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THE EFFECT OF EDM PARAMETERS ON SURFACE ROUGHNESS AND MATERIAL REMOVAL RATE

Sohan Singh[1], Pradeep Kumar Sharma[2]
E-Mail Id: sohanganechiya@gmail.com
Department of Mechanical Engineering, DKNMU, Newai, Tonk, Rajasthan (India)

Abstract-Electrical discharge machining (EDM) is a process for shaping hard metals and forming deep complex shaped holes by arc erosion in all kinds of electro-conductive materials. The objective of this project is to study the influence of operating parameters of EDM on the machining characteristics such as surface quality, material removal rate and electrode wear. The effectiveness of EDM process is evaluated in terms of the material removal rate, the relative wear ratio and the surface finish quality of the work piece produced. It is observed that copper tungsten is most suitable for use as the tool electrode in EDM. Better machining performance is obtained generally with the electrode as the cathode and the work piece as an anode. In this Project, a study was carried out on the influence of the parameters such peak current, power supply voltage, pulse on time and pulse off time.
Keywords: EDM, Electrode, Cathode, Anode, Current, Voltage

1. INTRODUCTION

In the manufacturing industries, various machining processes are adopted for removing the material from the work piece to obtain finished product. Due to demands for alloy materials having high hardness, toughness and impact in aerospace and automotive industries; it is very difficult to use conventional machining methods to remove the material from the work piece. During the conventional machining process, direct mechanical contact between the tool and the work piece takes place to remove the material, which often causes undesired changes in the properties of work piece and tool wear, due to this cost of production increases. The innovative materials such as super-alloys, composites, ceramics and many other advanced materials, which are difficult to or cannot be machined by conventional machining methods, require new manufacturing technologies. These engineering challenges facilitated the development of unconventional manufacturing processes. Mainly this project is based on various parameter's effect on surface roughness. Because now a days finishing is the main object of any product. In EDM, surface roughness and Material removal rate is opposite to each other, so to maintain both and get better performance this research is done in laboratory.

2. SURFACE ROUGHNESS

Roughness of a surface is a measure of the texture of a surface. It is counted by the vertical nonconformities of the real surface from the perfect surface. If this deviation is large, the surface is said to be rough and if they are minor, the surface is smooth. During EDM machining, the melted material is not flushed away completely and the remaining material solidifies to form discharge craters. As a result, machined surface has micro-cracks and pores caused by which results n Surface Roughness of that work-piece. Roughness measurement is completed using a portable style type profilometer, Talysurf (Taylor Hobson, Surtronic 3+). Surface roughness measuring device i.e. Profilometer or Talysurf is an electronic device that is used to calculate the surface roughness.

Prior using the device it has to be calibrated. For calibrating the device we use a standard surface which has the surface roughness of 6 micro m. The instrument has a probe and there is a very tiny tip made up of ruby. The tip should touch the work-piece machining surface when it moves up and down with respect to minute difference of voltage is amplified and the roughness is calculated. The measurement is taken during the forward motion of the stylus. Profilometer is a very delicate instrument and it should be used very carefully [8].

3. ELECTRIC DISCHARGE MACHINING

Electrical discharge machining (EDM) is one of the earliest non-traditional machining processes. EDM process is based on thermoelectric energy between the work piece and an electrode. A pulse discharge occurs in a small gap between the work piece and the electrode and removes the unwanted material from the parent metal through melting and vaporizing. The electrode and the work piece must have electrical conductivity in order to generate the spark. There are various types of products which can be produced using EDM such as dies and moulds. Parts of aerospace, automotive industry and surgical components can be finished by EDM.

The non-contact machining technique has been continuously evolving from a tool and dies making process to a micro-scale application machining alternative attracting a significant amount of research interests. In Electrical

Discharge Machining the electrode is moved downward toward the work material until the spark gap (the nearest distance between both electrodes) small enough so that the impressed voltage is great enough to ionize the dielectric. Short duration discharges (measured in microseconds) are generated in a liquid dielectric gap, which separates tool and work piece. The material in the form of debris is removed with the erosive effect of the electrical discharges from tool and work piece. EDM does not make direct contact between the electrode and the work piece where it can eliminate mechanical stresses chatter and vibration problems during machining [7].

4. EXPERIMENTAL DATA

The experiments have been conducted on Electric Discharge Machine M320+AZ50+D320 of JOEMERS" Taiwan available at Mechanical Depharusat University, Changa. A pictorial view of the machine is shown in fig. 4.1.

Fig. 4.1 EDM Machine

4.1 Power Supply Requirement

- Maximum Machining Current: 50 A.
- Total Power Input : 4.5 A
- Maximum Metal Removal Rate: 390 mm
- Best Surface Roughness: 0.25 □m Ra
- Electrode Wear Ratio : 0.2 %
- Net Weight : 180 Kg.
- Outside Dimension : 580 * 500 * 1720

4.2 Dielectric Tank

- 1. Capacity : 240 Liters
- 2. Pump : 0.5 H.P
- 3. Filter : Paper Filter

With standard accessories like paper filter, tool Box, Flushing Nozzle, Drill Chuck, Clamping Kit, Electrode holder, Leveling pads, 3-axis digital readouts and with provision for optional accessories like CNC-orbit cutting attachment / orbit cut system.

Table-4.1 Machining Parameters in EDM

Factor	Name	Units	Type	Subtype	Minimum (+1)	Maximum (-1)
A	Voltage	Volts	Numeric	Continuous	30	45
B	Current	Ampere	Numeric	Continuous	6	25
C	Pulse on	Microsecond	Numeric	Continuous	6	200
D	Pulse off	Microsecond	Numeric	Continuous	12	100

4.3 Non-electrical Parameters

- Injection flushing pressure
- Rotational of speed electrode

4.4 Electrical Parameters

- Peak current
- Polarity
- Pulse duration
- Power supply voltage
- Duty Factor

Some of the most important parameters implicated in the EDM manufacturing process are the following ones:

4.4.1 On-Time (Pulse Time or t)

The duration of time (μs) the current is allowed to flow per cycle. Material removal is directly proportional to the amount of energy applied during this on-time. This energy is really controlled by the peak current and the length of the on-time.

4.4.2 Off-Time (Pause Time or t)

It is the duration of time (μs) between the sparks (that is to say, on-time). This time allows the molten material to solidify and to be wash out of the arc gap. This parameter is to affect the speed and the stability of the cut. Thus, if the off-time is too short, it will cause sparks to be unstable.

4.4.3 Arc Gap (or Gap)

It is the distance between the electrode and the part during the process of EDM. It may be called as spark gap.

4.4.4 Duty Cycle

It is a percentage of the on-time relative to the total cycle time. This parameter is calculated by dividing the on-time by the total cycle time (on-time plus off-time). The result is multiplied by 100 for the percentage of efficiency or the so called duty cycle.

4.4.5 Intensity (I)

It points out he different levels of power that can be supplied by the generator of the EDM machine. (I) represents the mean value of the discharge current intensity.

4.4.6 Duty Factor

The ratio of pulse duration to pulse period, expressed as a percentage. When expressed as a decimal, also called as duty factor. The ratio of average pulse power to peak pulse power. Also called duty ratio.

5. EXPERIMENTAL DETAILS

- MATERIAL- AISI-D3 DIE STEEL
- ELECTRODE- Copper.
- DIE ELECTRIC FLUID: kerosene with silicon carbide powder.

A number of experiments were conducted to study the effects of the various machining parameters on EDM process. These studies have been under taken to investigate the effects of current, pulse on time and duty factor on the MRR, Surface roughness. The Inconel-718 metal is machined with the copper tool. Kerosene is the dielectric medium [3-4]. Variation of surface roughness with constant Current and Pulse on Time.

The effect of voltage on surface roughness at constant current (15.5 A), constant pulse on time (103 microseconds) and constant pulse off time (56 microseconds) is shown in fig. 5.1.

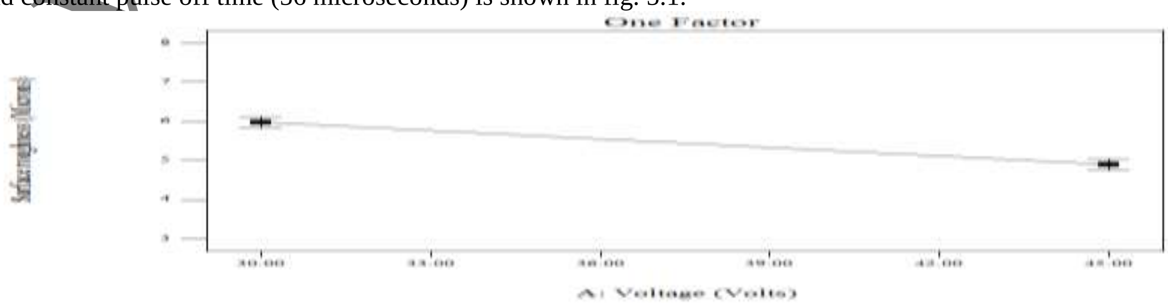

Fig. 5.1 Plot Between Roughness and Voltage at Current (15.5 A), Pulse on Time (103 microseconds) and Pulse Off Time (56 Microseconds)

The result shows that the surface roughness decreases as the voltage increases from 30 V to 45 V. With the higher voltage, the discharge time gets longer. This will lead to a wider average discharge gap. Therefore, the discharge condition becomes more stable but the number of discharge cycles decreases within a given period. Owing to this stable machining, surface accuracy becomes better and surface roughness value decreases[23].

Fig. 5.2 shows the effect of current on surface roughness at constant voltage (37.50 Volts), constant pulse on time (103 microseconds) and constant pulse off time (56 microseconds).

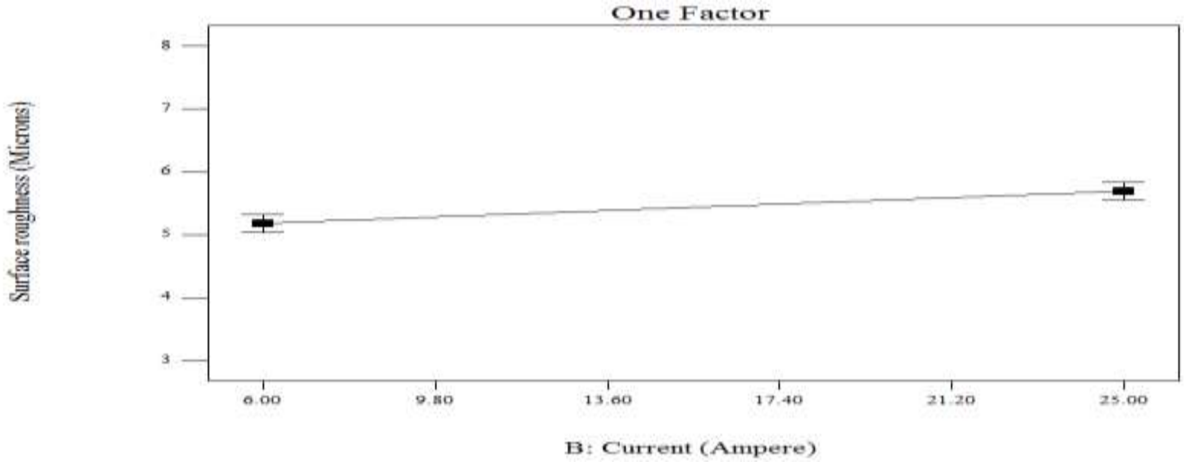

Fig. 5.2 Plot Between Current and Surface Roughness at Voltage (37.50 Volts), Pulse on Time (103 Microseconds) and Pulse Off Time (56 Microseconds)

The surface roughness increases as the current increases. The higher is the peak current, the larger is the discharge energy. This leads to increase in surface roughness.

The effect of pulse on time on surface roughness at constant voltage (37.50 Volts), constant current (15.5 A) and constant pulse off time (56 microseconds) is shown in fig. 5.3.

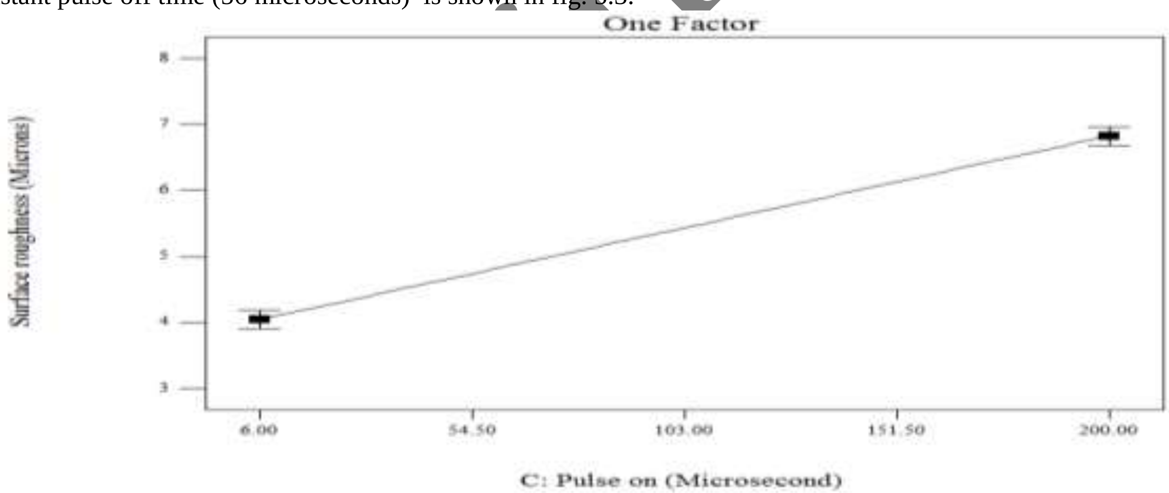

Fig. 5.3 Plot Between Pulse on and Surface Roughness at Voltage (37.50 Volts), Current (15.5 A) and Pulse Off Time (56 microseconds)

It is clear from the plot that as the pulse on time increases from 6 microseconds to 200 microseconds, the value of surface roughness also increases. The surface roughness is most affected by the amount of discharge energy which increases with increase in pulse on-time. The surface roughness depends on the size of spark crater. A shallow crater together with a larger diameter leads to a better workpiece surface roughness. To obtain a flat crater, it is important to control the electrical discharging energy at a smaller level by setting a small pulse-on time. A large discharging energy will cause violent sparks resulting in a deeper erosion crater on the surface. Accompanying the cooling process after the spilling of molten metal, residues will remain at the periphery of the crater to form a rough surface. Furthermore, greater discharge energy will produce a larger crater, causing a larger surface roughness value on the workpiece [25,26].

The Influence of pulse off time on surface roughness at constant voltage (37.50 Volts), constant current (15.5 A) and constant pulse on time (103 microseconds) is shown in figure 5. The amount of discharge energy decreases with increase in pulse off-time. Further as the discharge energy decrease, the roughness also decreases[27].

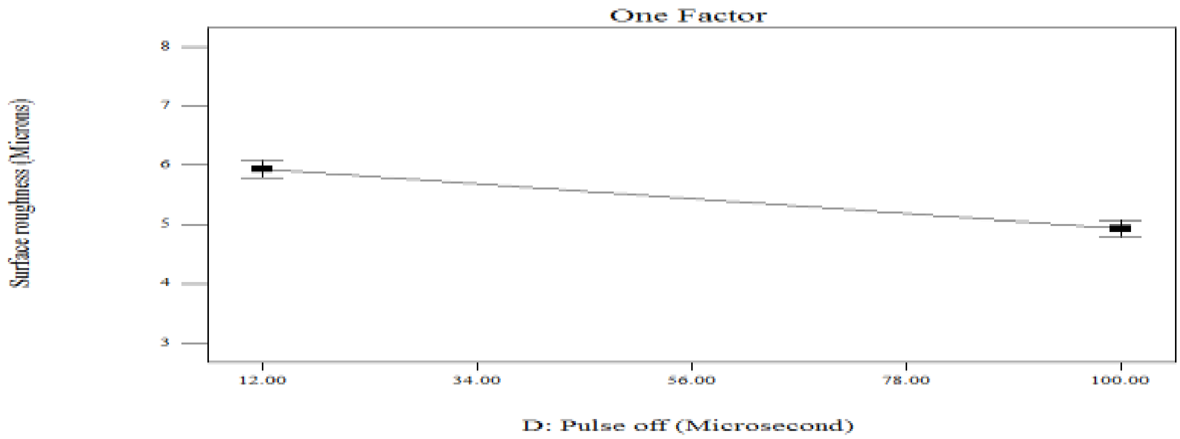

Fig. 5.4 Plot Between Pulse on and Surface Roughness at Voltage (37.50 Volts), Current (15.5 A) and Pulse on Time (103 microseconds)

6. RESULTS AND DISCUSSION

- When current increases, the MRR also increases. The higher the current, intensity of spark is increased and results in high metal removal will takes place.
- When the current is increased, surface roughness is also increased. Because due to increase in current, the spark intensity is also increases. So the MRR per minute increases. Finally the surface roughness is increase.
- When duty factor is increases, the MRR is also increases. The higher the duty factor, intensity of spark and machining time is increased and results in high metal removal will takes place.
- When the Duty factor is increased, surface roughness is also increased, because due to increase in duty factor, the spark intensity, machining time is also increases. So the MRR per minute increases. Finally the surface roughness is increase.
- When pulse on time is increases, the MRR is decreased. The higher the pulse on time, intensity of spark is decrease due expansion of plasma channel and results in less metal removal will takes place.
- When the Pulse on time is increased, surface roughness is decreased, because due to increase in pulse on time, the spark intensity is also decreases due to the expansion of plasma channel. So the MRR per minute decreases. Finally the surface roughness is decrease.
- When Voltage is increase, surface roughness is decreased

REFERENCES

[1] Liao Y.S., Huang J.T., Su H.C.,"A study on the machining- parameters optimization of wire electrical discharge machining",Journal of Material Processing and Technology, 72, 1(1), pp. 487-493, 1997

[2] Satishkumar D. et.al,"Investigation of wire electrical discharge characteristic of AI6063/SiCp composites", International journal of advance manufacture and technology, 48, 2(2), pp. 234-242, 2011.

[3] El-Taweel T.A.,"Multi-response optimization of EDM with Al-Cu-Si-tic P/M composite electrode", International Journal of Advanced Manufacturing Technology, 44(1-2), 3(3), pp.100-113, 2009.

[4] Mohan B., Rajadurai A., Satyanarayana K.G.,"Effect of sic and rotation of electrode on electric discharge machining of Al-sic composite", Journal of Materials Processing Technology, 124(3), 4(4), pp. 297-304, 2002.

[5] Lin Y., Cheng C., Su B., Hwang L.,"Machining characteristics and optimization of machining parameters of SKH 57 high- speed steel using electrical-discharge machining based on Taguchi method", Materials and Manufacturing Processes, 21(8), 5(5), pp. 922-929, 2006.

[6] P.M.George, B.K.Raghunath, L.M.Manocha, Ashish M Warrier,“EDM machining of Carbon-Carbon composite- a Taguchi approach”.

[7] Ali Ozgedik, Can Cogan,“An Experimental investigation of tool wear in electric discharge machining”, Received on 07/10/2003.

[8] K. H. Ho, S .T .Newman,“State of the art electrical discharge machining (EDM)”, International journal of Machine Tools & Manufacture 43, pp. 1287-1300, 2003.

[9] Y. S .Wong, L .C .Lim, L. c. Lee,“Effects of flushing on Electro discharge machined surface”, Journal of material processing technology, 48, pp. 299-305, 1995.