Optimization of the effects of process parameters for tensile strength in MIG Welded Joints: A critical Review

Anmol Bhatia[1*], Anmol Lakhwan[2], Ankit Jain[2]

[1]Asistant Professor, Department of Mechanical Engineering, The NorthCap University, Gurugram, India, [*]Corresponding Author E-mail: *anmolbhatia@ncuindia.edu*

[2,3] U.G Scholars, Department of Civil Engineering, The NorthCap University, Gurugram, India

Abstract: MIG welding is one of the most commonly used welding processes that is used to achieve high strength in the Joint. To produce a sound weld, input parameters need to be optimized, various studies have been conducted in the recent past to optimize the welding parameters for tensile strength. The paper presents the intensive literature review in which the process parameter optimization has taken place. The review is based on many significant factors which are termed as input parameters and also the output parameters that are termed as response parameters.

Keywords: MIG Welded Joints, Critical Review, Optimization, Tensile Strength.

I. INTRODUCTION

MIG welding also is known as Gas Metal Arc Welding (GMAW) is a process that uses a consumable electrode in the form of a weld pool. In this process, the base metal is melted with the help of the heat produced from the electrode. The shielding gas is provided with the wire electrode, that helps to protect the weld from any kind of contaminants. The welding gun feeds the wire continuously from the weld pool along with the shielding gas that helps to protect the contaminants. This welding process has many advantages such as this process produces high-quality welds, No flux is used in this process hence there is no chance of slag entrapment, thereby producing high-quality welds. Apart from the advantages, the process has disadvantages also like this is a sensitive process to contaminants, also has sensitivity towards wind, this can offer welding in limited positions, It produces defects like lack of fusion etc. Another drawback is that a shielding gas is used during the welding operation.

The input parameters which are mainly used are welding current, voltage, gas flow, speed, wire feed, machine speed, pressure etc. Many researchers have used the techniques such as Taguchi, ANOVA, RMS, DOE, ANE and GE to optimise the input parameters.

Taguchi method is one of the prominent method used by many researchers for the optimizing the process parameters in which the variations are reduced in the process through DOE. The objective of this method is to produce a high-quality product at a low cost. The Percentage Contribution of every factor is analysed using the statistical method known as Analysis of Variance.

II. LITERATURE REVIEW

K. Sivasakthivel et.al [1] achieved appreciable quality by MIG welding Titanium alloy using Taguchi & ANOVA technique. The following parameters were used welding voltage (v) 20-30, current(A) 250-310, speed(cm/min). The optimum values of the input parameters were predicted using the Taguchi method. As per the experimentation, it was concluded that MIG can weld the Titanium alloys

successfully. The paper reports that the parameters significantly affecting the tensile strength was welding Speed. Kapil B. Pipavat et.al [2] achieved appreciable quality by MIG Welding Austenitic steel AISI 316 using DOE method. The following parameters used were welding voltage(v) 28-32, welding current(A) 140-180, welding speed(mm) 300-400. The greater tensile strength was achieved during the welding process. Ajit Hooda et al [3] achieved appreciable quality by MIG welding AISI1040 medium steel joint by using RMS method. The following parameters were used -Voltage (V) 23-25, welding current (A) 200-220, wire-speed(m/min) 2.4-3.2, gas flow(1/mm) 12-16. The author optimized tensile strength and found the value 398.907 MPa respectively for the optimum parameters. The microstructure was also shown in the study which shows the Ferrite greens in the network. Sindri Mahesh et.al [4] achieved appreciable quality by MIG welding AISI1050 mild steel joint by using Taguchi Technique. The following parameters used were welding current (A) 180-280, welding speed (mm/s) 200-400, welding voltage (V) 22-26. The author optimized the welding parameters in MIG welding at welding speed 400 mm/s, welding voltage 26V and welding current 180A. Sudhir S. Kulkarni et.al [5] achieved appreciable quality by MIG welding SAE1018 low-quality alloy steel joints by using Taguchi technique. The following parameters used were wire feed (m/min) 2.8-3.2, current (A) 100-140, voltage (V) 18-24, gas flow (lit/min) 10-15, machine speed (sec) 20-30. The author optimized the parameter for penetration that was 1.06 mm & S/N ratio is 0.506117. Nabendu Ghosh et.al [6] achieved appreciable quality by MIG welding of AISI316L austenitic stainless steel joint by using the Taguchi method. Welding current, Gas flow rate, nozzle to plate distance were the parameters used for the study. Grey-Taguchi Methodology has been used to optimize the input parameters. Jigar Shah et.al [7] achieved appreciable quality by MIG welding of a metal joint by ANN method. The following parameters used were welding speed (mm/sec) 4.5-6.5, welding current (A) 150-190, gas pressure (psi) 12-18. The author optimized that the tensile strength increases initially and decrease with an increase in the value of welding speed. Process parameter has been done using the ANN method. Raj Kumar Yadav et.al [8] achieved appreciable quality by MIG welding of mild steel by Taguchi method. The following parameters used were voltage (V) 350-370, current (A) 340-360, WFR 80-120. Based on the ANOVA method the highly effective parameter on Torsional Rigidity was found as voltage and wire feed rate. The optimum parameters are voltage (V) 360, current (A) 350, WFR 100. S.V. Sapkal et.al [9] achieved appreciable quality by MIG welding of MS C20 by Taguchi method. Welding Current, Voltage and Speed were the parameters used for the study. The study demonstrated that welding speed was the most critical factor for obtaining sound weld. Amit Kumar et.al [10] achieved appreciable quality by MIG welding of stainless steel 304 and 316 by ANN and GA method. The following parameter used were voltage (V) 100-120, current (A) 16-20, velocity (cm/min) 40-50. Author optimized that the stainless steel grade 304 has better strength than the stainless steel grade 316. Dinesh Mohan Arya et.al [11] achieved appreciable quality by MIG welding alloy steel using Grey Taguchi analysis method. The parameter used were wire diameter (mm) 0.8-1.2, welding current (amp) 80-110, arc voltage (volt) 18-19.5, welding speed (cm/mm) 45-55, gas flow rate (lit/min) 10-15. The author optimised the tensile strength and predict optimal parameter setting with the help of ANOVA. Vijender Kumar et.al [12] achieved appreciable quality by MIG welding hot die steel using Taguchi methodology. The following parameter was used welding current 180-200 (amp), welding voltage 21-27 (volt), nozzle to plate difference 12-20 (mm). The author optimised the tensile strength and found the value 390.8 mph at 200 amps current 16mm NPD and 27 volts. The welding current and NPD was the most effective parameters. Diganta Kalika et.al [13] achieved appreciable quality by MIG welding 20 carbon steel by Taguchi Orthogonal methodology. The following parameter was used welding current 170-230 (amp), welding voltage 20-30 (volts), gas flow

rate 8-12 (lit/min). The author optimised tensile strength and found the value as 475.87 N/mm2. The optimal set of process parameter was found as 200A (current), 30 volts, 8 (lit/min) gas flow. All welding |and| work has been carried out using ER 705-4 electrodes. Kamaleshwar Dhar Dwivedi et.al [14] achieved appreciable quality by MIG welding stainless steel by Taguchi methodology. The following parameter was used- welding current 160-180 (amp), voltage 20-24 (volts) wire feed rate 400-420 (imp). The author optimised that wire feed rate is the first parameter whist affect the hardness first then-current voltage.

Table 1. Summary of the Input and Output parameters used by researchers

Ref. No.	Author(s)	Input Parameters	Technique
1.	K. Sivasakthivel et.al	welding voltage(v), current(A), speed(cm/min)	Taguchi & ANOVA Technique
2.	Kapil B. Pipavat et.al	welding voltage(v), welding current(A), welding speed(mm)	DOE Technique
3.	Ajit Hooda et.al	voltage(V), current(A), wire speed(m/min), Gas flow(1/mm)	RMS Technique
4.	Sindiri Mahesh et.al	current(A), speed (mm/s),Voltage (V)	Taguchi Technique
5.	Sudhir S. Kulkarni et.al	wire feed (m/min), current(A),voltage(V), gas flow(lit/min), machine speed(sec)	Taguchi Technique
6.	Nabendu Ghosh et.al	welding current(A), Gas flow rate(L/mm), nozzle to plate distance(mm)	Taguchi Technique
7.	Jigar Shah et.al	welding speed (mm/sec),welding current(A), gas pressure	ANN Technique
8.	Raj Kumar Yadav et.al	voltage(V),current (A),WFR	Taguchi Technique
9.	S.V. Sapkal et.al	welding current(A), welding voltage(V), welding speed	Taguchi Technique
10.	Amit Kumar et.al	voltage(V),current (A) ,velocity (cm/min)	ANN and GA Technique
11.	Dinesh Mohan Arya et.al	wire diameter(mm), welding current(amp) ,arc voltage(volt), welding speed (cm/mm),gas flow rate(lit/min)	Grey Taguchi analysis Technique
12.	Vijender Kumar et.al	welding current(amp), welding voltage(volt), nozzle to plate difference(mm)	Taguchi methodology Technique
13.	Diganta Kalika et.al	welding current(amp), welding voltage(volts),gas flow rate(lit/min)	Taguchi Orthogonal methodology Technique
14.	Kamaleshwar Dhar Dwivedi et.al	welding current(amp), voltage(volts),wire feed rate(imp)	Taguchi methodology Technique

III. CONCLUSION

The paper presented a brief comparison of different process parameters found significant by the researchers and also the techniques that are used from time to time by different authors to optimize the input parameters.

Conflict of interest: The authors declare that they have no conflict of interest.

Ethical statement: The authors declare that they have followed ethical responsibilities

REFERENCES

[1] K. Srivasakthinel, K. Jamerthanan and R. Raj Kumar(2014), Optimization of welding parameters in mig welding by Taguchi method, International Journal of Advanced Research in Mechanical Engineering & Technology, Vol. 1, pp. 36-38.

[2] Kapil B. Pipavat, Dr. Divyang Pandya, Mr. Vivek Patel (2014), Optimization of welding parameters in mig welding by Taguchi method, International Advance Engineering & Research Development, Vol. 1, pp. 1-6.

[3] Ajit Hooda, Ashwani Dhingra and Satpal Sharma (2012), Optimization of MIG welding process parameters to predict maximum yield strength in AISI1040, International Journal of Mechanical Engineering and Robotics Research, Vol.1 (3), pp. 203-213.

[4] Sindiri Mahesh, Mr. Velamala Appalaraju(2017), Optimization of mig welding parameter for improving strength of welded joint, (IJITR) International Journal of Innovative Technology & Research, Vol. 5(3), pp. 6453-6458.

[5] Sudhir S. Kulkarni, Rohan S. Jamgekar, optimization of mig welding parameter for improving strength of welded joints for Husqvarna-pulley of material SAE1018 (2017), International Journal of Research in Applied Science and Engineering Technology, Vol.5(10), pp. 896-904.

[6] Nabendu Ghosh, Pardip Kumar Pal, Goutam Nandi, parametric optimization of mig welding on AISI316L austenitic stainless steel by Grey-Taguchi method (2017), International Journal of Mechanical Engineering and Robotics Research, Vol.6(2), pp. 88-95.

[7] Jigar Shah, Gourav Patel, Jatin Makwana, Purvi Chauhan, optimization and prediction of mig welding parameter using ANN(2018), Journal of Engineering Technologies and Innovative Research, Vol.5(11), pp.1011-1016.

[8] Raj Kumar Yadav, Sandhaya Yadav, Anurag Singh & Pankaj Singh(2016), Optimization of MIG welding technique parameter with the help of Taguchi method, International Journal of Production Technology and Management, Vol.7(2), pp.16-27.

[9] S.V. Sapakal, M.T. Telsang, Parametric Optimization of MIG welding using Taguchi design Method (2012), International Journal of Advanced Engineering Research and Studies, Vol.1(4), pp.28-30.

[10] Amit Kumar, Dr.R.S. Jadoun, Ankur Singh Bist, optimization of mig welding parameter using ANN and GA (2014), International Journal of Engineering Science & Research Technology, Vol.2 (4) pp. 614-620.

[11] Dinesh Mohan Arya, Vedansh Chaturvedi, Jyoti Vimal, parameter optimization of mig welding process parameter using grey Taguchi Method(2016), International Journal of Research in Engineering and Applied Sciences, Vol-3(6),pp. 1-17.

[12] Vijander Kumar, Navneet Goyal, parametric optimization of mig welding for hot die steel by Taguchi Approach(2018), Material Science Research India, Vol 15(1), pp.100-106.

[13] Diganta Kalika, Parimal Dabul Barua, Taguchi optimization of mig welding parameter affecting tensile strength of 20 welds (2015), International Journal of Engineering Trends and Technology, Vol. 26 (1), pp.43-49.

[14] Kamleshwar Dhar Dwivedi, Anurag Srivastava, Parametric optimization of mig welding for dissimilar metals using Taguchi method (2017), International Journal of Scientific Research in Science and Technology, Vol. 3(4), pp. 213-219.

