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Original Research Article

CRATER WEAR EVALUATION OF TiN COATED TOOL IN MACHINING

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Abstract: The present work studies the performance of multi-layer coated tool in machining of hardened steel (AISI 4340 steel) under high speed turning. The influence of cutting parameters (speed, feed, and depth of cut) on cutting forces and surface finish has been analyzed. The increasing of tool life need to boost productivity, to machine more difficult materials and to improve quality in high volume by the manufacturing industry has been the driving force behind the development of cutting tool materials will be analyzed.

Key Words: - Coated tool, Machining forces Crater Wear.

Introduction

Metal cutting is the removal of metal from work piece in the form of chips in order to obtain a finished product with desired size, shape and surface finish. In virtually all producing sectors for example automobiles, railways, shipbuilding, aircraft manufacture, home appliance , consumer electronics and construction industries etc one finds large shops with many thousands of machining .The cost of machining amounts to more than 15% of to value of the all manufactured products in all industrial countries.

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Of all the processes used to shape metals, in metal cutting the conditions of operation can be varied to a greater extent to improve the quality and the rate of producing with a reduced cost. Finish hard turning is a new machining process that enables manufacturers to machine hardened materials to their finish part quality without the aid of grinding. This process enables manufacturers to increase product quality and efficiency, while decreasing the cost and processing time. Hard turning is also very attractive to manufacturers because this process is possible without the use of cutting fluid or other lubricants. Dry cutting is beneficial because of the elimination of the cost of the cutting fluid as well as the high cost of fluid disposal. High speed machining has been the main objective of the Mechanical Engineering through ages. The trend to increase productivity has been the instrumental in invention of newer and newer cutting tools with respect to material and designs.

High speed machining is not associated with increased productivity and better surface finish rather associated with a great amount of heat generation. Tugrul O zel et al [7] presented the effects of cutting edge preparation geometry, workpiece surface hardness and cutting conditions on the surface roughness and cutting forces in the finish hard turning of AISI H13 steel. They have found that the cutting forces are influenced not only by cutting conditions but also the cutting edge geometry and workpiece surface hardness. The lower workpiece surface hardness and small edge radius resulted in lower tangential and radial forces. Jeong Suk Kim et al [8] investigated that hard coatings improve the performance of cutting tools in aggressive machining applications, such as high-speed machining. Additionally, the relationship between the machining characteristics and the Si contents were investigated under various high-spindle speeds. It has shown that the tool life was improved up to 50% at the Si content.

Theoritical Analysis

Metal cutting process forms the basis of the engineering industry and is involved either directly or indirectly in the manufacture of nearly every product of our modern civilization. The cutting tool is one of the important elements in realizing the full potential out of any metal cutting operation. Over the years the demands of economic competition have motivated a lot of research in the field of metal cutting leading to the evolution of new tool materials of remarkable performance and vast potential for an impressive increase in productivity.As manufacturers continually seek and apply new manufacturing materials that are lighter and stronger and therefore more fuel efficient it follows that cutting tools must be so developed that can machine new materials at the highest possible productivity.

The properties that a tool material must process are as follows:

- Capacity to retain form stability at elevated temperatures during high cutting speeds.
- Cost and ease of fabrication
- High resistance to brittle fracture
- Resistance to diffusion
- Resistance to thermal and mechanical shock

Developmental activities in the area of cutting tool materials are guided by the knowledge of the extreme conditions of stress and temperature produced at the tool-work piece interface. Tool wear occurs by one or more complex mechanisms which includes abrasive wear, chipping at the cutting edge, thermal cracking etc.

Flank wear is observed on the flank or clearance face of a metal cutting insert and is caused mainly by abrasion of the flank face by the hard constituents of the workpiece .

Crater wear is observed on the rake face of cutting tools and is caused by chemical interactions between the rake face of a metal cutting insert and the hot metal chip flowing over the tool.

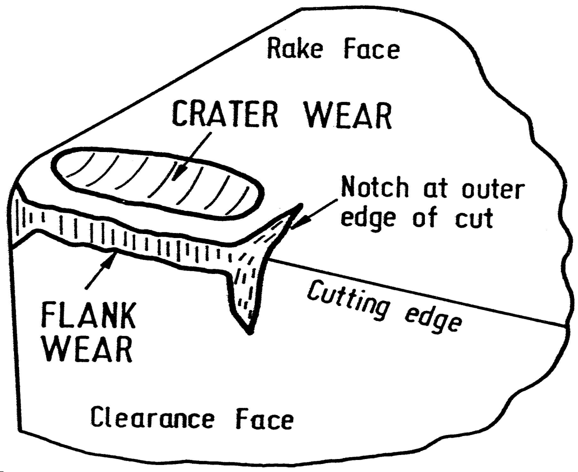
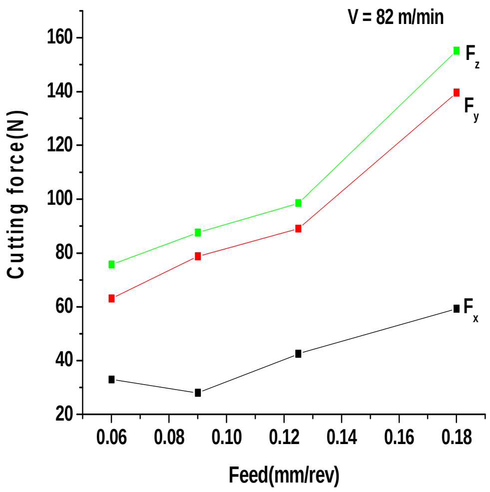


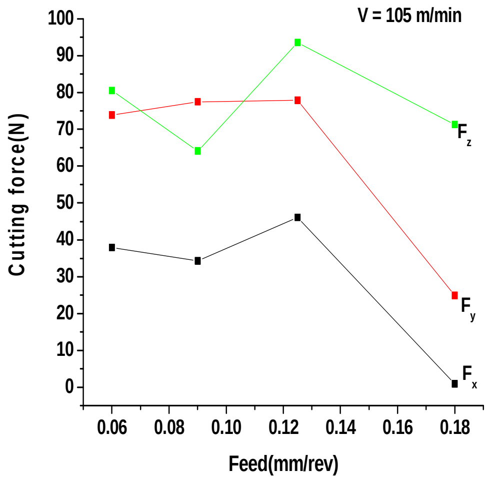
Fig. 1 Flank and crater wear

Discussion

It has been seen that, as cutting speed is increased, the three components of the machining forces (*Fx, Fy, Fz)* are reduced. This reduction in the forces may be attributed to the variation of friction due to the temperature increase in the secondary- shear zone area, which resulted in a reduction in the restricted force.For all the tested tools, the cutting forces for the coated tools present a lower value. For the uncoated tool, this minimum value of cutting force is obtained for a cutting speed of about 160 m/min, which corresponds to a limit value. In fact, it is usually expected that the main cutting force *Fz* should be the highest and the radial force *Fy* and thrust force (*Fx*)should be the lowest in magnitude. The cutting force usually decreases with increasing cutting speed because of the high temperatures generation at the cutting zone. This result is mainly caused by the high adhesion and ultrafine crystallinity as well as high oxidation resistance of the coating. Low cutting forces are offered when cutting speed was high and feed rates were low. The higher forces under higher feed rates are due to increased thrust components resulted for increase chip cross sectional area. However, the cutting forces for coated tools under similar cutting feeds are lower than that of uncoated tools.



A



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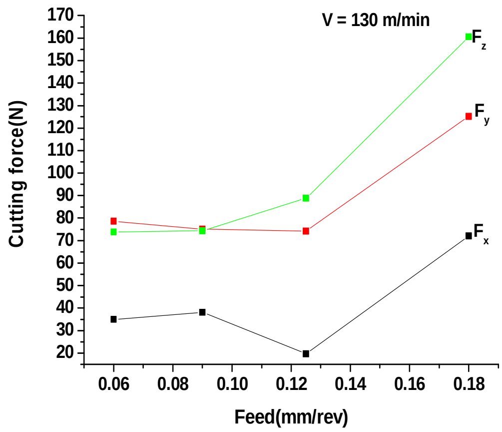

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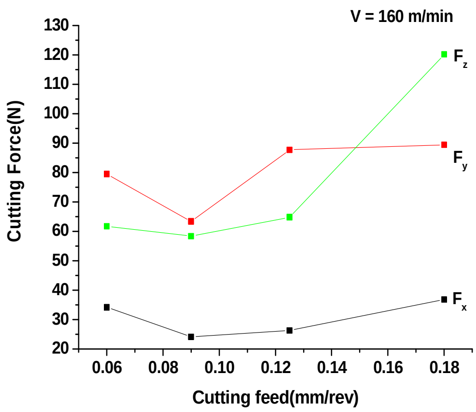

D

Fig. 2 Effect of speed on different forces (A, B, C, D)

Conclusions

Based on the experimental results presented and discussed, the following conclusions can be drawn on the effect of cutting speed and feed on the performance of uncoated and TiN coated carbide tools when turning AISI 4340 steel. Coated carbide tools perform better than uncoated carbide tools as far as cutting forces are concerned. For average magnitudes of forces obtained with uncoated carbide tool were higher than those obtained with coated carbide tools under experimental condition.

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