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OPTIMIZATION OF MACHINING PARAMETERS FOR TURNING OF ALUMINIUM ALLOY LM4 USING TAGUCHI METHOD

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Abstract: *In today manufacturing industries aims to produce a large number of products within a short interval of time. In this project, an experiment has been carried out on aluminium alloy LM4 for optimisation of process parameters in turning by use of Taguchi method of design. In this, an experiment has been carried out on L_9 orthogonal array design having three parameters i.e. cutting speed, feed, depth of cut for the machining process. After machining signal to noise ratio with machining parameters were carried out to study the performance of various parameters in turning operation. This experiment has been carried out for smaller the better Taguchi approach. After analysis, it results to know about LM4 machining characteristics and its scope in the industries.*

Keywords: ***Aluminium alloy LM4, Taguchi approach***

1. Introduction

In manufacturing industries, they all want to increase its productivity and quality production. And to achieve this all manufacturing industries tries to use better materials that can fulfil their needs. And aluminium alloy LM4 may be one of them that can be used in turning process in the manufacturing industries. Aluminium alloy is one of the materials that have high machining rate using parameters cutting speed, feed, and depth of cut. Aluminium alloy LM4 has good mechanical properties such as high strength, better ductility, less corrosion, less costly and are lighter in weight. This aluminium alloy has a various application such as in gearboxes, junction boxes, crankcases, switchgear covers, cylinder heads, instrumental boxes etc. In this optimisation of process parameters of aluminium alloy LM4 the methodology used is Taguchi method and Minitab software has been used for the design of the experiment and the analysis of the result. The machining process has been done on the CNC machine for the desired given parameters.

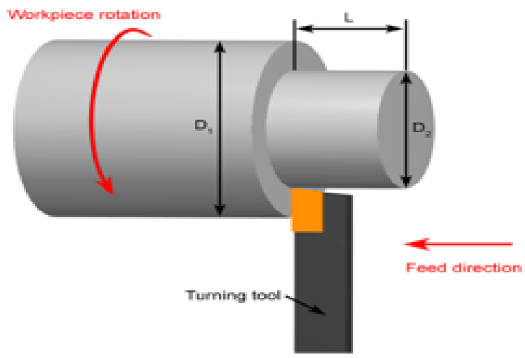

Fig 1.1 Turning Process

1.1 Material

The material that is used to carry out the experiment is aluminium alloy LM4.

The standard compositions of the LM4 are given as follows:

1.2 Chemical Composition (LM4)

COMPONENTS	PERCENTAGE (%)
Copper	2.0 – 4.0
Magnesium	0.15 max
Silicon	4.0 – 6.0
Manganese	0.2 – 06
Zinc	0.5 max
Tin	0.1 max
Titanium	0.2 max
Iron	0.8 max
Nickel	0.3 max
Lead	0.1 max
Aluminium	Remainder.

Fig1.2 LM4

1.3 Mechanical Properties

Shear Strength(N/mm²)	150
Tensile Strength(N/mm²)	160 – 220
Elongation (%)	2 – 4
Brinell Hardness No.	70 – 90

2. Carbide Coated Tip Cutting Tool

Coatings are generally applied to tools that increase tool life almost 10 times and enable higher cutting speed. Common coating materials include titanium carbide, titanium nitride, and aluminium oxide generally 2-18 µm thick.

Fig 1.3Tungsten Carbide Tool

3. Selection of machining parameters

For the machining process basically, three parameters have been selected i.e. cutting speed (rpm), feed (mm/min)and depth of cut (mm).

PARAMETERS	LEVEL 1	LEVEL 2	LEVEL 3
CUTTING SPEED	1000	1500	2000
FEED	15	25	30
DEPTH OF CUT	0.5	0.9	1.2

4. Methodology

The experiment has been carried out on turning process on CNC machine by the use of Taguchi Method.

The picture of automatic CNC machine taken from the lab is shown below.

Fig. 1.4 CNC Machine

4.1 Taguchi Approach

Taguchi method is generally used as a loss function to determine the quality characteristics. Taguchi method provides the robust design. These loss function values can be converted to signal-to-noise (S/N) ratio. The term "signal-to-noise" represents the desirable value (mean) and undesirable value for the output characteristic. The experiment has been carried out for smaller the better S/N ratio in which ANOVA is performed to see which input parameters are significant.

Smaller is better

$S/N = -10*\log(\Sigma (Y^2)/n))$

Where,
Y= Observed data
n= No. of trials

L9 Orthogonal array

S. NO	Parameter 1(speed in rpm)	Parameter 2 (feed-in mm/min)	Parameter 3 (depth of cut In mm)
1.	1000	15	0.5
2.	1000	25	0.9
3.	1000	30	1.2
4.	1500	15	0.9
5.	1500	25	1.2
6.	1500	30	0.5
7.	2000	15	1.2
8.	2000	259	0.5
9.	2000	30	0.9

4.2 Measurement of Surface Roughness

In this, stylus type surface roughness meter was used for the surface roughness measurement. Stylus type surface roughness measurement is used because of its easy availability and easy to operate.

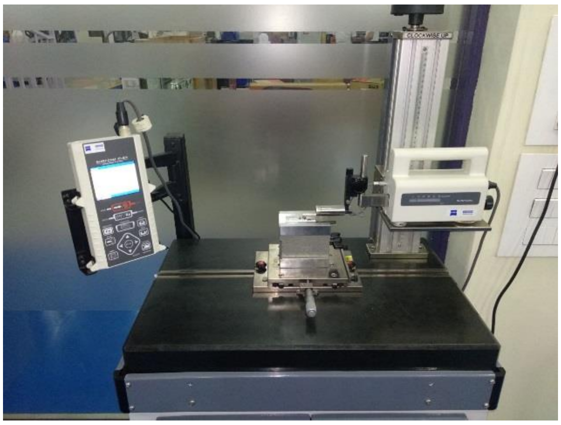

Fig 1.5

Stylus Type Surface Roughness Testing Machine

The reading of surface roughness on the following values of parameters,

Speed	1000
Feed	15
DOC	0.5

Fig 1.6 Reading of surface roughness

The RA value which is measured from the stylus type surface roughness machine for the given input parameters is shown in the table.

S. NO	Speed (in rpm)	Feed (in mm/ min)	depth of cut (In mm)	Surface roughness
1.	1000	15	0.5	0.551
2.	1000	25	0.9	0.767
3.	1000	30	1.2	0.897
4.	1500	15	0.9	2.867
5.	1500	25	1.2	0.861
6.	1500	30	0.5	0.685
7.	2000	15	1.2	0.897
8.	2000	25	0.5	1.528
9.	2000	30	0.9	2.321

4. Result and Discussion

4.1 S/N Ratio Analysis

The S/N ratio was analysed using the equation of smaller the better formula of Taguchi Method. Figures 1.7 and 1.8 shows the main effects plots of S/N ratios for LM4 alloy graphically

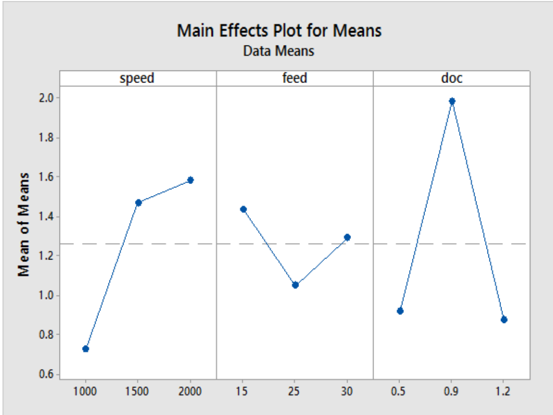

Fig 1.7

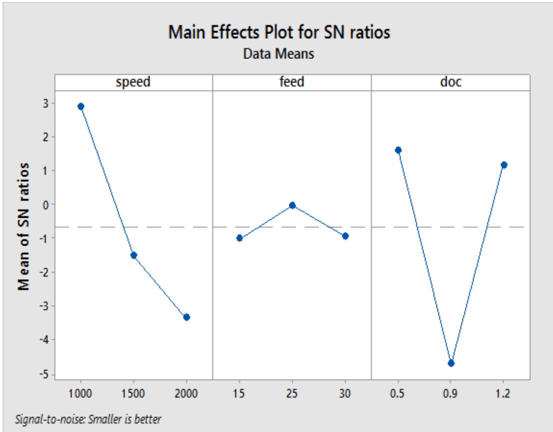

Fig 1.8

For ex
For smaller is the better
For experiment no1
SN Ratio= S/N = -10*log (Σ (Y^2)/n))
=-10log ((1/1) (0.551) ^2)
=5.1769
Similarly all values are given as follows:

4.2 ANOVA (analysis of variance)

ANOVA is used to explore the outline parameters and to show which input parameters are influencing the output parameters. F-test quality at 95% certainty level is used to choose the parameters influencing the procedure. ANOVA investigation is demonstrated in the table given below.

S. NO	Speed	Feed	DOC	RA	SNRA1	Mean1
1	1000	15	0.5	0.551	5.17697	0.551
2	1000	25	0.9	0.767	2.30409	0.767
3	1000	30	1.2	0.867	1.23962	0.867
4	1500	15	0.9	2.867	-9.1485	2.867
5	1500	25	1.2	0.861	1.29994	0.861
6	1500	30	0.5	0.685	3.28619	0.685
7	2000	15	1.2	0.897	0.94415	0.897
8	2000	25	0.5	1.528	-3.6824	1.528
9	2000	30	0.9	2.321	-7.3135	2.321

Source	DF	SS	MS	F	P
Speed	2	1.2926	0.6463	0.91	0.523
Feed	2	0.2281	0.1140	0.16	0.861
Doc	2	2.3656	1.1828	1.67	0.374
Error	2	1.4154	0.7077		
Total	8	5.3018			

5. CONCLUSION

Taguchi design of experiment can be used efficiently in the optimization of machining parameters in turning process.

The significant factors concluded that the effect of feed rate and cutting speed are more on the quality characteristic.

The depth of cut parameter has more effect on machining process that led to maximum surface roughness followed by cutting speed.

In this experiment, the analysis has shown that Taguchi parameter design can successfully verify the optimum cutting parameters.

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