

THE GEOMETRICAL INFLUENCE ON THE LIFE OF HIGH SPEED STEEL CUTTING TOOLS

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ABSTRACT

An investigation has been made to study the geometrical influence on the life of high speed steel cutting tools. The process was completed in three steps (1) with same speed, (2) Same cutting depth and (3) same time duration. The results obtained by using lathe machine, showed the maximum cutting life of high speed steel tool with a geometry of 4.5° , 14.5° , and 15° . In addition to this higher cutting life values were obtained with the same geometry by using lubricant. The results of present work shows that life of high speed cutting steel tools is increased by using lubricants.

Key word: Geometrical influence, cutting tool

Introduction

All machining process consists of forcing a cutting tool with various geometry of cutting edges through the excess material on a work piece. The air-craft industry, production of domestic equipment's, machine tool industry, maintenance shop, railway, automobile industry, etc, require a good number of efficient and good cutting tool for increasing the machinability with minimum cost and labour. The improper machining will produce a high rate of scraps and a greater rejections by both foundry man and machine shop [1].

During metal cutting, various parameters are considered, such as, metal around the cutting edge which determines the performance of the tool, the machinability of metals and alloys and the qualities of the machined surface including concerning stresses, temperature metal flow, and interaction between the tool and work piece [2].

Several efforts have been made for the development of the techniques of shipping components in which metal losses are reduced to a minimum, employing process such as cold forging, precision casting and powder metallurgy [3].

Theory.

The cutting tool material must be coarse, strong, tough, rigid, abrasive resistant and harder than the work piece [4].

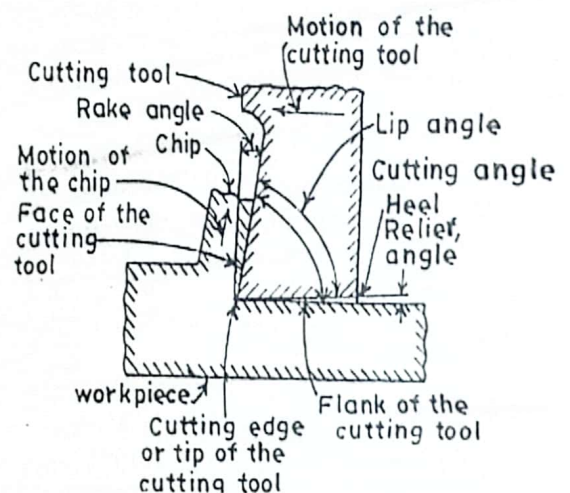


Fig-1. A two dimensional presentation showing the action of a cutting tool and some important angles.

In order to introduce cutting shape, a two dimensional shape is drawn (see Fig 1). The face of the cutting tool is that surface against which the chip slides upward. The rake angle is the angle between the face of the cutting tool and the normal to the machined surface at the cutting edge. Rake angles may be positive, zero, or negative as shown in (Fig 2a, 2b, & 2c). Cutting angle depends on the rake angle.

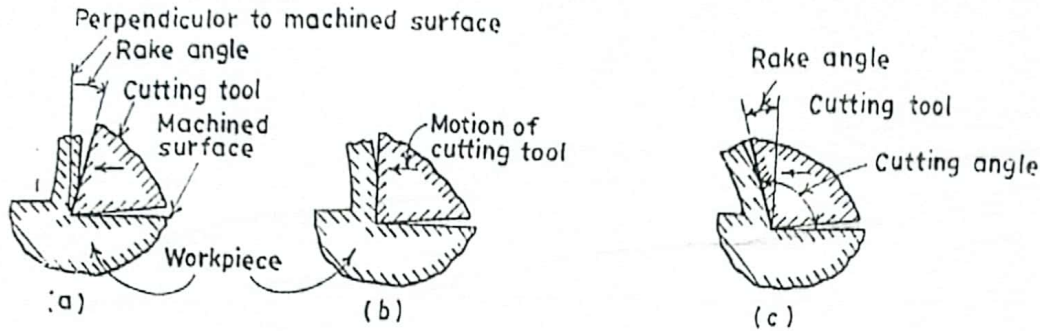


Fig-2. Different kinds of rake angles on cutting tools (a) Positive Rake Angle. (b) Zero Rake Angle. (c) Negative Rake Angle.

The smaller the cutting angle, the cutting angle also reduces the amount of metal, which backs up, or supports the cutting edge. This backup metal helps to conduct heat away from the cutting edge. For this reason, smaller cutting angles cause cutting edges to wear, or fail in shorter periods of time. Thus the selection of a suitable rake requires a compromise. The relief angle enables the surface of the cutting tool called as flank, to clear the surface of work piece without rub. The relief angle is the angle between the flank of the cutting tool and the tangent to the machined surface at the cutting edge, as shown in Fig: (1)

Experimental Work

A high speed steel cutting tool was used with the composition of 0.45% Carbon, 3% Tungsten, 6% Chromium, 5% Cobalt, 8% Vanadium, and 3% Molybedanium. They were prepared with different geometries according to the specification and were allowed to cut a circular spacemen of 1.5 inch diameter at a depth of 1.8 inch made of medium carbon steel.

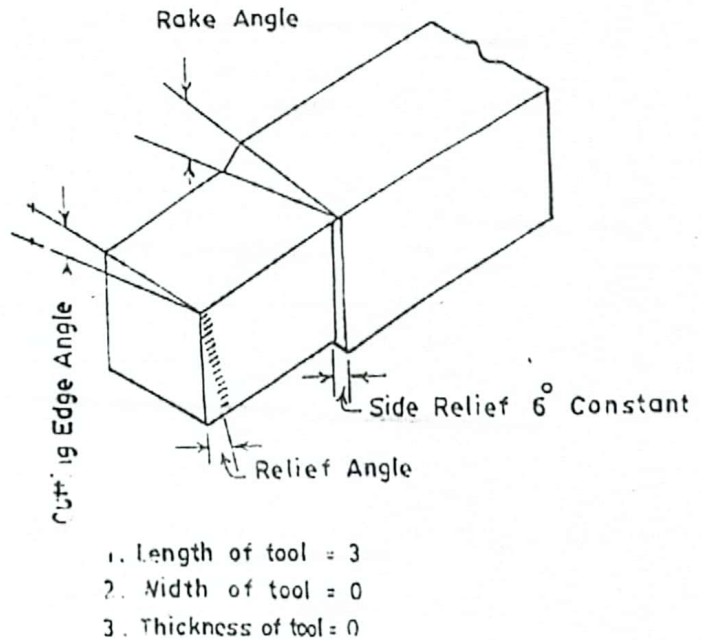


Fig-3. Geometry of High Speed steel cutting tool.

The specimen was fixed into a lathe machine, rotating at a speed of 510 R.P.M for 1 hour duration each time. The geometry of the cutting tool is given in the Figure 3.

Observation of the effect of cutting tools on the rake angle, relief angle, cutting angle and length of cut on the various samples were made, by using the tool with and without coolant.

Results.

Table, 1 (a) and 1(b), give the influence of cutting tool (with coolant) on the length of cut

at variation of rake angle, relief angle and cutting angle. Where as, Table 2(a) and 2(b), give the observations of the tool without using coolant.

Table No. 1(a) The cutting tool used with coolant.

Specimen	Rake angle	Relief angle	Cutting Angle	Length of cut (inch)
1.	4.5°	14.5°	21°	18.50
2.	6.5°	14.5°	21°	13.00
3.	8.5°	15°	20.5°	12.00
4.	7°	16.5°	21.5°	12.00
5.	5.5°	17°	22°	11.25
6.	7°	15°	21°	11.00

The colour remains blackish through this cutting.

Table No. 1(b) The cutting tool used with coolant.

Specimen	Rake angle	Relief angle	Cutting Angle	Length of cut (inch)
1.	4.5°	14.5°	21°	18.00
2.	6.5°	14.5°	21°	13.00
3.	8.5°	15°	20.5°	12.00
4.	7°	16.5°	21.5°	11.50
5.	5.5°	17°	22°	11.00
6.	7°	15°	21°	11.00

The colour remains blackish through this cutting.

Discussions.

During metal cutting operation arise in temperature occurs which brings structural changes in the cutting tools especially at the Rake and Relief angles. Such temperature measurement is very difficult to record, although one can see such changes from the structure of cutting edges of the tools.

In high speed steel tools, diffusion of carbon takes places, during the turning operation. This diffusion increases, with the decrease in the cutting tool. A tool with geometry 4.5° 14.5° & 15°, shows lower diffusion rate, thus

confirming the higher life values for such geometry with and without lubricant as shown in table 1(a), 1(b), 2(a) & 2(b), respectively. Further more a constant colour was not observed as in the later case. In this case various colours ranging from green & light blue to dark blue were observed.

By comparison of these two results, it is clear that lubricant has got the effect on the life of cutting tools. The present work suggest a tool for turning operation with a geometry of 4.5° 14.5° & 15°, be used especially when work piece is cylindrical.

Table No. 2(a) The cutting tool used without coolant.

Specimen	Rake angle	Relief angle	Cutting Angle	Length of cut (inch)	Effect on colour
1.	4.5°	14.5°	21°	16.50	Green
2.	6.5°	14.0°	21°	14.50	Dark Blue
3.	8.5°	15°	20.5°	7.50	Light Blue
4.	7°	16.5°	21.5°	10.00	Light Blue
5.	5.5°	17°	22°	9.50	Light Blue
6.	7°	15°	21°	8.50	Dark Blue

Table No. 2(b) The cutting tool used without coolant.

Specimen	Rake angle	Relief angle	Cutting Angle	Length of cut (inch)	Effect on colour
1.	4.5°	14.5°	21°	16.50	Green
2.	6.5°	14.5°	21°	14.25	Dark Blue
3.	8.5°	15°	20.5°	10.10	Light Blue
4.	7°	16.5°	21.5°	10.25	Light Blue
5.	5.5°	17°	22°	9.50	Light Blue
6.	7°	15°	21°	9.00	Dark Blue

Conclusion

The result obtained, showed that a cutting tool with a geometry 4.5° 14.5° & 15°, increases the cutting life values of the tool in comparison to other geometries used for cylindrical work piece at a constant cutting depth, rotating speed and time duration. Also there is an increase in cutting life values with the same geometry used as in above case with lubricant.

In case of lubricant blackish colour was observed throughout the turning operation. While change in colour ranging from greenish to dark blue was observed when coolant was not used.

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