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Review of Design & Thermal Analysis of Single Point Cutting Tool

Sandeep Kajalekar[1], Digambar Date[2], V.V Mane[3]

[1]M-Tech Student, Dept. of Mechanical Engg. College of Engineering, Osmanabad, Maharashtra, India
[2]HOD Dept. of Mechanical Engg. College of Engineering, Osmanabad, Maharashtra, India
[3]Principal College of Engineering, Osmanabad, Maharashtra, India

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Abstract - At various operational cutting speed of lathe, temperature of the tool-chip interface is determined experimentally and modelled. Specifically, analysis is carried out at three different speeds- low, medium and high. Analyses are done of a High Speed Steel and of a Carbide Tip Tool machining process at three different cutting speeds, in order to compare to experimental results produced as part of this study. Heat generation in cutting tool is investigated by varying cutting parameters at the suitable cutting tool geometry. The experimental results show that the factors which are responsible for increasing cutting temperature are cutting speed, depth of cut and feed respectively. Various techniques can be used to measure these cutting temperatures generated during machining. "Infrared Thermometer" is used for measuring temperature at tool-chip interface. Single point cutting tool has been modelled and analyzed using ANSYS.

Key Words: Ansys, Single point cutting tool, Thermal Analysis etc.

1. INTRODUCTION

Machining is the process in which a material is cut to a desired final shape and size by a controllable material-removal process. It is the most widespread process for the shaping of metal; it has become a very significant aspect of modern society and industry. Machining is a common fabrication technique in which metal is removed from a part using a tool with a small, hard tip.Over the history of machining, guidelines and conventions have arisen based on empirical information of trade-offs between cutting speed and tool replacement time. Machining is a term covering a large collection of manufacturing processes designed to remove material from a work piece.

In today‟s CIM environment and competition age the main attention of manufacturer is a cost reduction. When it is not possible to reduce the fixed cost, it is necessary to concentrate on variable cost like electricity, cutting fluids, cotton waste, oil grease, welding rods, cutting tools etc. Of all the factors the cost of cutting tool is very high. Tools of H.S.S, carbide, diamond tip are costing very high.

Therefore it is necessary to pay attention to increase the tool life. As the tool life increases, the variable cost decrease. In exact mechanism of metal cutting briefly stated is that a cutting tool exerts a compressive force on the work piece.
Under this compressive force the material of the work piece is stressed beyond its yield point causing the material to deform plastically and shear off. The sheared material begins to flow along the cutting tool face in the form of small pieces called chips The flowing chips causes the wear of cutting tool. Heat is produced during shearing action. The heat generated raises the temperature of tool, work and chips. The temperature rise in cutting tool tends to soften it and causes loss of intensity in the cutting edge leading to its failure. This temperature during metal cutting is maximum at the tip of the tool, is to be measured by experimental set up and this experimental temperature is given as input to the software and analyzes the stresses and deformation on the single point cutting tool. Hence the FEM is capable of providing this information, by creating the geometric model required for the finite element using software like
PRO-Engineer and analyzing the model using software likes ANSYS. PRO-Engineer generates the three dimensional model of tools and analysis can be performed using ANSYS on the tool easily. Also the forces acting on the tool due to the workpiece are responsible for deformation of tool and the tip of the tool displaces in XYZ direction. During the metal cutting process heat is produced due to shearing action and it raises the temperature of the tool. Due to this temperature the tool gets soften at the tip and various stresses and deformation is take place in the tool. It is essential to measure this temperature experimentally at various depth of cut. Also to find out the effect of forces acting on the tip of the tool

The use of the software, **ANSYS** has been very helpful for determining the deformation of the cutting tool under the influence of maximum loads.

1.1 Objectives

1. To study and compare the temperature distribution on a single point machining tool made of different materials at different parameters.
2. To model the single point machining tool.
3. To compare of experimental data.

1.2 Thermal Facets of metal machining process

The effect of the cutting temperature is mostly detrimental to both the tool and the job. The major portion of the heat is taken away by the chips. But it does not matter because chips are thrown out. So attempts should be made such that the chips take away more and more amount of heat leaving small amount of heat to harm the tool and the job. Due to friction three heat zones are generated.

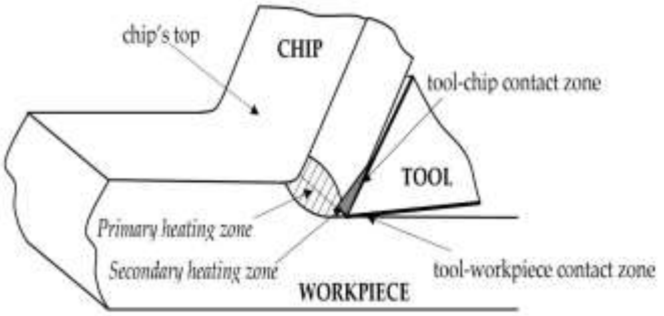

Fig -1: Evolution of heat at three zones

1.3 Tool-Chip interface temperature

It is necessary to measure the temperature of the interface as it decides the tool wear and tool life. There are several techniques from which cutting temperature at tool-chip interface can be measured:

- Thermocouple
- Infrared thermometer
- Infrared photography
- Thermal paints etc

2. Literature Review

The purpose of this chapter is to provide a review some of past research efforts related to single-point cutting tool and thermal analysis. The review is done to offer insight to how past research efforts have laid the groundwork for subsequent studies, including the present research effort. The review is detailed so that the present effort can be properly tailored to add to the present body of literature as well as to justify the scope and direction of the present effort.

Sandro Metrevelle [1] studies the heat influence in cutting tools considering the variation of the coating thickness and the heat flux. K10 and diamond tools substrate with TiN and Al2O3 coatings were used. Boundary conditions and constant thermo physical properties of the solids involved in the numerical analysis are known. To validate the proposed methodology an experiment is used.

M. Hameedullah [2] developed first and second order mathematical models in terms of machining parameters by using the response surface methodology on the basis of the experimental results. The experiment was turning of EN-31 steel alloy with tungsten carbide inserts using a tool-work thermocouple technique.

P. D. Kamble [3] studied the approaches for modelling the turning process for EN-24 type of steel. In this study, a Finite Element Analysis software Deform 3D is used to study the effects of cutting speed, feed rate, and type of alloy steel in temperature behavior.

Shreepad Sarange [4] presented a methodology in order to determine tool forces and temperatures for use in finite element simulations of metal cutting processes. From the experimental set up, it is clearly observed that as depth of cut increases, the temperature generated in the tool at the tool tip also increases. It is also observed that, as the depth of cut increases, tool forces are also increases. It is main reason of tool failure.

3. Selection of Material for Cutting Tool

In our project work, experimental results are the temperature formed at the cutting tool tip face when machi ning at different speed and depth of cut. Here we analyse the error using the temperatures obtained for HSS & Carbide tool at a time 10 seconds after machining starts.

For machining and chip formation processes we have selected metal mild steel for metal cutting & the selected insert materials for single point cutting tool are of HSS & Carbide.

1. HSS

High speed steel (HSS) is an iron-based alloy with good cutting properties. HSS belongs to a tool steel group and is an iron-based alloy with mainly tungsten and molybdenum as alloying elements. Chromium, vanadium and cobalt are also used to create optimal cutting properties for different applications.

2. Carbide Tool

The carbide insert selected provides a high hardness for a wide range of temperature and thus provides a good cutting speed with high wear resistance. It has low thermal expansion and less thermal conductivity than steel.

4. Cutting Force Acting on Single Point Cutting Tool

Most of the time cutting force acting on a tool is measured experimentally. But it is also important to predict quantity of cutting force and how different cutting parameters are affecting cutting force even before setting up the machining operation due to following reasons.

In order to design of mechanical structure of cutting machine, which will with stand cutting force and thrust force effectively.

To determine power consumption during machining process, this will help in selecting suitable motor drive.

3. CONCLUSIONS

The optimal tool geometry is expected to have more tool life than the basic tool.Due to Cutting Force huge number of power and temperature get created which can harm by utilizing thermocouples, so we can measure its temperature as we can explore this point, and can expand its device life.

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