

Optimization of Cutting Parameters in Turning Operation of Mild Steel

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Abstract

The main objective of today's manufacturing industries is to produce low cost, high quality products in short time. The selection of optimal cutting parameters is a very important issue for every machining process in order to enhance the quality of machining products and reduce the machining costs. Surface inspection is carried out by manually inspecting the machined surfaces. As it is a post-process operation, it becomes both time-consuming and laborious. In addition, a number of defective parts can be found during the period of surface inspection, which leads to additional production cost. In the present work the cutting parameters (depth of cut, feed rate, spindle speed) have been optimized in turning of mild steel of in turning operations on mild steel and as a result of that the combination of the optimal levels of the factors was obtained to get the lowest surface roughness. The Analysis of Variance (ANOVA) and Signal-to-Noise ratio were used to study the performance characteristics in turning operation. The analysis also shows that the predicted values and calculated values are very close, that clearly indicates that the developed model can be used to predict the surface roughness in the turning operation of mild steel.

Keywords: Mild Steel, Cutting Parameters, Taguchi Method, ANOVA, S/N Ratio.

1. Introduction

Machining is one of the most wide spread metal machining process in mechanical manufacturing industry. The goal of changing the geometry of raw material in order to form mechanical parts can be met by putting material together. Conventional machining is one most important material removal methods. Machining is a part of the

manufacture all most all metal products. In turning, higher values of cutting parameter offered opportunities for increasing productivity but it also involves greater risk of deterioration in surface quality and tool life. Turning operation is very important material removal process in modern industry. At least one fifth of all applications in metal cutting are turning operations.

2. Literature Review

Unfortunately, in most scenarios, time is limited and design of experiments (DOE) methods tend to be lengthy and cumbersome when considering the complex factors and noise that affect such an operation .. An excellent solution to this issue is an approach known as Taguchi Parameter Design.

S. Thamizhmanii et al (2007) studied on Analyses of Surface Roughness using Taguchi Method . They stated that depth of cut plays a very significant role in producing lower surface roughness followed by feed and cutting speed has lower role on surface roughness from the tests. Purpose of this research was to analyze the optimum cutting conditions to get lower surface roughness in turning process.

A.K.Sehgal, Amit Agarwal et al (2009) studied on surface roughness optimization based on taguchi design of experiment . They stated that the milling is found by the Taguchi parameter design method to determine minimum surface roughness with a relatively small number of experimental runs in an End Milling Process.

Deepak pal et al. (2012) studied on optimization of grinding parameters for minimum surface roughness by Taguchi parametric optimization technique . They stated that optimum value of surface roughness is 1.7Ra. They selected work speed, grinding wheel grades and hardness of material as their parameters with L9 orthogonal array.

3. Experimental Setup

3.1 MATERIAL

The work piece material selected for investigation is the EN9 is an unalloyed medium carbon steel. EN9 finds wide varieties of application such as, forming and molding dies, rollers, blanking and forming tools, forging, die making industries. This steel can be provide a greater strength and wear resistance. The size of the work piece used for experiment is round bar with 50 mm diameter and 250 mm length.

Table 1: Chemical Composition of the work piece Material.

Element	C	Si	Mn	S	P
Weight (%)	0.5	0.25	0.7	0.05	0.05

Table 2: Physical properties of work piece Materiel.

Density (Kg/m ³)	Coefficient of thermal expansion Per C from 200C	Modulus of elasticity(N/mm ²)
7800	11.6 x10 ⁻⁶	206000

Table 3: Selection of Process Parameters Value.

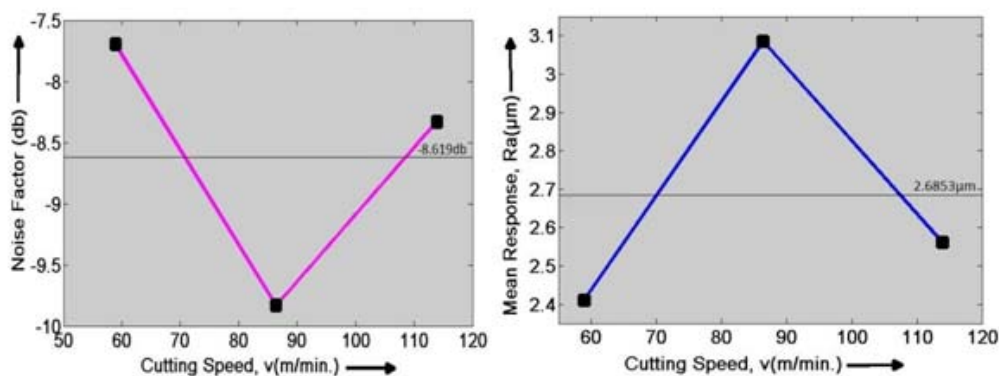
S. No.	Levels of process parameters	Process Parameters		
		Cutting speed (m/min.)	Feed Rate (mm/rev.)	Depth of cut (mm)
1	Low	58.9048	0.1	0.4
2	Medium	86.3938	0.2	0.6
3	High	113.8827	0.3	0.8

4. Results and Discussion

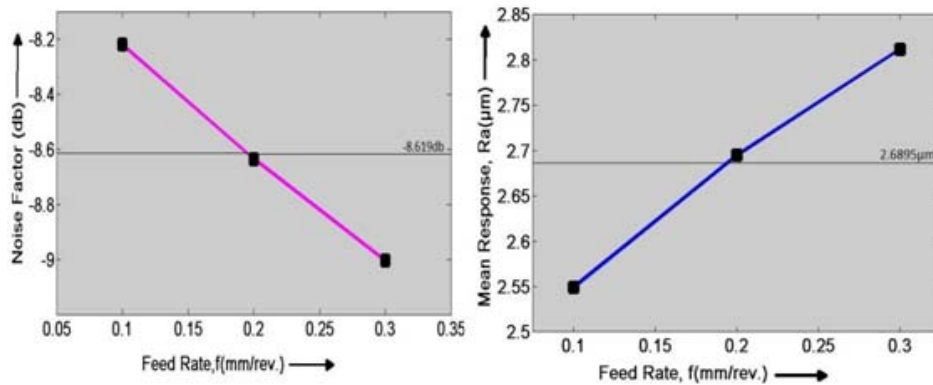
4.1. Optimization and Analysis by Taguchi Technique

Table 4: Average Surface Roughness based on Taguchi Technique:

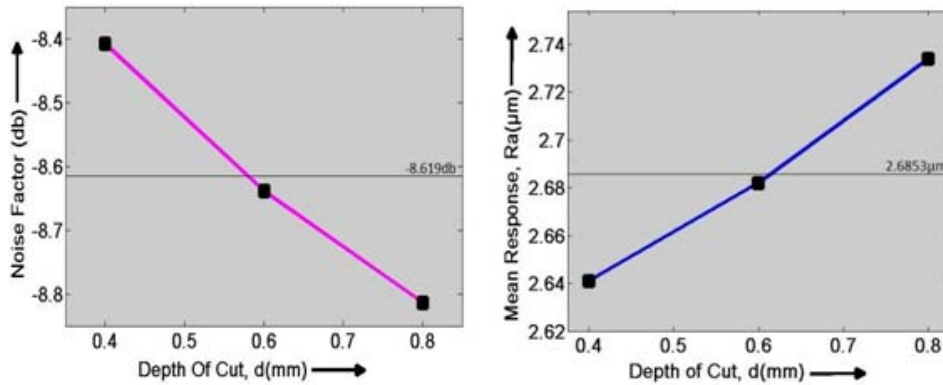
Exp. No.	Cutting Speed (m/min.) Level	Feed Rate (mm/rev.) Level	Depth of cut(mm) Level	Surface Roughness value(μm)			Average Surface Roughness (μm)
				Y1	Y2	Y3	
1	1	1	1	1.920	2.020	2.720	2.220
2	1	2	2	2.780	2.489	2.000	2.423
3	1	3	3	2.860	2.550	2.359	2.589
4	2	1	2	3.020	2.449	3.380	2.949
5	2	2	3	2.660	3.080	3.660	3.133
6	2	3	1	3.360	3.060	3.100	3.173
7	3	1	3	3.280	2.390	1.770	2.480
8	3	2	1	3.000	2.460	2.130	2.530
9	3	3	2	3.200	2.800	2.020	2.673



(a) Effect of Cutting Speed on Mean Response, Ra and Noise Factor



B) Effect of Feed Rate on Mean Response, Ra and Noise Factor



C) Effect of Depth of Cut on Mean Response, Ra and Noise Factor

Table 4.5: ANOVA Table for S/N

Factor/Source	Degree of Freedom	Sum of Squares	Mean squares	F(Variance ratio)
A(Cutting Speed)	2	7.153	3.576	203.34
B(Feed Rate)	2	0.928	0.464	26.38
C(Depth of cut)	2	0.247	0.123	7.0217
Errors	2	0.035	0.017	
Total	8	8.363	-	

5. Conclusion

Taguchi method has been adopted for the design of experiments and results have been by minimizing S/N ratio. Optimization of the surface roughness was done using Taguchi method and Predictive equation was obtained. A confirmation test was then performed which depicted that the selected parameters and predictive equation were accurate to within the limits of the measurement instrument.

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