Multi-Response Optimization of Wire Electrical Discharge Machining for Titanium Grade-5 by Weighted Principal Component Analysis

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Abstract

This paper reports the results of research to examine the effects of cutting parameters such as pulse-on time, pulse-off time, servo voltage, peak current, wire feed rate and cable tension on surface finish, overcut and metal removal rate (MRR) during Wire Electrical Discharge Machining (WEDM) of grade-5 titanium (Ti-6Al-4V). Taguchi's L_{27} orthogonal design method is used for experimentation. Multi-response optimization is performed by applying weighted principal component analysis (WPCA). The optimum values of cutting variables are found as a pulse on time 118 µs, pulse off time 45 µs, servo voltage 40 volts, peak current 190 Amp. , wire feed rate 5 m/min and cable tension 5 gram. On the other hand, Analysis of Variance (ANOVA), simulation results indicate that pulse-on time is the primary influencing variable which affects the response characteristics contributing 76.00%. The results of verification experiments show improvement in the value of output characteristics at the optimal cutting variables settings. Scanning electron microscopic (SEM) analysis of the surface after machining indicates the formation of craters, resolidified material, tool material transfer and increase in the thickness of recast layer at higher values of the pulse on time.

Keywords: WEDM, titanium grade-5, Taguchi method, weighted principal component analysis, ANOVA, SEM analysis.

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