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EXPERIMENTAL INVESTIGATION OF OPTIMUM VALUES OF PROCESS PARAMETERS IN EDM FOR MATERIAL AISI D3 STEEL BY GREY RELATIONAL METHOD

MR. SUNIL B. MISHRA,
P.G .Student, Department of Mechanical engineering, M.G.M'S College of Engineering, Nanded, Maharashtra, India. Email- sunilbajrangmishra@yahoo.com

PROF. J.K.SAWALE
Professor, Department of Mechanical Engineering, MGM.'s College of engineering, Nanded, Maharashtra , India Email- jksawale @rediffmail.com

ABSTRACT
This paper deals with the experimental investigation of optimum values of process parameters in EDM to improve the productivity and also to improve the surface quality. Problem has been formulated in maximization of MRR in order to increase productivity and minimization of Ra. Taguchi method is used for Design of experiment. Optimum values of process parameters are obtained using grey relational analysis method. It is observed that the material removal rate increases for the optimum values maintaining the surface quality. This work demonstrates the use of Grey relational method approach for the optimization of multi-response problem.

KEYWORDS: EDM, optimization, process parameters, Taguchi method, grey relational analysis method, Material removal rate, surface roughness (Ra), etc.

INTRODUCTION
Electric discharge machining is a thermo-electric non-traditional machining process. Material is removed from the work piece through localized melting and vaporization of material. Electric sparks are generated between two electrodes when the electrodes are held at a small distance from each other in a dielectric medium and a high potential difference is applied across them. Localized regions of high temperatures are formed due to the sparks occurring between the two electrode surfaces. Work piece material in this localized zone melts and vaporizes. Most of the molten and vaporized material is carried away from the inter-electrode gap by the dielectric flow in the form of debris particles. To prevent excessive heating, electric power is supplied in the form of short pulses. Spark occurs wherever the gap between the tool and the work piece surface is smallest. After material is removed due to a spark, this gap increases and the location of the next spark shifts to a different point on the work piece surface. In this way several sparks occur at various locations over the entire surface of the work piece corresponding to the work piece-tool gap. Because of the material removal due to sparks, after some time a uniform gap distance is formed throughout the gap between the tool and the work piece.

EXPERIMENTAL SET UP

Fig. 1. EDM machine

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For this experiment the whole work is done by using Electric Discharge Machine, model ELECTRONICA-ELECTRAPULS PS 50ZNC (die-sinking type), having provision of programming in the Z-vertical axis and manually operated X and Y axes. The tool is made of cathode and the work piece as anode. Commercial grade EDM oil (specific gravity= 0.763 kg/ m^3), freezing point= 94°C) was used as dielectric fluid with lateral flushing (pressure of 0.3 kgf/cm2) system for effective flushing of machining debris from working gap region. The pulsed discharge current was applied in various steps in positive mode.

DESIGN OF EXPERIMENT

Design of Experiments (DOE) refers to planning, designing and analyzing an experiment so that valid and objective conclusions can be drawn effectively and efficiently. In performing a designed experiment, changes are made to the input variables and the corresponding changes in the output variables are observed. The input variables are called resources and the output variables are called response.

Input variables: Discharge current (Ip); Spark on time (Ton); Spark off time (Toff); Spark gap (SG)

Response Variables: Material removal rate(MRR), Surface Roughness (Ra)

TAGUCHI METHOD

Taguchi Method is developed by Dr. Genichi Taguchi, a Japanese quality management consultant. The method explores the concept of quadratic quality loss function and uses a statistical measure of performance called Signal-to-Noise (S/N) ratio. The S/N ratio takes both the mean and the variability into account. The S/N ratio is the ratio of the mean (Signal) to the standard deviation (Noise). The ratio depends on the quality characteristics of the product/process to be optimized. The standard S/N ratios generally used are as follows: - Nominal is Best (NB), Lower the Better (LB) and Higher the Better.

EXPERİMENTAL RESULTS

Table 1. Experimental results

Exp. No.	Ip (A)	Ton (µs)	Toff (µs)	SG (mm)	Time (min)	Density (gm/mm^3)	MRR (mm^3/mim)	Ra Value
1	3	40	5	0.05	5	0.00765	3.9215	2.603
2	3	50	6	0.1	5	0.00765	4.6143	3.656
3	3	60	7	0.15	5	0.00765	5.6143	4.311
4	3	70	8	0.2	5	0.00765	7.8300	5.026
5	7	40	6	0.15	5	0.00765	22.4183	5.594
6	7	50	5	0.2	5	0.00765	25.5555	4.817
7	7	60	8	0.05	5	0.00765	26.1568	3.975
8	7	70	7	0.1	5	0.00765	27.7124	3.124
9	11	40	7	0.2	5	0.00765	28.4967	5.606
10	11	50	8	0.15	5	0.00765	32.6797	4.352
11	11	60	5	0.1	5	0.00765	36.0784	5.876
12	11	70	6	0.05	5	0.00765	38.1895	5.175
13	15	40	8	0.1	5	0.00765	30.5882	6.346
14	15	50	7	0.05	5	0.00765	36.8627	6.746
15	15	60	6	0.2	5	0.00765	39.8039	5.124
16	15	70	5	0.15	5	0.00765	40.5882	5.840

GREY RELATIONAL ANALYSIS METHOD

In grey relational analysis, experimental data i.e. measured features of quality characteristics of the product are first normalized ranging from zero to one. This process is known as grey relational generation. Next, based on normalized experimental data, grey relational coefficient is calculated to represent the correlation between the desired and actual experimental data. Then overall grey relational grade is determined by averaging the grey relational coefficient corresponding to selected responses. The overall performance characteristic of the multiple response process depends on the calculated grey relational grade. This approach converts a multiple-response- process optimization problem into a single response optimization situation, with the objective function is overall grey relational grade.

Step 1: Normalization of the responses
Step 2: Checking for correlation between two quality characteristics
Step 3: Calculation of the principal component score
Step 4: Calculation of the individual grey relational grades

6.1 NORMALIZATION OF THE RESPONSES

Table 2. Normalization of the responses

Sr. No.	MRR	Surface roughness (Ra)
Ideal Sequence	1.0000	1.0000
1	0.0966	1
2	0.1137	0.712
3	0.1383	0.6038
4	0.1929	0.4653
5	0.5523	0.4653
6	0.6296	0.5404
7	0.6444	0.6548
8	0.6828	0.8332
9	0.7021	0.4643
10	0.8052	0.5981
11	0.8889	0.443
12	0.9409	0.503
13	0.7536	0.4102
14	0.9082	0.3859
15	0.9807	0.508
16	1	0.4457

6.2 CHECKING FOR CORRELATION BETWEEN TWO QUALITY CHARACTERISTICS

Table 3. Checking for correlation between two quality characteristics

Sr. No.	Correlation between responses	Pearson correlation coefficient	Comment
1	MRR and Ra	-0.5557	Both are correlated

6.3 CALCULATION OF THE PRINCIPAL COMPONENT SCORE

Table 4. Calculation of the principal component score

	Ψ_1	Ψ_2
Eigen value	1.72952	0.27048
Eigen vector	-0.707107	-0.707107
	0.707107	-0.707107
AP	0.86476	0.13524
CAP	0.86476	1.0000

6.4 CALCULATION OF THE INDIVIDUAL GREY RELATIONAL GRADES

Table 5. Calculation of the individual grey relational grades

Sr. No.	Grey relational coefficients for individual principal components	
	Ψ_1	Ψ_2
1	0.988	0.7336
2	0.8296	0.6258
3	0.7558	0.5988
4	0.6915	0.5738
5	0.6733	0.6985
6	0.7543	0.7694
7	0.8577	0.8419
8	1	1
9	0.6852	0.7676
10	0.829	0.9111
11	0.678	0.8625
12	0.7494	0.9412
13	0.6298	0.7663
14	0.6121	0.8387
15	0.759	0.9769
16	0.6908	0.9426

6.5 MAIN EFFECTS PLOT OVERALL GREY RELATIONAL GRADE

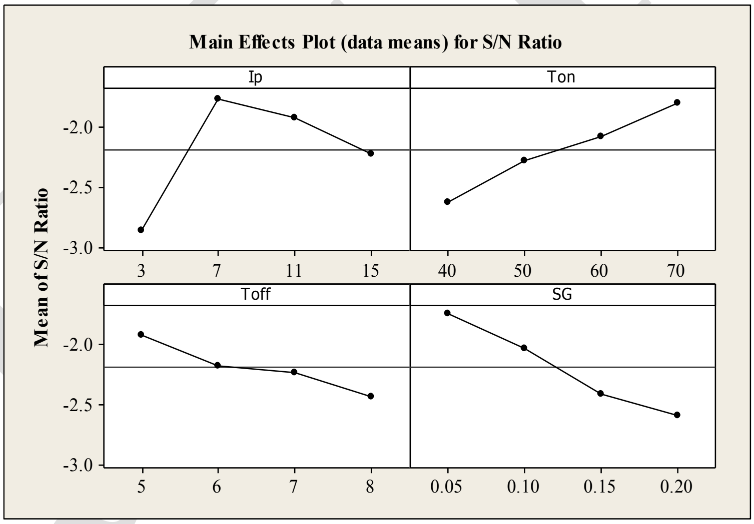

Fig. 2. S/N Ratio plot of overall grey relational grade

CONFIRMATORY EXPERIMENTS

Table 6. Results of confirmatory experiment

	Optimal setting	
	Prediction	Experiment
Level of factors	$Ip_2, Ton_4, Toff_1, SG_1$	$Ip_2, Ton_4, Toff_1, SG_1$
S/N ratio	-1.2016	-0.8949
Overall grey relational grade	0.8708	0.9021

CONCLUSION

In the present study the effect of machining parameters on MRR and surface roughness (Ra) for material AISI D3 using the cylindrical shaped copper tool with side flushing system have investigated for EDM process. Discharge current and Spark on time are the most influencing factors. MRR increases with the increase in discharge current (Ip) and Spark on time. While machining the material AISI D3, the industrialist can directly use the optimum values so that the material removal rate will be maximum and Ra value will be minimum. This will save the time required for machining, improve surface roughness save the electrical power consumption, reduce labor cost, etc

REFERANCES

1) Md. Ashikur Rahman Khan, M.M. Rahman1, K. Kadirgama1, M.A. Maleque and M. Ishak *PREDICTION OF SURFACE ROUGHNESS OF TI-6AL-4V IN ELECTRICAL DISCHARGE MACHINING: A REGRESSION MODEL Journal of Mechanical Engineering and Sciences (JMES) e-ISSN: 2231-8380; Volume 1, pp. 16-24, December 2011.*

2) Pichai Janmanee and Apiwat Muttamara, *Optimization of Electrical Discharge Machining of Composite 90WC-10Co Base on Taguchi Approach, European Journal of Scientific Research ISSN 1450-216X Vol.64 No.3 (2011), pp. 426-436 © EuroJournals Publishing, Inc. 2011*

3) S. Murugesan and K. Balamurugan, *Study on EDM of Al-15%SiC MMC using Solid and Multihole Electrodes- A Taguchi Approach,European Journal of Scientific Research ISSN 1450-216X Vol.68 No.2 (2012), pp. 161-171 © EuroJournals Publishing, Inc. 2012*

4) Prof.B. R. Jadhav and Prof.M.V.Kavade, *EXPERIMENTAL STUDY OF AI-Si ALLOY PLATE ON ELECTRIC DISCHARGE MACHINING USING TUNGSTEN ELECTRODE, International Journal of Advanced Engineering Research and Studies E-ISSN2249– 8974*

5) B. C. Routara, P. Sahoo, A. Bandyopadhyay, *APPLICATION OF RESPONSE SURFACE METHOD FOR MODELLING OF STATISTICAL ROUGHNESS PARAMETERS ON ELECTRIC DISCHARGE MACHINING, Proceedings of the International Conference on Mechanical Engineering 2007 (ICME2007) 29- 31 December 2007, Dhaka, Bangladesh ICME2007-AM-17*

6) Mohan Kumar Pradhan and Chandan Kumar Biswas, *Modelling of machining parameters for MRR in EDM using response surface methodology, Proceedings of NCMSTA'08 Conference National Conference on Mechanism Science and Technology: from Theory to Application November 13-14, 2008 National Institute of Technology, Hamirpur*