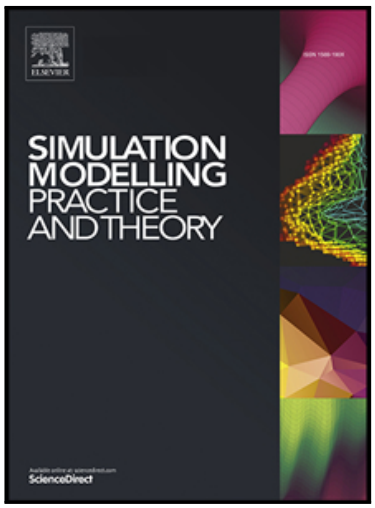

Tool Wear Modeling in Rotary Turning Modified by Ultrasonic Vibration

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Tool Wear Modeling in Rotary Turning Modified by Ultrasonic Vibration

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Abstract

Modification of conventional turning operation is carried out by using different methods to improve machinability conditions. In this study, rotary turning is modified by adding ultrasonic vibrations to cutting tool. Accordingly, the effect of this method on output parameters namely, tool wear and temperature, cutting force, and surface roughness, is investigated. Having detailed analysis, finite element method is used beside the experiments. As a result, it was revealed that tool-chip engagement time during rotary motion of cutting tool significantly reduced wear propagation on tool faces. This was explained by heat analysis in which disengagement time resulted in lower heat transfer from chip to tool. Moreover, the result of surface roughness produced in vibratory-rotary turning was compared by rotary one.

Keywords: Rotary turning; Wear; Surface; Heat; Simulation; Ultrasonic vibration.

1. Introduction

Non-conventional methods are used in different cutting approaches to improve machinability of materials when the desires are not achievable by conventional machining strategies [1]. Adding rotary motion to cutting tool in turning operation is one of these methods which is called rotary turning (RT) [2]. The main purpose of RT operation is to change the contact condition between tool and chip. In fact, the rotary motion of cutting tool causes the tool-chip contact to be temporary along the circumstance of cutting tool, while this contact is constant in conventional turning (CT) [3]. In such conditions, some enhancements, particularly in tool life, are accomplished as reported by a variety of researchers. Olgun and Budak [4] compared two types of turning tool when it was in rotation and in station. They stated that longer tool life was seen when rotary motion was added to cutting tool. The same result (more than 60 times increment in tool life) has been reported by Lei and Liu [5]. Based on Dessoly et al. [6], 50 °C reduction in the temperature of cutting tool was achieved in RT compared to CT by providing cooling cycle in tool-chip contact zone. Aside from the experimental works, chip flow direction and cutting