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EFFECT OF DIFFERENT TYPES OF ELECTRODES ON SURFACE RESIDUAL STRESSES INDUCED BY EDM PROCESS FOR AISI D2 DIE STEEL

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ABSTRACT
Electrical-discharge machining (EDM) technique has been increasingly adapted to new industrial applications within the field of aerospace, medical, die and mould production, precision tooling, etc. This paper concerns with studying the effect of EDM input parameters (type of electrode, peak current, and pulse-on time) on the surface residual stresses. Response surface methodology (RSM) has been used to plan the experiments. The experimental plan adopts the two level full factorial design (FFD). To verify the experimental results, the analysis of variance (ANOVA) was used and regression models are built to predict the EDM output performance characteristics, including the surface residual stresses for AISI D2 die steel in terms of an empirical equations. The results obtained when using the copper and graphite electrodes showed that the minimum tensile surface residual stresses reaches with pulse current (22 A) and pulse on duration (120 µs). The results concluded that the using of copper electrodes induced tensile residual stresses about (13.3%) lower than when using graphite electrodes.

KEYWORDS: EDM, RSM, FFD, Surface residual stresses, ANOVA, Die stee.

INTRODUCTION
Electrical discharge machining (EDM) is one of most popular nonconventional machining processes used for machining parts that cannot be done by conventional machines and for creating complex shapes within the parts and assemblies in the manufacturing industry [1]. The main advantages that it is a unique method to machine parts regardless of hardness, since the tool does not touch the work piece and there are no cutting forces generated. Electric Discharge machinery developed in late 1940's has been accepted worldwide as a standard process in manufacturing and is capable of machining components that are precise and difficult-to-machine, such as heat treated tool steels, heat resistant steels, composites, super alloys, ceramics, hastalloys, nitralloy, nemonics, carbides being widely used in die and mold making industries, aerospace, aeronautics, medical, micromechanics, and nuclear industries.

The AISI D2 die steel is an air hardened, high carbon, high chromium steel and also has molybdenum and vanadium characterized by extremely high wear resistance combined with moderate toughness (shock-resistance) and compressive strength, good through-hardening properties and resistance to tempering-back and high stability in hardening. Owing to its superior quality and hardness, AISI D2 die steel finds application in various fields like die making, blanking dies, forming dies, coining dies, extrusion dies, drawing dies, rolls making: forming rolls, edging rolls, beading rolls, tool making, punches, etc[2-5].

Residual stresses generated during EDM are mainly due to the non-homogeneity of heat flow and metallurgical transformations or to localized inhomogeneous plastic deformation, respectively. Investigation of the residual stresses of EDM machined components revealed their tensile nature, the extremely narrow superficial zone where they appear, their high magnitude at the surface layers, and their increase with increasing pulse energy [6,7]. The formation of surface cracks has attributed to the differentials of high contraction stresses exceeding the material's ultimate tensile stress within the white layer [8]. Mamalis et al. [9] and Rebelo et al. [10] found that the peak stresses are almost independent of the discharge energy and approach the ultimate tensile strength of the material. Kruth and Bleys [11] have observed that the peak stress is not located at the surface, but somewhat below for rough machining conditions. B.Ekmekci et al. [12]

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presented a procedures and results of experimental work to measure residual stresses and hardness depth in electric discharge machined surfaces.

Ghanem et al. [13] have studied on martensitic hardenable and non-hardenable steels. They have reported a high tensile stress level and a wide profile associated with surface stress relaxation for hardenable steels. A qualitative relationship with the operating parameters was presented by Ekmekci et al. [14]. Then, a semi-empirical equation was suggested for scaling residual stresses in EDM machined surfaces [15].

In the present work, a model to represent the surface residual stress due to EDM parametric effects has been developed based on response surface methodology (RSM) technique to reduce the number of experimental runs required to generate sufficient information for a statistically adequate result. The principal aim of developing this model is to predict the nature and levels of these stresses resulting from EDM machining and to obtain engineering parts with higher fatigue endurance limits and longer service lives.

EXPERIMENTAL WORK

AISI D2 die steel with a high carbon and high chromium contents was selected to prepare the specimens for chemical and mechanical tests. This grade of steel is used for cold working processes and contains molybdenum that offers the ability to be hardened in air and gives a high degree of dimensional stability in heat treatment. Strips of this type of steel were used as a workpiece raw material with a dimension of 600x102x10 mm. Three specimens of dimension 40x40x10 mm were prepared for chemical composition by using the AMETEX SPECTRO MAX material analyzer. The average values of chemical composition for the selected workpiece material and the equivalent values given according to ASTM A 681-76 standard specification for alloy and die steels [16] are given in table (1).

For mechanical properties tests, four specimens with dimensions of 50x12.5x2.7 mm were prepared for tensile tests by using the universal testing machine type UNITED on the bases on ASTM-77 steel standard for flat workpiece [17]. These four specimens were also tested for Rockwell hardness tests by using the hardness testing machine type INDENTEC. The average of four tests readings fot the HRB hardness value and the tensile tests results are given in table (2). The manufacturing of the workpieces were done by the wire electrical discharge machine (WEDM) type ACRA Brand/ Taiwan and by a surface grinding machine, then specimens were polished mechanically and manually by abrasive silicon carbide paper up to grade ASTM 3000 . Measuring the surface residual stresses before and after EDM machining was conducted by using the X-RAY DIFRACTOMETER (XRD) testing equipment type lAB XRD-/Japan 5217A.

Two types of electrode materials, copper and graphite were selected to be used in EDM experiments. The copper electrode material was examined for chemical composition properties using the X-MET 3000TX HORIZONT metal analyzer, and the compositions obtained are: 0.006% Zn, 0.001% Pb, 0.0005% Sn, 0.005% P, 0.0002% Mn, 0.007% Fe, 0.004% Ni, 0.011% Si, 0.007% Al, 0.002% S, 0.005% Sb, and the remaining is 99.96% Cu. The electrodes were manufactured with a square cross-section of 24 mm and 30 mm lengths, with a quantity of 24 pieces for each type, as shown in figure (1). The prepared electrodes were polished as mentioned above.

Figure (1): Copper and graphite manufactured electrodes

The main designed EDM parameters are the gap voltage, Vp (140 V), the pulse current, Ip (8 and 22 A), the pulse on time duration, Ton (40 and 120 µs), the pulse off time duration, T off (14 and 40 µs), i.e., the duty factor (33%), and the electrode polarity (+). The EDM experiments were carried out on ACRA CNC-EB EDM machine shown in figure (2).

Several tests and analysis for the kerosene dielectric were doing. The flash point of the kerosene dielectric was tested by using the kerosene flash point tester type K, and other properties are: the specific weight=0.785 gm/cm³ at 26ºC (the standard value given by Iraqi marketing specifications guide for oil

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product is 0.801), the flash point=51 ºC. (standard value is 40 ºC), the free water = Nil, the smoke point= 25 mm and the final boiling point=300 ºC. The kerosene dielectric was adjust from both sides of the work piece electrode interface with a flashing pressure =0.73 bar (10.3 PSI).

In the first group, (11) experiments were performed by using the copper electrodes, and a new set of work piece and electrode was used in each experiment. The second group, graphite electrodes were used for comparing the surface residual stresses produced from thermal stresses producing by the EDM

Figure (2): ACRA type CNC-EB EDM machine manufactured by FREJOTH INTERNATIONAL LTD. /TAIWAN

machining using (11) specimens of experiments with the same procedure as mentioned above. The work pieces prepared for both groups and the used copper and graphite electrodes after EDM machining are shown in figure (3).

RESULTS AND DISCUSSIONS

Modeling of Surface Residual Stresses Using Copper Electrodes

The surface residual stresses experimentally obtained after EDM machining are modeled and analyzed by using the response surface methodology (RSM) and the two level factorial design for both experimental groups. The two input EDM process parameters are designed for the experiments (X1 and X2) and transformed into an output response variable, (Y) in an attempt to reach a conclusion, the experimenter needs to plan and design the experiments and analyze the results [18]. The input

Figure (3): The specimens and the used copper and graphite electrodes for the first and second group of experiments after EDM machining

EDM parameters and their levels are given in table (3) for the first and second groups using copper and graphite electrodes respectively. The designed EDM experimental matrix in a random manner with the selected factors (actual and coded) and the experimental measured response results by XRD method for the both groups using the kerosene dielectric and the copper and graphite electrodes are given in tables (4 and 5) respectively.

The response results show that all the measured residual stresses after EDM machining are tensile residual stresses values for the both groups. In group (1) using copper electrodes, the maximum residual stresses obtained is (366.261), and the minimum (314.592) Mpa. In group (2) experiments using the graphite electrodes, the maximum residual stresses obtained is (409.285), and minimum (362.963) MPa. The two level factors full factorial design (FFD) is used to set the necessary number of experiments to fit the model. The ANOVA technique is used to analyze the significance of EDM process parameters, where the F-test ratio is calculated for a 95% level of confidence. The inversion model obeys the least squares theory [19, 20]. The ANOVA function then runs in order to assess the results which are given in table (6) using the inverse transform model for lower the p-value main effects. The Model F-value of 242.50 implies the model is significant. In terms of statistical significance, it is often suggested that when the p value is more than 0.05, corresponding to a 5% confidence. Values of "Prob > F" less than 0.0500 indicate model terms are significant. In this case A, B and AB are significant model terms. The "Predicted R-Squared" of 0.9755 is in reasonable agreement with the "Adj R-Squared" of 0.9864; i.e. the difference is less than 0,2.

The final empirical equation for group (1) using

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the copper electrodes is :

1/(Residual Stresses) =+2.91080E-003-1.17082E-005*A-3.27331E-006* B +3.37027E-007*A*B (1)

This equation in terms of actual factors can be used to make predictions about the response for given levels of each factor. Here, the levels should be specified in the original units for each factor.

Modeling of Surface Residual Stresses Using Graphite Electrodes

The ANOVA analysis for the EDM machining surface residual stresses response for group (2) experiments using graphite electrodes with an inverse transform main effects model is given in table (7).

The Model F-value of 11.13 implies the model is significant. Values of "Prob > F" less than 0.0500 indicate model terms are significant. In this case A, B are significant model terms. The "Predicted R-Squared" of 0.4809 is in reasonable agreement with the "Adj R-Squared" of 0.6696; i.e. the difference is less than 0,2.

The final empirical equation in terms of actual factors for EDM machining using the graphite electrodes is:

1/(Residual stresses) = +2.37144E-003+1.03993E-005* A +1.53392E- 006 * B (2)

The diagnostic Process was used to evaluate the model fit and transformation choice as in the next lots. Figure (4) shows the normal probability plot to check for normality of residuals after EDM machining for copper and graphite electrodes. The plots show that the residual are distributed normally on a straight line.

The two dimensional (2D) contour model graphs given in figures (5 and 6) are used to interpret and evaluate the model. These figures show the influence of the EDM parameters on the work pieces surface residual stresses for copper and graphite electrodes, respectively. Both figures indicated that the tensile residual stresses decreases with increasing the pulse current up to (22A) and pulse on duration values to the selected maximum value too (up to 120 µs), where the surface residual stresses reached (317.456 MPa), experimentally observed (314.592 MPa) as shown in figure (5), and where the minimum residual stresses obtained when using the graphite electrodes is (359.384 MPa), experimentally observed (362.963), as shows in figure (6). means that the using of copper electrodes induced residual stresses about(13.3%) lower than when using graphite electrodes because the electrical resistivity of copper is much larger than that of graphite thereby increasing the thermal discharge energy, the smelting and removal processes in the gap

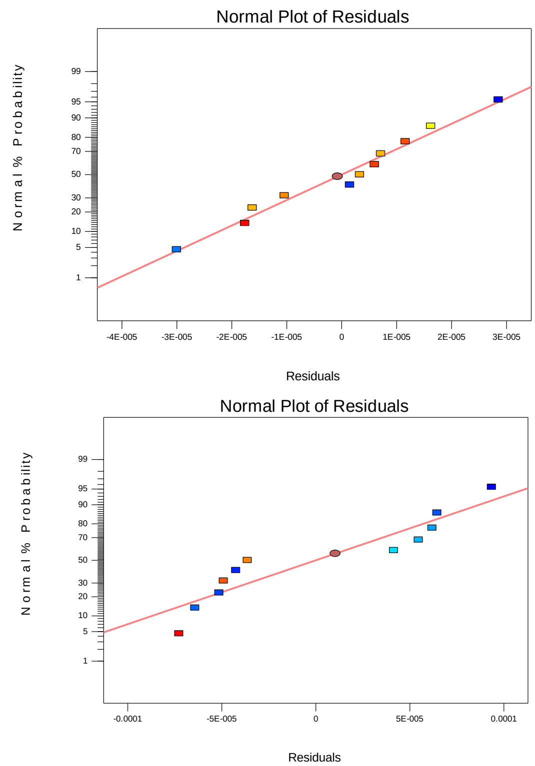
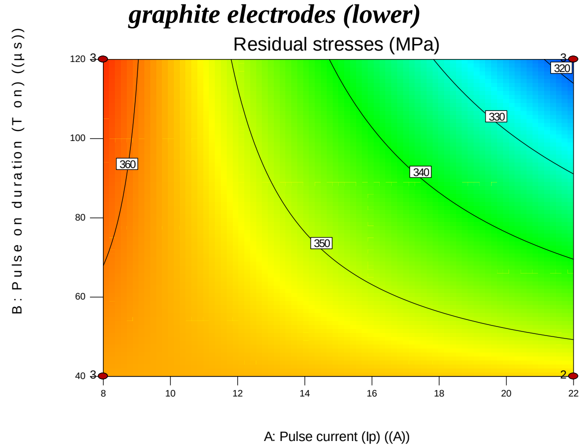


Figure (4): The normal probability plot the residuals, for copper electrodes (the upper) and graphite electrodes (lower)



Figures (5): Contour model graphs for EDM parameters using copper electrodes

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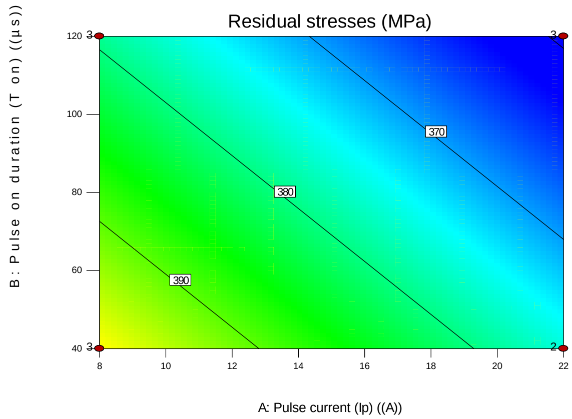
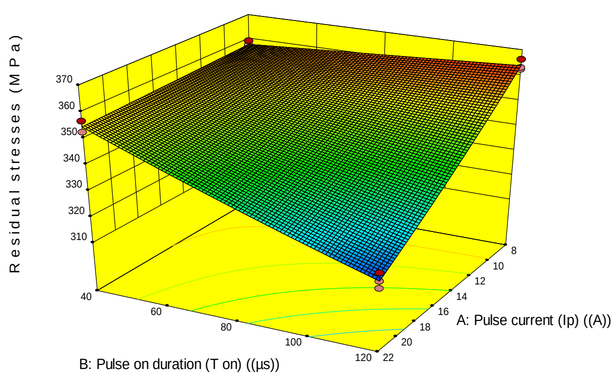


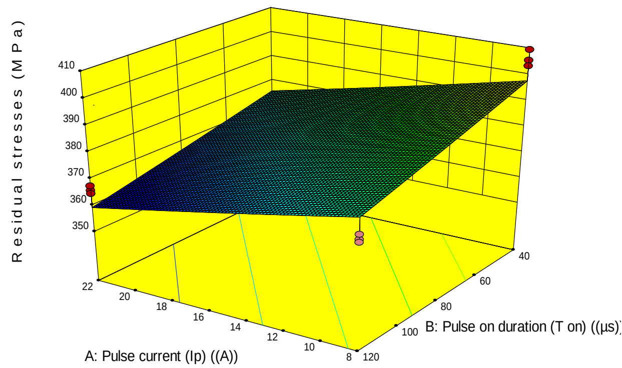
Figures (6): Contour model graphs for EDM parameters using graphite electrodes

area between the electrode and work piece, especially when using high current for a long period of time and all that cause annealing, softening, re-building and re-welding lot of voids and micro cracks of the machined material surface and consequently reduce the surface residual stresses.

Figures (7 and 8) show the three dimensional (3D) surface graphs for the influence of the selected EDM parameters on surface residual stresses for both copper and graphite electrodes, respectively. These figures manifest that the higher values of tensile residual stresses obtained when using the graphite electrodes as compared with copper electrodes and with the same best parameters as mentioned above. It can be seen that increasing both the current and pulse on duration, the tensile residual stresses decrease due to the same reason mentioned earlier.



Figures (7): 3D surface graph for the influence of the selected EDM parameters on the surface residual stresses using copper electrodes



Figures (8): 3D surface graph for the influence of the selected EDM parameters on the surface residual stresses using graphite electrodes

Numerical Optimization

For optimization and to development of the predicted inverse model with the best EDM parameters, a set of new goals for the response will be conducted to generate optimal combination conditions for these parameters. The new objective function named the desirability, will allow evaluating the goals by a proper combination .The desirability as an objective function for maximize or minimize the main goal through the numerical optimization is ranged from zero to one for each parameter. The main goals are to minimize the values of response surface residual stresses with the same ranges of the selected EDM parameters and electrodes types as mentioned in table (8) for EDM experiments using the copper electrodes.

The best solutions founded from the desirability process shows that the optimum predicted values of the surface residual stresses obtained when using the copper and graphite electrodes with pulse current about (22 A) and pulse of duration about (120 µs) gives the minimum surface residual stresses (317.456 Mpa) and (359.384 MPa) with a maximum desirability ratio (0.945) and (1.000) respectively, as shown in table(9). This means that the optimum predicted input parameters found similar when using copper and graphite electrodes but with different minimum tensile residual stresses values.

CONCLUSIONS

The main conclusions obtained can be summarized in the following:

1- Using DOE and RSM technique with full factorial design, two empirical models were obtained for surface residual stresses in terms of input parameters (pulse current and pulse on duration) during the EDM process.

2- All surface residual stresses models were found tensile type.
3- For the EDM machining of AISI D2 die steel using the copper electrodes, the best results for minimum tensile surface residual stresses obtained when working with values of pulse current (22 A) and pulse on duration (120 µs) where the surface residual stresses reaches (314.592 MPA).
4- When using the graphite electrodes, the best results for minimum tensile surface residual stresses obtained when working with the same input parameters, i.e. with pulse current (22 A) and pulse on duration (120 µs), where the minimum residual stresses obtained is (362.963 MPa). This means that the using of copper electrodes induced minimum residual stresses about (13.3%) lower than when using graphite electrodes.
5- The optimization process gives the same results for all cases regarding the input parameters of the EDM process.

REFERENCES

1. O. A. Abu Zeid, "On the effect of electro-discharge machining parameters on the fatigue life of AISI D6 tool steel", Journal of Materials, Processing Technology 68 (1), 27–32, 1997.
2. B. B. PATEL and K. B. RATHOD, "Multi-Parameter Analysis and Modeling of Surface Roughness in Electro Discharge Machining of AISI D2 Steel", International Journal of Scientific & Engineering Research, Vol. 3, Issue 6, pp. 1-6, June, 2012.
3. T. C Bhagat, B. L. Seth and H. S. payal, "Optimization of EDM process parameters for surface roughness machining of die steel using copper tungsten electrode by Adopting Taguchi array design ", Vol 5, issue 10, ISSN 0974-6846, 2012.
4. R. Atefi, N. Javam, A. Razmavar and F. Teimoori," The Influence of EDM Parameters in Finishing Stage on Surface Quality, MRR and EWR", Research Journal of Applied Sciences, Engineering and Technology, 4(10), pp. 1287-1294, 2012.
5. S. K. Majhi, T. K. Mishra, M. K. Pradhan and H. Soni," Effect of Machining Parameters of AISI D2 Tool Steel on Electro Discharge Machining" International Journal of Current Engineering and Technology, Vol. 4, No.1, February 2014.
6. Izquierdo, B., J. A. Sanchez, S. Plaza, I. Pombo and N. Ortega, "A numerical model of the EDM process considering the effect of multiple discharges", International Journal of Machine Tools & Manufacture, Vol. 49, Nos. 3–4, pp. 220–229, 2009.
7. M. K. Pradhan and C. K. Biswas, "Predictive modeling and analysis of surface roughness in electro-discharge machining of D2 tool steel using regression and neural networks approach", International Journal on Design and Manufacturing Technologies, 3, pp. 20-29, 2009.
8. H. T. Lee, F. C. Hsu, and T. Y. Tai, "Study of surface integrity using the small are EDM process with a copper-tungsten electrode", Mater. Sci. Eng. A364, pp. 346–356, 2004.
9. A. G. Mamalis, N. M. Vosniakos, N. M. Vacevanidis, and X. Junzhe, "Residual stress distribution and structural phenomena of high-strength steel surfaces due to EDM and ball-drop forming", CIRP Annu. 37 (1), pp. 531–535, 1988.
10. J. C. Rebelo, A. M. Diaz, D. Kremer, and J. L. Lebrun, "Influence of pulse energy on the surface integrity of martensitic steels", J. Mater. Process. Technol. 84 (1–3), pp. 90–96, 1998.
11. J. P. Kruth, and P. Bleys, "Measuring residual stress caused by wire EDM of tool steel", Int. J. Electrical Mach. 5 (1), pp. 23–28, 2000.
12. B.Ekmekci, O. Elkoca, A. E. Tekkaya and A. Erden, "RESIDUAL STRESS STATE AND HARDNESS DEPTH IN ELECTRIC DISCHARGE MACHINING: DE-IONIZED WATER AS DIELECTRIC LIQUID", Machine Science and Technology, 9, pp. 39–61, 2005.
13. F. Ghanem, C. Braham, H. Sidhom, Influence of steel type on electrical discharge machined surface integrity, J. Mater. Process. Technol. 142 (1), pp. 163–173, 2003.
14. B. Ekmekci, O. Elkoca, A. E. Tekkaya, and A. Erden, "Residual stress state and hardness depth in electric discharge machining: de-ionized water as dielectric liquid", Mach. Sci. Technol. 9 (1), pp. 39–61, 2005.
15. B. Ekmekci, A. E. Tekkaya, and A. Erden, "A semi empirical approach for residual stresses in electric discharge machining

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(ISRA), Impact Factor: 2.114

(EDM)", Int. J. Mach. Tools Manuf. 46 (7–8), pp. 858–868, 2006.
16. ASTM A681, "Standard Specification for Tool Steels Alloy", American Society for Testing and Materials, Washington, D.C., 1976.
17. ASTM A370, "Standard Test Method and Definitions for Mechanical Testing of Steel Products", American Society for Testing and Materials, Washington, D.C., 1977.
18. Montgomery D. C., "Design and analysis of experiments response surface method and designs", Wiley, New Jersey, 2005.
19. Lawson C. L., and Hanson R. J., "Solving least squares problem", Englewood Cliffs, New York, 1974.
20. Kariya T. and Kurata H., "Generalized least squares", Wiley, New York, 2004.

Table (1): The chemical composition for the selected workpiece material and the equivalent given by the standard for AISI D2 die steel

SAMPLE	C %	Si %	Mn %	P %	S %	Cr %	Mo %	Ni %	Co %	Cu %	V %	Fe %
Tested plates	1.51	0.174	0.264	0.014	0.003	12.71	0.555	0.158	0.0137	0.099	0.306	Bal.
ASTM-A 681-76 Standard for AISI D2 die steel	1.40 to 1.60	0.60 max.	0.60 max.	0.03 max.	0.03 max.	11.00 to 13.00	0.70 to 1.20	-	1.00 Max.	-	1.10 Max.	Bal.

Table (2): The mechanical properties for the selected materials

	Ultimate Tensile stress N/mm²	Yield strength N/mm²	Elongation %	Hardness HRB
Average	704.25	415.25	18.125	90.25

Table (3): The input EDM parameters and their levels for first and second groups

Factor	Name	Units	Min.	Max.	Coded Values		Levels
A	Pulse current (Ip)	(A)	8	22	-1	+1	2
B	Pulse on duration (Ton)	(µs)	40	120	-1	+1	2

Table (4): The designed experimental matrix for Group (1) using copper electrodes

Std.	Run	Input factors (Actual) X1 A: Pulse current Ip (A)	Input factors (Actual) X2 B: Pulse on duration Ton (µs)	(Coded) X1	(Coded) X2	Response Residual stresses (MPa)
3	1	8	40	-1	-1	359.242
7	2	8	120	-1	+1	363.125
8	3	8	120	-1	+1	366.261
1	4	8	40	-1	-1	356.993
11	5	22	120	+1	+1	317.294
6	6	8	120	-1	+1	362.386
2	7	8	40	-1	-1	357.482
10	8	22	120	+1	+1	320.497
5	9	22	40	+1	-1	356.806
4	10	22	40	+1	-1	352.721
9	11	22	120	+1	+1	314.592

Table (5): The designed experimental matrix for Group (2) using graphite electrodes

Std.	Run	Input factors (Actual) X1 A: Pulse current Ip (A)	Input factors (Actual) X2 B: Pulse on duration Ton (µs)	(Coded) X1	(Coded) X2	Response Residual stresses (MPa)
11	1	22	120	+1	+1	367.637

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5	2	22	40	+1	-1	366.825
1	3	8	40	-1	-1	405.358
10	4	22	120	+1	+1	364.718
3	5	8	40	-1	-1	409.285
9	6	22	120	+1	+1	365.911
8	7	8	120	-1	+1	373.108
7	8	8	120	-1	+1	370.287
2	9	8	40	-1	-1	403.279
4	10	22	40	+1	-1	362.963
6	11	8	120	-1	+1	371.285

Table (6): The (ANOVA) analyses for the EDM group (1) experiments using copper electrodes

Source	Sum of Squares	df	Mean Square	F Value	p-value Prob > F	
Model	3.009E-007	3	1.003E-007	242.50	< 0.0001	significant
A-Pulse current (Ip)	*1.316E-008*	*1*	*1.316E-008*	*31.82*	*0.0008*	
B-Pulse on duration (Ton)	*3.575E-008*	*1*	*3.575E-008*	*86.43*	*< 0.0001*	
AB	*9.499E-008*	*1*	*9.499E-008*	*229.68*	*< 0.0001*	
Pure Error	2.895E-009	7	4.136E-010			
Cor Total	3.038E-007	10				

Table (7) : The (ANOVA) table for the EDM group (1) experiments using graphite electrodes

Source	Sum of Squares	df	Mean Square	F Value	p-value Prob > F	
Model	1.086E-007	2	5.431E-008	11.13	0.0049	significant
A-Pulse current (Ip)	*5.723E-008*	*1*	*5.723E-008*	*11.73*	*0.0090*	
B-Pulse on duration (Ton)	*4.066E-008*	*1*	*4.066E-008*	*8.34*	*0.0203*	

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Residual	3.902E-008	8	4.878E-009			
Lack of Fit	*3.747E-008*	*1*	*3.747E-008*	*168.51*	*< 0.0001*	*significant*
Pure Error	*1.556E-009*	*7*	*2.224E-010*			
Cor Total	1.476E-007	10				

Table (8): The new constraints goals for numerical optimization for copper electrodes

Name	Goal	Lower Limit	Upper Limit	Lower Weight	Upper Weight	Importance
B:Pulse current (Ip)	is in range	8	22	1	1	3
C:Pulse on duration (T on)	is in range	40	120	1	1	3
Residual stresses	minimize	314.592	366.261	1	1	3

Table (9): The desirability process for optimization of the predicted surface residual stresses for copper electrodes

Number	Pulse current (Ip)	Pulse on duration (T on)	Residual stresses	Desirability	
1	22.000	120.000	317.456	0.945	Selected
1	22.000	120.000	359.384	1.000	Selected