speed, and are gap's importance as process factors have all been determined.

**T. ODIAKA et.al [19]:** In the work done, MIG welding was used to weld steel metal, This work's goal was to comprehend the mechanical structural characteristics., to improve the integrity of the welding joint in steel. The optimization was done once with Taguchi method and once without Taguchi method to find out the advantages and disadvantages of Taguchi method.

**P. VASANTHARAJA et.al [20]:** In this review paper the problem was that selection of input variables for good quality weld joints. This problem was solved by Response surface method. Parameters to obtain the required RSM uses weld bead shape factors such heat-affected zone (HAZ) width, bead width, and depth of penetration. Welded power, flame velocity, electrodes tip direction, and arc gap were the input variables. The response factors were bead width, HAZ width, and depth of penetration. The parameter that was determined to be most important was welding current. Arc gap between 2 and 3 mm, torch speed between 90 and 130 mm/min, and welding current between 200 and 300 A RMS errors of 0.1593, 0.2674, and 0.2089 were discovered for the predicted and observed DOP, HAZ length, and bead width, respectively. RSM was discovered to more accurately forecast the optimal welding processing parameters for attaining the highest DOP during the A-TIG welding process.

**A.UGLA et.al [21]:** This research looked at bead geometry, welding parameters, microstructure traits, and mechanical properties. 5-500Hz was chosen as the frequency level for this work. 308L of 304L were used to fill a sheet. Three stages and four factors were used in this work. They chose the specimen using Taguchi L9. They said that with a participation percentage of 43%, speed travel is the most important aspect ratio, followed by cooling state at 19%. The maximum tensile strength recorded during this study, they claimed, was 765.8 MPa at a frequency of 500 Hz. Hz.

**G. GHADI et.al [22]:** The goal of this project was to analyse the stainless (ss 202) TIG parameters used to create pressure vessels and heat exchangers. By using a full factorial design, it was possible to determine the percentage contribution of each model parameters and forecast tensile strength, bending strength, and BHN. The project was successfully completed, and the mechanical properties of the stainless steel (ss 202) substance were studied through the analyzation of input process parameters. In the production of pressure vessels, heat exchangers, and chemical equipment, stainless steel is employed. It was possible to draw the conclusion that better performance came from the weldment of the shell as it was rolled and rerolled during manufacturing.

**S. FATIMA et.al [23]:** This researched seeks to improve the plasma arc welding process parameters for welding stainless-steel austenitic ss-304 l and carbon steel a-36, which are dissimilar metals. It looks at how welding speed and current affect the quality of a welded connections. For the purpose of qualifying the welded samples, quality parameters such as bead shape, microstructure, hardness, ferrite measurement, and tensile test were taken into consideration. Either with and without the welding of the filler material, welded specimens were made. By assisting the operator in achieving targeted performance criteria, the operator saves time and increases productivity, according to the authors' analysis.

**N. BHAVSAR et.al [24]:** The goal of this study was to examine the effects of different tungsten inert gas welding (tig) process factors (welding current, filler materials, and groove design) on aspect ratio, hardness, and impact resistance of ss304l welded joins. The influence of several welding process variables (welding current, filler materials, and groove design) on the aspect ratio, hardness, and impact strength of an SS304l welded joint. By dividing the proportion of bead penetrating to bead width, the aspect ratio was calculated. Vernier callipers might be used to measure this bead's dimensions

**.K. PANCHAL et.al [25]:** Experiments were conducted to investigate the impact This essay's major objective is to investigate how TIG welding affects plates made of mild and stainless steel. TIG welded plates are mostly utilised in industrial settings. The best uses for welding different metals are in structural applications. However, the challenge with welding such plates is the carbon loss from mils steel and chromium precipitation in steel material during welding. The best method for addressing these issues when welding base metal connections is TIG welding.

**M. AISSANI et.al [26]:** The problem of combining The characteristics of heat transmission in a titanium gas are studied using simulations in three dimensions and experimental methods. was the main subject of this study. He was told that testing on welded material, such as metallographic and instrumental monitoring, would involve welding stainless steel 304L sheets together at the butt joint. Stainless steel sheets and tig welding simulations revealed that The heat surface was well approximated by the bi-elliptic shape.. The largest temperature mismatch was also revealed by this analysis. There weren't any changes caused by a few microns during the slow creation of the HAZ during welding.

**R. KUMAR et.al [27]:** The aim of this project : A technique for choosing close to ideal values for the friction welding process parameters was put forth. A number of input factors, including contact force, friction time, upset pressure, and upset time, as well as output characteristics, including tensile strength, hardness, and material loss, were used to determine if the conventional welding process was successful. joints made of a mix of metals. were popular in recent years in the field of special applications liked automotive, aerospace, defence, marine, etc. , the joining of dissimilar metal by solid state welding was widely preferred in such situation.vessels and chemical industries.

**B. SINGH et.al [28]:** The Understanding the tensile stress, hardness, and microstructure of the completed weld was the primary goal of this investigation. In this project, mild steel and stainless steel were joined together using GTAW welding. To optimise this job, the Taguchi method was used. During the work, certain significant metrics were measured, including welding current and gas flow rate. As a consequence, it was discovered through testing on UTM that several welding factors, such as current, gas flow rate, etc., had an impact on the characteristics. of weld.

**L. S. PATEL et.al [29]:** By means of experiments (DOE) with employing, The effectiveness of tig welding techniques was investigated on thin strips of 304l iron that have been 4 mm thick. The Taguchi technique generates reactions (tensile strength &distortion). After the data collected was analyzed using anova, the significance of effects for each parameter investigated on primary outcome was assessed. The weld strength inaccuracy for stainless 304lr varies around 0.410 through 2.295%, which is outside of the allowed range. The inaccuracy in distortion for the same steel ranged from 0.056 to 0.078%; both errors were deemed acceptable.

**K. S. PRASAD et.al [30]:** One of the most popular welding techniques inside the sheet metal manufacturing sector was welding using development of " micro plasma (pcmpaw). The front and back of this study's back widths, as well as the minimum front and back heights, are taken into account when optimizing the pcmpaw process. The ideal spot weld geometry was created by examining the pulsed current plasma arc welding's characteristics. According to the author's analysis, the optimal outcome helps the user achieve its desired outcome measures, which reduces the operator's workload and boosts productivity.

**D. DEVAKUMAR et.al [31]:** Tig welding was an electric arc welding procedure that created an arc between the work item being welded and a non-consumable tungsten electrode. Due to its exceptional corrosion resistance, stainless steel was widely utilised in businesses as a crucial material. Numerous facets of microstructure, characteristics of corrosion resistance, welding of dissimilar metals, and optimization of various welding techniques have all been researched. In-depth research on welding processes of those stainless steel kinds that are increasingly being used in the rail, automotive, and chemical sectors assumes a lot of significance.

**N. S. PATEL et.al [32]:** The primary goal of industries was found to be increasing productivity while creating goods of higher quality at lower costs. Tig welding was the most important and popular method for combining two parts that were identical or dissimilar by heating the material, applying pressure, or using filler material in order to increase productivity with less time and expense.

**K. S. PRASAD et.al [33]:** One Development of " micro thermal plasma welding was one of the most widely used welding methods in the metal sheet production industry (pcmpaw). The front and back of this study's back widths, as well as the minimum front and back heights, are taken into account when optimizing the pcmpaw process. The ideal spot weld geometry was created by examining the pulsed current plasma arc welding's characteristics. According to the author's analysis, the optimal outcome helps the user achieve its desired outcome measures, which reduces the operator's workload and boosts productivity.

**P. K. GIRIDHARAN et.al [34]:** The given paper, work was done on GTAW welding. According to this paper, A non-consumable tungsten electrode that has to be protected with an inert gas is used in gas tungsten arc welding (GTAW). The electrode's tip forms the arc, which melts the metal that is being welded. Either manually or mechanically, the disposable filler metal is inserted. The weld bead characteristics include penetration, weld bead (W), aspect ratio (Ab), and weld bead area. The Tig process parameters include pulse intensity (Ip), circulating current time (Tp), the welding speed (S).

**S. A. A. AKBARI MOUSAVI et.al [35]:** The source of thermal strain will be fairly non-uniform. They advised using grooves in the best possible shape to reduce residual stress in the welded joints. The effect of This study considered air conductivity, radiation, and convection as well as the flow rate of inert gas. The simulations revealed that the tensile stress concentration was lower in the U-grooved configuration than in the V-grooved design. The mechanical impact on samples with 50 u and v grooves was investigated. Transverse residual stress increased in us, it was also found. All along length of the weld, the peak temperature of the fusion zone rose., according to a 3D computer simulation.

**M. ABBASS et.al [36]:** The goal of this study is to determine how austenitic stainless steel AISI 304L's maximum base shear and spot diameter are affected by TIG spot welding settings., including welding current, welding time, and sheet thickness.Offers 0.6, 0.8, and 1.0 mm thick options.The spot Tig parameters were (3) and 27 samples were created using MATLAB software, therefore the minimum number of tests should not be fewer than 27.Successful TIG arc welding was used to combine nickel steel sheets of various thicknesses and produced high-quality spot joints.As welding current, duration, and thickness rise, as does the diameter of the weld or nugget.The maximal shear force of a TIG spot weld is significantly influenced by the parameter of sheet thickness.

**G. RÜCKERT et.al [37]:** By examining the impact The effectiveness of silica coating after Tg (or Gt) welder of AISI304L stainless steel has been examined in terms of coating shape and thickness on weld penetrations. examined. To determine the mechanical behaviour in several typical zones of the welded samples, tensile tests were carried out. The fluxes silica particles are responsible for the weld metal's decreased strength properties. For the purpose of fusion welding stainless steels utilising traditional Tig welding, the current study investigates the layout of flux application by setting out what produces the optimal flux performance and defining the silica coating shape. on the basis of the welding current, it is discovered that the optimal thickness in A-TIG varies from 40 and 70 lm.

**P. K. GIRIDHARAN et.al [38]:** In this paper presents the results of a research on how the GTA welding method influences the stainless steel weld's electrochemical pitting and corrosion properties. The weld's susceptibility to pitting corrosion was evaluated using potentiodynamic anodic polarisation. Utilizing mathematical models that connect the pulse GTA welding process conditions active transport, pulse current duration, and welding speed, pitting corrosion features were created. The variance analysis was performed to assess the models' adequacy (ANOVA) An examination of the primary and cumulative effects of the pulse GTAW process variables on the weld's electrochemical corrosion characteristics was reported. GTAW process settings that were optimized significantly improved the weld's resistance to pitting and corrosion.

## III. CONCLUSION

The majority after being identified in various literature studies attempts to determine the tig welding process, welding characteristics including welding current, welding current, and depth to breadth ratio were frequently used in study work. Furthermore, it was found that tig welding had been done on a range of materials, including sheet metal, titanium, brass, charcoal, and stainless, but we may have chosen the item. of work that is most applicable to industrial processes and differs from the materials mentioned above. We may have attempted to use theoretical calculations and experimentation with the aid of various input parameters to determine welding tensile strength. The austentic variety of stainless steel with grade E310 was utilised to successfully complete the experiment. Successful tig spot welding was done to link stainless steel. FEM anaysis will alsobe executed in ANSYS workbench to match simulated result and experiment data.

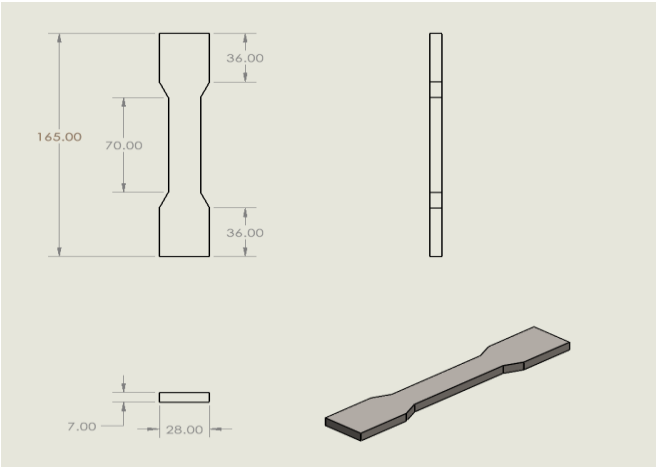


Fig 1 :- 3D Model of Specimen For Experiment and Simulation

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