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Effect of Different Process Parameters on Over Cut in Optimizing of Electrical Discharge Machining (EDM) Process

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Abstract

Electric Discharge Machining (EDM) is a thermo-electric and non-traditional machining process in which material removal takes place through the process of controlled spark generation between a pair of electrodes. These electrodes are submerged in a dielectric medium. This process is capable to machining the difficult heat treated tool steels such as composites. For making EDM economic and effective there is need to study and control the process parameters like peak current, gap voltage, pulse on time, polarity, current density, dielectric medium, shape and size of electrode etc.

In this Research Work it has been try to explain the effect of various process parameters of EDM on its performance to measures Over Cut. There had used hardened medium carbon steel as work material.

Keywords- EDM, Over Cut, Fluid.

1.Introduction

Electrical Discharge Machining (EDM) is a process which is widely used to machine electrically conductive materials. EDM is a thermo-electric process in which tool wear is related to the melting point of the materials. It is one of the most popular non-traditional machining process which is used today in the industry. EDM is commonly used in mould and die making industry and in manufacturing automotive and aerospace components. Since there is no mechanical contact between the tool and the work piece, thin components can be machined without any risk of damage. EDM has achieved a status of being nearly indispensable in the industry because of its ability to machine any electrically conductive material irrespective of its mechanical strength.

2.Principle of EDM

In this process the metal removes from the work piece due to erosion caused by rapidly recurring spark discharge taking place between the tool and work piece.

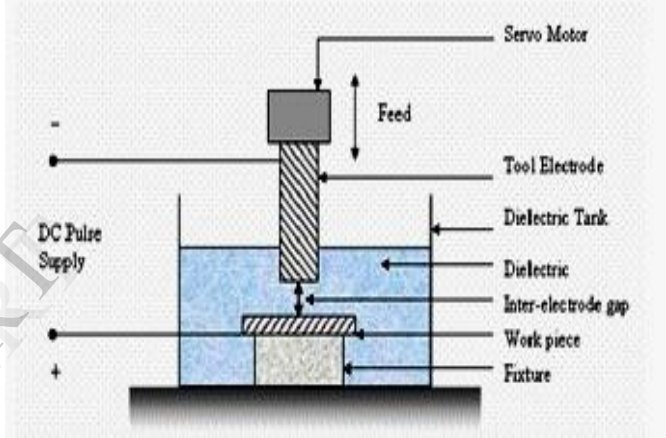

Figure 1(a) Servo system of EDM

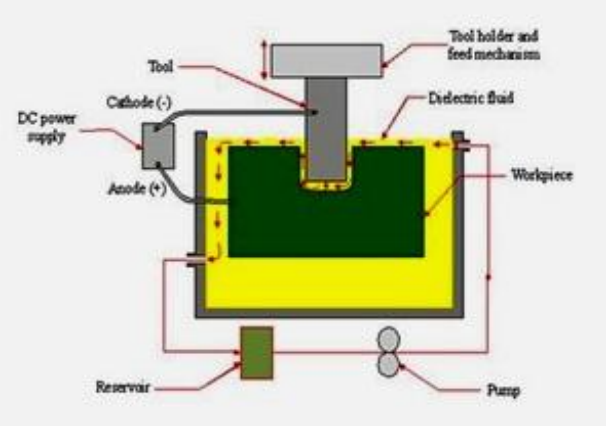

Figure 1(b) Machining principle of EDM

A thin gap about 0.025 mm to 0.050 mm is maintained between the tool and work piece by a servo system shown in fig. 1(a) and 1(b) Both tool and work piece are submerged in a dielectric

fluid Kerosene/EDM oil are very common type of liquid dielectric. The tool is made cathode and work piece is anode. When the voltage across the gap becomes sufficiently high it discharges through the gap in the form of the spark in interval of from 15 of micro seconds. And positive ions and electrons are accelerated, producing a discharge channel that becomes conductive. It is just at this point when the spark jumps causing collisions between ions and electrons and creating a channel of plasma. A sudden drop of the electric resistance of the previous channel allows that current density reaches very high values producing an increase of ionization and the creation of a powerful magnetic field. The moment spark occurs sufficiently pressure developed between work and tool as a result of which a very high temperature is reached and at such high pressure and temperature that some metal is melted and eroded. Such localized extreme rise in temperature leads to material removal. Material removal takes place due to instant vaporization of the material as well as due to melting.

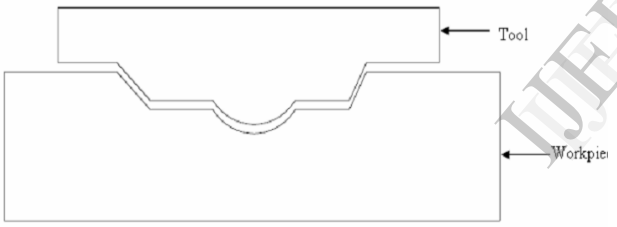

Figure 1(c) Tool shape and corresponding cavity formed on work piece after operation

3. Experimental setup

For this experiment the whole work can be done by Electric Discharge Machine, Fig.2 ,model ELECTRONICA- ELECTRAPULS PS 50ZNC (die-sinking type) with servo-head (constant gap) and positive polarity for electrode was used to conduct the experiments. Commercial grade EDM oil (specific gravity= 0.763) was used as dielectric fluid. Experiments were conducted with positive polarity of electrode. The pulsed discharge current was applied in various steps in positive mode.

Figure 2 Experimental setup of Electric Discharge Machining (EDM).

The EDM consists of following major parts:

1. Dielectric reservoir, pump and circulation system.
2. Power generator and control unit.
3. Working tank with work holding device.
4. X-Y table accommodating the working table.
5. The tool holder.
6. The servo system to feed the tool.

3.1 Selection of tool material

For this experiment copper has been selected as the tool material. The reasons for selecting the copper as a tool material are as follows:

1 .High electrical conductivity
2 .Sufficiently high melting point
3. Easily available

3.2 Selection of work piece material

For this experiment medium carbon steel has been selected as a work piece material due to following reasons:

1. Widely used in industries
2. Easily available

3.3 Selection of process parameters

There are many process parameters in EDM like peak current, gap voltage, pulse on time, pulse off time, current density etc. but here, peak current pulse on time and pulse off time have been taken for the experiment because other

parameters affect the performance measures most significantly. This has been found by conducting the trial runs and from the literature survey.

3.4 Selection of range of process parameters

1. Peak Current (Ip): The experiment has been conducted at 3A because at the higher value of Ip there was more chances of arcing and at the lower value of the Ip the material removal rate was very low thus the time taken for machining of a single work piece was very long.

2. Pulse on time (Ton): The experiment has been conducted at 50µs and 300µs because at the higher value of Ton, more energy supplied for machining which may lead excessive heating of machining zone which may cause of arcing and at the lower value of the Ton, less energy supplied for machining which may lead more time taken for machining.

3. Gap Voltage (Vg): It is a potential difference between tool and work piece, when this gap voltage reaches a sufficient value the discharge takes place it also affect the performance measures of EDM, it measured by volt.

3.5 Determination of Over Cut (OC)

During the process of Machining cavity produced are always larger than the electrode half of this difference size of electrode and cavity is called Over Cut (OC). It becomes important when close tolerance components are required to be produced for space application and also in tools, dies and moulds for press work (Singh and Maheshwari [7]). OC is expressed as half of the difference of cavity size produced after machining and tool size. The size of the cavity formed was measured with help of digital vernier calipers having least count of 0.02 mm. Following equation was used for calculating the Over Cut.

$$OC = \frac{D_{jt} - D_t}{2}$$

Where,

Djt = Cavity size produced in the work piece.

Dt = Tool size

4.Experimental procedure

Using copper tool and medium carbon steel as work piece. Tool was very fine of diameters 1mm, 1.5 mm and 2.05mm respectively. Current was taken as 3Amp and rest parameters same as for other experiments which will be given in observation table 1.

5. Calculation

For the efficient utilization of EDM there is need to optimize the machine by optimizing the process parameters which may be individual optimized parameter or set of optimized parameters. In this Research Work the aim was to optimize the set of process parameters. In the optimization of process parameters, the third set gave the maximum Over Cut (O C) as shown in table 1 given below.

Results and discussion

In this experiment three set of experiments have being conducted according to the design of experiment table. The Over Cut (OC) have been calculated from the data obtained by conducting the experiment. The values are shown in the table 1.

Table 1: Over Cut (O C) Calculation from the data given in observation table

Set	Run	Ip(A)	Ton(µs)	Vg(v)	Weight loss(gm)	Average
1	I	3	300	50	0.030	0.045
	II	3	300	50	0.045	
	III	3	300	50	0.060	
2	I	3	300	75	0.025	0.055
	II	3	300	75	0.055	
	III	3	300	75	0.085	
3	I	3	50	75	0.049	0.069
	II	3	50	75	0.069	
	III	3	50	75	0.089	

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Biographical sketch

My name is shivendra Tiwari and my Date of Birth is 21/02/1982. I have passed my three years Diploma course in Mech. Engg. (production) from Chandauli Polytechnic, Chandauli conducted by Board of Technical Education (Lucknow) U.P. and after completion of this course I have doing B.E. in Mech. Engg. From Vinayaka Missions University, salem, Tamilnadu. At present time, I am pursuing M.Tech in Mech. Engg..