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Micro Drilling of Conduction Material by EDM Process

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Abstract— **Electrical discharge machining (EDM) is one of the non-conventional machining processes. Thermoelectric power between the tool and work piece is main factor for on which EDM is based. In EDM process, the material removal rate is important performance measure. Many of the researchers found the no. of ways to improve the MRR. By using Dielectric medium between work piece and tool erosion of electrically conductive work piece is controlled with the rapid and repetitive spark discharge. Work piece and tool both are taken as conductor of electricity, in order to generate the spark. EDM is used for machining of thin and fragile parts. In this paper the micro drilling on conduction material by using EDM is attempted. Based on concentration, current, time and diameter of tool, the MRR is studied.**

Key Words: - **EDM, Micro drilling, concentration, MRR, etc.**

I. INTRODUCTION

Electrical Discharge Machining (EDM) is now become the most important accepted technologies in manufacturing industries since many complex 3D shapes can be machined using a simple shaped tool electrode. Electrical discharge machine(EDM) is an important 'non-traditional' manufacturing method,' developed in the late 1940s and has been accepted worldwide as standard processing manufacture of forming tools to produce plastics mouldings, die castings, forging dies and etc. New developments in the field of material science have led to new engineering metallic materials, composite materials, and high tech ceramics, having good mechanical properties and thermal characteristics as well as sufficient electrical conductivity so that they can readily be machined by spark erosion.

As the present time, electrical discharge machine (EDM) is a widespread technique used in industry for high precision machining of all types of conductive materials such as: metals, metallic alloys, graphite, or even some ceramic materials, of whatsoever hardness. Electrical discharge machine (EDM) technology is increasingly being used in tool, die and mould making industries, for machining of heat treated tool steels and advanced materials (super alloys, ceramics, metal matrix composites) requiring high precision, complex shapes and high surface finish. Traditional machining technique is often based on the material removal using tool material harder than the work material and is unable to machine them economically. An electrical discharge machining (EDM) is based on the eroding effect of an electric spark on both the electrodes used. Electrical discharge machining (EDM) actually is a process of utilizing the removal phenomenon of electrical-discharge in dielectric. Therefore, the electrode plays an important role, which affects the material removal rate and the tool wear rate.

II. PAPER BACKGROUND

Electrical discharge machine (EDM) is commonly used in tool, die and mould making industries for machining heat-treated tool steel materials. The heat treated tool steels material falls in the difficult-to-cut material group when using conventional machining process. The high rate of tool wear is one of the main problems in electrical discharge machine (EDM). The wear ratio is defending as the volume of metal lost from the tool divided by the volume of metal removed from the work materials, varies with the tool and work materials used [3]. If the rate of tool wear is high means that the material is easy to wear and not good for machining performance.

The significant of this study is to promote the consideration of electrode selection in electrical discharge machine (EDM) machine for advance machining in the manufacturing industries. This is because very electrode materials have their own characteristics that lead to different result due to its properties, electrical discharge machine (EDM) has been analyzed since several years in order to improve the material removal rate and the ratio, which are the most critical aspects of the process. In the machining of

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electrical discharge machine (EDM), there are a few characteristics which influence the machining process. Most important are the material removal rate (MRR) and electrode wear ratio (EWR).

III. WORKING PRINCIPLE:

The principle of EDM, also called as electro-discharge and spark-erosion machining of metals by spark discharges. We know that when two current-conducting wires are allowed to touch each other, an arc is produced. When the point of contact between two wires is closely examined, it will be noted that a small portion of the metal has been eroded away, leaving a small crater. It has become one of the most important and widely used production technologies in manufacturing industries.

The EDM system consist of a shaped tool (electrode) and the work piece, which are connected to a DC power supply and placed in a dielectric (electrically non conducting) fluid. When a voltage is applied to tool, a magnetic field causes suspended particles in a dielectric fluid to concentrate between electrode and work piece, eventually forming a bridge for current to flow to the work piece. An intense electrical arc in then generated, causing sufficient heating to melt a portion of the work piece and usually, some of the tooling materials as well. In addition, the electric fluid is heated rapidly, causing evaporation of the fluid in the arc gap. This evaporation, in turn, increases the resistance of the interface, until they can no longer be maintained. Once the arc is interrupted, heat is removed from the gas bubble by the surrounding dielectric fluid, and the bubble collapses (cavities). The associated shock wave and flow of dielectric fluid flush debris from the work piece surface and entrain any molten work piece material into the dielectric fluid. The capacitor discharge is repeated as rates of between 50 and 500 KHz, with voltage usually ranging between 50 and 380 V and currents from 0.1 to 500 A.

IV. GENERAL PROCEDURE:

1.Prepare the electrolyte of required concentration by adding pure sodium hydroxide flakes in distilled water.
2.Make the proper connections of an anode and cathodes electrodes as per the given block diagram.
3.Set the required voltage and current on DC power supply unit with help of adjusting knobs on the unit.
4.Take the weight of work piece and fix it on work piece holding table in electrolyte tank.
5.Then adjust the required gap between the work piece and tool electrode with the help of filler gauge.
6.Now set the time of 10 minutes on stopwatch as machining is carried out for time of 10 minutes.
7.Start the DC power supply and take observations.
8.Take weight of work piece after the machining and calculate the material removal rate as per the given calculations.

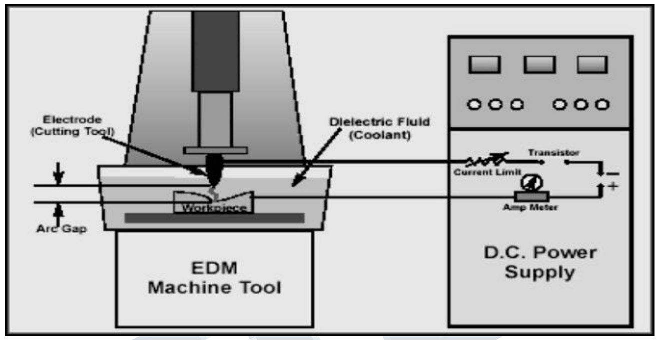

Fig.Schematic Diagram of electro-Discharging Machining

Precautions to be Taken:

1) Stand of distance should be maintained regularly during machining.
2) Concentration of electrolyte should be maintained.
3) Protective measures to be taken avoid burns on skin. Use of gloves for hand is a must.
4) Keep safe distance from machine while machining process is on, as Noah fumes arises at site of spark.
5) Observe the machining process away from equipment vicinity.
6) Before operation use hand loses.

Experimental Conditions for Tests:

Total (Anode)	Stainless Steel needle (diameter2 mm)
WORKPIECE (CATHODE)	Copper (Thickness 8mm)
ELECTROLYTE	NaOH solution
MACHINING CONDITIONS	Applied voltage: 150-240 (D.C.) Peak current: 1-2Amps Electrolyte concentration: 20-40% Gap:0.0-0.06 mm

Component Images

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V. MECHANISM OF MATERIAL REMOVAL AND SPARK GENERATION:

The changed electrode is brought near the work piece. Between them is an electrolyte, a large enough potential can cause the fluid breakdown into ionic fragments, allowing an electrical current to pass from electrode to work piece. The electrical field is strongest at the point where the distance between the tool and the work piece is least. As the number of ionic particles increases, the insulating properties of electrolyte being to decrease along a narrow channel cantered in the strongest part of the field. A current is established as fluid becomes less an insulator. Heat builds up rapidly as current increases. The heat vaporizes some of the fluid; discharge channel begins to from between the electrode and work piece. The discharge channel consists of super-heated plasma, vaporized electrolyte and carbon, with an intense current flowing through it.

Hence a spark is discharged in the discharge channel and strikes the work piece surface which enables the material to melt at the localized region. The vapor bubble formed at this vicinity collapses due to the pressure exerted on the bubble, due to which molten metal is expelled out from the work piece. The expelled metal solidifies into tiny spheres dispersed in the electrolyte. Performance measures such as Material Removal Rate: Tool wear and surface finish for same energy depends on current impulses. Thus the material is removed from the work piece in micron lever i.e., in milligrams by the expenses of spark and chemical reaction.

Experiments conducted by varying the following parameters which have a major role in Material Removal Rate:

i) Electrolyte concentration.
ii) Stand-off distance.
iii) Voltage.

Calculations:
Approximate empirical relationship can be used as guide to the metal removal in EDM:

MRR = 4* 104I T w1.23

Where,
MRR is in mm3/min.
I is the current in amp. And
Twist melting point of work piece in K -273.15 K.
The wear rate of the electrode estimated from the empirical equation.

Wt= (1.1 * 1011) ITt-2.38

We can also define the wear ratio of work piece.
The material removal rate cane also calculated as

W = W1 – W2

W = 45.03-44.98

= 0.0433gms/2min

Where,
W = M.R.R (gms/2min)
W1 = WEIGHT BEFORE EXPERIMENT (gms)
W2= WEIGHT AFTER EXPERIMENT (gms)

Observation Table: -

Sr. No.	Concentration (%)	Voltage (volt)	Gap Size (mm)	MRR(gms /2min)
1	10	40	0.02	0.0633
2	10	50	0.04	0.0866
3	10	60	0.06	0.0600
4	20	40	0.04	0.0700
5	20	50	0.06	0.0433
6	20	60	0.02	0.1100
7	30	40	0.06	0.113
8	30	50	0.02	0.1270
9	30	60	0.04	0.1420

Electric Discharge Machine (EDM) Capabilities:
The electric discharge machine (EDM) capabilities compare with the other methods.

1) Material of any hardness can be cut.High accuracy and good surface finish are possible.
2) No cutting forces involved.Intricate-shaped cavities can be cut with moderate tolling costs.
3) Holes completed in one “pass”.

Applications of Electro Discharge Machining
This Process is highly economical for machining of every hard material as tool wear is independent of hardness of workspace material. It is very useful in tool manufacturing. used for broach making, making holes with straight or curved axes, and for making complicated cavities which cannot be produced by conventional machining operations.

Advantages of EDM

1) This process is very much economical for machining very hard material.
2) Maintains high degree of dimensional accuracy so it is recommended for tool and die making.
3) Complicated geometries can be produced which are very difficult otherwise.
4) Highly delicate sections and weak materials can also be processed without any risk of their distortion because in this process tool never applies direct pressure on the work piece.
5) Fine holes can be drilled easily and accurately.

Paper Scope

The research scope is limited to Machining parameters refers to electrical parameters on electrical discharge (EDM) i.e. polarity, pulse-on-duration, discharge current, discharge voltage. The scope should be limited in this experiment due to low cost and time. Besides, there are three tool electrode used that are Aluminum's, brass and cooper. The reason for using these only three materials is regarding to cost limitation and availability this is also including calculation of the machining characteristics i.e. material removal rate (MRR).

Beside, this paper hopefully can gain a lot of understanding and get mare knowledge about the electric discharge machine (EDM) theseis important to get familiar with this method nowadays. This process is well suited for machining of casting and forging dies powder metallurgy and injections melds, and aerospace parts.

VI. CONCLUSIONS

Finding the result of MRR, discharge current is most influencing factor and then pulse duration time and the last is diameter of the tool. MRR increased with the discharge current (IP). As the pulse duration extended, the MRR decreases monotonically.

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