Optimization of EDM Process Factors for Machining Al-Si Alloy Using Response Surface Methodology

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Abstract

This work exhibits an incorporated way to deal with the procedure demonstrating and multi-target improvement of EDM parameters of Al-Si based on response surface methodology (RSM) combined with desirability function (DF) method. The effect of process parameters for example, pulse current (I_p), pulse on time (T_{on}) as well as pulse off time (T_{off}) on metal removal rate (MRR), electrode wear rate (EWR) and surface roughness (Ra), were analyzed. An extensive investigation of difference (ANOVA) at fixed indicative level of 5%, was done to completely distinguish the most persuasive parameters, and the sufficiency of all fitted relapse models were checked. To completely comprehend the trademark machinability conduct under various EDM conditions, fundamental effect investigation. The results indicate that MRR increases with the rising I_p and T_{on}. Low EWR and Ra can be acquired by diminishing I_p and T_{on}. Be that as it may, the I_p is the most commanding parameter pursued by T_{on} and T_{off} for MRR and Ra whereas in the EWR, the I_p is the foremost factor, followed by the T_{off} and T_{on}. Lastly, a multi-optimization way dependent upon the desirability function (DF) idea was used to discover ideal blends of machining parameters so that it was capable to produce the the most extreme estimation of MRR and least estimations of EWR and Ra, inside the noteworthy information parameters.

Keyword: Al-Si alloy, Electrical Discharge Machining EDM, Response Surface Methodology RSM, MRR, EWR, and Ra.

1. Introduction

Aluminum is significant in manufacturing applications such as the production of vehicles, space equipment and packaging of food and drinks, in building, the transmission of electrical power, the transportation manufacture, the manufacturing of machinery and paraphernalia, and in many other field. The fact that aluminum is non-ferromagnetic adds to its significance in the electrical and electronics industries. This element is also observably non-poisonous and is routinely utilized in the industry of containers for food and drinks. Utilization of aluminum and its combinations has expanded fundamentally in the course of the last number of years, effectively supplanting iron and steel in various diverse applications. Moreover, the aluminum is highly resistant after heat treatment, and it has made the mold easier to achieve because of its high flexibility. **[1].**

Al-Si alloys include many acicular eutectic silicon elements in the α-Al matrix within hypoeutectic composition range. As the silicon content rises to the hypoeutectic level, primary silicon particles, except those in the acicular hypereutectic silicon phase, form rod- like and massive structure [2]. Al-Si combinations have potential in infuse plastic shaping molds, such compounds display warm conductivity, hostile to erosion properties, wear resistivity and have a low warmth development coefficient [3],[4].

The utilization of silicon as the major alloying component in aluminum offers astounding properties, for example, castability, great weldability, great warm conductivity, brilliant consumption obstruction and acceptable maintenance of physical and mechanical properties at hoisted temperatures [5],[6].

EDM is known as Spark-Erosion Machining. This electro machining strategy is fundamental for slicing machining gear used to infuse plastic for assembling molds. Metal shape normally incorporate hard-to-cut parts, for example, complex 3D bended appearances and sharp points. EDM is therefore of great value in the manufacture of material molds. The assessed release point temperature is numerous thousand degrees (◦C) in common EDM, to quickly liquefy machined materials at the dis-charge point. The privately produced high-temperature flashes prompt the encompassing kerosene to dissipate quickly and its volume to grow. The high weight created by this idleness walled in area impact quickly expels liquid metals from the surface of machined materials [4].

The goal of the present work is to examine the operational reaches and stages of the EDM factors viz. pulse' current' (Ip), pulse' on' time' (Ton) and' pulse' off' time (Toff) on' the' EDM act measures similar to MRR, EWR and Ra in EDM method and modelling of the execution measures by means of response surface methodology (RSM). Also multi- thematic optimization of the EDM factors using a desirability role in combining with RSM.

2. Experiential work

In this survey, a series of tests on EDM of Al-Si alloy was directed on CNC-50 N electric emptying machine to examine the effects of input machining parameters such as current, pulse on time and pulse off time on MRR, EWR and Ra.

2.1. Machine tool and dielectric medium

All tests where executed on an EDM, CNC sinking machine (CHMER CH 323C/ 50N /German). For the experimentation purpose "Kerosene" oil having dielectric was used as a dielectric medium at a flushing pressure of 0.3 Kg/cm2. It should acts as flushing medium that carries away the melted material.

2.2. Workpiece material

Al-Si alloy was used as workpiece in this survey. The chemical composition of this alloy is recorded in table 1. Specimens of (15mm) in diameter and (10 mm) in height were prepared for machining test. During the machining process the workpiece was arranged as a negative polarity.

Table (1) Chemical Composition of Alloy Prepared in this Study.

Material	Al	Si	Mn	Cr	Mg	Zn	Cu	Fe
% weight	80.9	18.8	0.001	0.0033	0.0019	0.0150	0.0605	0.250

2.3. Tool Electrode

The machining process was applied to create a Blind puncture in the external face of the workpiece. So a rod of (30mm) in length and (10mm) in diameter was used as an electrode tool. The rod was made of copper with a purity of 99.9% and was sited of positive polarity.

2.4 mensuration of Responses feature

Discussions relay to evaluating the assets of an EDM response, for example. MRR, EWR, and Ra stay obtainable in the following sub-sections

.2.4.1. Metals Removal Rate (MRR)

The workpiece was isolated from the machine afterward the task of sinking, arranged and became rare to be permitted of soil, garbage plus insulation. rigor tool (Denver Instrument) was used for a precision of 0.01 mg in the weightiness reduction strategy. The MRR recipe (mm3 / min.) Is expressed by Equation 1 [7].

$$\mathrm{MRR} = \frac{\mathrm{W}_{iw} - \mathrm{W}_{fw}}{t} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Where:

W_{iw}= initial weight of workpiece (gm).

W_{fw} W_{fw}= final weight of workpiece (gm).

t= duration time of the machining process (min.).

2.4.2. Electrode' Wear Rate (EWR)

As' in' MRR' procedure', but' the' workpiece' was changed by' the' conductor. The' EWR' equation i's mentioned in equations 2 [8].

$$\mathrm{EWR} = \frac{W_{ie} - W_{fe}}{t} \quad \ldots\ldots (2)$$

Where:

W_{ie}= initial weight of electrode (gm).

W_{fe}= final weight of electrode (gm).

2.4.3 Measurement of Surface roughness

The surface roughness of the new-machined paradigm has been measured for several machining conditions. This test has been carried exhausting surface roughness tester type (TR210). The probe scans the surface, compare between peaks and valise to indicate the Ra. Subsequent each evaluation, the surface roughness value was recorded, and the sample was relocated slightly for further reading. The average of three measurements was taken in this experiment.

2.5. Machining parameters and their levels

Th'e chosen EDM parameters (Ip, Ton and Toff) were varied up to three levels. The EDM parameters an'd theirr levels are given inn Ta'ble 2.

Table 2: EDM Parameters and Their Levels.

Actual Factors	Parameters	Unit	Levels		
I_p	Pulse current	A	2	6	10
T_{on}	Pulse on time	µs.	100	150	200
T_{off}	Pulse off time	µs.	50	100	150

3- Results and discussion

The selected design metrics according to RSM design array are shown in Table 3. It was the three factor three levels containing 17 sets of actual conditions run which allowed the assessment of the effects the factors on the MRR, EWR, and Ra. The value of the output is organized in Table 3.

Table 3: Observed Values for Performance Characteristics.

Run No	Ip Amp	Ton µsec.	Toff µsec.	MRR gm/min	EWR mm^3/min	Ra µm
1	6	100	100	0.0772	0.1263	2.1109
2	6	150	150	0.0898	0.1276	2.6436
3	6	150	100	0.1004	0.1340	2.7436
4	6	150	50	0.1068	0.1666	2.8463
5	2	150	100	0.0514	0.0506	1.6136
6	6	200	100	0.1158	0.1700	3.1663
7	6	150	100	0.1003	0.1373	2.7500
8	10	150	100	0.1804	0.2023	5.6500
9	10	200	50	0.2213	0.2403	6.7627
10	2	200	150	0.0531	0.0513	1.8000
11	10	100	150	0.1239	0.2000	4.1872
12	2	100	50	0.0422	0.0503	1.2909
13	2	200	50	0.0632	0.0836	1.9318
14	10	100	50	0.1476	0.2033	3.9927
15	2	100	150	0.0354	0.0366	1.2000
16	10	200	150	0.1859	0.1996	6.2809
17	6	150	100	0.1004	0.1483	2.7545

Selecting the appropriate models and developing the response, the models were implemented through the use of Minitab "Ver.17" statistics. The second-order regression equation for responses and manufacturing variables was developed using RSM. The ending response equation for MRR, EWR and Ra are set in equation 3-5.

$$MRR= -0.0228 - 0.00250\ I_p + 0.000643\ T_{on} + 0.000278\ T_{off} + 0.000949\ I_p^2 - 0.000002\ T_{on}^2 - 0.000001\ T_{off}^2 + 0.000061\ I_p{\times}T_{on}\ 0.000026\ I_p{\times}T_{off} - 0.000001\ T_{on}{\times}T_{off} \quad \text{.................................} \ (3)$$

$$EWR= -0.0143 + 0.03295\ I_p + 0.000004\ T_{on} - 0.000145\ T_{off} - 0.001056\ I_p^2 + 0.000002\ T_{on}^2 + 0.000001\ T_{off}^2 - 0.000007\ I_p{\times}T_{on} + 0.000001\ I_p \times T_{off} - 0.000003\ T_{on}{\times}T_{off} \quad \text{...............}(4)$$

$$Ra = -0.162 - 0.4961\ I_p + 0.0217\ T_{on} + 0.00726\ T_{off} + 0.05304\ I_p^2 - 0.000058\ T_{on}^2 - 0.000015\ T_{off}^2 + 0.002264\ I_p{\times}T_{on} - 0.000040\ I_p \times T_{off} - 0.000036\ T_{on}{\times}T_{off} \ \text{......................................} \ (5)$$

The above-mentioned advanced forms can be used as dependable implements to express the designing extent inside the scope of method parameters for an in-depth accepting of operation features and can also be used in the More powerful phase to discover the best EDM settings on Al-Si.

3.1 Parametric Analyses of response

MRR is an important factor in the EDM process because of its necessary impact on the engineering economy. Figure (1) offering the major effect of each variable on MRR. MRR tends to raise with the raising in Ip. This can be referring to the fact that MRR is proportionate to the output power of each pulse and pulse frequency. Increasing the pulse current at fixed frequency increases the pulse energy and eventually increases the MRR rate.

As is lucid from Figure 1, the ton has an action on MRR. To hold other factors fixed at the moderate level. The short ton causes negligible vanishing, while the span the long pulse causes the development of the plasma channel. The development of the plasma channel causes a lower vitality thickness in the workpiece, or, in other words liquefy and/or dissipate the workpiece material. In this way the most extreme MRR was at around 200 ° C. For a scope of examinations led [9].

at last, on the inversion, the main action appears to remain inverse. The increase in pulse time (Toff) reduces the rate of MRR while maintaining additional factors unaffected. As by the extended Toff, the insulating liquid produces a cooling result on the conductor and interrupts the process and thus reduces the MRR [10].

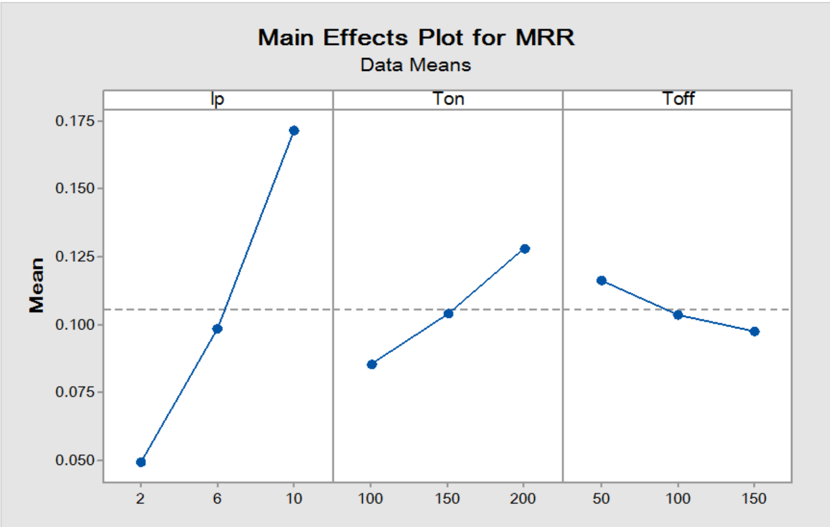

Figure. 1: Main Effect Plots for MRR.

Figure 2 offer the main impact of each variable in EWR. EWR resort to increase with the increase of the Ip alone. High current density obtainable in the work gap, In the current high pulse conditions, create a massive amount of temperature. This quickly warms the conductor and rises the EWR.

It is’ obvious from th’e master effect plot of’ Ton th’at E’WR excess with increases in Ton alone at’ fixed middle values of other param’eters. This is due to th’e increase in discharge capacity.

Finally, choose Top Toff results in the minimal EWR. This is the same reason above-mentioned in MRR which can certainly be used here, while maintenance other variables unaltered.

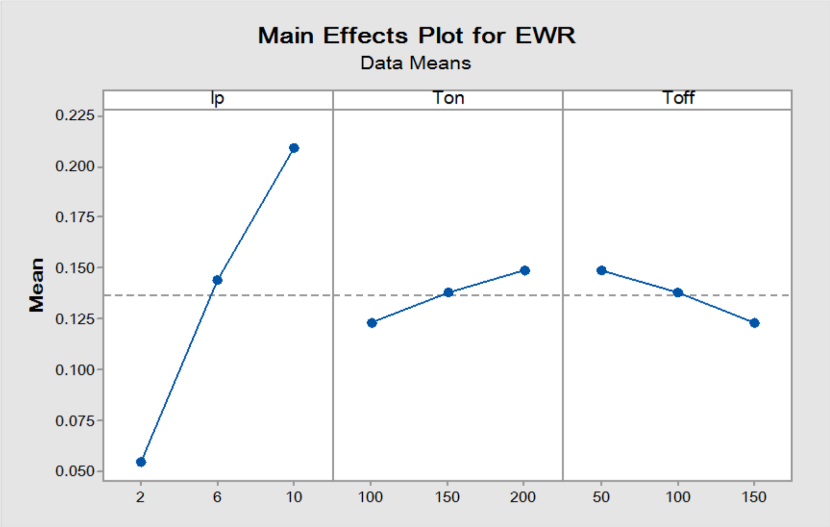

Figure. 2: Main Effect Plots for EWR.

Figure (3) describe the master impact effects of the three governable parameters in Ra. It is knowing that two variants (IP and Ton) have a more functional effect on Ra. Ra increases with Ip increases in other word Increases in Ip Ra increase in Ra and discharge samples surface intensively, creates impact force on magma in the hole, resulting in more magma output from the hole, Ra increases from the mechanical surface as shown In the reference [11].

Similarly, Ra increased value with ton raise from lower to tallness level alone at steady intermediate values for further parameters. Extensive Ton causes furthermost transferal to the sample and excludes the liquid material from the electrode material, as the pressure of the wash is constant. In other words, while the Ton is increasing the fusion isotherm which penetrates more into the inside of the material, the molten region extends to more materials and this produces the thickness of a larger white

Finally, the tendency tends to decline when the Toff increases. Low scale of Toff form the height hesitation that produces a low Ra, from one perspective. furthermore, a prolonged Toff produces a lower mineral removal until small and blurry nozzles are achieved. Long Toff supply a preferable cooling action and sufficient timing to remove magma and wrack from the cavity amidst the electrode and the workpiece. consequently, the extended Toff offering a lower Ra.

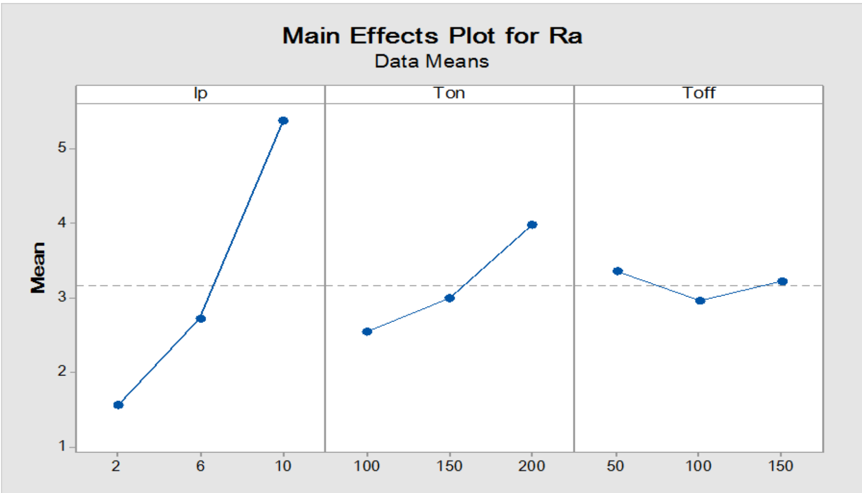

Figure. 3: Main Effect Plots for E.

3.2 Checking the adequacy of the model

The adequacy of the models so developed is then tested by using the analysis of variance technique (ANOVA) with 95% confidence level. Using this technique, it can be noted that, as illustrated in Table 4, all the quadratic regression models either more significant (p-value = 0) or significant (0 < p-value < 0.05), except lack of fits for EWR and Toff for Ra (p-value = 0.470 and 0.199 respectively) turn out to be insignificant and thus all the models adequately represent the experimental data.

Another criterion that is commonly used to illustrate the adequacy of a fitted regression model is the coefficient of determination (R2). For the models, the calculated R2 values is above 97 %, 94 % and 92 %, respectively as shown in Table 5. Those values mark that the retraction models are somewhat acceptable. The validity of regression models developed is further tested by drawing scatter diagrams. Typical scatter diagrams for all the models are presented in Figs. 4 - 6. The observed values and predicted values of the responses are scattered close to the 45° line, indicating an almost perfect fit of the developed empirical models.

Table 4: ANOVA for MRR, EWR and Ra Models.

Source	DF	Seq SS	Adj MS	F	P
For MRR					
I_p	1	0.037675	0.037675	5856.47	0.000
T_{on}	1	0.004537	0.004537	705.25	0.000
T_{off}	1	0.000865	0.000865	134.45	0.000
Lack-of-Fit	5	0.000045	0.000009	2701.49	0.000
Pure Error	2	0.000000	0.000000		
Total	10	0.045212			
For EWR					
I_p	1	0.059768	0.059768	836.15	0.000
T_{on}	1	0.001646	0.001646	23.03	0.002
T_{off}	1	0.001664	0.001664	23.28	0.002
Lack-of-Fit	5	0.000388	0.000078	1.38	0.470
Pure Error	2	0.000112	0.000056		
Total	10	0.064781			
For E					
I_p	1	36.2415	36.2415	1435.83	0.000
T_{on}	1	5.1266	5.1266	203.11	0.000
T_{off}	1	0.0508	0.0508	2.01	0.199
Lack-of-Fit	5	0.1766	0.0353	1177.38	0.001
Pure Error	2	0.0001	0.0000		
Total	10	45.7243			

Table 5: R2 Test for MRR, EWR and Ra Regression Model.

Response	R^2 value	Remarks
MRR	97.90%	Adequate
EWR	94.23%	Adequate
Ra	92.61%	Adequate

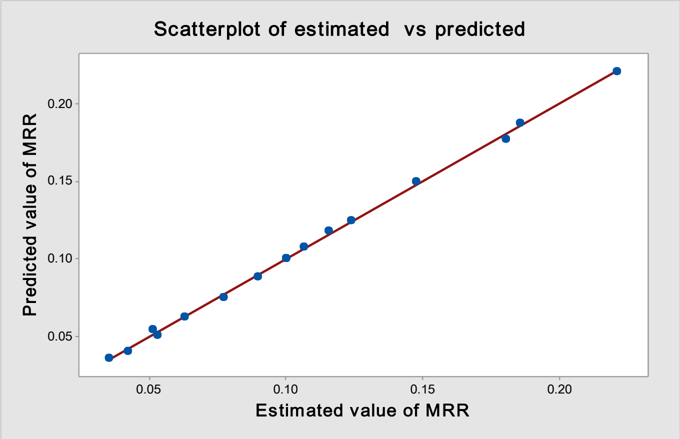

Figure. 4: Scatter diagram of the MRR.

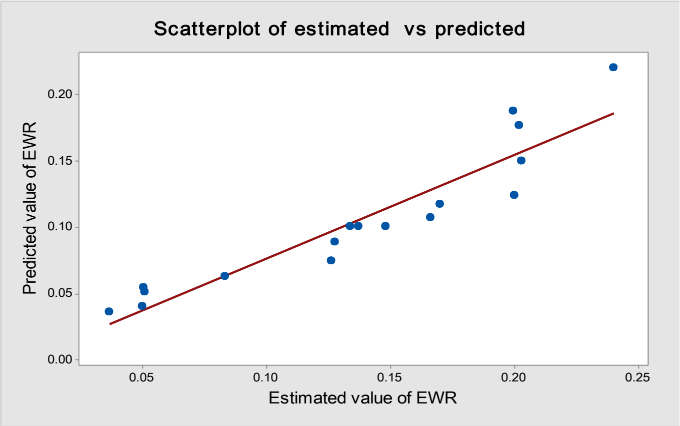

Figure. 5: Scatter diagram of the EWR.

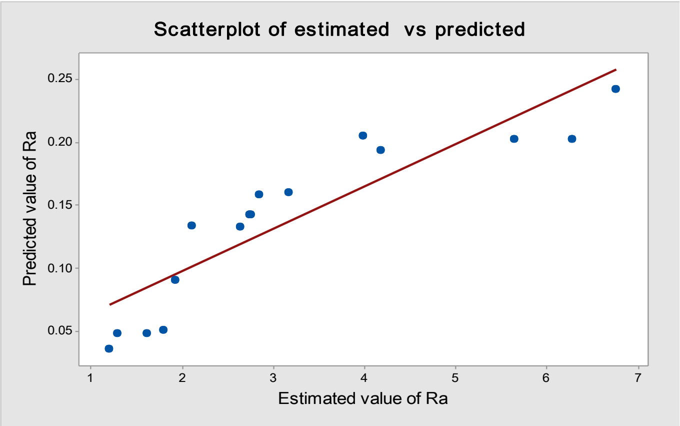

Figure. 6: Scatter diagram of the Ra.

3.3 Multi-Response Optimization Founded on Composite Popularity

Most of the problems in multiple response leading to a set of optimal solutions rather than the only optimal solution. The function to determine optimal parameters of EDM parts to improve responses or outputs (MRR, EWR, and Ra) was used in this research. The central composite experimental design, which includes three factors (Ip, Ton and Toff), was used for each of the three scales to invention them the best arrangement of elements and stages in EDM for Al-Si.

MRR is an index of output while EWR and Ra are two practical and accurate economies. In specific, EWR is a major concern, especially when close variations are needed in complex geometric shapes. ED’’M, as a co’m’plex a’nd random pro’c’ess, shows great diffi’’culty in determ’i'ning the opti’mal parame’ters for operation to get the best running perfor’mance. Performance ind’icators, viz. MR’R, EW’R, and R’a compete in their nature where it is al’ways desira’ble to ha’v’e a hi’g’her M’R’R rate wi’t’h a lo’we’r va’l’ue than EW’’R and R’a at th’e sa’me ti’me.

Because there are a lar’ge num’ber of pro’cess varia’bles and mu’tual inter’actions, selecting ideal param’eter combinat’ions to ob’tain a hig’her rate of M’RR and reducing EW’R and Ra is a difficult ta’sk.

The mathemati’cal formula for the current optimizat’ion prob’lem can be formulated as foll’ows:

Ma x: F 1 (x) = MR R

Mi n: F 2 (x) = EW R

Mi n: F 3 (x) = Ra

Subject to:

$2 \leq x_1 \leq 10$

$100 \leq x_2 \leq 200$

$50 \leq x_3 \leq 150$……..………………………………..… **(6)**

Where: x1, x2 and x3 denote the process response parameters Ip, Ton and Toff correspondingly. It is a three varia’ble-three-objec’tive optim’ization state’’ment, e’ach of wh’ich ha’s be’en distinct by respe’ctive subsequent ord’er deterioration equatio’ns.

3.3.1. Optimiz ation of th e ED M Pro cess on Al-Si

In light of the created quadratic scientific reactions condition (3), (4) and (5), d1, d2 and d3 are chosen as the autonomous attractive quality capacities for the MRR, EWR, and Ra separately. Additionally, the objectives are set on the MRR to end up boosted while the rest to be limited.

The resp’onse optimiz’er opt’ion with’in th’e (D’OE) m’odule of M’initab sta’tistical soft’ware pac’kage, relea’se 17, ha’s be’en utilized he are to look fo’r the b’est arrangement of ideal info par’ametric mixes bringing about the mo’st allur’ing bargain between various reactions.

Ta’ble (6) condenses the ke’y para’meters set to discover worldwide ideal sett’ings, inclu’ding the imperatives of info factors and’d th’at of reactions' prerequisites while T’able (7) give ideal got of composite attractive quality (D). The clos’er the D to 0.506569 the m’ore positive are th’e ED’M conditi’ons fulfilling issue necessities.

It very well may be se’en fro’m Ta’ble (7) that the most attractive working conditions compare to 4.5 Amp. 175.75 μsec. what's more, 100.50 μsec., individually. Figure (7) outlines the visual portrayal of the ideal outcome. The enhancement plot demonstrates the impact of each factor (segments) on the reaction or composite attractive quality (lines). Besides, every cell displays how the procedure yield shifts as a component of one of the procedure elements while keeping alternate parameters unaltered. Additionally, the perpendicular lines inside the cells demonstrate current ideal parameters sets, while the specked lines speak to the present yield esteems.

Table 6: Constraints and Criteria of Input Parameters and Responses

Parameter/ Response	Goal	Lower Limit	Upper Limit	Lower Weight	Upper Weight	Importance
I_p	In range	2	10	1	1	1
T_{on}	In range	100	200	1	1	1
T_{off}	In range	50	150	1	1	1
MRR	Maximize	0.0354	0.2213	1	1	1
EWR	Minimize	0.0366	0.2403	1	1	1
Ra	Minimize	1.2000	6.7627	1	1	1

Table 7: Optimum Conditions.

Solu-tion	Ip	Ton	Toff	Ra	EWR	MRR	Composite Desirability
1	4.50505	175.758	100.505	2.41787	0.118594	0.0871830	0.506569

High and low sets per action plan variable can likewise be seen in this plot. The most helpful part is the ideal Required parameter settings to accomplish the procedure regular objective standards, situated at the center line among the great and small column, symbolized by "mutt". At long last, the primary left segment demonstrates the composite and also all individual attractive quality, all being solidarity, alongside ideal reaction esteems.

The mix of the factors and their levels would have established out perfectly parameter mix to cause least surface harshness and efficiency prompting ideal, Table (8) demonstrates various reaction forecast.

Table 8: Multiple Response Prediction

Variable	Ip (Amp)	Ton(μsec)	Toff (μsec)
Setting	4.5	175.75	100.5

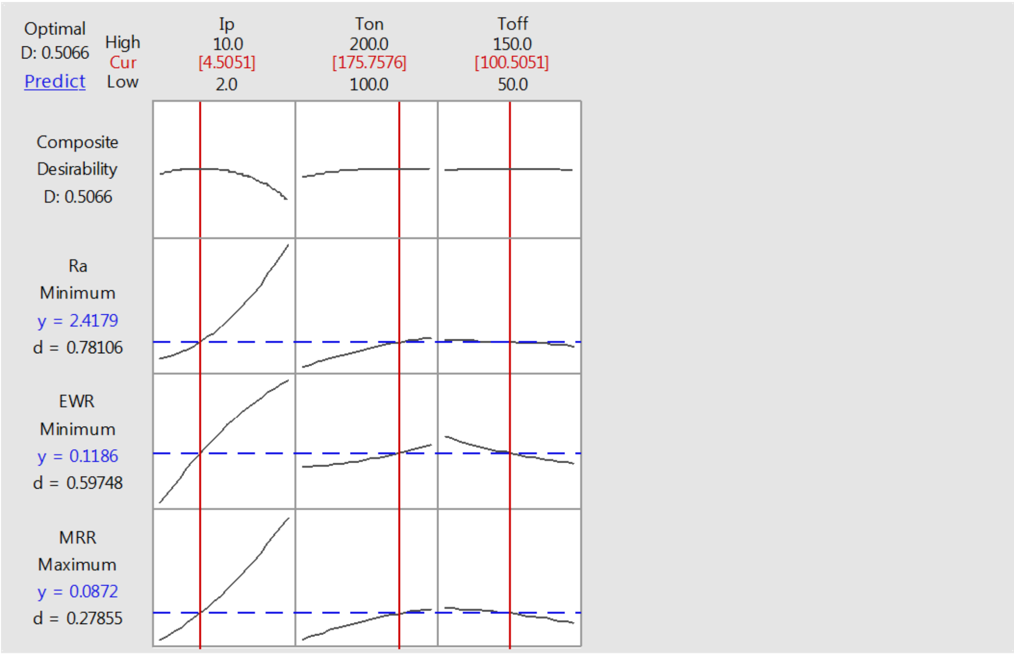

Figure. 7: Final Optimization Results

3.4 Affirmation of the Optimum Results

The affirmation analyze is imperative advance and an irreplaceable piece of each improvement endeavor to approve the ideal machining conditions that came about because of reaction surface procedure approach. Confirmation analyze was performed at the gotten ideal information parametric setting to think about the genuine MRR, EWR and Ra with those as ideal reactions overcame attractive quality methodology. Table 9 outlines the examination of the test (MRR, EWR, and Ra) with the anticipated (MRR, EWR, and Ra) and their level of relative check blunders utilizing ideal machining conditions. It ought to be noticed that the blunders have been ascertained as in condition (7) [13].

$$\text{Prediction error\%} = \frac{\text{Experimental result} - \text{Predicted result}}{\text{experimental result}} \ldots\ldots\ldots\ldots.\ldots\ldots (7)$$

Table 9: Confirmation Test Results and Percentage Errors.

Response	Experimental	Predicted	Error %
MRR (gm/min)	0.0856	0.0872	1.8
EWR (gm/min)	0.1125	0.1180	4.6
Ra (μm)	2.390	2.417	1.1

Unmistakably the blunder esteems are attractive from the perspective of building applications, 4.6 % as the most pessimistic scenario in foreseeing EWR. Consistency guarantees the plausibility and proficiency of the utilized technique

4. Conclusi ons

1-Al l the primary impacts of information param eters, i.e. Ip, T_{on}, and T_{off} w ere observed to be huge in influencing the MRR, EWR and Ra.

2-Risi ng eit her Ip or Ton res ults in high er estimations of reaction (MR R, EW R and R a) while expanding Toff gives the inverse of yield.

3- The test esteems relate to the anticipated qualities sensibly well, with R2 of 0.9790, 0.9423 and 0.9261 for MRR, EWR, and Ra separately.

4- From the multi-reaction advancement, the ideal mix of parameter settings are Ip of 4.5 Amp., Ton of 175.758 μsec. what's more, Toff of 100.505 μsec. for accomplishing the required higher MRR and lower EWR and Ra.

5- The mistake among trial and anticipated qualities at the ideal mix of parameter settings for MRR, EWR and Ra exists in 1.8 %, 4.6 % and 1.1 % separately. Clearly, this affirms astounding reproducibility of the trial ends.

CONFLICT OF INTERESTS.

- There are no conflicts of interest.

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الأمثلية لمتغيرات عملية تشغيل EDM لسبيكة الالمنيوم سيليكون (Al-Si) باستخدام طريقة استجابة السطح (RSM)

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الخلاصة

يقدم هذا البحث نهجا متكاملا لنمذجة العملية والأمثلية متعددة الاهداف لمتغيرات التشغيل بالشرارة الكهربائية لسبيكة الالمنيوم سيليكون (Al–Si) اعتمادا على نمط استجابة السطح (RSM) إلى جانب تكنيك دالة الرغبة (DF). أختيرت ثلاث متغيرات منفصلة كمدخلات وهي تيار النبضة (I_p)، فترة إفراغ النبضة (T_{on}) وفترة توقف النبضة (T_{off}) للتأكد من تأثير المتغيرات الثلاث سابقة الذكر على المخرجات المتمثلة بمعدل إزالة المادة (MRR)، معدل بلى القطب (EWR) وخشونة السطح (Ra). تحليل عام للتفاوت (ANOVA) عند درجة من الأهمية مقدارها 5% لتعيين المعاملات الأكثر تأثيرا، وأنجز اختبار مدى كفاءة كافة النماذج. ولفهم السلوك الشامل لقابلية تشغيل لسبيكة الالمنيوم سيليكون (Al–Si) تحت أوضاع التشغيل المتفاوتة، تم إجراء تحليل التأثير الأساسي. بينت النتائج ان معدل الازالة المعدنية يزداد مع رفع تيار النبضة وفترة إفراغ النبضة. يمكن الاستحصال ايضا على نقصان في كل من معدل بلى القطب وخشونة السطح عن طريق خفض تيار النبضة ووقت إفراغ النبضة. ومع ذلك، فإن تيار النبضة هو العامل المتحكم (الاكثر تأثيرا) على معدل الازالة المعدنية وخشونة السطح متبوعا زمن تفريغ النبضة وزمن توقف النبضة، في حين أن في معدل بلى القطب فان تيار النبضة هو العامل الاكثر تأثيرا يليه زمن توقف النبضة وزمن إفراغ النبضة. أخيرا استعملت أسلوب الامثلية متعددة الاهداف بالاعتماد على نظرية دالة الرغبة للاستحصال على المقدار الامثل لمتغيرات التشغيل بحيث يمكن الاستحصال من خلالها على اعلى مقدار لمعدل الازالة المعدنية وأدنى مقدار لكل من متوسط بلى القطب وخشونة السطح مع المتغيرات المؤثرة.

الكلمات الداله: سبيكة المنيوم سيلكون، التشغيل بالشرارة الكهربائية، طريقة استجابة السطح، معدل الازالة المعدنية، معدل بلى العدة وخشونة السطح.