ISSN : 2455-9679
Impact Factor : 4.256

IJRTSM
INTERNATIONAL JOURNAL OF RECENT TECHNOLOGY SCIENCE & MANAGEMENT

"AN OPTIMIZATION ON WELDING PROCESS PARAMETERS USING TAGUCHI STATISTICAL APPROACH"

***Charles Joy* [1]*, Yogesh Mishra* [2]**

[1] *M.Tech. Scholar, Department of Mechanical Engineering, NRI Institute of Information Science & Technology, Bhopal*

[2] *Professor, Department of Mechanical Engineering, NRI Institute of Information Science & Technology, Bhopal*

ABSTRACT

In present thesis work, importance of optimization is taken care of using Taguchi and ANOVA statistical approaches. Weld joints between AISI 304 Stainless steel is fabricated and the weld distortion and depth of penetration are measured in various samples. These samples are fabricated with set of values of welding current, gas flow rate, root face and welding speed taking into consideration. Using Taguchi and ANOVA relations, the predicted values of weld distortion and depth of penetration are calculated and compared with the actually observed values. Since the predicted values are within the range of observed values, the corresponding sets of experimental values are considered to run the operations. Further, ANOVA results show the utilization of each process parameter in strengthening of the weld.

Key Words: *Optimization, ANOVA, Gas flow rate, Welding current, Root face, Welding speed.*

I. INTRODUCTION

Welding process is a two-way combination. It is the fastest and most economical process compared to all the spread and fraud. Metal detectors in the production of many products around us include a few ships, railway equipment, car launch, boilers, nuclear power plants, pipeline construction, piping, aircraft, cars etc. The various welding methods available are: Tungsten Inert Gas (TIG) Welding, Inert Gas Wert (MIG) Welding, Shielded Metal Arc Welding (SMAW), Plasma Arc Welding (PAW), Flux Cored Arc Welding (FCAW), Submerged Arc Welding (SAW), Gas Metal Arc Welding (GMAW), Electro Slag Welding (ESW) and Oxyacetylene (OA) Welding. Welding processes play an important role in the metalworking industry. There are different types of welding, but the most widely used types are tungsten inert gas (TIG) and inert gas processor (MIG / MAG). In the TIG welding process an inedible electrode is used but in the event of MIG welding a corrugated wire is used to join the metal. The metal gas heating system (MIG) consists of an AC motor heat exchanger, a soluble electrode, a water cooling and tightening tube for the parent steels and fillers in the area of the joint assembly is a temporary heat source to create a connection between the parent steels. WIG Welding parameters are the most important factors affecting the quality, production and cost of composite compositions. Factors such as current arc, arc voltage and welding speed and their interactions play a major role in the welding process. Welding process is used to permanently join various materials such as metals, alloys or plastics, together in their contact points through heat and pressure. During the welding process, the pieces of work to be assembled dissolve and after the solidification of the molten metal can be achieved by permanent bonding. Sometimes filler is installed that forms a weld pool of molten material between two or more work pieces which after hardening provides a strong bond between the work piece, welding, change in hardness in the weld area due to rapid hardening, high oxidation due to the reaction of atmospheric oxygen substances and the

ISSN : 2455-9679
Impact Factor : 4.256

tendency to form a stand in the welded area.

1.1. Technology Method

The Taguchi process is a mathematical method developed by Genichi Taguchi to improve the performance and quality of products. Based on Taguchi, the main point just before the analysis was the establishment of the study. Only in this way, it is possible to improve the quality of the process. This method can achieve the final output value and reduce the variance from the output value at a lower cost. He believes that the easiest way to improve quality is to build and build on the product. The main purpose of this method is to create a good product that is not expensive for the manufacturer. Taguchi has developed an experimental design approach to test how different parameters affect the meaning and variability of a process performance. The new layout that is easily designed by Taguchi includes the introduction of orthogonal layouts to develop guidelines that affect the path and the number at which it should be varied. Instead of tackling exploring all possible mixes as a true make-up, the real Taguchi method examines people for integration. The following will allow most of the facts needed to determine which variables are most likely to contribute to higher productivity using a low-volume trial, thus saving your time and resources. Taguchi arrangements are usually produced or tested small arrangements usually go slowly by hand; large-scale editing can be based on determination algorithms. Generally, the order can be purchased online. The setting is easily selected by the number of guidelines (variable) and the number of grades (levels).

II. LITERATURE REVIEW

Sudhir Kumar et al. (2019) research work, AISI 1018 steel samples are inserted into the V-butt by a combined arrangement using MIG welding. The test design is Taguchi based Orthogonal Array (L9). The effect of process parameters such as current temperatures, voltages and pre-temperature is studied and the welds are tested using X-ray radiographic examination. Weld quality is tested in terms of solid metal structures such as high strength and percentage elasticity. Process parameters are optimized using a Taguchi-based gray method.

Himanshu Yadav, et al. (2019) focuses on building performance of these frameworks to achieve the best parameter combination of targeted quality. In the fine-tuning of these parameters, the Taguchi method has emerged as the most widely accepted method by researchers for the across the globe.

Ravinder Kumar, et al. (2019) most widely studied Argon and Helium blend is preferred for improved welding quality because it does not respond to each other. Argon and Helium gases protect the welding area from the outside and help keep the arc stable due to low energy ionization. Aluminum is lightweight and is very effective in the aerospace, aviation, maritime, automotive, defense and other industries. TIG welding parameters such as current welding, flow rate and welding voltage are considered to affect the tensile strength, Hardness and Toughness of the aluminum weld joint. Welding parameters are controlled by electronic control units. The AC power supply prefers the use of aluminum as compared to DC electric power due to the melting of its aluminum melting point at lower levels.

Prakash BabuKanakavalli, et al. (2019) discussed the use of Taguchi and Gray-related analytical methods in determining the appropriate MIG Welding process criteria presented. The Taguchi method is widely used in constructing valid tests, while the gray relationship analysis assists decision-making when considering multiple approaches; this combination serves as an effective tool in determining the correct process parameters. In the current welding work current, voltage, speed, bevel angle were considered as the input parameters for combining two different metals (AISI1010 and AISI1018), as these influence the output characteristics such as tensile strength and stiffness, these parameters need to be adjusted.

Ashish Chafekar, in al. (2019) discussed the MIG semi-automatic welding machine according to the recurring L9 orthogonal array. Process parameters viz. welding voltage, wire feed rate and dynamic are important for a smart MIG welding machine that is considered flexible. Responses such as tensile strength, hardness and thermal conductivity (HAZ) of AA6061-T6 aluminum alloy welded joints were investigated and adjusted using gray-related gray matter analysis. From this multi-purpose use, it has been found that current welding is the most important

ISSN : 2455-9679
Impact Factor : 4.256

parameter followed by the supply chain level and the dynamic power of the smart welding machine under consideration.

Priyanka Devidas Shinde, et al. (2018) presented the effect of welding parameters such as current welding, welding voltage and flow rate at penetration depth and strength of the strength using the Taguchi process. Two types of oxides $MgCO_3$ and Cr_2O_3 were used to test the effects of flow flow in the steel entry Fe 410 size 100 × 65 × 6 mm by GMAW with V-groove weld design combined. Cr_2O_3 was found to be the leading vehicle leading to high penetration. Nine Cr_2O_3 (L9) test runs are used based on orthogonal listing. The most important factor and the correct parameter estimates were identified using the ANOVA and S / N ratios. With the power of the tensile the dominant object was present, and then the rate of gas flow and electric power respectively. Results were obtained next to the expansion results after performing a confirmation test.

Nabendu Ghosh et al. (2018) discussed the differences between AISI 409 ferritic stainless steel and AISI 316L austenitic stainless steel, manufactured by GMAW (Gas welding arc welding) using ESAB AUTO Rod 316L as a filling wire. Welding is done on the L9 orthogonal path of the Taguchi road. Three levels of input parameters are selected: current welding, gas flow rate and nozzle at the plate level, selected. After welding, visual inspection and X-ray radiographic examination were performed on the weld types, to detect further deformities and the lower surface of the weld types made of different stainless steels. Weld quality has been assessed in terms of yield strength, final strength strength and percentage of flexibility of the types included. The observed data was translated, discussed and analyzed by the gray-Taguchi method

III. EXPERIMENTATION

Butt weld joints are arranged utilizing GTAW under changed interaction boundaries of welding as given by L9 symmetrical exhibit of Taguchi strategy under argon gas protecting. As the metal testimony rate if there should be an occurrence of gas tungsten curve welding is basically administered by welding current, gas stream rate, welding speed (welding time) and somewhat root face. In this way, these information boundaries have been thought about for the investigation and examination. The three levels of every one of the information boundaries have been taken for present investigation dependent being investigated try delivering sound weld without any imperfections of porosity and absence of combination. They chosen cycle boundaries and their levels are given in Table. 1. The welding machine is Lincoln Electric Italia make with 3 stages, 400V. Treated steel welded test got together with the extremity of direct current terminal negative using diverse cycle boundaries have been portrayed in Table 1.

Table 1 Input parameters and their level

Process parameters	**Levels**		
	1	**2**	**3**
Welding current, A (A)	90	100	110
Gas flow rate, LPM (B)	1.0	1.5	2.0
Root face, mm (C)	1.0	1.5	2.0
Welding speed ,mm/min (D)	15.384	21.428	31.578

ISSN : 2455-9679
Impact Factor : 4.256

Figure 1 Welded specimen

Table 2 Chemical Properties of AISI 304 Stainless Steel								
(Base Metal: AISI 304 SS)								
Element	**C**	**Cr**	**Mn**	**Ni**	**P**	**S**	**Si**	**Fe**
Wt. (%)	0.02	18.90	2.00	10.0	0.043	0.02	0.87	Balance
(Filler Metal: ER SS304L)								
Element	**C**	**Cr**	**Mn**	**Ni**	**P**	**S**	**Si**	**Fe**
Wt. (%)	0.03	18-19	2	8-12	0.045	0.03	0.75	Balance

The range of the TIG welding parameters selected under this currents study and the constant parameters are shown in Table 1 . In the present study, the Taguchi method was applied to experimental data using statistical software MINITAB 16. The number of parameters under study is four and the level of each parameter is three. The degree of freedom of all the three parameters is 8. Hence, L9 orthogonal array is selected for the present work.

- The number of D.O.F. for a factor = Number of level–1
- The number of D.O.F. for current = 3 –1 = 2
- The number of D.O.F. for gas flow rate= 3 – 1 = 2
- The number of D.O.F. for root face = 3 – 1 = 2
- The number of D.O.F. for welding speed = 3 – 1 = 2

Since there is no interaction between parameters, then total degree of freedom is 2+2+2+ 2=8.

The details of the selected OA were presented and the S/N ratio for each level of the parameters is computed.

The quality characteristics i.e. distortion of the welds was evaluated for all the trials and then statistical analysis of variance (ANOVA) was carried out. The contribution of each process parameters in influencing the quality

ISSN : 2455-9679
Impact Factor : 4.256

characteristic is evaluated using ANOVA. The optimum parameters combination are presented and verified. Before welding, edges were cleaned in order to remove dirt, oil and grease. The plates are then kept on backing bars and ends were clamped in order to maintain the root gap and alignment. Then the welds are made 30 mm apart. Table shows the welding conditions. Joints are prepared in single roots passes. Weld beads of 50 mm were deposited along the width using 2.4 mm filler wires of ER SS304L.

IV. RESULTS AND DISCUSSION

Table 3 Distortion and depth of penetration (DOP) in weld joints at different combination of GTAW Parameters

S. No.	Welding Currents (A)	Gas Flow Rate (LPM)	Roots Faces (mm)	Welding Speed (mm/min)	Weld Distortion (mm)	Depth ofs bead Penetration (DOP)s (mm)
1	90	8	1	15.384	1.0	241.25
2	90	10	1.5	21.428	0.15	36.187
3	90	12	2	31.578	0.35	84.437
4	100	8	1.5	31.578	0.6	144.75
5	100	10	2	15.384	1	241.25
6	100	12	1	21.428	1	241.25
7	110	8	2	21.428	0.55	132.687
8	110	10	1	31.578	0.09	21.712
9	110	12	1.5	15.384	2.4	579

Figure 2 Main effects plots of Mean (weld distortion)

Table 4 Results of confirmation test for weld distortion

Performance measure	Optimal settings of parameters	Predicted and Experimental results		
		Predicted optimal value (mm)	Experimental value (mm)	%Error
Weld Distortion	I1GFR2RF1WS3	2.3996	2.2587	5.871

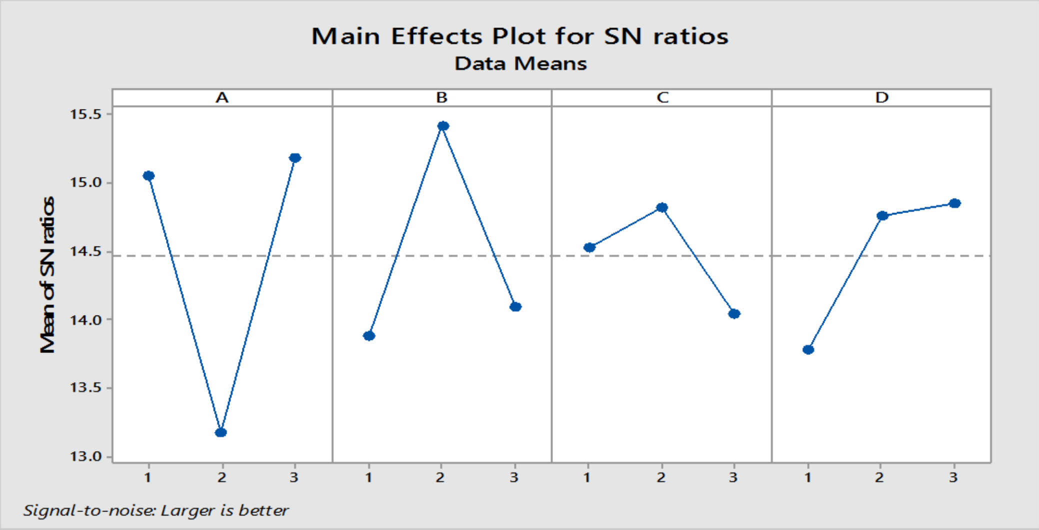

Figure 3 Main effects plots of S/N ratio (DOP)

Table 5 Results of confirmations test for DOP				
Performance measure	Optimal settings of parameters	Predicted and Experimental results		
		Predicted optimal value	Experimental value	%Error
DOP	I3GFR2RF2WS3	5.6961	5.4962	3.5094

V. CONCLUSION

This work presents improvement of the cycle boundaries of gas tungsten curve welding by taking weld twisting, profundity of weld dot entrance as a reaction variable. The accompanying end can be drawn for powerful welding of treated steel plate by gas tungsten circular segment welding measure as follows:

1. Welding velocity (WS) is the main boundary for contortion during gas tungsten curve welding. The suggested parametric blend for ideal contortion is welding current (90 A), gas stream rate (10 LPM), root face (1 mm) and welding speed (31.578 mm/min) and the ideal reaction esteem is 2.3996 mm.
2. A confirmation try was additionally performed and confirmed for the adequacy of the Taguchi technique. The test esteem acquired from setting of ideal welding boundaries was discovered 2.2587 mm. The % error between anticipated ideal and trial upsides of metal affidavit rate was found 5.871.
3. Welding current (A) is the main boundary for profundity of globule infiltration (DOP) during GTA welding. The suggested parametric blend for ideal profundity of globule entrance is welding current (110A), gas stream rate (10 LPM), root face (1.5 mm) and welding speed (31.578 mm/min.) and the ideal reaction esteem is 5.6961 mm.
4. A confirmation analyze was additionally performed and checked for the viability of the Taguchi technique. The exploratory worth got from setting of ideal welding boundaries was found 5.4962. The % mistake between anticipated ideal and trial upsides of metal statement rate was found 3.5094.

REFERENCES

1. Kumar, S., & Singh, R. (2019). Optimization of process parameters of metal inert gas welding with preheating on AISI 1018 mild steel using grey based Taguchi method. *Measurement*, *148*, 106924.
2. Yadav, H., & Niranjan, M. S. (2019). A Review on Parametric Optimization of Aluminium Alloy 5754 for MIG Welding.
3. Kumar, R., & Kumar, D. D. (2019). Optimization of Process Parameters on TIG Welding to Enhance Mechanical Properties of AA-6351 T6 Alloy. International Journal of Trend in Scientific Research and Development, 3, 505-509.

ISSN : 2455-9679
Impact Factor : 4.256

4. Kanakavalli, P. B., Babu, B. N., & Sai, C. P. V. (2019). A hybrid methodology for optimizing MIG welding process parameters in joining of dissimilar metals. *Materials Today: Proceedings*.
5. Chafekar, A., & Sapkal, S. (2020). Multi-objective Optimization of MIG Welding of Aluminum Alloy. In *Techno-Societal 2018* (pp. 523-530). Springer, Cham.
6. Dharmendra, B. V., Kodali, S. P., & Boggarapu, N. R. (2019). Multi-objective optimization for optimum abrasive water jet machining process parameters of Inconel718 adopting the Taguchi approach. *Multidiscipline Modeling in Materials and Structures*.
7. Shinde, P. D., & Madavi, K. R. (2018). Experimental Investigation for Parametric Optimization of Gas metal arc welding process by using Taguchi technique on mild steel Fe 410.
8. Ghosh, N., Pal, P. K., & Nandi, G. (2018). Investigation on dissimilar welding of AISI 409 ferritic stainless steel to AISI 316L austenitic stainless steel by using grey based Taguchi method. *Advances in Materials and Processing Technologies*, *4*(3), 385-401.
9. Khan, A., Agrawal, B. P., Siddique, A. N., & Satapathy, S. N. (2018). An Investigation on Cladding of Stainless Steel on Mild Steel using Pulse Current GMAW. *International Journal of Engineering Trends and Applications (IJETA)*, *5*(2).
10. Rizvi, S. A., & Ali, W. (2018). Optimization of Welding Parameters and Microstructure and Fracture Mode Characterization of GMA Welding by Using Taguchi Method on SS304H Austenitic Steel. *Mechanics and Mechanical Engineering*, *22*(4), 1121-1131.
11. Srivastava, S., & Garg, R. K. (2017). Process parameter optimization of gas metal arc welding on IS: 2062 mild steel using response surface methodology. *Journal of Manufacturing Processes*, *25*, 296-305.
12. Ghosh, N., Pal, P. K., & Nandi, G. (2017). GMAW dissimilar welding of AISI 409 ferritic stainless steel to AISI 316L austenitic stainless steel by using AISI 308 filler wire. *Engineering science and technology, an international journal*, *20*(4), 1334-1341.
13. Sivaraman, A., & Paulraj, S. (2017). Multi-Response Optimization of Process Parameters for MIG Welding of AA2219-T87 by Taguchi Grey Relational Analysis. *Materials Today: Proceedings*, *4*(8), 8892-8900.
14. Anand, K. R., & Mittal, V. (2017). Parameteric Optimization Of Tig Welding On Joint Of Stainless Steel (316) & Mild Steel Using Taguchi Technique. *Int. Res. J. Eng. Technol*, 2395-56.
15. Songsorn, K., Sriprateep, K., & Rittidech, S. (2017). Optimization of Metal Inert Gas Pulse Brazing Process on Galvanized Steel Sheets Based on Taguchi Method. *The Journal of Industrial Technology*, *13*(2), 78-95.
16. Chauhan, M. J. OPTIMIZATION OF PARAMETERS FOR GAS METAL ARC WELDING OF MILD STEEL USING TAGUCHI'S.
17. Deshpande, M. U., Kshirsagar, J. M., & Dharmadhikari, D. H. (2017). Optimization of GMAW Process Parameters to Improve the Length of Penetration in EN 10025 S 235 Grade. *Journal of Welding and Joining*, *35*(1), 74-78.
18. Patel, H. M., & Bhatt, B. PARAMETRIC OPTIMIZATION OF GMAW PROCESS ON MILD STEEL IS-2062.
19. Kumar, A., Khurana, M. K., & Yadav, P. K. (2016, September). Optimization of Gas Metal Arc Welding Process Parameters. In *IOP Conference Series: Materials Science and Engineering* (Vol. 149, No. 1, p. 012002). IOP Publishing.
20. Ghosh, N., Rudrapati, R., Pal, P. K., & Nandi, G. (2017). Parametric Optimization of Gas Metal Arc Welding Process by using Taguchi method on Ferritic Stainless Steel AISI409. *Materials Today: proceedings*, *4*(2), 2213-2221.
21. K. Nandagopal, C. Kailasanathan "Analysis of mechanical properties and optimization of Gas Tungsten Arc Welding (GTAW) parameters on dissimilar metal titanium and aluminium 7075 by Taguchi and ANOVA techniques". Elsevier, Journal of Alloys and Compounds, 1 August 2016, pp 1-10.