A Review Study of Thermal Electrical Model using ANSYS software

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ABSTRACT -In recent era, many of conventional machining process has grown out the need of machine exotic engineering metallic materials, composite materials, composite thermal alloys and high tech ceramics having good mechanical and thermal characteristics with sufficient electrical conductivity. So this paper presents to design a thermal-electrical model for sparks generation by using electrical discharge manufacturing process and also used to determine the temperature distribution curve. Apart this, thermal-electrical model is designed and analyzed by using ANSYS software. In addition, also to determine Material Removal Rate, Surface Roughness and the maximum temperature parameters by mathematical model to validate the ANSYS software.

Keywords: Thermal-Electrical Model, Material Removal Rate, Surface Roughness.

1. INTRODUCTION

With the 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 necessary electrical magnetic conductivity so that they can readily be assembled by spark erosion. Outdated machining technique has grown out of the need to manufacture

these exotic materials. The machining processes are not used in traditional in the sense, so that they do not use traditional tools for metal removal and instead they directly use another forms of potential energy. The process of manufacture is difficult in nature, so complication is complex in shape, size parameters, and also in higher demand for product preciseness and exterior finish can be done through outdated traditional techniques. 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 As removal rate enhanced, the cost value of operations also add to, stimulating ever greater uses of outdated traditional process [1]. The Electrical free manufacturing process is implemented widely for making tools, dies and other precision parts.

Electrical Discharge mechanized procedure has been opted by current procedures such as drill, milling, grind and other unadventurous manufacturing operations and is now a well established machining and assembling options in many developed industries throughout the world. Modern Electric Discharge equipment developed in late 1940's has been widely accepted worldwide as a standard process in manufacturing and assembling, also it is capable of machining geometrically exterior finishing which make it hard problem in nature or hard material mechanism, that are specific and complex-to-manufacture such as heat treated tools steels, composite, super alloys, earthenware, hastalloys, nitralloy, nemonics, carbides, heat resistant steels etc. being widely used in die and moulding making industries, aerospace, aeronautics and nuclear industries [2].

Principle of Electrical Discharging Machining: Thermo-electric character is sensed by electrical discharging manufacturing process and also helps to root out the substance from the work piece by continuous distinct spark between tool and work electrodes which are dipped in a electric medium. The polar electrode is transferred towards the work piece in anticipation of the gap is small enough to ionize the dielectric medium. Small timing duration degradation of charge is generated in a liquid state dielectric gap, which separates out tool and work piece. The dielectric fluid makes it possible to flush eroded material substances from the gap and it is really significant to maintain this flushing from very beginning to later on. The material is removed with the bleaching effect of the electrical mechanical discharging properties from tool and work piece. As the electrode and work piece have no direct relation who eliminate mechanical stresses, prattle and suspensions problems in their nature during manufacturing process. Since rusting led erosion problems is produced by electrical discharges, due to electrically conductive in nature. In this whole procedure, the assembling unit forces are much smaller than that in current cutting processes, because molten substance can be eradicate with a very small thrust. Traditional electric machining uses electric and mechanical power by discharge in a continuous manner which leads a result of dielectric breakeven point between positive tool electrode and negative work process.

I. LITERATURE REVIEW

Drayl D.Bitonto et al. [3], presented a simple electrode based erosion model for electric discharge manufacturing process. This point heat-source model accepts power rather than temperature as the boundary condition at the plasma/cathode interface. Mukund R.Patel et al. [4], presented an erosion model for anode material. The model accepts power rather than temperature as boundary condition at plasma/anode interface. P. Madhu et al. [5], proposed a model for predicting the material removal rate and depth of damaged layer during EDM. The transient heat conduction equation for the work piece which accounts for the heat absorption due to melting has been solved by Finite Element Method. Philip T. Eubank et al. [6], designed a dynamic mass, cylindrical shape plasma model for sparks generation by electric discharge in a state of liquid. Indrajit Basak et al. [7], developed a simplified model to predict the features of the sample removal rate by changing the input parameters with the objective to find the possibility of increasing the power of the electrochemical discharge manufacturing process and it has been concluded that an extra control parameter can be generated by designing an additional inductance parameter in the circuit. J.C. Rebelo et al. [8], also showed an experimental based study to find EDM parameters to check the volume material removal rate (MRR) and surface quality, when manufacturing high strength copper-beryllium alloys. So this paper has undertaken to develop a thermal-electrical model for sparks generated by electrical discharge in a liquid media.

II. SIMULATION ENVIRONMENT

Copper and En-19 was used as sample in electric discharge test. The copper is used worldwide with the electrode substances. The single discharging analysis process implement the commercial finite element code ANSYS Multiphysics software to determine both temperature graph distribution and deformation of molten substances by plasma pressure in curve form. ANSYS is a generally a software based simulator to use finite element code to solve engineering and architectural based problems. The thermal procedure has been carried out when the electrical discharge constraints of machining met and the material properties were given. The heat flux intensity varied with discharge gap current trace and the diameter of plasma. During the discharge on-time, the melting region and the evaporating region were found. The material was assumed that certain part whose temperature goes over the evaporating point would be removed. Material properties for the tool, work piece and discharge channel was set as input values. The boundary conditions were given as nodal variables. Based on the governing equations, the loading conditions applied were temperature and voltage which varied between nodes. Considering these properties the simulation was carried out for a single discharge. Actual electric discharge assembling process consists of cycle having OFF Time and On Time parameters.

III. EXPERIMENTAL DETAILS

This section deals with the experimental details and procedure followed for the machining and estimation of material removal rate. The model named as ELECTRONICA- ELECTRAPULS PS 60ZNC served as electric discharge assembled unit with servo-head against constant gap with positive polarity for electrode, which was used to conduct the implementation of manufacturing units. Industrial grade electric discharge manufacturing oil (specific gravity= 0.873, freezing point= 84°C) was used as dielectric aqueous in nature. Experiments were conducted with positive polarity of electrode. The pulsed discharge current parameter was provided through different steps in positive and negative mode cycle. The electrode made up of copper was machined in cylindrical shape on a lathe machine and brazed with mild steel. Diameter of the electrode was 30mm and thickness 40mm. The work piece material is En-19 with diameter 50mm and thickness 10 mm. All surfaces were ground finished. The initial weight of the work piece material was measured.

IV. RESULTS

A graph showing the material removal rates with varying current conditions and different T_{on} values is presented in Fig. It indicates that for T_{on} =100, with increase in current the material removal rate increases. As the current enhanced consequently volume of material removal rate is also increased and hence the Material Removal Rate is also increasing for T_{on} = 150 and 200. The material removal rate increases with T_{on} for same current which is obvious. As the T_{on} parameter increase spark time also increases, and in the discharge channel more energy is released and consequently the material removal rate also increases.

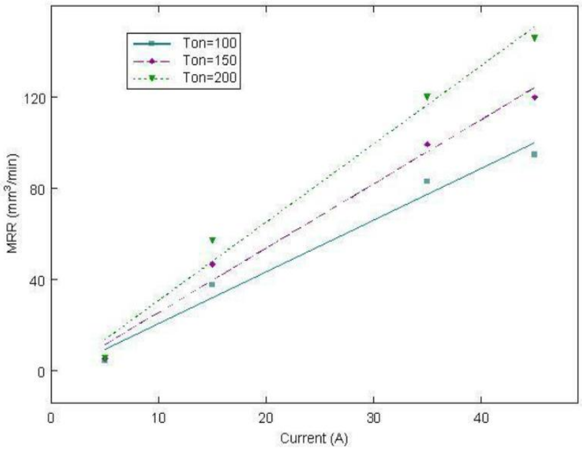

Fig-1: Material Removal rates with varying current conditions for Experiment.

V. CONCLUSION

In the present paper, the Joule heating factor was used to model the EDM process and predict the maximum temperature reached in the discharge channel. The temperature distribution curve showed that the volume of material removal rate from the work piece increases and R_{max} was easily estimated from the temperature distribution curve. Experiments were conducted with different pulse on-time (T_{on}) and current values and the material removal rate was calculated. Material removal rate increases with the increase in current. Also Maximum surface roughness (R_{max}) increases with the increase in current. From the experiments conducted it is also observed that, the volume of material removed and material removal rate is calculated and its trend in variation with current is in agreement with FEA results.

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