Optimization of Turning Parameter for Improved Surface Property and MRR of 4043 Aluminum Alloy

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ABSTRACT

Turning is one of the most important metal removing operations performed on lathe. In turning process, the work piece is rotated at some speed by rotating the machine chuck and the stationary tool is fed in order to remove the material. The parameters such as speed, feed and depth of cut are required to perform any turning operation and responsible for metal removing process. It is also found that during the turning process the machining parameters like speed of rotation of work piece, tool feed and depth of cut have their own effect on the work piece surface. By observing this phenomenon author proposed a research on Optimization of turning parameters for improved surface property and Metal Removal Rate (MRR) for the material 4043 Aluminum alloy. In this work experimental analysis is performed by varying the machining parameters and simultaneously recording the surface roughness and MRR of work piece for the same set of parameters and the optimum set of parameters is proposed which has the maximum surface finish property and MRR.

Keywords: Turning, Lathe, Stationary Tool, Machining Parameters, Surface Finish, MRR, etc.

1.INTRODUCTION

Turning is one of the metal removing processes generally performed on lathe. In such process the work piece is rotated at some speed generally fixed into the chuck and at the same time a stationary tool is fed in order to remove the material. Generally for turning operations three parameters are much important such as speed, feed and depth of cut. Again the metal removal rate is also depends on the same. All these three machining parameters have their own effect on the work piece to be machined. By varying these parameters the surface roughness property can be varied. Therefore a research work is performed which shows the relation between work piece surface roughness and the machining parameters. The experiments work is performed by turning a cylindrical work piece of 4043 aluminum alloy. During these experiments 9 sets of reading are taken which involve variation in machining parameters for the turning also the 9 sample of work piece of same material is taken in order to measure the roughness valve after machining. The turning operations are performed on the CNC lathe VLM-T- 100. The table 1 shows the material property of 4043 aluminium alloy.

Table 1 Properties of 4043 Aluminium alloy

Parameter	Value
Density	2.69 g/cm3
Poisson's Ratio	0.34
Tensile Yield Strength	145MPa
Shear Strength	90MPa

And figure 1.1 shows the 9 sample of work piece before machining.

Fig.1.1 4043 Aluminum Alloy Work piece Sample before Machining

2. EXPERIMENTAL ANALYSIS

2.1 Selected Parameters for Machining

Table 2 shows the cutting speed, Feed rate and depth of cut selected for the machining in level 1, level 2 and level 3 in order to form an orthogonal array to machine nine work pieces. The table 3 shows the orthogonal array of machining parameter required for machining.

Table 2 Parameters, codes and value of Orthogonal Array

Parameter	Code	Level 1	Level 2	Level 3
Cutting Speed, S (rpm)	A	500	700	900
Feed Rate, f (mm/min)	B	50	70	90
Depth of Cut, d (mm)	C	0.2	0.5	0.8

Table 3 Orthogonal array of Experimental machining parameters

Job No.	Spindle Speed (Rpm)	Feed Rate (mm/min)	Depth of Cut (mm)	Length of Cut (mm)
1	500	50	0.2	25
2	500	70	0.5	
3	500	90	0.8	
4	700	50	0.2	
5	700	70	0.5	
6	700	90	0.8	
7	900	50	0.2	
8	900	70	0.5	
9	900	90	0.8	

After setting up the parameters the work piece is directly fed to the machine tool in order to perform the machining. The figure 2 shows the work piece produces by after machining.

Fig. 2.1 Work Piece after machining

3. SURFACE ROUGHNESS MEASUREMENT

After collecting the post machining data and the work piece, the surface roughness of each work piece is measured by a contact type surface roughness tester to find out the maximum surface finish obtained by a set of machining. The table 4 shows the roughness value of each work piece with the machining parameters.

Table 4 Surface Roughness Measurement

Job No.	Spindle Speed (Rpm)	Feed Rate (mm/min)	Depth of Cut (mm)	Surface Roughness (Ra μ_m)
1	500	50	0.2	2.224
2	500	70	0.5	2.651
3	500	90	0.8	2.253
4	700	50	0.5	1.892
5	700	70	0.8	2.812
6	700	90	0.2	2.907
7	900	50	0.8	3.112
8	900	70	0.2	3.467
9	900	90	0.5	3.882

4. MEASUREMENT OF MRR

After collecting the machined work piece and the machining data including machining time, the weight of the work piece is measured and tabulated in table 4 to have the material removal rate (MRR).

Table 5 MRR Measurement

Job No.	Weight Before Machining (gm)	Weight after Machining (gm)	Machining Time (min)	MRR (mm^3/min)
1	108.642	105.582	2.12	601.28
2	108.591	104.340	2.01	787.63
3	108.641	100.012	1.68	2892.42
4	108.472	99.078	2.20	945.98
5	108.755	98.980	0.718	5568.16
6	108.650	100.035	0.399	1256.50
7	108.760	100.045	0.478	6906.23
8	108.674	103.017	0.427	3210.87
9	107.032	100.219	0.429	7639.10

5.RESULT AND DISCUSSION

From the data mentioned in table 4 and table 5 it is clear that the all the three parameters have their effect on the surface roughness value and the MRR which varies accordingly. From the table 4 it is cleared that the roughness value measured in microns is minimum for the 4th set of parameter and it I minimum for the 9th set of parameters. Therefore the 4th set of parameter gives the maximum surface finish for turning of 4043 aluminum alloy. Whereas from table 5 it is clear that the 9th set of parameters gives the maximum MRR while 1st set gives minimum MRR. In order to have the parameter which gives maximum surface finish and maximum MRR one has to choose the parameter from table 4 and 5. It is cleared that for maximum surface finish the MRR is very low and on the other hand if MRR is high the surface finish is poor. Therefore the parameters are to be selected such that they should have optimum surface finish and MRR in order to improve the productivity. Hence the parameters selected as an optimum parameters and are tabulated in table 6.

Table 6 Optimum Parameters with Maximum Surface Finish

Spindle Speed (Rpm)	Feed Rate (mm/min)	Depth of Cut (mm)	Surface Roughness (Ra μ_m)	MRR (mm3/min)
500	90	0.8	2.253	2892.42

6.CONCLUSION

By analyzing surface roughness table 4 and MRR table 5 it is concluded that all the three parameters speed, feed and depth of cut have their equal effect towards surface properties. By varying any of them the desired surface finish can be obtained for any material.

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