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Research Article

A Literature Review on Modeling and Simulation of Crater Dimension in Electrical Discharge Machining

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Abstract
A comprehensive model of electrical discharge machining has been used for simulating the crater size during the process for materials Aluminum, Brass and die steel D2. It is very difficult by theoretically to analysis temperature distribution in whole work -piece because of its complexity process and a single discharge is occurs very short time. A novel model proposed with realistic condition such as plasma radius, Gaussian heat flux and temperature dependent properties and this model use software ABAQUS 6.2. In this work piece crater diameter and depth is predicted on the basis of simulation. FEM model show the variation of crater size (temperature distribution) with variation in input parameter. In model, increasing discharge energy causes crater size increase means MRR and surface roughness increases. In this model, simulation show better result with experimental result and error is taken under consideration like 13 to 20% which is better result in present research scenario.

Keywords: Electrical Discharge Machining, FEM model, ABAQUS 6.2, Crater Size, MRR, Surface Roughness.

1. Introduction

Electrical discharge machining is a most used non-traditional machining processing which allthermal energy produced by spark is utilize for remove the material from the work piece. In this EDM process the work piece as anode and tool as cathode is separated by small gap, thisgap is known as spark gap. The work piece and tool are sinking in dielectric medium. Initially dielectric medium is work as insulated medium. the electric power is supply between the gap of tool and work piece when intensity of power supply is greater than intensity of dielectric itcauses breakdowns to create plasma channel comprise of electron and positive ion between the tool and work piece. These electrons and ions are accelerated by electrical field after they affect the high velocity electrodes. In localized heating, it causes the removal of materials by melting and evaporation on high temperature anodic and cathodes surfaces of a very small area. But molten material is not flushes completely into a realistic condition, and some of the molten material is still present in the work piece that solidified and reworked the work piece. It causes HAZ due to high temperature gradient. Fig.1 shows schematic diagram of EDM, radius of plasma is maximum at anode compare cathode. Hence maximum material is removed fromanode surface.

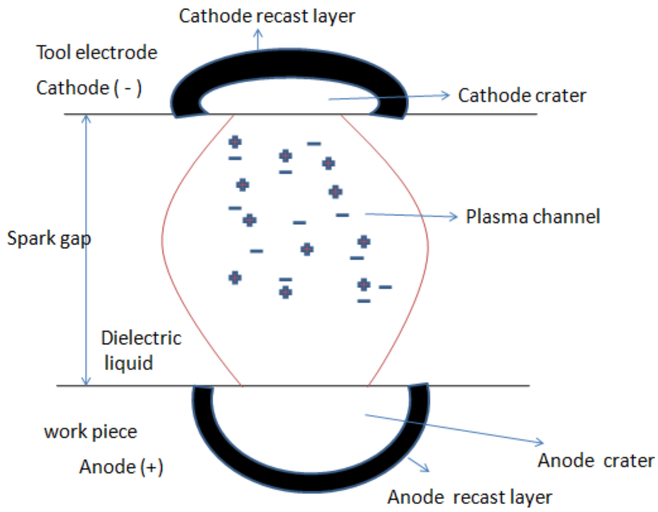

Fig.1 Schematic diagram of EDM

During machining some phenomenon has happened like, heat conduction, heat convection, plasma formation, heat radiation, shock wave generation and HAZ, which cannot understand by ordinary method because of its complexity many scientists have tried both numerical and analytical techniques to model and simulation the spark erosion system. In order to estimate crater sizes, when the working parameters are known to the most prominent analyses, are given a cathode regression template. However, numerical designs for the spark formation phase which followed, because of the chance of more realistic assumptions regarding real functioning of EDM, have been suggested for a stronger forecast of crater sizes. Scientists have used a variety of techniques, including the Finite Element method, the Finite Differential approach (FDM), among the numerical modeling techniques. In EDM simulation, FEM is regarded as the most common. It has attempted to replicate spark release for one of the first FEM application. During a spark discharge, we assessed the temperature and thermal losses induced by the flow of water into the work product. Significant compressive and pressure values were discovered around the flow surface in a thin layer which could harm the surface also used FE modeling in other works to evaluate crater sizes, stage changes and remaining pressures that happened on the cathode ground following the freeing of sparks. It proposed that a more realistic strategy should be taken during the FE simulation, such as dependent material property temperature, the incorporation of latent fusion temperatures, Gaussian allocation, present spark radius values, and release time. The FE survey was performed to evaluate the impact of multiple working parameters on the temperature distribution at cathode. With increasing values of the working parameters such as current, voltage and working cycles, the temperatures and thus the size of the holes were demonstrated to improve continually. The sizes of the crater nevertheless indicate a rise in importance to a large dump. For further rise in the release time, crater sizes reduce. It has given a template for predicting recast coating density (RLT) based on thermal effectiveness (PFE) according to the liquid present and pulse time release. They indicated that present PFE rises with increased release and pulse reduces on moment.

Different writers have attempted to draw true statements about their FE model so that the real EDM method is approached. However, apart from those assumptions, the varying nature in the single-spark system also must take into account the variables such as the cathode power percentage (CE) and PFE with working parameter. Although it. takes into concern the varying size of FC and PFE with discharge current and discharge in time, PFE is an adjustable word for calculating crater sizes following simulations. However, it should be included in the simulation in perspective of the varying size of PFE as a correction word in order to prevent the shape / profile of the pit. A correct forecast for the crater shape is crucial in the application of this template for various feature situations for the assessment of the ground texture in various working circumstances. The objective of this job is thus to create an EDM system to forecast the crater profile achieved during the EDM phase, taking into account the above significant elements. In the last few decades, EDM has non-traditionally been used in machining materials that are electro-conductive or difficult to manufacture like Ti6Al4V or tungsten and innovative for the implementation of technological advancements. The tolerance conditions for different parts of these products have become progressively stringent. In personal parameter sparks, this enables precise forecast in crater sizes to make the EDM method precise.

2. Literature Review

Salah et al. [1]

In the case of applied two-dimensional (2D) finite differential scheme in the study of the EDM temperature distribution and the MRR obtained was the result of the one- off discharge. The use of temperature-based thermal conductivity has been shown to be crucial to increase modeling precision and better fit experimental results than if a constant conductivity is to be assumed.

Shankar et al. [2]
A broad effort to analyze the spark profiles was made based in the Finite Element Method (FEM), and reported the non-cylindrical plasma form with the minimum cross-sectional region in the middle of a discharge feed. Its results are, yet, in conflict by the experimental evidence mentioned in highly developed technological installations that reveal anon-cylindrical drum shape of plasma channel.

Marafona and Chousal [3]
He developed an electrical-thermal model that considered Joule heating effect as the main thermal energy source, using the FEM software Standard. A good agreement was reached on anode and cathode erosion levels when comparing the results with those of the experimental values reported by AGIE SIT Corporation, USA. On the other hand, the result of latent heat of melting was unseen and a uniform material property was used as well.

Ahn and Chung, [4]
Numerical analysis was accepted out with variable release and duty cycles of unstable move toward on the alumina-titanium carbide composites underneath the EDM condition. Increased current intensity and duties were found to lead to higher erosion rates.

Bitonto et al. [5]
For EDM process, a cathode erosion model was developed with power as the boundary condition and optimum pulse time facteur as process parameters at the plasma / cathode interface.

Rebelo et al. [6]
MRR and surface quality during machining of copper beryllium alloys of high strength have been investigated. Different thermal erosion models were discussed in view of optimal parameter settings. Surface quality and MRR are affected by the polarity in the electrodes.
The increase in current and time discharge increases the ruggedness of the surface for roughand final systems.

Patel et al. [7]
He has developed an anode material erosion model considering the boundary condition of power on plasma. The heat flux distributed by Gaussian in the anode area is regarded as being growing with time.

Yadav et al. [8]
A finite-element method model has been created to predict temperature and thermal stresses given the high temperature gradient created during EDM at gap. Following a single spark, compressive and tensile stresses develop around the spark and thermal stresses lead to crack formation by overcoming the work piece's output strength.

Bhondwe et al. [9]
During electro-chemical spark processing, he developed a thermal model for MRR. As the concentration of electrolytes increases with ECSM of soda lime glass material, MRR also increases and reaches more than alumina. With an increasing duty factor for soda lime glass and alumina work piece, MRR and energy partition increase.

Marafona et al. [10]
The thermal models for sparks produced by EDM were developed. The anode and cathodium respectively were copper and iron. Driver effect of the EDM process is regarded as the driving phenomenon. The black layer formed as one of carbon and other elements such as iron, chromium, vanadium or molybdenum during workmanship has been highlighted. The equivalent carbon in the black layer was found to influence the wear of the tool.

Kansal et al. [11]
The Finite Element Method (FEM) was used to develop a two-dimensional PMEDM model to forecast the effect of the mechanism for temperature and material removal. The model employs temperature sensitive material characteristics, shape and size of heat source, percentage distribution of heat in a tool, dielectric and working part, time-on / off

pulses, material ejection efficiency and phase change. The model uses heat sensitive material properties.

Bhattacharya et al. [12]
Defined the H-11 PMEDM process Finite Element Simulation Model. A simulated temperature profile was used to evaluate the volume of material removed from an individual crater. Prediction of the cooling rate and calculation of thermal load stresses were calculated using the model.

Izquerdo et al. [13]
He performed the EDM process simulation and modeling with a finite differential method. Numerically calculated the different temperature distributions are generated by the overlay ofseveral dumps in the work piece.

Dhar et al. [14]
Use a model to determine the effect on selected responses of al–4Cu–6Si alloy–10 wt.percent SiCP composites of the electric discharge machines. Khazrazi et al. (2016) [138] have been studying the effect of PMEDM parameters on refreshing surface using copper and graphite electrodes. With the help of FEM simulation models, the total heat flow and fatigue failure of the EDM and PMEDM process have been analyzed.

3. Analysis of Literature Review

A lot of research has been done on modeling and simulation of crater dimension in electrical discharge machining. Some of researcher follow the flush efficiency is 100% and thermal properties of material is constant throughout process therefore It has difficult to predict accuracy of simulation result in FEM model close to the experimental result. But current research scenario a very few researchers are working, and they are taken the flush efficiency is function of pulse on time and discharge current and thermal property is function of temperature to meet accuracy of result with experimental result. In this FEM model I have used three material Almunium, Brass and Die steel d2 to predict the crater size and effect of same input parameter in theses material, what temperature distribution occurs and what changes in crater dimension.

Conclusion

For the simulation of a single spark in EDM, a finite element model is proposed. The outstanding characteristics of this model include real assumptions such as with a distribution of Gaussian heat flux, discharge-on-time and current plasma channel range, temperature dependent material properties, latent fusion heat, and a inconsistent cathode power and plasma flush efficiency. The results of this work are as follows:

a. From above result at same input parameter, we consider that generation of crater profile is not only functioning of input parameter it also the function of temperature dependent materials property.

b. The radius of craters and depth of craters increase as operating parameter values such as pulse current and pulse on time increase. It is because the input pulses and the input heat flow time are increased.

c. At low discharge time and discharge current the craters aspect ratio displays a high value. This is because the radial heat distribution is significantly bigger at lowoperational parameters values.

d. A FEM model for single spark has been simulated with error 12.5% to 20% with realistic model and condition. As current research scenario error accounted during simulation is considerable.

Conflict of interest

The author declares no conflict of interest.

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