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A Current Review of Process of Electric Discharge Machine

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Abstract: EDM stand for Electrical Discharge Machine which was developed in late 1940s which has now become the most important technologies in manufacturing industries. It is used for many complex 3D shapes can be machined using a simple shaped tool electrode. It is used for manufacture of forming tools to produce plastics moldings, die castings, forging dies and etc. At 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. Now a days 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 requiring high precision, complex shapes and high surface finish. 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.

Key words: EDM, Electrode, Dielectric fluid, MRR, EWR.

INTRODUCTION

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 defined as the volume of metal lost from the tool divided by the volume of metal removed from the work material, varies with the tool and work materials used. 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. In the machining of EDM, there are a few characteristics which influence the machining process. Most important are the **material removal rate** (MRR) and **electrode wear ratio** (EWR). These characteristics should be taken into account when good machining performance is needed. The case studies of this project are to determine the best material removal rate (MRR) and electrode wear ratio (EWR) from different selection materials. This would lead to the better process and product finishing. The energy is not only used to machine the work piece, but also degrades the tool electrode.

WORKING PRINCIPLE OF EDM

The working principle of EDM process is based on the **thermoelectric energy**. This energy is created between a work piece and an electrode submerged in a dielectric fluid with the passage of electric current. The work piece and the electrode are separated by a specific small gap called Spark gap. Pulsed arc discharges occur in this gap filled with an insulating medium, preferably a Dielectric liquid like hydrocarbon oil or de-ionized (de-mineralized) water. The working principle of EDM is shown in Fig. 1. This technique has been developed in the late 1940s. The electrode moves toward the work piece reducing the spark gap so that the applied Voltage is high enough to ionize the dielectric fluid. Short duration discharges are generated in a liquid dielectric gap, which separates electrode and work piece. The material is removed from tool and work piece with the erosive effect of the electrical discharges. The dielectric fluid serves the purpose to concentrate the discharge energy into a channel of very small cross sectional areas. It also cools the two electrodes, and flushes away the products of machining from the gap. The electrical resistance of the dielectric influences the discharge energy and the time of spark initiation. Low resistance results in early discharge. If resistance is large, the capacitor will attain a higher charge value before initiation of discharge. A servo system is employed which compares the gap voltage with a reference value and to ensure that the electrode moves at a proper rate to maintain the right spark gap, and also to retract the electrode if short-circuiting occurs. When the measured average gap voltage is higher than that of the servo reference voltage, preset by the operator, the feed speed will increases. On the contrary, the feed speed decreases or the electrode is retracted when the average gap voltage is lower than the reference voltage, which is the case for smaller gap widths resulting in a smaller ignition delay. Thus short circuits caused by debris particles and humps of discharge a crater are avoided. Also quick changes in the working surface area, when tool shapes are complicated, does not result in hazardous machining.

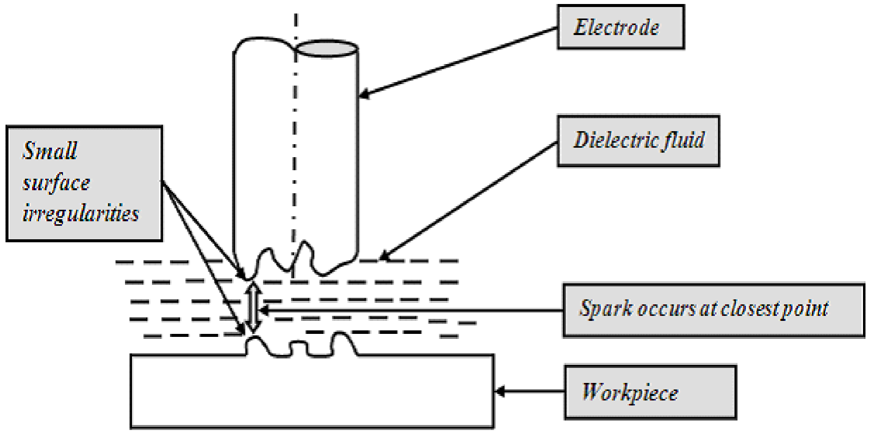

Fig1.

MATERIAL SELECTION

Material selection is the most important to this experiment because different materials have different working parameters based of their properties. The right selection of the machining material is the most important aspect to take into consideration in processes related to the EDM.

Electrodes

The important factors in selecting aluminum, brass and cooper are their high strength-to-weight ratio, resistance to corrosion by many chemicals, high thermal and electrical conductivity, non-toxicity, reflectivity, appearance and ease of formability and of mach inability; they are also nonmagnetic. The important factors in selecting aluminum (Al) and its alloys are their high strength-to-weight ratio, resistance to corrosion by many chemicals, high thermal and electrical conductivity, no toxicity, reflectivity, appearance and ease of formability and of mach inability; they are also nonmagnetic.

Brass is any alloy of copper and zinc; the proportions of zinc and copper can be varied to create a range of brasses with varying properties. In comparison, bronze is principally an alloy of copper and tin. Despite this distinction, some types of brasses are called bronzes. Brass is a substitution alloy. It is used for decoration for its bright gold-like appearance; for applications where low friction is required such as locks, gears, bearings, ammunition, and valves; for plumbing and electrical applications; and extensively in musical instruments such as horns and bells for its acoustic properties.

MACHINE AND EQUIPMENT

The following equipments were used in this experimental works:

- **CNC EDM die sink**: This machine was used to drill hole on the tool steel for experiment in the electrical discharge machining process.

Brand : Sodick CNC EDM die sink

Model : AQ55L

No of axis : 3 axes (X, Y & Z)

Figure : EDM machine

- **BALANCE**

Brand : Precisa

Model : 92SM – 202A DR

Resolution : 10 nanogram

Precision balance was used to measure the weigh of the work piece and electrode before ands after the machining process.

Figure: Balance machine

Experimental Set-up

Before run the experiment, the electrode and work piece is cut regarding their dimension. The electrode needs to be cut its diameter same for all material. The lathe machine is used to cut the electrode. For the work piece, the wire cut EDM machine is used for cutting all specimens in same dimension. This picture refers all the material dimension that should cut and shape.

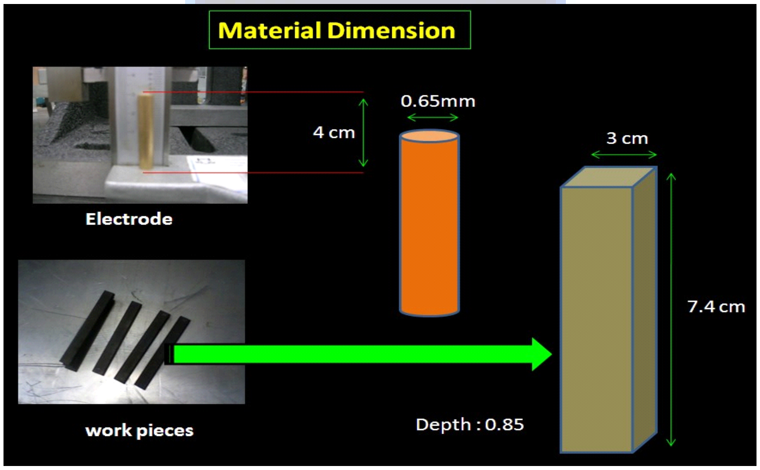

Figure : Material dimension

EXPERIMENT PROCEDURE

The electric discharge machine, model SODICK AQ55L (die sinking type) with servo-head (constant gap) and positive polarity for electrode (reverse polarity) will used to conduct the experiment. Kerosene will used as dielectric fluid. These are the procedure of this experiment:

- Experiment will conducted with positive polarity of electrode. The electrode aluminum is taken. The diameter of electrode is measured with a micrometer.
  Make sure its dimension is according to specification.
- An initial mass is measured with Precisa balance model 92SM – 202A DR. Take the electrode mass value and the work piece mass value.
- The work material (tool steel) was mounted on the T-slot table and positioned at the desire place and clamped. The electrode was clamped on the V-block, and its alignment was checked with the help of the try square.
- Set the parameters of the experiment regarding table 1.1
- A depth of cut of 1 mm was set for the machining of all work materials. Finally, switches 'ON' for operating the desire discharge current values.
- After machining operation, the electrode was taken out and weight again on Precisa balance. Also take the mass value of work piece after machining.
- The same experiment was repeated with other different electrode materials. This experiment is done by 5 times. The data will take and the average data calculated. This is to make sure the data more accurate.

CALCULATION OF MATERIAL REMOVAL RATE (MRR)

Although other ways of measuring material removal rate (MRR) and electrode wear ratio (EWR) do exist, in this work the material removal rate and electrode wear values have been calculated by the weight difference of the sample and electrode before and after undergoing the electric discharge machine (EDM) process. The present work highlights the development of mathematical solution to calculate the electric discharge machine (EDM) machining parameters such as: mass of electrode, pulse duration and voltage on the metal removal rate, wear ratio and surface roughness. This work has been established based on the mathematical equation. The material removal rate (MRR) of the work piece was measured by dividing the weight of work piece before and after machining against the machining time that was achieved. The material removal rate (MRR) is expressed as the work piece removal rate (WRR) under a period of machining time in minute (T), that is :

$$\text{MRR (g/min)} = \text{WRR}/\text{T}$$

Where;
WRR = Work Piece Removal Rate (g), T = time (minutes)

THE FORMULA OF ELECTRODE WEAR RATIO (EWR)

Therefore, studying the electrode wear and related significant factors would be effective to enhance the machining productivity and process reliability. The electrode wear ratio (EWR) is define by the ratio of the electrode wear weight (EWW) to the work piece removal weight (WRW) and usually expressed as a percentage, that is:

$$\text{EWR (\%)} = [\text{EWW}/\text{WRW}] \times 100$$

Where;
EWW = Electrode Wear Weight
WRW = Work Piece Removal Weight

The electrode wear ratio (EWR) can be obtained by divide the value of electrode wear weight (EWW) against the value of work piece removal weight (WRW). We also use the same method to calculated electrode wear ratio (EWR) in every experiment. All the (EWR) value then can be analyze and discuss. The value of the electrode wear ratio (EWR) when machining electric discharge machine (EDM) using brass electrode now can be determine. Then, the different mass of brass electrode is calculated by minus the mass before experiment against mass after experiment. The different mass value of this calculation is called electrode wear weight (EWR). Meanwhile, the different mass of work piece also calculated. The mass of tool steel after experiment then will minus by the mass of tool steel before the experiment to get the different masses. This different mass is called work piece removal weight (WRW).

DISCUSSION OF MATERIAL REMOVAL RATE (MRR) AND ELECTRODE WEAR RATIO (EWR)

MATERIAL REMOVAL RATE (MRR)

In industries, the production rate is a part that they consider most. The production rate is a rate or time taken to do a process in making product. If the production rate is slow, the profit flow is also slow. But if the production rate is high, the more profit can gain. To increase the production rate, we need to increase the material removal rate (MRR). When the material removal rate (MRR) is higher, the production also run faster.

ELECTRODE WEAR RATIO (EWR)

The high rate of tool wear is one of the main problems in electric discharge machine (EDM). Actually, the wear ratio defined as the volume of metal lost from the tool divided by the volume of metal removed from the work material, varies with the tool and work materials used. If the rate of tool wear is high means that the material is easy to wear and not good for machining performance. In industries, the wear ratio is an important thing because it will cost the production. They are trying to optimize this factor to make sure no waste occur and reduce the purchasing the material with high wear.

ELECTRIC DISCHARGE MACHINE (EDM) CAPABILITIES

There are a lot of benefits when using electrical discharge machine (EDM) for machining. This is due to its capabilities and advantage of EDM. To summarize, these are the electric discharge machine (EDM) capabilities compare to other method.

- Material of any hardness can be cut.
- High accuracy and good surface finish are possible.
- Not any type of cutting forces involved.
- Intricate-shaped cavities can be cut with modest tooling costs.
- Holes are completed in one “pass”.
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ELECTRIC DISCHARGE MACHINE (EDM) LIMITATIONS

But, when using electric discharge machine (EDM).There are some limitations also during machining of any material. These are electric discharge machine (EDM) limitation.

- It is limited to electrically conductive materials.
- Slow process, when good surface finish and high accuracy are required.
- Dielectric fluid vapour may be dangerous.
- Heat Affected Zone (HAZ) near cutting edges.
- Die sinking tool life is also limited.
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REFERENCES

[1]. K.H. Ho, S.T. Newman, State of the art electrical discharge machining (EDM), International Journal of Machine Tools & Manufacture 43 (2003) 1287–1300
[2]. Y.Y. Tsai, T. Masuzawa, An index to evaluate the wear resistance of the electrode in micro- EDM, J. Mater. Process. Technol. (2004)
[3]. J.L. Lin and C.L. Lin “grey-fuzzy logic for the optimization of the manufacturing process” Journal of Materials Processing Technology 160 (2005) 9–14
[4]. M. Mahardika and K. Mitsui, A new method for monitoring micro-electric discharge machining processes, International Journal of Machine Tools & Manufacture (2007) doi:10.1016/j.ijmachtools.2007.08.023
[5]. M. Mahardika and K. Mitsui, Total energy of discharge pulse calculation by stochastic methods, Proceeding of the International Conference of the 10th AUN/SEED.Net Field Wise Seminar, Hanoi, Vietnam in 28th– 29th August 2007.
[6]. Mohd. Khairul Anuar Bin Mohd. Idris ME05052 November 2008.
[7]. Anand Pandey and Shankar singh “review on Current research trends in variants of Electrical Discharge Machining” International Journal of Engineering Science and Technology Vol. 2(6), 2010, 2172-2191
[8]. Kuldeep Ojha, R.K Garg, K.K Singh, Department of Production and Engineering, Department of Mechanical Engineering and Mining Machinery Engineering 2010.
[9]. A. Klinka, Y.B. Guoa,b*, F. Klockea, “Surface integrity evolution of powder metallurgical tool steel by main cut and finishing trim cuts in wire-EDM” Procedia Engineering 19 (2011) 178 – 183

[10]. S Sivakiran, C. Bhaskar Reddy and C. Eswara reddy "Effect of Process Parameters on MRR in Wire Electrical Discharge Machining of En31 Steel" International Journal of Engineering Research and Applications (IJERA) ISSN: 2248-9622 www.ijera.com Vol. 2, Issue 6, November- December 2012, pp.1221-1226

[11]. V. Muthuraman, R. Ramakrishnan and L. Karthikeyan, "Influences of Process Variables during Wire Electric Discharge Machining of O1 Steel" 2012 published in European Journal of Scientific Research

[12]. Kumar Sandeep Dept. of Mechanical Engineering, University Institute of Engineering and Technology, MD University, Rohtak-124001, Haryana, INDIA February 2013.