Yanbu Journal of Engineering and Science

Volume 23 | Issue 1 Article 6

2026

Optimization of Gas Metal Arc Welding Parameters for Maximizing Tensile Strength and Hardness of AISI304 Steel Joints Using Response Surface Methodology (RSM)

Saadat Ali Rizvi
University Polytechnic, Jamia Millia Islamia, New Delhi-110025, sarizvi1@jmi.ac.in

Wajahat Ali
Department of Mechanical Engineering SCRIET (CCS University), Meerut-UP, wajahatali@rediffmail.com

Ali Hussain
Department of Chemical Engineering HBTU-Kanpur-UP, whosean110@gmail.com

Follow this and additional works at: https://yjes.researchcommons.org/yjes

The journal in which this article appears is hosted on Digital Commons, an Elsevier platform.

Recommended Citation

Rizvi, Saadat Ali; Ali, Wajahat; and Hussain, Ali (2026), Optimization of Gas Metal Arc Welding Parameters for Maximizing Tensile Strength and Hardness of AISI304 Steel Joints Using Response Surface Methodology (RSM), *Yanbu Journal of Engineering and Science*: Vol. 23: Iss. 1, 100-108.
DOI: https://doi.org/10.53370/3122-3303.1212
Available at: https://yjes.researchcommons.org/yjes/vol23/iss1/6

This Research Article is brought to you for free and open access by Yanbu Journal of Engineering and Science. It has been accepted for inclusion in Yanbu Journal of Engineering and Science by an authorized editor of Yanbu Journal of Engineering and Science.

YANBU JOURNAL OF ENGINEERING AND SCIENCE 2026;23:100–108

Scan the QR to view the full-text article on the journal website

RESEARCH ARTICLE

Optimization of Gas Metal Arc Welding Parameters for Maximizing Tensile Strength and Hardness of AISI304 Steel Joints Using Response Surface Methodology (RSM)

Saadat Ali Rizvi [a,*], Wajahat Ali [b], Ali Hussain [c]

[a] University Polytechnic, Jamia Millia Islamia, New Delhi-110025
[b] Department of Mechanical Engineering SCRIET (CCS University), Meerut-UP
[c] Department of Chemical Engineering HBTU-Kanpur-UP

ABSTRACT

This research article is focused on Gas Metal Arc (GMA) Welding which is also known as Metal Inert Gas (MIG) welding of AISI304 of 5mm thickness. In this research article basic aim is to discover how welding parameters like arc voltage, gas flow rate, and welding speed affect the mechanical quality of weldment i.e. tensile strength and hardness. The highest tensile strength recorded is 470 N/mm^2 at 20V and hardness is 196 at 24V. The strength and quality of the welds can be greatly increased by choosing the right welding parameters. In this study, Response Surface Methodology (RSM) was used to create a model that shows the connection between the welding process variable settings and the weld strength. The most significant factors for weld quality were determined using ANOVA tests, and the findings were verified at a 95% confidence level. Strong and dependable welds are crucial in the manufacturing, automotive, and construction sectors, so this research is beneficial. Future research on welding and advancements in the process will also benefit from the data gathered. The results showed that arc voltage had a considerable impact on ultimate tensile strength and hardness, and there was good agreement between the observed and anticipated values.

Keywords: GMA welding, RSM, Optimization, Welding parameters, AISI304, Mechanical properties

1. Introduction

Due to its numerous advantages, such as outstanding weld strength, high efficiency, automation, consistent performance, and cost-effectiveness, gas metal arc (GMA) welding is a prevalent electric arc welding technique employed to join various materials, including mild steel, stainless steel, and aluminum [1], among others. It finds extensive application in industries such as aviation, shipbuilding, automotive, fabrication, and production, among others [2]. The 304L is the 300 series grade of ASS often utilized in elevated temperature. Austenitic stainless steel (AISI 304), which primarily consists of chromium (18–20%) and nickel (8–12%) as alloying elements aside from iron [3], is extensively utilized across a range of industrial sectors, including petrochemical, food processing, automotive, aerospace, nuclear, thermal power plant, and heat exchange industries [4, 5], among others, owing to its remarkable corrosion resistance. The main role of nickel is to stabilize the austenite structure and improve the mechanical properties [6, 7] of ASS. The AISI 304 possesses excellent mechanical properties, remarkable strength at elevated temperatures, high creep resistance, and effective corrosion and oxidation resistance when subjected to high temperatures [8]. The primary objective of the experimental

Received 24 May 2025; revised 29 November 2025; accepted 6 April 2026.
Available online 16 April 2026

* Corresponding author.
E-mail addresses: sarizvi1@jmi.ac.in, saritbhu@gmail.com (S. A. Rizvi), wajahatali@rediffmail.com (W. Ali), whosean110@gmail.com (A. Hussain).

https://doi.org/10.53370/3122-3303.1212
3122-3303/© 2026 The Author(s). Yanbu Journal of Engineering and Science. This is an open access article under the CC BY 4.0 Licence (https://creativecommons.org/licenses/by/4.0/).
Published by Yanbu Industrial College, Saudi Arabia. The journal is hosted on Digital Commons, an Elsevier Platform.

design methodology is to comprehend the interactions of various factors, as this understanding can facilitate the optimization of experimental parameters and the development of a statistical model [9, 10]. The response surface methodology (RSM) has been employed by many researchers to investigate the influence of process parameters on the mechanical properties of weldments. In order to connect the connection between mechanical properties and welding parameters Patel, H et al., [11] create a mathematical model to determine the relation between welding parameters and weld strength and they validate model with experimental data.

Koli et al., [12] enhanced and created mathematical models to estimate the tensile strength and percentage elongation of butt welded aluminium alloys. They concluded that the welding speed had a significant influence on the tensile properties, while the shielding gas flow was less impactful on these properties. Sahu et al., [13] utilized the Response surface methodology approach to optimize the process variables for gas inert gas welding of mild steel plate, demonstrating that the base current had the most considerable effect on the mechanical properties of the welded mild steel plate. In another study, C.Rajendran et al [14] developed a model to optimize the FSW welding process parameters by using RSM approach during the spot welding of AZ31B magnesium alloy and AA6061 aluminium alloys and they concluded that the plunge rate showed a significant effect on the TSFL capability of joints followed by tool rotational speed, tool diameter ratio and dwell time. A model for UTS and hardness of AA 2050 weldment, which is welded by friction stir welding, was developed by Kamminana and Kambagowni [15]. Their findings showed that the developed model can predict the overall weld quality at a 95% confidential level within ±10% of the overall weld quality calculated from experimental results. This study employed Response Surface Methodology (RSM) based on Central Composite Design (CCD) to create a mathematical model that describes the parameters of the Metal Inert Gas (MIG) welding process and the mechanical properties of the weldment. An analysis was conducted to examine the influence of individual parameters on the mechanical properties of the weldment, as well as the interactions among the various parameters.

2. Experimental work procedure and design

In this study, a 150 mm x 75 mm x 5 mm AISI 304 structural steel plate with E-308L filler wire measuring Ø 1.2 mm was the parent metal to be fused utilizing the gas metal arc (GMA) welding technique.

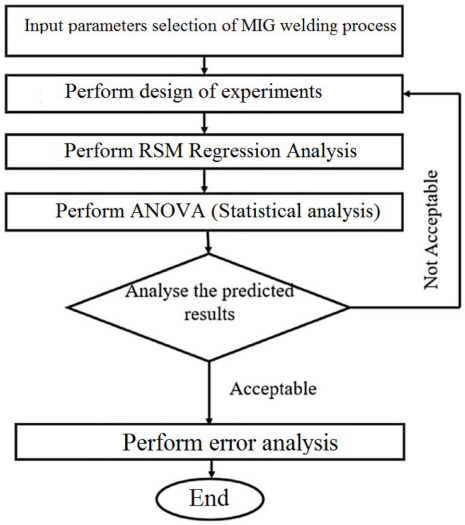

Fig. 1. Flow chart of optimization steps.

The gas atmosphere was protected by pure Ar. The suggested optimization processes' flow chart is shown in Fig. 1. Table 1 shows the chemical composition of the filler wire and workpiece for AISI 304 welding.

Fig. 2 illustrates a schematic representation of the GMA welding process. For the welding purpose power wave model type Lincoln C-300 welding machine was used. Before welding, welding plates (parent metal) were properly clamped.

The direct input parameters of GMA welding i.e. wire feed speed (F), arc voltage (V), and gas flow rate (L) were considered as per their level range value (lower to higher) and are tabulated in Table 2.

A total 12 numbers of experiments were conducted. Fig. 3 shows the actual tensile test sample after fracture.

2.1. Establishment of regression model (development of a model)

The parameters selected for this experiment include gas flow rate (L), arc voltage (V), and wire feed speed (F) due to their influence on the weld bead. Previous studies have clearly demonstrated that an increase in wire feed speed enhances both bead penetration and width. A mathematical model was established through regression analysis, linking the dependent and independent variables to evaluate its effectiveness. Response Surface Methodology (RSM) encompasses a range of mathematical and statistical techniques that utilize quantitative data from experiments to formulate the regression model and optimize a response or output. Additionally, RSM is employed to explore the interactions among various influencing parameters and to develop an empirical model

Table 1. Chemical composition of the parent metal and filler wire (wt %).

	% of C	% of Si	% of S	% of P	% of Cr	% of Ni	% of Mn
Parent metal AISI 304	0.065	0.48	0.015	0.025	18–20	8–10.5	1.25
Filler metal E-308L	0.035	0.9 Max	0.04	0.02	18–21	9–11	0.5–2.5

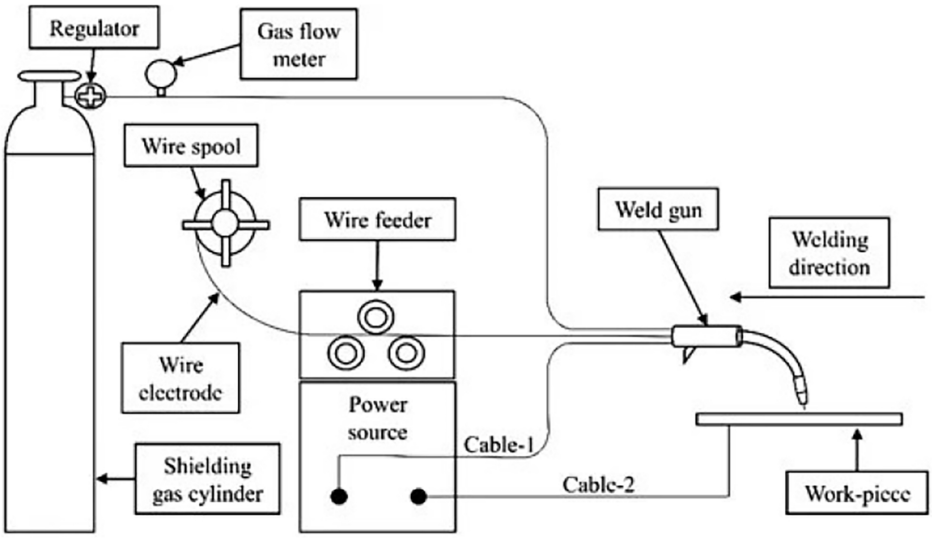

Fig. 2. Schematic diagram of a GMA welding set-up.

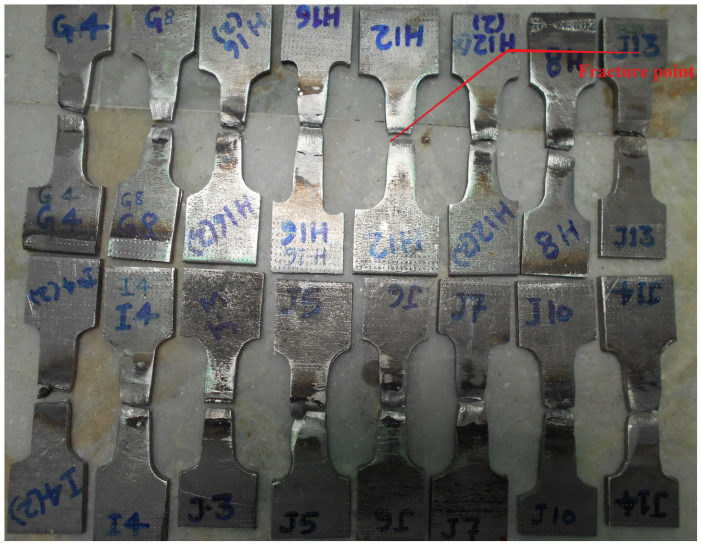

Fig. 3. Tensile test samples after fracture.

Table 2. GMA welding process parameters and their levels.

S.No	Parameters	Unit	Symbol	Low (–)	High (+)
1	Arc voltage	V	V	20	24
2	Wire feed speed	F	F	250	450
3	Gas flow rate	l/m	L	10	25

for estimating the weld bead shape. In this study, an RSM approach based on central composite design (CCD) was utilized, and the model was subsequently validated using ANOVA [16]. This research employed the Response Surface Methodology (RSM) to establish a relationship between MIG welding parameters and the chosen response. The function representing the weld bead size response can be expressed by the provided Eq. (1):

$$Y_{trans} = f(x_1, x_2, x_3,) \quad (1)$$

where x represents the input parameters and Ytrans denotes the power transformation of the welding parameters. The selected welding input parameters are

Table 3. Statistical model summery of arc voltage, welding current and gas flow rate for UTS.

Source	Sum of Squares	df	Mean Square	F-value	p-value	
Model	8998.02	9	999.78	19.99	0.0072	significant
A-Arc voltage	32.29	1	32.29	0.1751	0.6845	
B-Wire feed speed	1826.87	1	1826.87	9.90	0.0104	
C-Gas flow rate	1475.51	1	1475.51	8.00	0.0179	
AB	210.13	1	210.13	1.14	0.3109	
AC	1540.13	1	1540.13	8.35	0.0161	
BC	1653.13	1	1653.13	8.96	0.0135	
A^2	1.72	1	1.72	0.0093	0.9250	
B^2	21.78	1	21.78	0.1181	0.7383	
C^2	2147.02	1	2147.02	11.64	0.0066	
Residual	1844.53	10	184.45			
Lack of Fit	724.53	5	144.91	0.6469	0.6778	not significant
Pure Error	1120.00	5	224.00			
Cor Total	10842.55	19				

x_1 = arc voltage, x_2 = wire feed speed, and x_3 = gas flow rate. To minimize inaccuracies and the influence of uncontrolled parameters, the experimental runs were randomized. Consequently, the second-order polynomial equation based on RSM utilized in this research can be expressed as Eq. (2) [17–19]:

$$y = \beta_0 + \sum_{i=0}^{k} \beta_o x_i + \sum_{i<j} \sum \beta_{ij} x_i x_j + \sum_{i}^{j} \beta_{ii} x_i^2 + \varepsilon \quad (2)$$

In this equation y = estimated response i.e. ultimate tensile strength and hardness

βo = constant coefficient

β_i, = β_{ii} & β_{ij} = coefficient of linear, quadratic, and cross-product terms, respectively

ϵ = random error

3. Results and discussion

3.1. Influence of process parameters on ultimate tensile strength (UTS)

The analysis of variance, commonly referred to as ANOVA, is utilized for evaluating the proposed model. It is acknowledged as a statistical method that assists in determining the influence of process parameters on the response signal. Consequently, it aids in drawing essential conclusions regarding the characteristics of both controlled and uncontrolled process parameters. Typically, it is employed to identify and classify the parameters that significantly contribute to the generation of the response signal [20]. ANOVA is applied within response surface methodology (RSM) to ascertain the optimal behavior that dictates the established equation. RSM encompasses a collection of mathematical and statistical methods that can be employed for modeling predictive equations, while ANOVA facilitates the examination of the impact of process variables on the generation of response surfaces, which depend on various factors. Analysis of variance (ANOVA) of UTS is presented in Table 3, ANOVA table shows that a significant model is developed with a non-significant lack of fit i.e. the developed model is absolutely fitted with a p-value of 0.0072. the model F-value of 19.99 greater than the P-value also attest to the model significance. If the P-value is below 5%, this indicates that the parameter is statistically significant [21].

$$\begin{aligned} UTS = {} & +985.22820 - 22.12627{*}A - 0.026628{*}B \\ & - 22.62229{*}C + 0.025625{*}A*C + 0.925000 \\ & *C*B - 0.019167{*}C*B - 0.086337{*}A^2 \\ & - 0.000123{*}B^2 + 0.216992{*}C^2 \end{aligned} \quad (3)$$

The interaction plots illustrating the parameters of the welding process, namely arc voltage, gas flow rate, and wire feed speed, along with their effects on the response values, specifically tensile strength and hardness, are presented in Figs. 4 and 5. These plots are three-dimensional representations that depict the behavior of response values under varying welding conditions of the process parameters. It is evident from Fig. 4 (a) and (c) that an increase in arc voltage results in a decrease in the ultimate tensile strength of the weldments. whereas the gas flow rate (F) has minimal impact on tensile strength [22].

3.2. Influence of process parameters on micro-hardness

Analysis of variance (ANOVA) of hardness is presented in Table 4.

Fig. 5 (a) clearly illustrates that a reduction in arc voltage leads to an increase in hardness. Fig. 5 (b) demonstrates that the gas flow rate has minimal impact on the hardness of the weldment. Meanwhile,

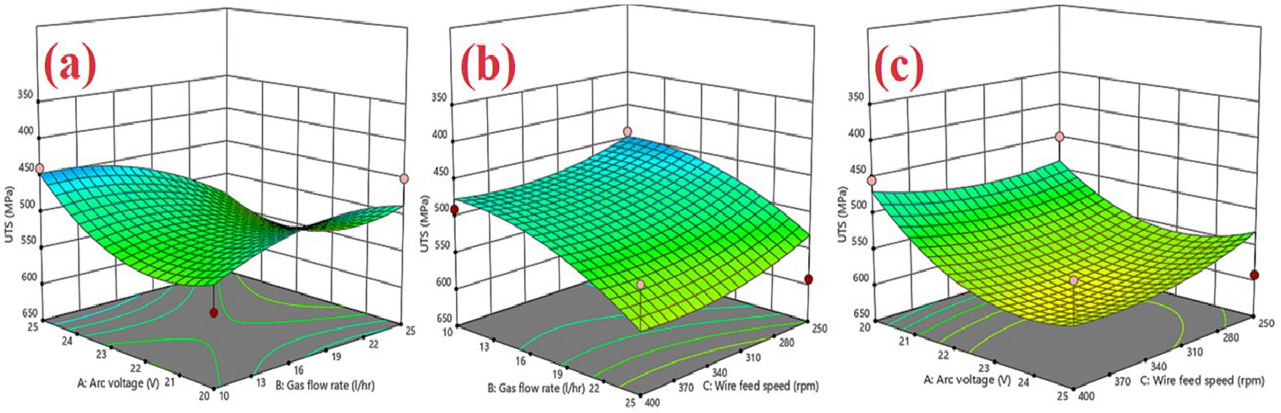

Fig. 4. 3-D response surface plot for ultimate tensile strength (MPa).

Table 4. Statistical model summary of arc voltage, welding current and gas flow rate for hardness.

Source	Sum of Squares	df	Mean Square	F-value	p-value	
Model	1183.08	9	131.45	19.13	<0.0001	significant
A-Arc voltage	615.47	1	615.47	89.56	<0.0001	
B-Wire feed speed	4.02	1	4.02	0.5849	0.4621	
C-Gas flow rate	80.62	1	80.62	11.73	0.0065	
AB	91.12	1	91.12	13.26	0.0045	
AC	28.13	1	28.13	4.09	0.0706	
BC	10.13	1	10.13	1.47	0.2527	
A^2	11.89	1	11.89	1.73	0.2177	
B^2	235.37	1	235.37	34.25	0.0002	
C^2	113.30	1	113.30	16.49	0.0023	
Residual	68.72	10	6.87			
Lack of Fit	31.89	5	6.38	0.8657	0.5610	not significant
Pure Error	36.83	5	7.37			
Cor Total	1251.80	19				

Hardness $= +121.91072 + 9.63049*A - 0.622468*B + 1.85431*C + 0.016875*A*B - 0.125000*A*C - 0.001500*B*C - 0.227105*A^2 + 0.000404*B^2 + 0.049847*C^2$.

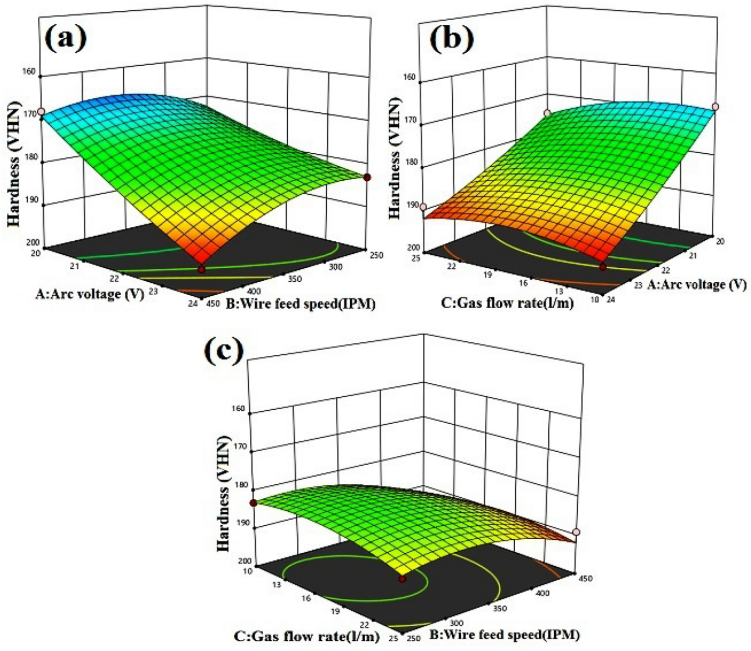

Fig. 5. 3-D response surface plot for hardness (VHN).

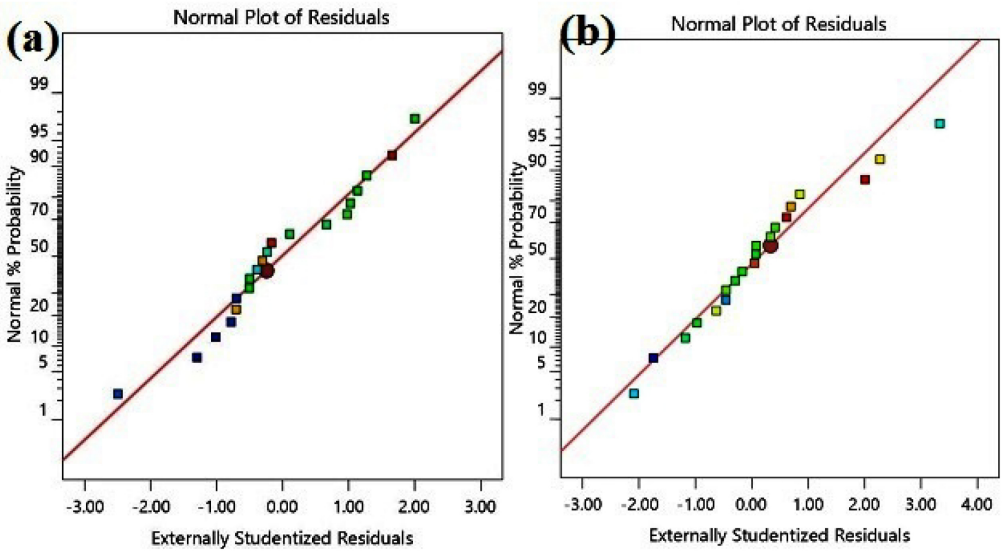

Fig. 6. Normal probability curve for UTS and hardness.

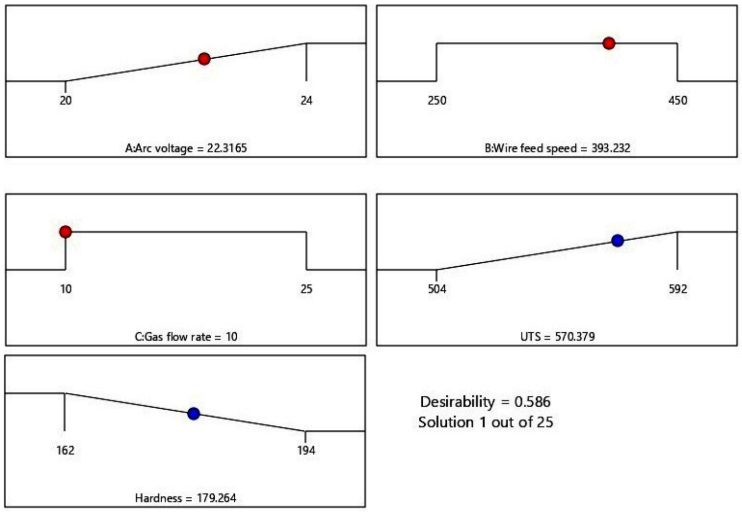

Fig. 7. Ramp-up function plot for UTS and hardness of weldments.

Fig. 5 (c) shows that as the arc voltage decreases, hardness increases, whereas the gas flow rate continues to have a negligible effect on hardness.

Fig. 6 displayed the studentized residual curve and normal probability for ultimate tensile strength (UTS) and hardness. It is evident from Fig. 6 that there was no response transformation or apparent normalcy problem. These curves are commonly used to assess the model's adequacy since they show that the model is appropriate when all of the points form a S pattern [20, 21].

The optimized result's ramp for the response i.e. UTS and hardness of weldments are shown in Fig. 7. The red dot on each ramp represents the optimal level of those particular parameters while the blue dot represents how the mechanical properties of weldments are enhanced. Accordingly, the optimal level was chosen as A2B2C1. The height at which the dot was positioned indicates the amount of desirability and the value of desirability lies between 0 to 1, depending upon the confidence of the response when compared with required values [22].

The desirability plot for multi-objective optimization is shown in Fig. 8. From Fig. 8 it is very clear that the desirability value obtained during this optimization is 0.584, which is near to the desired value of 1. Hence this model is accepted.

Fig. 9 shows the contoured curves for ultimate tensile strength and hardness from figure it is very clear that ultimate tensile strength of weldments decreases with increasing the voltage while hardness decreases with increasing with the wire feed speed.

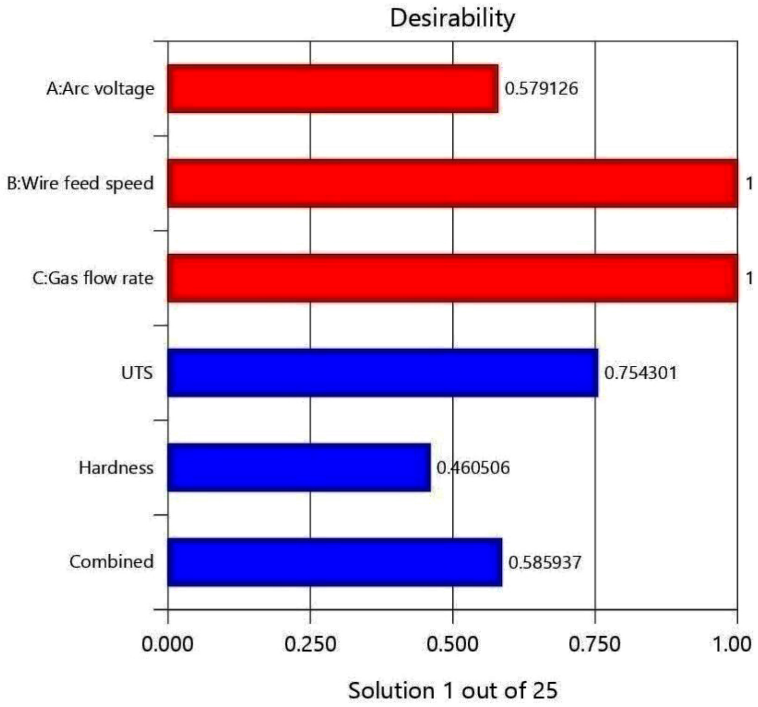

Fig. 8. Desirability plot for multi-objective optimization.

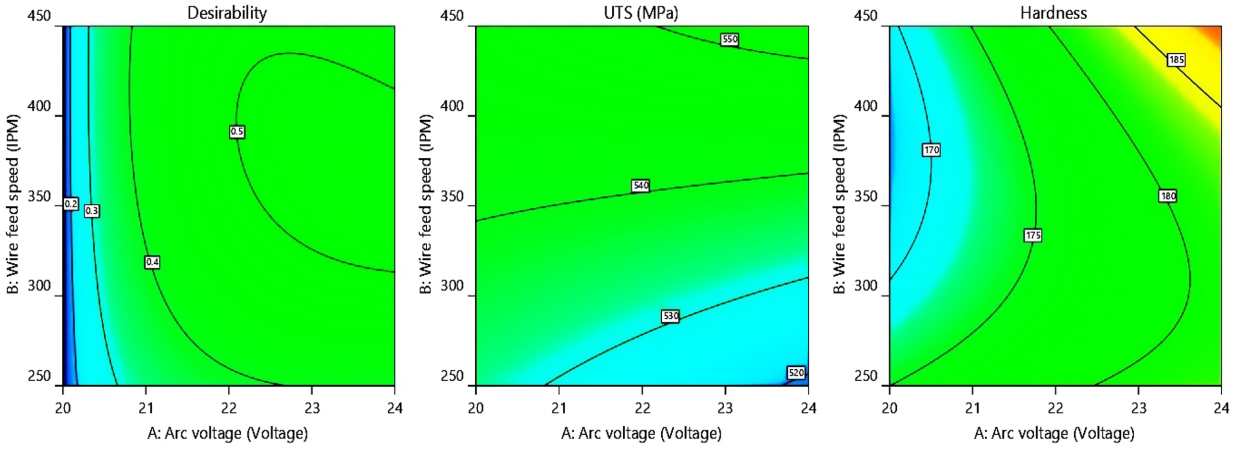

Fig. 9. Contour curve.

4. Mode of fracture

4.1. Mode of fracture for tensile test samples

Scanning electron microscopy (SEM) is utilized to analyze tensile test specimens to identify their fracture characteristics. Fig. 10 illustrates the fracture pattern of these tensile test specimens.

4.2. Fracture mode of tensile test specimen

SEM equipment was utilized to analyze the fracture mode of tensile test specimens at ambient temperature. Fig. 10 illustrates the fractography of tensile samples from SS304 welded joints produced through MIG welding. An effort is made to understand the fracture mode of the tensile test specimens, and the image clearly indicates that the fracture occurred in a ductile manner, characterized by numerous dimples of varying sizes [23]. Furthermore, the findings indicate that the fracture pattern is irregular, with cleavage fractures being classified as tear-type fractures. The SEM image of the fracture surface clearly shows both cleavage and secondary cleavage.

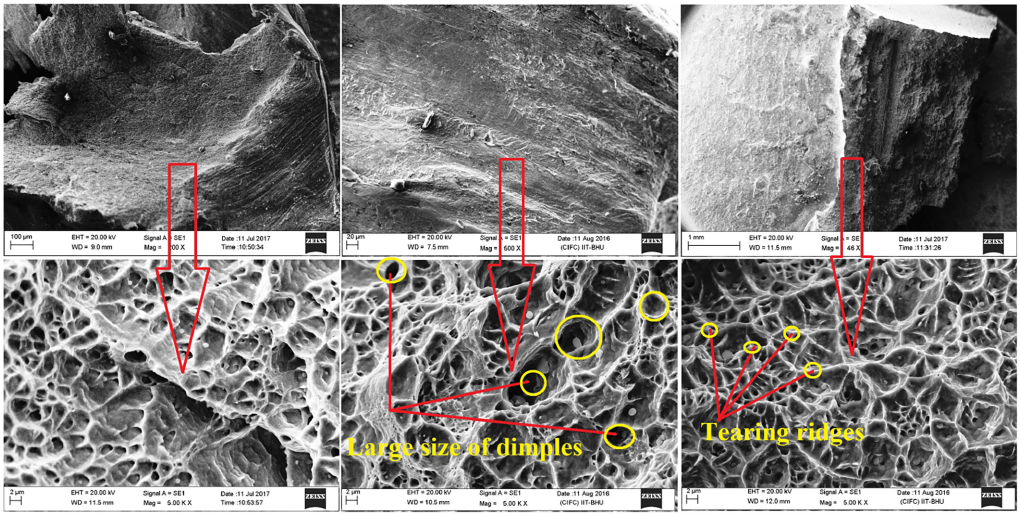

Fig. 10. Fractography of (SEM) tensile test samples.

5. Conclusion

This study outlines a comprehensive method for optimizing process parameters utilizing response surface methodology (RSM). Experiments were carried out to examine the influence of welding parameters on weld morphology, ultimate tensile strength, and hardness of AISI304 steel plate. The key findings and conclusions are summarized as follows:

1) The conducted ANOVA analysis for the established multiple regression model indicated that the model is statistically significant at $P < .00001$. This suggests that the model is capable of approximating the true response within the design space.
2) The close alignment between the predicted model results and the experimental findings confirmed that the optimization attained in this research was dependable.
3) The study established that the most cost effective and efficient optimum set of input factors to achieved optimal tensile strength of 470 MPa was 20 V and hardness was 196 at 24V respectively.
4) The research indicated that arc voltage and wire feed speed were the key input factors that significantly influenced tensile strength and hardness. In contrast, gas flow rate exhibited a lower sensitivity to the response.
5) The mechanical properties, specifically the ultimate tensile strength and hardness of weldments, were successfully analyzed using response surface methodology (RSM).
6) SEM fractrography of tensile test samples revealed brittle fracture.

Conflict of interest

The authors declare no conflict of interest.

Author contribution

Saadat Ali Rizvi: Conceptualization, Validation, Form analysis, Data curation, Writing-original draft, Visualization.

Wajahat Ali: Methodology, Software, Investigation, Resources, Writing-original draft.

Ali Hussain: Writing-review & editing.

Funding

This research received no external funding.

Data availability

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

References

1. Rizvi SA, Ali W. Advanced Welding Technology, Katson publishers, New Delhi, INDIA. 2007:48–49.
2. Van Huong H, Nguyen TT, Nguyen V-T, Nguyen VTT. Material Strength Optimization of Dissimilar MIG Welding between Carbon and Stainless Steels Metals. 2024;14(9):1011. DOI:10.3390/met14091011.
3. Shridhar, Janapareddy PK, Kumar, Kumar GBV, Sahu SK, Rayyes AE, Giri J, Singh B. Mechanical properties and residual stresses in multi pass AISI 304 to AISI 1018 steel welds by SMAW and GTAW Science Report. 2025;15:27052. DOI:10.1038/s41598-025-06063-0.

4. Shafeek M, Suranjan S, Doreswamy D, Sachidananda HK. Effect of welding parameters on microstructure and mechanical properties of GMAW welded S275 steel welded zone Discover Materials. 2024;4:96. DOI:10.1007/s43939-024-00169-4.
5. Sonar T, Ivanov M, Shcherbakov I, Trofimov E, Khasanova E, Cheepu M, Liu K. Enhancing Welding Productivity and Mitigation of Distortion in Dissimilar Welding of Ferritic-Martensitic Steel and Austenitic Stainless Steel Using Robotic A-TIG Welding Process. Journal of Manufacturing and materials processing. 2024;8:283. DOI:10.3390/jmmp8060283.
6. Yan J, Gao M, Zeng X. Study on microstructure and mechanical properties of 304 stainless steel joints by TIG, laser and laser-TIG hybrid welding. Optics and Lasers in Engineering. 2010;48:512–517. DOI:10.1016/j.optlaseng.2009.08.009.
7. Sonar T, Ivanov M, Shcherbakov I, Okulov A, Shaburova N, Liu K, Khasanova E, Samoilovskikh P. Effect of activated flux GTAW with AlCoCrFeNi2.1 eutectic high entropy alloy interlayer on microstructure and mechanical properties of dissimilar P91/304L steel joints. Journal of Materials Processing Tech nology. 2025;340. DOI:10.1016/j.jmatprotec.2025.118873.
8. Sonar T, Ivanov M, Trofimov E, Liu K, Shcherbakov I, Shaburova N, Samoilovskikh P. A critical review on dissimilar welding of ferritic-martensitic steel and austenitic stainless steel using gas tungsten arc welding process: Weldability issues, processing, and performance characteristics of joints. Journal of Manufacturing Processes. 2025;133(17):811–864. DOI:10.1016/j.jmapro.2024.11.081.
9. Zewide YT, Yemata TA, Ayalew AA *et al.* Application of response surface methodology (RSM) for experimental optimization in biogenic silica extraction from rice husk and straw ash Scientific Reports. 2025;15:132. DOI:10.1038/s41598-024-83724-6.
10. Yu D-W, Qing X-T, Lin H-Y, Yang J, Yang J-C, Wang X-J. Response Surface Methodology Optimization of Resistance Welding Process for Unidirectional Carbon Fiber/PPS Composites. Materials. 2024;17(10):2176. DOI:10.3390/ma17102176.
11. Patel H, Joshi U, Joshi A. Optimization of MIG welding parameters for dissimilar metals IS 2062 and SS 304 using response surface methodology. Welding International. 2025:1–16. DOI:10.1080/09507116.2025.2557369.
12. Koli Y, Yuvaraj N, Aravindan S, Vipin. CMT joining of AA6061-T6 and AA6082-T6 and examining mechanical properties and microstructural characterization. Transactions of the Indian Institute of Metals. 2021;74(2):313–329.
13. Sahu AK, Sahu NK, Sahu AK, Rajput MS, Narang HK. Modeling the predictive values of ultimate tensile strength in welded joint by response surface methodology. Materials Today. 2021;44:3110–3114. DOI:10.1016/j.matpr.2021.02.798.
14. Rajendran C, Sonar T, Ivanov M, *et al.* Optimization of friction stir spot welding parameters for joining dissimilar AZ31B magnesium alloy and AA6061 aluminium alloy using response surface methodology. International Journal on Interactive Design and Manufacturing. 2025;19:115–126. DOI:10.1007/s12008-023-01527-x.
15. Kamminana R, Kambagowni VS. Multi-Response optimization of Friction stir welding of AA2050 using Response Surface Methodology coupled with Grey relational analysis and principal component analysis. Manufacturing Technology. 2022;22(2):156–167. DOI:10.21062/mft.2022.016.
16. Kumar N, Chakravarty S, Kumar N, Sen RS. A combined RSM – FEM analysis of weld quality in laser transmission welding of plastics. Material Research Express. 2024;11:115310. DOI:10.1088/2053-1591/ad95e3.
17. Dhamothara Kannan T, Sivaraj P, Balasubramanian V, Sonar T, Lvanov M, Sathiya S. Unsymmetric rod to plate rotary friction welding of dissimilar martensitic stainless steel and low carbon steel for automotive applications–mathematical modeling and optimization. International Journal on Interactive Design and Manufacturing. 2024;18:1731–1759. DOI:10.1007/s12008-022-01193-5.
18. Igbinake AO. Comparison of Response Surface Methodology (RSM) and Artificial Neural Networks (ANN) in Optimisation of the Thermal Diffusivity of Mild Steel TIG Welding. Am. J. Mech. Mater. Eng. 2025;9(2):43–49. DOI:10.11648/j.ajmme.20250902.11.
19. Rizvi SA, Ali W. Development of mathematical model and optimization of GMA welding parameters of IS 2062 grade A steel weldments. Fracture and Structural Integrity. 15(56):84–93. DOI:10.3221/IGF-ESIS.56.07.
20. Baghel PK. Parameter optimization of pulse current gas tungsten arc welding process using teaching learning based optimization and cuckoo search algorithm Discover Mechanical Engineering. 2025;4:33. DOI:10.1007/s44245-025-00120-8.
21. Mayai A, Prasomthong S, Pookamnerd Y. Development of hybrid ANN-GA and RSM models for optimizing mechanical properties in SS400-SUS304 welds. EUREKA: Physics and Engineering. (3):152–165. DOI:10.21303/2461-4262.2025.003606.
22. Jebbur AM, AlKareem SSA, Mustafa FF. Effect of MIG Welding Parameters on the Mechanical Properties of AISI 304 Austenitic Stainless Steels. Al-Khwarizmi Engineering Journal. 2022;18(1):1–15. DOI:10.22153/kej.2022.01.001.