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Experimental Study of Electrode Wear in Die-Sinking EDM using Cylindrical Copper Electrode

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***Abstract*: - EDM (Electrical Discharge Machining) is a modern machining method for manufacturing, complex hard material parts which are extremely difficult to machine by conventional machining process. There are various type of products which can be produced by using die-sinking EDM, such as dies, moulds. Parts of aerospace, automobile industry and surgical components can be finished machined by EDM. In recent year numbers of researchers have explored a number of ways to improve EDM efficiency. The optimum selection of manufacturing condition is very important in manufacturing processes as there determine surface quality, dimensional accuracy of the obtained parts. This experimental study is mainly focused on electrode wear in cylindrical copper electrode which is one of the important parameter. In this experimental work, a study has been made to optimize the response parameter (electrode wear) of EDM on D-3(die) steel with electrolytic cylindrical copper electrode. D-3 die steel (HRC-58) is widely used in production of dies and is difficult to machine with conventional machining option. In study copper has been taken as electrode and die-steel as a work piece. Electrode wear has been investigated in the form of weight (g) and length (mm.) of electrode on different input process parameters. viz discharge current (amp.), pulse on time (T-on), pulse off time (T-off)**

Keywords- Weight(g); Length(mm.); T-on; T-off; Current(amp.)

I. INTRODUCTION

A. EDM

Electrical discharge machining is modern machining method. It is a non conventional machining method. Also, it is called spark erosion machining. Spark that is produced by electric current, which flows between electrodes and work piece when some gap maintained between them. The principle of working of an electrical discharge machining (EDM) is shown in fig(1).

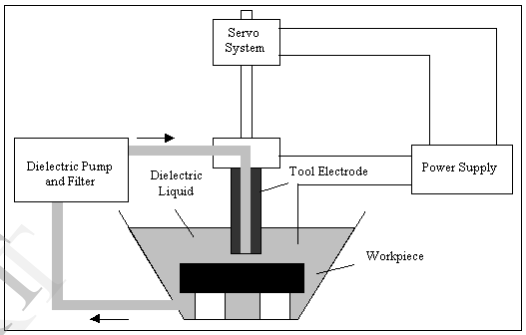

Fig.1. Electrical discharge machining

The work piece and electrode are placed in the working position in such a way that they do not touch each other. Both are separated by a gap which is filled with an insulating fluid. This fluid is called dielectric fluid. The machining process therefore takes place in a tank. The work piece and electrode are connected to a d.c. source with a cable. There is a switch in one lead. When this is closed, and electrical potential is produced between electrode and work piece.

First of all there is no current flow to the dielectric fluid between the work piece and electrode as an in insulator. However, if the gap is reduced then a spark jumps across it when it reaches a very small size. Spark jumps, that is also known as a discharge, in which the current is converted to heat. The surface of the material is much more heated in the area of discharge and if the flow of current is interrupted the discharge channel collapses very quickly. This discharge helps to remove or machine the material from the work piece which is called by electrical discharge machining process.

II. DIE-SINKING

Die-sinking (also known as ram) EDM machines require the electrode to be machined in the exact opposite shape as the one in the work piece. Die-sinking EDM machines consist of hydrocarbon oil and submerse the work piece and spark in the fluid die sinker which is processed of machining impressions in die-block. This process solves the problems of manufacturing accurate complex shaped electrodes for die-sinking of three dimensions cavities.

Die-sinker EDM machines are normally used for producing three-dimensional shapes. These shapes utilize either cavity type-machining or through-hole machining.

Die sinking EDM is a kind of machining of varying the shape of electrode to the work piece and the shape of the electrode is changed by sparks.

Die-sinking sparking occurs across the end surface and from the corners of the electrode. Spark length is set by the machine controls. Sparks produce from the electrode corners, producing a clearance between the electrode corner and the sidewalls of the work piece. The machined clearance between the electrode corner and work piece sidewall is the spark overcut. The electrode-end sparking surface, plus the sidewall over cut distance, is the sparking area. Die sinking (known as ram also) type EDM machine requires the electrode to be machined in the exact opposite shape as the one in the work piece.

III. ELECTRODE WEAR

The shape of electrode which is changed by sparks. This change is called electrode wear. The ratio of the amount of machining of the work piece to the amount of electrode wear is called electrode wear ratio, and it is important on varying the shape of the electrode to the work piece. Electrode wear ratio changes due to the combination of electrode and work piece material, polarity of the voltage to apply, duration of the spark etc. Electrode wear is an important affecting factor in die-sinking EDM. Which influences the metal removal rate and surface roughness. It is really important to know that how and why electrode wear occurs in order to achieve maximum EDM efficiency.

In this experimental study Electrode wear has been investigated in cylindrical copper electrode on die-steel as a work piece material. Electrode wear has been investigated in the form of weight (g) and length (mm). This electrode wear is called end wear which is the common form of wear and is defined as the reduction in length of electrode during the machining process. End wear is the only type of wear that can be reduced by operating parameters.

IV. EXPERIMENTATION

This study is carried out to find out the electrode wear in cylindrical copper material in die-sinking EDM and comp aired the wear of copper electrode on different input process parameters and optimized the electrode wear at certain conditions.

A) Input process parameters:-

Discharge current (amp.), Pulse on time (T-on), Pulse off time (T-off), Depth of machining Voltage.

B) Response parameter

Weight (g) of electrode, Length (mm) of electrode

C) Specification of EDM

The EDM used for the experiment is Die-sinking Electrical Discharge Machining Model No- Sparkonix 25-amp.

D) Electrode piece material

Copper

E) Work piece material

Die-steel (HRC-58)

F) Die-electric fluid

Kerosene

V. EXPERIMENTAL RESULTS FOR ELECTRODE WEAR

Table.1 Work Piece-Die-Steel

Sr. NO.	current (amp)	weight (g)	time-on	time-off	surface finish
1	16	0.069	6	5	rough
2	14	0.059	6	5	rough
3	12	0.023	6	5	good
4	10	0.027	6	5	good

Depth of Machining-1mm, Voltage-50v, Electrode Material-Copper

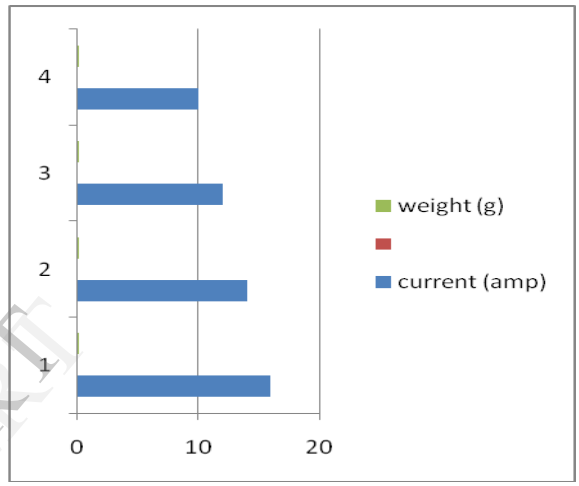

Fig. 2.

Tabale.2 Work Piece-Die-Steel

Sr.NO.	current (amp)	length (mm)	time-on	time-off	surface finish
1	16	0.04	6	5	rough
2	14	0.04	6	5	rough
3	12	0.04	6	5	good
4	10	0.02	6	5	good

Depth of Machining-1mm, Voltage-50v, Electrode Material-Copper

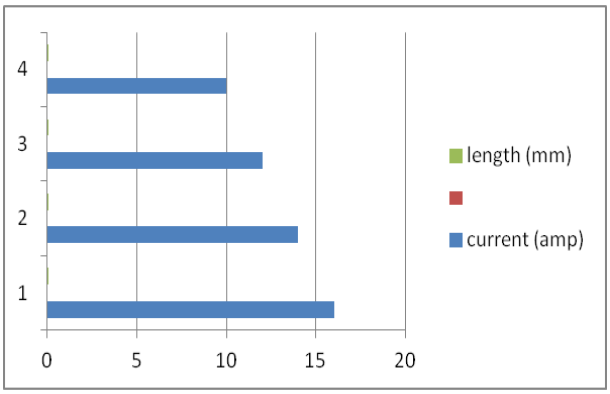

Fig. 3.

VI. RESULT AND DISCUSSION

From table-1, it is observed that if the current supply is low then the wear of copper electrode in the form of weight (g) will decrease and it can be minimized (optimized) at particular current supply which is 0.023g at 12amp current supply. Also this experimental result is shown in fig. 2 where column size of weight (g) is very small at 12 amp current supply.

From table-2, it is observed that if the current supply is low then the wear of copper electrode in the form of length (mm) will decrease and also it can be minimized at particular current supply which is 0.04mm at 12amp . it is also shown in fig. 3 where column size of length (mm) is very small at the current of 12amp.

In both results it has been investigated that electrode wear in cylindrical copper can be optimize (minimized) at constant pulse on-time and pulse off-time which is 6 micro-sec.(pulse on-time) and 5 micro-sec.(pulse off-time).

VII. CONCLUSION

Electrode wear increases with the increase in current supply as well as pulse on-time and pulse off-time. Electrode wear decreases with the decrease in current supply but at particular lower current and T-on and T-off where surface finish is also good. This electrode wear has been investigated in the form weight (g) of cylindrical copper electrode. It has been also investigated that electrode wear in the form of length (mm) of electrode decreases with the decrease in current supply and also at particular lower current and T-on and T-off. From this experimental investigation it has been concluded that cylindrical copper electrode can be used for long time without redressing the electrode. Due to less wear die-sinking EDM will provide an economic advantage for making different holes and cavities.

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