A PERSPECTIVE ON PROCESS PARAMETERS IN EDM USING AHP APPROACH

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Abstract: Electro-discharge machining (EDM) is as a machining process for machining of conducting materials. A number of parameters must be taken into consideration for optimizing the EDM process. Various parameters considered in this study are:Current, Pulse- On, Pulse Off, Material Removal Rate (MRR), Electrode Wear Rate (EWR), Surface finish (Ra). EDMis primarily used for those materials that are difficult to machine with traditional techniques. The present analysis is aimed towards the ranking of various identified parameters of EDM.

Keywords: EDM, Surface Finish (Ra), Pulse-on, Pulse-off, current, MRR, EWR

1. INTRODUCTION

EDM is a non-conventional machining process which is employed for machining hard electrically conductive materials. It works on the principle of repeated electrical discharges.EDM causes erosion of materials to obtain the desired shape of the work piece with closer dimensional tolerances. There is no physical contact between the electrode and work piece.
Review of Literature reveals that there is need for optimizing the process parameters of EDM. The present work is devoted towards the development of a mathematical model using Analytic Hierarchy Process (AHP).
The various parameters selected for the modelling are shown in table1.

Table 1: Various EDM parameters

Parameters	Description of Parameters
P1	Current
P2	Surface finish (Ra)
P3	Material Removal Rate (MRR)
P4	Pulse Off
P5	Electrode Wear Rate (EWR)
P6	Pulse- On

2. ANALYTIC HIERARCHY PROCESS (AHP)

AHP is an MCDM technique used by various researchers for because of its wider acceptability and adaptability. AHP method is capable of solving a wide range of decision problems involving pairwise comparison and analysis. The following steps has been used in the AHP analysis:
a. Developing questionnaire for Pair wise comparison
b. Formation of Comparison matrix
c. Normalization
d. Evaluation and Consistency analysis
The relative importance scale (Saaty & Vargas, 1991) has been used for pairwise comparison.A panel of experts from the field of EDM were involved for the pair wise comparison of identified process parameters. Table 2 shows the Pair-wise comparison matrix.

Table 2 Pair-wise matrix

Parameters	P1	P2	P3	P4	P5	P6
P1	1	½	1/3	6	3	6
P2	2	1	1/2	7	4	6
P3	3	2	1	7	6	8
P4	1/6	1/7	1/7	1	2	3
P5	1/3	¼	1/6	1/2	1	2
P6	1/6	1/6	1/8	1/3	½	1

Table 3a and 3b reflects the steps for Normalization matrix.

Table 3a Normalization matrix (Step-I)

Parameters	**P1**	**P2**	**P3**	**P4**	**P5**	**P6**
P1	1.00	0.50	0.33	6.00	3.00	6.00
P2	2.00	1.00	0.50	7.00	4.00	6.00
P3	3.00	2.00	1.00	7.00	6.00	8.00
P4	0.17	0.14	0.14	1.00	2.00	3.00
P5	0.33	0.25	0.17	0.50	1.00	2.00
P6	0.17	0.17	0.13	0.33	0.50	1.00
Total	**6.667**	**4.060**	**2.268**	**21.833**	**16.500**	**26.000**

Table 3b Normalization matrix (Step-2)

Parameters	**P1**	**P2**	**P3**	**P4**	**P5**	**P6**
P1	0.150	0.123	0.147	0.275	0.182	0.231
P2	0.300	0.246	0.220	0.321	0.242	0.231
P3	0.450	0.493	0.441	0.321	0.364	0.308
P4	0.025	0.035	0.063	0.046	0.121	0.115
P5	0.050	0.062	0.073	0.023	0.061	0.077
P6	0.025	0.041	0.055	0.015	0.030	0.038

Table 4 shows the Consistency measure of the process parameters.

Table 4 Consistency analysis

Parameters	**P1**	**P2**	**P3**	**P4**	**P5**	**P6**	**TOTAL**	**AVERAGE**	**C. R**
P1	0.150	0.123	0.147	0.275	0.182	0.231	**1.108**	***0.185***	6.664
P2	0.300	0.246	0.220	0.321	0.242	0.231	**1.561**	***0.260***	6.674
P3	0.450	0.493	0.441	0.321	0.364	0.308	**2.376**	***0.396***	6.471
P4	0.025	0.035	0.063	0.046	0.121	0.115	**0.406**	***0.068***	6.063
P5	0.050	0.062	0.073	0.023	0.061	0.077	**0.346**	***0.058***	6.118
P6	0.025	0.041	0.055	0.015	0.030	0.038	**0.205**	***0.034***	6.115

Consistency Ratio C. R =CI/RI, where RI = 1.240 (for n=6)
RI is called Random Index and is obtained from RI index chart.
CI= 0.070, C. Ratio= 0.057
Value of CI is <0.10, which reflects judgmental consistency of the analysis.
Table 5 shows the ranking of various parameters of EDM.

Table 5 Ranking of identified parameters of EDM

Parameters	Consistency Ratio	Rank
P1	6.664	II
P2	6.674	I
P3	6.471	III
P4	6.063	VI
P5	6.118	IV
P6	6.115	V

The Ranking obtained from the analysis are: P2>P1>P3 > P5>P6>P4

3. RESULTS AND DISCUSSION

The current work reflects the relative ranking/ importance of the selected parameters in EDM using AHP method. Based on expert's opinion and followed by consistency analysis, the ranking of EDM process parameters arefound as: P2- P1- P3- P5- P6- P4. This reflects that Surface finish (Ra) having highest value of CR= 6.674is the most important parameter in EDM. Other important parameters are current followed by MRR. In order to optimize the EDM process, these parameters seek due attentionbased on their rankings.

4. CONCLUSIONS

The present work is aimed towards the analysis of selected parameters in EDM based on their relative rankings. The AHP analysis reflects that Surface finish is the most important parameter in EDM process. Managers are expected to put due importance on all EDM parameters based on their relative importance. This will help in improving the process efficiency as well as in optimizing the EDM process. Future research might involve other important parameters for more in-depth analysis using other MCDM techniques like TOPSIS, ANN, GTA etc.

REFERENCES

1. Angelos P. Markopoulos, Dimitrios E. Manolakos, Nikolaos M. Vaxevanidis, (2008); "Artificial neural network models for the prediction of surface roughness in electrical discharge machining", Journal of Intelligent Manufacturing, Volume 19, Issue 3, pp 283–292.
2. I. Puertas, C. J. LuisL, Álvarez (2004); "Analysis of the influence of EDM parameters on surface quality, MRR and EW of WC–Co",Journal of Materials Processing TechnologyVolumes 153–154, Pages 1026-1032.
3. Jai Prakash, Ashish Agarwal, Vipin, Optimisation of MRR in EDM Process, IJAPIE-2016-01-102, Vol 1(1), 7-10.
4. K. M. Patel, Pulak M. Pandey &P. Venkateswara Rao (2009); "Determination of an Optimum Parametric Combination Using a Surface Roughness Prediction Model for EDM of Al2O3/SiCw/TiC Ceramic Composite" Materials and Manufacturing Processes, Volume 24, Issue 6.
5. M.M. Rahman, Md. Ashikur Rahman Khan, M.M. Noor, K. Kadirgama, (2011); "Optimization of Machining Parameters on Surface Roughness in EDM of Ti-6Al-4V Using Response Surface Method", Advanced Materials Research, Vol. 213, pp. 402-408
6. Murat Kiyak, Bilal Ensari Aldemir, Erhan Altan (2015); "Effects of discharge energy density on wear rate and surface roughness in EDM**";**The International Journal of Advanced Manufacturing Technology, Volume 79, Issue 1–4, pp 513–518.
7. Pankaj R. Shelar, Ramesh R. Lekurwale, "Selecting Appropriate Cutting Tool Insert for Turning Using Analytical Hierarchy Process and Weighted Product.
8. Pradhan, M KBiswas, C K (2009); "Modelling and Analysis of process parameters on Surface Roughness in EDM of AISI D2 tool Steel by RSM Approach"; International Journal of Mathematical, Physical and Engineering Sciences, Volume 3 No 1.
9. R. W. Saaty, "The Analytic Hierarchy Process- What It Is and how It Is used", Mathl Modelling, Vol. 9, No. 3-5, 1987, pp. 161-176.
10. S. Dhanabalan et al. (2012), Optimization of EDM Process Parameters with Multiple Performance Characteristics FOR Titanium Grades. European Journal of Scientific Research. Vol 68. No. 3, Pp 297-305.
11. S. Prabhu et al. (2012). Modeling the machining parameters of AISI D2 tool steel material with multi wall Carbon nano tube in EDM process using response surface methodology. International Journal of the Physical sciences. Vol7(2), Pp 297-305.
12. Saaty T L (1980). The Analytic Hierarchy Process, McGraw Hill International.
13. Subrata Kumar Patra, Tilak Raj, B.B. Arora, An Analysis of Selected Parameters in an Energy Efficient Sustainable Manufacturing System Using AHP, IJAPIE-2017-02-211, Vol 2 (2), 01-04.
14. Thomas L. Saaty, "Decision making with the analytic hierarchy process", Int. J. Services Science, Vol. 1, No. 1, 2008, pp. 83-98.
15. VikasaApurba, KumarRoy, Kaushik Kumar (2014); "Effect and Optimization of Various Machine Process Parameters on the Surface Roughness in EDM for an EN41 Material Using Grey-Taguchi"; Procedia Materials Science Volume 6, Pages 383-390.
16. Y.H.GuuaH, Hocheng, C.Y.ChouaC.S.Deng (2003); "Effect of electrical discharge machining on surface characteristics and machining damage of AISI D2 tool steel" A; Volume, 15, Pages 37-43.
17. Yusuf Keskin, H. Selçuk, Halkacı, Mevlüt Kizil (2006); " An experimental study for determination of the effects of machining parameters on surface roughness in electrical discharge machining (EDM)"; The International Journal of Advanced Manufacturing Technology, Volume 28, Issue 11–12, pp 1118–1121.