Modeling and optimization of parameters for minimizing surface roughness and tool wear in turning Al/SiCp MMC, using conventional and soft computing techniques

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ABSTRACT

Aluminium alloy with silicon carbide particulate (Al/SiCp) reinforced metal matrix composite (MMC) are used within a variety of engineering applications due to their excellent properties in comparison with non-reinforced alloys. This presented work attempted the development of predictive modeling and optimization of process parameters in the turning of Al/SiCp MMC using a titanium nitride (TiN) coated carbide tool. The surface roughness Ra as product quality and tool wear VB for improved tool life were considered as two process responses and the process parameters were cutting speed v, feed f, and depth of cut d. Two modeling techniques viz., response surface methodology (RSM) and artificial neural network (ANN) were employed for developing Ra and VB predictive models and their predictive capabilities compared. Four different RSM models were tried out viz., linear, linear with interaction, linear with square, and quadratic models. The linear with interaction model was found to be better in terms of predictive performance. The optimum operating zone was identified through an overlaid contour plot generated as a response surface. Parameter optimization was performed for minimizing Ra and VB as a single objective case using a genetic algorithm (GA). The minimum Ra and VB obtained were 2.52 μm and 0.31 mm, respectively. Optimization of multi-response characteristics were also performed employing desirability function analysis (DFA). The optimal parameter combination was obtained as v = 50 m/min, f = 0.1 mm/rev and d = 0.5 mm being the best combined quality characteristics. The prediction errors were found as 4.98 % and 3.82 % for Ra and VB, respectively, which showed the effectiveness of the method.

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