OPTIMIZATION OF PROCESS PARAMETERS FOR ELECTRIC DISCHARGE MACHINING OF HYBRID COMPOSITES

D. Nikshitha

M. Tech (AMS), Roll No.:20011P0308, Department of Mechanical Engineering, JNTUH College of Engineering, Hyderabad

Under the Guidance of Dr. A. Chennakesava Reddy, Senior Professor, JNT University Hyderabad

ABSTRACT

1. Topic Overview:
The project focuses on Electric Discharge Machining (EDM) of a hybrid metal matrix composite (HMMC) — specifically Al7075 reinforced with 8% SiC and 4% BN — fabricated using electromagnetic stir casting.

2. Relevance:
The study is highly relevant for aerospace, automotive, and defense applications, where high-strength and lightweight materials are critical. The composite's enhanced mechanical and thermal properties make traditional machining methods ineffective — thus, EDM is a logical choice.

3. Methodology:
- Material: Al7075 + 8% SiC + 4% BN
- Fabrication Method: Electromagnetic stir casting
- Machining Method: EDM with copper electrode (12 mm diameter), using EDM oil
- Design of Experiments: Taguchi L9 orthogonal array
- Process Parameters: Current, pulse-on time, pulse-off time, electrode gap
- Analysis Tool: ANOVA + Regression modeling + Contour plots

4. Key Results:
- Maximum MRR (Material Removal Rate): 0.0432 g/min
- Maximum TWR (Tool Wear Rate): 0.0066 g/min
- Most Influential parameter is pulse-on-time which contributes 46.55% to MRR and 55.58% to TWR. Minor influence is electrode gap and pulse-off-time.

The optimal parameter combination for achieving high MRR and low TRR is
- Current: 20 A;
- Pulse-on time: 300 □s;
- Pulse-off time: 50 □s; and
- Electrode gap: 0.1 mm.

5. Conclusions:
EDM is effective for machining Al7075–SiC–BN composites
Multi-objective optimization is crucial for balancing material removal and tool wear.

REFERENCES

1. A. C. Reddy, Wear and Mechanical Behavior of Bottom-Up Poured AA4015/Graphite Particle-Reinforced Metal Matrix Composites, 6th National Conference on Materials and Manufacturing Processes, Hyderabad, 120-126, 2008.

2. A. C. Reddy, Investigation of the Clustering Behavior of Titanium Diboride Particles in TiB2/AA2024 Alloy Metal Matrix Composites, 4th International Conference on Composite Materials and Characterization, Hyderabad, 216-220, 2003.

3. A. C. Reddy, Effect of Clustering Induced Porosity on Micromechanical Properties of AA6061/Titanium Oxide Particulate Metal matrix Composites, 6th International Conference on Composite Materials and Characterization, Hyderabad, 149-154, 2007.

4. A. C. Reddy, Finite Element Analysis Study of Micromechanical Clustering Characteristics of Graphite/AA7020 Alloy Particle Reinforced Composites, 4th International Conference on Composite Materials and Characterization, Hyderabad, 206-210, 2003.

5. B. Kotiveerachari and A. C. Reddy, Interfacial effect on the fracture mechanism in GFRP composites, CEMILAC Conference, India, 85-87, 1999.

6. S. Madhava Reddy and A. C. Reddy, Evaluation of process parameters on surface roughness and residual stresses in high-speed end milling of Al-Si-Mg-Fe alloy, International Journal of Advances in Machining and Forming Operations, ISSN: 0975-4784, Vol. 3, No. 1, pp. 57-70, 2011.

7. P. Laxminarayana and A. C. Reddy, Nonlinear finite element modeling of machining process to minimize distortion in forged turbine disk, National Conference on Computer integrated Design and Manufacturing, Coimbatore, 28-29th November 2003, 97-102.

8. S. Madhava Reddy and A. C. Reddy, Studies on machining characteristics of silicon nitride ceramics, National Conference on Advanced Materials and Manufacturing Techniques, Hyderabad, 08-09th March 2004, 88-90.

9. Naresh Baki, A. C. Reddy, and Thella Babu Rao, Selection of optimal process parameters in wire-electrical discharge turning while machining Ti-6Al-4V alloy, International Conference on Advanced Materials and Manufacturing Technologies, Hyderabad, 18-20 December 2014, 147-157.

10. S. Madhava Reddy, A. C. Reddy, and K. Sudhakar Reddy, Latest developments in condition monitoring of machining operations, Journal of Applied Sciences, ISSN: 1812-5654, Vol. 12, No. 10, pp. 938-946, 2012.

11. K. Shiva Kumar and A. C. Reddy, Experimental Investigation on Mechanical and Tribological Properties of Mgo/Abs Polymer Composites, International Journal of Mechanical and Production Engineering Research and Development, 10(1), 449-458, 2020.

12. V. K. Reddy and A. C. Reddy, Mathematical Models for Dry Wear of H18 Heat Treated AA1100/TiB2 Composites, 3rd International Conference on Modern Materials and Manufacturing, New Delhi, 341-346, 2011.

13. A. C. Reddy, Evaluation of surface roughness using image processing technique, International Conference on Systemics Cybernetics and Informatics, Hyderabad, 571-573, 2004.