Thermal Model for Single Discharge EDM Process Using Comsol Multiphysics

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Abstract

Electrical Discharge Machining (EDM) process is a non-conventional process used for machining electrically conducting materials. In die sink-EDM, sparks are generated between tool and workpiece resulting in heating of both electrode surfaces creating a melt pool of metal which leads to generation of new surfaces on cooling. An attempt has been made to study the temperature profiles and residual stresses prevailing in the electrodes during single discharge EDM on the basis of Heat Conduction and Joule Heating physics. Predictions of temperature profiles and residual stresses obtained from this can then be compared with experimental data and it can further be useful in determining the optimal operating conditions for the process.

Simulations used to obtain temperature profile have been performed using Joule Heating (jh) and Heat Transfer in Solids (hs) modules of Comsol Multiphysics. 2D Axisymmetric geometry (Figure 1) has been used for modeling cylindrical electrodes so as to reduce some computational efforts. A Graphical User Interface (GUI shown in Figure 2) is also created based on Livelink with Matlab feature which extracts results from Comsol and plots isotherm radius and depth using the same. This GUI can also be used to modify geometrical parameters, heat flux properties, power input, equations of plasma channel expansion, fraction of energy transferred to electrodes and temperature dependent material properties in the model. Thermal Stress (ts) module is then used to obtain residual thermal stress prevailing in the electrodes after machining.

There are three types of results available from single spark model: 1. Isotherm plot obtained for workpiece and tool 2. Graph for particular isotherm width vs. time at surface of electrode and depth vs. time of the same along central axis 3. Residual thermal stress results. Figure 3(a) refers to isotherm plot from one of the results obtained by revolution around axis of symmetry and 3(b) refers to plot for thermal stress. Figure 4 refers to graph of 700 degC isotherm width vs. time at surface of workpiece.

Model can provide good predictions for temperature profiles and also for residual stresses. Dependence of temperature profile on various factors such as plasma expansion, energy transfer, etc. can also be shown and comparison can be done between them. Residual Stresses as observed from model are quite high in the central portion resulting in the formation of cracks. The model can be a useful guide to an EDM researcher for better understanding of process.
Future work includes improving upon the model so as to reach as close as possible to experimental

results.

Reference

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Figures used in the abstract

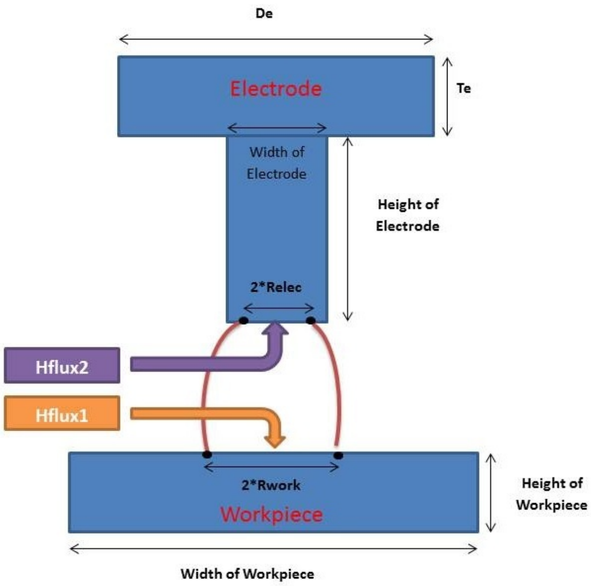

Figure 1: Geometry and Various parameters involved in model

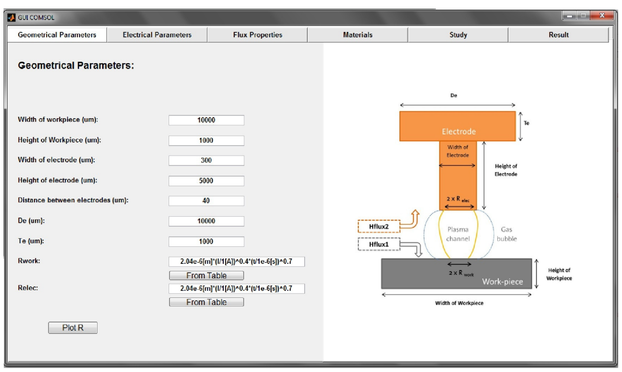

Figure 2: Matlab GUI

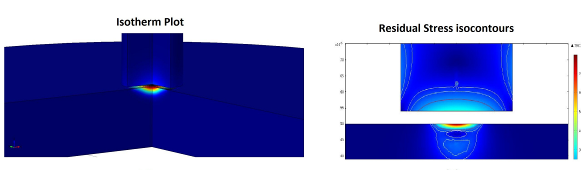

Figure 3: Plots (Results)

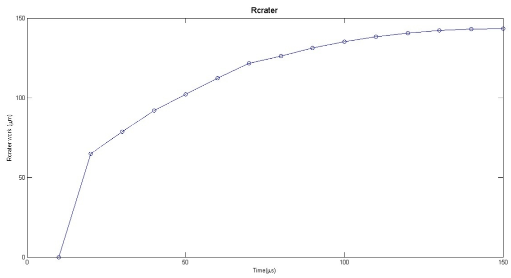

Figure 4: Crater radius vs. time (graph)