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A MIG WELDING TESTING ON TENSILE, AND HARDNESS USING TAGUCHI METHOD

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ABSTRACT

Parametric optimization of MIG welding for Hardness has been performed by using Taguchi method. Welding Speed, Welding Current and Welding Voltage were chosen as welding parameters. Welding is a complex manufacturing process that generates extremely high temperatures and temperature gradients at and near the weld bead.
The aim of the present research is to show the influence of different input parameters such as welding current, arc voltage and root gap on the mechanical properties during the Metal Inert Gas Welding (MIG) of mild steel. Optimization of parameters was done by Taguchi method using statistical software MATLAB 2014Ra. Confirmation tests were carried out with optimal levels of welding parameters to validate the Taguchi's optimization method.

Keywords: MATLAB, MIG Welding, Aluminum, Taguchi method etc.

I. INTRODUCTION

Pure aluminum having poor strength is improved by alloying with other metals. Lightweight materials like aluminum alloys possessing high specific strength and corrosion resistance are being used in automotive and aerospace industries. Many components are made by casting and few of them may require welding. They will be loaded statically and dynamically as per requirement. Metal inert gas (MIG) welding and tungsten inert gas (TIG) welding (see Figure 1) are widely used techniques for joining ferrous and non-ferrous metals. Both welding processes initially superheat the parent metals into a liquid state, and finally a filler material is used to fuse the parent metals together. They use a shielding during welding process. MIG welding runs the filler material from a wire coil through the MIG torch. This wire carries the electrical current, and does the actual welding. TIG welding uses a tungsten electrode to superheat the parent metals. The filler material will be dabbed onto the weld puddle. The sharpened tungsten

electrode is poking out the front of the torch when the two metals have reached a liquid state. TIG welding uses pure argon welding gas, whereas MIG welding generally uses a mix of 25% Argon, 75% CO_2. TIG welding process is a more versatile than the MIG welding process due to quick changing of the filler material by just grabbing another rod, whereas MIG welding requires a wire change.

In general, the quality of a weld joint is influenced by the weld input process parameters. This is the reason why the welding is considered as a multi-input and multi-output process. Hence there is a necessity for identifying the optimum weld process parameters to achieve the required quality of a weld joint with minimal detrimental residual stresses and distortion. Various optimization techniques have been adopted to specify the optimum weld process parameters for achieving the required quality of a weld joint, and to avoid the time-consuming trial and error developmental efforts of the process engineers.

Welding

Welding of steels is a metal-joining process used in various manufacturing industries. The United States of America is currently the third largest producer of steel behind China and Japan. [1] Welding is a widely used manufacturing process in multiple production fields, namely, recreational equipment, defense technology, transportation, pipelines, and structural design. The widespread applications of steel piping in corrosive environments can be hindered by metallurgical damage caused by extremely high temperatures generated during

welding. Welding is extensively used in industry though with a known failure rate as there are no good alternatives to replace it. Pipe industries utilize carbon steels in millions of miles of non-submerged and submerged pipelines for the transport of multiple media; water, natural gas, oil, sewage, drainage. Overall,welding is a necessary but an unfavorable manufacturing process.
Welding processes are classified into two main categories solid-phase welding and fusion-phase welding. The main difference is the lack of pressure in the solid-phase and dependence on pressure in the fusion-phase.

II. Literature survey

Chavda, S. P., et al (2014) [1] investigated the effect of welding parameters : current, welding voltage, Gas flow rate and wire feed rate on weld strength, weld pool geometry of medium Carbon Steel material during welding by Taguchi method.

Kumar, D., et al. (2014) [2] considered optimization of the procedure parameters in GMAW by Taguchi's exploratory outline strategy. L9 Orthogonal Array was chosen to upgrade include welding parameters: voltage, current and gas stream rate influencing elasticity on 1018 Mild Steel. The ideal settings are: present of 220 A, voltage of 40V and gas stream rate of 17 lit/min.

Verma, S., et al. (2014) [3] performed experiments for acquiring better dot height and dot width independently. The ideal parameters blend of dot height for CRC steel 513 GR-D was welding voltage 26 volts, welding current 170 amps and the wire augmentation 10 mm, and for globule width was welding voltage 22 volts, current 190 amps and the wire expansion 10 mm.

Kadani, M., et al. (2014) [4] utilized Taguchi's orthogonal array configuration to build up a basic dab geometry based standard for choice of MIG welding process parameters to acquire the coveted reactions. Wire sustain rate (3-6m/min), bend voltage (14-18volt), welding speed (1.5-1.9mm/min), gas stream rate (8-16lit/min) and 6 to 8mm plate thickness are chosen as the information procedure parameters.

Patel, C., et al. (2013) [5] considered the accompanying procedure parameters: welding current, wire breadth and wire bolster rate to explore their impact for MIG welding and TIG welding. By utilization of GRA optimization method, the ideal parameter esteems for better hardness for MIG are 100amp present, 1.2 mm wire breadth and 3 m/min wire encourage rate. Correspondingly the qualities got for TIG are 80 amp present and 0.8mm wire breadth on Carbon Steel (plain).

Vishwakarma, B., et al. (2013) [6] contemplated the impact of terminal measurement, welding current, voltage and welding strategies on mechanical properties of gentle steel and process parameters arrangement into two gatherings (essential and optional). It was seen in microstructure examination that with expanding current and voltage the grains has a tendency to be coarser, while with expanding terminal breadth it has a tendency to be better. The experiments were performed between current range100A to 200A and voltage in the middle of 10 V to 30 V.

Boob, A. N., et al. (2013) [7] performed experiments for getting better microstructure. The information procedure parameters : welding current (150-200amp), welding voltage (30 volt) and welding speed (156-276mm/min) and reasoned that expansion in welding speed diminishes the width of warmth influenced zone.

Singh, V., (2013) [8] connected taguchi optimization strategy to locate the ideal procedure parameters for Tensile Strength. The enhanced esteems along these lines found for better rigidity are 40 CFH gas stream rate, 35V voltage and 1.5mm welding position hole.

Patil, U. S., et al. (2013) [9] connected Artificial Neural Fuzzy Interface framework to upgrade the procedure parameters for MMA welding of stainless steel and mellow steel. Ideal metal testimony is discovered for more noteworthy weld quality.

Sapakal, S. V., et al. (2012)[10] introduced optimization of impact parameters current, voltage and welding speed on entrance profundity of MS material with the assistance of Taguchi's plan.. The entrance acquired is 5.25mm with ideal welding parameters.

Satish, R. et al. (2012)[11] examined variety in warm info brought about huge changes in the mechanical properties of the weld. Lower warm info brought about lower rigidity and too high warmth input likewise brought about lessened elasticity. Gas stream (12.5 lpm) rate is the factor that altogether added to a higher rate and has more prominent effect on the elasticity took after by commitments from current (110 amp to 115 amp) and incline edge (450).

Kumar, L. S. et al. (2011) [12] looked at weld nature of MIG and TIG welded austenitic stainless steel. It

is inferred that TIG welded examples have higher extreme rigidity though MIG welded examples are more pliable.

III. PROBLEM STATEMENT

The goal of the present work is to examine the impact of three vital info parameters of MIG welding: bigger the better, medium the better and lower the better on the Tensile Strength of welded joints having grade low carbon mellow steel as parent metal. Likewise the second target of this work is to advance the Electric field quality info parameters for Maximum Tensile Strength of the weld.

IV. SYSTEM MODEL

4.1WORKING PRINCIPLE OF MIG WELDING

As appeared in fig. the electrode in this procedure is as loop and constantly nourished towards the work amid the procedure. In the meantime latent gas (e.g. argon, helium, or $CCCC2$) is passed around electrode from a similar light. Idle gas generally argon, helium, or a reasonable blend of these is utilized to keep the air from reaching the liquid metal and HAZ. At the point when gas is provided, it gets ionized and a bend is started in the middle of electrode and work piece. Warmth is subsequently delivered. The work-piece is associated with the negative extremity. The power source could be steady voltage DC control source, with electrode positive and it yields a steady curve and smooth metal exchange with slightest splash for the whole current range.

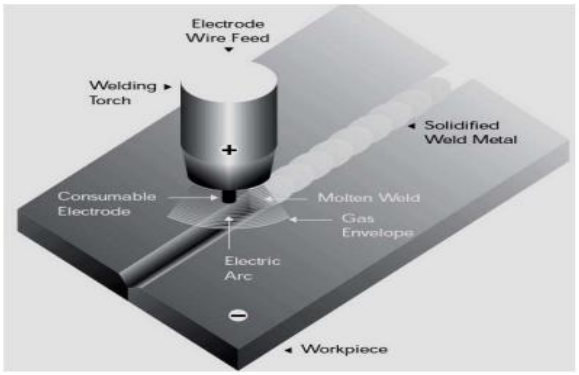

Figure 1: working condition of Work piece

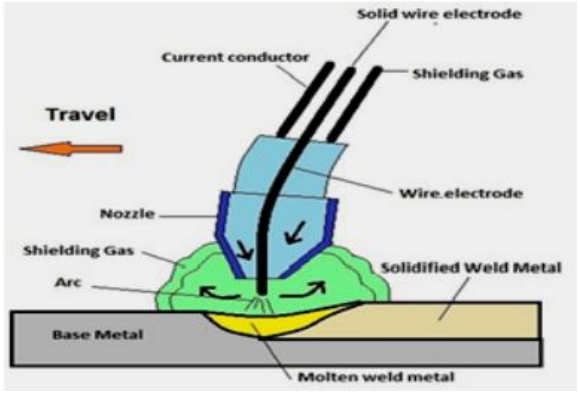

Figure 2: Working principles of GMAW

The gas shield around it doesn't ionized, which averts weld against environmental co tainting and surface oxidation. Some light has water cooling frameworks. MIG welding is likewise called Gas Metal Arc Welding. The filler metal is transmitted from electrode to joint by various strategies. It is reliant on the present going through the electrode and voltage.

4.2 GMAW / MIG welding applications

MIG may be operated in semiautomatic, machine, or automatic modes. All commercially important applicable metals such as carbon steel, high-strength, low-alloy steel, and stainless steel, aluminum, copper, titanium, and nickel alloys can be welded in all positions with this process by choosing the appropriate shielding gas, electrode, and welding variables.

4.3 MIG Welding Effecting parameters

Weld quality and weld testimony rate both are affected especially by the different welding parameters and joint geometry. Basically a welded joint can be delivered by different mixes of welding parameters and additionally joint geometries. These parameters are the procedure factors which control the weld affidavit rate and weld quality. The weld globule geometry, profundity of infiltration and general weld quality relies upon the accompanying working factors.

- Electrode estimate, Welding current, Arc voltage
- Arc travel speed, welding position
- Gas Flow rate, Shielding Gas piece
- Electrode augmentation (length of stand out)

a. Electrode Size

The electrode breadth impacts the weld dot design, (for example, the size), the profundity of infiltration, dot width and consequently affects the movement speed of welding. When in doubt, for a similar welding current (wire bolster speed setting) the curve turns out to be additionally infiltrating as the electrode breadth diminishes.

b. Welding Current

The benefit of welding current utilized as a part of MIG has the best impact on the statement rate, the weld globule size, shape and infiltration. In MIG welding, metals are by and large welded with coordinate current extremity electrode positive (DCEP, inverse to TIG welding), since it gives the greatest warmth contribution to the work and subsequently a moderately profound entrance can be gotten. [13]

c. Welding Voltage

The bend length (circular segment voltage) is a standout amongst the most essential factors in MIG that must be held under control. At the point when every one of the factors, for example, the electrode arrangement and sizes, the kind of protecting gas and the welding strategy are held consistent, the circular segment length is specifically identified with the curve voltage. The bend voltage to be utilized relies upon base metal thickness, sort of joint, electrode structure and size, protecting gas piece, welding position, kind of weld and different elements. [13]

4.4 Shielding Gas

The essential capacity of protecting gas is to ensure the bend and liquid weld, pool from environment oxygen and nitrogen. If not appropriately secured it frames oxides and nitrites and result in weld inadequacies, for example, porosity, slag consideration and weld embrittlement.

V. PROPOSED METHOD

Taguchi Design Method

The Taguchi method developed by GenuchiTaguchi is a statistical method used to improve the product quality. Optimization of process parameters is the key step in the Taguchi method for achieving high quality without increasing cost. This is because optimization of process parameters can improve quality characteristics and the optimal process parameters obtained from the Taguchi method are insensitive to the variation of environmental conditions and other noise factors.
Taguchi recommends the use of the loss function to measure the deviation of the quality characteristic from the desired value.
In this paper, the design of experiment work can be decided by this method.Steps of Taguchi method are as follows:

1. Identification of main function, side effects and failure mode.

2. Identification of noise factor, testing condition and quality characteristics.

3. Identification of the main function to be optimized.

4. Identification the control factor and their levels.

5. Selection of orthogonal array and matrix experiment.

6. Conducting the matrix experiment.

7. Analyzing the data, prediction of the optimum level and performance.

8. Performing the verification experiment and planning the future action.

VI. EXPERIMENTAL RESULTS

All the experimental results are analyzed by a power full statistical tool named MATLAB software of latest version 2014a. First of all the input parameters are defined in the software as per their corresponding value and then give the responses data to optimize. Here, the main objective of the problem is to maximize the Tensile Strenght. So, the criterion of Larger-The-Better is adopted for the optimization of Tensile Strenght.

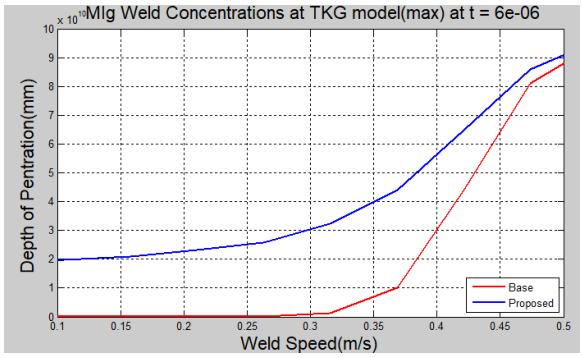

Figure 3: MIG weld concentration at TKG model (max) at t=6e-06

Hence, from the graph, it can be seen that the optimum welding parameter can be obtained by points or values of parameters having the peak position in the graph. Therefore Factor levels for predictions. Above figure show the larger the better for MIG welding.

Weld speed	Base (Depth of penetration (mm))	Proposed (Depth of penetration (mm))
0.1	0	2
0.15	0	2
0.2	0	2.2
0.25	0	2.5
0.3	0.1	3.0
0.35	0.8	4.0
0.4	3.0	5.8
0.45	6.5	7.8
0.5	8.8	9.2

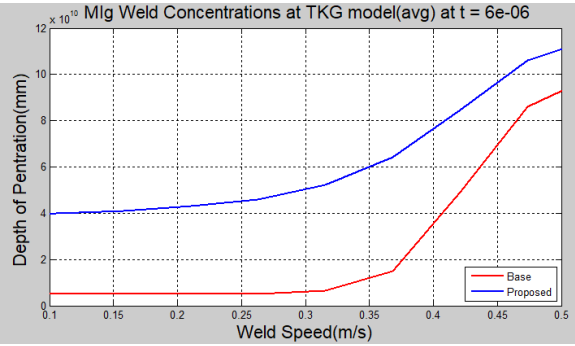

Figure 4: MIG weld concentration at TKG model (average) at t=6e-06

In figure 4 we show the depth of penetration as vice versa tensile strength of Base and proposed work for medium the better.

Weld speed	Base (Depth of penetration (mm))	Proposed (Depth of penetration (mm))
0.1	0.5	4
0.15	0.5	4
0.2	0.5	4.2
0.25	0.5	2.5
0.3	0.5	4.5
0.35	1.5	6.0
0.4	3.9	7.9
0.45	7.2	8.8
0.5	8.5	10.5

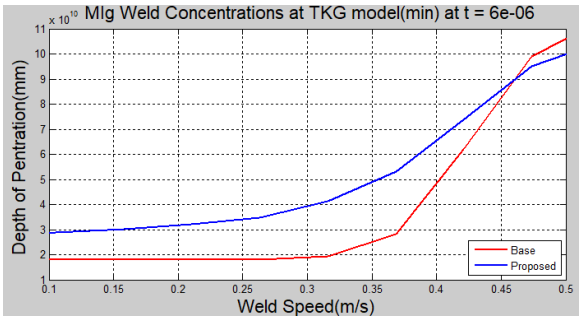

Figure 5: MIG weld concentration at TKG model (minimum) at t=6e-06

In figure 5 we show the depth of penetration as vice versa tensile strength of Base and proposed work for lower the better.

Weld speed	Base (Depth of penetration (mm))	Proposed (Depth of penetration (mm))
0.1	1.9	2.9
0.15	1.9	3.0
0.2	1.9	3.1
0.25	1.9	3.4
0.3	1.9	4.0
0.35	2.5	5.0
0.4	5.0	6.8
0.45	7.0	8.6
0.5	10.5	10.0

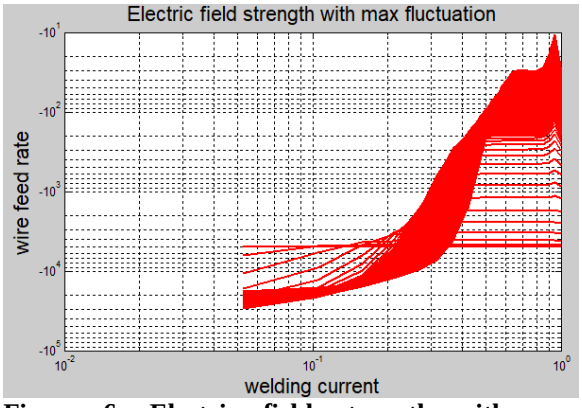

Figure 6: Electric field strength with max fluctuation

Figure 6 shows the electric field strength with maximum fluctuation when we applied the welding current for wire feed rate.

VII. CONCLUSION

Taguchi method was used to optimize the welding parameters which are affecting the weld penetration. An orthogonal array of Taguchi's design is used to find out the electric field strength which is then followed by analysis of larger the better, medium the better and lower the better. According to the result obtained from the statistical software it has been found that maximum penetration is 9.2.mm.

In MIG Welding method, we will optimize other parameters which are not used in this experiment and This experiment will be done for same method or workpice by other DOE method or other optimization techniques and also if you can be compared Experimental result with prediction result by using Finite Element Analysis.

REFERANCES

[1] Satyaduttsinh P. Chavda, JayeshV.Desai and TusharM.Patel , ―A Review on Optimization of MIG Welding Parameters using Taguchi's DOE Method‖, International Journal of Engineering and Management Research, vol.4(1), pp. 16-21, February 2014.

[2] Deepak Kumar and Sandeep Jindal, ―Optimization of Process Parameters of Gas Metal ARC Welding by Taguchi's Experimental Design Method‖, International Journal of Surface Engineering & Materials Technology, vol. 4 (1), pp. 24-27, January-June 2014.

[3] SudeshVerma and Rajdeep Singh, ―Optimization of Process Parameters of Metal Inert Gas Welding By Taguchi Method On CRC Steel IS 513 GR _D'', International Journal of Advance Research In Science And Engineering IJARSE, vol. 3 (9), pp. 187-197, September 2014.

[4] MallikarjunKadani and DR. G. K. Purohit, ―Developing A Bead Geometry Based Criterion For Selection Of Process Parameters Of Metal Inert Gas Welding Using Taguchi Techniques‖, Journal of Information , Knowledge and Research in Mechanical Engineering, Vol.3 (1), pp. 589-597, November 2013- October 2014.

[5] Chandresh. N. Patel and Sandip Chaudhary, ―Parametric Optimization of Weld Strength of Metal Inert Gas Welding and Tungsten Inert Gas Welding By Using Analysis of Variance and Grey Relational Analysis‖, International Journal of Research in Modern Engineering and Emerging Technology, Vol.1 (3), pp. 48-56, April 2013.

[6] B. Vishwakarma, M. Verma, and T. K. Mishra, ―Investigation of Welding Parameters on Mechanical Properties of Different Welding Joints of Mild Steel‖, International Journal on Mechanical Engineering and Robotics (IJMER), Vol.1 (1), pp. 23-27, 2013.

[7] Ajay N. Boob and G. K.Gattani, ―Study on Effect of Manual Metal Arc Welding Process Parameters on Width of Heat Affected Zone (Haz) For MS 1005 Steel‖, International Journal of Modern Engineering Research (IJMER), Vol. 3 (3), pp. 1493-1500 May-June 2013.

[8] Vikram Singh, ―An Investigation for Gas Metal Arc Welding optimum Parameters of Mild Steel AISI 1016 using Taguchi Method‖, International Journal of Engineering and Advanced Technology (IJEAT),Vol. 2 (6), pp. 407-409, August 2013.

[9] U. S. Patil and M. S. Kadam, ―Effect of Welding Process Parameters in MMAW for Joining Of Dissimilar Metals and Parameter Optimization Using Artificial Neural Fuzzy Interface System‖, International Journal of Mechanical Engineering and Technology, vol. 4 (2), pp.79-85, April 2013.

[10] S. V. Sapakal and M. T. Telsang, ―Parametric Optimization Of MIG Welding Using Taguchi Design Method‖, International Journal of Advanced Engineering Research and Studies, Vol.1 (4), pp. 28–30, JulySeptember 2012.

[11] R. Satish, B. Naveen and V. S. Rao, ―Process Parameter Optimization of Dissimilar Pipe Joints Using GTAW‖, International Journal of Engineering Research and Applications (IJERA), Vol. 2 (3), pp. 2525-2530, 2012.

[12] L. Suresh Kumar, S. M. Verma, P. Radhakrishna Prasad, P. Kiran kumar and T. Siva Shanker, ―Experimental Investigation for Welding Aspects of AISI 304 & 316 by Taguchi Technique for the Process of TIG & MIG Welding‖, International Journal of Engineering Trends and Technology, vol. 2 (2), pp. 28-33, 2011.

[13] Ador Welding Limited, "Modern Arc Welding Technology", Oxford &IBH Publishing Co. Pvt. Ltd (Book)