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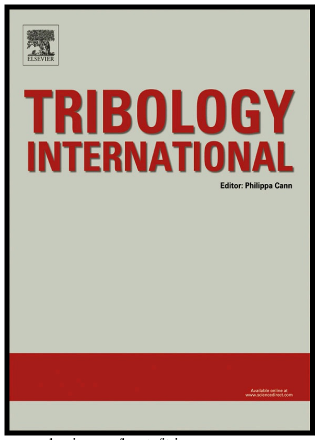

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Wear Estimation of Ceramic and Coated Carbide Tools in Turning of Inconel 625: 3D FE Analysis

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Abstract

Examination of cutting tool wear by experimental approaches is too costly. The main objective of this work is to develop an accurate 3D finite element model to predict the tool wear of PVD-TiAlN coated carbide and ceramic inserts in turning of Inconel 625. Thus, the cutting tools with complex geometries are modeled. Usui wear rate model is used to estimate wear rate where its constant parameters are achieved based on the cutting tools and workpiece material. The verification tests showed that the predicted values are in good agreement with the experiments. Moreover, among the cutting parameters, the increase of depth of cut were found as the most effective factor on the generation of temperature and stresses on the tool faces.

Keywords: Machining; Wear; Ceramic; Finite-element method

1. Introduction

Nickel-based superalloys are being used widely in the aerospace field and production of aircraft engine components particularly. The numerous usage is due to the existence of some considerable characteristics of nickel-based superalloys, namely, creep resistance, high-temperature corrosion resistance, and oxidation resistance [1]. In general, various types of machining operation, turning in particular, are being used in order to generate the desired shape of mechanical components. But turning of superalloys (as known difficult-to-cut materials) always faced with some difficulties in which rapid tool wear is the main one due to the rapid strain hardening, high strength as well as poor thermal conductivity [2, 3]. To overcome this problem, a proper comprehension of the metal cutting process and identification of effective cutting parameters could be helpful. Therefore, different theoretical, empirical, and simulation studies have been performed by researchers [4-6]. Among these methods, finite element (FE) simulation of turning operation can be more applicable because of the high cost of superalloys in experiments and complexity of metal cutting process that may not be modeled adequately in theoretical works. However, some theoretical models (e.g., friction, flow stress, wear) with the accurate elastic, plastic, and thermal parameters of materials are needed to be defined based on the experimental data