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Optimization and characterization of cutting parameters for EN19T material in CNC turning

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Abstract

In modern manufacturing technology has undergone major technologically changes through various developments in a manufacturing industries that involve are basically turning operations in a main role of the cutting process to produces low cost and high quality of components in a least time of turning operations. The quality of a product adopted in turning operation is to get maximum surface finish and MRR. Hence this paper work has been followed by optimization of input parameters i.e. feed rate, spindle speed and depth of cut and output parameters for high quality of surface finish and MRR of product in turning operation on CNC machine using EN19T alloy steel. In the current work L9 Array has been introduce and verified to the significant process of input and output parameters to optimize to surface roughness and MRR in turning operations through Taguchi parameter design which should be used to analysis the performance Characteristics of Material removal rate (MRR) and Surface roughness (SR) in a turning which shows that spindle speed is the main key point for maximum the dimensional variation.

Keywords—*Taguchi Method, Surface Roughness, MRR, EN19T alloy Steel, CNC Turning Lathe*

1. Introduction

The turning operation of a lathe and is main role of machining processes to produce cylindrical parts which is valuable to improve tool life, surface roughness, reduce cutting force and material removal rate in turning operations through an optimization. Cutting speed, feed rate, depth of cut, tool- work piece material, tool geometry, and coolant conditions are very important turning parameters which highly affect the performance measures. Among these surface roughness and material removal rate are play main roles in the performance of a turning process. In order to improve machining life, the quality of machined parts and to reduce the machining cost. In order to minimize these machining condition there is a need to develop standard methods to select cutting conditions for any cutting of metals. Machining is mostly concerned with satisfying customer need to meet the increasing demand to manufacturing complicated components of high accuracy in quantities, sophisticated technological equipment and machines are needs which have been developed, hence the quality of machines products depend on the various machining parameters of the materials The machining parameters are control by means of storied the information through the computer numerical controlled unit which involved in the design of machine structures are as follows. Static tool, dynamic load, thermal load, guide ways, feed rate, spindle speed, tool monitoring systems. The machining processes that producing cylindrical components of high accuracy in large quantities in order to sophisticated technology of machine by CNC lathe which performs the various controlling function under the program to controls the motion of cutting tool, feed rate and several other functions of the lathe.

Turning operation is carried out on a CNC lathe that provides the power to turn the work piece

at a given rotational speed and to feed the cutting tool at specified rate and depth of cut. Therefore three process parameters namely cutting speed, feed and depth of cut need to be analysis in a CNC lathe for turning operation.

The two machined surfaces are come in to contact with each other, the quality of the machine parts plays an important role in the performance and wear rate of the mating parts. The height, shape, tool arrangement and direction of these surface model on the work piece depend upon a number of factors such as:

a) Spindle speed.
b) Feed
c) Depth of cut.
d) Cutting tool force and wears,
e) Several other parameters

Optimization is refers to the art of science in a allocating several resources to the best possible method.one of the best method is Taguchi approach which is a well known technique and provides an efficient methodology to optimization design process. For this the advantage of the design of experiment using Taguchi's technique that includes simplification of experimental process and feasibility of determine the interaction between different process parameters. Analysis of Variance (ANOVA) is then used to study the process parameter in order to be statistically significant and other contribution of every parameter towards the output characteristic of turning operation.

2. Review of Literature

The most easily controlled factors in a turning operation are feed rate, cutting speed, and depth of cut; which may have an effect on surface finish of parts. Spindle speed and depth of cut were found to have different levels of effect in this study, which playing a stronger role as part of an interaction between them. The controlled parameters in a turning operation are under normal conditions affect surface finish mostly deeply disturbing the feed rate and cutting speed. Recent studies that explain the effect of input parameters on surface finish and find that there is a direct effect of feed rate and spindle speed often interactive with other parameters, and that depth of cut can also some effect due to heat generation. Several studies especially exist which to find the effect of feed rate, spindle speed, and depth of cut on surface finish. These all studies supported the idea that feed rate has a strong influence on surface finish. Feng and Wang (2002) investigated for the forecast of surface roughness in finish turning operation by developing an actual model through considering processes parameters. Kirby et al. (2004) developed the based on real model for surface roughness in turning operation. Rafi & Islam (2009), Present research and analytical results of an investigation into dimensional accuracy, metal removable rate and surface finish achieved in a turning operation. Tzeng Yih-Fong (2006) has taken a set of optimal turning parameters for producing high dimensional tolerance and accuracy in the computerized numerical control turning operation was developed. Gilbert (1950) studied the optimization of machining parameters in turning with respect to maximum production rate with minimum materials cost as criteria. Armarego & Brown (1969) investigated unconstrained machining parameters are optimization using differential calculus. Optimal selection of machining rate at several variables such as, cutting speed and feed rate, by geometric programming.

Paramasivam et al. (2014) The investigation of the optimization of turning process parameters for EN24 steel based on Regression analysis. The L9 orthogonal is used for the experiment cutting speed, feed rate and depth of cut are considered as input parameters and material removal rate and surface roughness are output parameters. From the experiment study it can be seen that spindle speed has the significant effect on MRR and surface roughness when compared to feed rate. Narayanareddy et al. (2014) The machining parameters of CNC horizontal lathe for 20MnCr5 steel were analyzed. The L9 orthogonal array, signal to ratio and Analysis of variance were employed to study the performance and characteristics parameters of turning operation. This study they have used 4 input parameter like cutting speed, feed rate, depth of cut and hardness of the cutting tool for identifying the output parameters like surface roughness and MRR Aravind kumar. (2014) The turning parameters are optimized for mild steel 1018. It is used for three cutting parameters to find out the maximum metal removal rate from the manufactured component. The purpose of optimization used is Taguchi approach with L9 orthogonal arrayed with the feed rate influence the material removal rate. Anand S. Shirade et al. (2014) The experiment was setup to determine the optimum cutting parameters for minimizing surface roughness when turning of EN8 steel material. The L9 orthogonal array design is used for design of experiments. RK Suresh et al.(2013) The optimization process for EN41B steel in turning operation by using Taguchi method. In this research L27 orthogonal array is followed the experiment. Three process parameters used for maximizing the material removal rate of the manufactured product. Rahul davis et al.(2012) He have used Taguchi method to identify the effect of turning parameters on surface roughness. For this optimization purpose EN24 steel work material is

selected. The spindle speed, depth of cut, and feed rate were selected as input parameters .Nirav.M.Kamdar et al.(2012) The investigation of machining parameters of EN 36 steel was carried and analysis the surface roughness, spindle speed and feed rate are used as machining parameters as a input parameters and surface roughness are output parameters.

Based on the above literature review there are two kinds of aspects of this paper. The first one is to determine a systematic approach of using Taguchi method of parameter design of process control in CNC turning machine of surface roughness and metal removable. The second one is to demonstrate the use of Taguchi approach of design in order to identify the optimum dimensional tolerance performed with combination of cutting parameters in a CNC turning operation.

3. Materials and Methods

3.1 Materials

From the literature review of different materials articles, this can be concluded that the variety of materials can be used on CNC turning machine. Work Material used for to conduced experiment as EN19T alloy. steel in the field of heavy vehicle transmission components, engineering machinery gearbox parts and chuck jaws. The Table 1 and Table 2 show the chemical and mechanical properties of EN19T steel.

Table 1. Chemical composition of EN19T Steel

S.No	Elements	Percentage (%)
1	Carbon	0.10 - 0.18
2	Silicon	0.05 - 0.35
3	Manganese	0.60 - 1.00
4	Sulphur	0.05
5	Phosphorus	0.05

Table 2 Mechanical Properties of EN19T Steel

S.No	Property	Value
1	Yield strength	240MP
2	Tensile strength	350-450MPa
3	Elongation	25%
4	Hardness	255 HB Max

3.2 Method

The CNC lathe is programmed by speed, feed rate and cutting depth, which are frequently determined based on the machining processes. The performance and characteristics are considered to quality of product to be acceptable. With all the viewpoints, the purpose of the study is an optimization approach by using orthogonal array in a turning operation.

Table 3: L9 Orthogonal Array

Trial No.	A	B	C
1	1	1	2
2	1	2	1
3	1	3	3
4	2	1	3
5	2	2	2
6	2	3	1
7	3	1	3
8	3	2	2

In this experiment, there are three factors with level number 3 consequently, the total degrees of freedom is 6. In mean time, the interaction between the cutting parameters is neglected here. There by L9 orthogonal array is used.

3.3. Parameter Identification:

The input parameters which affect the aforementioned output parameters are numerous such as:

i. Cutting speed
ii. Feed rate.
iii. Depth of cut.
iv. Side cutting edge angle
v. Type of power.
vi. Cutting tool material.
vii. Working temperature.
viii. Operator.
ix. Make of the CNC machine.
x. Noise.

4. Experimental Description

In order to identity the process parameters, affecting the selected machining quality characteristic of turning parts, by the cases of effect as the following selection of input.

Cutting speed – (A), Feed rate – (B), Depth of cut – (C) &
Tool material – HSS,

In this study, L9 orthogonal array of Taguchi experiment was selected for three parameters in precision turning on an CNC lathe. Through the Examination of surface roughness (Ra) and the calculation of metal removal rate (MRR) Ware then obtained. Turning operation were carried out on a CNC lathe that provides the power to turn the work piece at a given rotational speed, feed and depth of cut. There fore, three parameters (i.e. Speed, Feed & Depth of cut) as the input parameters and MRR and

surface roughness as the output parameters are taken in the present experimental setup.

Table 4: Parameters and their Levels

S.No	Parameters	L- 1	L - 2	L - 3
1	Speed (A), rpm	1500	2000	2500
2	Feed (B), mm^3/rev	0.5	0.8	1.0
3	DOC (C),mm	1.3	2.7	3.2

Table 5: Experimental Layout Using an L-9 Orthogonal Array

S.No	Speed (A) in rpm	Feed rate (B) in mm/rev	DOC(C) in mm
1	1500	0.20	0.5
2	1500	0.25	0.8
3	1500	0.30	1.0
4	2000	0.20	0.5
5	2000	0.25	0.8
6	2000	0.30	1.0
7	2500	0.20	0.5
8	2500	0.25	0.8
9	2500	0.30	1.0

The conducted for the 9 sets of parameters such as speed, feed rate & depth of cut are checked with for maximum surface roughness and metal removal rate. The average value of metal removal rate and surface roughness in microns are listed in table 6.

Table 6: Experimental Results

S. **No**	Speed (A) in rpm	Feed rate (B) in mm/rev	DOC (C) in mm	Metal removal rate, mm^3/min	Surface Roughness (Ra)in µm
1	1500	0.20	0.5	5.192	1.2
2	1500	0.25	0.8	4.311	1.4
3	1500	0.30	1.0	2.157	1.6
4	2000	0.20	0.5	8.642	2.5
5	2000	0.25	0.8	6.810	2.6
6	2000	0.30	1.0	3.200	2.8
7	2500	0.20	0.5	8.186	1.9
8	2500	0.25	0.8	5.402	3.2
9	2500	0.30	1.0	4.900	2.6

5. Results and Discussion

Table 7 shows that the analysis of surface roughness and metal removal rate are obtained by using EN19T Alloy steel in Taguchi Method. The following statement as given below for the result of analysis

1. Effect of cutting speed from the range of 1500 – 3000, percentage of error is 39.99%
2. Effect of cutting Feed from the range of 0.2 –0.3, percentage of error is 23.18%
3. Effect of Depth of cut from the range of 0.5-1.0, percentage of error is 18.13%

For the above percentage of error will considered maximum surface roughness and metal removal rate for the material EN19T.

Table 7: Analysis of Surface Roughness

S.**No**	Factor	DOF	% of Error
1	Speed	2	39.99
2	Feed	2	23.18
3	DOC	2	18.13

6. Conclusion

The above study, experimentally verify that the Taguchi approach gives us the optimal parameters in the CNC turning process using the optimum set of speed, feed rate and depth of cut which are mostly affecting the speed parameters having the impact of 39.9%.

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