"A Review Paper on Study of Electrical Discharge Machining Process Performance Parameter"

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Abstract

In modern era precision, accuracy, better surface finish, optimization of time, optimization of cost and optimization of material plays major role in every machining process. To machine complicated geometrical shapes materials which are very hard and not machined by conventional machining process such as Ceramic materials, Composite materials, Heat treated steels, Super-alloys and Carbides are easily machined by Electrical Discharge Machining. Electro discharge machining is a not a conventional machining process and known as non conventional machining process. Electrical Discharge Machines are widely used in variety of applications such as, Drilling of small holes, Mold making, Die casting industry, Tool, Electronics industry, Automobile industry and Aerospace industry. In recent decade many Electrical Discharge Machining researchers developed number of new experiments to study the effect of EDM process parameters like as Spark on time, Spark off time, Peak Current and Voltage to improve and optimize, EDM performances which are rate of material removal (MRR), OC, rate of tool wear (TWR) and Surface finish, related with surface roughness. The focus of all the researchers is to improve Surface finish, less Tool wear and Efficient Material removal rate. This paper reviews the various machining parameters related with EDM from past research works. The selection of electrodes, method of optimization, process parameters and their effects are done in this paper, concluded from previous research works.

Index Terms: EDM, MRR, OC, TWR, Design Experiments.

1. Introduction:

Electrical discharge machining is based on principle of spark generation and material is removed due to spark erosion. Electrical discharge machining spark erosion is similar to electric spark. Electric spark is used as a cutting tool to cut the work piece in a finished desired shape. The tool and work piece should be electrically conductive. A small gap is maintained between them. The tool and work piece is submerged in a dielectric fluid (kerosene oil, Deionized water, EDM oil). A high frequency current is used to generate spark between tool and work piece. This spark generates heat and removes material from the work piece. Dielectric fluid act as flushing system for chips and also serves as a coolant medium. It is a non- conventional machining process and used for machining of complicated geometrical shapes materials which are very hard and not machined by conventional machining process. Ceramic materials, Composite materials, Heat treated steels, Super-alloys and Carbides are easily machined by Electrical Discharge Machining. Electrical Discharge Machines are widely used in variety of applications such as, Drilling of small holes, Mold making, Die casting industry, Tool, Electronics industry, Automobile industry and Aerospace industry.

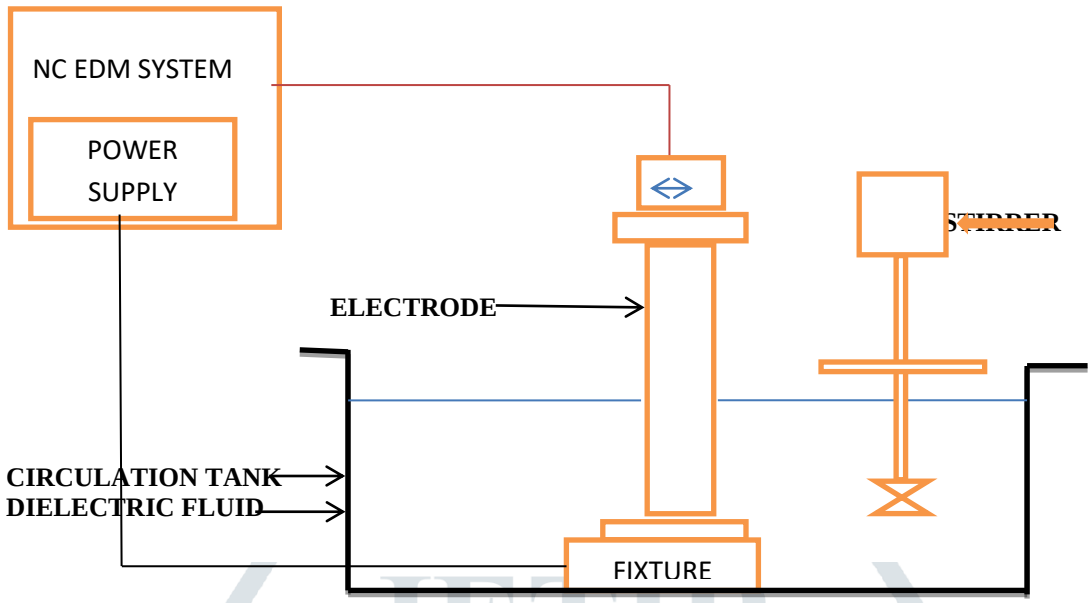

Figure1 Schematic set up of an EDM

2. Methods and Materials:

Electrical Discharge Machining has been demanding application over conventional metal removal. Basically three types of Electrical Discharge Machines are used according to their application.

1. Wire EDM
2. Die Sinker EDM
3. Hole Drilling EDM

Operating principle of all EDM is same, but method and applications are different. Die sinker EDM is used to create complex cavity shapes in tool and die. In Wire EDM, as name suggest wire is used for an electrode. Wire EDM is used to make a through hole in work piece. Hole drilling EDM provides excellent surface finish and minimum heat effected zone. Hole drilling EDM is used to create pilot hole required for wire threading. In Die sinking EDM hydrocarbon oil is used as a dielectric fluid, where as in Wire EDM, Deionized water is used as a dielectric fluid. Material used for machining should be electrically conductive. Ceramic materials, Composite materials, Heat treated steels, High Nickel alloys and Carbides are easily machined by Electrical Discharge Machining.

2.1. Important Parameters of EDM:

(a) Spark on time (Ton): Spark on time is the duration for which the voltage pulse is applied. Removal of material and amount of energy applied for MRR is directly proportional to pulse on time.

(b) Spark off time (T_{off}): Spark of time is the duration at which the voltage pulse is shut off. During this duration molten materials solidify and wash out.

(c)Arc gap: It is the gap provided between electrode and work piece. It is maintained with the help of a servo system.

(d)Voltage (V): Voltage handles servo tool mechanism and it controls efficient working gap having fixed value. It affects the material removal rate and allows per cycle.

(e)Peak Current (Ip): Peak current is measured in amperage. Peak current is the most important machining parameter in EDM. High peak current improves MRR but damage surface finish and tool wear.

(f) Duty Factor: Duty factor is given in percentage of pulse duration relative to total cycle time. It is the ratio of spark on time to total cycle time.

$$T = (\mathbf{Ton}) \div (\mathbf{Ton} + \mathbf{Toff})$$

2.2. Design Variable: In design variable following parameters are considered.

Design Parameters: In design parameters following parameters are considered:

(1) MRR (2) TWR (3) OC

Machining Parameters: In machining following parameters are considered:

(1) Discharge Current (2) Spark on time (3) Diameter of tool electrode

Electrical Parameters: In Electrical parameters following parameters are considered:

(1) Duty cycle voltage (2) Flushing pressure (3) Polarity

3. Literature Review:

Purohit and Dhar [1] evaluate the effect of Current, Spark on time, arc gap voltage on MRR, ROC and TWR on EDM with Al-4Cu-6SiCp composites. ANOVA technique was used to find ROC, MRR and TWR all these parameters increase significantly in a nonlinear fashion with increase in current.

Satyanarayana and B. Mohan [2] evaluated the effect of EDM current, Electrode material, Polarity, pulse duration and rotation of Electrode on SR, MRR, and TWR. MRR increased with increase in discharge current and specific current, it decreased with increase in Pulse duration.

Yan Cherng [3] investigated the effects of machining parameters in EDM by using SKH57 high speed steel. Experiment was conducted with, L18, orthogonal array, based on Taguchi method. Furthermore, signal to noise ratios were determined by ANOVA and F-test. During experiment MRR increases with Peak current. MRR initially increases to peak at 100 microseconds and then fall.

J.Simao [4] developed surface modification by using EDM. Operation involves powder metallurgy tool electrodes and use of powder suspended in dielectric fluid, typically, Al, Ni, Ti etc. Experimental result was presented on surface alloying of AISI H13 hot work tool steel during die sinking operation using partially sintered tungsten/Cobalt electrodes operating in hydro carbon dielectric oil. Taguchi method was used to identify the effect of key operating factors on output measures.

Han and Lin [5] demonstrated study about tube electrode for an EDM drilling includes a stabilizer block and a mover. The stabilizer block had a sensor to detect whether the tube electrode is seated into stabilizer block or not to measure the available length of tube electrode before and after drilling.

4. Conclusion:

Mostly researchers conducted their experiments according to Taguchi method L-18, L-27, L-9 orthogonal array used to calculation and optimization of results, with different approaches such as, ANOVA, MINITAB and RSM software by using the machining set up, different shaped electrodes with dielectric flushing. Most research experiments were performed many times and weight of work piece, tool, and dimensional measurements of cavity are chosen for evaluation rate of material removal, rate of tool wear and OC BY controlling parameters like as Discharge current, Diameter of electrode and Spark on time.

1. To find out the observation result of rate of material removal discharge current is most influencing factor, then Pulse duration time and last is diameter of tool. Rate of material removal increases with increase in discharge current. As spark on time extended rate of material removal decreases monotonically.

2. In case of rate of tool wear most important factor is discharge current, diameter of tool and last is spark on time. Rate of tool wear increases with increase in Discharge current.

3. In case of OC dominating factor are discharge current, then diameter of tool and no effect of Spark on time. OC increases with increase in current.

5. References:

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