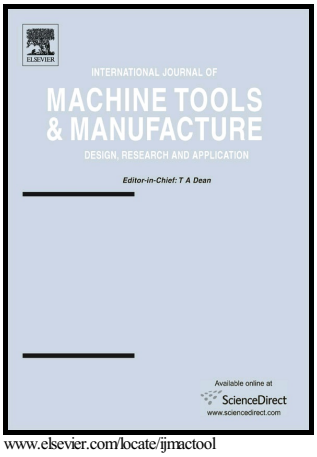

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Machined Surface Temperature in Hard Turning

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Abstract

Machined surface temperature is critical in turning of hardened steels because high surface temperature can lead to the formation of the white layer, which may have negative impacts on the steel fatigue life. This paper presents two experimental methods to measure machined surface temperatures in hard turning. The first method, based on a tool-foil thermocouple, estimates the machined surface temperature using a metal foil embedded in the workpiece to measure the tool tip temperature. The second method uses a thermocouple embedded in the tool with its tip continuously sliding on the machined surface behind the cutting edge during hard turning. A three-dimensional thermal model is developed and the inverse heat transfer method is applied to find the machined surface temperature near the cutting edge. For validation, hard turning tests were conducted and the cutting forces, tool-foil voltages and embedded thermocouple voltages were measured simultaneously at three levels of feed rates. The peak machined surface temperature occurred along the intersection of cutting edge and the machined surface. Its magnitude was mainly determined by the shear plane heat source and further increased due to flank face frictional heat source. Measurement results showed comparable predictions between the two developed methods with an average deviation of 30°C over the 500°C to 800°C range. These two methods, although based on very different approaches, have both proven feasible for the measurement of hard turning machined surface temperatures.