NOVATEUR PUBLICATIONS
INTERNATIONAL JOURNAL OF INNOVATIONS IN ENGINEERING RESEARCH AND TECHNOLOGY [IJIERT]
ISSN: 2394-3696
VOLUME 2, ISSUE 5, MAY-2015

PROCESS PARAMETERS OPTIMIZATION IN EDM FOR AISI D3 STEEL BY GREY RELATIONAL ANALYSIS METHOD

Sunil. B. Mishra
Department of Mechanical Engineering,
Mahatma Gandhi Mission's College of Engineering, Nanded, India

Prof. J. K. Sawale
Department of Mechanical Engineering,
Mahatma Gandhi Mission's College of Engineering, Nanded, India

ABSTRACT

In this work, optimization problem for AISI D3 material has been solved to satisfy requirements of productivity in EDM operation. Experiments on die sinking EDM have been conducted using L16 orthogonal array design using various process control parameters like discharge current (Ip), pulse on time (Ton), pulse off time (Toff) and spark gap (SG) which are varied in four different levels. Material Removal Rate (MRR) and surface roughness (Ra) has been measured for each experimental run. 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.

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 SETUP

Figure01. EDM machine

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

Exp. No.	Ip (A)	Ton (μs)	Toff (μs)	SG (mm)
1	3	40	5	0.05
2	3	50	6	0.1
3	3	60	7	0.15
4	3	70	8	0.2
5	7	40	6	0.15
6	7	50	5	0.2
7	7	60	8	0.05
8	7	70	7	0.1
9	11	40	7	0.2
10	11	50	8	0.15
11	11	60	5	0.1
12	11	70	6	0.05
13	15	40	8	0.1
14	15	50	7	0.05
15	15	60	6	0.2
16	15	70	5	0.15

Table 1. L_{16} Orthogonal Array

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

Table 2 Experimental results

GREY RELATIONAL ANALYSIS METHOD

This method gives the common optimum values for material removal rate and surface roughness.

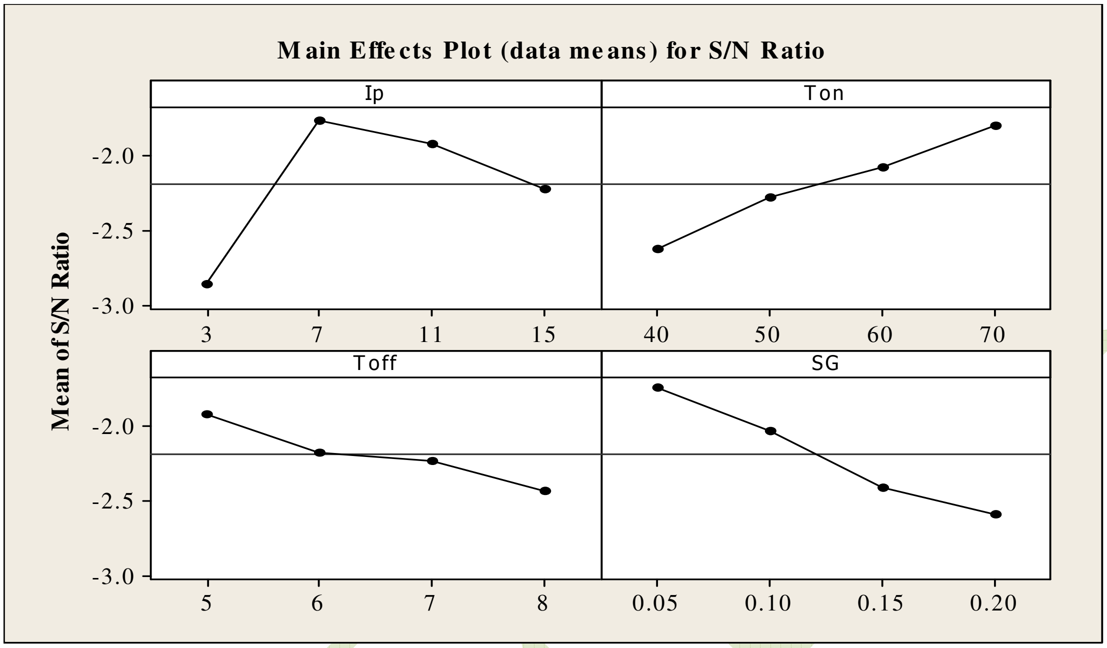

Figure02 Graph 1 S/N Ratio plot of overall grey relational grade

CONFIRMATORY EXPERIMENTS

	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

Table 3 Results of confirmatory experiment

CONCLUSIONS

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

REFERENCES

[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*

[7] Saurabh P Shah, Anand Y Joshi, *Application of Taguchi Method for Optimization of Parameters used in Electrical Discharge Machining Process, International Conference on Science, Technology and Innovation for Sustainable Well-Being (STISWB), 23-24 July 2009, Mahasarakham University, Thailand.*