PARAMETER OPTIMIZATION ON EDM

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ABSTRACT

Spark erosion is a non-traditional machining process which is used to work hard material generally not machined by conventional machining process. The development of EDM technology started in the forties. Since then, it is the most important machining process in tool engineering. To achieve high removal rate and low electrode wear in sinking electrical discharge machining process (EDM), rough machining parameters have to be selected according to the size of the eroding surface. The EDM has become mature technology but the researches and improvements of the process are still going on. The response surface will be obtained for observing effect of variable parameters on output response. Comparison and the effect of dielectric fluid with abrasive powder of different size on the responses will be done.

Keywords: Dielectric fluid, Electrical discharge machining, Metal Removal Rate, Parameter selection, Tool Wear Rate.

I INTRODUCTION

Electro Discharge Machining (EDM) is an electro-thermal non-traditional machining process, where electrical energy is used to generate electrical spark and material removal mainly occurs due to thermal energy of the spark. EDM is mainly used to machine difficult-to-machine materials and high strength temperature resistant alloys. EDM can be used to machine difficult geometries in small batches or even on job-shop basis. Work material to be machined by EDM has to be electrically conductive.

In the mid 1980s.the EDM techniques were transferred to a machine tool. This migration made EDM more widely available and appealing over traditional machining processes. The new concept of manufacturing uses non-conventional energy sources like sound, light, mechanical, chemical, electrical, electrons and ions. With the industrial and technological growth, development of harder and difficult to machine materials, which find wide application in aerospace, nuclear engineering and other industries owing to their high strength to weight ratio, hardness and heat resistance qualities has been witnessed. 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. Non-traditional machining has grown out of the need to machine these exotic materials.

The machining Processes are non-traditional in the sense that they do not employ traditional tools for metal removal and instead they directly use other forms of energy. The problems of high complexity in shape, size and higher demand for product accuracy and surface finish can be solved through non-traditional methods.

Currently, non-traditional processes possess virtually unlimited capabilities except for volumetric material removal rates, for which great advances have been made in the past few years to increase the material removal rates. As removal rate increases, the cost effectiveness of operations also increase, stimulating ever greater uses of non-traditional process. The Electrical Discharge Machining process is employed widely for making tools, dies and other precision parts.

EDM has been replacing drilling, milling, grinding and other traditional machining operations and is now a well established machining option in many manufacturing industries throughout the world and is capable of machining geometrically complex or hard material components, that are precise and difficult-to-machine such as heat treated tool steels, composites, super alloys, ceramics, carbides, heat resistant steels etc. being widely used in die and mold making industries, aerospace, aeronautics and nuclear industries. Electric Discharge Machining has also made its presence felt in the new fields such as sports, medical and surgical, instruments, optical, including automotive R&D areas.

II PRINCIPLE OF EDM

In this process the metal is removing from the workpiece due to erosion by rapidly recurring spark discharge taking place between the tool and work piece. Fig. 1.1 shows the mechanical set up and electrical set up for electro discharge machining. A thin gap about 0.025mm is maintained between the tool and work piece by a servo system shown in fig 1.1. Both tool and workpiece are submerged in a dielectric fluid Kerosene/EDM oil/deionized water is very common type of liquid dielectric although gaseous dielectrics are also used in certain cases.

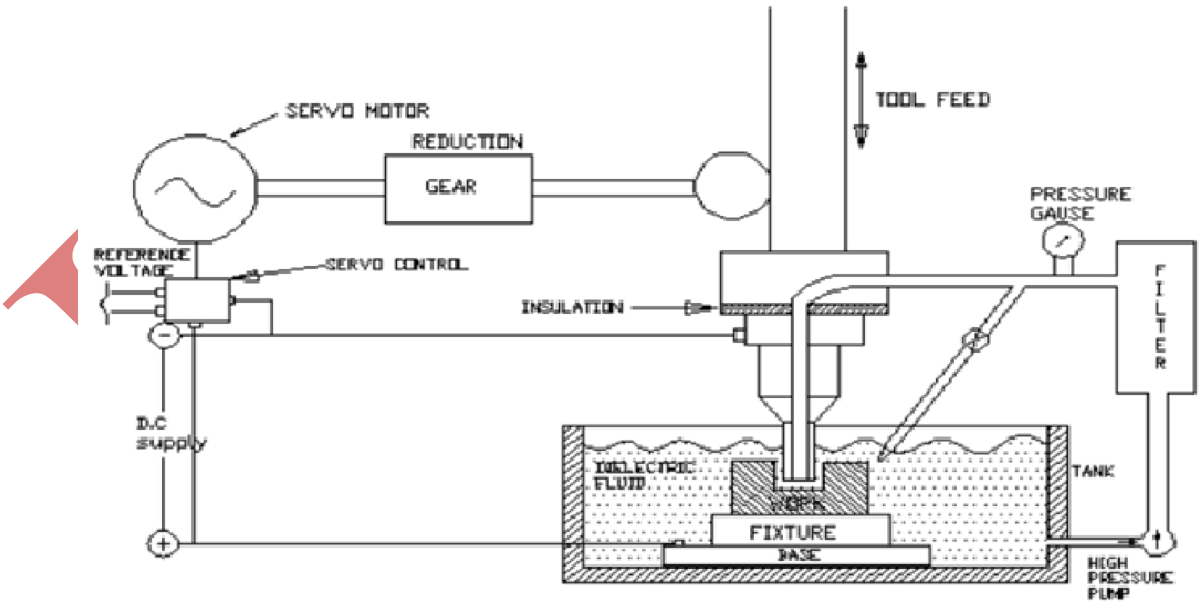

Fig 1.1: Set Up of Electric Discharge Machining

This Fig.1.1 is shown the setup of the Electric Discharge Machining. The tool is made cathode and workpiece is anode. When the voltage across the gap becomes sufficiently high it discharges through the gap in the form of the spark in interval of from 10 of micro seconds and positive ions and electrons are accelerated, producing a discharge channel that becomes conductive. It is just at this point when the spark jumps causing collisions between ions and electrons and creating a channel of plasma. A sudden drop of the electric resistance of the previous channel allows that current density reaches very high values producing an increase of ionization and the creation of a powerful magnetic field. The moment spark occurs sufficiently pressure developed between work and tool as a result of which a very high temperature is reached and at such high pressure and temperature that some metal is melted and eroded. Such localized extreme rise in temperature leads to material removal. Material removal occurs due to instant vaporization of the material as well as due to melting.

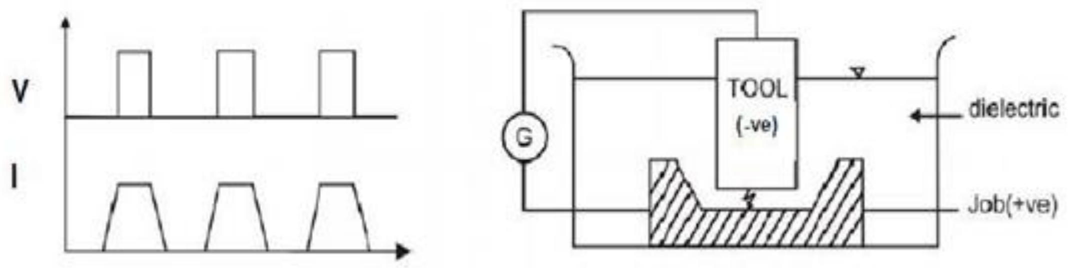

Fig.1.2: Working Principle of EDM Process

The molten metal is not removed completely but only partially. As the potential difference is withdrawn as shown in Fig. 1.2, the plasma channel is no longer sustained. As the plasma channel collapse, it generates pressure or shock waves, which evacuates the molten material forming a crater of removed material around the site of the spark.

III IMPORTANT PARAMETERS OF EDM

Following parameters will be the tentative input parameters for the actual experimentation.

3.1 Discharge current (current Ip): Current is measured in amperes allowed per cycle. Discharge current is directly proportional to the Material removal rate.

3.2 Voltage (V): It is a potential that can be measured by volt it is also effect to the material removal rate and allowed per cycle

3.3 Pulse time (Ton): The duration of time (μs) the current is allowed to flow per cycle. Material removal is directly proportional to the amount of energy applied during this on-time. This energy is really controlled by the peak current and the length of the on-time.

3.4 Pulse time (Toff): The duration of time (μs) between the sparks (that is to say, on-time). This time allows the molten material to solidify and to be wash out of the arc gap. This parameter is to affect the speed and the stability of the cut. Thus, if the off-time is too short, it will cause sparks to be unstable.

3.5 Duty cycle (τ): It is a percentage of the on-time relative to the total cycle time. This parameter is calculated by dividing the on-time by the total cycle time (pulse on-time pulse off time).

IV DIELECTRIC FLUID

In EDM, as has been discussed earlier, material removal mainly occurs due to thermal evaporation and melting. As thermal processing is required to be carried out in absence of oxygen so that the process can be controlled and oxidation avoided. Oxidation often leads to poor surface conductivity (electrical) of the work piece hindering further machining. Hence, dielectric fluid should provide an oxygen free machining environment. Further it should have enough strong dielectric resistance so that it does not breakdown electrically too easily but at the same time ionize when electrons collide with its molecule. Moreover, during sparking it should be thermally resistant as well.

V THE DIELECTRIC FLUID HAS THE FOLLOWING FUNCTIONS

a) It helps in initiating discharge by serving as a conducting medium when ionized, and conveys the spark. It concentrates the energy to a very narrow region.
b) It helps in quenching the spark, cooling the work, tool electrode and enables arcing to be prevented.
c) It carries away the eroded metal along with it.
d) It acts as a coolant in quenching the sparks.

VI OBJECTIVES

Spark erosion is a non-traditional machining process which is used to work hard material generally not machined by conventional machining process. It is difficult to Set the input parameter current, voltage, T on, T off for the required values of roughness so it is important to optimize the input parameters of machine and set the parameters for the better accuracy and control of machine.

Attempts are require to made to optimize the parameters for required value of Roughness using Design of Experiments and ANOVA are suggested for the better performance of machine.

VII METHODOLOGY

- Selection of tool steel material as a workpiece for machining by EDM and graphite as electrode material.
- Selection of operating parameters of EDM to be optimized.
- Conduction of experiments and finding values of operating parameters and tool wear rate.
- Optimization of input parameters using ANOVA and design of experiments.
  Cross checking of experimental values using Taguchi analysis.

VIII CONCLUSION

The research work aims at obtaining the effect of process parameters on yield output response. The generalized equation is to be formulated for each of the output response such as Metal Removal Rate (M.R.R.) and Tool Wear Rate (T.W.R.). The input process parameters used are voltage, current, pulse on time, and pulse off time. The optimization technique will be applied for finding out the best suitable parameters and its range for minimum tool wear and maximum metal removal rate (M.R.R.). To achieve high removal rate and low electrode wear in sinking electrical discharge machining process (EDM), rough machining parameters have to be selected according to the size of the eroding surface. The EDM has become mature technology but the researches and improvements of the process are still going on.

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