Analysis on the Effect of Machining parameters on MRR Using Different Coolants

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ABSTRACT

In the present paper, by using Taguchi Robust Design methodology, the Turning of EN-36 Steel Alloy is carried out in order to optimize the turning Machining parameters. The present work deals with the optimization of selected Machining parameters, i.e. Type of Lubricant, Cutting Speed, Feed rate and Depth of cut. The experiments are carried out using L_9 (3^4) orthogonal array. Taguchi method stresses the importance of studying the response variation using the Analysis of Variance (ANOVA) and signal to noise (S/N) ratio, resulting the minimization of quality characteristic variation due to uncontrollable parameter. The Material Removal Rate (MRR) is considered as the quality characteristic in the concept of "the Larger the better". The Material Removal rate (MRR) measured from experiment and their optimum value for MRR are calculated. Analysis of Variance suggests that the selected cutting parameters are significant for the MRR.

Keyword: - *Taguchi Method, EN-36 Steel Alloy, Material Removal Rate (MRR), Analysis of Variance (ANOVA), Signal to noise (S/N) ratio etc.*

1. INTRODUCTION:

Quality and productivity play significant role in today's manufacturing market. From customers' viewpoint quality is very important because the extent of quality of the procured item (or product) influences the degree of satisfaction of the consumers during its usage. Therefore, every manufacturing or production unit should concern about the quality of the product. Quality of a product can be described by various quality attributes. The attributes may be quantitative or qualitative. Our present study is based on the analysis of machining parameters on Material Removal Rate (MRR) on EN 36 steel alloy using Carbide tool on CNC lathe. Taguchi methodology is used to determine the optimum cutting conditions more efficiently. Four control factors viz. type of lubricant; cutting speed; feed rate and depth of cut are investigated at three different levels. The work piece material used is EN 36 Alloy. Taguchi methodology is used to optimize the process parameters using signal-to-noise ratio for turning process of the work piece material. Experiments are carried out using L_9 (3^4) orthogonal array [1-14].

Turning is a machining process in which a cutting tool, typically a non-rotary tool bit, 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 [1]. Turning machines used in manufacturing are classified as engine, automatics, and computer numerical control etc. The Turning used for machining in this work is CNC Turning machine. Basically Turning machines are classified according to the operation required [2].

In this work, the output parameter Material Removal Rate. Robust design is an engineering methodology for improving productivity during design and development so that high quality products can be produced at low cost. EN 36 is nickel- chromium high hardenability, case hardening (carburizing) steel, generally available in the annealed condition with a maximum brinell hardness of 255, characterized by high core strength, excellent toughness and fatigue resistance in relatively large sections with case hardness upto RC62 when carburized, hardened and tempered. EN 36 can also be used (uncarburized) as high tensile steel which when suitably hardened and tempered can be utilized for various applications requiring good tensile strength and excellent toughness [1][6].

2. EXPERIMENTAL SETUP AND DESIGN:

The aim of the work is to find out the set of optimum conditions for the selected machining conditions in order to increase matrial removal rate using Taguchi design methodology. The turning operations are carried out on CNC Lathe machine shown in Fig No. 1. The work material selected is EN-36 steel alloy with the dimensions of 28mm dia X 110mm long and the cutting insert used is TNMG UNCOATED carbide tool of KORLOY Company. The machining are conducted under- Dry Condition (Without Lubricant), With Lubricant using Veg oil and Using Veg oil + Boric Acid. The machining tests are also conducted under the different Cutting speed, Feed rate and Depth of cut with respect the Type of Lubricant.

Fig. No. 1: CNC Lathe

Fig. No. 2: EN36 Alloy Steel

The four control factors Type of Lubricant (A), Speed (B), Feed Rate (C) and Depth Of Cut(D) are selected with three levels and the corresponding orthogonal array $L_9(3^4)$ is chosen with respect to its degrees of freedom[1] and are tabulated in Table No.1. Steel bars of 28mm diaX110mm length are prepared for conducting the experiment. Using different levels of the process parameters as per the experimental design shown in table no.2, the specimens have been machined in CNC Lathe Machine accordingly, the Cutting Temperature is measured precisely with the help of a portable Digital Thermometer tester.

Table No. 1: Control Factors & Levels

Factors /Levels	Type of Lubricant (A)	Speed (B) (rpm)	Feed (C) (mm/min)	Depth Of Cut (D) (mm)
1	Without Lubricant	350	0.4	5
2	Veg Oil	500	0.5	7.5
3	Veg Oil+ Boric Acid	650	0.6	10

Fig. No. 3: Machining of EN36 Alloy Steel in CNC Lathe

3. RESULTS & DISCUSSIONS:

The Material Removal rate is measured precisely [6] and the experiments results are tabulated in table no. 2 for two trails. For each experiment the corresponding S/N values at larger the better are also tabulated. Optimization of Material Removal Rate is carried out using Taguchi methodology. Confirmatory test have also been conducted to validate optimal results.

Table No. 2. Experimental Design and results of MRR with corresponding S/N ratios

NO.	TYPE OF LUBRICANT	SPEED	FEED	DEPTH OF CUT	TRAIL-I	TRAIL-II	MEAN MRR	S/N RATIO
1	Without Lubricant	350	0.4	5	0.0191	0.0145	0.0168	-35.4938
2	Without Lubricant	500	0.5	7.5	0.011323	0.011146	0.0112345	-38.9889
3	Without Lubricant	650	0.6	10	0.024136	0.02375	0.023943	-32.4164
4	Veg Oil	350	0.5	10	0.023885	0.029654	0.0267695	-31.4472
5	Veg Oil	500	0.6	5	0.01559	0.01662	0.016105	-35.8608
6	Veg Oil	650	0.4	7.5	0.028842	0.02789	0.028366	-30.944
7	Veg Oil+Boric Acid	350	0.6	7.5	0.0299	0.0289	0.0294	-30.6331
8	Veg Oil+Boric Acid	500	0.4	10	0.041012	0.04013	0.040571	-27.8357
9	Veg Oil+Boric Acid	650	0.5	5	0.02485	0.02685	0.02585	-31.7508

Table No 3: Summary of S/N Ratios

Factor	Level 1	Level 2	Level 3
Type of Lubricant(A)	-35.633	-32.750	**-30.073**
Speed(B)	-32.524	-34.228	**-31.703**
Feed(C)	**-31.424**	-34.062	-32.970
Depth of Cut(D)	-34.368	-33.522	**-30.566**

The best condition for Type of Lubricant factor is level 3 (Veg Oil+ Boric Acid), for Speed is level 3 (650rpm), for Feed is Level 1 (0.4 mm/min) and Depth of Cut is level 3 (10mm). Thus, the optimum conditions chosen were: **A3-B3-C1-D3**. A confirmation test is performed with the obtained optimum machining parameters, the MRR is calculated and the S/N ratio is obtained for this condition. The conformation test and the predicted values are tabulated in the table no 5 & 6.the corresponding ANOVA table no in 7.

Table No 4: Optimum Set Of Control Factors

Factors /Levels	**Type of Lubricant (A)**	**Speed (B) (rpm)**	**Feed (C) (mm/min)**	**Depth Of Cut (D) (mm)**
Optimum Value	Veg Oil+ Boric Acid	650	0.4	10

Table No 5. Conformation results

Material removal rate			S/N RATIO
1	2	Average	
0.0524	0.0504	0.0514	-25.7807

Table No 6. Comparison of S/N ratios

η predicted	-25.3109
η conformation	-25.7807

Table No.7: Analysis Of Variance

FACTOR	**S.S**	**D.O.F**	**M.S.S**	**F-RATIO (DATA)**	**F-RATIO (TABLE)**	**RESULT**
TYPE OF LUBRICANT	0.00064389	2	0.000322	82.59426	4.26	Significant
SPEED	0.0000350	2	0.0000175	4.491168	4.26	Significant
FEED	0.00017233	2	0.0000862	22.10549	4.26	Significant
DEPTH OF CUT	0.0003688	2	0.000184	47.30737	4.26	Significant
ERROR	0.0000311	9	0.0000039			
MEAN	0.01066179	1				
ST	0.01191301	18				

4. CONCLUSIONS

The objective of the work is to find out the set of optimum values for the selected factors in order to improve material removal rate. Taguchi methodology is successfully implemented, to determine the optimum cutting conditions more efficiently considering the control factors viz. type of lubricant; cutting speed; feed rate and depth of cut are investigated at three different levels for EN 36 Steel Alloy

- Analysis of Variance suggests that the selected control factors are significant for the Material Removal rate
- In the present experimentation the optimum Type of environment obtained using Tauguchi Robust Design Methodology is Veg oil + Boric Acid. Similarly the results obtained for speed and feed are 650m/min and 0.4mm/min respectively. The optimum Depth of cut obtained is 10mm.
- Hence it can be concluded that the control factors obtained are valid and within the range of EN 36 machining standards.
- The S/N ratio of predicted value and verification test values are valid when compared with the optimum values. It is found that S/N ratio value of verification test is within the limits of the predicted value and the objective of the work is full filled

5. REFERENCES

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