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A REVIEW ON MULTI OBJECTIVE OPTIMIZATION OF PROCESS PARAMETERS IN MIG WELDED HIGH THICKNESS SS304 MATERIAL USING TAGUCHI METHOD.

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Abstract : The review commences by outlining the importance of MIG welding for connecting SS304 material and how widely it is used in many industrial fields. The foundations of the Taguchi technique are then explained, along with its benefits for optimising process parameters. The Taguchi approach is used in this study to fully review the literature on multi-objective optimisation of process parameters in MIG welding of high thickness SS304 material. It looks at the experiments done to determine the important welding parameters and how much they effect the final tensile strength and elongation %. Additionally, a full evaluation of the methodology used for data analysis, optimisation techniques, and experimental design is done. In addition to identifying the best combinations of process variables that result in better ultimate tensile strength and percentage of elongation, the review also highlights major discoveries and trends from earlier studies. It also covers how specific welding parameters affect the desired mechanical qualities and sheds light on the underlying mechanisms. The significance of the Taguchi approach in optimising process parameters for MIG welding of high thickness SS304 material is summarised in the paper's conclusion. It focuses on the advantages of this strategy in terms of increasing the ultimate tensile strength and percentage of elongation, which can increase the weld quality and structural integrity. This review paper provides thorough information on the multi-objective Taguchi method process parameter optimisation for MIG welded high thickness SS304 material, making it a significant resource for researchers, engineers, and welding practitioners.

Keywords – MIG welding, Optimization, Taguchi method.

1 INTRODUCTION

Welding is a manufacturing method that produces a permanent union by fusing the surfaces of the pieces to be joined together, with or without the use of pressure and a filler material. The materials to be bonded could be comparable or dissimilar. The heat required for material fusion can be supplied through gas combustion or an electric arc. Because of the faster welding speed, the latter approach is more widely utilized. Welding is widely employed in fabrication as an alternative to casting or forging, as well as to replace bolted and riveted joints. It is also used as a repair medium, for example, to reassemble a metal at a crack, to reassemble a small part that has broken off, such as a gear tooth, or to repair a worn surface, such as a bearing surface[1]. As the name implies, metal inert gas welding is a process in which the source of heat is an arc formed between a consumable metal electrode and the work piece, and the arc and molten puddle are shielded from contamination by the atmosphere (i.e., oxygen and nitrogen) by an externally supplied gaseous shield of inert gas such as argon, helium, or an argon-helium mixture. There is no need for an external filler metal because the metallic electrode provides both the arc and the filler metal. MIG welding is an abbreviation for metal inert gas welding. MIG is an arc welding method that achieves coalescence by continually heating the job using an electric arc created between the work piece and the metal electrode feed. A metal inert gas (MIG) welding technique consists of a transitory heat source heating, melting, and solidifying parent metals and a filler material in a localized fusion zone to form a joint between the parent metals. Gas metal arc welding is a gas-shielded method that works well in all positions[2].

Metal inert gas arc welding (MIG), also known as gas metal arc welding (GMAW), employs a consumable electrode, so the phrase metal appears in the title. Other gas shielded arc welding methods that use consumable electrodes, such as flux cored arc welding (FCAW), can all be classified as MIG. Though gas tungsten arc welding (GTAW) can weld all metals, it is best suited for thin sheets. When welding thicker sheets, the filler metal requirement makes GTAW unsuitable. The GMAW comes in handy in this circumstance. Figure 1 depicts a schematic diagram of the GMAW or MIG welding process. The consumable electrode is a wire reel that is fed at a consistent pace through feed rollers. The welding torch is linked to the gas supply cylinder, which supplies the required inert gas. The welding power supply is connected to the electrode and the work-piece. Power supplies are always of the constant voltage variety. The rate of feeding of the electrode wire affects the welding machine's current. For GMAW with electrode positive (DCRP), DC arc welding machines are typically used. The DCRP accelerates metal deposition while simultaneously ensuring a stable arc and smooth electrode metal transfer. The arc becomes more unstable with DCSP, resulting in a massive splatter. However, special electrodes with calcium and titanium oxide mixtures as coatings have been found to be effective for welding steel with DCSP. The filler metal is transferred from the electrode to the joint during the GMAW process. Metal transfer occurs in several ways depending on the current and voltage applied to a given electrode[3].

The Taguchi methodology is an efficient method for analyzing the parameter space with few experiments utilizing orthogonal arrays. The number of levels and factors both increase exponentially in a factorial design. This method provides an efficient, clear, and systematic approach to cost, performance, and quality optimization in design. As the number of factors and levels increase, it becomes necessary to conduct a large number of experiments. In the Taguchi method, an orthogonal array is created to investigate all parameters in order to solve the problem. These data are transformed using the S/N (signal to noise) ratio. This S/N ratio can be classified into three categories: nominal-the-better, lower-the-better, and larger-the-better. Welding is an important procedure in the manufacturing business, especially when it comes to joining metals. The welding process's performance is dependent on the selection and optimization of welding parameters. Stainless steel has recently become one of the most widely utilized materials in a variety of industries, including construction, automotive, aerospace, and food processing. SS304 is the most often used stainless steel due to its superior corrosion resistance, formability, and weldability.

1.1 MIG welding process

MIG welding, also known as Gas Metal Arc Welding (GMAW), is a type of welding that involves creating an electric arc between a consumable wire electrode and the workpiece. The wire electrode is supplied into the weld pool constantly and melts, establishing a junction between the workpieces. Because of its great productivity and versatility, the MIG welding method is widely employed in a variety of sectors. MIG welding operates on three basic components: the power supply, the wire feeding system, and the shielding gas system. The power source supplies the electrical energy required to spark an arc between the wire electrode and the workpiece. The wire feeding system continually feeds the wire electrode into the weld pool at a predetermined rate. The shielding gas system creates a safe environment around the weld pool, keeping contaminants from the surrounding air at bay.

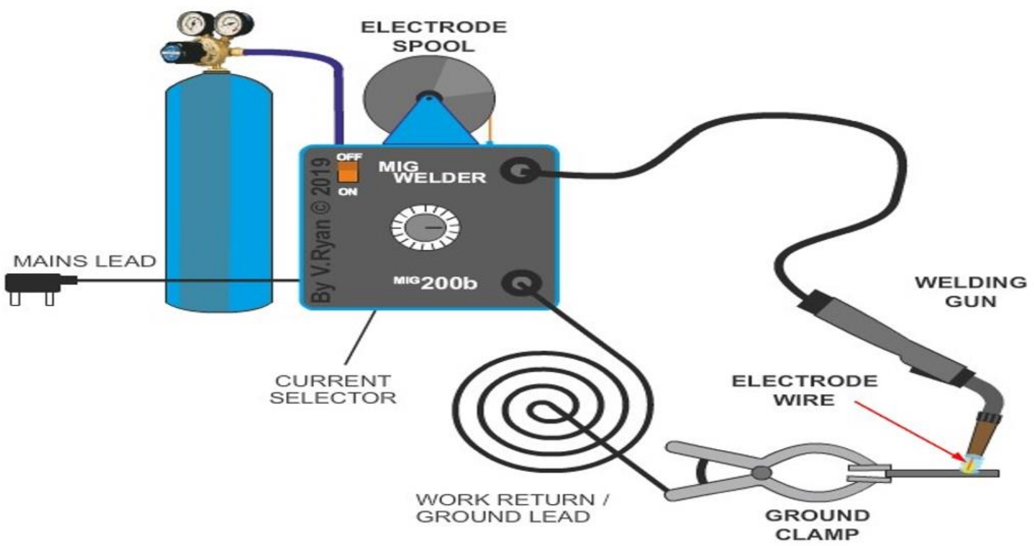

Fig. 1: MIG welding

The wire electrode is continually fed into the weld pool throughout the welding procedure. Both the wire electrode and the base metal are melted by the arc formed between the wire electrode and the workpiece. The melted metal solidifies the joint between the workpieces as it cools. The shielding gas system aids in preventing contamination and oxidation, which could weaken the joint and harm the molten metal. Due to the great degree of controllability of the MIG welding process, the welding parameters can be changed to meet the particular needs of the welding application. The welding current, welding voltage, welding speed, and wire diameter are all welding parameters that can be changed. The quality of the weld can be improved by optimizing these factors, leading to welds that are stronger and more dependable.

2 LITERATURE SURVEY

Parametric optimization of stainless steel 304 for MIG welding by using Taguchi's method:[1] The goal of this study is to demonstrate how various welding factors, such as welding current, stick out length, and gas flow rate, affect the tensile strength of the weld joint and the hardness of the weld. Each of these variables affects welding quality in a different way. The Taguchi method has been used to optimize these parameters for better weld quality. As a material for welding, stainless steel plates have been employed. Additionally, the ANOVA is used to forecast the percentage impact of each parameter on the outcomes.

A review on optimization and prediction of MIG welding process parameters using ANN:[2] a result of different process variables such as electrode size, welding current, arc voltage, arc travel speed, welding position, gas flow rate, and shielding on a variety of materials, the effect of gas composition on output parameters including tensile strength and hardness was investigated. This examination of the literature reveals that exact output with high production can be produced by properly optimizing the process parameters of MIG welding.

Experimental investigation on mechanical property of MIG welding process:[3] The effects of MIG welding on the mechanical characteristics of AA 6061 T6 will be attempted to be analyzed. The aircraft industries most frequently employ aluminum as a material. In terms of annual usage, aluminum comes in second place to steel. In comparison to mild steel, aluminum alloys are lighter in weight, have a lower density, and have better mechanical qualities. Therefore, we thought about studying aluminum alloys. The microstructure of the welded specimens will be determined by a variety of mechanical testing, such as tensile and hardness tests. The MIG welding input parameters, such as welding current, arc voltage, and welding speed, are employed as variable process parameters, which may be crucial in the assessment of various attributes.

Optimization of 316 stainless steel weld joint characteristics using Taguchi technique:[4] It has been noted that the root gap, current, and speed all have some bearing on the material's tensile and bending strengths. According to Analysis of Variance (ANOVA), welding speed has a bigger impact on bend strength (46.51% contribution) than welding current (96.75%) has on tensile strength. Additionally, it has been discovered that root gaps affect both tensile and bend strengths.

An optimization of welding parameters for MIG welding: [5]The ideal specifications for high tensile strength are current 250 amps and wire feed rate 4.2 mm/min. The ideal parameters for increasing hardness are current 250 amps and wire feed rate 4.2 mm/min. Welding at a current of 250 amps thus produces the best results, it may be said. There is thermal analysis. Observing the outcomes reveals that the heat flux is rising due to an increase in welding current. Analysis of structures is also performed. Observing the outcome reveals that the applied load is extremely high and that the welding has failed since the calculated stress value exceeds the material's strength.

Experimental studies on high thickness welding of SS316l using TIG-MIG welding:[6] According to the necessary protocols, the manufacturing of subcomponents for vacuum vessels mostly uses high-thickness stainless steel materials in the 20–60 mm range. As a result, the TIG-MAG combination is suggested. The tensile strength, bending test, and hardness test for the TIG-MAG welding method utilizing the material SS316 thicknesses up to 30mm are reported in this work. Additionally, the radiography test of the welded sample is studied.

Studies on mechanical properties, microstructure and fracture morphology details of laser beam welded thick SS304L plates for fusion reactor applications:[7] One-pass deep penetration, a small heat-affected zone, little distortion, and strong mechanical qualities are some of the benefits of laser welding. In order to overcome weld flaws like voids caused by a lack of penetration over depth, undercuts, and porosity, the laser welding process parameter optimization faces a number of difficulties. The tests that were done using CO2 laser welding of 8 mm thick austenitic stain-less steel SS304L plates and the detailed evaluation of their mechanical characteristics, microstructure, and fracture morphology are reported in the current study.

Optimization of MIG welding parameters for improving strength of welded joints: [8]This study examines how welding parameters such as welding current, voltage, and speed affect the ultimate tensile strength (UTS) of AISI 1030 mild steel during the welding process. Taguchi technique-based experiments have been planned. To examine the welding characteristics of the material and optimize the welding settings, an orthogonal array, signal to noise (S/N) ratio, and analysis of variance (ANOVA) are used. The calculated result takes the form of a contribution from each parameter, and it allows for the identification of the best parameters for achieving the highest tensile strength. According to this study, welding current and welding speed are the two main factors that affect the tensile strength of welded joints.

Multi-objective optimization of process parameters in tig-MIG welded AISI 1008 steel for improved structural integrity:[9] Using the grey-based Taguchi approach, multi-objective optimization of TIG/MIG hybrid welding on AISI 1008 mild steel has been studied. For the proper parameter settings, first- and second-order mathematical models have been constructed. The TIG-MIG hybrid welding process proved successful in joining AISI 1008 mild steel. Welded junctions were shown to have higher tensile and yield strengths than the parent material.

Optimization of process parameters and experimental investigation MIG welding for stainless steel 304 and mild steel 2062:[10] The study discovered that the welding voltage had the greatest effects of the control parameters on the tensile strength. In terms of mechanical qualities and weld bead shape, they have an impact on the weld quality. The Grey Relation Analysis and ANOVA (Analysis of Variance) methodologies can be used to optimize welding process parameters. The key control parameters of the Metal Inert Gas Welding process include welding current, arc voltage, shielding gas type, gas flow rate, wire feed rate, electrode diameter, etc. The Taguchi Method's ideal welding conditions for achieving the best tensile strength include gas flow rate of 18 psi, welding current of 150 amps, and welding voltage of 25 volts.

Optimization of the process parameters for MIG welding of AISI 304 and is 1079 using fuzzy logic method:[11] The experiment created using the Taguchi method achieves the desired result. The MRPI (Multi Response Performance Index) of the ideal combination of hardness and tensile strength has been determined using a fuzzy interference technique. MATLAB 7.5.0 software was used to calculate every conceivable value of the MRPI. Finding the significance level of each parameter is made easier with the aid of analysis of variance (ANOVA).

Optimization of MAG welding process parameters using Taguchi design method on dead mild steel used in automotive industry:[12] Welding current has been discovered to have a significant impact on the caliber of welded joints. The results of the experiments for the ideal setting produced welding conditions with more hardness than the original setting. For Ethiopian businesses, this study is beneficial for diverse material and thickness fluctuation of welding plate.

Optimization of MIG welding parameters for improving strength of welded joints:[13] For MIG welding of work piece made of AISI1050 steel, the welding parameters are welding current, welding voltage, and welding speed. The ideal welding parameters for this project are welding currents of 180, 230, and 280 amps, welding speeds of 200, 300, and 400 m/s, and welding voltages of 22, 24, and 26 volts. The aforementioned parameters are taken into account when conducting experiments. Experimental confirmation of ultimate tensile strength. The experimental outcomes supported the efficacy of the Taguchi approach for improving welding performance and maximizing welding parameters in MIG welding at welding speeds of 400 m.m./s, 26 volts, and 180 amps.

Optimization of MIG welding process parameters using Taguchi design method:[14] This article reports on the process parameter optimization for stainless steel GMA welding with increased weld strength. Tensile strength predictions take into account the Higher-the-better quality characteristic. To resolve this issue, the Taguchi method is used. The optimization of welding settings utilized a Taguchi orthogonal array, the signal-to-noise (S/N) ratio, and analysis of variance (AVOVA). The levels attained are best at A3B3C1. The results demonstrate that among the primary input welding parameters, the effect of welding voltage and welding current on the tensile strength of welded joints is substantial. With the aid of (ANOVA), the most important element was likewise discovered in this case to have the highest percentage contribution. Therefore, it has the greatest impact on the outcome.

Effect of TIG welding parameter of welded joint of stainless steel SS304 by TIG welding:[15] TIG welding of stainless-steel sheets depends on a large number of factors. Due to practical constraints, four dominant parameters were considered during experimental investigation. The values of the parameters were selected on the basis of material characteristics and equipment available in the industry for experimentation. The existing process of welding the hoarding pipes was studied. Design of experiments technique was used for planning the experiments. Optimum welding parameters were determined for improved ultimate tensile strength, hardness and depth of penetration. The selection of optimum parameters was confirmed by mechanical testing - destructive as well as non-destructive. Welding of stainless steel SS304 by using optimized parameters resulted in improvement in joint tensile strength and hardness by 10.56% and 7.36%, respectively. The quality of welded joints was also checked for internal flaws using ultrasonic testing.

Mechanical assessment of SS 304 & SS316l by using pulsed TIG welding process:[16] The practice of uniting two or more metals either identical or dissimilar by applying pressure and heat is known as welding. Because TIG welding generates strong welds and requires less cleaning after welding than any other type of welding, it is frequently employed to attach the components of nuclear reactors. This study uses a pulsed TIG welding method using SS 316LER filler wire to link SS 304 with SS 316L. Welding current, gas flow rate, and root gap are among the variables. In order to evaluate these parameters, Taguchi L4 Orthogonal array is used. Tensile tests for mechanical properties were conducted prior to and following the post-welding heat treatment process, and microstructure analysis was carried out using an optical microscope at a 500X magnification.

Characterization and analysis of TIG welded stainless steel 304 alloy plates using radiography and destructive testing techniques:[17] The purpose of this particular article is to compare the mechanical behaviors, such as tensile testing, bending, hardness, and impact testing, performed under various loads and situations in destructive testing to the flaws caused by welded-joints. The endeavor of butt joints is made on stainless steel 304(SS304) plates using a TIG welding unit to repair any internal flaws discovered during nondestructive testing of the specimens. After finishing the task, examine the quality and performance of the TIG-welded plates to compare mechanical faults and radiographic testing defects.

Influences of Groove Angles and Filler Metals on 304L Stainless Steel to AISI 1040 Carbon Steel Dissimilar Joint by Gas Tungsten Arc Welding:[18] In this study, gas tungsten arch welding was used to unite AISI 1040 carbon steel and 304L stainless steel using various welding conditions. In-depth research is done on the mechanical characteristics and microstructure of the dissimilar junction.

Effect of welding methods for different carbon content of SS304 and SS3041 materials on the mechanical properties and microstructure:[19] According to the study's findings, MIG produces stronger tensile bonds than TIG and SMAW. The maximum tensile stress value 679.64 MPa occurs in SS304 material when MIG welding is used, while the lowest 604.89 MPa occurs in SS304L material when SMAW welding is used.

Experimental investigation and comparative study of MIG & TIG welding on SS202 and SS304 materials:[20] Modern welding techniques such as TIG and MIG use inert and active gases to shield the weld pool from air oxidation. Both of these techniques include arc welding, which uses an electric spark to produce the necessary thermal energy to fuse the parent metals. While MIG utilizes CO2gas, TIG uses argon and helium gases to shield the weld pool. While MIG welding uses a consumable feed wire, TIG welding uses a non-consumable tungsten electrode. The welding method is frequently used in industry to create long-lasting connections between materials.

Mechanical properties assessment of TIG welded SS 304 joints:[21] The current study's objective is to determine how the filler material composition affects the welding characteristics of stainless steel (SS) 304 when it is welded using a semi-automatic TIG technique. For this reason, plates that were 6 mm thick and single V-butt joints were used. Then, with different filler materials as ER 308L, 316L, and 310, surface roughness, tensile strength, hardness, and EDAX/SEM analysis of joints were employed and evaluated. When compared to ER 308L, the filler materials ER 316L and 310 showed weaker characteristics. The joints manufactured with the filler materials ER 310, ER 316L, and ER 308L had high alloying components, according to SEM/EDAX analysis.

Common root causes of pressure vessel failures: a review:[22] BSI PD6493 is one of the current guidelines in fabrication codes that aims to lessen the likelihood of failures in welded pressure vessels subjected to cyclic pressure or vibrations. Nevertheless, there have been a number of spills and pipe ruptures recently. These failures frequently involve crack initiation in the weld metal and heat impacted zones of the welds, which are all due to inadequate reinforcing design and subpar welding technique execution. One instance of insufficient welds was caused by an increase in thickness in an effort to promote safety, which also raised cycle loads since the vessel was overly heavy.

Reactor pressure vessel (RPV) design and fabrication: a literature review:[23] Complex temperature variations that occur during welding result in transient thermal stresses and non-elastic strain in the vicinity of the weld. According to reports, the weld area is where industrial equipment has the majority of its servicing failures.

Parametric optimization of MIG welding for stainless steel (SS-304) and low carbon steel using Taguchi design method:[24] For the analysis, three MIG welding parameters current, voltage, and travel speed are used. To gather the data, an experimentation strategy based on the Taguchi technique was employed. Using MINITAB-13 software for higher-the-better quality attributes, the signal-to-noise ratio was analyzed. The ANOVA (Analysis of Variance) was used to investigate the importance of each parameter. In order to compare the predicted values with the experimental values, confirmation tests were lastly carried out, confirming their usefulness in the analysis of the joint's tensile strength.

The effect of gas metal arc welding (GMAW) processes on different welding parameters:[25] By raising the welding current by 90, 150, and 210 A, the value of depth of penetration rose. The penetration will depend on the welding current. The parameters from welding speed and arc voltage also affect penetration. The graph shows that 22 V at 210 A is a good number for penetration for three different welding speeds. It displayed the highest penetration values compared to the competition. The good value for penetration occurred at a welding speed of 60 cm/min and is 26 V at 210 A.

Optimization on machining parameters of friction surfacing of SS304 over iron plate:[26]The Friction Surfacing method was used to successfully coat stainless steel 304 on an iron base. For important applications, friction surfacing was the optimum technique for producing deposits of stainless steel 304 over ductile iron. Better response values were achieved through process parameter optimization. The ideal coating parameter was A1B2C2, and the ideal displacement parameter was A3B2C1 in order to achieve the highest coating hardness. For improved hardness and maximal displacement, axial load dominates, followed by traverse speed and rotational speed. Results from the Taguchi method are a perfect match with ANOVA.

Table 1: Literature survey

Sr. No.	Title of Research Paper	Author Name	objective	Process parameters	Improvements/ Outcomes	Year
1	Parametric Optimization of Stainless Steel 304 for MIG Welding by Using Taguchi's Method	Abhishek D. Dhonde, Subhash S. Mane.	The purpose of this study is to demonstrate how various welding factors, such as welding current, stick out length, and gas flow rate, affect the hardness and tensile strength of the weld joint.	current, stick out length, and gas flow rate	Gas flow rate is a highly effective parameter on hardness and is followed by current and stick out length.	2019
2	A review on optimization and prediction of MIG welding process parameters using ANN	Jigar Shah, Gaurav Patel, Jatin Makwana.	The impact of welding parameters such welding current, welding voltage, gas flow rate, and wire feed rate is presented in this study.	welding current, welding voltage, gas flow rate, and wire feed rate	It has been determined that accurate MIG welding process parameter optimisation can result in high production and exact output.	2017
3	Experimental investigation on mechanical property of MIG welding process	S. Maheshwaran, Dr. T. Senthilkumar	An effort will be made to look into how MIG welding affects the mechanical characteristics of AA 6061 T6.	welding current, arc voltage, welding speed	The use of welding current, arc voltage, and welding speed as variable process parameters may be crucial in determining various attributes.	2017
4	Optimization of 316 stainless steel weld joint characteristics using Taguchi technique	P. Bharatha, V.G. Sridharb, M. Senthil kumar	find out how different welding parameters affect the weld bead of an AISI 316 welded junction.	welding speed, root gap, current, electrode	The most important component in determining bend strength is speed, while the most important factor in determining tensile	2014

					strength is the amount of current employed during welding.	
5	An optimization of welding parameters for MIG welding	R. Raghu`	Effect of current and wire feed rate on the tensile strength and hardness of the material	Current and wire feed rate	To get optimal tensile strength and hardness current 250Amp and wire feed rate 4.2mm/min.	2018
6	Experimental studies on high thickness welding of ss316l using TIG-MIG welding”	Mohammad Kamran Habeeb	investigation of the tensile strength, bending test and hardness test for the TIG-MAG welding process using the material SS316 thicknesses	current, gas flow rate and filler wire diameter shielding gas and welding speed	According to the examination of the literature, factors such as welding current, gas flow rate, filler wire diameter, shielding gas, and welding speed are crucial to improving the tensile strength of stainless steel.	2022
7	Studies on mechanical properties, microstructure and fracture morphology details of laser beam welded thick SS304L plates for fusion reactor applications	Ramesh Kumar Buddua, N. Chauhana, P.M. Raolea, Harshad Natub	For austenitic stainless steel that is defect-free, optimise the CO2 laser welding conditions.	Laser Power, Weld speed Shielding gas pressure, Frequency	A refined weld zone with improved hardness but decreased impact fracture energy was discovered by the microstructural study.	2015
8	Optimization of MIG welding parameters for improving strength of welded joints	S. R. Patil, C. A. Waghmare	to ascertain the ideal welding conditions for AISI 1030 mild steel in order to achieve maximum tensile strength.	Welding current, welding voltage, welding speed	It has been discovered that welding speed significantly affects the tensile strength of welded joints.	2014
9	Multi-objective optimization of process parameters in TIG-MIG welded AISI 1008 steel for improved structural integrity	Cynthia Samuel Abimaa, Stephen Akinwale Akinlabib, Nkosinathi Madushelea, Olawale Samuel Fatobac, Esther Titilayo Akinlabid	effectiveness of the grey relational grading system in multi-objective TIG-MIG welding process optimisation	welding current, welding voltage, gas flow rate	Higher tensile and yield strengths were attained when AISI 1008 mild steel was successfully TIG-MIG hybrid welded.	2021
10	Optimization of process parameters and experimental investigation MIG welding for stainless steel 304 and mild steel 2062	Santosh J. Bardeskar, Shitole Jagdish	examining their microstructure and the effects of welding settings on the UTS of AISI 304 and IS 2062.	Welding current, welding voltage, gas pressure.	Identification of optimal parameters for maximum tensile strength and studying microstructural changes during welding.	2020
11	Optimization of the process parameters for MIG welding of AISI 304 and is 1079 using fuzzy logic method	Prasenjit Mondal, Dipankar Bose	Adjusting MIG welding parameters for stainless steel and mild steel junctions with different metals.	Welding current, welding voltage, welding speed.	Enhanced MIG welding performance and parameter optimisation utilising the Taguchi method.	2015
12	Optimization of MAG welding process parameters using Taguchi design method on dead mild steel used in automotive industry	Tadele Tesfaw1, Ajit Pal Singh, Abebaw Mekonnen Gezahegn1, Berhanu Tolosa Garedew	enhanced welding hardness by employing the Taguchi method's ideal parameter choices.	Welding voltage, welding current, wire speed, and gas flow rate.	increased welding hardness by applying the Taguchi method to select the parameters optimally.	2021
13	Optimization of MIG welding parameters for improving strength of welded joints	Sindiri Mahesh, Mr. Velamala.Appalar aju	Determine the ideal conditions for the welded joint's maximal tensile strength.	Welding current, welding voltage, welding speed.	The validity of the Taguchi approach for optimising the MIG welding parameters (400 mm/s, 26 volts, and 180 amps) has	2017

					been demonstrated by experimental findings.	
14	Optimization of MAG welding process parameters using Taguchi design method	Kapil B. Pipavat, Dr. Divyang Pandya, Mr. Vivek Patel	influence of welding parameters on austenitic stainless steel's mechanical characteristics (tensile strength, hardness), including current, voltage, and speed.	current, voltage, and speed.	The most important factor was likewise discovered in this instance, where welding current contributed the highest proportion. Therefore, it has the greatest impact on the outcome.	2020
15	Effect of tig welding parameter of welded joint of stainless steel SS304 by TIG welding	Manabendra Saha, S. S. Dhami	To establish the best welding conditions for stainless steel SS304 TIG welding with better tensile strength, hardness, and penetration.	current, filler wire rod diameter, gas flow rate and speed.	Using the best welding conditions, the tensile strength improved from 515 MPa to 556 MPa, increasing the joint strength by 10.56%.	2019
16	Mechanical assessment of SS 304 & SS316L by using pulsed tig welding process	Darbha Rohit, Kunapuli Naga Sriranga Abhiram, Boppidi Sumanth Reddy, Valaboju Anvesh	SS 304 and SS 316L joints' mechanical properties and microstructure will be evaluated utilising pulsed TIG welding.	Gas Flow Rate, Welding Current & Root Gap	Using pulsed TIG welding, new information about the mechanical properties and microstructure of SS 304 and SS 316L joints is revealed.	2021
17	Characterization and analysis of TIG welded stainless steel 304 alloy plates using radiography and destructive testing techniques	Ajay Prakash Pasupulla, Habtamu Abebe Agisho, Suresh Seetharaman, S. Vijayakumar	evaluating the mechanical behaviours of welded joints, such as tensile, bending, hardness, and impact tests, in relation to the flaws they cause.	Heat, pressure, and non-consumable electrodes.	Radiography testing and destructive testing for the evaluation of TIG welded plate flaws, mechanical characteristics, and performance.	2021
18	Influences of groove angles and filler metals on 304l stainless steel to AISI 1040 carbon steel dissimilar joint by gas tungsten arc welding	Eriek Wahyu Restu Widodo, Vuri Ayu Setyowati, Suheni, and Ahmad Rilo Hardianto	Influence of Groove Angles and Filler Metals	Groove Angles & Filler Metals	With ER 308L-16 filler metal, the groove angle of 60° produced the highest tensile strength (614.54 MPa).	2019
19	Effect of welding methods for different carbon content of SS304 and SS3041 materials on the mechanical properties and microstructure	VA Setyowati, Suheni, F Abdul and S Ariyadi	Effect of welding techniques for materials with various carbon contents on the mechanical characteristics and microstructure of SS304 and SS3041	current, voltage, and speed.	The maximum tensile stress value 679.64 MPa occurs in SS304 material when MIG we	2018
20	Experimental investigation and comparative study of MIG & TIG welding on SS202 and SS304 materials	Raghuram Pradhan, Krishna Prasad K.M, SD Asif, Sai Krishna G., Rama Krishna A and Muruthy D.S.S.K	Compare the physical and mechanical characteristics of TIG and MIG-welded joints made from SS202 and SS304.	welding current, arc voltage, welding speed	Between TIG and MIG welded connections, significant differences in the physical and mechanical properties have been identified.	2019
21	Mechanical properties assessment of TIG welded SS 304 joints	Aishna Mahajan, Harvinder Singh, Satish Kumar, Santosh Kumar	determine how the filler material composition affects the welding characteristics of stainless steel (SS) 304	Filler material	The joints manufactured with the filler materials ER 310, ER 316L, and ER 308L had high alloying components	2022
22	Common root causes of pressure vessel failures: a review	M. A. Khattak, A. Mukhtar and K. Azam Khan	Failure potential of pressure vessels exposed to cyclic pressure or vibration	Impact toughness, absorbed , crack-tip plastic zone, fatigue crack growth	identifying the causes of pressure vessel failures and emphasising the importance of correct	2016

					design, operation, and inspection.	
23	Reactor Pressure Vessel (RPV) Design and Fabrication: A Literature Review	M. A. Khattak, A. Mukhtar, A. F. Rafique, and N. Zareen	Give a brief introduction of pressure vessels, focusing on their structure, material, design, and any pertinent details.	SME Boiler and Pressure Vessel Code.	A516 is the material that has been examined and used the most frequently for pressure vessel design and construction, according to an analysis of 32 studies.	2016
24	Parametric optimization of MIG welding for stainless steel (ss-304) and low carbon steel using Taguchi design method	Vikas Chauhan and Dr. R. S. Jadoun	To enhance the MIG welding procedure for fusing various metals	Current, voltage, and travel speed	Analysis of tensile strength of the joint, confirming the effectiveness of the improved welding process.	2015
25	The effect of gas metal arc welding (GMAW) processes on different welding parameters	Izzatul Aini Ibrahim, Syarul Asraf Mohamat, Amalina Amir, Abdul Ghalib	Examine how the arc voltage, welding current, and welding speed affect the GMAW process' penetration, microstructure, and hardness.	Current, voltage, and travel speed	Analysis of how welding factors affect the depth of penetration, microstructural changes, and hardness.	2012
26	Optimization on machining parameters of friction surfacing of SS304 over iron plate	S. Sakthivelu, P.P. Sethusundaram, M. Selwin, M. Meignanamoorthy d, S. Dinesh Kumar, S.V. Alagarsamy	Through friction surfacing with SS304 coating, iron substrate surface qualities can be improved.	Rotational speed, axial load, and traverse speed.	enhancements to wear resistance, corrosion resistance, maximum displacement, hardness, and bonding strength.	2020

3 CONCLUSION

With a focus on enhancing the ultimate tensile strength and percentage of elongation, this literature analysis offers useful insights into the multi-objective optimisation of process parameters in MIG welding. The investigations under consideration covered a variety of materials, including mild steel (AISI 1030, AISI 1050, IS 1079), aluminium alloy (AA 6061 T6), stainless steel (SS304, SS304L, SS316, SS316L), and their corresponding weld joints. The impacts of welding parameters were investigated using a variety of welding procedures, including MIG (Metal Inert Gas), TIG (Tungsten Inert Gas), MAG (Metal Active Gas), and hybrid TIG-MIG approaches.

In terms of time and money savings, the Taguchi approach has a big benefit. It assists in determining the ideal set of parameters for enhancing product quality by utilising an orthogonal array design and signal-to-noise ratio analysis. This methodical approach lowers the necessary number of experiments, decreasing expenses and quickening the optimisation process, making it a useful and affordable technique in the field of welding optimisation.

To find the important factors affecting weld quality, the optimisation efforts mainly used the Taguchi approach in conjunction with statistical tools like ANOVA (Analysis of Variance). The welding current, voltage, speed, stick out length, gas flow rate, shielding gas composition, electrode size, root gap, and filler material choice were all process variables that were looked at in the experiments.

The research made clear that careful process parameter optimisation can result in sizable weld quality improvements. Researchers improved the tensile strength, elongation, hardness, and structural integrity of the welded connections by methodically altering the welding conditions. In order to obtain desired mechanical qualities, the findings highlighted how crucial it is to choose the right welding processes, optimise welding conditions, and use the right filler materials.

A thorough analysis of the examined literature shows the variety of materials, welding methods, and process variables that have been looked at to increase the ultimate tensile strength and percentage of elongation in MIG welded joints. The concluding observations highlight the necessity of parameter selection and process optimisation for obtaining high-quality welds, greater strength, and improved ductility.

Overall, this literature study offers insightful information on how to optimise MIG welding process variables for increasing ultimate tensile strength and percentage of elongation. The findings from the evaluated studies can direct future research and provide as a resource for professionals in the industry looking to improve weld quality and productivity.

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