International Journal of Engineering

Journal Homepage: www.ije.ir

Experimental Investigation of Tungsten Inert Gas Welding Input Parameters Effects on Mechanical Characteristics

F. Salehpour-Oskouei*[a], V. Nematifard[b], G. Marami[c], A. Afkar[d]

[a] *Mechanical Engineering Department, Islamic Azad University, Shabestar Branch, Shabestar, Iran*
[b] *Islamic Azad University, Ilkhchi Branch, Ilkhchi, Iran*
[c] *Mechanical Engineering Department, Tabriz University, Tabriz, Iran*
[d] *Research Center of Technology and Engineering, Standard Research Institute, Karaj, Iran*

PAPER INFO

Paper history:
Received 12 November 2020
Received in revised form 02 December 2020
Accepted 04 December 2020

Keywords:
Tungsten Inert Gas
Mechanical Arm
Tensile Strength
316 Stainless Steel

ABSTRACT

Tungsten inert gas (TIG) welding process is one of the complex production methods. The reason is the drastic changes in the metallurgical structure of welding parts due to the heating and cooling cycle during welding. These changes cause various metallurgical and mechanical defects of the parts and weaken the mechanical properties of the parts. Many parameters in welding have different effects on the quality of welding parts. To create a suitable weld, it is necessary to identify the effect of these parameters and to be able to estimate it and select the appropriate and optimal conditions. Accordingly, In this study, an experimental investigation were conducted on determining the mechanical characteristics of the pieces through variation of three main welding parameters including advance speed, welding amperage and preheating temperature. Due to the difficulty of changing the rate of advance speed in manual welding, a robotic welding arm was designed for welding 316 stainless steel in the current paper, in which a microcontroller tuned the speed and welding length. By collecting the practical data, the effect of the input data (advance speed, welding amperage and preheating temperature) investigated in durability and strength of the joints. In other words, the tension and durability of the joints for stainless steels are proposed for various welding parameters to enhance the optimal conditions based on the experimental results. In samples with low advance speed, in addition to increase the solidification time, the coarseness of the structure and the burning of the edges of the welded parts due to the low speed and high amps, reduce the tensile strength. Also, the results showed that by increasing the amperage, the strength of welding parts decreases due to the burn defect of the plate edges, which can be minimized by increasing the welding speed and reducing the effect of extreme heat on the edges. Finally, by analyzing the effect of the input parameter on the output, the best conditions of the adjustment parameters in butt-welding were acquired among existed samples for welding 316 stainless steel.

***doi**: 10.5829/ije.2021.34.02b.30*

1. INTRODUCTION

Newly, there has been a regular shift from merely theoretical to applied research, especially in the field of information processing, and for issues, which are complicated or have no clear-cut solutions. Hence, there has been an increasing interest in the theoretical development of intelligent dynamic systems of free models, which are based on experimental data. Now, the Unmanned Flexible Manufacturing System (UFMS) is growing without human presence [1]. For this reason, different sensors are required to control and gain information from process conditions. Nonetheless, the information on these sensors must be processed in some ways, and decisions must be made to control and supervise the process. Hence, the decision-making unit must be a sort of intelligent system [2]. In other study, the deposition ratio of welding bead for gas arc of SS316 optimized by the Taguchi method [3]. Their results showed the efficiency of the optimization method in

---

*Corresponding Author Institutional Email: Farzin.salehpour@gmail.com (F. Salehpour-Oskouei)

Please cite this article as: F. Salehpour-Oskouei, V. Nematifard, G. Marami, A. Afkar, Experimental Investigation of Tungsten Inert Gas Welding Input Parameters Effects on Mechanical Characteristics, International Journal of Engineering, Transactions B: Applications Vol. 34, No. 02, (2021) 564-571

welding process. The control factors of the tungsten inert gas welding and its penetration for the thin layers were presented in literature [4]. In addition, the activated tungsten inert gas (ATIG) welding procedure was optimized for ASTM/UNS S32205 DSS joints to enhance intended aspect ratio [5].

The welding process is considered one of the complex production methods [6]. In some researches, the effect of welding parameters on joint quality were investigated [7-9]. Halimi et al. [7] have investigated the effect of welding parameters such as speed and power on dissimilar pulsed laser joint between nickel-based alloy and austenitic stainless steel AISI 304l. Findings showed that the highest-quality none-similar joints could be achieved by optimizing the proposed welding parameters [7]. Saeheaw [8] represented that the length of joining of very dissimilar material increased, by using a ring weld path, assist the achievement of sufficient joint strength and findings in efficient application of the restricted area accessible for welding performance. In addition, welding speed on characteristics of the welding and joint of dissimilar parts discussed by Langari and Kolahan [9]. The parameter analysis including the speed and rotational rate, microstructure, defects, and mechanical properties of aluminum alloys joint in welding. Kurt and Samur, [10] have estimated the mechanical characteristics of the TIG welded joints for a determined set of input parameters. In proposed study, microstructure evolution and mechanical properties of 316 austenitic stainless steel (SS) jointed by tungsten inert gas (TIG) welding by using 308 stainless steel filler wire were examined. In the closest research to the present study, Kumar et al. [11] have focused on the optimization of the procedure parameters of TIG joining procedure. Applied material in the proposed research is AISI 304. It was concluded that the current is the most influential parameters in case of tensile strength as indicated by response value graph [12]. One of the substantial methods of welding is the TIG method and, as mentioned, one of the main disadvantages of this method is that in this method, welding is performed manually [13]. On the other hand, since the welding process is done manually, the initial speed parameter and distance between the tips of the electrode to the workpiece cannot be kept constant and measured accurately. Moreover, since the speed of the welding operator's hand is not stable, the welding is not carried out uniformly and the quality of the welding is reduced [14].

In this research, a smart mechanical arm will be designed and built for tungsten electric arc welding, in which a microcontroller controls the welding speed and distance advanced. Assessing the impact of the welding input parameters on tensile strength for 316 stainless steel, which is one of the most widely used metals in the food industry, and its welding requires high skills. Hence, initially, a 316 stainless steel sheet with a thickness of 3 mm will be prepared in the dimensions of 3*60*250 mm according to the Minitab design of experiment (Taguchi optimization). To carry out and determine tensile tests with different Amp parameters at three levels of 90,110,120 amperes and four levels of advance speed of 1, 2, 3, 4 mm per second and three preheat temperatures of 120,180 ˚C and ambient temperature, the welding process is performed by a smart mechanical arm. To build this mechanism, closed-loop control will be utilized by embedding the shaft encoder in the mechanism axis, in a way that its speed can be controlled online via computer at the beginning of practical tests as desired. Next, the welded joints are prepared and examined to carry out investigations and tensile tests, and the mechanical properties of the welded joints will be practically measured. The input variables are current intensity, torch advance speed, and preheat temperature. The output is also the tensile strength and distortion of the welding joints

2. RESEARCH METHODS

2. 1. Designing an Automatic Welding Arm

The welding quality of the tungsten arc welding process is higher than other processes due to its high reliability, cleanliness, and high weld strength [15]. The quality of the weld depends to the initial input variables of the welding [16]. In this survey, to assess and control the impact of speed parameters on the mechanical properties of welded joints in the tungsten arc welding, a welding arm was designed and made on AISI 316 stainless steel with a thickness of 3 mm. After designing and manufacturing the mechanical parts according to Figure 1, the components of the electronic speed control by installing the Shaft Encoder EN50S8 in the DC motor shaft with 110v power supply and with the aid of an ATMEGA8 microcontroller, which is from AVR family, was manufactured to control the speed and distance. To calculate the speed and distance advanced in the automatic arm, it is assumed that with each rotation of the mechanism, the automatic arm will advance a distance equal to the circumference of the wheel according to

Figure 1. Mechanical components of the automatic arm of the gas tungsten arc welding

Figure 2. Therefore, by multiplying the wheel circumference by the number of turns per unit time, the distance that the mechanism advances per unit time can be achieved.

Shaft encoder generates 2500 pulses per each turn of DC motor. Given Equation (1) and the diameter of the wheel (d_i), which is 67.034 mm, the course length (L) at each turn is 210.478 mm. Using a 1.800 gearbox, and considering that each turn of the wheel requires 800 turns from the DC motor shaft, and also that the shaft encoder produces 2500 pulses per round; hence, for one turn of the wheel, the output of shaft encoder will be virtually 2,000,000 pulses. By dividing course length by number of shaft encoder pulses, the rate of motion (RoM) of the automatic mechanism at each pulse is obtained according to Equation (2):

$$L=d_i\times\pi \tag{1}$$

$$\begin{aligned}&RoM= L/\text{number of pulses}\\&RoM =210.478\div2000000= 0.00010521\ \text{mm/pulse}\end{aligned} \tag{2}$$

Therefore, in order to convert the rate of arm movement at each pulse to speed, it is enough to set time to 0.00001 through adjusting the microcontroller, according to Equation (3), in which V indicates the torch advance speed. That is to say, the microcontroller can evaluate and control all calculations, including distance and speed, according to the transmitted pulses and their number.

$$V=X/t \tag{3}$$

The speed control system of the automatic welding arm, by pulse width modulation method (PWM), implies changing the correlation coefficient of a signal in order to send information to a communication channel or adjust the amount of power sent to the load. Pulse width Modulation, or PWM, is a signal that can be generated from a digital IC such as a microcontroller or timer 555. The output signal is a pulse train, and these pulses form a square waveform. In other words, at any given time, the wave will be in the high or low position. In this way, according to Figure 3, it should be adjusted using the feedback obtained by sending the pulse by the shaft encoder and converting it to the speed unit and comparing the speed set in the software with the aid of computer and PID routine (proportional–integral–derivative) to achieve the desired speed. After attaining the actual speed of the automatic arm movement, which is performed 10,000 times per second (due to setting the time of micro-measurement on 0.1 ms), the results obtained are delivered to the PID routine, and after carrying out the necessary software calculations, PWM is instructed to reduce or increase the speed to the desired speed and limit with the pulse width modulation method. This value is based on a unit of 0.1 mm/s and can be defined from 0.1 mm/s to 25 mm/s. The connection between the controlled automatic welding arm and the computer is done through RS-232.

The circuit was then printed using the Protel electronic circuit design program.

2. 2. Welding and Preparing Samples

After manufacturing an automatic arm, to begin practical tests, to optimize and reach the best possible results with the least number of tests, designing experiments was performed using statistical and optimization techniques by RSM method and of Box-Behnken type in Minitab 1.5 software [17]. The experimental factors and test levels were conducted according to the order and conditions mentioned by this software in four modes of torch speed, three current intensity modes, and three preheat temperatures according to Table 1. In this survey, AISI 316 stainless steel with a thickness of 3 mm was applied and the steel parts were examined for chemical analysis, which is presented in Table 2. The samples after welding by the automatic arm is shown in Figure 4. Welding of joints in the dimensions of 60 × 250 mm was performed, according to Figure 5, through utilizing argon shielding gas with the double-sided torch to further protect the molten pool of the welding area from atmospheric factors.

3. RESULTS

3. 1. Experimental Sample Preparation for Distortion

Distortion and deformation are some

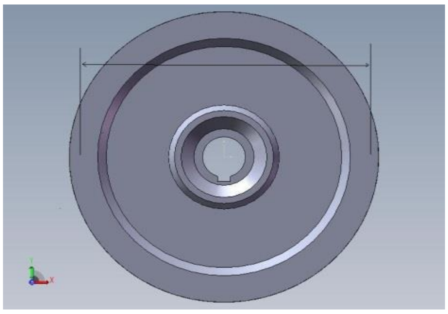

Figure 2. Wheel designed for automatic arm movement

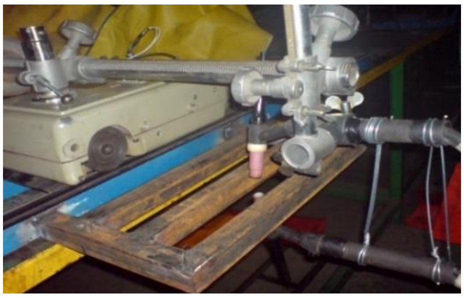

Figure 3. Double-sided torch to further protect argon from subsamples

TABLE 1. Design of experiments in Minitab software

Experimental samples	Advance speed (mm/s)	current intensity (A)	Preheat temperature (^{0}C)
1	4	130	180
2	1	90	25
3	1	130	180
4	4	90	25
5	3	130	25
6	2	90	180
7	4	90	180
8	1	130	25
9	3	90	120
10	2	110	25
11	3	110	180
12	1	110	120
13	4	110	120
14	2	130	120
15	3	130	180
16	2	130	180
17	2	90	25
18	1	110	25

TABLE 2. Results of chemical analysis and its comparison with the standard

Element	Min	Max	Available
C	0	0.080	0.075
S	0	0.030	0.025
p	0	0.045	0.042
Mn	0	2.000	1.160
Si	0	0.750	0.479
Ni	10.00	14.00	10.110
Cr	16.00	18.00	17.771
Mo	2	3	2.133
N	0	0.10	0.043
Co	0	0	0.030
Cu	0	0	0.090

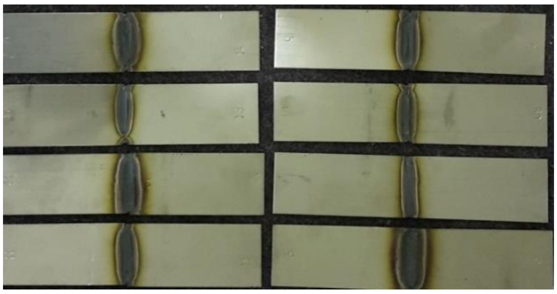

Figure 4. Samples after welding by the automatic arm

of the significant issues caused by the expansion factor, the amount of contraction in the solid state, the design error, and the welding operation technique. During welding operations, due to the application of local heat flux to the weld and the cooling rate of the welding site, the contraction, that was supposed to be distributed throughout the part, will inevitably be reduced to the same range. Moreover, if this contraction is in a place that is geometrically angular, it will lead to angular distortion according to the schematic Figure 6. Angular distortion was measured using a profile projector (Figure 5). The obtained results are summarized in Table 3.

3. 2. Preparation of Tension Sample

316 stainless steel samples, after welding by an automatic arm to perform tensile tests in accordance with EN895 standard of the DIN standard series, were initially milled using milling machines according to the dimensions of Figure 6. Then, sandpapers to reduce the stress concentration sanded their edges and surfaces. Finally, they were prepared according to Figure 7.

The mechanical properties of metals, including elastic reactions, are due to the application of force or the

Figure 5. Profile projector device

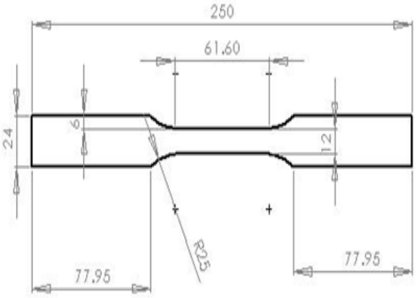

Figure 6. Dimensions of sample preparation according to EN895

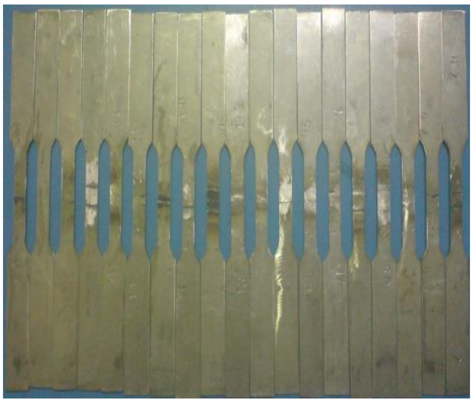

Figure 7. Samples prepared for practical tests

relationship between tension and their relative length change. Tensile strength is the maximum tensile force that the body will withstand before failure. To investigate the mechanical properties, ZWICK tensile tester according to Figure 8 tested the prepared samples. The results obtained are shown in Table 3. During the tensile test, it was observed that all test samples were broken from the weld site, which is a testament to the correctness of the samples based on the standards.

4. ANALYSIS AND DISCUSSION

Given the repeatability of the results of practical experiments is essential, the repetition of the experiment was conducted for some samples. After securing the repeatability of the test results, its values are listed in Table 3.

4. 1. The Effect of Advance Speed on the Distortion of Joints

Figure 9 indicates the impact of speed on the distortion of welding joints (samples 1, 3, 15, 16 and 12, 13 according to Table 3) in the same conditions of temperature and initial amperage, in which by altering the advance speed of the torch, its effect on the output is investigated. The results of the samples' analysis demonstrate that as the advance speed of torch increases, the angular distortion rate of the welded joints decreases.

4. 2. The Impact of Welding Current Intensity on Components Distortion

Figure 10, which assesses the impact of welding current intensity on component distortion, reinforces the fact that with the constant initial parameters, torch advance speed and preheat plate temperature, different amps do not have a considerable effect on the angular distortion of the welding joints.

4. 3. The Effect of Preheat Temperature of Joints on Tensile Strength

In the experimental study of the samples mentioned in Figure 11, it was found that by increasing the preheat temperature in the same initial conditions, the angular distortion of the joints decreases after welding. Furthermore, the results of the samples' analysis indicate that as the advance speed of the welding torch and the preheat temperature increases, the angular distortion rate of the welded joints decreases, which is in accordance with the theory mentioned in the first chapter. Preheating, heat management during welding, and machining, if possible, after welding can also bring distortion reduction. The results illustrate that the most optimal setting values of the initial parameters, to reduce the distortion of the welded samples, were acquired by setting the speed value to 3 mm/s, the amperage to 90 amps, and the preheat temperature to 120 ˚C.

4. 4. The Effect of Advance Speed on Tensile Strength

Figure 12 demonstrates the effect of speed on the tensile strength of welding joints in the same

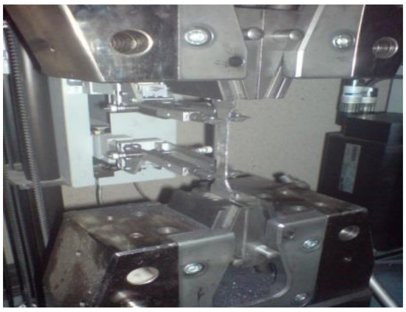

Figure 8. ZWICK tester in welding test mode

TABLE 3. Results of tensile tests on experimental samples

Experimental samples	Speed (mm/s)	Current (A)	Preheat temp (^{0}C)	Tensile strength (MPa)	Distortion angle (degrees)
1	4	130	180	715.26	1.34
2	1	90	25	631.13	4.85
3	1	130	180	492.01	2.87
4	4	90	25	398.39	2.004
5	3	130	25	662.23	4.24
6	2	90	180	682.26	2.01
7	4	90	180	230.54	1.83
8	1	130	25	546.27	4.45
9	3	90	120	457.69	1.32
10	2	110	25	661.59	2.84
11	3	110	180	604.31	2.76
12	1	110	120	583.63	4.05
13	4	110	120	445.98	3.18
14	2	130	120	591.34	4.36
15	3	130	180	703.65	2.11
16	2	130	180	604.47	2.53
17	2	90	25	678.22	3.04
18	**1**	**110**	**25**	**585.37**	4.73

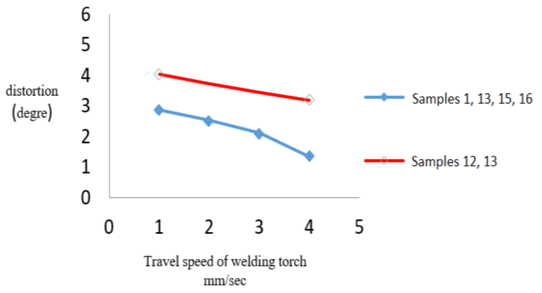

Figure 9. The effect of advance speed on distortion in welding joints with constant current and preheat temperature

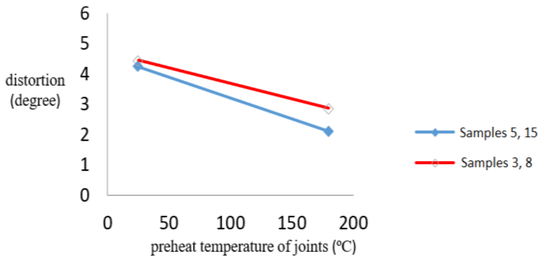

Figure 11. The effect of preheat temperature on distortion in welding joints with constant advance speed and current intensity

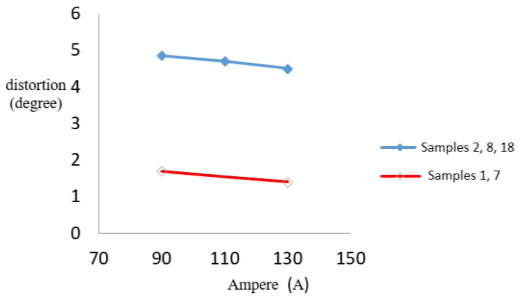

Figure 10. The impact of welding current intensity on distortion in weld procedure with constant advance speed and preheat temperature

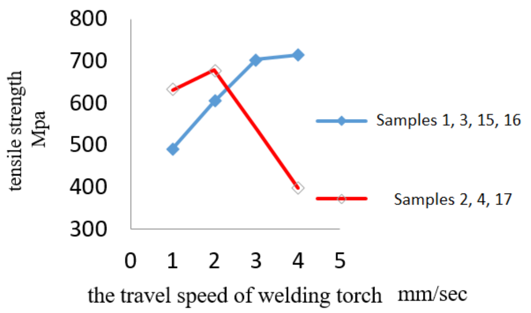

Figure 12. The effect of advance speed on tensile strength in welding joints with constant current intensity and preheat temperature

conditions of initial temperature and amperage, in which by changing the torch advance speed, its effect on the output is checked. In samples 1, 3, 15, 16, the first sample due to low speed, in addition to increasing the freezing time, causes coarse-grained structure. On the other hand, given the burning defect of the edges of the welding joints (Under Cut), due to the low speed and high amperage, it reduces the tensile strength. The increase in tensile strength is due to the increase in the advance speed, which is the result of the reduction of the two main defects mentioned. In samples 2, 4, 17, the increase in strength to the speed equal to 2 (mm/s) is valid. However, at the speed equal to 4 (mm/s), the tensile strength decreases due to the enormous reduction in melting time of the molten pool and the uncompleted melting of the edges, due to the reduction of amperage and the increase in speed.

4. 5. The Effect of Welding Current Intensity on Tensile Strength

Examination of Figure 13 indicates that with the stability of the initial welding parameters except for the amperage, the strength of the welding joints decreases due to the burn defect of the plate edges. This defect can be minimized by increasing the welding speed and reducing the impact of extreme heat on the edges. Given the samples 11 and 15, an increase can be seen in durability because the increase in amperage is accompanied by an increase in the advance speed. This is mainly because of the reduction of the impact of extreme heat on the edges and therefore the reduction of the burn defects of the plate edges.

4. 6. The effect of Preheat Temperature of Joints on Tensile Strength

Investigating Figure 14 shows that preheat temperature has little effect on tensile strength, and according to the results, its greatest effect is on the angular distortion of the welding joints.

The overall results demonstrated that the most optimal setting values of the initial parameters in order to increase the tensile strength, is through setting the speed to 4 mm per second, the amperage to 130 amps, and the preheat temperature to 180 ˚C.

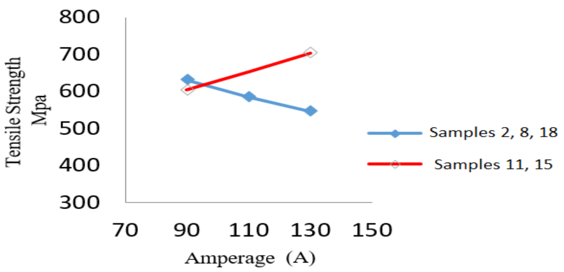

Figure 13. The effect of welding current intensity on tensile strength in welding joints with constant advance speed and preheat temperature

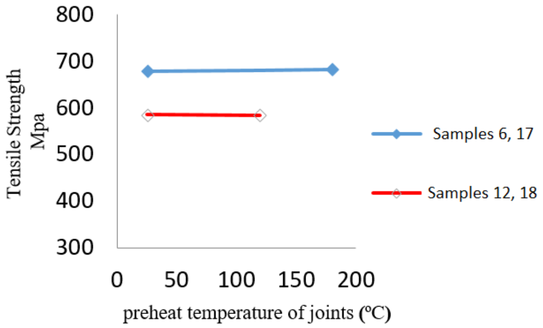

Figure 14. The effect of preheat temperature on tensile strength in welding joints with constant advance speed and current intensity

5. CONCLUSION

Tensile strength of welding joint and its deformity are the main indicators of welding quality. In this study, TIG welding processes was performed on 316 stainless steel in butt mode with different initial parameters including advance speed, amperage and preheats temperature. Then practical experiments were performed to obtain mechanical properties such as tensile strength and angular distortion of samples. Scientifically, the independent effect of each of the welding input parameters on the tensile strength and distortion were specified, and by examining the effect of the input parameter on the output, the best adjustment parameters of butt-welding were extracted for stainless steel welding 316.

The results show that by keeping the amperage and the preheating temperature constant, reducing the advance speed on the one hand increases the solidification time and coarseness of the structure and on the other hand leads to burns of the edges of welded parts which results in reduced tensile strength. In addition, by keeping the advance speed and preheating temperature constant and increasing the amperage, the tensile strength is reduced due to the burning defect of the edges of the parts. However, by performing various experiments, it was found that in conditions of high amperage, the mentioned defect could be eliminated by increasing the advance speed. Finally, by keeping the advance speed and amperage constant and changing the preheating temperature, no significant effect on tensile strength was observed.

According to the illustrated survey of the effect of all input values separately on output values, required measures should be taken in designing and adapting the initial welding parameters. According to the outcomes of this study, so as to obtain the desired mechanical properties, applying machines and robots are more advantageous and preferable than manual welding, due to the exact control of the initial parameters.

6. REFERENCES

1. Ethiraj N, Sivabalan T, Sivakumar B, Vignesh Amar S, Vengadeswaran N, Vetrivel K. "Effect of Tool Rotational Speed on the Tensile and Microstructural Properties of Friction Stir Welded Different Grades of Stainless Steel Joints", ***International Journal of Engineering*, *Transactions A: Basics***, Vol. 33, No. 1, (2020), 141-147, DOI: 10.5829/ije.2020.33.01a.16

2. Subrammanian A., Pvsenthii L., Jabaraj DB. & Jayaprakash J. "Effect of process parameters on the mechanical performance of resistance spot welded joints of AISI409M ferritic stainless steel", ***Indian Journal of Engineering and Material Sciences***, Vol. 25, (2018), 11-18, http://nopr.niscair.res.in/handle/123456789/44450

3. Atul Raj, A.S., Phanden, R.K., & Gehlot, N. "Optimization of Deposition Rate of Weld Bead for Gas arc welding of Stainless Steel (SS316) using Taguchi Methods", ***International Journal for Technological Research in Engineering***, Vol. 2, No. 7, (2015), 3-13, http://www.ijtre.com/images/scripts/14289.pdf

4. Mbonde N. "Penetration Management in Tungsten inert Gas (TIIG) welding of thin plates by detecting oscillation of the molten pool", ***International Journal of Scientific Engineering And Applied Science***, Vol. 3, No. 5, (2017), 3-13, http://ijseas.com/volume3/v3i5/ijseas20170543.pdf

5. Ibrahim, M., Maqsood, SH., Khan, R., Amjad, M., & Jaan, SH. "Optimization of Gas Tungsten Arc welding parameters on penetration depth and bead width using the TAGUCHI method". ***Journal of Engineering Applied Science***, Vol. 35, No. 2, (2016), 78-89, https://doi.org/10.25211/JEAS.V35I2.2060

6. Teng, T. L., Lin, C. C., "Effect of welding condition on residual stresses due to butt welds, International Journal of Pressure Vessel and Piping", Vol. 75, (1998), 857-864, https://doi.org/10.1016/S0308-0161(98)00084-2

7. Halimi H., Vakili G., Safari E. "Effect of Welding Parameters on Dissimilar Pulsed Laser Joint between Nickel-Based Alloy Hastelloy X and Austenitic Stainless Steel AISI 304L", ***Scientia Iranica***, (2019), in press, https://doi.org/10.24200/sci.2019.52221.2602.

8. Saeheaw T. "Regression Modeling and Process Analysis of Plug and Spot Welds Used in Automotive Body Panel Assembly". ***International Journal of Engineering*, *Transactions B: Applications***, Vol. 33, No. 11, (2020), 2384-2398. 10.5829/ije.2020.33.11b.29.

9. Langari J., Kolahan F., "The effect of friction stir welding parameters on the microstructure, defects, and mechanical properties of AA7075-T651 joints", ***Scientia Iranica***, (2019), in press, https://doi.org/10.24200/sci.2018.5700.1434.

10. Kurt, H.I., Samur, R. "Study on Microstructure, Tensile Test, and Hardness 316 Stainless Steel Jointed by TIG Welding", ***International Journal of Advances in Engineering*, *Science and Technology***, Vol. 3, No. 1, (2013), 2249-2258, http://www.ijaest.com/docs/IJAEST13-03-01-006.pdf

11. Kumar S., Jena S., Lahoty V., Paswan M., Sharma B., Patel D., Prasad S.B., Kumar Sharma V., "Experimental investigation on the effect of welding parameters of TIG welded joints using ANOVA", ***Materials Today Proceedings***, Vol. 22, No. 4, (2020), 3181-3189, https://doi.org/10.1016/j.matpr.2020.03.455

12. Saleem M. "Microplane modeling of the elasto-viscoplastic constitution", ***Journal of Research in Science, Engineering and Technology***, Vol. 8, No. 3, (2020), https://doi.org/10.24200/jrset.vol8iss3pp%25p

13. Basavaraju, Ch., "Simplified analysis of shrinkage in a pipe to pipe butt welds", ***Nuclear Engineering and Design***, Vol. 197, (2000), 239-247, https://doi.org/10.1016/S0029-5493(99)00302-7

14. Patchett, B. M. "The metals blue book: welding filler metals", Vol. 3, (1998), Asm International., https://www.casti.ca/books_ebooks/lite/BlueBookLite.pdf

15. Saha M., Dhami, S. "Effect of TIG Welding Parameter of Welded Joint of Stainless Steel SS304 by TIG Welding", ***Trends in Mechanical Engineering & Technology***, Vol. 5, No. 3, (2018), 18-27, https://doi.org/10.37591/tmet.v8i3.1433

16. Hu, X., Ma, C., Yang, Y. "Study on Residual Stress Releasing of 316L Stainless Steel Welded Joints by Ultrasonic Impact Treatment", ***International Journal Steel Structure***, Vol. 20, (2020), 1014-1025. https://doi.org/10.1007/s13296-020-00338-0.

17. Uematsu Y, Kakiuchi T, Ogawa D, Hashib K., "Fatigue crack propagation near the interface between Al and steel in dissimilar Al/steel friction stir welds", ***International Journal of Fatigue***, Vol. 138, (2020), 105706, https://doi.org/10.1016/j.ijfatigue.2020.105706.

Persian Abstract

چکیده

فرآیند جوشکاری گاز بی اثر تنگستن (TIG) یکی از روشهای پیچیده تولید است. دلیل آن تغییرات شدید در ساختار متالورژی قطعات جوشکاری ناشی از چرخه گرمایش و سرمایش در هنگام جوشکاری است. این تغییرات باعث نقص های مختلف متالورژیکی و مکانیکی قطعات شده و خصوصیات مکانیکی قطعات را تضعیف می کند. بسیاری از پارامترها در جوشکاری تأثیرات متفاوتی بر کیفیت قطعات جوشکاری دارند. برای ایجاد یک جوش مناسب ، لازم است اثر این پارامترها مشخص شود و بتوان آن را تخمین زده و شرایط مناسب و بهینه را انتخاب کرد. بر این اساس ، در این مطالعه ، یک تحقیق آزمایشی در مورد تعیین مشخصات مکانیکی قطعات از طریق تغییر سه پارامتر اصلی جوشکاری از جمله سرعت پیشروی ، آمپراژ جوش و دمای پیش گرم انجام شد. به دلیل دشواری تغییر سرعت پیشروی در جوشکاری دستی ، یک بازوی جوشکاری رباتیک برای جوشکاری فولاد ضد زنگ ۳۱۶ در مقاله فعلی طراحی شده است که در آن میکروکنترلر، سرعت و طول جوشکاری را تنظیم می کند. با جمع آوری داده های عملی ، تأثیر داده های ورودی (سرعت پیشروی ، آمپراژ جوشکاری و دمای پیش گرمایش) در دوام و مقاومت کششی اتصالات بررسی می شود. به عبارت دیگر ، کشش و دوام اتصالات برای فولادهای ضد زنگ برای پارامترهای مختلف جوشکاری پیشنهاد می شود تا شرایط بهینه بر اساس نتایج تجربی افزایش یابد. در نمونه هایی با سرعت پیشروی پایین ، علاوه بر افزایش زمان انجماد ، درشت دانه‌گی ساختار و سوختن لبه های قطعات جوشکاری شده به دلیل سرعت کم و آمپر زیاد ، مقاومت کششی را کاهش می دهد. همچنین نتایج نشان داد که با افزایش آمپراژ ، مقاومت قطعات جوشکاری به دلیل نقص سوختگی لبه های صفحه کاهش می یابد که می توان با افزایش سرعت جوشکاری و کاهش اثر گرمای شدید بر روی لبه ها ، آن را به حداقل رساند. سرانجام ، با تجزیه و تحلیل تأثیر پارامتر ورودی بر خروجی ، بهترین شرایط پارامترهای تنظیم در جوشکاری لب به لب در میان نمونه های موجود برای جوشکاری فولاد ضد زنگ ۳۱۶ بدست آمد.