IJISET - International Journal of Innovative Science, Engineering & Technology, Vol. 4 Issue 5, May 2017
ISSN (Online) 2348 – 7968 | Impact Factor (2016) – 5.264
www.ijiset.com

Investigation of Machining Parameter for EDM Hole Drilling

Hemant Pawar[1], Rahul Shelke[2]

[1] Mechanical Engineering Department, EESCOET, BAMU, Aurangabad, Maharashtra 431001, India

[2] Mechanical Engineering Department, EESCOET, BAMU, Aurangabad, Maharashtra 431001, India

Abstract

This paper investigates the Electric Discharge Machining (EDM) of SKD 11 with copper as electrode. In this research work, the effects of four parameters, namely, Current, Voltage and pulse on time were studied upon material removal rate (MRR) and electrode wear rate (EWR). The objective was to study the effect of input parameter individually on the final outcome. Response surface methodology was used to design the experiments and the performance characteristics in EDM drilling operation were studied. The experimental result indicate that current is the most significant factor. At high values of current MRR and EWR were found high.

Keywords: *EDM Drilling, Response Surface Methodology, Material removal rate, Electrode wear rate.*

1. Introduction

SKD 11 is most widely used material in automobile industry. It has drawn special attention due to its excellent properties. It is possible to machine this material with some conventional machining processes, however the high accuracy required in drilling holes cannot be possible. Among non-conventional machining processes, the EDM drilling is the only method capable of machining SKD 11 with desired accuracy.

EDM is non-conventional machining process, widely used for machining electrically conductive materials, more specifically hard materials. The EDM has many advantages, such as non-contact with the workpiece during the machining process and ability to machine any conductive material, regardless of its hardness. Hence, it does not create any vibration during machining as compared to other conventional machining and proved effective in machining holes, blind holes, deep holes, inclined holes and irregular holes; because there is no microscopic force during machining [1]. Various applications of hole can be found like fuel injection nozzles, spinneret nozzle holes, standard defects for testing material, biomedical filters and so on [2]. Creating cooling channels in turbine blades made of hard alloys is a typical application of EDM drilling [8]. M.P. Jahan et. al [2] investigated the influence of major operating parameters on the performance of micro-EDM of WC (tungsten carbide) with focus in obtaining quality micro-holes in both transistor and RC-type generators. Hung-Sung Liu et al. [3] checked the feasibility of fabricating micro-holes in the high nickel alloy using micro-EDM. G. Kibria et. al [4] investigated micro-EDM characteristics such as MRR, EWR, DOC, T and machining time (MT) during micro-machining of through holes on Ti-6Al-4V super alloy employing de-ionized water based dielectric other than conventional hydro-carbon oil i.e. kerosene. M.P. Jahan et. al [5] introduces a simplistic analytical model to evaluate the effectiveness of low frequency work piece vibration during the micro EDM drilling of deep micro-holes. Yan et al. [6] described the characteristics of micro-hole on carbide, produced by micro-EDM using copper tool electrode and investigated the effects of various machining parameters on the quality of micro-holes. B.H. Yan et al. [7] investigated the drilling of precision micro holes in borosilicate glass using micro EDM combined with micro ultrasonic vibration machining.

2. Experimental set-up for EDM drilling

During this study, series of experiments on the SKD 11 were conducted by Die sinking Rapid Drill EDM to examine the effect of input machining parameters, such as current, voltage and pulse on time on MRR and EWR. In this experimental work rotary copper hollow tubular electrode of diameter ϕ 1 mm was used under servo control. The weight of workpiece and electrode was measured by denver's weight balancing device having least count 0.1 mg.

2.1 Experimental design

The experiments has been conducted with four controllable factors namely current, voltage and pulse-on time. On the basis of preliminary experiments conducted by using one variable at a time approach the range of current, voltage and pulse-on time are selected. Machining parameters and their level chosen for this study are presented in Table 1.

IJISET - International Journal of Innovative Science, Engineering & Technology, Vol. 4 Issue 5, May 2017
ISSN (Online) 2348 – 7968 | Impact Factor (2016) – 5.264
www.ijiset.com

Table 1: Machining Parameters and their levels

Parameters	Units	Levels		
		-1	0	1
Pulse on time	µsec	17	33	50
Current	Amp	2	4	6
Voltage	V	20	30	40

3. Result and discussion

In this study the machining parameter such as current, voltage and pulse on time were studied to evaluate MRR and EWR.

3.1 Analysis of MRR

The MRR is calculated as the work piece removal weight over the machining time, which is expressed as grams per minute. Figure 1 shows that the MRR is directly proportional to the current and pulse-on time. But the MRR is lower with increasing voltage. MRR mainly depend on discharge energy, long pulse energy results in higher MRR.

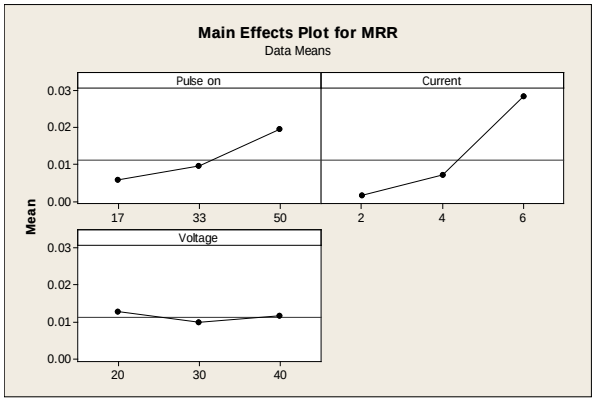

Fig 1: Main Effect Plot for MRR

Then, regression equation 1 is performed based on the results by the design of experiment software, which is shown in figure 2. Here, the MRR act as dependent variable, which has three independent variables.

MRR = 0.006861 - 0.000358 × Ton - 0.021039 × I + 0.002000 × V - 0.000005 × Ton^2 + 0.002642 × I^2 - 0.000034 × V^2 + 0.000238 × Ton x I + 0.000005 × Ton × V - 0.000044 × I ×V ……. (1)

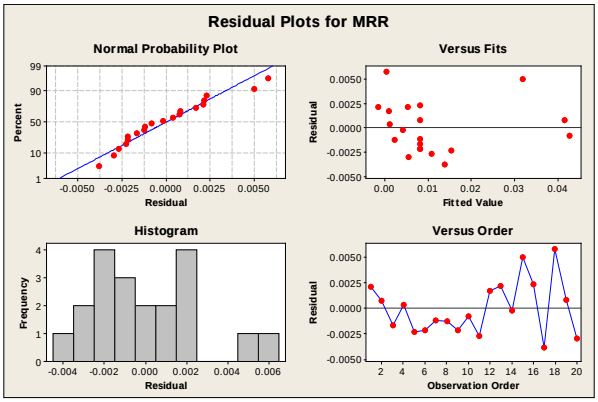

Fig 2: Residual Plot for MRR

3.1 Analysis of EWR

EWR is calculated as the ratio of tool wear weight to the machining time, which is expressed as grams per minute. Figure 3 shows that the EWR is directly proportional to the current and pulse-on time. However, the EWR decreases initially with increase in voltage then it star increasing.

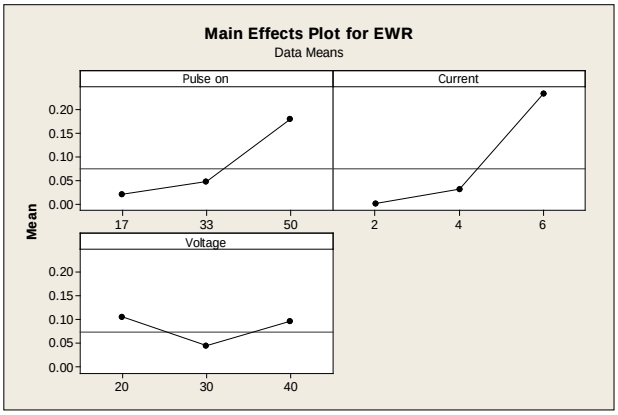

Fig 3: Main Effect Plot for EWR

Then, regression equation 2 is performed based on the results by the design of experiment software, which is shown in figure 4. Here, the EWR act as dependent variable, which has three independent variables.

EWR = 0.442693 - 0.006822 × Ton - 0.204904 × I - 0.005076 × V -0.000020 × Ton2 + 0.021000 × I2 + 0.000060 × V2 + 0.002925 × Ton × I + 0.000042 × Ton × V -0.000094 × I × V ……. (2)

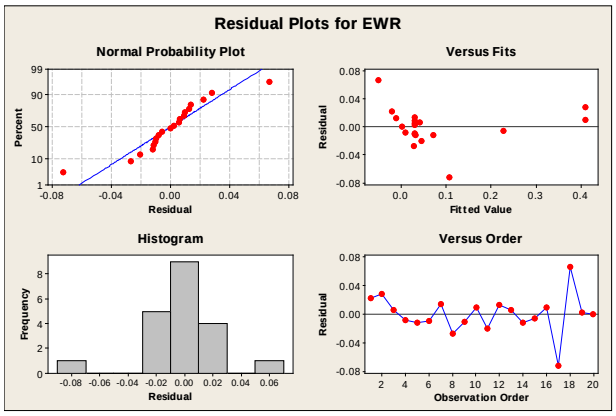

Fig 4: Residual Plot for EWR

4. Conclusions

The EDM drilling experiment were conducted on SKD 11 using copper electrode. The MRR and EWR was evaluated. It is observed from the experimental result that machining time reduces drastically with increase in discharge energy at the same time large amount of electrons are removed from electrode surface that result into simultaneous electrode wear. It was found that current is most significant factor followed by pulse on time and voltage.

Acknowledgments

The authors would like to express their deep gratitude to the Everest Educational socity's Group of Industries. Aurangabad, INDIA for providing the laboratory facilities.

References

[1] M. Shiva, M. Parivallal, M. Pradeep Kumar "investigation on the effect of process parameters in micro electrical discharge machining" Procedia material Science 5 (2014) 1829-1836

[2] M.P. Jahan, Y.S. Wong, M. Rahman, "A study on the quality micro-hole machining of tungsten carbide by micro- EDM process using transistor and RC-type pulse generator", Journal of materials process ing technology 2 0 9, pp. 1706–1716,2009.

[3] Hung-Sung Liu, Biing-Hwa Yan, Fuang-Yuan Huang, Kuan-Her Qiu, "A study on the characterization of high nickel alloy micro-holes using micro-EDM and their applicat ions ", Journal of Materials Processing Technology 169, pp. 418-426, 2005

[4] G. Kibria, B. B. Pradhan and B. Bhattacharyya, "Experimentation and analysis into micro-hole machining in EDM on ti-6al-4v alloy using boron carbide powder mixed de-ionized water", International Journal of Materials, Manufacturing and Design, Academic research Journals, pp. 17-35, 2012.

[5] M.P. Jahana, Y.S. Wongb, M. Rahmanb, "Evaluation of the effectiveness of low frequency work piece vibration in deep-hole micro-EDM drilling of tungsten carbide", Journal of Manufacturing Processes 14, pp. 343-359, 2012.

[6] B. H. Yan, F. Y. Huang, H. M. Chow and J. Y. Tsai, "Micro-hole machining of carbide by electric discharge machining," J. of Mat. Process. Technol., Vol. 87, 1999, pp. 139–145.

[7] B.H. Yan, A.C. Wang, C.Y. Huang, F.Y. Huang," Study of precision micro-holes in borosilicate glass using micro EDM combined with micro ultrasonic vibration machining" International Journal of Machine Tools and Manufacture 42 (2002) 1105–1112.

[8] Natarajan N., Suresh P., Thanigaivelan R. "Experimental investigation of effect of process parameter in the micro-EDM process" international conference on precision , MESO, MICRO and NANO engineering (COPEN-8:2013)