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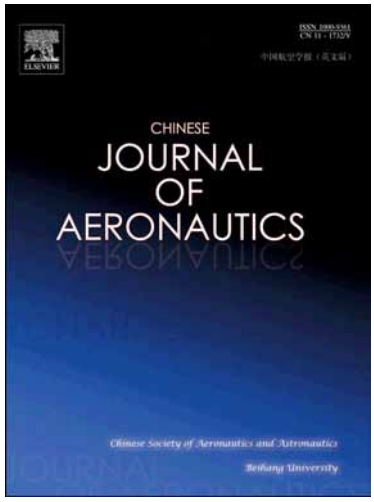

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Cutting tool temperature prediction method using analytical model for end milling

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Abstract

Dramatic tool temperature variation in end milling can cause excessive tool wear and shorten its life, especially in machining of difficult-to-machine materials. In this study, a new analytical model-based method for the prediction of cutting tool temperature in end milling is presented. The cutting cycle is divided into temperature increase and decrease phases. For the temperature increase phase, a temperature prediction model considering real friction state between the chip and tool is proposed, and the heat flux and tool-chip contact length are then obtained through finite element simulation. In the temperature decrease phase, a temperature decrease model based on the one-dimension plate heat convection is proposed. A single wire thermocouple is employed to measure the tool temperature in the conducted milling experiments. Both of the theoretical and experimental results are obtained with cutting conditions of the cutting speed ranging from 60 m/min to 100 m/min, feed per tooth from 0.12 mm/z to 0.20 mm/z, and the radial and axial depth of cut respectively being 4 mm and 0.5 mm. The comparison results show high agreement between the physical cutting experiments and the proposed cutting tool temperature prediction method.

Keywords: Cutting tool; Temperature prediction; Tool temperature; Analytical model; End milling

1. Introduction[1]

Cutting heat is a fundamental physical phenomenon in machining and causes high temperature in local cutting zone, which results in many serious problems, including excessive tool wear, shortened tool life, and low machining accuracy. [1-3] End milling, which plays a critical role in manufacturing, has been extensively employed to finishing-cut parts of planar or curved shapes, as well as in rough machining. During an end milling process, enormous heat is produced because of the severe deformation of metal in the cutting zone and intensive friction in the chip-tool interface, especially for difficult-to-cut materials. The resulting excessive temperature inevitably worsens the tool wear and shortens its life, while at the same time detriments the surface integrity and machining quality. Understandably, it is necessary to study the temperature of cutting tool in order to improve the cutting condition in end milling.

There are many theoretical or experimental research works on interrupted cutting temperature, especially on end

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