A Review of process parameter of EDM.

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ABSTRACT

Electrical discharge machining is vital & one of the efficient non-traditional machining processes. It is based on the thermoelectric energy between the workpiece and a tool electrode. A pulse discharge occurs in a small gap between the workpiece and the tool electrode and it removes the unwanted material from the base metal through melting and evaporating.

The main objective of this paper is to study the influence of process parameters and electrode shape configuration on the machining characteristics such as surface quality, material removal rate and electrode wear. This review is based on various study carried on this field by various researchers. In this study we found better machining performance is obtained generally with the electrode as the cathode and the work-piece as an anode. As far as tool shape configuration concerned best tool shape for higher MRR and lower TWR is circular, followed by square, triangular, rectangular, and diamond cross sections.

Keyword: *EDM, electro-conductive materials, electrode geometry, Material Removal Rate, Tool Wear Ratio (TWR)*

1. INTRODUCTION

The advanced materials have striking properties i.e., high strength, high bending stiffness, good damping capacity, low thermal expansion, better fatigue characteristics which make them prospective material for modern industrial application. Present manufacturing industries are facing challenges from these advanced materials viz. super alloys, ceramics, and composites, that are hard and difficult to machine, requiring high precision, surface quality which increases machining cost [1]. Conventional machining processes utilize the ability of the cutting tool to stress the material beyond the yield point to start the material removal process. This requires that the cutting tool material is harder than the work piece material.

New materials which are having high strength-to weight ratio, heat resistance and hardness, such as nimonic alloys, alloys with alloying elements such as tungsten, molybdenum, and columbium are difficult to machine by the traditional methods.

Machining of these materials by the conventional methods is very difficult as well as time consuming, since the material removal rate reduces with an increase in the work material hardness. Hence, there is the, need for development of non-traditional machining processes which utilize other methods for the material removal. As a result, these processes are termed as unconventional or non-traditional machining methods. Non-Traditional machining processes are being used to achieve optimum metal removal rate, better surface finish and greater dimensional correctness, with a reduced amount of tool wear. Electrical Discharge Machining, commonly known as EDM is a non-conventional machining method used to remove material by a number of repetitive electrical discharges of small duration and high current density between the work piece and the tool. EDM is an important and cost-effective method of machining extremely tough and brittle electrically conductive materials. In EDM, since there is no direct contact between the work piece and the electrode, hence there are no mechanical forces existing between them. Any type of conductive material can be machined using EDM irrespective of the hardness or toughness of the material.

2. LITERATURE REVIEW.

For this work we go through various research work done on this field. Some works are given below;
The electrode has an important role in electrical discharge machining. Different studies were conducted to evaluate the effects of different electrode materials on MRR,
TWR and surface roughness. The overall performance of the electrode depends on the tool materials properties, particularly the boiling point, melting point, and thermal conductivity as well as the priority of the relevant response variables, i.e. MRR, TWR, and surface integrity. Tsai and Masuzawa (2004) conducted an experimental study evaluating the performance of different tool materials including Ag, Al, Cu, Fe, Mo, Ni, Pt, Ti, and W. They concluded that the TWR of tungsten was the lowest due to its high melting and boiling points. They reported the lower TWR of copper and silver compared to iron and nickel electrodes. They attributed this finding to the higher thermal conductivity of copper and silver. Coated electrodes are also used for micro EDM to improve the machining performance. Jahan, Wong, and Rahman (2009a) investigated the effects of different electrodes including tungsten, copper tungsten, and silver tungsten (AgW) to achieve fine surface finish in micro-EDM of WC. Considering all responses, they concluded that AgW was the best electrode for finish die-sinking of WC. Chiou, Tsao, and Hsu (2015) conducted a comparison study of the performance of WC electrode and WC coated electrode by Ag and Cu. They reported the lowest surface roughness using the WC-coated Ag, the highest MRR by the WC-coated Cu, and the lowest TWR by the WC electrode. In a similar study, Kadirvel, Hariharan, and Mudhukrishnan (2014) studied the die-sinking micro EDM of EN-24 using different electrodes including tungsten, copper, copper tungsten, and silver tungsten and identified that Cu provided the highest MRR, W gave the lowest TWR, and AgW exhibited better surface finish. Besides different types of materials and coating, the shape of the electrode can also affect the EDM performance. Plaza et al. (2014) studied the effect of helical-shaped electrodes on micro-EDM drilling of Ti-6Al-4V. They reported 37% reduction in machining time of a micro hole with high aspect ratio of 10:1.

3. DISCUSSIONS

Principle of EDM-

In this process the material is removed from the work piece due to erosion caused by rapidly recurring electrical spark discharge between the work piece and the tool electrode. There is a small gap between the tool and the work piece. The work piece and tool both are submerged in dielectric fluid, commonly used are EDM oil, deionized water, and kerosene.

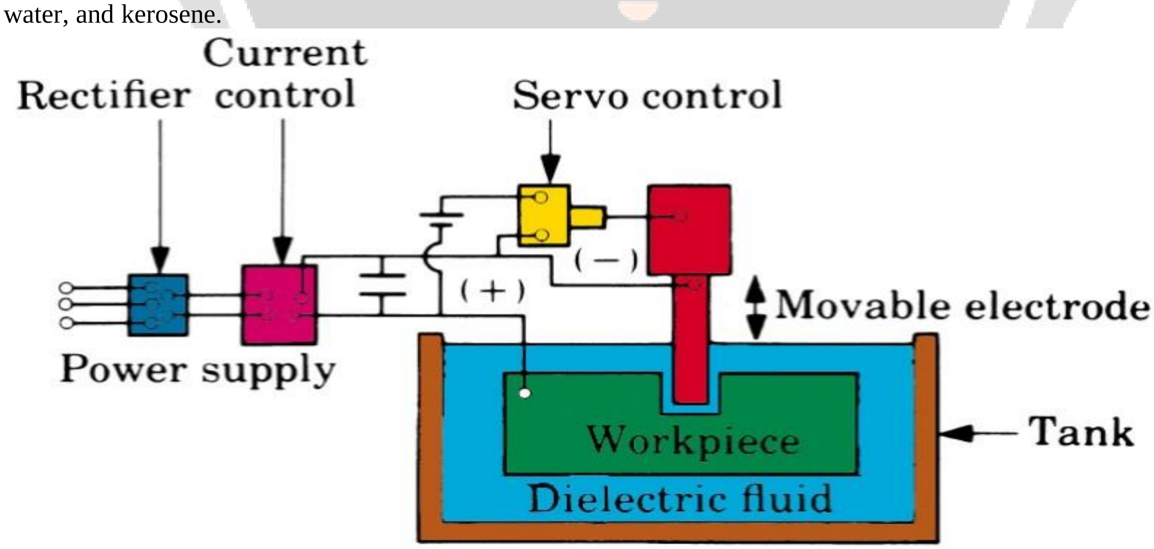

Fig.1

MECHANISM OF MATERIAL REMOVAL IN EDM PROCESS-

Electrical Discharge Machining (EDM) is a non-contact thermal machining process capable of machining conductive and semi-conductive materials regardless of their hardness. Conversion of electrical energy to thermal energy through repeated occurrence of sparks between the tool and the work piece immersed in a dielectric medium and separated by a small distance (spark gap) results in the material removal from work piece as well as tool by melting , evaporation and spalling in some special cases. The material removed is the major source of debris particles. The common dielectric fluids used are kerosene, paraffin, and light hydrocarbon oils. A necessary condition for producing a discharge is the ionization of the dielectric medium and splitting up its molecules into ions and electrons (i.e., formation of plasma). A schematic sketch of EDM and the material removal mechanism are shown in Figure 1.4.
The mechanism of metal removal in electrical discharge machining mainly involves the removal of material due to melting and vaporization caused by the electric spark discharge generated by a pulsating direct current power supply between the electrodes. In EDM, negative electrode is a continuously moving wire and the positive electrode is the work piece. The sparks will generate between two closely spaced electrodes under the influence of dielectric liquid. Water is used as dielectric in EDM, because of its low viscosity and rapid cooling rate.
No conclusive theory has been established for the complex machining process. However, empirical evidence suggests that the applied voltage creates an ionized channel between the nearest points of the work piece and the wire electrodes in the initial stage. In the next stage the actual discharge takes place with heavy flow of current and the resistance of the ionized channel gradually decreases. The high intensity of current continues to further ionize the channel and a powerful magnetic field is generated. This magnetic field compresses the ionized channel and results in localized heating. Even with sparks of very short duration, the temperature of electrodes can locally rise to very high value which is more 6 than the melting point of the work material due to transformation of the kinetic energy of electrons into heat. The high energy density erodes a part of material from both the wire and work piece by locally melting and vaporizing and thus it is the dominant thermal erosion process.

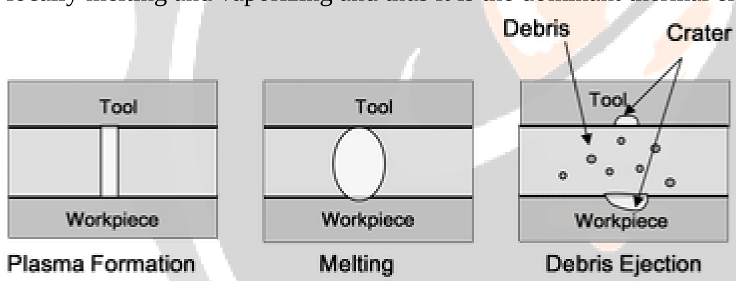

Fig.2

Flushing method-

Flushing is the most important function in any electrical discharge machining operation. Flushing is the process of introducing clean filtered dielectric fluid into the spark gap. There are number of flushing methods used to remove the metal particles efficiently.

Effect of Spark gap on MRR and TWR

The MRR as well as TWR both increase with discharge current. The MRR increases linearly with current, whereas the TWR increases nonlinearly with current. This is due to the fact that an increase in discharge current increases the pulse energy that leads to an increase in heat energy rate, which is subjected to both of the electrodes, and in the rate of melting and evaporation.

4. CONCLUSIONS

The main effects of process parameters such as peak current, pulse on-time, pulse off-time, higher-order effect of pulse on-time, and the interaction effect of discharge current and pulse on-time have significant contributions in MRR. The MRR increases linearly, whereas the TWR increases nonlinearly with discharge current. Initially, the MRR increases with pulse on-time duration and then starts decreasing with increase in pulse on time duration. On the other hand, the TWR suddenly decreases with increase in pulse on-time duration at the beginning and then starts decreasing slowly and remains constant for longer pulse on-time durations. The MRR almost increases linearly with pulse off-time duration and the TWR decreases linearly with increase in tool area.

Cavities made by EDM die sinking may have intricate shapes and it is difficult to achieve high accuracy at the sharp corner of the cavities. The single irregular electrode contains several geometries such as flat, round, square surface, pointed tip, etc. which removes materials with different effectiveness. The present paper proposes to carefully select the EDM parameters for machining cavities with multiple and intricate shaped electrodes.

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