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Cutting parameter optimization by using taguchi method in hard turning of EN24 steel

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Abstract

Surface finish is a vital thing during any machining processes; hence it is very essential to control the required surface quality to have a better choice of optimized cutting parameter. The main intension is to optimize the cutting parameter. Generally hard turningis turning process in which work material whose hardness about 46-69 HRC are used. Thus, various sort of tipped tools are used for turning operation.

The orthogonal array, signal to noise ratio are employed to study the performance characteristics in turning operation. To study the performance characteristics, three process parameter are mainly briefed viz speed, feed and depth of cut. Experiments have been conducted using L9 orthogonal array under Dry turning tests which was carried out on hardened EN24 (46 HRC) with coated carbide cutting insert on CNC machine.

The main aim is not only to increase machine utilization but also to decrease production cost and achieve best surface finishing. From experimental results, it predicts that the feed is highly influential for good quality of a surface.

Keywords: Hard turning, surface finish, taguchi method

1. Introduction

Hard turning is a machining process which is performed on materials whose hardness value ranges between 46-69HRC. For this machining process, the use of tipped as well as solid cutting inserts are suited. This machining process exhibits unique behaviour, which is totally different than conventional turning operation. Hard turning is different than conventional turning in the following ways:

1. Hardness of work piece
2. Cutting tools required
3. Mechanism of chip formation.

Grinding is a process which is used to produce good surface finish at high feed rates but hard turning can also be used to produce better surface finish at higher material removal rates. This processis accomplished with small depth of cut and feed rate, which in turn estimates a reduced machining time as high as60% for conventional hard turning. Apart from this another advantages of hard turning over grinding are –low cost of equipment, less set up time, flexibility, no use of cutting fluid.

In hard turning cutting parameters are selected on the basis of hardness of materials, surface roughness of the work piece, etc. As material hardness is high, it results in the decrease of machining cost, saves time, improves surface quality & also eliminates deformities in parts caused by temperature. Also surface finish is influenced by many factor such as feed rate, speed, cutting time, cutting fluid, work piece hardness and depth of cut, but selection of only three parameter like speed, feed, and depth of cut is made. Fabrication of complex parts by conventional turning is much costlier and the use of hard turning for the same thing reduces cost by 30%.

Surface finish also determines the machinability of materials. Whereas Surface roughness is an important aspect of product quality which governs performance of mechanical parts & production cost. When optimization of cutting parameter takes place, it results in the increase of the utility for machining economics & product quality.

2. Literature Review

In this section the views of different authors related to optimization of cutting parameter has been reported.

Many researchers have worked on many factors of hard turning most of them were based on the cutting speed. As reported in various works, the ranges for speed, feed, and depth of cut selected were between 90-250 m/min., 0.05-0.2 mm/rev, up to 0.6 mm respectively. Ilhan Asilturk & Harun Akkus studied effect of cutting parameter on surface roughness in hard turning by using AISI4140 with coated carbide tools. They observed that the feed rate has more significant effect on Ra & Rz [1] Gaurav Bartarya & S.K Choudhury concluded that very few works reported using coolant for hard turning while most works do without coolant. It was found that tools with low CBN content provide better tool life. Also interrupted cutting provides greater tool life than continuous cutting. Adequate machine rigidity is required to reduce the process inaccuracy [4]. Ashok Kumar Sahoo & Bidyadhar Sahoo approached that coated insert performed better than an uncoated insert. Titanium based hard thin films are mostly used due to better wear resistance. The specific cutting energy for the hard turning is found to be smaller than grinding. Cutting force & surface roughness is smaller with PCBN inserts compared to ceramics tools under same cutting environment [7] Ucun & Aslantas determined the effect of cutting parameter on surface roughness in hard turning by using AISI 52100 grade bearing steel with coated carbide cutting tools. They checked machining performance with respect to tool wear & surface roughness as a result they observed that carbide cutting tools were not suitable for higher cutting parameter values [14]. Thamizhmani detected that poor surface finish due to machine tool vibration & chattering, whose effects were ignored for analysis. Author concluded that only depth of cut is significant factor which contributed to surface roughness [15].

3. Experimental Set up

Fig 1: Set Up For Experiment Using 4 Axis CNC Turn Mill Center

4. Work piece material and Methodology

In this experiment, a work piece material made up of EN24 (45-46HRC) steel was used. Chemical composition of EN24 material is carbon (0.36-0.44%), chromium (1-1.40%), nickel (1.3-1.7%), molybdenum (0.20-0.35%), silicon (0.10-0.35%), manganese (0.45-0.70%), sulphur (0.040%) and phosphorus (0.035%). Work piece material having Ø24×100 mm. The experiment was conducted on 4 Axis CNC Turn Mill Canter (3D SIEMENS 810D DMG-CTX310). The experiment was conducted under dry condition. The tool holder used was model PCLNL 2020K12 and coated carbide (CNMG 120404) insert was used as cutting tool. ZEISS & ACCT'S (ver 5.13) surf com 130A surface roughness tester where used for surface roughness measurement in sampling length of 45mm. Experimental arrangement is as shown in in Fig. (2).

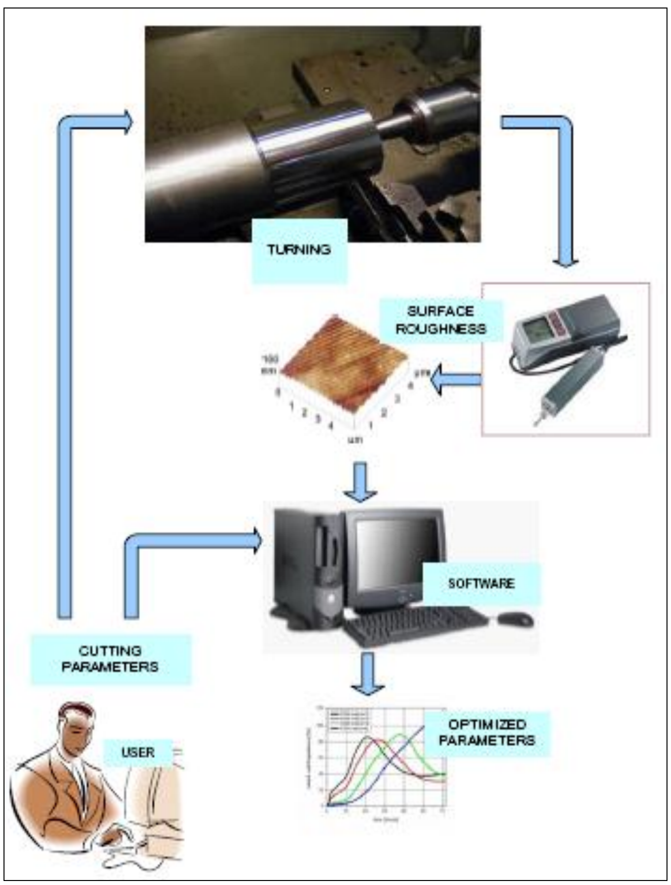


Fig 2: Methodology

The level of cutting parameter values were chosen from the manufacturer's catalogue suitable for the material. These cutting parameter are as shown in the table.

Table 1: Cutting parameters for the experimentation are selected as below

Level	Cutting speed (m/min)	Feed (mm/rev)	Depth of cut (mm)
Low	100	0.06	0.25
Medium	110	0.1	0.50
High	120	0.14	0.75

To reduce the number of experiments the taguchi method and L9 orthogonal array were employed.

4.1 Experimental design

The traditional experimental design methods are too much complex and time consuming. To overcome limitations of traditional method the taguchi method is used. Advantages of implementation of taguchi method are: To find out significant factors in a shorter time period, to decrease the cost, decrease the experimental time. The taguchi method is mostly used to design the best process parameter to minimize the variation.

4.2 Taguchi Orthogonal Array

Table 2

Exp. No.	Cutting speed (m/min)	Feed (mm/rev)	Depth of cut (mm)
1	100	0.06	0.25
2	100	0.10	0.50
3	100	0.14	0.50
4	110	0.06	0.50
5	110	0.10	0.50
6	110	0.14	0.25
7	120	0.06	0.75
8	120	0.10	0.25
9	120	0.14	0.50

Smaller is better

The S/N ratio for smaller is better used for situation where the target value is zero, such as computer response time, automotive emission and surface roughness value.

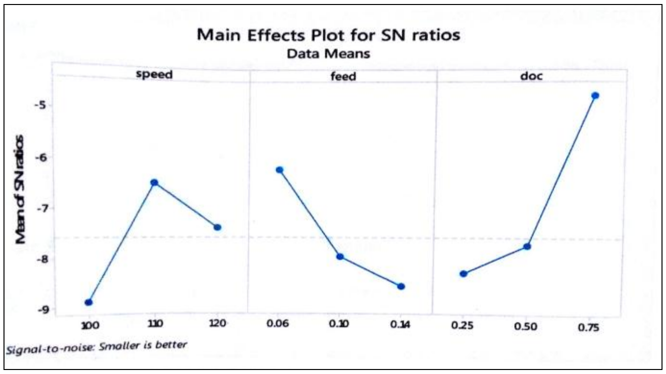
$$\frac{S}{N} = -10\log\frac{1}{n}\left(\sum y^2\right)$$

Where; S/N ratio=Signal to noise ratio
n=no of measurements
y=measured values.

5. Observation/Result

Table 3: After measurement of the surface roughness value we calculate S/N ratio and Means by using Minitab 17 software.

Exp. No.	Cutting speed (m/min)	Feed (mm/rev)	Doc (mm)	Ra (µm)	Rz (µm)	s/n ratio	means
1	100	0.06	0.25	0.399	3.675	-11.3051	3.675
2	100	0.1	0.5	0.39	3.638	-11.2173	3.638
3	100	0.14	0.5	0.47	4.5	-13.0643	4.5
4	110	0.06	0.5	0.322	2.675	-8.5465	2.675
5	110	0.1	0.5	0.362	2.963	-9.4346	2.963
6	110	0.14	0.25	0.397	3.275	-10.3042	3.275
7	120	0.06	0.75	0.225	2.413	-7.6511	2.413
8	120	0.1	0.25	0.338	4.063	-12.1769	4.063
9	120	0.14	0.5	0.387	3.638	-11.2173	3.638



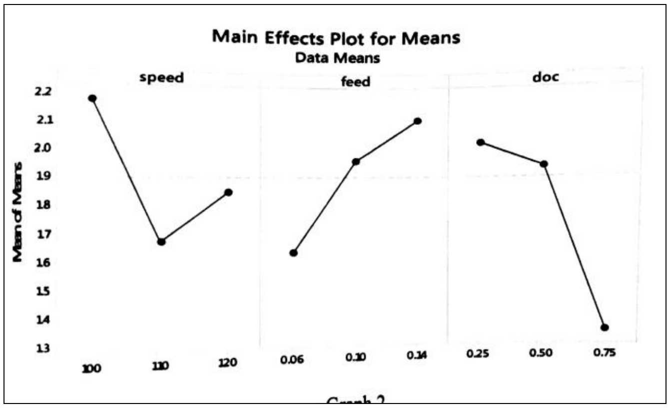


Fig 3: Graphs for results

6. Conclusion

The taguchi experimental design was used to obtain optimum cutting parameter on hard turning, L9 orthogonal array was selected for three different level of cutting speed, feed& depth of cut. Nine experiments were conducted instead of the 27 experiments. The results obtained from this experiment were:

- By using S/N ratio equation of "The smaller –the better", the maximum value was obtained. Proper cutting parameters were obtained by the maximum S/N ratio. Optimum cutting conditions which corresponds to maximum -7.65 S/N value of the smaller Ra value for the smaller surface roughness in hard turning (2-1-3) was found to be 110m/min for cutting speed, 0.06 mm/rev for the feed rate, o.75mm for the depth of cut.
- The feed rate was the most influential factor for the quality of surface roughness in hard turning.
- With increase in the feed rate the quality of surface finish decreases.
- The best surface roughness was obtained at the lower feed rates and higher cutting speeds.
- Through this study satisfying results were achieved and it would have wide range of applications in the future industrial and academic studies.

7. References

1. Ilhn Asilturk, Harun Akkus. Determining the Effect of Cutting Parameter on Surface Roughness in Hardtuning Using the Taguchi Method measurement. 2011; 44:1697-1704.
2. Rahul Davis, Vikrant Singh, Shaluza Priyanka. Optimization of Process Parameter of Turning Operation of EN24 Steel Using Taguchi Design of Experiment Method WCE, 2014, 2.
3. Krishnakant, Jatin taneja, Mohit Bector, Rajesh Kumar. Application of Taguchi Method for Optimizing Turning Process by the effect of Machining Parameters (IJEAT) ISSN: 2:2249-8958.
4. Gaurav Bartarya SK Chaudhury. State of the art in hard turning" International Journal of Machine Tools & Manufacture, 2012; 53:1-14.
5. Vipindas MP, Dr. Govind P. Taguchi-Based Optimization of Surface Roughness in CNC Turning Operation IJLTET ISS: 2:2278-621X.
6. Mahendra Korat, Neeraj Agrawal. Optimization of Different Machining Parameter of EN24 Alloy Steel in CNC Turning By use of taguchi Method (IJERA) ISSN: 2:2288-9622.
7. Ashok kumar, sahoo, Bidyadhar sahoo. Experiment investigation on machinability aspect in hard turning of AISI 4340 steel using uncoated & multilayer coated carbide insert measurement, 2012; 45:2153-2165.
8. Singh D, Rao pv. A surface roughness prediction model for hard turning process Int. J Adv. mfg. 2007; 32(11-12):115-1124.
9. Hascalik A, Caydas U. Optimization of turning parameters for surface roughness & tool life based on the Taguchimethod Int. J adv mfg. Tech, 2008; 38:896-903.
10. Sijo MT, Biju N. Taguchi Method for optimization of cutting parameter in turning operation proc. of int. conf. on adv. in mech Engg, 2010.
11. Puneet mangla, Nishant KR. singh, Yashvir Singh. Study of effect of turning parameters on work piece hardness using Taguchi method ICAM, 695-700.
12. Mahapatra SS, *et al.* parametric Analysis & optimization of cutting parameters for Turning operation based on Taguchi method, proc to Int.conf on global mfg. & innovation, 2006, 27-29.
13. Raghuwanshi BS. A course in work shop Tech, Dhanpat Rai & company pvt. ltd. 2009, 2.
14. Ucun I, Aslantas K. Investigation of performance of carbide cutting tool in turning hardened 52100 tool steel", IATS'09,Karabuk, turkey, 2009, 1-6.
15. Thamizhmanii S, Saparudin S, Hasan S. Analysis of surface roughness by using Taguchi method Ach. Mater. mfg. engg. 2007; 20(1-20):503-505.