Multi-Response Optimization of Electrochemical Machining Parameters for Inconel 718 via RSM and MOGA-ANN	
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Publication Year	2024
Grant Number	IMSIU-RG23023
DOI link	10.3390/machines12050335

Abstract: Inconel 718's exceptional strength and corrosion resistance make it a versatile superalloy widely adopted in diverse industries, attesting to its reliability. Electrochemical machining (ECM) further enhances its suitability for intricate part fabrication, ensuring complex shapes, dimensional accuracy, stress-free results, and minimal thermal damage. Thus, this research endeavors to conduct a novel investigation into the electrochemical machining (ECM) of the superalloy Inconel 718. The study focuses on unraveling the intricate influence of key input process parameters—namely, electrolytic concentration, tool feed rate, and voltage—on critical response variables such as surface roughness (SR), material removal rate (MRR), and radial overcut (RO) in the machining process. The powerful tool, response surface methodology (RSM), is used for understanding and optimizing complex systems by developing mathematical models that describe the relationships between input and response variables. Under a 95% confidence level, analysis of variance (ANOVA) suggests that electrolyte concentration, voltage, and tool feed rate are the most important factors influencing the response characteristics. Moreover, the incorporation of ANN modeling and the MOGA-ANN optimization algorithm introduces a novel and comprehensive approach to determining the optimal machining parameters. It considers multiple objectives simultaneously, considering the trade-offs between them, and provides a set of solutions that achieve the desired balance between MRR, SR, and RO. Confirmation experiments are carried out, and the absolute percentage errors between experimental and optimized values are assessed. The detailed surface topography and elemental mapping were performed using a scanning electron microscope (SEM). The nano/micro particles of Inconel 718 metal powder, obtained from ECM sludge/cakes, along with the released hydrogen byproducts, offer promising opportunities for recycling and various applications. These materials can be effectively utilized in powder metallurgy products, leading to enhanced cost efficiency.