Investigation to optimize the Input Parameters with Carbide Inserts and HSS Tool on CNC Turning to minimize the surface roughness on EN19 Steel

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Abstract*: This paper deals with the experimental investigation and testing on a single point cutting tool with carbide inserts and high speed steel tool. Cutting tool has to be strong enough to withstand the wear resistance. It is to be proved that carbide inserts have better performance than HSS tools on machining operation. Components with higher surface quality, higher material removal rate in less time and lower tool wear is only possible by carbide insert tools. The tool material selected for this experiment are cemented & tungsten carbide inserts along with high speed steel tool on machining medium carbon steel EN19. The complete machining process is performed on cnc lathe machine Hence the intention of this project is to minimize the surface roughness, and tool wear. Taguchi's L9 orthogonal array is favor for this investigation work. The result obtained in this project can be further used for optimizing the process parameters there by optimized results helps the operator to improve the quality as well as production rate.

Keywords: Single point Cutting tool, carbide inserts, HSS, surface roughness, Tool wear.

I. INTRODUCTION

Machining process is one of the metal removal process in which the unwanted substance from the work piece is detached by cutting tool in the type of chips. The cutting tool rake angle plays an important role in surface finish also wear. Heat is generated at the tip of the tool during the machining process that affects the tool geometry and properties. Therefore, proper material selection with accurate rake angles is provided to tool in order to overcome the failure of tool. It is also determined that any sudden change in cutting speed, cutting depth & feed rate has the maximum cause on increasing cutting temperature, wear as well as surface unevenness.

Hence any improvement in tool life will have a direct impact on the cost of production. The cutting tool geometry includes back rake angle, end relief angle, side cutting edge angle, end cutting edge angle, lip angle, side rake angle and side relief angle.

During machining operation enormous amount of heat and resistance is developed among tool and work piece. Coolant supplying during the machining operation is also plays an important role to overcome the tool failure and it acts an lubricant.

II. OBJECTIVES

- To determine the optimum surface finishing of work piece by varying the cutting parameters.
- In order to reduce the tools wear without failure such that tool life increases.

III. EXPERIMENTALDETAILS

A. Selection of tool material

In this investigation the carbide inserts material used are Cemented and Tungsten carbide inserts with tool holder PCLNL12x12H12WIDAXandalsoHigh-speedsteelM2is selected for machining. The complete investigation is done on CNC lathe machine. The dimensions of tools and work pieces are tabulated below.

Table 1 Dimensions and materials of tools and work pieces

	Name of the cutting tools	Work piece material
Material used	1.Cemented carbide insert 2.Tungsten carbide insert With Tool holder 3.High speed steel bit M2	Medium carbon steel EN19
Dimensions	1.Insert sizes – 12-04-04 2.Tool holder size – 10cm length with 12 x12 C/S 3.HSS Bit size 10cm length with 12 x 12 C/S	50 mm diameter with 100 mm length

Fig 1. Different cutting tools

B. Selection of work piece material

The work piece substance preferred for this experimental investigation is Medium carbon steel EN19. It is also designated in AISI 4140 alloy steel. EN19 steel is most widely available in market and industries. The demand for this material is more in many sectors because it has wide spread application in automobile parts, gears, spindles, shafts, axles, bolts, pinions, and also in machinery equipment. The raw material selected is in the form of rods with dimension 50 mm diameter and 100 mm length.

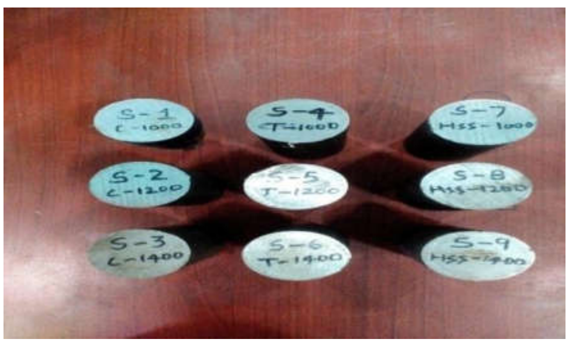


Fig 2. Work pieces before machining (EN19 steel)

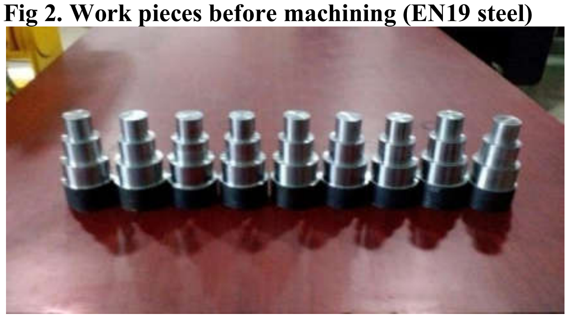


Fig 3. Work pieces after machining (EN19 Steel)

AISI 4140 alloy steel be heated at 845^0C and quenched in oil. Before is hardened it is normalized by heating at 913^0C for a long time. It is hot worked at 816 to 1038^0C. The composition of medium carbon steel EN19 is presented in below table.

IV. EXPERIMENTAL UNIT

The practical experiment is conducted on CNC lathe turning center on EN19 medium carbon steel. All the trials are conducted with varying cutting factors like cutting depth feed rate and spindle speed respectively. The below fig represent the machining operation on CNC turning lathe as follows.

Fig 4. Experimental unit

3.1 Surface roughness measurement

Roughness can be checked by physical judgment beside a "surface roughness comparator" a trial of known surface unevenness. Surface unevenness often summarized to roughness, is a component of surface texture.. If these abnormalities are large, the surface is irregular; if they are slight, the surface is level.

Fig 5. surface roughness tester

V. EXPERIMENTAL RESULTS

The experimental results achieved after performing the experiments as below the input parameters on CNC turning lathe machine.

Table 2 Cemented carbide insert tool experimentalresults

SL.NO	TOOL MATERIAL USED	SPINDLE SPEED (rpm)	FEED RATE (mm/rev)	DEPTH OF CUT (mm)	SURFACE FINISH Ra (um)
1	Cemented carbide	1000	0.15	0.50	1.423
2	Cemented carbide	1000	0.20	0.75	2.191
3	Cemented carbide	1000	0.25	1.00	1.671
4	Cemented carbide	1200	0.15	0.75	2.963
5	Cemented carbide	1200	0.20	1.00	2.412
6	Cemented carbide	1200	0.25	0.50	1.144
7	Cemented carbide	1400	0.15	1.00	3.068
8	Cemented carbide	1400	0.20	0.50	2.412
9	Cemented carbide	1400	0.25	0.75	1.244

Table 3 Tungsten carbide insert tool experimental results

SL.NO	TOOL MATERIAL USED	SPINDLE SPEED (rpm)	FEED RATE (mm/rev)	DEPTH OF CUT (mm)	SURFACE FINISH Ra (um)
1	Tungsten carbide	1000	0.15	0.50	3.882
2	Tungsten carbide	1000	0.20	0.75	2.944
3	Tungsten carbide	1000	0.25	1.00	1.638
4	Tungsten carbide	1200	0.15	0.75	2.908
5	Tungsten carbide	1200	0.20	1.00	2.249
6	Tungsten carbide	1200	0.25	0.50	2.387
7	Tungsten carbide	1400	0.15	1.00	2.892
8	Tungsten carbide	1400	0.20	0.50	2.338
9	Tungsten carbide	1400	0.25	0.75	0.905

Table 4 High speed steel tool experimental results

SL.NO	TOOL MATERIAL USED	SPINDLE SPEED (rpm)	FEED RATE (mm/rev)	DEPTH OF CUT (mm)	SURFACE FINISH Ra (um)
1	HSS	1000	0.15	0.50	1.640
2	HSS	1000	0.20	0.75	2.770
3	HSS	1000	0.25	1.00	1.844
4	HSS	1200	0.15	0.75	0.916
5	HSS	1200	0.20	1.00	2.225
6	HSS	1200	0.25	0.50	1.512
7	HSS	1400	0.15	1.00	4.415
8	HSS	1400	0.20	0.50	4.050
9	HSS	1400	0.25	0.75	3.695

VI. RESULT ANDDISCUSSION

6. ANALYSIS OF VARIANCE(ANOVA)

Statistical analysis of surface roughness for cemented carbide tool

It indicates that feed rate is the most important factor for surface roughness which has p- value of 0.228. Statistical ANOVA is shown in below table 5.

Table 5 surface unevenness ANOVA table

Basis	DF	Adj SS	Adj MS	F-Value	P-Value
Spindle speed	2	0.4039	0.2020	0.60	0.624
Feed rate	2	2.2730	1.1365	3.39	0.228
Cutting depth	2	0.8109	0.4055	1.21	0.453
fault	2	0.6706	0.3353	-	-
Total	8	4.1584	-	-	-

The interaction plot as shown in the figure examines that as the speed and feed increases surface roughness rises so as the feed and cutting depth reduces surface unevenness decreases.

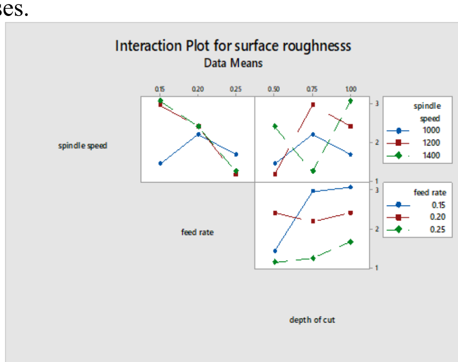
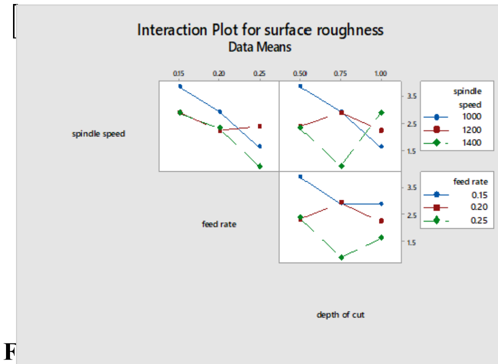


Fig 6. Surface unevenness Interaction plot

Statistical analysis of surface roughness fortungstencarbidetool

Table 6 ANOVA table for surface unevenness

Basis	DF	Adj SS	Adj MS	F-Value	P-Value
Spindle speed	2.0	0.9101	0.4551	2.52	0.284
Feed rate	2.0	3.7912	1.8956	10.48	0.087
Cutting depth	2.0	0.7557	0.3778	2.09	0.324
fault	2.0	0.3617	0.1808	-	-
Total	8	5.8186	-	-	-



F

Statistical analysis of surface roughness for High Speed steel tool

Table 7 surface unevenness ANOVA table

Basis	DF	Adj SS	Adj MS	F-Value	P-Value
Spindle speed	2	10.4221	5.2111	17.32	0.055
Feed rate	2	0.9204	0.4602	1.53	0.395
Cutting depth	2	0.3214	0.1607	0.53	0.652
fault	2	0.6018	0.3009	-	-
Total	8	12.2657	-	-	-

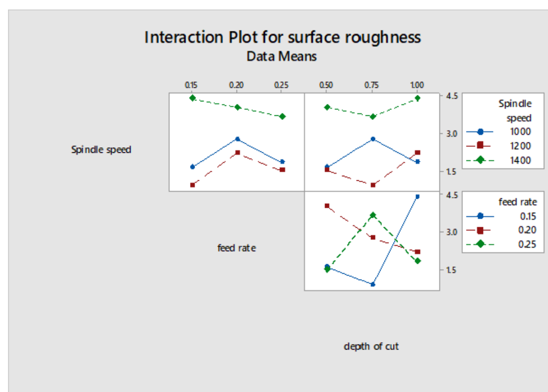


Fig 8. Interaction plot for surface roughness

Statistical analysis of MRR for cementedcarbidetool Itindicatesthatallthecuttingparametersl ikespindlespeed, feed rate and cutting depth are the significantfactors.

Statistical ANOVA is shown in below table.

VII. CONCLUSION

The following are the conclusions drawn afterconducting the experimental investigation with three different tool materials with varying cutting parameters to optimizethe results. From the analysis of results the signal to noise ratio (S/N) approach, taguchi's minimization technique and Analysis of variance (ANOVA) the following conclusions are obtained

- The surface finishing is mainly affected by feed rateand cutting depth. If the feed rate increases the surface roughness increases gradually.
- The optimum values for surface finish (1.144 µm) for cemented carbide insert asfollows
  i) Spindlespeed - 1200 rev permin
  ii) Feedrate - 0.25mm/rev
  iii) Depthofcut - 0.50mm
- The optimum values for surface finish (0.905 µm) for tungsten carbide insert asfollows.
  i) Spindlespeed - 1400 rev permin
  ii) Feedrate - 0.25 mm/rev
  iii) Depthofcut - 0.75mm
- The optimum values for surface finish (0.196 µm) for High speed steel asfollows
  i) Spindlespeed - 1200 rev permin
  ii) Feedrate - 0.15mm/rev
  iii) Depthofcut - 0.75mm
- Tungsten carbide insert undergoes more tool wear when compared to cemented carbideinsert.
- The outcomes of ANOVA and Taguchi technique illustrates that feed rate is more essential factor which damages the surface finishing and toolwear.

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