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Modelling and analysis of tool wear and surface roughness in hard turning of AISI D2 steel using response surface methodology

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The present work deals with some machinability studies on tool wear and surface roughness, in finish hard turning of AISI D2 steel using PCBN, Mixed ceramic and coated carbide inserts. The machining experiments are conducted based on the response surface methodology (RSM). Combined effects of three cutting parameters viz., cutting speed, cutting time and tool hardness on the two performance outputs (i.e. VB and Ra), are explored employing the analysis of variance (ANOVA).The relationship(s) between input variables and the response parameters are determined using a quadratic regression model. The results show that the tool wear was influenced principally by the cutting time and in the second level by the cutting tool hardness. On the other hand, cutting time was the dominant factor affecting workpiece surface roughness followed by cutting speed. Finally, the multiple response optimizations of tool wear and surface roughness were carried out using the desirability function approach (DFA).

Nomenclature

Vc	cutting speed (m/min)	RSM	response surface methodology
t	cutting time (min)	df	degrees of freedom
VB	flank wear (mm)	HV	Vickers Hardness
TH	Cutting tool hardness (HV)	*bj*	coefficients of linear terms
HRC	Rockwell Hardness	*bii*	quadratic terms
Ra	arithmetic mean roughness (µm)	*bij*	cross-product terms
R^2	determination coefficient		

1. Introduction

CBN, mixed ceramic and coated carbide tools are widely used in the manufacturing industry for cutting various hard materials such as high-speed tool steels, die steels, bearing steels, case-hardened steels, white and grey cast irons. In many applications, cutting of these hardened ferrous materials are produced mainly by a sequential series of processes, including costly and time consuming grinding and polishing

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