



ENHANCEMENT OF TURNING PROCESS WITH THE HELP OF TAGUCHI METHOD AND FUZZY LOGIC APPROACH ON ALUMINIUM 8011 ALLOY

VIKRAM D. PATIL¹, SONAL SALI²

¹Department of Mechanical Engineering Mumbai University / BVCOE Navi Mumbai, Mumbai,
India

²Department of Mechanical Engineering Mumbai University / BVCOE Navi Mumbai, Mumbai,
India



ABSTRACT

In this research paper optimization of turning process is carried out by the help of Taguchi method and fuzzy logic approach. Aluminium 8011 alloy is considered as a work material and Tin coated cutting tool is used for enhancing the process parameters like spindle speed, feed, depth of cut. By experiment we may expect or understand that which process parameter is more significant or which process parameter plays vital role in the optimization process. L9 array is used for this experiment and ranking could be done for each process parameter with the help of fuzzy logic approach.

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INTRODUCTION

The manufacturing industry boost up from the Second World War. From manufacturing of war equipment to medical equipment there is need of good quality of products. The term quality itself says that the surface finish, tolerance, material removal rate, cutting angle, tool wear, nose radius should be considered. In this study we have to understand how MRR could be increased with maintaining high surface finish. For that we take many samples for material 8011 aluminium alloy.

Literature

M. Nalbant et al. [1] have considered signal to noise ratio, analysis of variance and orthogonal array for turning operation on the material AISI 1030 where tool material is TiN coated cutting tool. For this experiment they used L9 array and considered following parameters for surface roughness-1. nose radius 2. depth of cut 3. feed rate. Final result for this

experiment is nose radius-48.54, feed- 46.95, DOC- 3.39.

Suleiman Abdulkareem et al. [2] has done same investigation for turning AISI 1045 metal by considering surface roughness. They use spindle speed, feed rate, cutting speed as a process parameter. Box Behnken experimental design method and analysis of variance (ANOVA) is used to optimize the process by surface roughness (Ra). Result of this investigation is feed is most significant parameter followed by cutting speed and the spindle speed is less effective. Also found that machining with high cutting and spindle speed improves surface roughness against feed rate.

H. K. Dave et al. [3] studied the different materials like EN-8 and EN-31 for maximum material removal rate (MRR) and minimum surface roughness (Ra). For this study they use tool insert, work material, speed, feed, DOC etc. parameters. L8 orthogonal array and ANOVA is used resulting that DOC is more

effective for Maximum MRR and tool insert plays important role for maintaining minimum surface roughness.

Methodology-

- Selection Of Process Parameters
- Design Of Experiment
- Experimentation
- Response Measurement

- Taguchi Methodology
- Fuzzy Logic Application

Material Specification-

For machining Aluminium Alloy 8011 we should use TiN coated cutting tool. Aluminium alloy 8011 is wrought alloy. The chemical and physical properties of work metal is as follows-

Chemical composition		Physical Properties	
Aluminum, Al	97.3 - 98.9	Test temperature (Gr)	20
Iron, Fe	0.60 – 1	Density , [kg/m ³]	2710
Silicon, Si	0.50 - 0.90		
Manganese, Mn	≤ 0.20		
Zinc, Zn	≤ 0.10		
Copper, Cu	≤ 0.10		
Titanium, Ti	≤ 0.080		
Chromium, Cr	≤ 0.050		
Magnesium, Mg	≤ 0.050		

Material diameter-25.5 mm

Maximum Turning length- 220mm

Maximum Spindle Speed- 6300 rpm

Spindle Power- 5.5kw

In this study, two different machines are used in which digital surface tester is one and digital weighing machine is another for surface testing and weighting respectively. Taylor-hobsonsurtronic 3 plus instrument is specially design to measure surface roughness. Electronic weighing machine with maximum capacity of 300 gm and least count 0.001 gm. is used to estimatematerial removal rate.

Machine Specification-

Turning operation of selected work piece is conducted on CNC trainer machine-Power Turn-SS-PT-100.The detailed specification of machine tool is as follows-

- Slant Bed Design Travel-
- X Axis=100mm,
- Y Axis=250 mm,
- Swing over Bed=200mm,
- Swing over cross-slide=80 mm,
- Distance between center=300 mm,
- Spindle motor=1HP/2HP

Independent parameters and there inputs-

Independent Parameters	Units	Aluminium 8011 alloy Levels		
		I	II	III
Spindle Speed	rpm	1400	1600	1800
Feed	mm/rev	0.08	0.14	0.2
Depth of Cut	mm	0.4	0.8	1.2

Taguchi Method-

This is the statistical method developed by Genichi Taguchi to improve the quality of overall production. Taguchi has design three steps for quality checks which are as follows.

1. System Design 2. Parameter Design 3.Tolerance Design

Then, for any quality improvement there are three conditions which are: smaller is better, Medium is better, higher is better. Depends on these condition one may decide the quality parameters.

Formula for signal to noise ratio for material removal rate (MRR) is

$$\left[\frac{S}{N} = -10 \log \left(\frac{\sum y_i^2}{n} \right) \right]$$

Larger – The – Better

Formula for signal to noise ratio for surface roughness (Ra) is

$$\left[\frac{S}{N} = -10 \log \left(\frac{\sum y_i^2}{n} \right) \right]$$

Smaller – The – Better

Layout of [L9 (3)²] orthogonal array-

	Cutting Speed (m/s)	Feed Rate (mm/rev)	Depth of Cut (mm)	SN ratio	MRR (mm/min)
1	1	1	1	-2.28	65.71
2	1	2	2	-2.14	76.29
3	1	3	3	-9.40	82.97
4	2	1	2	-5.21	71.79
5	2	2	3	-4.14	80.60
6	2	3	1	-5.10	74.60
7	3	1	3	-0.17	77.05
8	3	2	1	-4.40	81.75
9	3	3	2	-5.98	81.27

Levels	Surface Roughness IP for Aluminium 8011 alloy			MRR IP for Aluminium 8011 alloy		
	SS (rpm)	Feed(mm/rev)	DOC (mm)	SS (rpm)	Feed(mm/rev)	DOC (mm)
1	-4.176	-1.539	-3.360	74.97	74.01	71.27
2	-4.101	-3.808	-4.357	76.08	77.21	77.41
3	-3.941	-6.868	-4.500	77.23	79.63	82.16
Delta (Max-Min)	0.235	5.266	1.111	2.26	5.62	10.89
Rank	3	1	2	3	2	1

Table shows that lower independent parameters are better for surface roughness and higher for MRR is better. In table rank 1 shows that more influenced for response parameter next lesser influence.

Fuzzy Logic Approach-

Fuzzy logic is method to explaining degree of truthiness in which truth value is any number from 0 to 1, considered as "Fuzzy." In Boolean logic the truth values may only be 0 and 1.

In some cases we cannot explain the outputs in certain boundaries, so to explain that result fuzzy

logic is used. It has six operators- 1.Fuzzy interface 2.Fuzzy system 3. Fuzzy sets 4. Fuzzy rules 5.Membership function 6.Defuzzification.

Fuzzy logic approach is used to convert multi-objective response into single objective response that is called comprehensive output measure (COM).Using Taguchi method again CNC turning process parameters are optimized for single objective response.

Levels	Independent parameters for aluminium 8011 alloy		
	SS (rpm)	Feed (mm/rev)	DOC (mm)
1	-6.694	-9.735	-9.233
2	-5.851	-5.524	-4.952
3	-5.811	-3.097	-4.170
Delta (max-min)	0.884	6.638	5.063

Rank	3	1	2
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Conclusion

Optimization of the turning process for aluminium 8011 alloy is carried out in this experiment with the help of Taguchi approach and fuzzy logic approach is used to conclude that which process parameter is most significant for tuning of aluminium 8011 alloy. In fuzzy logic approach there is averaging of outputs found by using Taguchi method so that it can be ranked as above. The outcome in this study is that the feed is most significant parameter from selected process parameters (speed, feed, DOC) followed by depth of cut and lastly the spindle speed from the above table.

References

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