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# EFFECT OF WELDING SPEED AND DEPTH OF PENETRATION IN BUTT WELD JOINT USING TIG WELDING

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***Abstract***: *Welding is the metal joining process in which two or more metal having same material or different can be joined by heating to a plastic state .It is mostly used for joining metals in process industry, in fabrication, maintenance, repair of parts and structures. The metal plates and pipes used in process industry and they have welding strength as their important parameter.*

*In this thesis, the welding speed and geometry to find out tensile And hardness in case of butt weld joint will be done. For V-groove geometry different models of plate with various included angles from $30^0$, $40^0$, $50^0$will be made from stainless steel (SS grade 304). Currently different welding speed and welding current are used in precision welding applications such as nuclear reactor pressure vessels, boilers etc. where welding accuracy as well as quality with strength is an important parameter. So in this project experimentation will be done on different welding speed such as 0.6 cm/sec, 1.10 cm/sec and 1.20cm/sec welding current 80A, 100A and 120A to prepare a V-groove butt weld joint. Generally the V-groove geometry with included angle up to $60^0$ is in use.*

## I. INTRODUCTION

Welding is, at its centre, merely the way of bonding 2 objects of metallic. Whereas there are opportunity approaches in which to affix metallic (riveting, brazing and bonding, as an example), attachment has turn out to be the strategy of selection for its electricity, potency and flexibility.

There are loads of completely special attachment methods, and a number of are being unreal all of the time. Some methods use warmth to generally melt 2 objects of metal along, commonly including "filler

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steel" into the joint to behave as a binding agent. Opportunity methods deem pressure to bind metal along, and still others use a mixture of each heat and stress. No longer like bonding and brazing, anywhere the metal gadgets being joined stay unaltered, the approach of attachment continually adjustments the work items.

This may appear to be a trivial reason; however it is certainly vital to know-how why attachment produces such robust bonds. In the approaches of soldering and brazing, portions of steel are joined with the aid of introducing a third material (with a decrease melting factor) into the mixture. Melting this 0.33 material among the surfaces of the unique portions binds the portions together. The bond, but, is handiest as robust as the becoming a member of material. Welding, then again, cuts out the intermediary and joins the original portions immediately to each other. The result is a strong, cohesive bond that's regularly as strong as the fabric itself.

## THE HISTORY OF WELDING

With all of the energy and precision equipment involved in manufacturing welding, you might think about welding as a pretty new system. In reality, welding has been around for hundreds of years. Early examples of welding were discovered in places ranging from Ireland to India, with some dating again to the Bronze Age. Naturally, these civilizations lacked the widespread array of equipment and equipment that welders have get admission to now. How did they manage to weld?

The procedure they used is referred to as forge welding. To start the manner, black smiths might warmth the steel until it become bright crimson in coloration (however still not at its melting factor). The blacksmiths could then place the two portions, barely overlapping, on an anvil and pound them together. Forge welding has multiple barriers. Only tremendously s-oft metals may be forge welded, and the manner may be very exertions intensive. In places without energy, however, the system remains used.

Forge welding becomes the handiest sport in town till the nineteenth century. With the onset of the industrial revolution, however, several discoveries pushed welding ahead rapid. Research on energy yielded electrodes and electric powered arcs. Rudimentary torches had been evolved by way of mid-century as well. Both discoveries might play heavily into the welding strategies of the subsequent century.

By the past due 80 0s, numerous of the items have been in situ to create

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attachment a propulsion in producing. Still, the methods of this period weren't true. Chemical response (the technique of metals bonding to the O particles inside the surroundings) befell at some point of the attachment technique and created welds porous and brittle. Such welds posed a grave chance to team of workers. Throughout the amount from 1895 to 1905, as an example, poorly created boilers exploded every day, inflicting hundreds of deaths inside the technique. Clearly there has been a pressing want for higher attachment approaches.

## WELDING TOOLS OF THE TRADE

The most primary attachment rigs, for occasional use in a totally home workshop, may be had for under $100. Typically, those rigs are discovered out for covered metal arc welding (SMAW), or stick attachment. Several gadgets entirely have AN on/off transfer within the manner of controls, creating them smooth to work. Torch attachment rigs are little and easy to parent with, that could be a aspect of why they are unremarkably used. These torches use oxyacetylene for the flame, beside a filler rod. But therefore me rigs (like the ones utilized in laser-beam welding) are so luxurious and complex that they may be totally utilized in commercial applications

As for substances, a few are plenty of easier to weld than others Steel may be a fantastic choice because of its power, affordability and weld ability. As a rule, the more potent the metallic, the harder it's to weld. Consequently, many metallic alloys had been developed with attachment in thoughts. Of path, actually any metallic will be welded, in addition to forged iron, bronze, steel element and even metallic, although the latter wishes an extremely covered atmosphere as a result of the metal is consequently reactive.

Whatever you are welding, bear in mind: protection first. If you have ever seen welding in man or woman, you could testify to the blinding brightness the system creates. Looking directly at a weld web page without protection can produce what is referred to as arc eye, a painful irritation of the cornea that feels like getting sand on your eye. No surprise that an awesome welder's mask is a prerequisite for any welding outfit.

Welding mask are available many patterns. The handiest ones have a darkened panel that the welder seems thru even as welding. More superior masks automobile-darken as the welding website receives brighter.

## II. LITERATURE SURVEY

### 1. Effect of welding geometry parameter on hardness for aisi304 tag.

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Welding is an area wherein technological tendencies out match the tendencies in its technology base that's generally driven with the aid of the outstanding industrial demand for welded structure. Reliability, Reproducibility and Viability necessities are forcing Technologists to take a look at weld defects consisting of distortion, warm cracking, in a systematic and logical technique than on experimental basis. Distortion is an unwanted bodily trade from specs in a fabricated structures is as a result of non-uniform growth and contraction of the weld metal at some stage in heating and cooling cycle of the welding manner many factors viz., fabric houses, welding system and strategies followed make accurate prediction of distortion hard. Groove perspective, Root gap and root face become taken to analyze Hardness in butt weld joints.

**2. A overview paper on impact of welding pace and groove angle on Strength of butt weld joint the usage of tig welding.**

Welding is most critical operation in any enterprise. It is crucial to optimize the diverse parameters of welding process in order that we can achieve the reliability, productivity and great of the goods. So industries are forcing the engineers to take a look at the welding manner Parameters including electrodes, inert fuel, present day, voltage and so forth. The objective of any industry is manufacturing of excessive quality merchandise at low fee and increases the manufacturing fee. TIG welding system is versatile and normally used operation for joining of materials with the software of warmth and /or strain or fillet material to increase the production with much less time and price. The up going examine is performed to analyze the impact of welding speed, groove angle and bevel top on strength of mechanical residences along with tensile check, effect take a look at. Also the current examine purpose to investigate the impact of welding speed on hardness of HAZ (Heat Affected Zone) and longitudinal and transverse distortion of butt weld joint. Mechanical testing's performed to discover the mechanical houses of butt weld joint.

**3. Studies on Effects of Welding Parameters on the Mechanical Properties of Welded Low-Carbon Steel.**

In this work, the impact of warmth input at the mechanical homes of low-carbon metallic became studied the use of welding approaches: Oxy-Acetylene Welding (OAW) and Shielded Metal Arc Welding (SMAW). Two special edge preparations on a particular size, 10-mm thick low-carbon metallic, with the following

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welding parameters: twin welding voltage of 100 V and 220 V, various welding currents at 100, one hundred twenty, and 150 Amperes and unique slight metal electrode gauges of 10 and 12 were investigated. The tensile power, hardness and effect electricity of the welded joint had been carried out and it changed into found that the tensile energy and hardness lessen with the increase in heat input into the weld. However, the effect power of the weldment increases with the increase in heat enters. Besides it was additionally found that V-grooved aspect training has higher mechanical properties as compared with directly part training under the equal situations. Micro structural examinations carried out discovered that the cooling charge in specific media has substantial impact on the microstructure of the well-meant. Pearlier and ferrite have been located within the microstructure, however the proportion of ferrite to pearlier various below distinct situations.

**4. Optimisation of Tig Welding Parameters via the use of Taguchi's Approach – A Review**

The goal of any enterprise is production of excessive great merchandise at low fee and increase the manufacturing charge. Welding is most vital operation in any industry. It is critical to optimize the various parameters via; welding modern, welding velocity, voltage, gasoline goes with the flow rate, and so on. Of welding process in order that we will achieve the reliability, productiveness and great of the goods. TIG welding technique is flexible and normally used operation for joining of two substances with the utility of heat and /or strain or filler material to growth the production with less time and price. The cause of this observe is to describe one-of-a-kind strategies to decide close to most advantageous settings of the welding method parameters in TIG welding. The homes of the welded joints such as tensile electricity, effect pressure, hardness and so forth. Are laid low with unique welding parameters.

5. Effect of Pulsed Current Tig Welding Parameters on Mechanical Properties of J-Joint Strength of Aa6351.

The charge at which automation is being delivered into welding manner is dazzling and it may be anticipated that with the aid of the cease of this century more automated machines than guys in welding fabrication units may be found. To make powerful use of the automated systems it's far essential that a excessive diploma of self assurance be achieved in predicting the weld parameters to achieve the favoured mechanical energy in welded joints. Higher high-quality welds with fewer defects like porosity, and cracking

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and material residences toward the figure steel are most required in the present production procedures. The mechanical houses of the elements of AA6351 for the duration of the Gas Tungsten Arc Welding (GTAW)/Tungsten Inert Gas Welding (TIG) with non-pulsed and pulsed cutting-edge welding at extraordinary frequencies 3Hz and 7Hz is attempted on these paintings. The radiography and mechanical houses of the elements had been tested and as compared with non-pulse and pulsed modern welding (PCW).

## III METHODOLOGY

### Objective of the work

In this proposal, materials stain less Steel is welded by changing procedure parameters welding speed, welding current and welding voltage. Impact of process current on the rigidity of weld joint will be broke down.

### PROCESS PARAMETERS OF TIG WELDING THE PARAMETERS THAT AFFECT THE QUALITY AND OUTCOME OF THE TIG WELDING PROCESS ARE GIVEN BELOW.

**1 Welding Current**

Higher current in TIG welding can lead to splatter and work piece become damage. Again lower current setting in TIG welding lead to sticking of the filler wire. Sometimes larger heat affected area can be found for lower welding current, as high temperatures need to applied for longer periods of time to deposit the same amount of filling materials. Fixed current mode will vary the voltage in order to maintain a constant arc current.

**2 Welding Voltage**:

Welding Voltage can be fixed or adjustable depending on the TIG welding equipment. A high initial voltage allows for easy arc initiation and a greater range of working tip distance. Too high voltage, can lead to large variable in welding quality.

**3 Inert Gases:**

The choice of shielding gas is depends on the working metals and effects on the welding cost, weld temperature, arc stability, weld speed, splatter, electrode life etc. it also affects the finished weld penetration depth and surface profile, porosity, corrosion resistance, strength, hardness and brittleness of the weld material. Argon or Helium may be used successfully for TIG welding applications. For welding of extremely thin material pure argon is used. Argon generally provides an arc which operates more smoothly and quietly. 7 Penetration of arc is less when Argon is used than the arc obtained by the use of Helium. For these reasons argon is preferred for most of the applications, except where higher heat and penetration is required for welding metals

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of high heat conductivity in larger thicknesses. Aluminium and copper are metals of high heat conductivity and are examples of the type of material for which helium is advantageous in welding relatively thick sections. Pure argon can be used for welding of structural steels, low alloyed steels, stainless steels, aluminium, copper, titanium and magnesium. Argon hydrogen mixture is used for welding of some grades of stainless steels and nickel alloys. Pure helium may be used for aluminium and copper. Helium argon mixtures may be used for low alloy steels, aluminium and copper.

**d) Welding speed:**

Welding speed is an important parameter for TIG welding. If the welding speed is increased, power or heat input per unit length of weld is decreases, therefore less weld reinforcement results and penetration of welding decreases. Welding speed or travel speed is primarily control the bead size and penetration of weld. It is interdependent with current. Excessive high welding speed decreases wetting action, increases tendency of undercut, porosity and uneven bead shapes while slower welding speed reduces the tendency to porosity.

In this thesis, experiments are made to understand the effect of TIG welding parameters welding speed and groove angle on output parameters such as hardness of welding, tensile strength of welding.

TIG welding experimental images

**VERTICAL POSITION**

In the vertical position, a forward and backward weave is suggested for the weaving designs, the welding weapon movements and the dot successions for light measure with a back advance in the measure of the wire breadth at the dividers. For vertical up filet weld a Christmas tree design is prescribed with stops along the edge dividers. In the vertical down welding, a 844 topsy-turvy U design with delays along the edge dividers is utilized. In vertical down welding the weld puddle tends to stream down in front of the anode tip and in this manner the movement speed must be sufficiently high with the goal that the liquid metal streaming down does not occur between the cathode tip and the base metal.

Finished components

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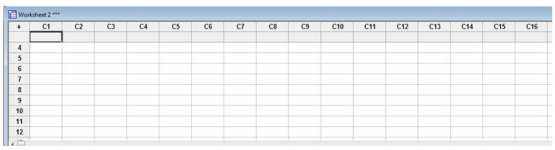
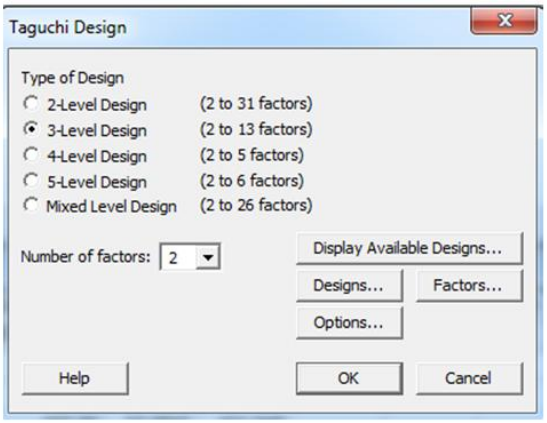
## IV DESIGN AND ANALYSIS

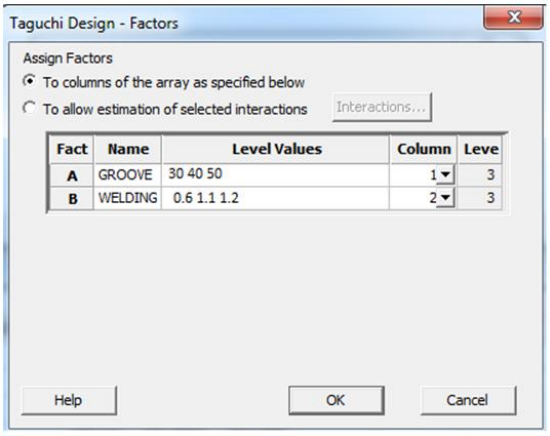
### Design of Orthogonal Array

First Taguchi Orthogonal Array is designed in Minitab17 to calculate S/N ratio and Means which steps is given below:



### FACTORS




### OPTIMIZATION OF PARAMETERS

Worksheet 1 ***

| | C1 | C2 |
|---|---|---|
| | GROOVE ANGLE | WELDING SPEED |
| 1 | 30 | 0.6 |
| 2 | 30 | 1.1 |
| 3 | 30 | 1.2 |
| 4 | 40 | 0.6 |
| 5 | 40 | 1.1 |
| 6 | 40 | 1.2 |
| 7 | 50 | 0.6 |
| 8 | 50 | 1.1 |
| 9 | 50 | 1.2 |

Worksheet 1 ***

| | C1 | C2 | C3 |
|---|---|---|---|
| | GROOVE ANGLE | WELDING SPEED | TENSILE STRENGTH |
| 1 | 30 | 0.6 | 597.149 |
| 2 | 30 | 1.1 | 410.000 |
| 3 | 30 | 1.2 | 451.197 |
| 4 | 40 | 0.6 | 698.132 |
| 5 | 40 | 1.1 | 440.581 |
| 6 | 40 | 1.2 | 372.000 |
| 7 | 50 | 0.6 | 375.287 |
| 8 | 50 | 1.1 | 369.000 |
| 9 | 50 | 1.2 | 378.000 |

## V Results

Taguchi technique stresses the significance of reading the response variant the usage of the sign–to–noise (S/N) ratio, resulting in minimization of great characteristic variation due to uncontrollable parameter. The slicing pressure is taken into consideration because the quality features with the idea of "the larger-the-better". The S/N ratio for the larger-the-higher is:

$$S/N = -10 * \log (\Sigma(Y2)/n))$$

Where n is the range of measurements in a tribulation/row, in this case, n=1 and y is the measured value in a run/row. The S/N ratio values are calculated by means of

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taking into account above Eqn. With the help of software program Minitab 17.

The pressure values measured from the experiments and their corresponding S/N ratio values are listed in Table

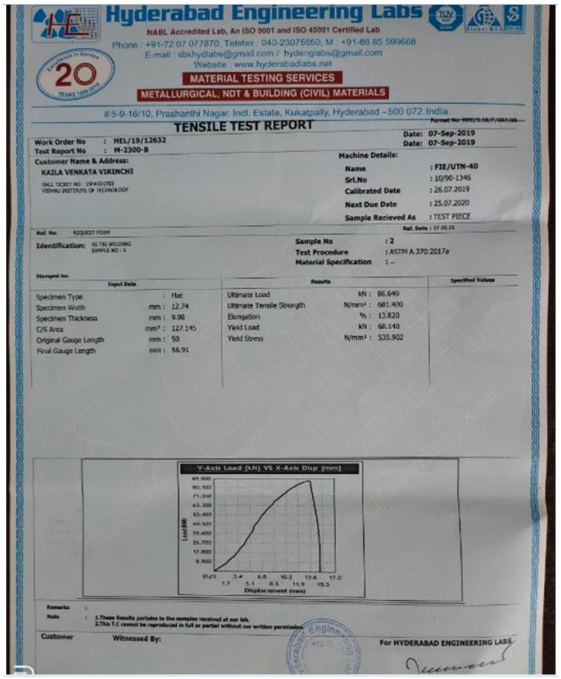
Worksheet 1 ***

| | C1 | C2 | C3 | C4 | C5 | C6 |
|---|---|---|---|---|---|---|
| | GROOVE ANGLE | WELDING SPEED | TENSILE STRENGTH | TENSILE STRENGTH1 | SNRA1 | MEAN1 |
| 1 | 30 | 0.6 | 598.143 | 376.00 | 51.4922 | 375.500 |
| 2 | 30 | 1.1 | 410.000 | 409.00 | 52.2451 | 409.500 |
| 3 | 30 | 1.2 | 451.197 | 450.90 | 53.0845 | 451.048 |
| 4 | 40 | 0.6 | 678. 173 | 403.01 | 52.1062 | 403.005 |
| 5 | 40 | 1.1 | 440.581 | 441.21 | 52.8867 | 440.895 |
| 6 | 40 | 1.2 | 372.000 | 372.10 | 51.4120 | 372.050 |
| 7 | 50 | 0.6 | 375.287 | 375.26 | 51.4870 | 375.274 |
| 8 | 50 | 1.1 | 369.000 | 368.00 | 51.3287 | 368.500 |
| 9 | 50 | 1.2 | 378.000 | 379.00 | 51.5613 | 378.500 |

The experiment designed by Taguchi method fulfils the desired objective. Fuzzy interference system has been used to find out the ultimate tensile strength .The all possible values of have been calculated by using MINITAB 17.0 software. Analysis of variance (ANOVA) helps to find out the significance level of the each parameter. The optimum value was predicted using MINITAB-17 software.

The welding parameters are welding speed, and groove angle for TIG welding of work piece steel. In this work, the optimal parameters of welding speed are 0.4cm/s, 0.8 cm/s & 1.2 cm/s, groove angle 35, 45 and 50 degrees. Experimental work is conducted by considering the above parameters. Ultimate tensile strength validated experimentally.

The experimental results confirmed the validity of the used Taguchi method for enhancing the welding performance and optimizing the welding parameters in TIG welding at welding speed 1.2 cm/s , and groove angle $35^0$.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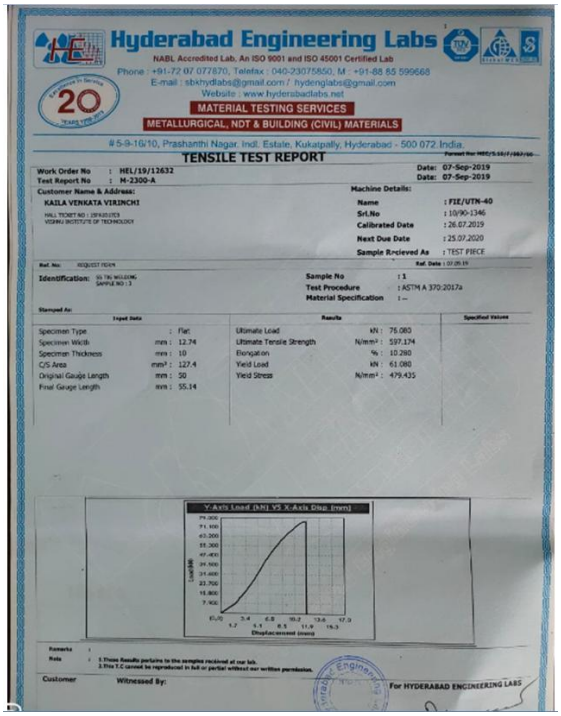
MATERIAL TESTING SERVICES
METALLURGICAL, NDT & BUILDING (CIVIL) MATERIALS
TENSILE TEST REPORT
Work Order No : HEL/19/12632
Test Report No : M-2300-B
Customer Name & Address: KAILA VENKATA VIRINCHI
Machine Details:
Name : FIE/UTN-40
Sr.No : 10/90-1346
Calibrated Date : 26.07.2019
Next Due Date : 25.07.2020
Sample Recieved As : TEST PIECE
Sample No : 2
Test Procedure : ASTM A 370:2017a
Material Specification : --
Specimen Type : Flat
Specimen Width : 12.74 mm
Specimen Thickness : 9.98 mm
C/S Area : 127.145 mm²
Original Gauge Length : 50 mm
Final Gauge Length : 56.91 mm
Ultimate Load : 86.640 kN
Ultimate Tensile Strength : 681.400 N/mm²
Elongation : 13.820 %
Yield Load : 68.140 kN
Yield Stress : 535.902 N/mm²
Y-Axis Load (kN) VS X-Axis Disp (mm)
Witnessed By:
For HYDERABAD ENGINEERING LABS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Sr.No : 10/90-1346
Calibrated Date : 26.07.2019
Next Due Date : 25.07.2020
Sample Recieved As : TEST PIECE
Sample No : 1
Test Procedure : ASTM A 370:2017a
Material Specification : --
Specimen Type : Flat
Specimen Width : 12.74 mm
Specimen Thickness : 10 mm
C/S Area : 127.4 mm²
Original Gauge Length : 50 mm
Final Gauge Length : 55.14 mm
Ultimate Load : 76.080 kN
Ultimate Tensile Strength : 597.174 N/mm²
Elongation : 10.280 %
Yield Load : 61.080 kN
Yield Stress : 479.435 N/mm²
Y-Axis Load (kN) VS X-Axis Disp (mm)
Witnessed By:
For HYDERABAD ENGINEERING LABS

## VI CONCLUSION

The experiment designed by Taguchi method fulfils the desired objective. Fuzzy

interference system has been used to find out the ultimate tensile strength .The all possible values of have been calculated by using MINITAB 17.0 software. Analysis of variance (ANOVA) helps to find out the significance level of the each parameter. The optimum value was predicted using MINITAB-17 software.

The welding parameters are welding speed, and groove angle for TIG welding of work piece stainless steel. In this work, the optimal parameters of welding speed are 0.6cm/s, 1.1 cm/s & 1.2cm/s, groove angle 30, 40 and 50 degrees. Experimental work is conducted by considering the above parameters. Ultimate tensile strength validated experimentally.

The experimental results confirmed the validity of the used Taguchi method for enhancing the welding performance and optimizing the welding parameters in TIG welding at welding speed 1.2 cm/s, welding current at 100A and groove angle 30.

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