RESEARCH ARTICLE

International Journal of Multidisciplinary and Scientific Emerging Research

Available at http://www.ijmser.com/ (ISSN 2349 – 6037)

Optimization of Machining Parameters in Turning Operation of Bronze Metal for MRR & Hardness

Sandeep Sharma# and Deepak Gupta^

#Department of Mechanical Engineering, GRIMT, Nachroun, Radaur, Haryana, India
Research Scholar Specialization in Industrial & Production, ^Asst. Professor (MED), GGGI, Dinarpur India

Accepted 30 July 2018, Available online 01 Aug 2018, **Vol.7, No.4 (Aug 2018)**

Abstract

In most of the production industries mostly the number of components is manufactured by the Metal removal turning. Centre lathe is a general purpose machine which is mostly used in most of industries and large amount of work is carried on it. First pilot experiments were done on the work piece using random values and then from those pilot experiments the suitable values of these parameters were selected. On the basis of observations from the pilot experiments three values of Cutting speed 220,330,440, three values of feed 1, 1.5, 2 and three values of Depth of cut 1, 2, 3 were chosen. L9 orthogonal array performed using these values. It is concluded that for MRR be maximum factor Cutting speed has to be at high level 3, Feed has to be at high level 2 & D.O.C has to be at high level 3. It is concluded that for hardness to be maximum Cutting speed has to be at level 2, Feed has to be at high level 3 & D.O.C has to be at level 2.

Keywords: *Machining, Taguchi, Orthogonal Array, Signal to noise ratio*

1. Introduction

Metal removal turning is a process in production industries for the manufacturing of components. The mostly used turning machines are centre lathe, turret lathe, and cnc machine. Centre lathe is a general purpose machine which is mostly used in most of industries. Mild steel is an unalloyed medium carbon steel which is used for manufacturing of shafts, studs, keys etc. Metal removal turning process is requiring to manufacturing them. Quality and quantity is also essential in industries. Therefore to optimize these parameters are necessary.

1.1 Controllable Cutting Factors In turning process

Cutting Speed/Spindle speed:

Speed always refers to the spindle and the work piece. When it is stated in revolutions per minute (rpm) it is their rotating speed. The important aspect for a particular turning operation is the speed at which the work piece material is moving past the cutting tool.

Feed:

Feed always refers to the cutting tool, and it is the rate at which the tool advances along its cutting path

Depth of Cut:

$$d_{cut} = \frac{D-d}{2}$$

Where, D,d are the initials & the final diameters of the workpiece..

Ozel and Karpat (2005) [1] considered for desire of surface disagreeableness and device flank wear by using the neural framework demonstrate stood out from the backslide show. Kohli and Dixit (2005) [2] proposed a methodology in light of the neural framework with the reviving of the winding vibration of the instrument holder as information. Abburi and Dixit (2006) [3] they made in perspective of data for predicting surface brutality in turning process system. M.P. Prabakaran and G.R. Kannan (2014)[4] This work with Aluminium alloy5083. The experimental values of surface finishing. The central composite face centered design (CCFD).

2. Data Collection

The results of the test are shown in the observation table below. After this these observations are used for doing analysis and finding the results with the help of Minitab software. The Signal to noise ratio for all runs of MRR are shown in following table:-

Table 2.1: Calculation of MRR

Density 0.0078 gm/mm3

Sr. No.	Cutting speed (rpm)	Feed	Depth of cut (mm)	MRR (mm^3/s)	SNRA1
1	440	1	1	50.2	34.01889
2	440	1.5	2	125.0	41.93964
3	440	2	3	125.5	41.97132
4	220	1	2	35.6	31.03161
5	220	1.5	3	81.2	38.1939
6	220	2	1	36.4	31.21345
7	330	1	3	86.9	38.77843
8	330	1.5	1	37.0	31.36953
9	330	2	2	69.8	36.87348

Table 2.2: MRR Response Table

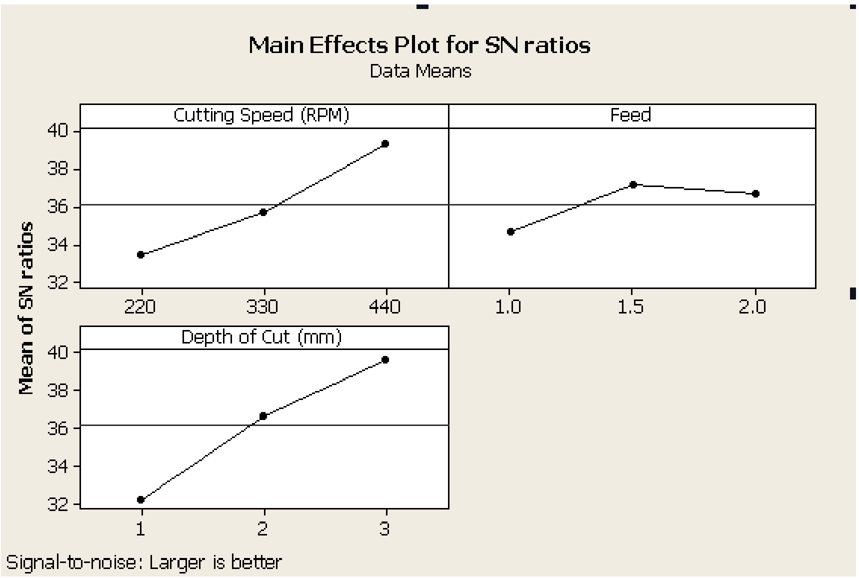
For Signal to Noise Ratios

Larger is better

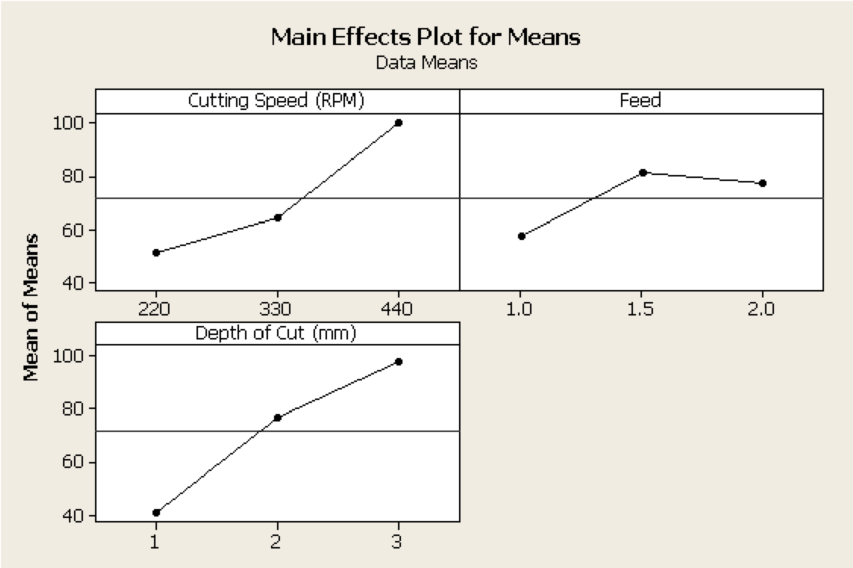
Level	Cutting speed(rpm)	Feed	Depth of cut(mm)
1	33.48	34.61	32.20
2	35.67	37.17	36.61
3	39.31	36.69	39.65
Delta	5.83	2.56	7.45
Rank	2	3	1

Table 2.3: MRR Response Table for Means

Level	Cutting speed(rpm)	Feed	Depth of cut(mm)
1	51.07	57.57	41.21
2	64.56	81.09	76.80
3	100.24	77.20	97.86
Delta	49.18	23.52	56.66
Rank	2	3	1



2.1 Main effects of Plot for S/N Ratio Material Removal Rate



2.2 Main effects of Plot for Means Material Removal Rate

Table 2.4: Analysis of Variance of MRR for SN ratios

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Cutting speed (rpm)	2	51.981	51.981	25.991	5.33	0.158
Feed	2	11.099	11.099	5.550	1.14	0.468
Depth of cut (mm)	2	84.165	84.165	42.083	8.63	0.104
Residual Error	2	9.755	9.755	4.877		
Total	8	157.000				

Table 2.5: Analysis of Variance of MRR for Means

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Cutting speed	2	3871.7	3871.7	1935.9	7.34	0.120
Feed	2	953.7	953.7	476.9	1.81	0.356
Depth of cut (mm)	2	4922.3	4922.3	2461.1	9.33	0.097
Residual Error	2	527.6	527.6	263.8		
Total	8	10275.3				

The effect of each parameter on the MRR is plotted on the graph in form of lines from the figure main effects plot for S/N ratios it can be clearly seen that the MRR with an increase in the values of cutting speed, feed & slightly decrease with increasing depth of cut.

3. Calculation of Hardness

The results of the test are shown in the observation table below. The Signal to noise ratio maximum is better for all runs of hardness are shown in following table:-

Table 3.1: Calculation of Hardness

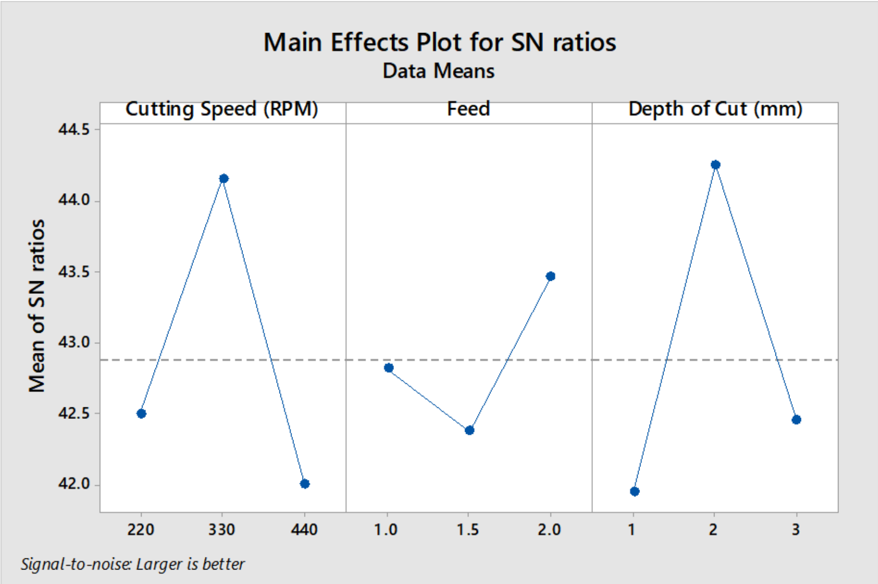
Sr. No.	Cutting Speed (RPM)	Feed	Depth of Cut (mm)	Hardness	SNRA1	Mean1
1	440	1	1	119	41.51094	119
2	440	1.5	2	125	41.9382	125
3	440	2	3	134	42.5421	134
4	220	1	2	162	44.1903	162
5	220	1.5	3	127	42.07607	127
6	220	2	1	115	41.21396	115
7	330	1	3	137	42.73441	137
8	330	1.5	1	143	43.10672	143
9	330	2	2	214	46.60828	214

Table 3.2 Hardness Response Table for Signal to Noise Ratios, Larger is better

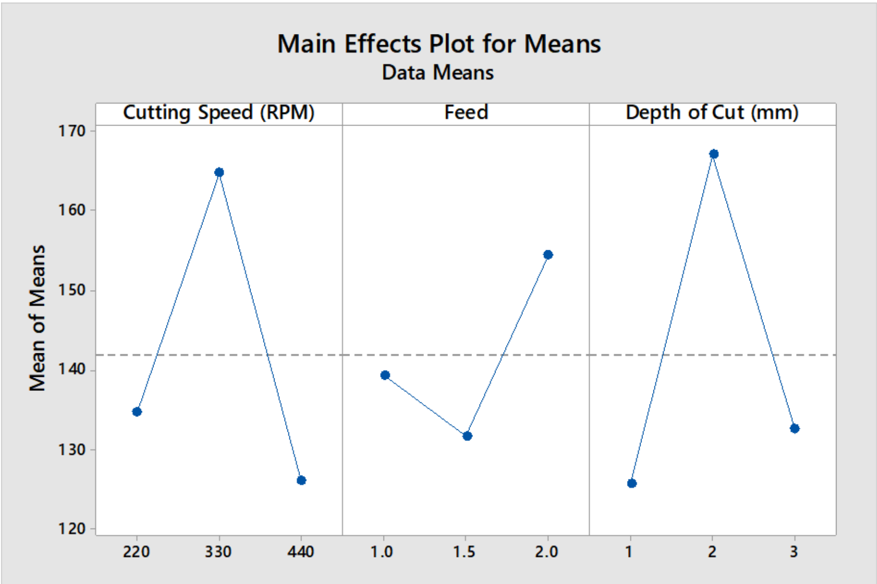
Level	RPM	Feed	D.O.C
1	134.7	139.3	125.7
2	164.7	131.7	167.0
3	126.0	154.3	132.7
Delta	38.7	22.7	41.3
Rank	2	3	1

Table 3.3 Hardness Response Table for Means

Level	**RPM**	**Feed**	**D.O.C**
1	134.7	139.3	125.7
2	164.7	131.7	167.0
3	126.0	154.3	132.7
Delta	38.7	22.7	41.3
Rank	2	3	1



Graph 3.1 Main effects of Plot for Signal to noise Ratio of Hardness



Graph 3.2 Main effects of Plot for Means of Hardness

The effect of each parameter on the hardness. is plotted on the graph in form of lines from the figure 4.5 main effects plot for S/N ratios it can be clearly seen that the hardness is maximum at the second level of cutting speed, Depth of cut & at third level of feed.

Table 3.3 Analysis of Variance of Hardness for SN ratios

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Cutting Speed (RPM)	2	7.624	7.624	3.8121	2.00	0.333
Feed	2	1.774	1.774	0.8871	0.47	0.682
Depth of Cut (mm)	2	8.776	8.776	4.3880	2.30	0.303
Residual Error	2	3.813	3.813	1.9064		
Total	8	21.987				

Table 3.4 Analysis of Variance of Hardness for Means

Source	DF	Seq SS	Adj SS	Adj MS	F	P
Cutting Speed(RPM)	2	2470.2	2470.2	1235.1	1.99	0.334
Feed	2	797.6	797.6	398.8	0.64	0.609
Depth of Cut (mm)	2	2936.2	2936.2	1468.1	2.36	0.297
Residual Error	2	1241.6	1241.6	620.8		
Total	8	7445.6				

Conclusion

1) It is concluded that for MRR be maximum factor Cutting speed has to be at high level 3, Feed has to be at high level 2 & D.O.C has to be at high level 3. As shown in table below.

Table 5.1 Optimal combination for MRR

Physical	**Optimal Combination**		
Requirements	C.S	F	D.O.C
Maximum MRR	440	1.5	3
	Level-3	Level-2	Level-3

2) It is concluded that for hardness to be maximum Cutting speed has to be at level 2, Feed has to be at high level 3 & D.O.C has to be at level 2. As shown in table below.

Table 5.3 Optimal combination for Hardness

Physical	**Optimal Combination**		
Requirements	C.S	F	D.O.C
Maximum Hardness	330	2	2
	Level-2	Level-3	Level-2

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