

A Study and Performance Evaluation of Coated Tool

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ABSTRACT: A continuous advancement and development in manufacturing industry demands the high speed machining at less time which improves the efficiency of the machining. The hard to machine material put the limitation to the cutting speed and generates a lot of heat during machining. Due to machining of these hard materials, tool experiences a high temperature at the cutting point which causes the tool to fail due to plastic deformation, change in mechanical properties or fracture failure of the tool. To avoid this generation of temperature, coating of TiN/TiC/Al₂O₃ has been used. In this paper, CVD coated tool is used for experimentation and the interface temperature is measured using tool work thermocouple. The nature of temperature with respect to different cutting speed and feed rate is explained.

KEYWORDS: CVD coating, Temperature measurement

1. INTRODUCTION

The mechanical work required for machining is highly converted into the heat which causes number of technical and mechanical problems of machining. The importance of knowledge on the temperature gradient and its distribution within the cutting zone resulting from changes in the cutting conditions is well recognized due to severe effects on the tool and work piece materials properties and a considerable influence on the tool wear. In general, three regions of intensive heat generation are distinguished, namely the primary shear zone, the tool-chip interface or the secondary deformation zone and the tool-work piece interface.

Heat is removed from the primary, secondary and tertiary zones by the chip, the tool and the work piece. Figure 1 schematically shows this dissipation of heat. The temperature rise in the cutting tool is mainly due to the secondary heat source, but the primary heat source also contributes towards the temperature rise of the cutting tool and indirectly affects the temperature distribution on the tool rake face.

Figure 1: Metal Cutting Process

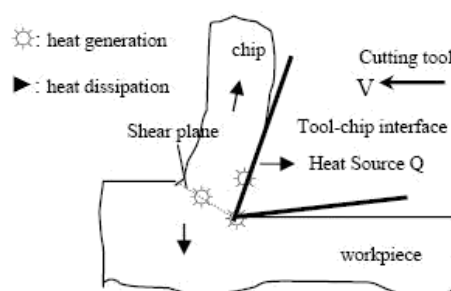


Figure 1: Metal Cutting Process

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During the process, part of the heat generated at the shear plane flows by convection into the chip and then through the interface zone into the cutting tool. Therefore, the heat generated at the shear zone affects the temperature distributions of both the tool and the chip sides of the tool- chip interface, and the temperature rise on the tool rake face is due to the combined effect of the heat generated in the primary and secondary zones .

Heat flow in a tool is known in thermodynamics as heat conduction. Its behavior is obviously expressed by using Fourier's law of conduction which is given by:

$$q = K (dT/dx)$$

Where q is heat flux (W/m^2), K is thermal conductivity (W/mK), dT is difference in temperature and dx is the linear distance perpendicular to which the flow of temperature takes place .

II.EXPERIMENTAL PROCEDURE

The cutting experiments were conducted on HMT heavy duty lathe LTM-20. A commercially available CVD coated turning insert CNMG 120408 PR 4225 and uncoated tungsten carbide insert CNMG 120404 grade K313 were used to compare the temperature obtained during machining. The machining was performed using work piece EN8 alloy steel (251mm long and 46mm diameter).

Among the various temperature measuring techniques, tool-work thermocouple was used to measure the interface temperature. Figure 2 schematically shows the principle of tool-work thermocouple technique. The tool-work thermocouple works on the principle of seebeck effect which states that if there is temperature difference between two junctions of dissimilar metals then an emf is produced between those metals. In this case tool and work piece comprise two dissimilar metal and cold end of tool and work piece acts as one junction whereas hot junction is cutting zone. The emf is produced only when the circuit is complete i.e. tool and work piece are in contact. The tool and work piece were insulated from the lathe machine using mica as an insulating material.

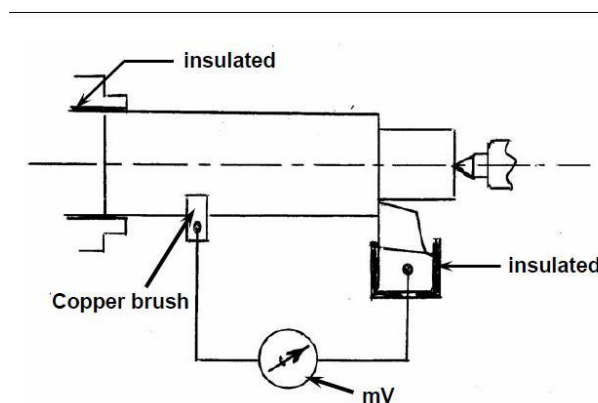


Figure 2: Tool-work Thermocouple Setup

In this work, calibration of the tool work thermocouple was carried out by using a heating coil. This set-up is similar to one used by in which workpiece was directly calibrated with the tool.

Figure 3 shows the calibration set-up for tool-work thermocouple. In this set-up, Junction of tool and work piece was connected to the milli Voltmeter and also K-type Alumel-Chromel thermocouple was connected to the heating rod. The temperature indicator was used to display the temperature of heating rod sensed by the Al-Cr thermocouple.

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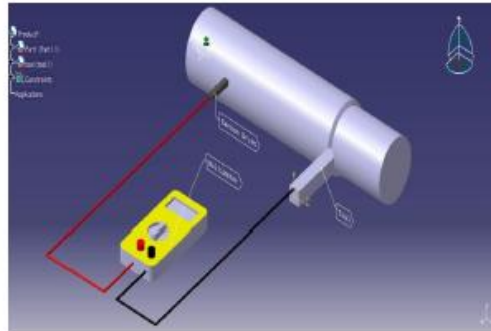


Figure 3: thermocouple

III. EXPERIMENTAL RESULTS

The primary objective of this test was to evaluate and compare the performance of aCVD coated Tungsten carbide insert with uncoated Tungsten Carbide turning insert. For this purpose cutting tests were conducted at cutting speeds (m/min) 35.32, 58.34, 100.32 and 169.56 m/min and the depth of cut was kept constant (1 mm) whereas the feed rate (mm/rev) was varied as 0.83, 1.05, 1.29 and 1.65 mm/rev. Using this cutting conditions the value of mV is measured on HMT heavy duty lathe which was further used to calibrate the temperature obtained during machining of EN8 alloy steel.

It was observed at $f=1.65$ mm/rev, $V_c=35.32$ m/min, the temperature difference between coated and uncoated tool was higher i.e. 32°C as compared to the readings obtained at $f=0.83$ mm/rev, $V_c=35.32$ m/min i.e. 8°C . At $f=1.60$ mm/rev, $V_c=170.56$ m/min the temperature difference for between coated and uncoated tool was higher i.e.

82°C as compared to the readings obtained at $f=0.83$ mm/rev, $V_c=169.56$ m/min i.e. 80°C but this difference is very less. Hence at higher cutting speed the coated tool found to be efficient due to its heat resistive ability.

The heat generation per unit area with respect to cutting speed by varying feed rate from 0.83 mm/rev to 169.56 mm/rev.

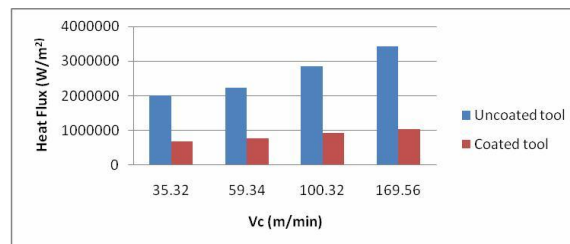


Figure 4: Heat Flux vs. Cutting Speed at $f=0.83$ mm/rev

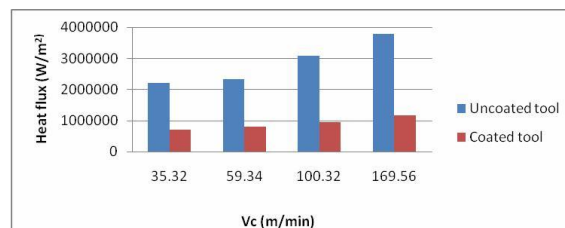


Figure 5: Heat Flux vs. Cutting Speed at $f=1.65$ mm/rev

The heat generated for uncoated tool per unit area is much higher than that of coated tool for different cutting

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speeds. The increase in heat flux for uncoated tool is rapid as compared to the coated tool.

IV.CONCLUSION

Coated Tool Can Be Used For High Cutting Speed Machining For The Same Tool Life. This Work Considered Some Ways To Improving Cutting Tool Life By Means Of Coating Method. The Performance Of Coated Cutting Tool Is Better Than The Conventional Cutting Tool. Tool Coating Improve Properties Of Cutting Tool Such As Surface Roughness, Chemical Stability, Anti-Welding And Thermal Conductivity.

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