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Optimization of Electrical Discharge Machining (EDM) with Respect to Tool Wear Rate

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***Abstract*- Electric Discharge Machining (EDM) is a thermo-electric and non-traditional machining process in which tool wear is affected by the precipitation of carbon from the hydrocarbon dielectric on the electrode surface during sparking. These electrodes are submerged in a dielectric medium. It is capable of machining the difficult-to-machine such as heat treated tool steels, 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 various parameters which affect the tool wear rate is identified. Copper is used as tool material.**

Keywords- EDM, Tool Wear, Fluid.

I. 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.

II. 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.

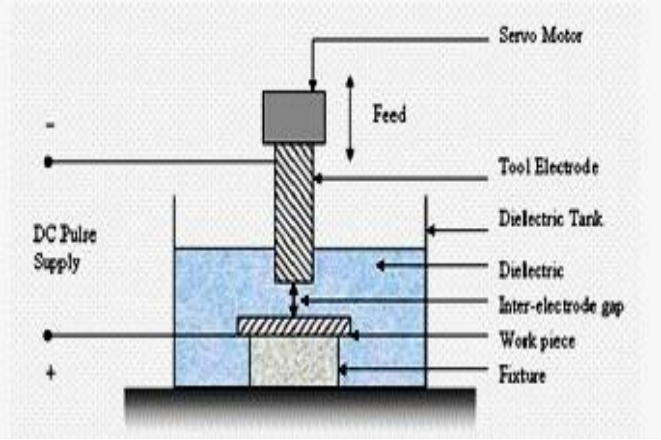

Figure 1(a) Servo system of EDM

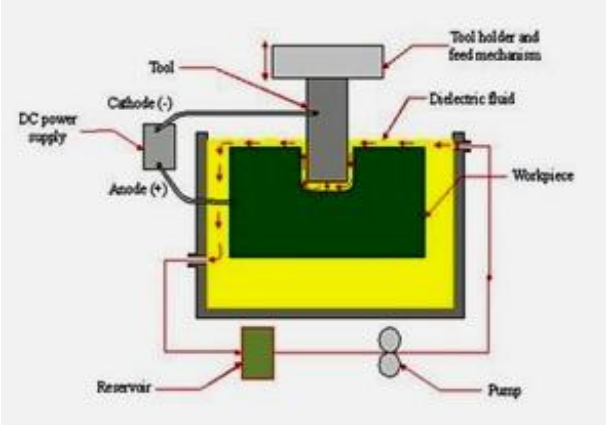

Figure 1(b) Machining principle of EDM

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.

III. EXPERIMENTAL SET UP

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.

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

Selection of work piece material

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

1. Widely used in industries
2. Easily available

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.

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.

Evaluation of Tool Wear Rate (TWR)

TWR is expressed as the ratio of the difference of weight of the tool before and after machining to the machining time and density of the material. That can be explain this equations

$$TWR = W_{tb} – W_{ta} / (t \times \rho)$$

Whereas

W_{tb} = Weight of the tool before machining.

W_{ta} = Weight of the tool after machining.

t = Machining time,

ρ = Density of copper = 8.92 gm/cm^3

W_{tb} - W_{ta} = Weight Loss

IV. EXPERIMENTAL PROCEDURE

Using copper tool and mild 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

V. 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 paper the aim was to optimize the set of process parameters. In the optimization of process parameters, the third set gave the maximum tool wear rate as shown in table 1 given below.

Table 1**:** MRR 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	0.0031	0.0050
	II	3	300	50	0.0010	
	III	3	300	50	0.0009	
2	I	3	300	75	0.0029	0.0124
	II	3	300	75	0.0054	
	III	3	300	75	0.0041	
3	I	3	50	75	0.0037	0.0173
	II	3	50	75	0.0060	
	III	3	50	75	0.0076	

VI. RESULT AND DISCUSSION

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

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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..