EFFECT OF CUTTING PARAMETERS ON THE TOOL WEAR AND TOOL LIFE IN DRY ENVIRONMENT – A REVIEW

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ABSTRACT

A cutting tool is a device used to remove unwanted material from the given workpiece. Cutting tools are majorly used in the machining processes such as facing, turning, drilling etc. to remove the unwanted material from the workpiece in the form of chips. During service various forces act on the cutting tool that causes the wear and tear of the tool and eventually the cutting tool stops giving satisfactory results. It is thus necessary to ensure that the cutting tool has an optimal life for higher productivity and an economic process. The following work tends to investigate the various factors affecting the cutting tool life in a dry environment. A review of various papers as done so as to summarize various findings.

KEYWORDS: CUTTING TOOL, MACHINING

INTRODUCTION

The current scenario of the industry faces high demand. Thus, it is important for the industries to maintain a high and rapid supply. It is essential to have higher productivity and the quality of the product cannot be tampered with. In the machining industry this means faster and accurate material removal by the same tool for a longer time. It is required for a cutting tool to function satisfactorily for a longer time.

Currently various types of cutting tools are used in the industry such as: Carbon Steel, High Speed Steel (HSS), Cemented Carbide, Ceramics, Diamond, Cubic Boron Nitride (CBN). Different type of tools has different properties and therefore different cost and life.

Tool life generally indicates, the amount of satisfactory performance or service rendered by a fresh tool or a cutting point till it is declared failed. In other words, actual machining time (period) by which a fresh cutting tool (or point) satisfactorily works after which it needs replacement or reconditioning or tool life means. Generally, the tool life is expressed by span of machining time in minutes.

CUTTING TOOL GEOMETRY

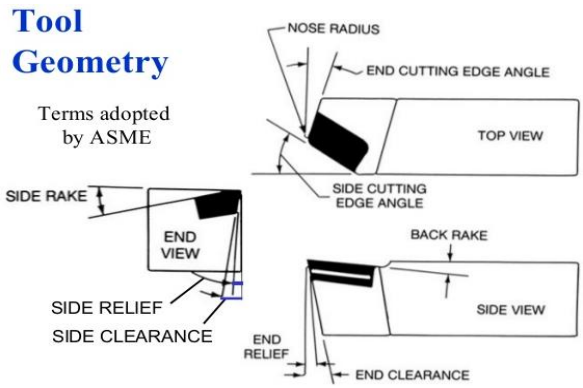

Figure 1: Cutting tool geometry

TYPES OF TOOL WEAR

There are several types of observed cutting tool wear which are listed below:
1. Crater wears which occurs on rake surface. Crater wear can increase the working rake angle and reduce the cutting force, but it will also weaken the strength of cutting edge.
2. Flank wear which occurs on the flank face due to friction between machined surface of workpiece and tool flank. Flank wear is mainly caused by the rubbing action of the tool on the machined surface.
3. Notch wears is special type of combined flank and rake face wear which occurs adjacent to the point where the major cutting edge intersects the work surface.

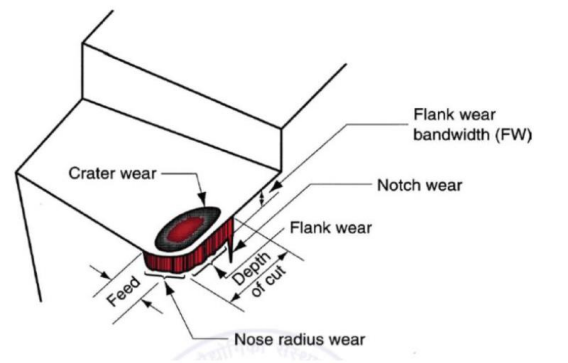

Figure 2: Types of Cutting tool wear

THE REVIEW PROCESS

In order to summarize the effect of various Parameters on the life of cutting tool, a study was done from various resources. The various factors affecting the life of a cutting tool are:

CUTTING SPEED AND DEPTH OF CUT

It has been experimentally found that the cutting speed and the cutting depth has an effect on the tool life. Grzegorz Królczyk, Maksymilian Gajek, Stanisław Legutko, in their research paper experimentally plotted a graph for tool life(minutes) against the cutting speed(mm/min) by using the workpiece material as stainless Steel.

Following graphical relations were obtained between the tool life, cutting speed and the depth of cut. Similar relations were observed for different combinations of workpiece materials and cutting tool materials.

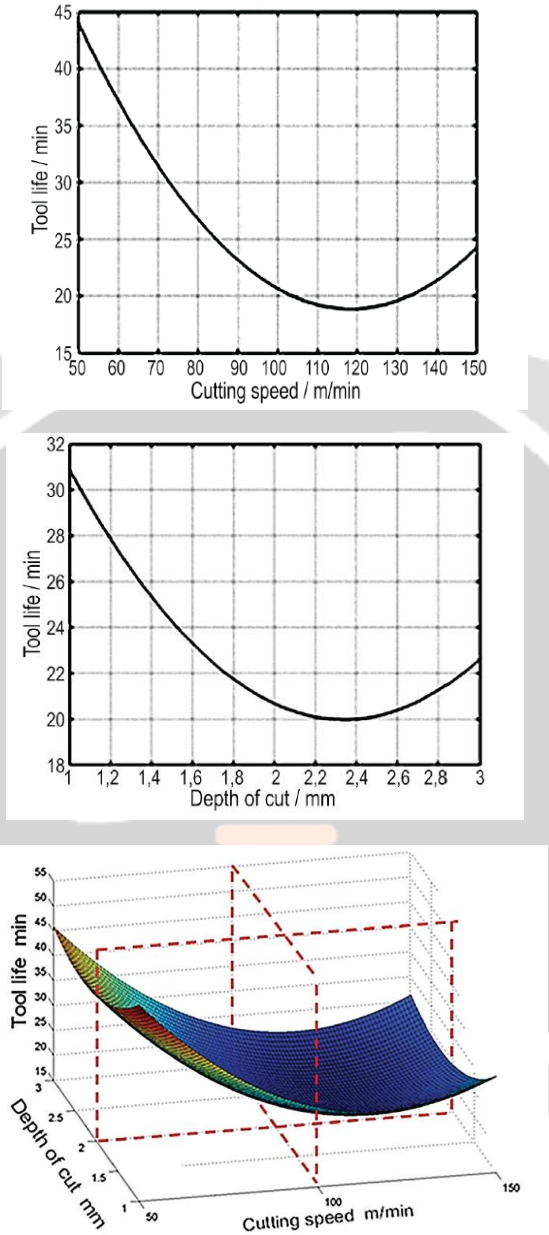

Chart 1: Effect of cutting speed and the depth of cut on cutting tool life

SPINDLE SPEED

In a paper published by Sunday Joshua Ojolo*, Olugbenga Ogunkomaiya "A study of effects of machining parameters on tool life", a relation was established between the spindle speed of the machine and the cutting tool life.

Various trials were taken by changing the spindle speed and keeping the feed rate and the depth of cut constant. The clearance angle of the tool was taken as 10^{o} and rake angle as 0^{o}. Tool life was determined by dividing the total length of effective cut by the product of feed rate and spindle speed of machining. The material used was AISI 1030

carbon steel and the cutting tools used were HSS, Tungsten Carbide Tool and DNMG Carbide tool. Following relation was obtained between the spindle speed and tool life at a constant feed rate of 0.1mm/rev:

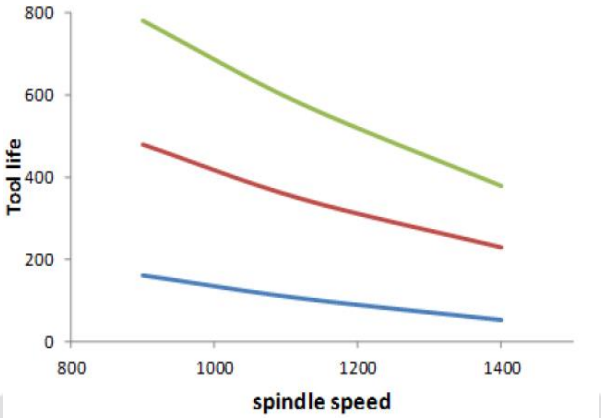

Chart 2: Effect of spindle speed on tool life at a constant feed of 0.1mm/rev

It can be observed that for all the tools, an increase in the spindle speed causes the tool life to fall drastically. A similar relation was obtained for various workpiece materials.

FEED RATE

In the same paper by Sunday Joshua Ojolo*, Olugbenga Ogunkomaiya "A study of effects of machining parameters on tool life", a relation was also established between the feed rate of the tool and the tool life.

Using the same material i.e. AISI 1030 carbon steel and tools i.e. HSS, tungsten Carbide tool and DNMG Carbide tool, the spindle speed and the depth of cut were now kept constant and the feed rate was gradually changed the effect on the tool life was observed.

Following graphical relation was observed between the feed rate of the tool and the tool life at a constant spindle speed of 1120 rev/min.

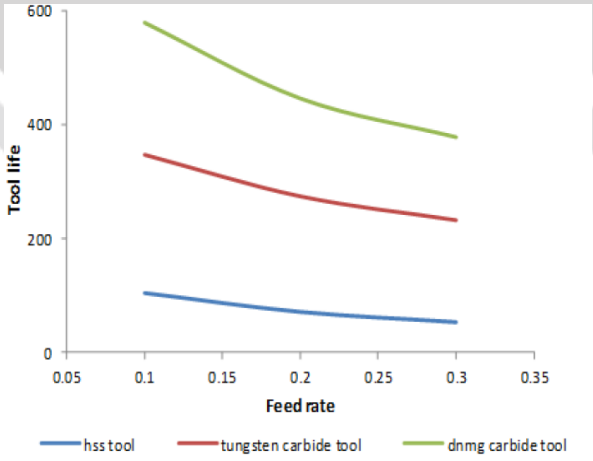

Chart 3: Effect of feed rate on the tool life at a constant spindle speed of 1120 rev/min

A combined effect of the cutting speed and the feed rate is plotted on the graph as follows:

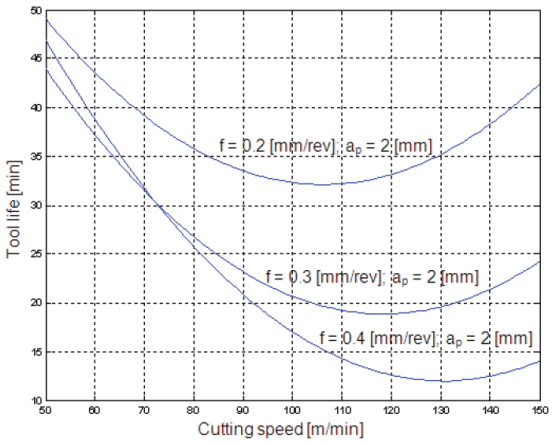

Chart 4: Effect of cutting speed and feed rate on the tool life at a constant depth of cut of 2mm

It can be seen the increase in the feed rate causes the tool life to decrease. Similar relation was obtained for various workpiece materials.

COATING ON TOOLS

Various coatings can be applied on the cutting tool to increase their abrasion resistance and thus increase the tool life.

In the paper "Effect of Boron Nitride Coating on Wear Behavior of Carbide Cutting Tools in Milling of Inconel 718" by Halil Caliskan, Bilal Kursuncu, Sevki Yilmaz Guven Abdullah Cahit Karaoglanli, Mustafa Sabri Gok and Akgun Alsaran, it was concluded that the Boron Nitride coated cutting tool was able to resist wear at higher cutting speeds than the uncoated one. This means that boron nitride coating of the tool can help to increase its life.
Al2O3 coating is also used to increase the wear resistance of the tool.
Natalia L. Cadena in the paper "Study of PVD AlCrN Coating for Reducing Carbide Cutting
Tool Deterioration in the Machining of Titanium Alloys" concluded that Aluminum-Chromium-Nitride coating on the cutting tools can significantly improve their life and increase their wear resistance.

CONCLUSION

From the above study, it can be concluded that:

1) The cutting speed has an inverse relation with the tool life.
2) The feed rate has and inverse relation with the tool life.
3) The depth of cut has an inverse relation with the tool life.
4) The spindle speed has an inverse relation with the tool life.
5) Various coatings on the tool effect their life.

Thus, by setting the cutting parameters in a proper proportion, the cutting tool life can be optimized.

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