A Review Paper of Electro discharge machining Process Parameters on Tungsten Carbide using Copper Electrode

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ABSTRACT

Electro-Discharge Machining (EDM) is a non-conventional manufacturing process which used for machining complex shapes in all type of conducting materials irrespective of the hardness for applied in aerospace industries, tool and die making industries etc. Material removal rate and surface roughness are the important performance measures in the electric discharge machining process. A reactive force is generated in the electric discharge machining process, due to the low electrical permittivity, reduces the damage to the tool and the required shape can be cut on the work piece with better accuracy.

Keywords: Electro-Discharge Machining, Material removal rate, Surface Roughness, permittivity, accuracy

I. INTRODUCTION

Electric discharge machining is employed in hard material and complex shapes could be create with high precision. Hard and brittle materials like tungsten carbide, high speed steels, stainless steels, ceramics etc., find a variety of applications in several industries. The tool and the work piece come into close touch during the traditional machining process and therefore, either the tool undergoes extreme wear or the machining part gets damaged. Also large cutting forces are involved in the traditional methods of machining and the stuff is taken out in the form of chips. How much heat is generated which induces the residual stresses that decrease the product structure's quality and life. The problems such as machining of complex shape, distortion and hardness of the materials were overcome in the non-conventional machining process. EDM removes the material from a workpiece by successive separate discharges occurred between the tool and the work item by a film of insulating liquid, called as dielectric liquid. In this process, the material is removed by the use of electrical energy and thermal energy. EDM is capable of metal processing regardless of its hardness, provided that the substance is a conductor of electricity.

The metal is taken out using discharge machining by an electrical spark erosion process, in which the electric spark jumps involving electrodes placed subjected to a voltage and through a dielectric medium. De-ionized water is a very common type of dielectric liquid. The tool acts as the cathode and the work piece acts as the anode. These electrodes are segregated by a small gap of about 0.01 to 0.5 mm.
The space is preserved with the help of a servo system as shown in Fig.1.

**Fig. 1: Schematic Electric Discharge Machining Process**

The metal is removed from the work piece, by involves passing a slightly elevated charged particles through an electrode onto the work item in a pulsed (on/off) manner. If the tool and work piece touch each other, arc would occur. Larger gap between the tool and the work piece will not support sparking. In order to maintain a constant gap between the tool and the work piece, a servo mechanism is applied.

**Basic Component of EDM:** The essential parts of discharge machining:

- Power supply
- Tool Material
- Dielectric medium
- Flushing
- Servo Mechanism

**Power supply:** It is given to the machining process i.e. Negative terminal is given to the tool and a Positive terminal is given to the workpiece. Electrical connections are made between the work item and the tool and a DC power source.

**Tool Material:** The tool material must be selected properly, to obviate experience of more wear when collided by the positive ions. In the machining process, the tool acts as the negatively charged electrode. The tool material must have the following characteristics:

- High thermal conductivity
- High electrical conductivity
- High melting point
- Must be easily workable
- High density

**Dielectric medium:** The tool and the work piece in this process are submerged in insulating oil known as dielectric fluid. The dielectric fluid initiates the discharge by serving as a conducting medium when ionized, and conveys the spark. The dielectric fluid helps to control the arc discharge.

**Flushing:** Flushing is the process of introducing the clean, filtered dielectric fluid in the spark gap. Flushing of the debris particles from the machining area is one of the most important tasks in the EDM process. Flushing must be carried out at optimal pressure. High pressure of the dielectric fluid flushes the debris before they assist in the cutting process, resulting in smaller material removal rate. Low pressure does not flush the debris particles effectively, and results in short circuiting.

**Servo Mechanism:** Electric discharge machining process is maintaining a constant gap between the tool and the work piece. If the tool and work piece touch each other, arcing would occur and the work piece will be damaged severely. Larger gap between the tool and the work piece will not support sparking. In order to maintain a constant gap between the tool and the work piece, a servo mechanism is applied.

**Process Parameters:**

**Peak Discharge Current:** The discharge energy is directly inversely correlated with the discharge current, and hence the material removal rate.

**Voltage:** It is the potential measured by volt. It also affects the material removal rate.
Arc Gap: This is the distance maintained between the tool and the work piece in the EDM process. The arc gap is maintained constant with the help of a servo system.

Pulse on Time: It is the duration of time in which current is allowed to flow per cycle. The pulse on time is also directly proportional to the discharge energy and material removal rate. Pulse off Time: It is the duration of time between two successive sparks. During the pulse off time, the removed molten material gets solidified.

Duty Cycle: It is the ratio of the pulse on time to the total cycle time (pulse on time + pulse off time).

II. LITERATURE REVIEW

Lighter weight, good strength, impact resistance, and thermal resistant materials have improved for a variety of applications due to advancement in new mechanization which include aerospace, medical, automobile and more. A good understanding on the phenomenon of achieving optimal responses in the EDM is possible through extensive research in this field. Literature review is made on the process of discharge machining, various factors affecting the performance, need for the development of the process of discharge machining, research works on the improvement of the performance in the process of discharge machining and the optimization procedures adopted to determine the best values of factors.

Lonardo et al. (1999) deals with the effect of flushing and electrode material on MRR, electrode wear, Surface roughness that found with the use of copper electrode lower surface roughness can be obtained. Mohan et al., (2002) deals with the machining of Al-SiC composite by EDM that found with positive polarity of work-piece. MRR rises with rise in peak current. Surface roughness decreases with decrease in peak current. Tosun et al. (2003) studied the impact of the process parameters on the surface roughness of the work piece. Wire EDM process was analyzed by increase in surface roughness with increasing pulse duration, open circuit voltage and wire speed, and decrease in surface roughness with increase in dielectric fluid pressure was reported. Tsai et. al. (2003) conducted the EDM experiments AISI 1045 medium carbon steel tool produced by a new method due to the migration of chromium elements present in the tool. Lee et. al. (2004) investigated the surface characteristics in the process of discharge machining by electric the machined surface characteristics on the selection of the variable, apart from the dielectrics used in the discharge machining by electric process. Luis et. al. (2005) conducted the EDM experiments on silicon carbide to study the MRR and the rate of wear. Current, pulse on time, duty cycle, open-circuit voltage and dielectric flushing pressure were used as process parameters. Sushant et. al. (2007) investigated as discharge machining by electric of aluminium alloy–10 wt. % SiCp composites using cylindrical brass electrode of 30 mm diameter. Sohani et. al. (2009) studied the impact of tool forms such as triangular, square, rectangular, and circular with size factor consideration along with other process variables such as discharge current, on-time, off-time, and tool area on discharge machining by electro of medium carbon steel. Jha et. al. (2010) studied the impact of discharge machining by electro on stainless steel component fatigue performance. Syed et. al. (2012) studied the performance of electric discharge machining of water as the dielectric medium. Current, on time, polarity and percentage of aluminium powder were chosen as the different input process parameters. Zhang et. al. (2014) investigated the influence of the dielectrics on the material removal characteristics in EDM and their impact on the melting volume and removed material and removal efficiency in different dielectrics. Younis et. al. (2015) studied the effect of the electrode material in electrode discharge machining of tool steel to avoid
the residual stresses and surface roughness. Kulkarni et al. (2018) studied focuses on effects of different input parameters of discharge machining by wire electric on results of output like surface roughness and rate of material removal during machining of NiTi alloys. M. R. Singh et al., (2020) has used varying parameter electric discharge machining on Ti–6Al–4 V alloy to estimate the two of the major performances i.e. the rate of material removal (MRR) and rate of tool wear (TWR). A. Gupta et al., (2021) focus on discharge machining parameters are usually evaluated on the based on surface abrasiveness (SR), Material removal rate (MRR), cutting speed (V), and rate of tool wear (TWR). The discharge machining by electrical parameter affecting to the characteristic measures of the course is Ip, arc gap, Ton, and Toff.

From the literature review, Electric discharge machining is a widely used industrial process for embossing and producing intricate shapes. It has been continuously observed that it is a very time consuming for effective material removal rate, its rate can be increased by increasing current, but the strength of shapes gets compromised and gets damaged before completing its life. Our objective is to provide such optimized process parameters to work on hard material such as Tungsten carbide using copper electrode by which we can get higher material removal rate with less time and constant strength.

III. CONCLUSION

In this review paper, we can conclude that electro discharge machine has the ability to cut complex shapes with high performance. Machining response of material removal rate is important that achieve with high accuracy and precision. Material removal rate (MRR) from all selected parameters, spark current is the most significant input factor affecting the machining of workpiece. The performance is affected by discharge current, pulse on time, pulse off time, duty cycle, voltage for electric discharge machining. Electro discharge machining is progressing process to make this procedure in the field of manufacturing is on the optimization by using Taguchi Grey Relational Analysis.

IV. REFERENCES


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