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EXPRIMENTAL AND STATISTICAL ANALYSIS OF PVD AND CVD COATED CUTTING TOOLS BASED ON TOOL WEAR IN END MILLING OF EN 8

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Abstract: The tool wear of PVD and CVD coated cutting tool inserts were investigated at various combination of cutting speed ,feed and depth of cut for end milling of low carbon steel EN 8. In the present study the comparison has been made data for experimental study and software study comparing the data for variation of tool wear and surface roughness. The objective of this study is to apply statistical analysis to predict output variables and establish relationship between the controllable factors (in this study: spindle speed, feed rate and depth of cut) and response factor (surface roughness and tool wear).It is found that tool wear primarily affected by cutting speed and then secondly affected by feed rate .PVD coated tool insert gives better tool wear as compared to CVD coated tool insert
Keyword: End milling, EN 8, tool wear, PVD and CVD

I. INTRODUCTION

Low carbon steel EN 8 materials have been widely used in the automobile bodies, structural shapes, pipelines, buildings, bridges and tin cans. So it has been used as the work piece material in this study. As a basic machining process, milling is one of the most widely used metal removal processes in industry and milled surfaces are largely used to mate with other parts in die, aerospace, automotive, and machinery design as well as in manufacturing industries [1, 2]. Surface roughness is an important measure of the technological quality of a product and a factor that greatly influences manufacturing cost. The mechanism behind the formation of surface roughness is very dynamic, complicated, and process dependent; it is very difficult to calculate its value through theoretical analysis [3]. Therefore, machine operators usually use “trial and error” approaches to set-up milling machine cutting conditions in order to achieve the desired surface roughness. Obviously, the “trial and error” method is not effective and efficient and the achievement of a desirable value. The flank wear of the coated tool insert are affected by type of coatings, tool geometry and cutting parameters which can be used for experimental test. In this present study we use PVD (PHYSICAL VAPOUR DEPOSITION COATING) and CVD (CHEMICAL VAPOUR DEPOSITION COATING) coated cutting tool insert for experimental study [4]. In this study the machining of EN 8 low carbon steel PVD and CVD coated tool insert with different cutting speed 251,314 and 471 mm/min with the feed rates of 0.133,0.166and 0.2 mm/tooth and depth of cut 0.2,0.25and0.3 mm. Our study focused on determines which of optimum condition for getting better tool wear for PVD and CVD coated tool insert. Also determine which of the coatings gives better tool flank wear out of two PVD and CVD coated tool insert. We use Taguchi design of experiment and regression analysis for experimental work.

II. MATERIALS AND METHODS

A. *Workpiece material*

EN 8 rectangular with 0.4 % carbon and 300x100x10 mm size with characteristics given in Table1 were used as a raw material.

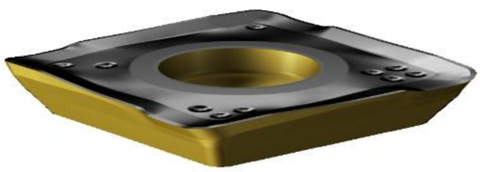
Mechanical property	Density(x1000 kg/m^3)	Tensile strength(MPa)	Yield strength(MPa)	Hardness (HRC)
value	7.7-8.03	615.4	375.8	42

Table 1

III. CUTTING TOOLS

The PVD and CVD coated tool insert are used for machining of EN 8.Details of these tools are shown in fig 1 and Table 2.

PVD Insert



CVD Insert

Figure 1

Item	**PVD**	**CVD**
Tool style code	490R/L.M-PM	490R/L.M-PM
Grade	1030	4230
Insert shape code	S	S
Weight of item	0.02kg	0.02kg
Coating	PVD	MTPVD
Insert included angle	90 deg	90 deg
Insert rake angle	20 deg	20 deg
Chip breaker manufacture's designation	PM	PM

Table 2

A. Experimental Procedure

The machine tool used in the cutting test was a three –axis vertical milling machine tool with a PC based NC controller. The machine table could be moved in Cartesian coordinated in x-, y- and z- direction. The experiments were conducted on an AKIRA SEIKHI PERFORMA SR3vertical milling center with a maximum power of 15 HP and maximum spindle speed of 9000 rpm. In this study the machining of EN 8 low carbon steel PVD and CVD coated tool insert with different cutting speed 251,314 and 471 mm/min with the feed rates of 0.133,0.166and 0.2 mm/tooth and depth of cut 0.2,0.25and0.3 mm .

Sr.No	Cutting speed(mm/min)	Feed(mm/tooth)	Depth of cut(mm)	Flank wear of CVD(mm)	Flank wear of CVD(mm)
1	251	0.133	0.20	0.13	0.14
2	251	0.166	0.25	0.22	0.17
3	251	0.2	0.30	0.29	0.22
4	314	0.133	0.25	0.32	0.27
5	314	0.166	0.30	0.36	0.30
6	314	0.2	0.20	0.41	0.34
7	471	0.133	0.30	0.42	0.35
8	471	0.166	0.20	0.44	0.37
9	471	0.2	0.25	0.45	0.39

Table 3

IV. RESULTS AND DISCUSSION

A. Effect of Coatings on Tool flank wear

The effects of different coatings in tool flank wear are compared for PVD and CVD coated tool insert which are shown in figures.

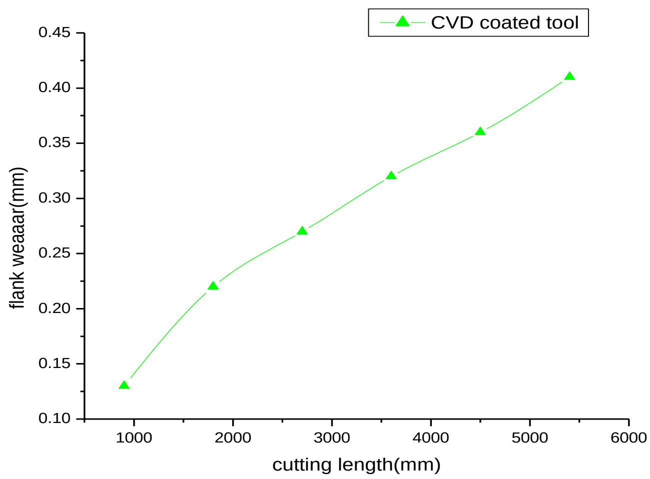


Figure 2: Flank wear v/s Cutting length of CVD coated cutting tool insert

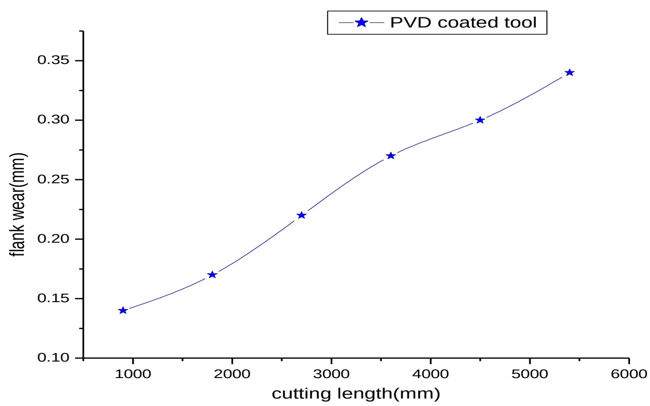


Figure 3: Flank wear v/s Cutting length of PVD coated cutting tool insert

Figure 2 and 3 shows the increment in the flank wear as cutting length increases for both PVD and CVD coated tool insert. The flank-wear as a function of the cutting length for the CVD coated tool is shown in Figure 2. From the figure, the flank wear appears to increase with the cutting length as expected. The wear appears to grow more rapidly at the initial stage up to around cutting length 3600 mm, and then grows at a lower steady rate. This result shows an initial stage with rapid growth and a second stage with steady lower growth. Figure 3 shows that tool flank wear has three stage, initially it is increasing with steep curve up to cutting length of 2700 mm then after wear rate is high in second stage from cutting length of 2700 to 3600 mm and finally it increasing slightly lower than the second stage after cutting length of 3600 mm.

V. CONCLUSIONS

An experimental study was conducted to analysis of PVD and CVD coated tools based on tool wear in end milling of

EN 8.The conclusion drawn from the study are as follows
1) For CVD coated cutting tools flank wear affected by cutting length. The flank wear appears to grow more rapidly at the initial stage up to around cutting length of 3600 mm and then grow at a lower steady rate 2) For PVD coated tool insert affected by cutting length. The flank wear has three stages; initially it increasing with step curve up to cutting length of 2700mm then after wear rate is high in second stage from cutting length of 2700 to 3600mm and finally it increasing slightly lower than the second stage after cutting length of 3600 mm. 3) The PVD coated tool insert are better coating materials for machining of EN 8 work piece because it has lower tool wear rate as compared to CVD coated tool insert.

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