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Study on Electrical Discharge Machining and Effect of its Parameters

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ABSTRACT

The Electrical Discharge Machining (EDM) is one of the most common and most accepted non-traditional machining processes used in tooling industries. EDM is an important manufacturing method developed in 1940's. The forming tools to produce plastic molding die casting, forging dies etc. It is an electro-thermal process and is based on eroding effect of an electrical spark on both electrode and work piece. It is a thermal erosion process where metal removal takes place by series of recurring electrical discharges between cutting tool acting as an electrode and a conductive work piece in the presence of a dielectric fluid. The dielectric fluid will be flooded in a small gap of about 0.01mm to 0.5mm. This discharge occurs in voltage gap between the electrode and work piece. Currently, non-traditional process possess virtually unlimited capabilities except for volumetric material removal rates, for which great advances here been made in past few years to increase the cost effectiveness of operations also increase. EDM is employed widely for making tools, dies and other precision parts.

Keywords *- EDM, Machining process, study of machining, erosion, MRR.*

1. INTRODUCTION

Electro Discharge Machining is an electro thermal non-traditional machining process, where electrical energy is used to generate electrical spark and material removal mainly occurs due to thermal energy of the spark. The new concept of manufacturing uses non-conventional energy sources like sound, light, mechanical, chemical, electrical, electrons and ions. The growth of industrial and manufacturing sector in the development of harder and difficult to machine material which find the application in aerospace, nuclear engineering and other industries. EDM has been replacing drilling, milling, grinding and other traditional machining operations and is now a well-established machining option in many manufacturing industries throughout the world.

2. WORKING PRINCIPAL OF EDM

In this process the metal is removed from the work piece due to erosion cause by rapidly recurring spark discharge between the tool and work piece. The figure 1 shows the mechanical set up and electrical circuit for electro discharge machining. A thin gap of 0.01 to 0.5mm is maintained between tool and work piece by a servo system, both tool and work piece are submerged in a dialectical fluid. The discharge fluid may be kerosene/EDM oil/ demonized water is very of liquid electrical.

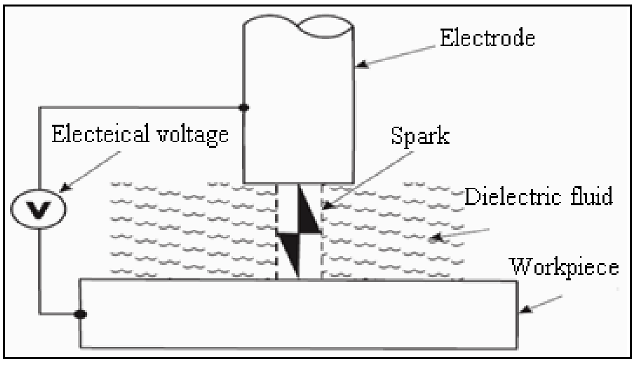

Fig 1: General Working Principal of EDM

3. METHODOLOGY

Concept of single variable at a time approach used to find out the effect of input parameters on the machining parameters namely MRR, SR. A series of experiments were conducted to study the effects of various machining parameters of EDM. In each experiment, one input variable was varied while keeping all other input parameter at fixed value. Studies have been undertaken to observe the effect of selected parameters namely discharge current, pulse on time, pulse off time, feed, servo voltage o MRR and SR.

4. IMPORTANT PARAMETER IN EDM

On-time or pulse time: It is the duration of time (μs) for which the current is allowed to flow per cycle. Material removal is directly proportional to the amount of energy applied during this on-time.

Off-time Or Pause time: It is the duration of time between the sparks. This time allows the molten material to solidify and to be wash out of the arc gap.

Spark Gap: It is the distance between the electrode and the work piece during the process of EDM. It may be called as the Arc gap.

Duty Cycle: It is the percentage of on-time relative to 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.

Intensity: It points out the different levels of power that can be supplied by the generator of the EDM machine.

Voltage (V): It is a potential that can be measure by volt it is also effect to the material removal rate and allowed to per cycle.

Effect of Various Parameters on Material removal Rate (MRR) and Speed rate (SR)

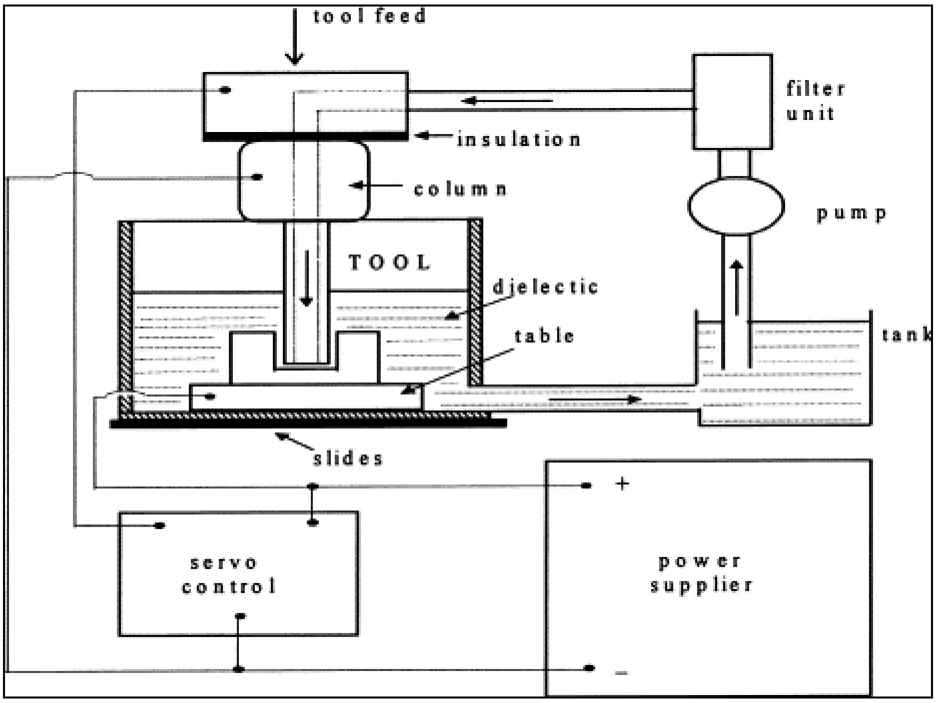

Fig 2: Schematic Representation of EDM Process.

Effect of peak current: To investigate the effect of peak current on MRR and SR, pulse-on time is varied while keeping other parameters like pulse-off time, servo voltage and feed rate constant. At low pulse duration, the MRR is low and nearly constant as low discharge energy is produced between the working gap due to insufficient heating of work-piece and low pulse duration. At high pulse duration, MRR increases with increase in peak current because of the sufficient availability of discharge energy and heating of the work-piece material. The small increase in cutting speed at high value of peak current and pulse duration is related to inferior discharge due to insufficient cooling of the work material. The surface roughness is function of two parameters, peak current and pulse-on time, both of which are function of power supply. A rough surface is produced at high peak current and/or pulse-on time. The reverse is also true. A finer surface texture is produced at low value of peak current and/or pulse duration. This is due to pulse energy per discharge is can be expressed as follows: E= ut.it dt Where, ut is the discharge duration, "it" is the discharge current and E is the pulse energy per discharge. Since the discharge voltage "ut" stays constant during the discharge pulse duration and discharge current. Thus from above formula of discharge energy we can say at low value of discharge current and/or pulse duration discharge energy will be low and at high value discharge energy will be high. But higher discharge energy will worsen the surface roughness because of increase in diameter and depth of the discharge.

Effect on time of pulse: To observe the effect of pulse-on time on MRR and SR value of peak current is varied while keeping the other parameter like pulse-off time, servo voltage. The MRR increases with increase in pulse duration at all value of peak current. The MRR is a function of pulse duration but at low value of peak current, the MRR is low due to the insufficient heating of the material and also after pulse duration, the MRR increases less because of insufficient clearing of debris from the gap due to insufficient pulse interval. Surface roughness increases with increase in pulse duration at different value of peak current but it is observed that surface roughness at low value of pulse duration and high value of peak current is less than the at high value of pulse duration and low value of peak current. This is due to low pulse duration materials remove mainly by gasifying and forms craters with ejecting morphology due to high value of peak current and heat flux in the ionized channel, which causes the temperature of the work-piece to be raised or to be easily exceed the boiling point. On the other hand long pulse duration removes material mainly by melting and forms craters with melting morphology due to low value of peak current and heat flux in the ionized channel, which prevents the temperature of the work-piece from reaching a high value.

Effect of pulse-off time: The MRR decreases when pulse-off time is increased as with long pulse-off time the dielectric fluid produces the cooling effect on electrode and work material and hence decreases the cutting speed. The surface roughness changed little even though the pulse-off time changed corresponding to a small value of pulse-on time. Mainly surface roughness improves with increase in pulse-off time. The surface roughness is high at low value of pulse-off time, this is due to with a too short pulse-off time there is not enough time to clear the melted small particles from the gap between the tool electrode and work-piece and also not enough time for deionization of the dielectric. Arcing occurs and the surface becomes rougher. It is observed that surface roughness first decreases with increase in pulse-off time and then increases with increase in pulse-off time. This is because more energy is required to establish the plasma channel and there-for there is higher electrode wear and higher surface toughness.

Effect of servo voltage: The effect of servo voltage on MRR and Surface roughness is observed by varying pulse duration while keeping other variable like pulse-off time, servo voltage. The MRR increases with increase in servo voltage and then it starts to decrease. This is due to increase in servo voltage result in higher discharge energy per spark because of large ionization of dielectric between working gap. Consequently, the MRR increases. However, a too high voltage result in high discharge energy per spark which causes unfavorable break down of dielectric and large amount of debris between the working gap which unable the material removal rate increases. At high value of pulse duration the surface roughness continuously decrease with increase in servo voltage. This is due to because at low pulse duration the discharge energy is low so melted particles cannot flow out of the machining zone and impinge on the work-piece material and surface roughness increase but with increase in more servo voltage more energy is produced which leads to uniform melting and melted particles flushed out between the working gap.

Effect of feed rate: The MRR increases less or remains nearly constant with increase in feed rate. The maximum material removal rate is obtained at feed rate of 7m/min. The MRR increases with increase in feed rate because there is less dissipation to the surrounding and hence more heat generated at spark gap, leading to higher material removal rate. For further increase in feed rate the cutting speed decrease due to the un-flushed debris between the working gap or unwanted melted particles between the working gap which form an electrically conductive path between the tool electrode and work-piece, causing unwanted spark between the tool electrode and work-piece. Thus only a portion of energy is used in work material removal which reduces the cutting speed. This is in agreement with work carried out by others. Surface roughness decreases with increase in feed at different value of pulse on time. With increase in feed rate area of work-piece electrode is small in comparison with the electrode and most heat is generated on the work-piece electrode. So that uniform melting of the work-piece and vaporized or melted material flush away by the dielectric fluid sufficiently. As a result finish surface is produced by the machining which is in agreement with the work carried out by the others8. The present study experimentally is calculated by the distribution of input discharge energy of electric discharge machining, using heat transfer equations.

5. Conclusion

When current increases, the MRR also increases. The higher the current, intensity of spark is increased and results in high metal removal rate. When the current is increased, surface roughness is also increased. When pulse-on-time increases, the MRR is decreased. The higher the pulse-on-time, intensity of spark decreases due to expansion of plasma channel and results in less metal removal. When Pulse-on-time is increased, surface roughness is decreased. With increase in pulse-off time, the MRR increases as with long pulse off time the dielectric fluid produces the cooling effect on electrode and work material, decreasing the cutting speed. Surface Roughness improves with increase in pulse-off time. The MRR first increase with increase in servo voltage and then starts to decrease. At low value of pulse duration, the SR increases with increase in servo voltage up to 30 v and then decreases with increase in servo voltage while at high value of pulse duration SR decreases continuously with increase in servo voltage. The MRR first increases with increase in feed rate and then decreases with further increase in feed rate. The SR decreases with increase in feed rate.

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