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EXPERIMENTAL ANALYSIS ON THE EFFECT OF PROCESS PARAMETERS DURING CNC TURNING ON NYLON -6/6 USING TUNGSTEN CARBIDE TOOL

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ABSTRACT

Quality and productivity of the machined parts are the main challenges of metal cutting industry during turning process. Therefore we should optimize and analyse the cutting parameters in such a way that the required surface quality can be controlled. Turning is the most widely material removal process in industrial area. It is important to study the effect of the cutting parameters on MRR and surface roughness to improve machinability. The purpose of this paper is to study the effect of speed, feed and depth of cut on surface roughness (Ra) and MRR in turning nylon-6/6 using tungsten carbide tool. Experiments were conducted on a CNC lathe and the influence of cutting parameters was studied using analysis of variance (ANOVA). Based on the main effects plots obtained optimum level for surface roughness was chosen from the three levels of cutting parameters considered. From the experiment it is found that feed, depth of cut, and the interaction of feed and depth of cut significantly influenced the variance. We have calculated the main effects and percentage contribution of various process parameters affecting surface roughness also determined.

KEYWORDS: CNC Turning, Taguchi Orthogonal Array, Nylon-6/6, Surface Roughness (Ra), Tungsten Carbide tool

INTRODUCTION

A lathe is a machine tool which rotates the work piece on its axis to perform various operations like turning, cutting, knurling, drilling, or deformation, facing by the help of cutting tools which are applied to the work piece to create a symmetric object. The work piece is held horizontally to the lathe bed by the jaws. Other work-holding methods include clamping the work about the axis of rotation using a chuck and tool is held by the tool post which perform different operations on the work piece. Out of all material removing process turning is the most important operation. Turning is a material removal process which removes metal from cylindrical object and hence reduce its diameter in order to get a certain diameter object with good surface finish. The main objective is always to increase the productivity with lowest manufacturing cost.

Surface roughness produced on the work piece is an important property which plays major role in production. Surface roughness determines the quality of the production and the quality of the product. Roughness on surface of the object is undesirable but at the same time it is unavoidable. On the other hand in order to get good surface roughness the machining process expensive. So a proper combination of cutting parameters that is cutting speed, feed and depth of cut should be selected so that we can achieve good surface roughness in lowest possible cost.

TAGUCHI METHOD

Taguchi method is an optimization method which is powerful tool for the design of quality systems. It is a statistical method used which improves the quality of products. It has various application in industry as well as various research organisations. Taguchi method is a step by step approach for the optimization of design which increases quality and performance and minimizes cost. It is an easy approach for optimization and don't need highly skilled users. The suitable input parameters for god surface roughness can be obtained by using Taguchi method.

Fig 1. Turning of nylon-6/6 in CNC lathe

EXPERIMENTAL SETUP AND CUTTING CONDITION

1. Work piece material

The work piece material is nylon-6/6 which is a thermoplastic polymer. It has good thermal and wear resistance, good strength and stiffness. It has wide range of application in textile, metal working, aircraft and material handling. Nylon is also used as a replacement for brass, wood rubber, aluminium and steel.

1. Process Variables

The process variables are cutting speed, feed and depth of cut. The experiment is conducted as per Taguchi's orthogonal array which has reduced the number of experiments. A range of the levels were identified for indivisual parameters with trial experiments as shown in Table 1.

2. Machining Process

The turning process was performed on a CNC lathe with tungsten carbide tool for its high thermal resistance and hardness. As per Taguchi L9 Orthogonal array, nine number of experiments were carried out as per Table 2 with its indivisual parameters and levels.

The Nylon 6/6 rod is cut into equal pieces of size 30 mm in diameter and 95 mm in length. Then the workpiece were fixed in the 3 jaw chuck of the CNC lathe and turning operation was performed for each job.

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Table 1 Factors and their level

Level	Cutting speed (rpm)	Feed rate (mm/min)	Depth of cut (mm)
1	1000	0.1	0.1
2	1200	0.2	0.2
3	1400	0.3	0.3

Table 2 Orthogonal L9 array of Taguchi

Experiment no.	Cutting speed (rpm)	Feed rate (mm/min)	Depth of cut (mm)	Theoretical MRR (mm^3 /min)
1	1000	0.1	0.1	922.025
2	1000	0.2	0.2	3688.229
3	1000	0.3	0.3	8298.517
4	1200	0.1	0.2	2212.937
5	1200	0.2	0.3	6638.813
6	1200	0.3	0.1	3319.406
7	1400	0.1	0.3	3872.641
8	1400	0.2	0.1	2581.760
9	1400	0.3	0.2	7745.282

ANALYSIS OF SURFACE ROUGHNESS

The following table shows the value of surface roughness obtained from the experiment at different level of cutting parameters.

Fig 2. Machined specimens and Surface roughness test of nylon-6/6

Table 3 Surface roughness readings

Expt. Run	Cutting Speed (RPM)	Feed (mm/min)	Depth of Cut (mm)	Surface Roughness (µm)
1	1000	0.1	0.1	4.580
2	1000	0.2	0.2	5.960
3	1000	0.3	0.3	7.041
4	1200	0.1	0.2	4.267
5	1200	0.2	0.3	4.350
6	1200	0.3	0.1	6.231
7	1400	0.1	0.3	2.228
8	1400	0.2	0.1	3.435
9	1400	0.3	0.2	4.743

Analysis of variance for surface roughness

Analysis of variance (ANOVA) consist of statistical models which analyse the difference among means and its associate procedures. The following table gives the ANOVA with F-value and P-values and percentage contribution. The most significant factor is cutting speed and feed that contribute to the surface roughness and depth of cut has very less contribution on surface roughness.

Table 4 Analysis if variance for means **R-sq = 98.8% R-sq(adj) = 95.48%**

Source	DF	Seq SS	Adj SS	Adj MS	F	P	% contribution
Cutting speed	2	8.7424	8.7424	4.3712	43.56	0.022	50.1938
Feed	2	8.1695	8.1695	4.0847	40.70	0.024	46.9045
Depth of cut	2	0.3047	0.3047	0.1524	1.52	0.397	1.7494
Residual error	2	0.2007	0.2007	0.1004			1.1523
Total	8	17.4173					

Response optimizer

Response optimizer is used to optimize the surface roughness and to the desired ranking for all the process parameters according to its Delta value.

Table5. Response table for means

Level	Cutting speed	Feed	Depth of cut
1	5.860	3.692	4.749
2	4.949	4.582	4.990
3	3.469	6.005	4.540
Delta	2.392	2.313	0.450
Rank	1	2	3

MAIN EFFECTS PLOT

Main effects plots for this experiment as shown in Fig. 3 tells that, when cutting speed increases surface roughness (Ra) decreases, when depth of cut increases surface roughness first increases then decreases but when feed increases surface roughness (Ra) increases. As surface roughness fulfils the smaller the better criteria, so the optimum points for process parameters are, Cutting speed 1400 rpm, Feed 0.1 mm/min and Depth of cut 0.3 mm.

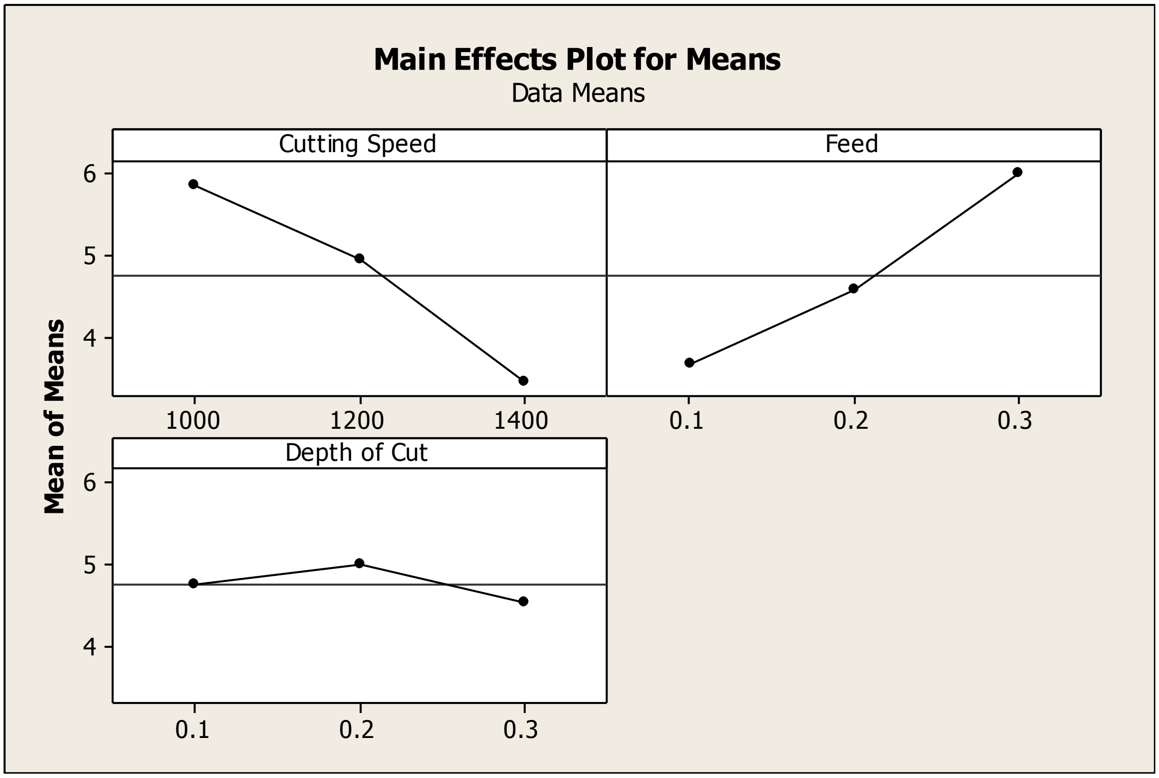

Fig. 3 Main effect plot for Surface Roughness

CONCLUSION

- Surface roughness is mainly influenced by cutting speed and feed rate and depth of cut has insignificant role.
- From the above experiment it is found that surface roughness decreases with increase in cutting speed whereas surface roughness increases with increase in feed rate.
- As surface roughness fulfils the smaller the better criteria, so the optimum points for process parameters are, Cutting speed 1400 rpm, Feed 0.1 mm/min and Depth of cut 0.3 mm.

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REFERENCES

1. Rodrigues L.L.R., Kantharaj A.N., Kantharaj B., Freitas W. R. C. and Murthy B.R.N., Effect of Cutting Parameters on Surface Roughness and Cutting Force in Turning Mild Steel, Research Journal of Recent Sciences, Vol. 1(10), 19-26, (2012).
2. B.Tulasiramarao, Dr.K.Srinivas, Dr. P Ram Reddy3, A.Raveendra4, Dr.B.V.R.Ravi Kumar., Finding Cutting Forces While Turning Aperation on Lathe Machine at Different Depth of Cut of Different Metals, International Journal of Innovative Research in Science, Engineering and Technology, Vol. 3, Issue 10,(2014).
3. H Aoici, M A Yallese, A Belbah, M Fameur and M Elbah., Experimental investigation of cutting parameters influence on surface roughness and cutting forces in hard turning of X38CrMoV5-1 with CBN tool, Sadhana Vol. 38, Part 3 (2013) pp. 429–445.
4. Roopa K Rao, Vinay Murgod, Dr. A S. Deshpande and Dr K K Jadhav., Analysis of effect of cutting parameters on responses Surface Roughness and Material Removal Rate for En 19 work-pieces material with and without heat treatment, International Journal of Scientific & Engineering Research, Volume 6, Issue 1 (2015).
5. L B Abhang and M Hameedullah., Parametric investigation of turning process on en-31 steel, Procedia Materials Science 6(2014), 1516 – 1523.
6. Mohd. Suhail Ansari, Deepak Sharma and Sagar Nikam., Study of Cutting Forces and Surface Roughness in Turning of Bronze Filled Polytetrafluoroethylene, International Journal of Advanced Mechanical Engineering. ISSN 2250-3234 Volume 4, Number 2 (2014), pp. 151-160.
7. Bala Raju, Leela Krishna, Tejomurthy., Effect and Optimisation of Machining Parameters on Cutting Force and Surface Roughness in Turning of Mild Steel and Aluminium, IJRET: International Journal of Research in Engineering and Technology ISSN: 2319-1163 | ISSN: 2321-7308.
8. Jadhav J.S, Jadhav B.R., Experimental study of Effect of Cutting Parameters on Cutting Force in Turning Process, International Journal of Innovative Research in Advanced Engineering (IJIRAE) ISSN: 2349-2163 Volume 1 Issue 6 (2014).
9. Sachin C Borse., OPTIMIZATION OF TURNING PROCESS PARAMETER IN DRY TURNING OF SAE52100 STEEL, International Journal of Mechanical Engineering and Technology (IJMET), ISSN 0976 – 6340(Print), ISSN 0976 – 6359(Online), Volume 5, Issue 12, (2014), pp. 01-08
10. Ashish Yadav, Ajay Bangar, Rajan Sharma, Deepak Pal., Optimization of Turning Process Parameters for Their Effect on En 8 Material Work piece Hardness by Using Taguchi Parametric Optimization Method International Journal of Mechanical and Industrial Engineering (IJMIE), ISSN No. 2231 –6477, Volume-1, Issue-3,(2012).
11.]Masood Atahar Khan, Jayant K. Kittur, Vishal. Dutt Kohir., Study and Analysis of Effect of Cutting Parameters on Cutting Forces and Surface Roughness, Advanced Engineering and Applied Sciences: An International Journal (2015); 5(3): 63-73.
12. Dr. C. J. Rao , Dr. D. Nageswara Rao, P. Srihari., Influence of cutting parameters on cutting force and surface finish in turning operation, Procedia Engineering 64 (2013) 1405 – 1415.
13. Rodrigues L.L.R., Kantharaj A.N., Kantharaj B., Freitas W. R. C. and Murthy B.R.N., Effect of Cutting Parameters on Surface Roughness and Cutting Force in Turning Mild Steel, Research Journal of Recent Sciences, International Science Congress Association ,ISSN 2277-2502,Vol. 1(10), 19-26, (2012).
14. Hamdi Aouici , Mohamed Athmane Yallese , Kamel Chaoui , Tarek Mabrouki , Jean-François Rigal, Analysis of surface roughness and cutting force components in hard turning with CBN tool: Prediction model and cutting conditions optimization, Journal of Measurement 45 (2012) 344–353.
15. Ilhan Asiltürk, Süleyman Nes_eli, Multi response optimisation of CNC turning parameters via Taguchi method-based response surface analysis,doi:10.1016/j.measurement.2011.12.004, Journal of Measurement 45 (2012) 785–794.
16. Ilhan Asiltürk, Harun Akkus, Determining the effect of cutting parameters on surface roughness in hard turning using the Taguchi method, Journal of Measurement 44 (2011) 1697–1704.
17. Mustafa Günay, Emre Yücel, Application of Taguchi method for determining optimum surface roughness in turning of high-alloy white cast iron, Journal of Measurement46 (2013) 913–919.