**INFORMATION OF RESEARCH RESULTS**

Dissertation title: Optimization of machining parameters in hard turning using standard inserts

Major : Mechanical Engineering Major code: 9520103

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**1. Thesis abstract**

Hard turning is an emerging technology for machining parts with high hardness (45 HRC and above). It offers several advantages over conventional grinding for finishing hard materials, including greater flexibility, higher productivity, lower cost, and more environmentally friendly production. However, significant challenges in hard turning involve achieving high-quality machined surfaces (low surface roughness) and minimizing cutting tool wear. Hard turning differs significantly from conventional turning, and much of the theoretical knowledge for conventional turning cannot be directly applied to hard turning. Therefore, to optimize the hard turning process, it is critical to appropriately select cutting tools (tool material and geometry) and cutting conditions (cutting speed, feed rate, depth of cut).

The primary objective of this study is to investigate the influence of the cutting tool's geometric parameters (cutting edge angle, rake angle, and inclination angle) on surface roughness, tool wear, and cutting forces, as well as to optimize tool geometry for the hard turning process using standard inserts. Experimental hard turning processes were conducted on AISI 1055 steel (52 HRC) using TiN-coated ceramic cutting tools. The results indicate that the inclination angle is the major factor affecting tool wear, surface roughness, and cutting forces in hard turning. Making the rake and inclination angles more negative decreases tool wear but increases surface roughness. However, beyond a certain negative inclination angle, surface roughness begins to decrease. This finding is novel and significant in hard turning research.

Based on the research findings, a large negative inclination angle (*λs* = -10°) should be applied to simultaneously reduce surface roughness and tool wear. With the optimal cutting tool angles identified in the research, the hard turning process is remarkably improved, with decreases in surface roughness and tool wear of 8.3% and 41.3%, respectively, compared to standard tool angles. Additionally, a new geometric model for hard turning, along with mathematical models for surface roughness, tool wear, and cutting forces, has been developed.

**2. New contributions of the thesis**

* It is the first study to simultaneously analyze the impact of three critical tool geometry parameters—namely, the cutting edge angle, rake angle, and, in particular, the inclination angle—on cutting force, tool wear, and surface roughness, which are among the most important output characteristics in hard turning. The predominant trends and interaction effects of these parameters on surface roughness and tool wear have been identified.
* Mathematical models have been established to describe the relationships among surface roughness (*Ra*), tool wear (*VB*), and cutting force (*F*) in relation to tool geometry parameters.
* Optimal tool angles for hard turning have been determined, thus enhancing the hard turning process by reducing both workpiece surface roughness and tool wear compared to the standard tool angles specified by the manufacturer.
* A new geometric mathematical model for hard turning has been developed to accurately represent the inherent nature of the hard turning process. This proposed model can be combined with other equations and mathematical models to calculate cutting force, cutting temperature, and tool wear for each cutting edge element as well as for the entire process. It may also be utilized for studies on other difficult-to-machine materials.
* The proposed fixture design method offers an effective means of varying the tool angle parameters of standard inserts to optimize the turning of hard or difficult-to-machine materials.
* The recommended optimal tool geometry parameters (determined from this research) can be applied in practice to prolong tool life and achieve high-quality surface finishes in hard turning operations.
* The findings of this study can be directly implemented in industrial production to improve the efficiency and effectiveness of hard turning processes.

*HCMC, 14/12/2024*

**PhD candidate**

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