*International Journal of Mechanical Engineering Research (IJMER)*
*Volume 1, Issue 1, March 2020, Pages 11-14*

# Study the Effect of System Parameter Of Micro- Electrical Discharge Machining

**Richa Thakur,**
Assistant Professor
Department of Mechanical Engineering
People'S College of Research & Technology
People's Univesity Bhopal
tricha.04@gmail.com

**Dr. Pankaj Agarwal,**
Professor
Mechanical Engineering Department
Samrat Ashok Technological Institute
(Engineering College) Vidisha (M.P.) 464001
dr_pankajagarwal@rediffmail.com

## ABSTRACT
The optimum selection of machining operation parameter is very important in manufacturing processes as these ones determine surface quality and dimensional precision of the so-obtained parts. Electric discharge machining one of the most extensively used nonconventional material removal processes. The principle of electric spark is used in this to generate high electrical discharge at high currents. In recent year's high carbon steel is widely used for making micro dies, micro punches and micro gears due to its high hardness, wear resistance and high strength. This study focuses on the effect of system parameter such as voltage, capacitance and spark gap on EDM process when drilling micro holes in hardened steel. A full factorial design was used for conducting the experiments. The effect of these system parameters on the Material Removal Rate (MRR) was analyzed.

## Keywords
Hardened Steel, Micro EDM, Full factorial design, MRR

## 1. INTRODUCTION

Electrical Discharge Machining (EDM) is a thermal erosion process in which an electrically generated spark vaporizes electrically conductive material as shown in Fig. (1-1) [1].The first EDM application was carried out by Mr. and Mrs. Lazarenko in the Technical Institute of Moscow during the Second World War MICRO manufacturing process nowadays is one of interesting subject that investigated World wide since the demand and needs of very small devices are increase day by day.

Some methods to make micro and high accuracy component are already introduced by some researchers to find the best and optimum process, such as using laser cutting, 3D micro stereo lithography, micro CNC, microinjection molding, micro-electro-mechanical system (MEMS) etc. Micro-EDM is one of the most extensively used non-conventional material removal processes. Both electrode (tool) and work piece must be electrically conductive The spark occurs in a gap filled with dielectric solution between the tool and work piece. The process removes metal via electrical and thermal energy, having no mechanical contact with the work piece. The mechanical characteristics of work piece and electrode are not a concern because the electrical energy is converted into thermal energy causing melting of the material. EDM process allows the machining of hard materials and more complex shapes which cannot be processed by other conventional methods. The EDM process is normally applied to mould and die making compared to conventional machining method, the material removal rate of these machining remains rather low.

Its unique feature of using thermal energy is to machine electrically conductive parts regardless of their hardness; its distinctive advantage is in the manufacture of mould, die, automotive, aerospace and other applications. In addition, EDM does not make direct contact between the electrode and the work piece, eliminating mechanical stresses, chatter and vibration problems during machining.

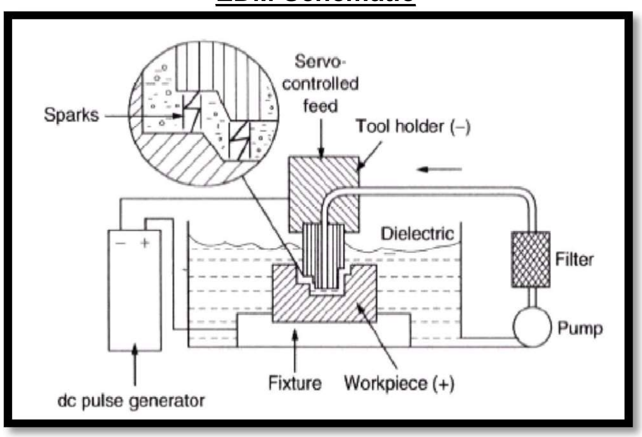
A performance study made by Jahanet.al in Tungsten carbide (WC) to achieve good quality micro holes using transistor and RC type generators. They concluded that the RC pulse generator produced better quality micro holes in WC, with rim free of burr-like recast layer, good dimensional accuracy and fine circularity. Iosub et.al.studied the effect of process parameters on MRR when machining a hybrid metal matrix composite material (Al/SiC). The study revealed that, the MRR increases with increase in current intensity and it was observed that low current intensity and pulse on time results in low electrode wear. From the literatures, it is clear that the effect of process parameters on the responses such as MRR, accuracy and others are important in improving the performance of μ-EDM.In micro EDM not much investigation has been carried to study the effect of various selected parameters on MRR when using RC pulsed power supply. Hence this research attempts to study the effect of various system parameters such as voltage, capacitance and spark gap on MRR when using a basic μ-EDM setup.

## 2. EDM MACHINING PROCESS

EDM is a non-conventional manufacturing process. In this process, the material is removed by erosive action of electric discharges occurring between a tool electrode and work piece based on the fact that no tool force is generated during machining. Both work piece and tool electrode are submerged in a solution called dielectric as shown in Fig. (2-1).

### 2.1 The Machining System

**EDM Schematic**




These components include the tool feed servo-controlled unit, which maintains a constant machining gap that ensures the occurrence of active discharges between the two electrodes. The power supply is responsible for supplying pulses at a certain voltage, current, on time, and off time. The dielectric circulation unit flushes the dielectric fluid to the inter electrode gap after being filtered from the machining debris.

## 3. EXPERIMENTAL SETUP

The influence of process parameters on hardened steel has been studied using a single axis (Z) tabletop μEDM setup. The set-up consists of various components such as machine structure; tool electrode feed system, closed loop spark gap system, dielectric fluid supply and circulation system and Resistance Capacitance (RC) power supply. Figure 1 shows the developed machine set-up. Mild steel is In this chapter the experimental work and testing procedures will be shown, it includes the specification of machine tool, power supply, mechanical properties of work piece material, electrode tools and the dielectric solution; in addition it will show the process mechanics.

**Figure 3.1: Experimental lab view setup of Micro Electric Discharge Machining**

In order to achieve the objective of this experimental study, 304L stainless steel was chosen as work material. The composition of the work material is shown in Table 1. To analyze the effect of selected parameters such as voltage, capacitance and spark gap on MRR, three levels for each parameter were chosen. A full factorial design was selected for experimentation. The Table 2 shows the selected parameters and their levels. The experiments were repeated once for better accuracy.

**Table 1: Composition of 316L stainless steels.**

| Fe | C | Cr | Ni | Mn | Si | P | S |
|---|---|---|---|---|---|---|---|
| 0.08 | 17.5 | 5-20 | 8-11 | 2 | 1 | 0.045 | 0.03 |

**Table 2: Process parameters and their levels**

| Parameters | Voltage(V) | Capacitance(c) | Spark Gap(μm) |
|---|---|---|---|
| Level 1 | 80 | 10 | 28 |
| Level 2 | 100 | 50 | 32 |
| Level 3 | 120 | 100 | 36 |

The selected three parameters have different effect on the machining performance. The MRR is calculated by dividing the volume of material removed by the actual machining time and expressed in mm3/min. The experimental results are shown in Table 3.

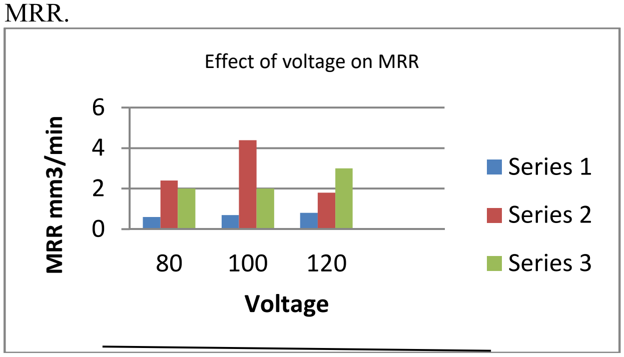
| Exp | Input parameters & values | MRR |
|---|---|---|

| No | Voltage | Capacitance | Spark gap | (mm3/min) |
|---|---|---|---|---|
| 1 | 80 | 200 | 28 | 0.636 |
| 2 | 100 | 200 | 28 | 0.7527 |
| 3 | 120 | 200 | 28 | 0.9022 |
| 4 | 80 | 300 | 32 | 0.711 |
| 5 | 100 | 300 | 32 | 0.8527 |
| 6 | 120 | 300 | 32 | 0.9655 |
| 7 | 80 | 500 | 36 | 0.7998 |
| 8 | 100 | 500 | 36 | 0.9613 |
| 9 | 120 | 500 | 36 | 1.108 |

## 4. EXPERIMENTAL RESULTS & DISCUSSION

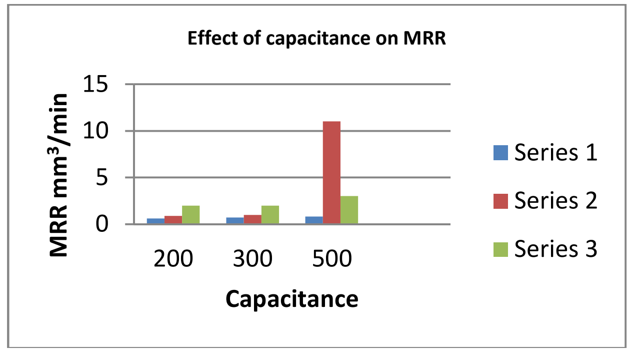
### 4.1. Effect of Voltage on MRR

In µ-EDM operations, the voltage is one of the important parameters. To study the effect of voltage, the spark gap and capacitance were kept constant. From figure 2, it is observed that, with increase in voltage, the MRR increases. This is because, the energy discharge from the electrode increases with increase in voltage. Due to increase in discharge energy, higher temperatures are generated between the electrodes. This results higher in MRR.



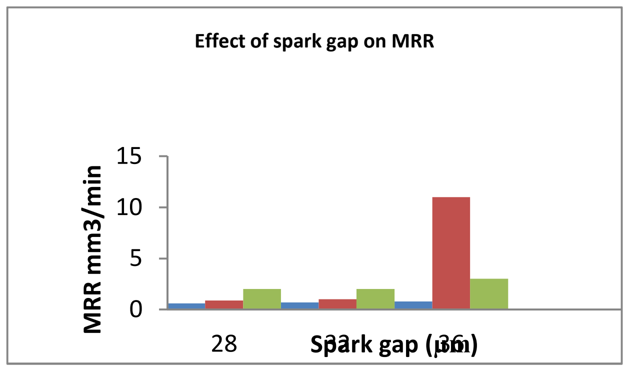

### 4.2. Effect of Capacitance on MRR

The capacitance is a more influencing parameter in µ-EDM especially when using RC circuit. To study the effect in capacitance, other two parameters such as voltage and spark gap are kept constant. From figure 3 it is observed that, with increase of capacitance the MRR also increases. This is because, the energy discharged from the capacitor increases. Therefore higher energy results in higher MRR.




### 4.3. Effect of Spark Gap on MRR

The spark gap also known as discharge gap between the electrodes (tool and work) must be maintained constant throughout the machining. To find the effect of the spark gap on MRR, current and voltage were kept constant. The effect of spark gap on MRR . With the increase in spark




gap, the MRR decreases. This is because, when the distance between electrodes increases, the discharge energy (thermal) concentration towards the work piece is less, results in lower MRR. Higher capacitance, results in higher discharge energies and so MRR increases. Also it is observed that, MRR is higher for higher capacitance and it decreases with decrease in capacitance

## 5. CONCLUSION

A full factorial design was used to conduct the experiments. The effect of three important process parameters in µEDM: voltage, capacitance and spark gap on MRR has been studied.

The following are some of the salient conclusions that could be drawn based on the studies:

1. Increase in voltage results in higher MRR.

2. Higher capacitance results in higher MRR but machining time decreases with increase in capacitance.

3. In case of spark gap, with increase in spark gap the MRR decreases.

## REFERENCES

[1] EDM Technical Manual, Poco Graphite Inc., 1993.

[2] C.J. Luis, J. Vivancos, M.A. Sebastián, Geometric roughness analysisin solid free form manufacturing processes, in: Proceedings of theAMPT'99, Ireland,1999.

[3] Geometrical Product Specifications (GPS)—Surface Texture: ProfileMethod—Terms, Definitions and Surface Texture Parameters, InternationalOrganisation for Standardisation, Geneva, 1997. ISO 4287:1997.

[4] G. Box, W. Hunter, J. Hunter, Statistics for Experimenters: An Introductionto Design, Data Analysis, and Model Building, Wiley, NewYork, 1978.

[5] D.C. Montgomery, Diseño y análisis de experimentos, Ed. Iberoamericana.

[6] V.S.R. Murti, P.K. Philip, A comparative analysis of machining characteristics
in ultrasonic assisted EDM by the response surface methodology.
**[7]**Lotfi, K., G., Electrical Discharge Machining (EDM), the AmericanUniversity in Cairo, Department of Mechanical Engineering, Vol. 202,2003.

**[8]** Ho, K., H., and Newman, S., T., State of the art electrical dischargemachining (EDM), International Journal of Machine Tools andManufacture, Vol. 43, pp. 1287-1300, 2003.

**[9]** John, E., F., Electrical discharge machining, Rockwell International,ASM Metals Handbook, Vol. 16 Machining, pp. 557-564, 1997.

**[10]** Margaret, H., C., Environmental Constituents of Electrical DischargeMachining, thesis Submitted to the Department of MechanicalEngineering, MassachuseInstitute of Technology, 2004.

**[11]**Pandey, P., C., and Shan, H., S., Modern machining processes, University of Roorkee, New Delhi, Chapter 4, pp.84-113, 1980.