Surface Roughness Optimization of Cermet and Carbide Inserts in Dry Hard Turning of En-19 Steel

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***Abstract-* Cutting tools are very much useful for improving their performance in high-speed machining such as Dry turning. However problem of quality and economical production occurs for developing cutting tools to use for high-speed machining of very hard materials. The present work studies the performance of multilayer coated cermet and carbide inserts or tools throughout the dry turning of EN-19 Steel. A comparison between the performance of all the coated inserts has been made using cutting parameters (speed, feed and doc) by using the Surface roughness A L9 orthogonal Array and ANOVA are applied to study the performance of machining parameters. Optimum parameters has been also found for improved Surface roughness during the machining of EN19.**

***Keywords:* Multilayer coated, Carbide, Cermet Inserts, Dry Turning, Surface Roughness.**

I. INTRODUCTION

Metal cutting is a process which involved in the manufacturing process either directly or indirectly for making every product in modern civilization. The main goal of the machining process is to produce a product having low cost with enhanced accuracy (Sahoo et al. 2012). In every metal cutting operation, the most vital element is cutting tool materials that are selected carefully. Machining is a process to shape the material to its desired shape with accuracy. It is one of the main process which is involved in all kind of manufacturing processes (Wang et al. 2000). So, main concentration is to reduce cost of the cutting tool material and simultaneously improve the quality of the machined parts. In the modern civilization, to meet the increasing demand, overall production and productivity, the major force on the industry is to developing a new and good quality tool material. The purpose of developing a new cutting tool material has following advantages like lead time reduces, manufacturing cost has been reduced, difficult and hard materials are easily machined, improve surface roughness and material removal rates (MRR) increases. The main trend in the manufacturing industries is to use hard machining such as to cut the hard metal with the treated tools (Poulachon et al. 2004). The heat resisted and wear resisted tools materials like carbides, cermet and ceramics coated tools reduces the effect of temperature and high wear.

At present most of tool materials can be prepared by means of various types of coating materials. In recent machining processes, coated cutting tools has been become quite famous and it is not any wonder that ample number of metal cutting industries are focused on coated cutting tools because coated tool enhance the tool properties (Noordin et al. 2001). By providing these coatings on the tools, it makes the machining easy as these tools can offer greater wear resistance and deformation under high speed machining. The first cutting tool material which was developed are carbon steel but the growth of cutting tool material industries was continuous up to till date. The main attention of the industries is to introduce a better cutting material having better properties (Prengel et al. 1997). In 1969, first indexable coated cemented carbide inserts for turning process were introduced and had an instant impact on the metal cutting industry (Soderberg et al. 2001).The coating on the cutting tools with the hard constituents like TiN, TiC and Al2O3 improves the cutting tool capabilities. Hence, the tools can be used to cut a material at higher cutting speeds for better productivity with less power requirements (Watmon et al. 2010). The cutting edges of cemented carbide tools coated with TiC, TiN can show an increase of service lifetime of tools by a factor of ten compared to the uncoated tools (Schulz et al. 2003).

Hard coating is an important aspect for cutting tools. These hard coatings are the thin films that can range from one layer to hundreds of layers and can have a thickness ranging from a few nanometers to a few millimeters. These hard coatings can provide a significant increase in the tool life. The tool life of the TiN coated tool increased by four times than the tool life of non-coated HSS tool (Arshi et al. 2013). The improvement in the metal cutting tool industry is development of coated tools. The coated tool not only enhancing the resist to wear capability but this can also leads to improve hardness as well as refractoriness. Coating also protects the tool from oxidation and makes the tool chemically stable (Bensouilah et al. 2016). The process provides several benefits such as increase product quality and efficiency, decreasing the cost and processing time.

II. EXPERIMENTAL DETAILS

Work piece Materials, cutting tools and CNC machine

The work materials used for the research work were EN19 steel round bar. It contains C 0.35-0.45%, Mn 0.50-0.80%, Si 0.10-0.35%, Cr-0.90-1.50%. The dimensions of the EN19 Steel procured are 40 mm in diameter and 60 mm in length and these were machined under dry condition. Cutting tools materials used for the experiment were coated Carbide and Cermet inserts.. The geometry of coated cermet insert was TNMG 160404 NS730 and for coated carbide inserts was TNMG 160404 TH10.These different inserts were coated with TiN with Al_2O_3 and TiC and then used for machining the material.The CNC machine used for the machining was TECNO WASINO L-J5 CNC turning under the dry-conditions and the Spindle Speed used were 700, 1000 and 1300 rpm having the feed rate of 0.10, 0.13 and 0.16 mm/rev and depth of cut was 0.4, 0.7 and 1.0 mm respectively. The cutting conditions tested are listed in Table 1. The Surface roughness of the surface was measured by using the Mitutoyo Roughness Testing Machine. L9 taguchi orthogonal array has been used and the graphs and tables were produced by using doe and analysis has been done by the use of Minitab software 16.

The important process parameters were cutting speed, depth of cut and feed rate.

Table 1: Machining Parameters used in the experiment

S.No.	Factors		
	1	2	3
Speed (r.p.m)	700	1000	1300
Feed Rate(mm/rev)	0.10	0.13	0.16
Doc (mm)	0.4	0.7	1.0

III. THE TAGUCHI METHOD AND DOE FOR THE EXPERIMENTATION

The Taguchi method of designing the experiments provides an easy and simple approach to the optimization of parameters and for performance quality and cost. Taguchi approach has been used for obtaining the design of experiments. In manufacturing industries it is an excellent approach for quality control [8].

In this method results are studied to achieve any of the following objectives.

- To estimate the contribution of individual factors.
- To estimate the response under the most favorable conditions.
- To establish the best of the optimum condition for the process or a product [9].

Depending upon the type of responses, these S/N ratios are used:

- Higher the better

  MSDHB=Mean Square Deviation for superior the better response

- Lower the better

  MSDHB=Mean Square Deviation for lower the better response [10].

IV. RESULTS AND ANALYSIS

4.1 Surface Roughness.

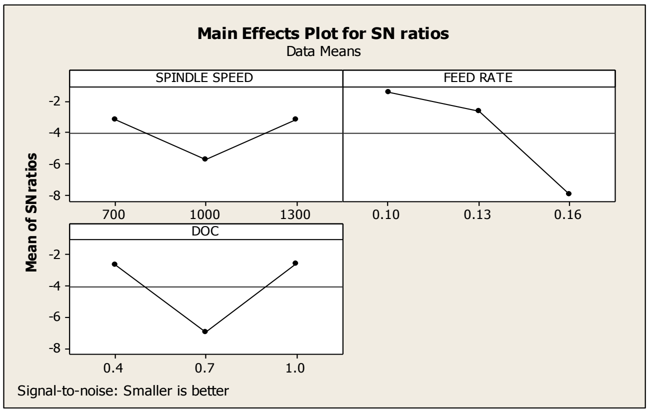
4.1.1Effect of Speed, Feed and DOC on Roughness for Coated Cermet inserts

The effects of various types of input parameters on the surface roughness are given below in fig. 1 for SN ratios

Table 2: Experimental data for Surface Roughness

S.NO.	SPINDLE SPEED (rpm)	FEED RATE (mm/rev)	DEPTH OF CUT (mm)	(CERMETINSE RTS) Ra (µm)	(CARBIDE INSERTS) Ra (µm)
1	700	0.10	0.4	0.98	1.20
2	700	0.13	0.7	1.52	1.68
3	700	0.16	1.0	2.01	2.15
4	1000	0.10	0.7	2.11	2.40
5	1000	0.13	1.0	1.50	1.79
6	1000	0.16	0.4	2.29	2.43
7	1300	0.10	1.0	0.80	0.92
8	1300	0.13	0.4	1.10	1.60
9	1300	0.16	0.7	3.43	2.90

Fig 1. Main effects plot of SN Ratios for R_a



Optimum parameters for minimum surface roughness for coated cermet inserts are speed1300 rpm, doc 1.0 mmand feed 0.10 mm/rev.

From Table 3, it has been found that feed is the factor which affects the roughness more effectively than the other factors.

Table 3: Value of Response for SN Ratios for Cermet Inserts

Level	Spindle Speed(rpm)	Feed Rate(mm/rev)	Depth of Cut(mm)
1.	-3.175	-1.457	-2.616
2.	-5.735	-2.662	-6.943
3.	-3.199	-7.989	-2.549
Delta	2.560	6.532	4.394
Rank	3	1	2

4.1.2 Effect of Speed, Feed and DOC on Roughness for Coated Carbide inserts

The effect of various factors on the surface roughness values is given in fig. 2 for SN ratios. Optimum parameters for minimum surface roughness for ceramic inserts are speed 1300 rpm,doc 1.0 mmand feed 0.10 mm/rev.

Fig 2. Main Effects Plot of SN Ratios for Ra (Carbide Inserts)

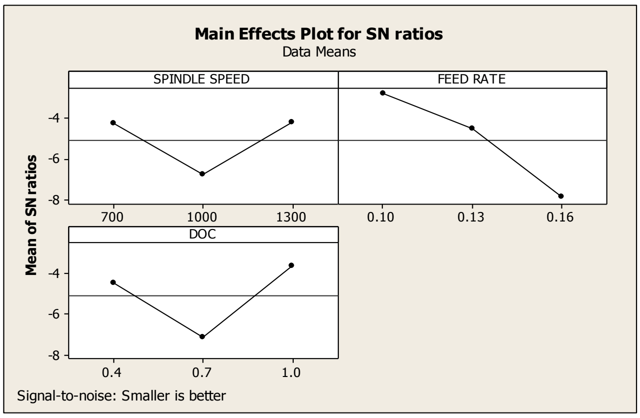


Table 4: Value of Response for SN Ratios for Carbide Inserts

Level	Spindle Speed(rpm)	Feed Rate(mm/rev)	Depth of Cut(mm)
1.	-4.246	-2.821	-4.459
2.	-6.791	-4.549	-7.139
3.	-4.222	-7.890	-3.661
Delta	2.569	5.068	3.479
Rank	3	1	2

From Table 4, it has been found that feed is the factor which affects the roughness more effectively than the other factors.

V. CONCLUSION

From the analysis of the results in the turning process using the conceptual (S/N) ratio approach, ANOVA and Taguchi optimization method, following conclusions has been made from the present study. The following conclusions, based on the experimental results presented and analyzed, are drawn on the effect of spindle speed, feedrate and depth of cut on the performance of coated cermet and carbide tools when turning EN19 Steel. Optimization of the different cutting parameters based on the experimentation. Feed and doc are the substantial aspects which distresses the Ra. Optimal parameters for min. surface roughness are speed 1300 rpm, doc 0.1 mm and rate of feed 0.10 mm/rev in instance of cermet inserts/tools.

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