Numerical Simulation of Optimizing Process Parameters of Micro Wire EDM of Al-SiC

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Introduction: Advancements in various fields is resulting in need for materials that possess a high strength, low weight, a good thermal conductivity, high corrosion resistance etc.., Hence the usage of Al-SiC alloy has increased in recent times. But there is a major challenge in machining this metal matrix composite. This paper mainly concentrates on the effects of certain parameters on Wire EDM, one of the most optimal methods for machining these composites.

•**Computational Methods**: The numerical model is created using FEM, one of the best methods to avoid costly trial and error techniques. The simulation of the temperature profile is done here where the heat source is assumed to be Gaussian pulse. The governing equations are as follows.

$$\rho C_p \frac{\partial T}{\partial t} = \left[\frac{1}{r}\frac{\partial}{\partial r}\left(Kr\frac{\partial T}{\partial r}\right) + \frac{\partial}{\partial z}\left(K\frac{\partial T}{\partial z}\right)\right]$$

$$Q(r) = \frac{4.57VIf}{\pi R^2} e^{-4.5(r^2/R^2)}$$

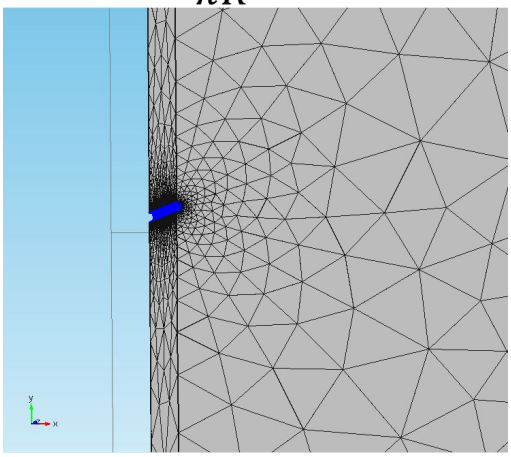

Figure 1.Extremely fine mesh used in analysis

Results: From the simulation, the temperature distribution profile is obtained. By conducting series of experiments, the effect of voltage and current on MMR in noted. It is observed that increase in either of them results in increase of MRR while keeping other as constant.

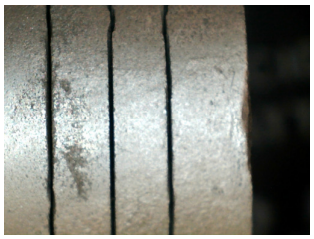

Figure 2.Current(3, 2,1) at 75V

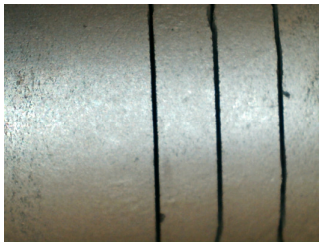

Figure 3.Current(3,2,1)A at 65V

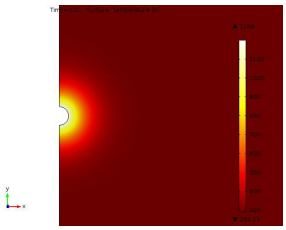

Figure 4. Temperature Distribution

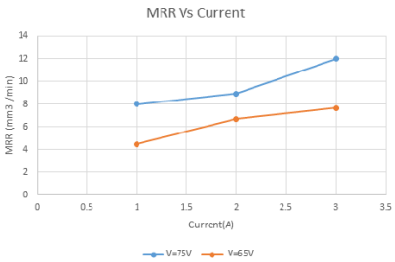

Figure 5. Effect of Current, Voltage on MRR

Conclusions: The increase in current at a particular voltage has an increased kerf width and material removal rate. Increase in voltage increases the material removal rate but causes a rough machining. Thus high current and low voltage produces good machining of the composite in lesser time

References:

1. Das, S. "Development of aluminium alloy composites for engineering applications." *Trans. Indian Inst. Met* 57.4 (2004): 325-334.
2. Yan, Cui, Wang Lifeng, and Ren Jianyue. "Multi-functional SiC/Al composites for aerospace applications." Chinese Journal of Aeronautics 21.6 (2008): 578-584.
3. Manna, A., and B. Bhattacharayya. "A study on machinability of Al/SiC-MMC."*Journal of Mater Materials Processing Technology* 140.1 (2003): 711-716.
4. Allen, Philip, and Xiaolin Chen. "Process simulation of micro electro-discharge machining on molybdenum." *Journal of materials processing technology* 186.1 (2007): 346-355.
5. Kansal, H. K., Sehijpal Singh, and Pradeep Kumar, Numerical simulation of powder mixed electric discharge machining (PMEDM) using finite element method, Mathematical and Computer Modelling 47.11:1217-1237 (2008).
6. D.D. DiBitonto, P.T. Eubank, M.R. Patel, M.A. Barrufet, Theoretical models of the electrical discharge machining process, A simple cathode erosion model, Journal of Applied Physics 66 (9) 4095-4103, (1989)