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Effect of Pulse On/Pulse Off Time On Machining Of AISI D3 Die Steel Using Copper And Brass Electrode In EDM

Harpreet Singh[1] , Amandeep Singh[2]
[1,]Department of mechanical Engg YCOE Talwandi sabbo
[2,]Department of mechanical Engg FCET Ferozepur

Abstract - *Electric discharge machining is non conventional machining process. EDM is generally used for machining for those materials which are cannot processed by conventional machining process. In this article we compared the material removal rate achieved using different tool materials. Workpiece used is AISI D3 and tool materials used copper and brass electrode with pulse on/pulse off as parameter. The electrolyte used is kerosene oil.*
Keywords - *EDM, pulse on/off, surface finish, Wear*

1. Introduction

EDM is a controlled metal removal process and it is used to remove the metal by mean of electric spark erosion (Singh et al., 2010). In this process, the removing of material from the work piece takes place by mean of series of electrical discharge produced by electric pulse generator at short interval between electrode and work piece in the presence of dielectric fluid (Kiyak et al., 2007). In EDM process with the increase in current and diameter of electrode the tool wear rate and material removal get increased (Kiyak et al., 2007). The EDM process can be compared with the conventional cutting process, except that in this case, a suitable shaped tool electrode, with a precision controlled feed movement is employed in place of cutting tool, and the cutting energy is provided by means of short duration electrical pulses (Pandey and Shan, 2004). EDM has found ready application in the machining of hard metals or alloys which cannot be machined easily by conventional methods. Thus it plays a major role in the machining of dies, tools, etc made of tungsten carbide or hard steels. Alloys used in aeronautics industry, for example, hastalloy, nimoic, etc, could also be machined conveniently by this process. This process has added advantage of being capable of machining complicated component (Luis et al., 2005).

1.1. Mechanism of EDM Process

The electro-sparking method of metal working involves an electric erosion effect which connotes the breakdown of electrode material accompanying any form of electric discharge. Fig 1 showing EDM process. A necessary condition for producing a discharge is the ionization of the dielectric, that is, spilitting up of its molecules into ions and electrons. Consider the case of a discharge between two electrodes (tool cathode and work anode) through a gaseous or liquid medium. As soon as suitable voltage is applied across the electrodes, the potential intensity of the electric field between them builds up, until at some predetermined value, the individual electrons break loose from the surface of the cathode and are impelled towards the anode under the influence of field forces. While moving in the inter-electrode space, the electrons collide with the neutral molecules at the dielectric, detaching electrons from them and causing ionization. At some time or the other, the ionization becomes such that a narrow channel of continuous conductivity is formed. When this happens, there is a considerable flow of electrons along the channel to the anode, resulting in a momentary current impulse or discharge. The liberation of energy accompanying the discharge leads to the generation of extremely high temperature, between 8000^{o}c and 12000^{o}c causing fusion or partial vapourization of the metal and the dielectric fluid at the point of discharge. The metal in the form of liquid drops is dispersed into space surrounding the electrodes by the explosive pressure of the gaseous products in the discharge. This results in the formation of a tiny crater at the point of discharge in the work piece (Pandey and Shan, 2004).

1.2 Pulse On-Time & Off-Time

Pulse on time is defined as the time during which the machining is performed. The machining process becomes faster after increasing the pulse on time. By increasing the pulse on time the material removal rate increase and poor surface finish on the material surface (Lee et al., 2003).Pulse Off-time:-It is the time during which re-ionization of the dielectric take place. An insufficient off time can lead to erratic cycling and retraction of the advancing servo thereby slowing down the operation cycle (Kumar et al., 2007).

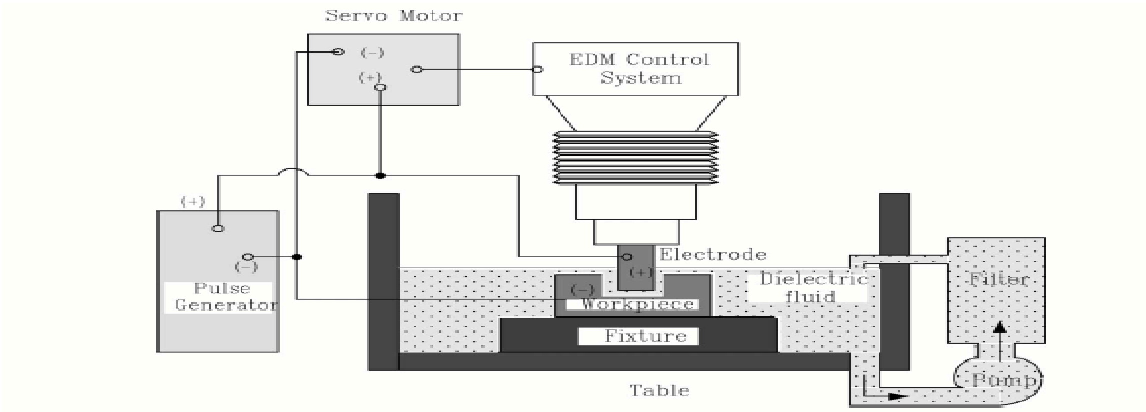

Fig1..Mechanism of EDM process

2 Experimental Detail

2.1 Work piece material

AISI D3 die steel was used as work piece material. Sample of size 25mm×18mm×6mm were prepared by using wire EDM. The prepare sample were heat treated to improve their hardness. After heat treatment the hardness of work piece material was 58HRc. Table 2.1 shows the chemical composition of work piece material.

Table 2.1 - The chemical composition of AISI D3 die steel

C%	Si%	Mn%	Cr%	Cu%
1.88	0.5	0.38	11.5	0.16

2.2 Tool Preparation

The electrodes having the size of 16 mm diameter and 55 mm length were prepared out of the rods of Copper and Brass for performing the experiments. After preparing the required size the face of all the electrodes was polished so as to get good surface finish using different emery papers ranges from 220 to 2000 grit size following general metallographic procedure. Table 2.2 and Table2.3 show the chemical composition of copper and brass electrode.

Table 2.2 - The chemical composition of the copper electrode

Cu%	Zn%	Al%	Bi%	Pb%
99.8	0.057	0.15	0.0011	0.0008

Table 2.3 - The chemical composition of the brass electrode

Cu%	Zn%	Pb%	Sn%	Fe%	Ni%
58.8	37.2	2.7	0.5	0.9	0.16

2.3 Dielectric used

The commonly available kerosene oil is used as dielectric fluid for all the experiments. The properties of the kerosene oil are shown in the Table no. 2.4.

Table 2.4 - Properties of kerosene oil

Surface Tension N/M	Density Kg / M³	Dynamic Viscosity
0.028	820	2400

2.4 Machining process

Machining was performed on the electronics CNC EDM machineEach experiment was performed for fix time period of 20 min using the input process parameters as PULSE ON/ PULSE OFF two different types of electrodes i.e. Cu, Br are used**.** Material removal rate was calculated by calculating the difference between the final weight (after machining) of the sample and initial weight (before machining) of the sample. Each experiment was repeated three times and mean of the material removal was taken. The weighting was done on the precision balance CONTECH BC- series machine, having weight range of 0 to 125 gm with readability of 0.1 mg. The MMR is calculated according to the formula: -

$$MRR(mm^3/min) = \frac{\text{Workpiece weight loss(gm)}}{\text{Density}(gm/mm^3)\times\text{Machining time(min)}}$$

3. Result And Disscussion

3.1 Influence of pulse-on time on MRR

The Fig. 3.1 shows that maximum MRR is obtained by using a copper electrode for value of pulse on =50µs. With the increase in pulse on-time from 50 -100 µs, the MRR decreased. This may be due to reason that with high pulse on time i.e. 100µs more material gets melted at the tool work piece interface, which require proper flushing time but as the value of pulse off time is too shot (15µs), so there is not enough time for the flushing to clear the debris from the inter-electrode gap between the tool and work piece, so arcing take place which result in decreasing the MRR (Saha et al., 2009).

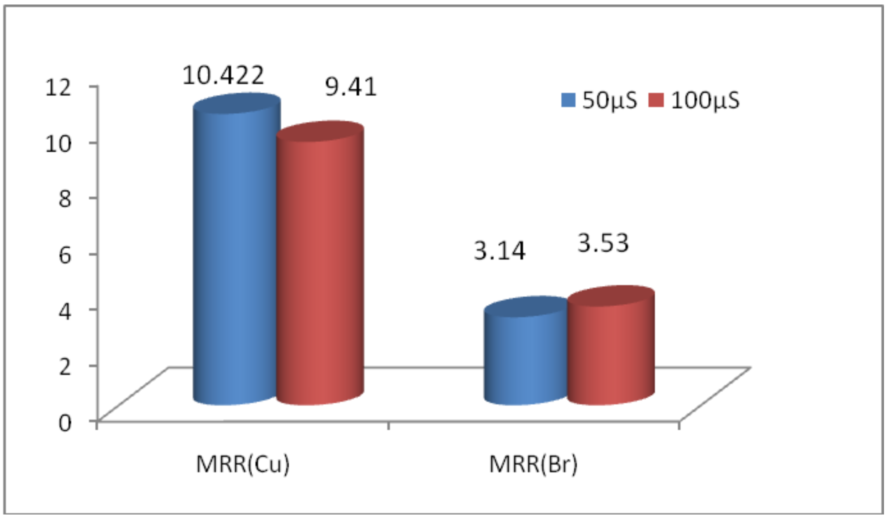

Fig. 3.1- Influence of pulse on time on MRR

In case of brass electrode the MRR increases with the increase in the pulse on-time from 50-100µs. This may be reason that as the MRR of brass electrode is less as compare to copper electrode so less debris are produced which can be easily flushed away in pulse off time of 50µs.

3.2 Influence of pulse-off time on MRR

Fig 3.2 shows that with the increase in pulse off time from 15µs to 20µs the MRR increased for both copper and brass electrodes .

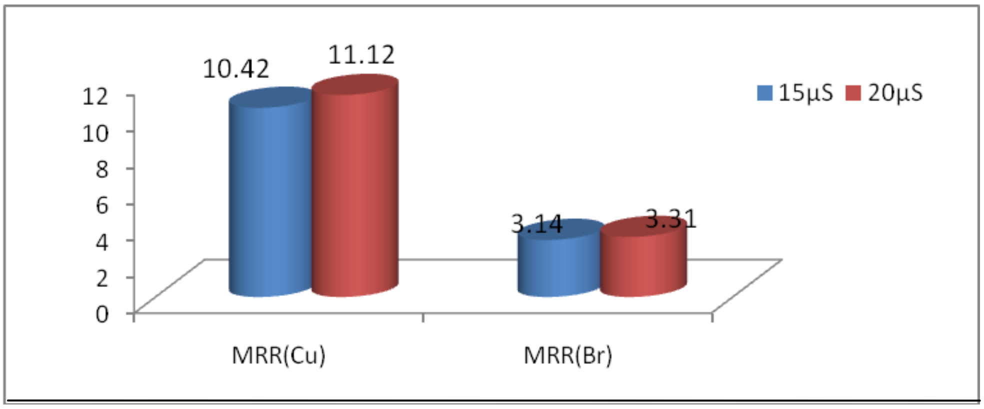

Fig. 3.2- Influence of pulse-off time on MRR

The pulse off time is the time require for the reestablishment of insulation in the working gap or deionisation of dielectric at the end of each discharge duration (Kumar et al., 2007). At short pulse off time (15µs) MRR is less due to the fact that with short pulse off time the probability of arcing is very high, because the dielectric in the gap between the work piece and electrode cannot be flushed away properly and the debris particles still remain in discharge gap and this results in arcing, due to which MRR decreases. With the increase in pulse-off time, better flushing of debris take place from the inter-electrode gap, resulting in increase in MRR (Saha et al., 2009). This result of increase in MRR with increase in pulse off is in agreement with the work done by Kumar (2007) and Choudhary (2007).

4. Conclusion

- Material removal rate is increased with increase in pulse off time
- material removal rate is decreased with increase in pulse on time in case of brass electrode and decrease in
- cooper electrode

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