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Investigation of Optimal Process Parameters for Better Surface Finish and MRR in Turning Process

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ABSTRACT:

In this thesis, the effect of cutting parameters cutting speed, feed rate and depth of cut for turning of work piece material Aluminum alloy 6082 is determined for better surface quality and material removal rates. The optimal parameters of cutting speed are 700rpm, 950rpm and 1440rpm, feed rate are 0.3mm/rev, 0.4mm/rev, 0.5mm/rev and depth of cut are 11mm, 6mm and 0.5mm. Experimental work is conducted by considering the above parameters taking 3 levels for each parameter and organizing using Taguchi L9 orthogonal array. 9 experiments are conducted as per Taguchi design and Surface finish and Material Removal Rate are validated experimentally. The cutting parameters are optimized for better surface finish quality and high material removal rates using Taguchi Method in Minitab 17 software.

INTRODUCTION TO TURNING

Turning is a machining process in which a cuttingtool, typically a non-rotary toolbit, describes a helical tool path by moving more or less linearly while the work piece rotates. The tool's axes of movement may be literally a straight line, or they may be along some set of curves or angles, but they are essentially linear (in the nonmathematical sense).

Usually the term "turning" is reserved for the generation of *external* surfaces by this cutting action, whereas this same essential cutting action when applied to *internal* surfaces (that is, holes, of one kind or another) is called "boring". Thus the phrase "turning and boring" categorizes the larger family of (essentially similar) processes. The cutting of faces on the work piece (that is, surfaces perpendicular to its rotating axis), whether with a turning or boring tool, is called "facing", and may be lumped into either category as a subset.

LITERATURE SURVEY

The work done by Karin Kandananond [1], the optimized settings of key machining factors, depth of cut, spindle speed, and feed rate on the surface roughness of the sleeve were determined using the response surface methodology (RSM). The results indicate that the surface roughness is minimized when the depth of cut is set to the lowest level, while the spindle speed and feed rate are set to the highest levels.

Even though the results from this paper are process specific, the methodology deployed can be readily applied to different turning processes. The paper by Neeraj Sharma[2], applied extended Taguchi method through a case study in straight turning of mild steel bar using HSS tool for the optimization of process parameters. The study aimed at evaluating the best process environment which could simultaneously satisfy requirements of both quality as well as productivity with special emphasis on reduction of cutting tool flank wear, because reduction in flank wear ensures increase in tool life.

EXPERIMENTAL INVESTIGATION

The experiments are done on the Lathe machine with the following parameters:

CUTTING TOOL MATERIAL – Tungsten Carbide Tool

WORK PIECE MATERIAL – Aluminum Alloy 6082 of dia. 19.5mm and 110mm length.

FEED – 0.3mm/rev, 0.4mm/rev, 0.5mm/rev

CUTTING SPEED – 700rpm, 950rpm, 1440rpm,

DEPTH OF CUT – 11mm, 6mm, 0.5mm

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SELECTION OF ORTHOGONAL ARRAY AS PER TAGUCHI

PARAMETER DESIGN The levels of inputparameters are shown in below table.

FACTORS	PROCESS PARAMETERS	LE VEL1	LEVEL2	LEVEL3
A	CUTTING SPEED(rpm)	700	950	1440
B	FEED RATE (mm/rev)	0.3	0.4	0.5
C	DEPTH OF CUT(mm)	0.5	6	11

Levels of Process Parameters considered for experimentation

JOB NO.	SPINDLE SPEED (rpm)	FEED RATE (mm/rev)	DEPTH OF CUT (mm)
1	700	0.3	0.5
2	700	0.4	6
3	700	0.5	11
4	950	0.3	6
5	950	0.4	11
6	950	0.5	0.5
7	1440	0.3	11
8	1440	0.4	0.5
9	1440	0.5	6

L9 Orthogonal Array based on Taguchi Method

Turning of Aluminum work piece

RESULTS & DISCUSSIONS

The Surface Roughness values are measured using surface roughness tester of model Surftest 211/212.

MATERIAL REMOVAL RATE

The material removal rates are calculated as per the formula given below and the measured material removal rates values are tabulated in the table.

$$MRR = \frac{\Pi}{4} * (D_i^2 - D_f^2) * f * N$$

Where

D_i = Initial Diameter mm

D_f = Final Diameter mm

f = feed rate mm/rev

N = Speed rpm

TAGUCHI ANALYSIS IN MINITAB SOFTWARE

OPTIMIZATION OF PARAMETERS FOR SURFACE ROUGHNESS

The cutting parameters are analyzed for smaller – the – better characteristic for surface roughness values.

Worksheet 1 ***

	C1	C2	C3	C4
	SPINDLE SPEED	FEED RATE	DEPTH OF CUT	SURFACE ROUGHNESS
1	700	0.3	0.5	3.78
2	700	0.4	6.0	6.10
3	700	0.5	11.0	6.33
4	950	0.3	6.0	5.89
5	950	0.4	11.0	5.13
6	950	0.5	0.5	6.48
7	1440	0.3	11.0	4.09
8	1440	0.4	0.5	4.67
9	1440	0.5	6.0	5.95

Measured Surface Roughness Values

Worksheet 1 ***

	C1	C2	C3	C4	C5
	SPINDLE SPEED	FEED RATE	DEPTH OF CUT	SURFACE ROUGHNESS	SNRA1
1	700	0.3	0.5	3.78	-11.5498
2	700	0.4	6.0	6.10	-15.7066
3	700	0.5	11.0	6.33	-16.0281
4	950	0.3	6.0	5.89	-15.4023
5	950	0.4	11.0	5.13	-14.2023
6	950	0.5	0.5	6.48	-16.2315
7	1440	0.3	11.0	4.09	-12.2345
8	1440	0.4	0.5	4.67	-13.3863
9	1440	0.5	6.0	5.95	-15.4903

Results of S/N Ratio

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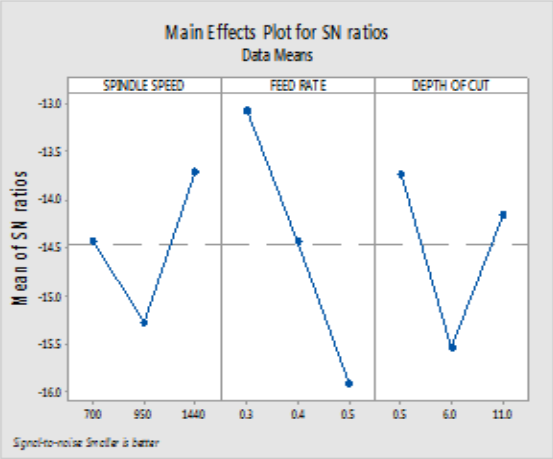


Effect of turning parameters on surface finish for S/N ratio

OPTIMIZATION OF PARAMETERS FOR MATERIAL REMOVAL RATE

The cutting parameters are analyzed for larger – the – better characteristic for MRR values.

Worksheet 1 ***

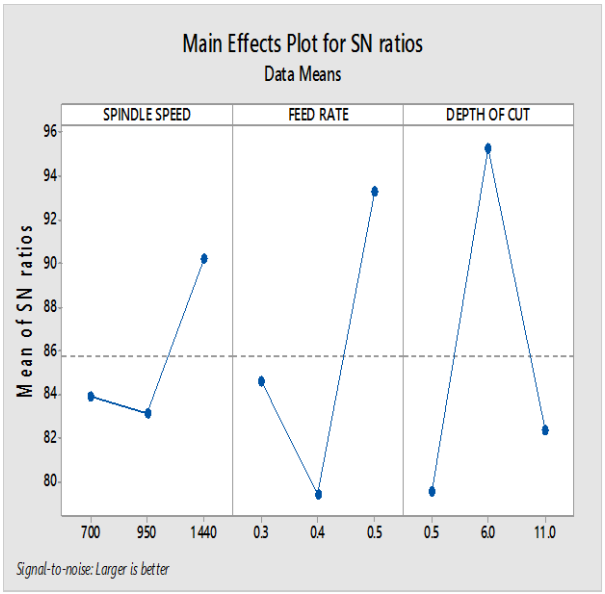
	C1	C2	C3	C4
	SPINDLE SPEED	FEED RATE	DEPTH OF CUT	MRR
1	700	0.3	0.5	3173
2	700	0.4	6.0	42202
3	700	0.5	11.0	28849
4	950	0.3	6.0	42955
5	950	0.4	11.0	2197
6	950	0.5	0.5	31322
7	1440	0.3	11.0	35608
8	1440	0.4	0.5	8704
9	1440	0.5	6.0	108518

Measured MRR values

Worksheet 1 ***

	C1	C2	C3	C4	C5
	SPINDLE SPEED	FEED RATE	DEPTH OF CUT	MRR	SNRA2
1	700	0.3	0.5	3173	70.030
2	700	0.4	6.0	42202	92.507
3	700	0.5	11.0	28849	89.203
4	950	0.3	6.0	42955	92.660
5	950	0.4	11.0	2197	66.836
6	950	0.5	0.5	31322	89.917
7	1440	0.3	11.0	35608	91.031
8	1440	0.4	0.5	8704	78.794
9	1440	0.5	6.0	108518	100.710

Results of S/N Ratio



Effect of turning parameters on MRR for S/N ratio

CONCLUSION

By observing the experimental results the following conclusions can be made:

To get better surface finish, the optimal parameters are spindle speed – 1440rpm, feed rate – 0.3mm/rev and depth of cut – 0.5mm.

To get high material removal rates, the optimal parameters are spindle speed – 1440rpm, feed rate – 0.5mm/rev and depth of cut – 6mm.

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