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To Determine the Effect of Machining Parameters on Material Removal Rate of Aluminium 6063 using Turning on Lathe Machine

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Abstract

Turning is a basic operation for various industries & it is very essential to optimize the various parameters affecting turning for the optimum condition. Turning operation is affected by both machining parameters & Cutting fluids. The parameter influence most are cutting speed, depth of cut , feed, geometry of cutting tool like principle cutting edge angle ,rake angle, nose radius etc. In order to control MRR it is very necessary to control these parameters. More Material Removal rate directly controls the cost of production and reduces the production. Thus generates the overall increase in profit to the industry. Thus the optimization of material removal rate is very essential for the different machining parameters. . The rotation speed, feed rate and the depth of cut are considered as parameters of interest which directly affects the material removal rate of the used material. The parameter influence most are cutting speed, depth of cut , feed, geometry of cutting tool like principle cutting edge angle ,rake angle, nose radius etc. . In the process of turning operation the different values of cutting parameters, cutting speed (165, 220,275,330), feed rate (.2, 0.3, 0.4, 0.5 mm/rev), depth of cut (.5, 1, 1.5, 2 mm) are selected. It is concluded that the material removal rate is highly influenced by depth of cut than feed rate than speed. Material Removal rate increases with increase of Speed. Material Removal Rate increases with increase of Feed rate. Material Removal Rate increases with increase of Depth of Cut.

Keywords: *Taguchi Design, Orthogonal Array, Turning of Aluminium 6063, Cutting Speed, Feed, MRR.*

Introduction

Initially the lathe machine was invented by the two-person. Lathe machine was designed by the Egypt in about 1300 BC. Initially, there are only two things that are achieved in this lathe machine tool. The first thing is the turning of the wood piece manually with the help of a rope; and the second cutting of shapes in the wood by use of a sharp cutting tool., But there have been some modifications and improvements with time over the first invented two-person lathe machine, and also most importantly the production of the rotary motion. Surface finish, also known as surface texture, is the characteristics of a surface. It has three components: lay, surface roughness, and waviness. Many factors contribute to the surface finish in manufacturing. In forming processes, such as molding or metal forming, surface finish of the die determines the surface finish of the work piece. In machining the interaction of the cutting edges and the microstructure of the material being cut both contribute to the final surface finish. In general, the cost of manufacturing a surface increases as the surface finish improves.

Literature Review

Pradeep L. Menezes, Kishore , Satish V. Kailas *et al*. (2006) carried out study of Influence of surface texture on coefficient of friction and transfer layer formation during sliding of pure magnesium pin on 080 M40 (EN8) steel plate The conclusions based on the experimental results is that The amplitude of stick–slip motion predominately depends on plowing component of friction.

In 2007, N.R. DHAR, M.T. AHMED, S. ISLAM *et al*. carried an experimental investigation on Effect of minimum quantity lubrication in machining AISI 1040 steel. They concluded that, the cutting performance of MQL machining is better than that of dry machining.

Rishu Gupta and Ashutosh Diwedi etal concluded that the analysis of the experimental observations highlights that MRR in CNC turning process is greatly influenced by depth of cut followed by cutting speed. It is observed that the feed is most significantly influences the Ra followed by nose radius.

Dhruv H. GajjarandPROF. Jayesh V. Desai *et al* concluded that MRR decrease with increase of pulse off time, while surface roughness reduces. During off time removed material flushed away. More the off time better the flushing. Servo voltage has little effect on SR and KERF width but it has more effect over MRR. Surface roughness reduces with increase of servo voltage.

Rajmohan T. *et al* have studied on optimization of machining parameters in electrical discharge machining of 304 stainless steel. From this study, it is found that different combination of EDM process parameters is required to achieve higher MRR for 304 stainless steel.

P V amsi Krishna,D N Rao, and R R Srikant (1984) carried out study on Predictive modelling of surface roughness and tool wear in solid lubricant assisted turning of AISI 1040 steel. Results indicate that content of solid lubricant in SAE oil and type of solid lubricant affect surface roughness and tool wear.

Methodology

The Taguchi method is a well-known technique that provides a systematic and efficient methodology for process optimization and this is a powerful tool for the design of high quality systems. Taguchi approach to design of experiments in easy to adopt and apply for users with limited knowledge of statistics, hence gained wide popularity in the engineering and scientific community. This is an engineering methodology for obtaining product and process condition, which are minimally sensitive to the various causes of variation, and which produce high-quality products with low development and manufacturing costs. Signal to noise ratio and orthogonal array are two major tools used in robust design.

The S/N ratio characteristics can be divided into three categories when the characteristic is continuous

1. Nominal is the best
2. Smaller the better
3. Larger is better characteristics.

For the maximum material removal rate, the solution is Larger is better and S/N ratio is determined according to the following equation:

S/N = -10 *log(Σ(1/Y2)/n)

Where, S/N = Signal to Noise Ratio,
n = No. of Measurements, y = Measured Value

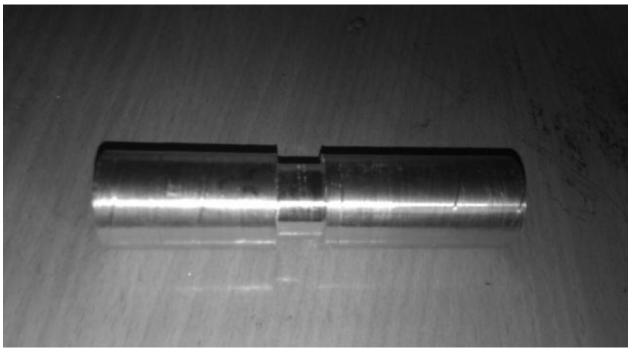
The influence of each control factor can be more clearly presented with response graphs. Optimal cutting conditions of control factors can be very easily determined from S/N response graphs, too. Parameters design is the key step in Taguchi method to achieve reliable results without increasing the experimental costs. If there is an experiment having 3 factors which have three values, then total number of experiment is 27. Then results of all experiment will give 100 accurate results. In comparison to above method the Taguchi orthogonal array make list of nine experiments in a particular order which cover all factors. Those nine experiments will give 99.96% accurate result. By using this method number of experiments reduced to 16 instead of 27 with almost same accuracy.

Surface finish measurement

The first step of analysis is to filter the raw data to remove very high frequency data since it can often be attributed to vibrations or debris on the surface. Next, the data is separated into roughness, waviness and form. This can be accomplished using reference lines, envelope methods, digital filters, fractals or other techniques.

Material used

Aluminium Alloy (Aluminium 6063). **AA 6063** is Aluminium Alloy , having elements in the concentrations Al (97.5 %), Cr (0.1 %), Cu (0.1 %) and Fe(0.35%).



Cutting tool used

The Cutting tool is high speed steel (tip Only). A tool bit is a non-rotary cutting tool used in lathes. Such cutters are also often referred to by the set-phrase name ofsingle-point cutting tool, as distinguished. The cutting edge is ground to suit a particular machining operation and may be resharpened or reshaped as needed. The ground tool bit is held rigidly by a tool holder while it is cutting.

Results and Analysis

The material Removal Rate of the Aluminium 6063 is shows an increasing trend as the speed initially increases from 165 rpm to 220 rpm. There is slight decrease in the material removal rate as the speed increases from 220 to 275 rpm. the trend is increasing as the spedd increases from 275 rpm to 330 rpm. The behavior is similar in both of the plots. The material removal rate is showing the increasing behavior with the increase of feed rate. The trend is somewhat linear. The behavior is same for both plots. The material removal rate is largely influenced by the depth of cut. There is a great change in the material removal rate as the depth of cut is initially increases from 0.5 mm to 1.0 mm. The overall trend of the material removal rate is increasing with the increase of depth of cut. The trend is similar for both of the plots. After the observation from experimentation and the data thus obtained is used in MINITAB software for the calculations of S/N ratio and mean.

Table 1 Observation Table for Temperature and material Removal Rate

S.N	Speed	Feed	D.O.C	Surface Finish	Temperature	**MRR $(W_i-W_f)/\rho stin$ mm^3 / sec**
1	165	0.2	0.5	2.2	28.35	12.8
2	165	0.3	1	5.1	28.3	39.74
3	165	0.4	1.5	2.71	28.95	85.7
4	165	0.5	2	2.52	31.7	147.39
5	220	0.2	1	1.66	28.5	38.62
6	220	0.3	0.5	3.33	29.9	13.28
7	220	0.4	2	2.95	29.7	142.08
8	220	0.5	1.5	3.31	29.45	158.47
9	275	0.2	1.5	5.32	29.2	58.91
10	275	0.3	2	3.15	30.5	127.68
11	275	0.4	0.5	2.49	28.75	31.82
12	275	0.5	1	4.14	29.15	127.31
13	330	0.2	2	4.55	30.75	98.73
14	330	0.3	1.5	2.52	29.5	103.32
15	330	0.4	1	2.86	28.5	128.95
16	330	0.5	0.5	4.05	28.45	76.9

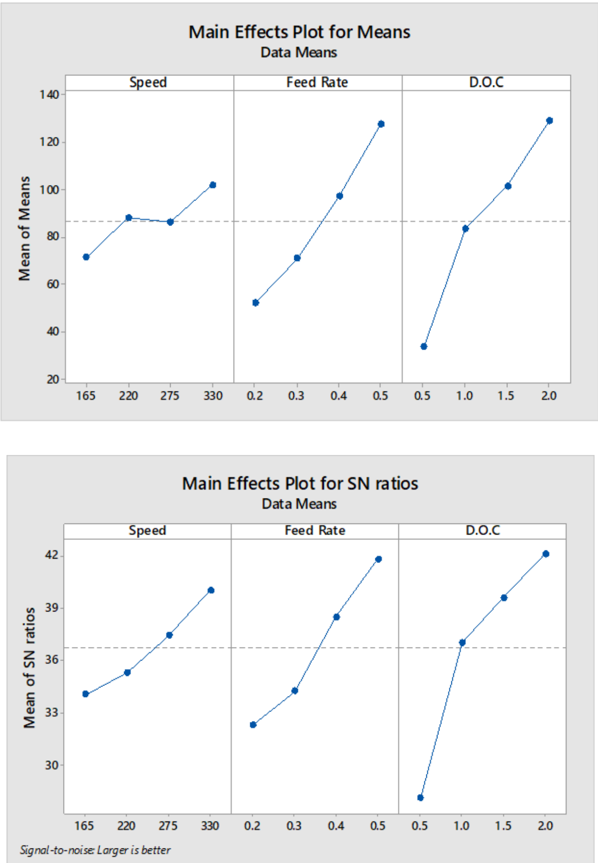


Fig: 2 Effect of Process Parameters on Surface Finish (S/N Data and Means) MRR

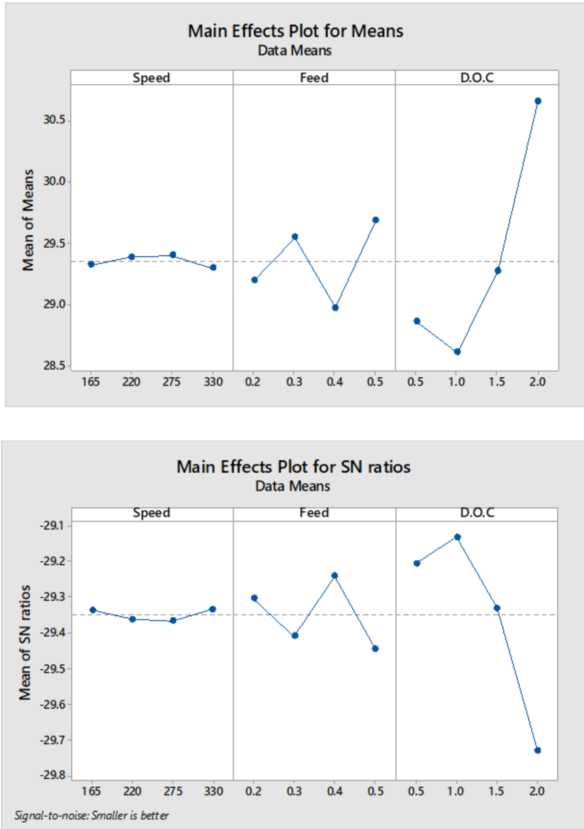


Fig: 3 Effect of Process Parameters on Surface Finish (S/N Data and Means) MRR

Table 2 Response Table for Signal to Noise Ratio

Level	Speed	Feed Rate	D.O.C
1	34.04	32.29	28.10
2	35.31	34.21	37.01
3	37.42	38.49	39.59
4	40.02	41.80	42.11
Delta	5.99	9.50	14.01
Rank	3	2	1

The temperature shows a increasing trend as the speed increases from 165 rpm to 275 rpm. But there is a slight decrease in the the temperature as the speed increases from 275 rpm to 330 rpm. The temperature is the direct function of heat generation. The overall behavior may be predicted as the increases. The trend is opposite for of the plots. The temperature of the workpiece increases initially as the feed rate increases from 0.2 mm to 0.3 mm. But there is a slight decrease in the temperature as the speed increases from 0.3 mm to 0.4 mm. Again the temperature increases as the feed ate increases from 0.4 mm to 0.5 mm. The overall behavior may be predicted as increasing. The behavior is opposite in both of the plots. Similarly the temperature shows an increasing trend with increase of depth of cut. There is a detectable decrease in the temperature initially as the depth of cut increases from 0.5 mm to 1 mm. After the observation from experimentation and the data thus obtained is used in MINITAB software for the calculations of S/N ratio and mean.

Table 3 Response Table for Signal to Noise Ratios

Smaller is better

Level	Speed	Feed	D.O.C
1	-29.34	-29.30	-29.20
2	-29.36	-29.41	-29.13
3	-29.36	-29.24	-29.33
4	-29.33	-29.44	-29.73
Delta	0.03	0.20	0.60
Rank	3	2	1

Conclusion

For material Removal Rate

- It is concluded that the material removal rate is highly influenced by depth of cut than feed rate than speed.
- Material Removal rate increases with increase of Speed.
- Material Removal Rate increases with increase of Feed rate.
- Material Removal Rate increases with increase of Depth of Cut.

Table 4 Optimal combination for Material Removal Rate

Physical	Optimal Combination		
Requirements	Speed (RPM)	Feed Rate (mm/min)	Depth of Cut (mm)
Max. Material Removal Rate	330	0.5	2.0
	Level-4	Level-4	Level-4

For Temperature Analysis

- Temperature is highly influenced by depth of cut than feed rate than speed.
- Temperature shows a negligible increasing trend with increase of speed.
- Temperature shows an increasing trend with increase of feed rate.
- Temperature shows an increasing trend with increase of depth of cut.

Table 5 Optimal combination for Hardness

Physical	Optimal Combination		
Requirements	Speed (RPM)	Feed Rate (mm/min)	Shoulder Diameter (mm)
	165	0.4	1
Min. Temperature	Level-1	Level-3	Level-2

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