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Effects of Cutting Variables on MRR and Tool Wear for EN8 Medium Carbon Steel with carbide insert

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Abstract

Turning is one of the most common of metal cutting operations. In turning, a work piece is rotated about its axis as single-point cutting tools are fed into it, shearing away unwanted material and creating the desired part. the quality and accuracy of the finished product is depends on so many parameters among those there are three key parameters plays a major role, cutting speed, feed rate and Depth of cut. in this project EN 8 is taken as the working material and carbide insert is a cutting tool. by conducting several experiments we observe the effect of these parameters on the MRR and Tool Wear

Keywords: *Tool Wear, cutting variables, EN8,turning.*

1. Introduction

Machining is the manufacturing process by which parts can be produced to the desired dimensions and surface finish from a blank by gradual removal of the excess material in the form of chips with the help of a sharp cutting tool. Almost 90% of the all engineering components are subjected to some kind of machining during manufacture. It is very important to design those parts in such a way that would lead to the increase in efficiency of the machining process, enhancement of the tool life and reduction of the overall cost of machining.

cutting speed or velocity [V], ft/min or in/sec, feed *[f]*, in/rev or mm/rev and depth of cut *[d]*, in. or mm. These three variables have a major effect upon the material [or metal] removal rate [MRR], these parameters have a major effect upon the economics of the processes. The cutting speed is the speed of the work as it rotates past the cutting tool. The feed rate is the rate at which the tool advances into the work. The depth of cut is the amount of material removed as the work revolves on its axis. Other factors include the machinability of the stock, the type and the geometry of the cutting tool, the angle of the tool to the work, and the overall condition and power of the lathe itself.

2. Tool wear

the gradual failure of cutting tools due to regular operation. It is a term often associated with tipped tools, tool bits, or drill bits that are used with machine tools. Types of wear include:

flank wear: in which the portion of the tool in contact with the finished part erodes. Can be described using the Tool Life Expectancy equation.

crater wear: in which contact with chips erodes the rake face. This is somewhat normal for tool wear, and does not seriously degrade the use of a tool until it becomes serious enough to cause a cutting edge failure. it can be caused by spindle speed that is too low or a feed rate that is too high. In orthogonal cutting this typically occurs where the tool temperature is highest. Crater wear occurs approximately at a height equaling the cutting depth of the material.

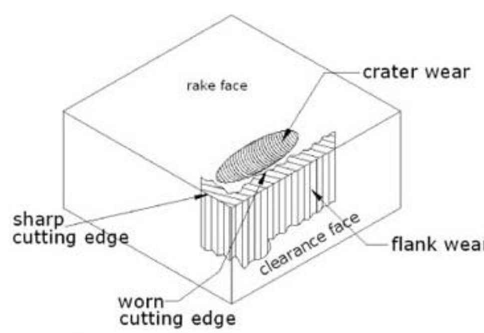

Fig: 1 Create wear & flank wear

3. MRR

MRR is the ratio of volume of material removed from work piece to the machining time.in this work we have taken MRR in gram/min.

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4. Experimental details :

4.1. Cutting Tool Material:

in metal-cutting, High Speed steel and Carbide are two major tool materials widely used. Ceramic tools and CBN (Cubic Boron Nitride) are the other tool materials used for machining very tough and hard materials. A tool's hardness, strength, wear resistance, and thermal stability are the characteristics that decide how fast the tool can cut efficiently on a job. Cemented Carbides Introduced in the 1930s. These are the most important tool materials today because of their high hot hardness and wear resistance. The main disadvantage of cemented carbides is their low toughness. These materials are produced by powder metallurgy methods, sintering grains of tungsten carbide (WC) in a cobalt (Co) matrix (it provides toughness). There may be other carbides in the mixture, such as titanium carbide (TiC) and/or tantalum carbide (TaC) in addition to WC. WC/TiC/TaC grains Co matrix Microstructure of cemented carbides Thread tap and die made of high-speed steel Assortment of cemented carbide inserts for use by different cutting tools. Some of the inserts are coated with a very thin layer of wear-resistant material. In spite of more traditional tool materials, cemented carbides are available as inserts produced by powder metallurgy process. Inserts are available in various shapes, and are usually mechanically attached by means of clamps to the tool holder, or brazed to the tool holder (see the figure in the next page). The clamping is preferred because after an cutting edge gets worn, the insert is indexed (rotated in the holder) for another cutting edge. When all cutting edges are worn, the insert is thrown away. The index able carbide inserts are never reground. If the carbide insert is brazed to the tool holder, indexing is not available, and after reaching the wear criterion, the carbide insert is reground on a tool grinder.

Fig: 2 carbide insert and seat clamp tool holder

4.2 Work piece material

The work piece material was EN8 steel in the form of round bars having 50 mm diameter and length of 150 mm. EN8 is a medium carbon steel usually supplied untreated. EN8 has good tensile strength and is often used in applications such as: shafts, gears, stressed pins, studs, bolts, keys etc.

EN8 is a very popular grade and is readily machinable in any condition. It can be further surface-hardened to produce components with enhanced wear resistance, typically in the range 50-55 HRC through induction processes.

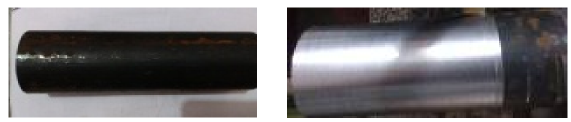

Fig: 3 EN8 before and after machining

Chemical composition of EN8 steel workpiece in percentage by weight

Carbon 0.36-0.44%, Silicon 0.10-0.40%, Manganese 0.60-1.00%, Sulphur 0.050 , Phosphorus 0.050

Table 1 : Experimental setup and conditions

Work piece materials	EN8 steel
Size	Φ50 mm x 150 mm
Cutting inserts designation)	CNMG 120408 -HM(ISO
Tool holder	PCBNR 2020 M12 (ISO designation)
Stop watch	------
Tool makers microscope	Magnification range 15x-30x
Weighing instrument	Range 0.01g -200g
Cutting conditions	Dry

5.Control variables along with the levels.

The ranges of the process control variables are
Two speeds S1 : 240 rpm (37.69 m/ min) and S2 : 580 rpm (91.106 m/ min)
Two feeds F1: 0.15 mm/rev and F2: 0.25mm/ rev .
Two depth of cut D1: 0.5 mm and D2: 1.5mm.

The above mentioned parameters are combined in various combinations and turning was carried out.
the combinations of speed, feed and depth of cut and number of trials to 8.
They are as follows.
S1F1D1
S1F2D1
S2F1D1
S2F2D1
S1F1D2
S1F2D2
S2F1D2
S2F2D2

6.Observations

- In each trail the machining time is measured by using stop watch
- MRR is measured by measuring weight of chips by weighing instrument .and
- Tool wear is measured by Tool makers microscope.

7.Experimental results

SNO	Control factors			Measured parameters	
	Speed, rpm	Feed rate, mm/rev	Depth of cut, mm	MRR gm/min	Tool Wear, mm
1	240	0.15	0.5	3.26	0.26
2	240	0.25	0.5	4.49	0.38
3	580	0.15	0.5	7.94	0.40
4	580	0.25	0.5	9.67	0.42
5	240	0.15	1.5	6.49	0.38
6	240	0.25	1.5	12.37	0.46
7	580	0.15	1.5	11.06	0.52
8	580	0.25	1.5	14.03	0.54

8.Results and discussion

As the spindle speed increases the material removal rate is also increased.
The Effect of speed, feed and depth of cut on MRR at different variables are shown in fig 4,5,6.

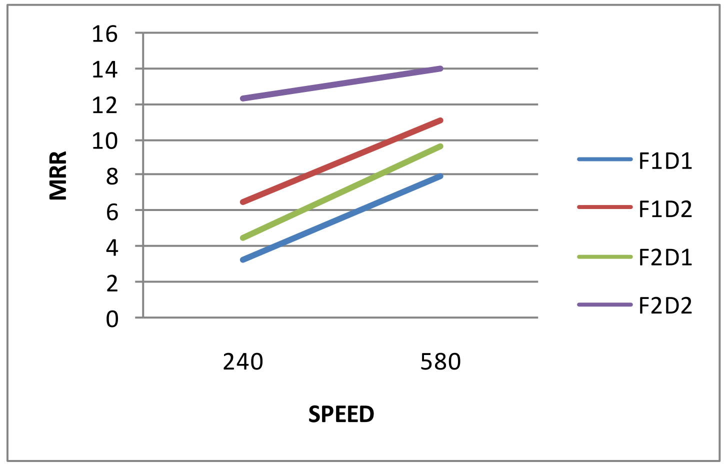

Figure 4. Effect of spindle speed on MRR at different variables

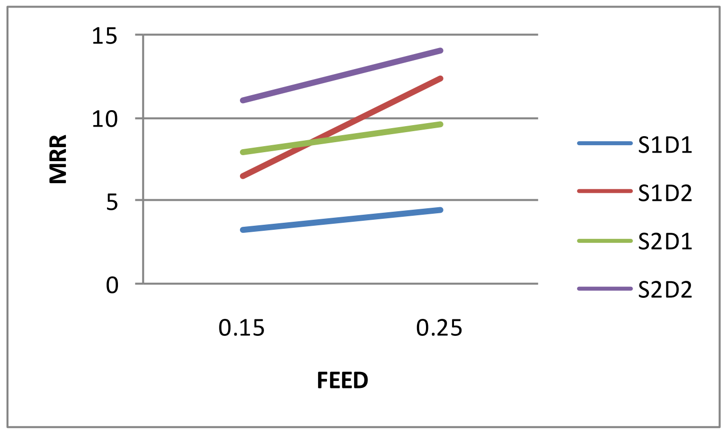

Figure 5. Effect of Feed Rate on MRR at different variables

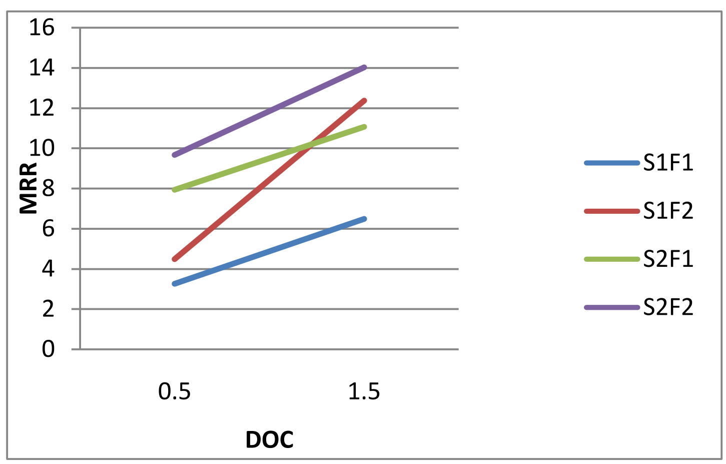

Figure 6. Effect of depth of cut on MRR at different variables

The Effect of speed, feed and depth of cut on Tool Wear at different variables are shown in fig 7,8,9.

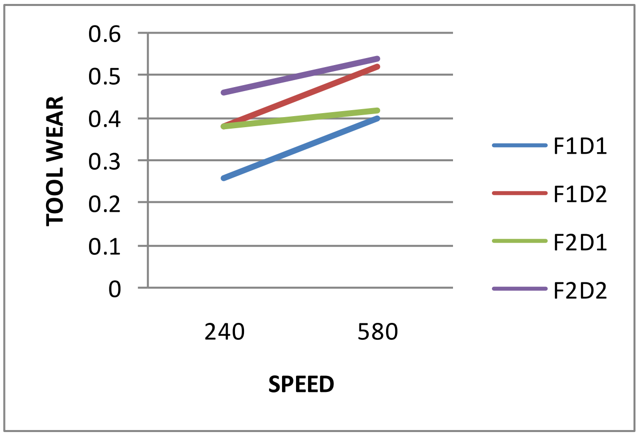

Figure 5. Effect of spindle speed on Tool Wear at different variables

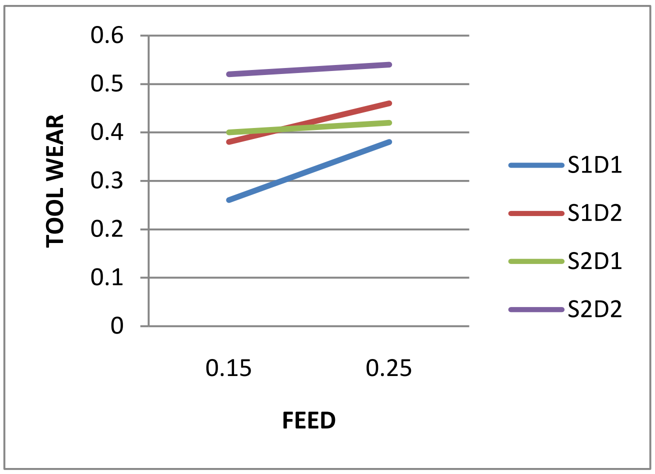

Figure 6. Effect of federate on Tool Wear at different variables

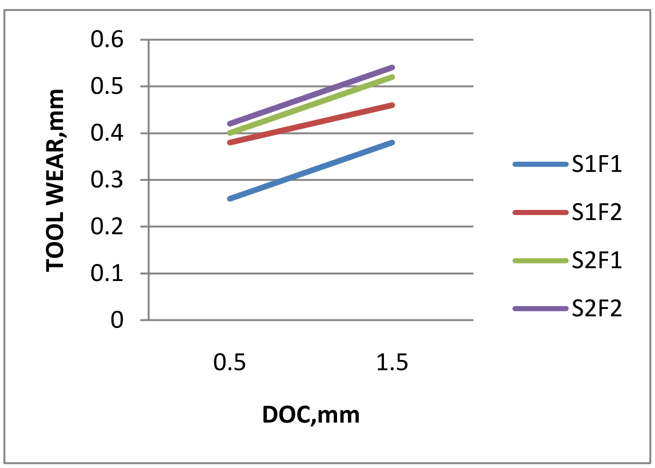

Figure 7. Effect of depth of cut on Tool Wear at different variables

9. Conclusions

The experimental results showed that the spindle speed is the key parameter which is mainly affect the MRR, followed by feed rate and depth of cut .based on these experimental values we can expand this work to determine cutting force,power,and surface roughness by using advanced attachments and software. The graphs plotted from the results of experimental work carried out provide us the trends in which it is possible to know how tool flank wear progresses towards failure.

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