ANALYSIS OF MATERIAL REMOVAL RATE AND SURFACE ROUGHNESS VARING PARAMETERS FROM CNC LATHE MACHINE

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ABSTRACT

The influence of machining parameters on MRR (material removal rate) and Ra surface roughness this is the important role in manufacturing using CNC machines. Machining industries more challenge of manufacturing good quality product and costeffective in short time. In the present work, Taguchi method is studied and implemented fort the design of system the process parameters design such as depth of cut, feed rate and spindle speed of CNC turning machine for aluminum material. This is three suitable factors affect and based on the orthogonal array is (L16) and Minitab-16 software is used to analyze the experimental work. The S/N ratio and ANOVA Methods are studying the performance in CNC machines. The MRR is considered “larger is better” whereas Ra “smaller is better”. In this Present work is the turning of material aluminum alloy 6262.

KEYWORDS: MRR, Ra, Taguchi, Aluminium Alloy, CNC Lathe, ANOVA & S/N Ratio

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INTRODUCTION

CNC Turning is important machining operation material removal rate and surface roughness is an important role in turning operation in rotating cylindrical workpiece using a single point cutting tool. Turning operation is done to reduce the diameter of the workpiece according to required diameter as shown in Figure 1, an experimental investigation approach carried out to obtain the value of MRR. The present experimental work design through Taguchi method the influence of depth of cut, feed rate and spindle speed of the turning operation. The output responses are considered surface roughness and material removal rate.

Figure 1: Representation of Figure during Turning Process

LITERATURE REVIEW

Julie Z. Zhang, Joseph. Chenb Et.al [1]. In his paper, an investigation of Taguchi outlines the function to upgrade surface quality in a CNC face processing procedure. Keeping up great surface quality typically includes extra assembling expenses or loss of profit. This study included feed rate, shaft velocity and depth of cut as control

components. The commotion elements where the working hollow temperature and the utility of the distinctive device surrounding the same detail, which presented apparatus condition what's more dimensions are changing. An orthogonal show of L9(34) was utilized; ANOVA examines must be completed to distinguish the huge variation influencing surface unpleasantness, and the ideal cutting, blending was dictated by looking for the best surface unpleasantness (reaction) and sign a two-commotion degree.

V. n. gaitonde, Et.al [2]. Has created the application of Taguchi technique and useful idea for upgrading the machining parameters in turning of liberated-machining steel utilizing an established carbide instrument has depicted. A setting of ideal procedure parameters, for example, feed rate cutting velocity and depth of cut on two numerous execution qualities to be specific, surface roughness and metal removal rate (MRR) is created. The tests were arranged according to an L9 orthogonal collection. The ideal levels of the procedure parameters was departed set during the dissection of means. The Relation vitality between the method parameters was distinguished during the dissection of difference (ANOVA). The ANOVA results showed that most critical methodology parameter is cutting velocity took after by the profundity of cut that influenced the streamlining of various execution qualities. The improvement results uncovered that a combo of larger amounts of cutting pace and depth of cut alongside feed rate in the medium level is crucial keeping in mind the end goal at the same time minimize the surface roughness and to improving the MRR.

Gaurav Pant, Shivasheesh Kaushik, Dr. D.K.Rao Et.al [3]. Study and Analysis of Material Removal Rate on Lathe Operation with Varying Parameters from CNC Lathe Machine In order to improve the quality and to reduce the cost material removal rate should be optimum. In machining accurate dimensions are desired, but with good product quality. Machining process involves many factors which affect the process directly or indirectly. The research study aims to analyze MRR by taking feed, depth of cut & spindle speed into consideration of Aluminum 6063 employing Taguchi method. An L9 Orthogonal array is used for performing the various experimental studies that analyse the MMR and analysis of surface roughness and signal to Noise Ratio

Rohit Angiras, Onkar Singh Bhatia, Et.al [4]. "Experimental investigation of the machining parameters effect on the material removal rate during the turning of aluminium-6063 using Taguchi approach", "International Journal of Advanced Technology in Engineering and Science",

Dore Swamy Deepak et al Et.al[5]. Studied the multi -response optimization of process parameters speed, feed, and depth of cut in CNC turning of aluminum 6061 using grey relational analysis in Taguchi L9 array method. From this analysis, they concluded that a high feed rate leads to broken chips and burrs in the surface of the job and high cutting speed gives more MRR and low feed and depth of cut gives the good surface finish.

V. Devkumaret Et.al [6]. Investigate the optimal cutting conditions for attaining the better surface roughness using the mathematical modeling and analysis of machining response and tool wear in the turning of aluminum alloy 6061. There were process parameters such as spindle speed, depth of cut, and feed rate used to determine the quality of surface roughness. Experiments were conducted as per central composite face centered design. Analysis of variance is used for the comparison study of tabulated values and experimental values for surface roughness.

MATERIAL AND EQUIPMENT'S

Experimental Details

The experiments are performed on a CNC lathe. In the material and tool is Carbide tipped tool and Aluminium

6262. The machining parameters are taken spindle speed (X), feed rate (Y), Depth of cut (Z) in Taguchi method this three are considered.

Table 1: Preferred Ranges of Level for Turning

Control Factors	Level 1	Level 2	Level 3	Units
Factor X	500	1000	1500	RPM
Factor Y	10	40	70	mm/min
Factor Z	0.2	0.5	0.8	Mm

Material Used

Aluminum 6262 was used as the target material in this paper. In this paper, chemical composition is mentioned in table 2. The dimension of workpiece 30mm diameter and total length 100mm out of which 60mm was machining length and the rest of reaming holding the workpiece. Aluminum has good surface machining properties such as lightweight and good surface finish can be achieved. It is normally used in free -machining alloy that offers users outstanding mechanical strength and good resistance to corrosion.

Table 2: Chemical Composition of Aluminium 6262

Si	Cu	Cr
0.6	0.25%	0.1%
Mg	Al	Pb
1.0%	96.8%	0.6%

Equipment Used

The equipments are used in this performed are listed below in table 3

Table 3: Equipment List

Item	Specification
CNC Lathe	FLEXTURN MTAB CNC lathe trainer machine Spindle speed range: 500 rpm minimum and 1500rpm maximum Feed rate:70mm/min
Surface roughness and weeing machine measurement devices	Mitutoyo surface roughness tester Measuring unit: R_a in μm Stylus travel:4.8mm Digital balance meter: mm^3/min
Cutting tool used	TNMG Tungsten coated carbide tipped tool

Table 4: Signal-to-Noise Ratio using Optimization of Static Problems Chart

Signal-to-Noise Ratio	Target of the Experiment	Data Response	Signal-to-Noise Ratio Formula
Higher-is-better	Maximize the response	Positive	$S/N = -10 \log(\Sigma(1/Y^2)/n)$
Nominal-is- finest	Response you want to base the S/N ratio on standard deviations only	Positive, Zero. or Negative	$S/N = -10 \log(\sigma^2)$
Smaller-is -better	Minimize the response	Non-Negative with a target value of zero	$S/N = -10 \log(\Sigma(Y^2)/n)$

Table 5: L16 Orthogonal Array Experiment Chart

Exp. No	Input Parameters			Output Parameters	
	Cutting Speed RPM	Feed Rate mm/min	Depth cut mm	MRR	Ra
1	500	10	0.2	0.1	1.821
2	500	10	0.5	2.9	0.395
3	500	40	0.8	2.3	0.536
4	500	40	0.2	2.8	0.615
5	500	70	0.5	2.4	1.304
6	500	70	0.8	1.5	1.458
7	1000	10	0.2	1.1	0.698
8	1000	10	0.5	4.7	1.153
9	1000	40	0.8	4.3	1.085
10	1000	40	0.2	2.7	0.703
11	1000	70	0.5	4.7	1.225
12	1500	70	0.8	2.8	1.392
13	1500	40	0.2	2.5	1.746
14	1500	40	0.5	1.8	1.969
15	1500	70	0.8	2.3	1.073
16	1500	70	0.5	4	2.764

MATHEMATICAL MODEL

Machining is an important cutting process of removing the unwanted material from the surface of work by turning operation. In turning process, Material removal rate is the quantity of material removed per minute. The machining operation is to a machine at the low surface roughness of the parts.

ANALYSIS OF S/N RATIOS

The S/N ratio is the tool using for analysis reason to measure the performance of cutting process parameters towards the material removal rate and surface roughness.

$$S/N \text{ Larger} = -10 \cdot \log (\Sigma (1/Y^2)/n)$$

$$S/N \text{ Smaller} = -10 \cdot \log (\Sigma (Y^2)/n)$$

Where, n=number of trails in examination Yi=Measuring value in the run, table (6) and (7) validates the responses for The S/N ratio for surface roughness and material removal rate was calculated using smaller the better and larger the better the better for each of the parameters.

RESULTS AND DISCUSSIONS

It can be Table 5 from above 16 sets of experiments that Material Removal Rate of experiment 16 is the highest with a feed rate of 70mm/min, spindle speed is 500 rpm and depth of cut is 0.2mm. The Surface roughness of the experiment 13very fine it was Spindle Speed is 1500rpm, the feed rate is 40mm/min and Depth of cut is 0.2mm

Figure 2: Graphical Variation of Material Removal Rate with Varying Samples

Figure 3: Graphical Variation of Surface Roughness with Varying Samples

Figure 4: Taguchi Analysis: MRR (cubic m versus RPM Vs. (m/min), FEED RATE, (DEPTH OF CUT)

Figure 5: Taguchi Analysis: Surface Roughness Versus RPM (M/Min), Feed Rate, (Depth Of Cut)

The model capability examination was conducted after performing an ANOVA analysis to verify the normality statement of the residual. Figure.6, 7 show constant variance, normality, independence, histogram plots, common

probability plots of the residuals and these figures reveal that almost all the residuals follow a straight line. This work will be useful for industries while the selection of process parameters in the Aluminium materials, to get better the quality of the Turning process by reducing the material removal rate and surface roughness.

Table 6: Two-Way ANOVA: MRR Versus Feed, Depth of Cut

Source	DF	SS	MS	F	P
Feed (mm/min)	2	1.7385	0.8693	1.30	0.297
Depth of cut (mm)	2	60.3585	30.1793	45.07	0.000
Interaction	4	2.1881	0.5470	0.82	0.531
Error	18	12.0533	0.6696	-	-
Total	26	76.3385			

Table 7: Two-Way ANOVA: Ra Versus Feed (mm/rev), Point Angle (Degrees)

Source	DF	SS	MS	F	P
Feed (mm/min)	2	1.7076	0.853801	1.54	0.240
Depth of cut (mm)	2	0.5971	0.298575	0.54	0.592
Interaction	4	1.2257	0.306428	0.55	0.699
Error	18	9.9516	0.552865	-	-
Total	26	13.4820			

$$S = 0.7435R\text{-Sq} = 26.19\% \text{ R-Sq(adj)} = 0.00\%$$

Figure 6: Residual Plots for Material Removal Rate Versus Feed, Depth of Cut

Figure 7: Residual Plots for Surface Roughness Versus Feed, Depth of Cut

CONCLUSIONS

CNC Turning tests were performed on Aluminium Alloy 6262 workpiece using cutting parameters are spindle speed, feed rate and depth of cut were examined on the material Removal Rate (MRR) and Surface roughness (Ra). the conclusions drawn from this work are as follows:

The optimum process parameters in the Aluminum 6262 material are:

- A feed rate of 70mm/min, spindle speed is 500 rpm and depth of cut is 0.2mm for material removal rate whereas for Surface roughness Spindle Speed is 1500rpm, the feed rate is 40mm/min and Depth of cut is 0.2mm is to be

optimum

- It is observed that the feed and spindle speed are most significantly influences the surface roughness (Ra) and material removal rate (MRR).

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