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A REVIEW ON INVESTIGATION OF COATED INSERT AND PREDICTION OF MRR IN TURNING OPERATION

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ABSTRACT

In this current scenario, the manufacturing industries are keenly observing and updating the manufacturing process to produce the quality products and improve the productivity with economical benefits (i.e, less cost) and resources. According to that nowadays, to achieve those goals manufacturing industries are mainly concerned about the optimization of machining process parameters (such as cutting speed, feed rate and depth of cut). From various literature surveys it is seen that the material removal rate can be further improved by coated inserts. It can be modelled using regression equations by Minitab software. From this software by giving input parameters the predicted output parameters can be observed. By this, optimized machining parameters can be achievable which will provide better manufacturing process.

Keywords: Tool wear , coating insert ,MRR.

1. INTRODUCTION

Optimization of cutting parameters is worthy in terms of providing high exactitude and efficient machining. So an attempt is made to optimize machining parameters using coated tools by analysis of tool wear. Due to their significantly higher hardness, carbide-cutting tools are more widely used in the manufacturing industry today than high-speed steels. Coated and uncoated carbides are widely used in the metal working industry and provide the best alternative for most turning operations. There are different classifications of tool wear in the metal cutting process such as abrasion, adhesion, fatigue, diffusion, and chemical wear. In hard turning, not only tool geometry and cutting conditions, but also the cutting tool type and composition and hardness of the work piece materials are important factors influencing wear mechanisms. Cutting type (continuous or intermittent turning) is also an important factor affecting tool wear behaviour. Results on intermittent turning using a cemented carbide cutting tool showed that the wear type that generally occurred was flank wear, and the wear mechanisms were abrasion, adhesion, and oxidation. The most prominent mechanisms of tool wear in typical hard turning applications have been found to be abrasion, adhesion, and diffusion. Many studies have been carried out to depict the tool wear and wear mechanisms in the hard turning process. These studies can be categorized into four groups: (a) work piece material type; (b) cutting tool type; (c) cutting edge geometry; (d) wear type and mechanisms. Another important factor in the hard turning process is tool geometry or edge preparation. The edge preparation of the cutting tool (round or chamfered edge) affects the cutting forces, cutting temperature, and tool wear. In another study, the effect of tool nose radius on finish turning of hardened AISI 4340 steels was investigated by **Chou** and **Song(2004)**. Their results showed that a large tool nose radius gave a finer surface finish, but the wear behaviour of a large tool nose radius was similar to that of a small nose radius tool. The alumina-based ceramic cutting tools are subjected to not only flank wear but also to crater wear and notch wear, especially where machining hard and tough materials. In the literature, many studies have reported on tool wear behaviour and tool life in the machining of hardened steel. The most observed wear mechanisms are abrasion and diffusion. Flank wear and crater wear are the most commonly encountered wear types due to diffusion and abrasion. **Xiao et al(1990)** has observed that zirconia toughened alumina ceramic cutting tools and TiC mixed alumina ceramic tools are more appropriate for machining hardened steel than other ceramic tools because of their superior flank wear resistance. **Kumar et al(2006)** studied the machinability of hardened steel (EN24) using alumina based ceramic cutting tools. **Lan T et al(2008)** studied the effect of the cutting parameters feed, speed, depth of cut and tool nose runoff on the surface roughness and cutting force. **Biswas C.K. et al(2008)** proposed their work on several methods used for predicting the surface roughness of the machined components. Their oncomings were classified into machining theory, experimental probe, designed experiments and artificial intelligence. **Lee et. Al(2001)** accentuated on artificial neural networks using a sensing technique to regulate the outcome of vibration produced by the motions of the cutting tool and work piece during the cutting process developed an on-line surface recognition system. **Abhijeet et al(2006)** submitted the results of cBN plus TiN (cBN–TiN) composite-coated, commercial grade, carbide inserts for hard turning applications. They found that the crater wear of the cBN–TiN coated inserts is less than that of the PCBN inserts because of the lubricate of TiN capping layer on the cBN–TiN coating. **Ji Xiong et al(2012)** examined the Tool life and wear of WC–TiC–Co ultrafine cemented carbide during dry cutting of AISI H13 steel. They found that the favourable cutting performance of ultrafine WC–5TiC–10Co inserts was attributed to the higher hardness and less thermal softening during machining. **Xu C. Jin C J(2008)**the surface residual stresses induced by machining are an important indication of the quality of the machined surface, and are also critical to determining the dimensional accuracy and fatigue life of the work piece. **Dipti Kanta Das et al(2014)**have examined surface roughness during hard machining of EN 24 steel with the help of coated carbide insert. Fine surface quality of roughness is procured during hard turning operation and found Feed is the most prevailing parameter for both output responses. **Tugrul O zel et a(2009)** studied the effects of cutting edge geometry, work piece hardness, feed rate and cutting speed on surface roughness and resultant forces in the end hard turning of AISI H13.

2. EXPERIMENTAL SETUP

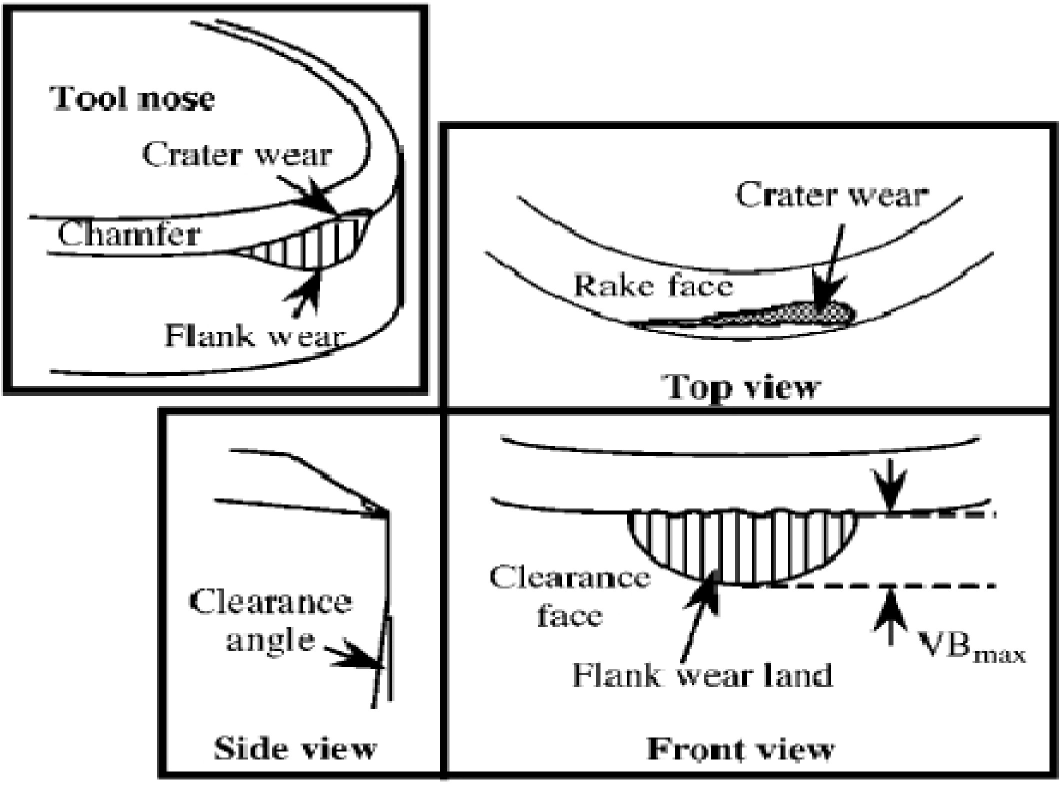
The machining tests can be carried out on the specimen material in cylindrical form which was 120 mm long and 35 mm in diameter with the help of coated cemented inserts of two different nose radii on CNC lathe with a variable speed of 50 to 50,000 rpm. For the experiment work the three process parameters at four levels and one parameter at two levels have to be decided. It is desirable to have two minimum levels of process parameters to reflect the true behaviour of output parameters of study. The tool inserts were made of cemented carbide material for the machining operation.

Fig 1. CNC machine.

3. TOOL WEAR

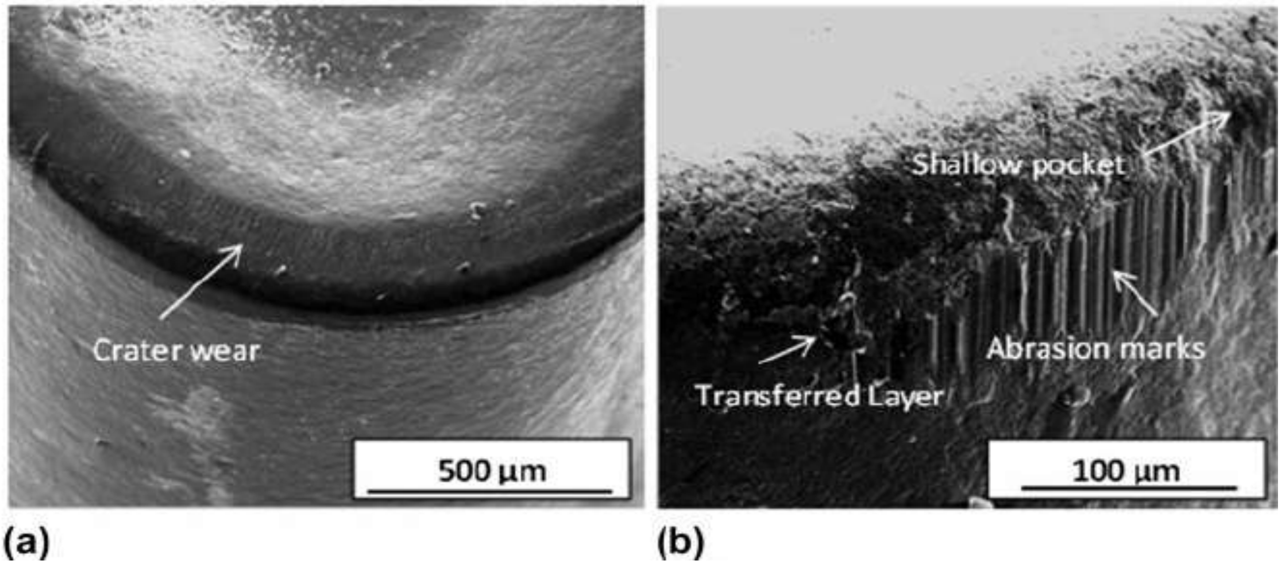
Tool wear depicts the progressive failure of cutting tools due to regular operation. It is a term often associated with tipped tools, tool bits, or drill bits that are used with machine tools.

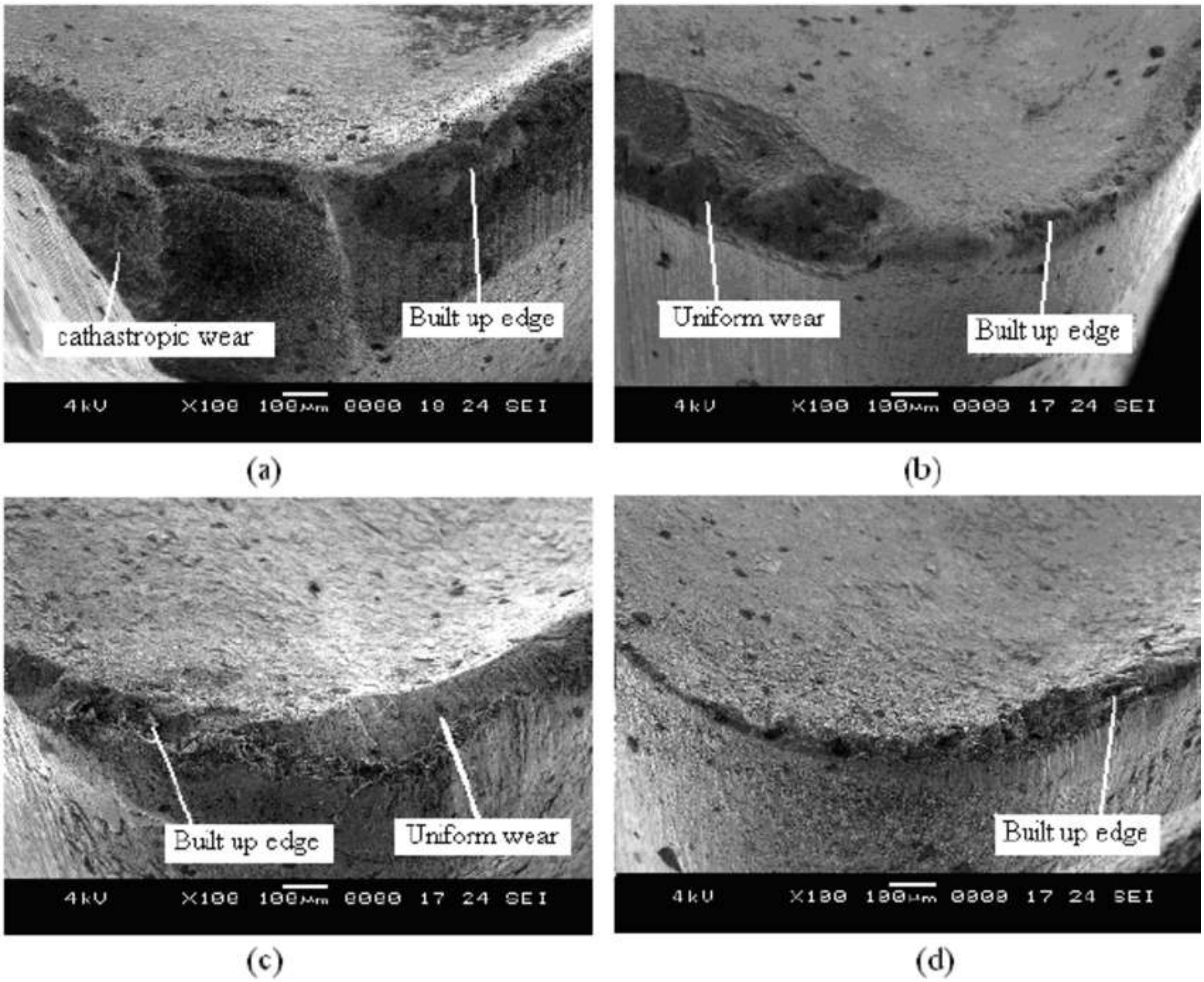
Fig 2. Various views of flank and carter wear.



3.1 EFFECTS OF TOOL WEAR

Certain general impacts of tool wear are increasing in cutting forces, poor surface finish, lower accuracy of finished part may lead to tool breakage causes change in tool geometry. Abatement in tool wear can be achieved by using lubricants and coolants while machining. These lower friction and temperature, thus reducing the tool wear. Insert wear can be predicted by using Scanning Electron Microscopy images. Higher magnification factor helps us to view the images in an unambiguous structure.





(a) (b)

(c) (d)

Fig 3. Analysis of wear using SEM

4. MATERIAL REMOVAL RATE

The material removal rate may be defined as the ratio of volume of material removed to the machining time. Other way to define MRR is to imagine an rapid material removal rate as the the rate at which the cross-section area of material being take off moves through the work piece. Machining is a terminology used to depict material removal processes in which a cutting tool removes unwanted material from a work piece to produce the required shape.

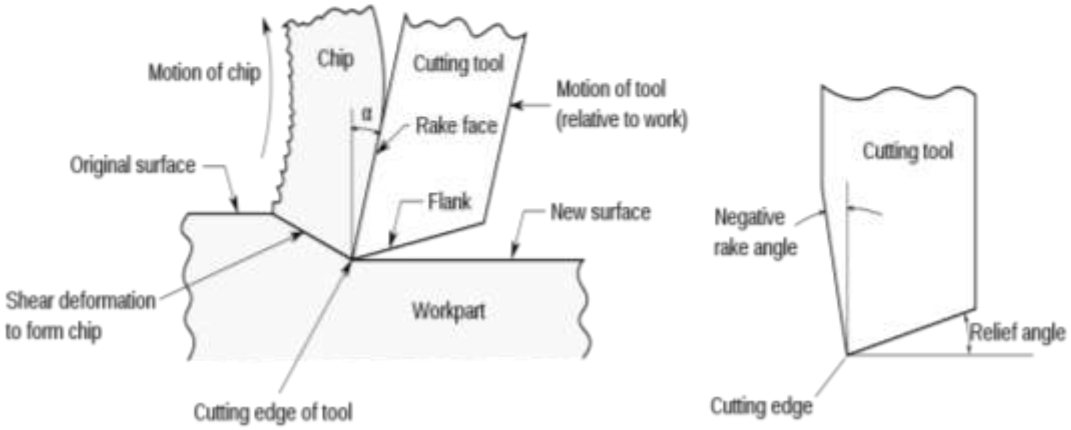


Fig 4.Material removal process using Cutting tool .

4.1 CUTTING SPEED

Cutting speed can be defined as the rate at the work piece surface, regardless of the machining operation used. A cutting speed for mild steel is the same whether it is the speed of the cutter passing over the work piece, such as in a turning operation, or the speed of the cutter moving past a work piece, such as in a milling operation. The cutting conditions will affect the value of this surface speed for mild steel.

4.2 FEED RATE

Feed rate can be defined as that the velocity at which the cutter is fed (i.e,) advanced against the work piece. It is formulated in units of distance per revolution for turning and boring (typically inches per revolution [IPR] or Millimetres per revolution). It may be explicit for milling also, but it is generally expressed in units of distance per time for milling (typically inches per minute [IPM] or Millimetres per minute), with considerations of how many teeth (or flutes) the cutter has then resolving what that means for each tooth.

Feed rate is depended upon the:

Type of tool, Surface finish required, Availability of Power, Rigidity of the Machine and setup, Strength of the work piece, Characteristics of material being cut, flow of chip depends upon feed rate.

4.3 DEPTH OF CUT

Feed rate and cutting speed both comes along with depth of cut to depict the material removal rate, when the volume of work piece material that can be removed per time unit.

4.4 SPINDLE SPEED

The spindle speed is the rotational frequentness of the spindle of the machine, measured in revolutions per minute (RPM). The preferred speed is determined by working backward from the desired surface speed (m/min) and integrating with the diameter of work piece or cutter. Using the accurate spindle speed for the material and tools will considerably improve tool life and the quality of the surface finish. For a given machining operation, the cutting speed will remain constant for most situations; therefore the spindle speed will also remain constant. Ideally this means adjusting the spindle speed as the cut advances across the face of the work piece, producing constant surface speed. Typically speaking, spindle speeds and feed rates are less critical in woodworking than metalworking.

4.5 CALCULATION OF MRR

Following equation is used to calculate the response Material Removal Rate (MRR).

$$MRR = \frac{\text{Initial weight of workpiece} - \text{Final weight of workpiece}}{\text{density} \times \text{Machining time}}$$

Where,

Volume of work piece in mm^3,

Machining time (MT) in ‘sec’ and

MRR in mm^3/sec

5. CONCLUSION

The past works revealed the dominance of various parameters for different process which involved the study of MRR, and tool wear. The experimental investigation involves turning of EN24 alloy steel using coated cemented carbide inserts. The coated inserts would produce less wear than the uncoated inserts. This can be analyzed by regression model with the help of Minitab software. Thus the insert life can be improved based on the machining parameters.

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