World Academy of Science, Engineering and Technology
International Journal of Mechanical and Materials Engineering
Vol:9, No:08, 2015

The Relationship between Spindle Sound and Tool Performance in Turning

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Abstract : Worn tools have a direct effect on the surface finish and part accuracy. Tool condition monitoring systems have been developed over a long period and used to avoid a loss of productivity resulting from using a worn tool. However, the majority of tool monitoring research has applied expensive sensing systems not suitable for production. In this work, the cutting sound in turning machine was studied using microphone. Machining trials using seven cutting conditions were conducted until the observable flank wear width (FWW) on the main cutting edge exceeded 0.4 mm. The cutting inserts were removed from the tool holder and the flank wear width was measured optically. A microphone with built-in preamplifier was used to record the machining sound of EN24 steel being face turned by a CNC lathe in a wet cutting condition using constant surface speed control. The sound was sampled at 50 kS/s and all sound signals recorded from microphone were transformed into the frequency domain by FFT in order to establish the frequency content in the audio signature that could be then used for tool condition monitoring. The extracted feature from audio signal was compared to the flank wear progression on the cutting inserts. The spectrogram reveals a promising feature, named as 'spindle noise', which emits from the main spindle motor of turning machine. The spindle noise frequency was detected at 5.86 kHz of regardless of cutting conditions used on this particular CNC lathe. Varying cutting speed and feed rate have an influence on the magnitude of power spectrum of spindle noise. The magnitude of spindle noise frequency alters in conjunction with the tool wear progression. The magnitude increases significantly in the transition state between steady-state wear and severe wear. This could be used as a warning signal to prepare for tool replacement or adapt cutting parameters to extend tool life.

Keywords : tool wear, flank wear, condition monitoring, spindle noise
Conference Title : ICMMM 2015 : International Conference on Machining and Machinability of Materials
Conference Location : Venice, Italy
Conference Dates : August 13-14, 2015