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Effect Of Hybrid Dielectric Fluid On The Performance Of Edm Parameters

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Abstract

Electric Discharge Machining (EDM) is a non-traditional machining process where tricky and multifarious profiles can be machined. Only electrically conductive materials can be machined by this practice and is one of the important machining method for machining high strength temperature resistance alloys. For accomplishing the finest performance of the EDM method, it is critical to convey out parametric design replies such as material removal rate (MRR), surface roughness (SR) etc. It is essential to consider most number of input parameters to get the better result. The objective of this work is to study the influence of three design factors current (I), pulse on time (Ton), pulse off time (Toff) which are the most relevant parameters to be controlled by the EDM process over machining characteristics such as material removal rate, surface roughness. In electrical discharge machining (EDM), a process utilizing the removal manifestation of electrical discharge in dielectric, the working liquefied plays a crucial role affecting the material removal rate and the properties of the machined surface. Choosing the right dielectric fluid is critical for successful operations. This work enhance properties of dielectric fluids by the combination of EDM oil and palm oil. In this work TOPSIS used for optimization.

Keywords:

Material Removal Rate (MRR);
Surface Roughness (SR);
TOPSIS;

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1. Introduction

The new idea of assembling utilizes non-regular vitality sources like sound, light, mechanical, concoction, electrical, electrons and particles. With the modern and mechanical development, advancement of harder and hard to machine materials, which find wide application in aviation, atomic building and different businesses inferable from their high quality to weight proportion, hardness and warmth protection qualities has been seen. New improvements in the field of material science have prompted new building metallic materials, composite materials and cutting-edge pottery having great mechanical properties and warm attributes and also adequate electrical conductivity with the goal that they can promptly be machined by start disintegration. Non-conventional machining has become out of the need to machine these fascinating materials. The machining forms are non-conventional as in they don't utilize customary instruments for metal expulsion and

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rather, they specifically utilize different types of vitality. The issues of high many-sided quality fit as a fiddle, measure and higher interest for item precision and surface complete can be settled through non-customary techniques. As of now, non-conventional procedures have practically boundless capacities aside from volumetric material evacuation rates, for which awesome advances have been made in a previous couple of years to build the material expulsion rates. As evacuation rate expands, the cost-adequacy of operations likewise increments, empowering ever more noteworthy employments of a non-traditional procedure. The Electrical Discharge Machining process is utilized generally to make devices, passes on and other accuracy parts.

EDM has been supplanting penetrating, processing, crushing and other customary machining operations and is presently a settled machining choice in many assembling enterprises all through the world. Furthermore, is equipped for machining geometrically mind boggling or hard material segments, that are exact and hard to-machine, for example, warm treated apparatus steels, composites, super amalgams, earthenware production, carbides, warm safe steels and so forth being generally utilized as a part beyond words shape making businesses, aviation, air transportation and atomic ventures.

Dhar and Purohit [1] assesses the impact of current (c), beat on time (Ton) and air hole voltage (v) on MRR, TWR, SR of EDM with Al– 4Cu– 6Si alloy– 10 wt. % SiCP composites. Also, three elements, three levels full factorial outline was utilizing and breaking down the outcomes. A moment arrange, non-straight numerical model has been created for setting up the relationship among machining parameters. The critical of the models were checked utilizing system ANOVA and finding the MRR, TWR and ROC increment huge in a non-straight design with increment in current. Karthikeyan et .al [2] has introduced the scientific embellishment of EDM with aluminum-silicon carbide particulate composites. Also, the impact of MRR, TWR, SR with Process parameters taken in to thought were the present (I), the beat term (T) and the percent volume division of SiC (25 µ measure). A three-level full factorial outline was picking. At last, the critical of the models were checked utilizing the ANOVA. The MRR was found to diminish with an expansion in the percent volume of SiC, Wei Bin et al. [3] has learn about electrical release machining with various gaps in an electrically conductive work piece, incorporates an electrical release machine for rotatable mounting a first anode, and no less than one electrical release unit for rotatable mounting no less than one moment cathode. The electrical release machine incorporates a driver and a controller, the driver is attractively coupled to the electrical release machine and the electrical release unit for turning the main terminal and the no less than one moment anode, and the controller is alluringly coupled to the electrical release machine and the no less than one electrical release unit for controlling a supply of electrical vitality from the primary cathode and second cathode to the work piece. M. Dastagiri et al. [4] explored the effect of EDM parameters on EDM of stainless steel and En 41b, and the results exhibit that Ra is affected essentially by the present, voltage, beat on, and commitment factor.

Kunge et al. [5] advancement the impact of MRR and EWR examine on the powder blended electrical release machining (PMEDM) of cobalt-reinforced tungsten carbide (WC-Co) has been done. In the PMEDM procedure, the aluminum powder molecule suspended in the dielectric liquid scatters and makes the releasing vitality scattering uniform; it shows various releasing impacts inside a solitary information beat. This investigation was made just for the completing stages and has been done considering the four preparing parameters: release current, beat on time, grain size, and convergence of aluminum powder molecule for the machinability assessment of MRR and EWR. Tsai et al [6] have working military of graphite, copper and copper amalgams are broadly utilizing EDM in light of the fact that these materials have high dissolving temperature, and magnificent electrical and warm conductivity. The terminals made by utilizing powder metallurgy innovation from unique powders have been utilized to change EDM surfaces as of late, to enhance wear and consumption protection. Cathodes are made at low weight (20MPa) and temperature (200 °C) in a hot mounting machine According to the test comes about, a blending proportion of Cu– 0wt%Cr and a sinter weight of 20 MPa got an incredible MRR. Dastagiri.M et al. [7] explored the effect of WEDM parameters on WEDM of EN-31 instrument steel, and the results exhibit that SR and MRR is affected essentially by the present, voltage, beat on, and furthermore to discover other machining parameters.

Ajit Singh, AmitabhaGhosh [8], clarified the obliviousness of electrostatic power following up on the surface of the metal for short heartbeat lengths (under 5 µs). For long heartbeats (more prominent than 100 µs), this electrostatic power turns out to be little and does not assume a noteworthy part in the evacuation of metal.

P.C. Pandey and S.T. Jilani [9] exhibited a logical model for the calculation of disintegration of anodes by a solitary start in EDM. An investigation for the calculation of the plasma channel measure was exhibited as an element of heartbeat on length in EDM. It has been demonstrated that representing the impacts of the plasma development prompts checked change in investigative outcomes acquired. This examination likewise recommends a technique for assessing the thickness of the re-hardened layer in EDM machined work pieces. B.Mohan and Satyanarayana [10] development the of impact of the EDM Current, terminal conjugal extremity, beat length and pivot of cathode on metal expulsion rate, TWR, and SR, and the EDM of Al-Sic with 20-25 vol. % SiC, Polarity of the anode and volume present of SiC, The electric engine can be utilized to pivot the electrode(tool) AV belt was utilized to transmit the power from the engine to the cathode Optimization parameters for EDM boring were additionally created to abridge the impact of machining trademark, for example, MRR, TWR and SR. Yan-Cherng Lin et al. [11] has detailed that Electrical Discharge Energy on Machining of Cemented Tungsten Carbide utilizing an electrolytic copper terminal. The EWR and width of the machining flotsam and jetsam were likewise identified with the thickness of the electrical release vitality. At the point when the measure of electrical release vitality carbides caused by EDM were obvious.

2. Research Method (10pt)

2.1 Experimental Setup&Equipment used for experiments

The gear used to play out the trials is bite the dust sinking EDM machine. It is invigorated by 128A heartbeat generator. Too, a stream flushing framework keeping in mind the end goal to guarantee the sufficient flushing of the EDM procedure flotsam and jetsam shape the hole zone is utilized. Weight of the dielectric is balanced physically toward the start of analysis. The equipment is shown in Fig. 1

Fig. 1: *Die-Sinking EDM Machine.*

Experiments are carried out on manganese steel. The chemical composition of the material physical properties & Mechanical properties are given in Table1, 2, 3 respectively.

Table 1 Chemical composition of Work Piece Material (Manganese steel)

Type	Fe	C	Si	Mn	P
Manganese steel	Bal	1.05%	1%	11.5%	0.07%

Table 2 Physical properties of Manganese steel

Density	7.89 gm/cc
Melting Point	1370° C

Table 3. Mechanical Properties of Manganese steel.

Hardness	220 BHN
Tensile Strength, Ultimate	940 Mpa
Tensile Strength, Yield	350 Mpa

TABLE 4. Process parameters and their levels

Parameters	Level 1	Level 2	Level 3	Level 4
Current (A)	6	9	12	15
Ton (μs)	20	50	100	200
Toff (μs)	20	50	100	200

In the investigation three components single level setup is picked. The analysis has 3 factors at 4 distinct settings. A full factorial examination would require 4^3=64 investigations. We directed a Taguchi explore different avenues regarding a L16 orthogonal exhibit (16 tests, 3 factors, 4 levels) is appeared in table 4 . The test configuration is appeared in table 5.

Table 5. Design of Experiments observation table

S.NO	Current (I)	Pulse on time (Ton)	Pulse of time (Toff)
1	1	1	1

2	1	2	2
3	1	3	3
4	1	4	4
5	2	1	2
6	2	2	1
7	2	3	4
8	2	4	3
9	3	1	3
10	3	2	4
11	3	3	1
12	3	4	2
13	4	1	4
14	4	2	3
15	4	3	2
16	4	4	1

DOE researches the impacts of info (factors) on a yield variable (reaction) in the meantime. Here the information factors are present, beat on time, beat off time as appeared in the table 6. These investigations comprise of arrangement of runs or tests in which an intentional change is made to the information factors are MRR, Ra.

Material removal rate

The material expulsion rate of the workpiece is the volume of the material expelled every moment. It can be ascertained utilizing the accompanying connection.

Table: 6. Design of experiments and experimental results

S.No	I (A)	TON (µs)	TOFF (µs)	MRR (mm^3/min)	SR (µm)
1	6	20	20	0.42247	3.7805
2	6	50	50	0.63371	3.9360
3	6	100	100	0.76045	4.1102
4	6	200	200	1.47866	4.9950
5	9	20	50	0.92944	4.1090
6	9	50	20	0.33798	3.3580
7	9	100	200	1.52091	6.3065
8	9	200	100	1.30967	6.1080
9	12	20	100	0.84495	3.6180
10	12	50	200	1.22517	4.9920
11	12	100	20	2.19687	5.4805
12	12	200	50	4.01351	7.0060
13	15	20	200	1.05618	4.8440
14	15	50	100	2.07013	5.8750
15	15	100	50	3.59104	6.0480

16	15	200	20	5.49218	8.1430

Taguchi's signal –to-noise ratio analysis on response variables[7]

Factual examination was helped out on the test acquired through Taguchi test configuration utilizing measurable programming MINITAB 17 as appeared in table 7 In this progression, S/N proportions are computed for reactions got from EDM operation and ideal mix of info parameters are resolved in view of the quality necessity[7].

In EDM process reaction attributes, for example, surface harshness ought to be low for better quality, consequently littler S/N proportions is considered for this parameter. Where as material evacuation is higher for machining so bigger S/N proportions is considered[7].

Motion To-Noise proportion for Smaller the Better:

- Surface harshness

Flag To Noise Ratio for Larger-The-Better:

- Material Removal Rate.

TOPSIS METHOD

Conventional Taguchi approach is deficient to take care of a multi-reaction streamlining issue. Keeping in mind the end goal to beat this constraint, a multi-criteria basic leadership strategy, systems for arrange inclination by likeness to perfect arrangement (TOPSIS) is connected in the present examination. So as to consider exploratory vulnerability, the reactions are communicated in process factors as opposed to fresh esteems. The variety of yield reactions with process parameters is numerically displayed. The models were checked for their sufficiency. The aftereffect of affirmation tests demonstrated that the built up scientific models can anticipate the yield reactions with sensible exactness and the calculate values are shown in table no 7, 8, 9repectively[7].

Table 7. TOPSIS Attribute

Attribute	MRR	SR
MRR	1	2
SR	0.5	1

Table: 8 Normalized decision matrix

Experiment No.	MRR	SR
1	0.047245	0.177259
2	0.070868	0.18455
3	0.085042	0.192718
4	0.165359	0.234204
5	0.10394	0.192662
6	0.037796	0.157449
7	0.170084	0.295697
8	0.146461	0.28639
9	0.094491	0.16964
10	0.137011	0.234063
11	0.245677	0.256968
12	0.448833	0.328495
13	0.118113	0.227124
14	0.231504	0.275465
15	0.401588	0.283577
16	0.614194	0.381807

Table 9. TOPSIS Ranking

S.No	I (A)	TON (µs)	TOFF (µs)	MRR (mm^3/min)	SR (µm)	Ci*= Si/ (SI*+Si)	RANK
1	6	20	20	0.42247	3.7805	0.152806	14
2	6	50	50	0.63371	3.9360	0.153617	13
3	6	100	100	0.76045	4.1102	0.151567	15
4	6	200	200	1.47866	4.9950	0.657894	7
5	9	20	50	0.92944	4.1090	0.156343	12
6	9	50	20	0.33798	3.3580	0.162893	11
7	9	100	200	1.52091	6.3065	0.229507	9
8	9	200	100	1.30967	6.1080	0.627665	8
9	12	20	100	0.84495	3.6180	0.169499	10
10	12	50	200	1.22517	4.9920	0.658523	6
11	12	100	20	2.19687	5.4805	0.806891	4
12	12	200	50	4.01351	7.0060	0.827792	3
13	15	20	200	1.05618	4.8440	0.139342	16
14	15	50	100	2.07013	5.8750	0.76653	5
15	15	100	50	3.59104	6.0480	0.85228	1
16	15	200	20	5.49218	8.1430	0.837107	2

3. Results and Analysis

Fig 2 demonstrates the primary impacts plot for MRR. As can be seen in this figure, most impacting factors are present and heartbeat on time. MRR incredibly expanded when the current is expanded from 6 to 15 Amps and heartbeat on time expanded from 20 to 200 µs.

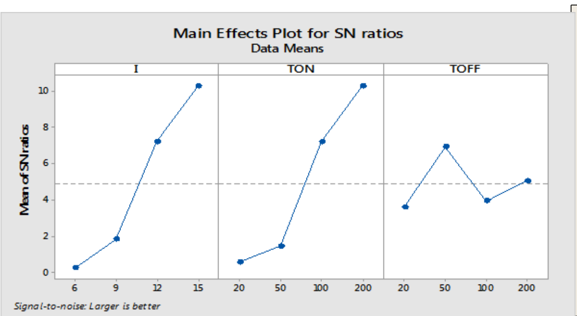

Fig.2.*Main effects plot for MRR and SR*

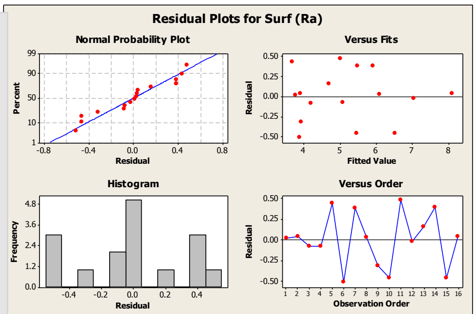

Fig 3*Residual plots for surface roughness*

Fig 3 shows lingering plots for surface unpleasantness, the residuals are framed in a cyclic way. The majority of the residuals lie closer to the lingering mean line.

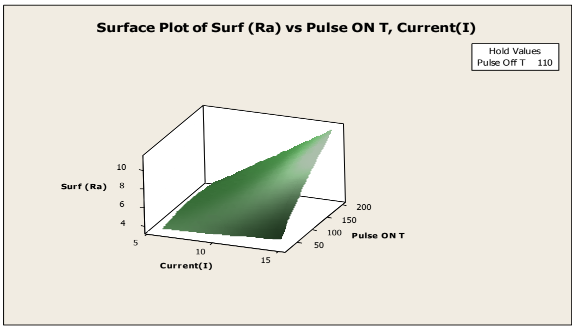

Fig 4*surface plot of surface roughness vs pulse on time, current*

From the figure 4 surface unpleasantness marginally increments with increment in present and surface harshness increments quickly with increment in pulse on time.

4. Conclusion

Taguchi's Signal – to – Noise proportion and TOPSIS is connected in this work to enhance the multi-reaction attributes, for example, MRR (Material Removal Rate) and Surface Roughness of manganese steel amid EDM process. The finishes of this work are compressed as takes after:

- The ideal parameters blend was resolved as A4B3C2 i.e. beat current at 15A, beat ON time at 100 µs and heartbeat OFF time at 50µs by utilizing TOPSIS technique
- This work exhibits the technique for utilizing TOPSIS and SAW strategies for enhancing the EDM parameters for different reaction attributes.
- In rundown, the proposed work empowers the assembling architects to choose the ideal esteems relying upon the generation necessities and as an outcome, robotization of the procedure should be possible in light of the ideal esteems.

References

[1] Dhar, s., Purohit, r., Saini, n., Sharma, a. and Kumar, G.H., 2007. Mathematical modeling of electric discharge machining of cast Al-4Cu-6Si alloy-10 wt.% sicp composites. Journal of Materials Processing Technology, 193(1-3), 24-29.

[2] E.Karthikeyan,P.R.Lakshminarayanan,R.S.Naagarazan,Mathematical modelling for electric Discharge Machining of aluminium-silicon carbide particulate composites, Journal of materials processing technology 87(1999)59-63.

[3] Wei; Bin, and Lee; Martin Kin-fei April 16, 2002. *Apparatus and method for electrical discharge machining multiple holes United States Patent 6,373,018, et al.*

[4] Dastagiri M, Kumar A H. Experimental Investigation of EDM Parameters on Stainless Steel & En41b [J]. Procedia Engineering, 2014, 97:1551–1564

[5] Kung, K.-., Horng, J.-. and Chiang, K.-., 2009. Material removal rate and electrode wear ratio study on the powder mixed electrical discharge machining of cobalt-bonded tungsten carbide. *International Journal of Advanced Manufacturing Technology, 40(1-2), 95-104.* Z.Jia,J.Zhang,X,Ai,Z.LiangaAi,Combined machining of USM and EDM for advanced ceramics,J.Adv.Mater.(1994)16-20.

[6] M. Dastagiri, P. Srinivasa Rao and P. Madar Valli, "TOPSIS, GRA Methods for Parametric Optimization on Wire Electrical Discharge Machining (WEDM) Process", Proceedings of 6th International & 27th All India Manufacturing Technology, Design and Research Conference (AIMTDR-2016), pp 497-504, ISBN: 978-93-86256-27-0.

[7] Tsai, H.C., Yan, B.H. and Huang, F.Y., 2003. EDM performance of Cr/Cu-based composite electrodes. *International Journal of Machine Tools and Manufacture, 43(3), 245-252.* I. Puertas and C.J. Luis. Journal of Materials processing Technology Volumes 143-144, 20 December 2003, Pages 521-526 A study on the machining parameters optimization of electrical discharge machining.

[8] M. Dastagiri, P. Srinivasa Rao and P. Madar Valli, "TOPSIS, GRA Methods for Parametric Optimization on Wire Electrical Discharge Machining (WEDM) Process", Proceedings of 6th International & 27th All India Manufacturing Technology, Design and Research Conference (AIMTDR-2016), pp 497-504, ISBN: 978-93-86256-27-0.

[9] P.C. Pandey and S.T. Jilani, Plasma channel growth and the resolidified layer in edm", Precision Engineering, Vol. 8, Issue 2, April 1986, Pages 104-110.

[10] Mohan B., Rajadurai A., Satyanarayana K.G., 2004, "Electric discharge machining of Al–SiC metal matrix composites using rotary tube electrode". Journal of Materials Processing Technology, 153–154, 978–985

[11] Yan-Cherng Lin, Yuan-feng chen, Ching-tien Lin, AND Hsinn-jyh Tzeng Feasibility study of rotary electrical discharge machining with ball burnishing for Al2O3/6061Al composite 2008, vol.23: 391–399,.