Application of ELECTRE- I,II methods for EDM performance measures in manufacturing decision making

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Abstract: Due to the demand of customer point of view requires good performance component with low cost. So, we have to expand the machining characteristics of Al7075 alloy containing 2wt% SiC on EDM. During machining following indicator has to be used for measures EDM performance. These output indicators for EDM are Surface roughness i.e., Ra and Rz, and also Energy consumption (PC). For experimenting, we choose the CCD approach in RSM. In this work, we have to apply a novel approach, multi-attributes decision making to predict the optimum result for the following criteria. In MADM approach using Electre I and II as an application to optimize EDM performance. Electre I and II have decided, based on Entropy weighting percentage. To predict sophisticated optimal attribute that contains the values of criteria (as an EDM performance indicator). Electre I and II offer Rank of alternatives that helps the designer to choose the best decision. At last, the graph shows the comparison of the computational results between Electre I and Electre II.

Keywords: Electrical discharge machine (EDM), RSM, MADM, Entropy-Weight method, ELECTRE I & II.

1 Introduction

Day-to-day, raising the demand of new material which can fulfill the demand of these areas like aerospace, defense, and medical field requirements. So, due to this requirement, machining of that material is typical task to cut into the different intricate shapes. Due to this machining of that material is not possible with the traditional machining process, because material having property to high hardness as well as strength. For this type of material can be easily machined with nontraditional machining methods. These NT-Machining (Non-Traditional-Machining) techniques have to resolve the problem of machining of these materials causes to affect the material removal rate, and also tool wear rate. So, to solve the issue of above two, causes with following desired output during the machining like good surface finish, dimensional accuracy and low power consumption are achieved with the electrical discharge machining (EDM). EDM machine has also ability to machined die steel and metal matrix composites. So, the performance of EDM machine is continuously trying to improve in the past decades. So, for improving the performance of EDM with the fulfillment of requirement of material requirement that have to be mentioned above, study the literature of few researcher to providing a solution is discussed in the below section. HO et. al., [1] has an attempt to study the last 20 years improvement in machining technology, especially in non-traditional machining processes like water jet machining, laser assisted machining, and electrical discharge machining. During this study, researchers was found that for precision requirement, traditional machining not prefer, so that at this time these were to suggest EDM machine is better for this. Tristo et. al., [2] has an attempt to study the industrial machining environment, because of raising the aspect of environment and ecological features. In this study, to suggest the machine to resolve the manufacturing requirement on the basis of environment without affect productivity and quality of goods. So, for this use electrical discharge machining to cut different intricate shape with low power consumption, and low expenses required to produce products with high productivity. Liang et. al., [3] has a study to find that CNC machine was required in manufacturing sectors, because it have a high reliability. So, due to this CNC machine has necessary for the survival of any industry in the competitive market. Shimizu et. al., [4] has an attempt to make the product with machines, reliability has important consideration during machining. So, on the basis of reliability, to produce high performance products according to customer need says that always choose the optimal parameter of the machine. Dubey et. al., [5] has an investigate the performance of power mixed EDM, while chromium particles added in dielectric fluid with copper electrode. During this MRR are the response parameter, for this
response uses four intakes. For this performance, use the central composite design approach on the response surface methodology for design the experiment. Kathiresh et. al., [6] has studied to investigate the performance characteristics of EDM such as surface roughness (Ra), TWR, MRR. For this performance characteristic select four intakes such as $T_{on}$, current, gap-voltage, and $T_{off}$. While this investigation, experiment was designed by Taguchi L9 Orthogonal array technique and optimized by using GRA. Kar et. al., [7] has attempted to develop the mathematical model for machining aluminium MMC with EDM. For this select response parameter such as radial over cut, MRR, and electrode wear rate and vary the following inputs such as open circuit voltage, discharge current, and $T_{on}$. This experiment was conducted on the basis of CCD-RSM approach. Nagarjun et. al., [8] has put an attempt to optimize multi-objective responses such as TWR, SR (Ra), and MRR by applying the integrated Fuzzy method with Taguchi. For this use intakes such as discharge current, discharge-voltage, $T_{on}$, inter-electrode gap. Govindan et. al., [9] has an attempt to provide the suitable service provider by using ELECTRE-I (determining the impact of reinforced preference) method. For this study, uses Simos procedure and stochastic multicriteria acceptability analysis for various service providers. Wang et. al., [10] has an attempt to remove the uncertainty in accuracy in ranking done by ELECTRE-I method. So, for this ELECTRE-II and ELECTRE-III are used to select the best attributes. Pang et. al., [11] has a studied CNC machine on the basis of reliability design scheme by applying ELECTRE-I method. In this study, weightage of the attributes determined by AHP method. And through this ELECTRE-I method provides an optimal ranking solution that was preferred by designers. Supraka et. al., [12] has an attempt to solve multi criteria decision making, problem of determine best PC framework out of three. So, in this study weight percentage of each criteria was calculated by AHP technique and the solved issue with ELECTRE method after comparing each other and providing a ranking for preference. From the literature survey find a gap, during the study, we have to see that in the manufacturing sector, one response are easily optimized during the process, but when multiple responses are considered process become complex to be optimized. And the material that becomes required in the industry found that aluminium MMC has an ability to solve the problem. During this decision making process have a problem for this solved by using traditional optimization technique. So, here decided after literature study, the objective of the present research is Al MMC i.e., to be used mainly are SiC and alumina for the reinforcement and rarely used B$_2$C (boron carbide). So. We have to use Al7075+2% wt SiC MMC i.e., fabricated by mechanical stir casting procedure is used in the present study. For this MMC machined by EDM. And this work aim is to develop the correlation between EDM input such as Ton, Toff, current and machining output are surface roughness (Ra and Rz), and also power consumption. And the desired response has to be optimized data set is preferred for machining is used ELECTRE-I and ELECTRE-II method. And the responses after comparing with each alternative and predict optimal data set of input corresponding to the response value for Al7075+2% wt MMC by EDM machine.

2 Equipment used in this experiment

In this work, practical conduct on an EDM machine having their model no. is Electronic Xpert1 die-sinking machine that is based on PLC model no. Electronica PRS-20 controller. The motion of an electrode tool has controlled by a DC servo control to provide too and fro motion toward the workpiece. To achieve good finished surface and high speed of machining, dielectric fluid to be used in EDM. Dielectric fluid used in EDM is Paraffin oil. While performing experiments, positioning of tool electrode and workpiece achieved by dial gauge. During this work, we have to choose ‘+ve polarity’ electrode. For this Copper electrode, circular in size has to be used as a tool, having their dimension 18mm in diameter and 80mm length[13]. The workpiece Al7075 alloy having circular in size and their dimension are 30mm diameter and 20mm thick has to be used. While performing following runs, depth of cut for each sample is 0.2mm. After machining, cleaning and polishing of both workpiece and electrode is necessary. But workpiece has clamped with vice and submerged in paraffin oil. The Al7075 alloy used consist following chemical ingredients shown in Table 1, Prasanna et. al., [14]. For conduct experiment suitable parameters, limits shown as Table 2 and Figure 1 seen the experimental setup.

Measuring the weight of workpiece before and after by using digital weighing balance (citizen), for calculating MRR. And the surface roughness of finished workpiece are measured by using TIME®3100 equipment, that gives both values of Ra, and Rz. Always take three readings in each measure and then average of this take as a final reading of SR And power consumption following the reading of current and voltage note that give directly from the control panel, put in formula for evaluation. For machining Al7075 composite in EDM, four process input functions were varied as Ton, Toff, and current, has chosen to study their impact on response parameters
Ra, Rz and PC. The limit of input parameter has decided on the experience of the pilot of the experiment as shown in Table 2.

### Table 1. Chemical composition of Al7075

| Element | Zn  | Cu  | Mg  | Cr  | Si  | Ti  | Fe  | Al  |
|---------|-----|-----|-----|-----|-----|-----|-----|-----|
| Weight (%) | 5.65 | 1.78 | 2.51 | 0.27 | 0.36 | 0.19 | 0.48 | Balance |

![Fig: 1(a) CNC die sinking EDM (b) Sparking zone (c) Work piece with cavity.](image)

### Table 2: Factors and their levels

| Input Parameters of EDM | Parameters | Units | Levels | L-1 | L-2 | L-3 |
|-------------------------|------------|-------|--------|-----|-----|-----|
| 1                       | Pulse on time (T<sub>on</sub>) | μs   |        | 100 | 150 | 200 |
| 2                       | Pulse off time (T<sub>off</sub>) | μs   |        | 10  | 15  | 20  |
| 3                       | Current (C) | Ampere |       | 3   | 4   | 5   |

3. Design of Experiments

Design of Experiments (DOE) has to be used to efficiently and effectively for purposes such as design, planning, and analysis. In DOE, change in inputs called as factors, cause changes in output (as a response). In DOE, the response surface approach used CCD to design the experiment. In a CCD, the face centered design has to be chosen to give a suitable impact of all inputs on the responses. The design of experiments on basis of Table 2 further goes to investigate the significance of the model, perform ANOVA. In DOE software, the regression analysis approach helps to retrieve the response according to independent input parameters. In RSM, dependent regression equation, i.e., the function of independent input parameters as shown in eq. 1:

\[ x = f(y_1, y_2, ..., y_n) + \varepsilon \]  

Eq. (1)

Here, \( \varepsilon \) denote the error in response \( y \) and surface function expressed as is \( f(x_1, x_2, x_3, x_n) \) known as response surface.

3.1 Analysis of variance (ANOVA)
ANOVA has to be used for check adequacy of the model. This measures the effect of independent function Ton, Toff, and current on the dependent responses Ra, Rz, PC. The term total sum of squared deviations is formed by adding, sum of squared deviations for each design parameter and the sum of squared error. Statistically, F-test performed to identify that parameter those have significant effect on the response characteristic. Then, the F-value finds for each design parameter is generally $F > 4$, then it describes the change in design parameter has affected significantly in response. ANOVA has to be used to form a significant model for Ra, Rz and PC are presented in Table 3. On the basis of this result, we have to optimized EDM responses by Electre method.

| Table 3 Analysis of variance |
|-----------------------------|
| Source         | DF     | SS       | MS       | F         | P         |
|-----------------|--------|----------|----------|-----------|-----------|
| Regression      | 09     | 0.75     | 0.083    | 12.03     | 0.0003    |
| Residual error  | 10     | 0.069    | 6.899E-03|            |           |
| Lack-of-fit     | 05     | 0.061    | 0.012    |           |           |
| Pure error      | 05     | 7.750E-03| 1.550E-03| 7.90      | 0.0203    |
| Total           | 19     | 0.82     |          |           |           |

ANOVA for Rz

| Source         | DF     | SS       | MS       | F         | P         |
|-----------------|--------|----------|----------|-----------|-----------|
| Regression      | 09     | 68.26    | 7.58     | 13.10     | 0.0002    |
| Residual error  | 10     | 5.79     | 0.58     |           |           |
| Lack-of-fit     | 05     | 5.57     | 1.11     | 25.55     | 0.0014    |
| Pure error      | 05     | 0.22     | 0.044    |           |           |
| Total           | 19     | 74.05    |          |           |           |

ANOVA for PC

| Source         | DF     | SS       | MS       | F         | P         |
|-----------------|--------|----------|----------|-----------|-----------|
| Regression      | 9      | 9.301E+005| 1.033E+005| 14.97     | 0.0001    |
| Residual error  | 10     | 69038.35 | 69038.84 |           |           |
| Lack-of-fit     | 5      | 69038.35 | 13807.67 |           |           |
| Pure error      | 5      | 0.000    | 0.000    |           |           |
| Total           | 19     | 9.9991E+005|         |           |           |

4. Multi-criteria decision-making (MCDM)

In this section, basic definitions of Entropy- approach, ELECTRE-I,II are presented. Multi-criteria decision-making (MCDM) methodology is popular in now a day for making decisions on realistic applications. Due to MCDM provide qualitative decision making that is efficient in circumstances. While the typical MCDM problem approach is to give a ranking of a finite number of alternatives that contains criteria (as a response) i.e., explicit both to each other simultaneously[10].

4.1 Entropy approach for weight determination

For calculating the weight of criteria, Entropy approach has to be widely used. Decision weights can explain the importance of each criteria, which has to be determined subjective weight on their knowledge, and the objective weight by calculating [15]. The objective weight measurement of criteria calculated by following some steps explained in Table 3.

| Entropy Weight Calculation Steps |
|----------------------------------|
| Step 1: Data normalization, we choose to follow method: $G = \{ g_{ij} \} = \frac{X_{ij}}{\sqrt{\sum_{j=1}^{n} X_{ij}^2}}$, $1 \leq i \leq m$, $1 \leq j \leq n$  |
| Step 2: Calculate decision information entropy value: $X_{ij} = \{ X_{ij} \}$ for beneficial attribute $1/X_{ij}$ for non-beneficial attribute |

Eq. (2)
### 4.2 Electre method

In ELECTRE method evaluating performance criteria that consist both as a qualitative and quantitative. However, this method gives the advantage that exactly focusses the needs of decision maker and provide appropriate results. In ELECTRE methods two major evaluations require i.e., concordance indices and discordance indices for each alternative. During this concordance index can measure hypothetically the strength between alternative A<sub>i</sub> and A<sub>k</sub> define A<sub>i</sub> is better than A<sub>k</sub>. And discordance index explains hypothesis that has to be endeavoring to each pair[16].

#### 4.2.1 Electre – I

For solving MCDM problem, ELECTRE I is used. In this ELECTRE method, pairwise comparison of alternatives for both concordance and discordance index. The flow procedure of ELECTRE I and II is explained in Table 4 as:

| ELECTRE I and II Calculation Steps | Description |
|-----------------------------------|-------------|
| **Step 1** | Normalizing the Decision Matrix:  
\[ r_{ij} = \bar{x}_i \sqrt{\sum_{j=1}^{m} \bar{x}_j^2}, \ 1 \leq i \leq m, \ 1 \leq j \leq n \]
Eq. (6)  
\[ \text{Here } \bar{x}_i = \{ x_{ij} : \text{if } x_{ij} \text{ is a benefit index.} \} \]

| **Step 2** | Weighting the Normalized Decision Matrix:  
\[ D = [y_{ij}]_{mn} = g_{ij} \times W_j \ (i=1,2,...,m; \ j=1,2,...,n) \text{ and } \sum_{j=1}^{n} W_j = 1 \]
Eq. (7)  

| **Step 3** | Decide the Concordance and Discordance Sets:  
Concordance set:  
\[ c_{ij} = \{ j, y_{ij} \geq y_{kj} \} \text{ for } J=1,2,3,...,n \]
Discordance Sets:  
\[ d_{ij} = \{ j, y_{ij} < y_{kj} \} \text{ for } J=1,2,3,...,n \]
Eq. (8)  
Eq. (9)  

| **Step 4** | Build the Concordance and Discordance Matrices:  
Concordance Matrix Indices:  
\[ c_{ij} = \sum_{j \in D_{ij}} w_j \text{ for } J=1,2,3,...,n \]
Discordance Matrix Indices:  
\[ d_{ij} = \max_{j \in D_{ij}} |y_{kj} - y_{ij}| \]
Eq. (10)  
Eq. (11)  

| **Step 5** | Determine the concordance index matrix:  
\[ r = \left[ r_{ij} \right]_{mn} = \sum_{k=1}^{m} \sum_{l=1}^{m} c_{kl} f_{kl}, \text{if } c \geq c \] \text{ otherwise, } f = 0, \text{ if } c < c \]
Eq. (12)  

| **Step 6** | Determine the discordance index matrix:  
\[ d = \left[ d_{ij} \right]_{mn} = \sum_{k=1}^{m} \sum_{l=1}^{m} d_{kl} f_{kl}, \text{if } c \geq c \] \text{ otherwise, } f = 0, \text{ if } c < c \]
Eq. (13)  

| **Step 7** | Calculate the net superior and inferior value:  
\[ \text{Eq. (14)} \]
\[ C = \sum_{i,k=1}^{n} \left( c(i,k) - c(k,i) \right) \]
\[ D = \sum_{i,k=1}^{n} \left( d(i,k) - d(k,i) \right) \]

Equ. (15)

Step 8 Determine the Aggregate Dominance Matrix:
\[ e_k = f_j \times g_k \]

Equ. (16)

4.2.2 Electre –II

Outranking gives by Electre I, has given two different outranking separately. But in the Electre II can provide ranking by computing pairwise comparison of aggregated relation formed by concordance and discordance. In which alternative A strongly outranks \( A_k \) for which examine concordance, pass strong \( A_i \) and discordance test also for strong pass perform. Note that, here all criteria becomes true for this method[17]. Note that in this method, all criteria are true. From past decades and present MCDM problem point of view, we have to go Electre II method that compensates Electre I limitations and obtained the final best ranking of the alternatives[18].

5 Result & Discussion

5.1 Entropy approach for weight determination

To determine the optimal machining parameters for EDM machine first to calculate the weightage of these criteria’s. For those we have to choose an Entropy method for weight calculation. According to Entropy approach, to calculate weighted by criteria’s we have to solve following equations from eq 2 to eq. 5 to obtained weight as shown in table 4. After these calculations expelled in Electre method to determine optimal EDM machining parameters.

| Criteria | C1 | C2 | C3 |
|----------|----|----|----|
| Weights  | .332| .333| .335|

Table 4: represents Entropy based Weight values.

5.2 Illustrations of Rank Reversals with ELECTRE I and II

In ELECTRE method have exploited for MADM to get found best attribute those having multi-performance criteria. In the present work, the main features of experimental model can be improved by implementing these Electre methods. In this experimental output obtained from EDM should take twenty attributes and having three criteria. In which each criteria are non-benefit index because each criteria becomes minimized. So, in the ELECTRE method, we have to find optimal attributes for those criteria. ELECTRE give a ranking, in which criteria are non-benefit index, so the “smaller-the-better” type. In the ELECTRE require to calculate the weight for each criteria, that have calculated on the basis of the entropy weight method as discussed in earlier sections. After this ELECTRE approach has applied to find the best attribute for those criteria’s explained below.

As an illustration the experimental result of EDM has to be applied for analytical approach, in this study. To obtain standard data for designers, Entropy based Electre I and II has more potential to study in EDM application.

5.3 Electre-I (Ra, Rz, PC)

In this region, discuss the obtained results on the basis of their study, for all alternatives that contain sets of criteria. In this MCDM problem is defined as to take 20 alternatives and 3 criteria to find best ranking. Note here all the criteria that has chosen are Non-benefit criteria, so that, the lower score gives better performance. So, in this segment, we have expelled the Electra I method to get found an optimal alternative ranking for these criteria’s. The individual alternatives are ranked by the users of ELECTRE-I concerning dominance. In Electra 1 solved by following the procedure that has explained in fig. 2. In this criteria are non-beneficial so, normalization for Electra have used the Eq. 6. After this normalized weight matrix calculated by Eq. 7 then find concordance set index and according to these find concordance indices for concordance according to Eq. 8 and
Eq. 10. Also, find discordance set index and discordance indices for discordance from eq. 9 and eq. 11. Then find $\bar{C}$ and $\bar{D}$ values from eq 12 and Eq. 13 then formed concordance matrix and discordance matrix after this find net superior value from the concordance matrix according Eq. 14. $C_j$ is the difference between the sums of Competitive superiorities of all alternatives, in which the more value defines, the better alternative. From Eq. 15 and net inferior value of the discordance matrix in which smaller becomes better. This is reason behind that the smaller net inferior value gets dominant better alternatives that has achieved large value in net inferior value, then provided ranking both superior and inferior, then to get a final matrix from average to get final ranking. From Table 5, decision matrix contains the performance alternatives $A_i$ which expresses the criteria $C_j$ are as follows: to see that attribute $A_7$ and $A_3$ has a better because it has a lower value. So attribute $A_7$ has optimal ranking according to Electre-I.

When computing net superior value and net inferior value to sort the result as shown in Table 5. In this table compare each pair of alternatives separately for both net superior and net inferior. From Table it becomes clear that the net superior values are lower value for $A_{17}$ alternative, which is giving best ranking (see Table 5). While for net inferior value has $A_7$ ranked first and $A_{10}$ on last. But due to Electre I for an optimal machining response from EDM machine on the basis of average, two alternatives $A_3$ and $A_7$ are best. As the Ranking gives as:

$$A_3 = A_7 < A_2 = A_9 = A_{11} < A_4 = A_{16} < A_{14} < A_{15} < A_{18} < A_{12} = A_{17} < A_9 < A_6 < A_1 < A_{10}$$

According to these Electre-I result, $A_3$ and $A_7$ alternative gives best result for EDM response parameter values at this alternative $A_3$ are Ra (0.64), Rz (5.37), and PC (250) relative input parameters are Ton (100), Toff (15), and current (4). And alternative $A_7$ response values Ra (0.45), Rz (4.62), PC (375). These criteria correspond to input parameter Ton (200), Toff (20), current (5). While those parameters are optimized parameter for machining on Al7075 machining in EDM machine were selected, then go to implement problem in Electre-II.

| Attributes | Criteria | C1 | C2 | C3 | Net superior values | Net Inferior values | Electre –I Final ranking | Electre -II Final ranking |
|------------|----------|----|----|----|---------------------|---------------------|------------------------|------------------------|
| A1         |          | 0.63 | 5.4 | 375 | -1.99              | -2.11              | 9                      | 7                      |
| A2         |          | 0.42 | 3.21 | 300 | -1.43              | 0.61               | 2                      | 6                      |
| A3         |          | 0.64 | 5.37 | 250 | -6.86              | 3.11               | 1                      | 5                      |
| A4         |          | 0.59 | 4.33 | 375 | -5.98              | 1.12               | 3                      | 2                      |
| A5         |          | 1.15 | 12  | 375 | 13.64              | 1.35               | 12                     | 3                      |
| A6         |          | 0.86 | 7.5  | 400 | 13.66              | 1.93               | 8                      | 4                      |
| A7         |          | 0.45 | 4.62 | 375 | -6.98              | 5.18               | 1                      | 1                      |
| A8         |          | 0.72 | 5.6  | 300 | -3.02              | 2                  | 2                      | 5                      |
| A9         |          | 0.47 | 3.5  | 750 | -4.29              | -1.36              | 7                      | 3                      |
| A10        |          | 0.56 | 4.89 | 750 | -0.96              | -6.92              | 10                     | 4                      |
| A11        |          | 0.27 | 2.3  | 225 | -19                | 0                  | 2                      | 7                      |
| A12        |          | 0.79 | 5.9  | 300 | 2.97               | 1.3                | 6                      | 4                      |
| A13        |          | 1.05 | 6.06 | 1125 | 15.68              | -2.8               | 14                     | 4                      |
| A14        |          | 0.83 | 6.2  | 300 | 5.63               | 2.5                | 4                      | 2                      |
| A15        |          | 0.59 | 4.55 | 375 | -4.99              | -0.31              | 5                      | 7                      |
| A16        |          | 0.76 | 5.73 | 300 | -0.36              | 2.17               | 3                      | 5                      |
| A17        |          | 0.75 | 6    | 300 | 1.65               | 1.19               | 6                      | 5                      |
| A18        |          | 0.74 | 5.87 | 300 | -0.36              | 1.48               | 5                      | 6                      |
| A19        |          | 0.69 | 5.82 | 750 | 5.7                | -6.41              | 13                     | 5                      |
| A20        |          | 0.77 | 7.4  | 450 | 11.67              | -1.11              | 11                     | 2                      |

5.4 Electre-II(Ra, Rz, PC)

In this work, we have to also find a ranking based on Electre II because Electre I has not completely define the ranking of the system define only attribute dominance according to superior and inferior. Due to the following limitations, we have to go to Electre II method. In Electre II some steps same as Electre I as shown in fig. 2. In
this calculation from Eq. 6 to Eq. 11 follow after this form E matrix from condition given in Eq. 12 in binary coding 0 and 1. Also, form F matrix according to condition 13 same as binary form. And then form a final matrix \( G = E \times F \) from Eq. 16 according to Boolean AND gate operation. Then, Ranking assigned on alternatives based on ascending and descending manner, then final ranking provided based on the average of these. From the above Table 5 in which \( A_7 \) dominates all other alternatives as seen in it. As the Ranking gives as:

\[
A_1 \prec A_4 \equiv A_{14} \prec A_5 \prec A_6 \equiv A_{10} \equiv A_{12} \equiv A_{13} \prec A_8 \equiv A_{16} \equiv A_{17} \equiv A_{19} \prec A_2 \equiv A_{18} \prec A_1 \equiv A_{11} \equiv A_{15}.
\]

According to these Electre-II result, \( A_7 \) alternative gives best result for EDM response parameter values at this alternative are \( R_a \) (0.45), \( R_z \) (4.62), PC (375). These criteria corresponds to input parameter \( T_{on} \) (200), \( T_{off} \) (20), current (5) are optimized result for machining on Al7075 machining in EDM machine.

The Ranking found from Electre I and Electre II plot on the graph between Ranking and Alternatives as shown in Fig. 2. These following results from ELECTRE I and II to give optimized responses according to process parameters. In graph clearly \( A_7 \) gives the best alternative set would belong in both Electre I and II, and resolve limitation of Electre I clearly seen. To fulfill the needs of industries where less power consumption produces a better surface finish for those uses these results.

![2D Graph 1](image)

**Fig: 2 Plot graph between Alternatives and Ranking according Electre I and II**

### 6 Conclusions

The conclusion of this study is that too obtained, to find the optimal parameters of EDM machine based on their response criteria by ELECTRE-I and ELECTRE-II methods. For this experiment has the design based on CCD in RSM. Then firstly, we have to adopt an Entropy approach for the calculation of weights of machining criteria. This Entropy-based ELECTRE-I methodology was used synthetically to rank the following machining alternatives. And then also analyze on the Entropy-based Electre-II method to compensate the Electre-I limitation not provide the final ranking of whole EDM machine to define \( A_i \) better than \( A_k \). So, this approach has proposed by this paper has provided choices for the designer to make a product, for this select the best alternative. At this alternative, the corresponding intakes are \( T_{on} \) (200), \( T_{off} \) (20), current (5) and optimized response values are \( R_a \) (0.45), \( R_z \) (4.62), PC (375). And then finally implement this novel approach of the algorithm in the EDM machine to give good prospect. In the above research was motivated to select this problem while machining in EDM generally takes place. In this work, to find an optimal alternative for that performance criterion of EDM corresponding to intake variables, for which model is developed. So, these optimal variables should choose while deciding on machining in EDM. This work is especially for manufacture Aircraft rifles. In the future, we will extend our work based on Electre III and IV.
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