Abstract

Wire Electro Discharge Machining (WEDM) is a widely used non-traditional machining process for precision machining of conductive materials. This abstract focuses on the modeling and optimization of WEDM for Al 7075, a high-strength aluminum alloy. The objective is to enhance the machining performance, surface quality, and dimensional accuracy of Al 7075 components through an optimized machining process.

This research presents a comprehensive investigation of various process parameters and their influence on the machining performance of Al 7075 in WEDM. The parameters studied include dielectric conductivity, open circuit voltage, pulse on time, pulse off time, pulse frequency, arc on time, arc off time, wire tension, servo voltage and servo sensitivity. The Taguchi experimental design methodology is employed to systematically vary these parameters and evaluate their impact on the machining characteristics.

This study also involves the development of a mathematical model to predict the machining performance indicators such as cutting speed (C_S), corner error (C_E), overcut (∂) and surface roughness (R_a). The model is based on the non-linear regression analysis. The model facilitates the identification of the optimal parameter combination for achieving the desired machining performance.

To further enhance the optimization process, a multi-objective genetic algorithm (MOGA) is utilized. This algorithm considers multiple conflicting objectives simultaneously, including maximizing cutting speed and minimizing surface roughness and corner error. The MOGA generates a set of Pareto optimal solutions, representing the trade-off between the different objectives, enabling the selection of the most suitable machining parameters.

The experimental results and optimization outcomes are presented and discussed, highlighting the significance of the proposed modeling and optimization techniques. The optimized machining parameters obtained through the combined approach of the mathematical model and MOGA lead to improved machining performance and surface quality for Al 7075 in WEDM.

In conclusion, this research provides valuable insights into the modeling and optimization of WEDM for Al 7075. The findings contribute to the advancement of machining processes for high-strength aluminum alloys, enabling the manufacturing of components with enhanced precision, efficiency, and quality. The developed mathematical model and optimization approach can serve as a foundation for future research and practical applications in the field of WEDM.