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Optimization of Machining Parameter for Surface Roughness

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Abstract : *Surface finish is integral part for any workpiece to work properly in service life. The different parameters are affects on surface quality like coolant flow rate, table speed and depth of cut. The small scale and medium scale industries generally neglect the parameters while working. Due to unoptimised machining parameters results in poor surface finish, wheel wear and wastage of coolant. Hence, an optimized technique is proposed in this study to overcome these problems. In this paper the author has suggested three parameters namely table speed, depth of cut and coolant flow rate and response parameter is surface roughness of workpiece. The machine selected for experimentation is horizontal surface grinding and material is EN-31. In this research, an attempt has been made to study the effects of cutting parameter that influence the surface roughness quality. The results shows that, for EN-31 material without hardening and with hardening the significant parameter was found depth of cut and table speed respectively.*
Keywords: *En31, Surface Grinding machines, surface roughness, Design of experiments(DOE)*

I Introduction

Surface grinding is used to produce a smooth finish on flat surface. It is abrasive machining process in which material removed by interaction of wheel grains with workpiece surface in number of passes and the depth of cut is small value to achieve the good surface finish and better machining results. In grinding the material removed by interaction of abrasive grains with workpiece by shearing and ploughing action. Due to complex material removal mechanism in grinding, the specific energy requirement is high as compared to other machining processes. The impact of sliding and ploughing is negligible in machining due to larger chip sizes. Significant amount of heat as high friction at contact interfaces. Such high generation of heat leads to thermal damages to workpiece and cutting tool. It gives certain limitation like metallurgical phase transformation, residual tensile stresses, cracks which reduces the fatigue strength of machined part. Thus, the cooling and lubrication of grinding surface is considered for better grinding performance. Surface roughness is a measure of the smoothness of a products surface and it is a factor that has a high influence on the manufacturing cost. Surface finish also affects the life of any product and hence it is desirable to obtain higher grades of surface finish at minimum cost

II Material And Methodology

2.1 Materials

EN31 is a high carbon Alloy steel which achieves a high degree of hardness with compressive strength and abrasion resistance. It contains C. 1.00%, Mn. 0.50%, Cr. 1.40%, Si. 0.20%. It has application in Ball and Roller Bearings, Spinning tools, Beading Rolls, Punches and Dies. By its character this type of steel has high resisting nature against wear and can be used for components which are subjected to severe abrasion, wear or high surface loading. We decided to go with hardening as well as a without hardening pieces of EN31 this will help to spread our conclusion widely.

Table 1:- Material composition EN31

C	Mn.	Cr.	Si.
1.00%	0.50%	1.40%	0.20%

2.2 Methodology

Taguchi method is a statistical method developed by Taguchi to design the experimental runs. This method used to analyze the machining process and accuracy of mathematical modeling and the significant parameters affecting on responses. Selection of control factors must be made such that it nullifies the effect of noise factors. Taguchi Method involves identification of proper control factors to obtain the optimum results of the process. Orthogonal Arrays (OA) are used to conduct a set of experiments. Results of these experiments are used to analyze the data and predict the quality of components produced. The analysis is carried out on signal to noise ratio. In this study, the smaller the better approach is used to find S/N ratio. The highest ratio is considered for analysis of process parameters.

2.3 Machining Parameter

To improve the quality of surface roughness of EN31 alloy steel and process with minimum cost and time constraints, the Taguchi parameter design techniques are applied in design of experiment (DOE). Minimum surface roughness average (Ra) was carried out since the value represents better or improved surface roughness. The controllable parameters are selected because of their most potential effecting factor on surface roughness quality in end surface roughness operation. The parameters are the Table speed (A), Depth of cut (B) and Coolant flow rate (C).

Table 2:-Input factors and levels.

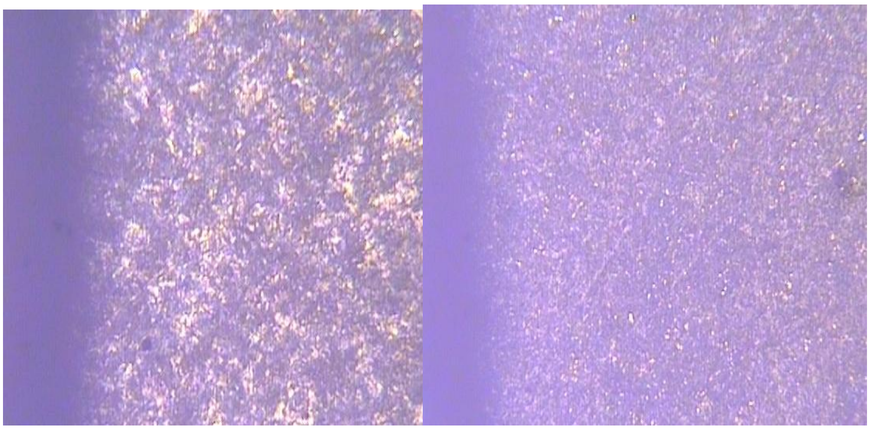
Factors	Level		
	Level 1	Level 2	Level 3
Table speed (mm/min)	8000	9500	11000
Depth of Cut (micron)	20	30	40
Coolant flow Rate (lit/min)	3	9	15

Fig. 1 (a) Surface grinding machine (b) Process (c) Surface roughness tester

III Results And Discussion

3.1 Surface Morphology

In this study, each 9 samples of EN-31 material were studied for hardening and without hardening were considered for experimentation. The microstructure of EN-31 material was observed under optical microscope range of 1000x for more detailed surface structure shown in fig.3.1. The Fig. 3(b) stated that, the surface structure are clearly smooth and very minimal level of bright patches. Microstructure shown in Fig. 3(a) shows the machining has a differentiated distribution of ferrite & perlite and fine tempered martensite microstructure.



Before hardening (a) After hardening (b)

Fig. 2 Microstructure of EN31

EN-31 (Without Hardening)

Table 3:- L9 orthogonal array with Ra values for EN31 (Without Hardening)

Sr. No	Table speed (mm/min)	Depth of Cut (micron)	Coolant Flow Rate (lit/min)	Ra	S/N ratio (dB)
1	11000	20	3	0.200	23.5
2	8000	40	3	0.318	19.5
3	8000	20	3	0.232	22.5
4	11000	40	3	0.238	22.0
5	8000	20	15	0.220	22.7
6	11000	40	15	0.198	23.6
7	11000	20	15	0.185	24.2
8	8000	40	15	0.306	19.8
9	9500	30	9	0.227	22.4

Table 4:- Response table for Signal to Noise ratio

Level	Table speed (mm/min)	Depth of Cut (micron)	Coolant Flow rate (lit/min)
1	13.051	15.218	13.656
2	9.843	9.843	9.843
3	14.770	12.604	14.165
Delta	4.927	5.375	4.323
Rank	2	1	3

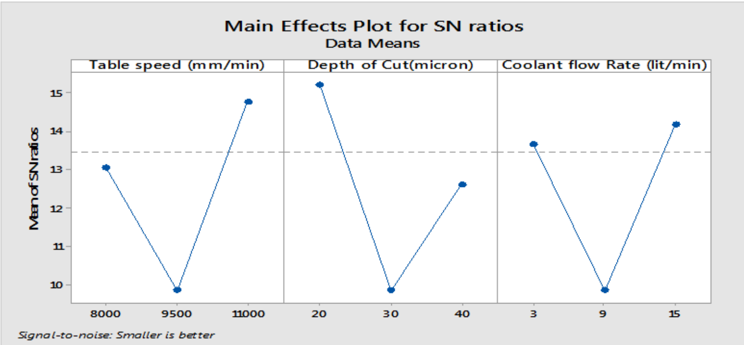


Fig. 3 Main effect Plot for SN Ratio

From Table 4, it clearly observed that for EN-31 material without hardening case, the depth of cut contributes the highest effect (Delta = 5.375) on the surface roughness followed by table speed (Delta = 4.927) and coolant flow rate (Delta = 4.323) respectively. It can conclude that depth of cut is far the most dominant factor affecting the surface roughness.

Analysis of Variance

Table 5:-Analysis of Variance

Source	DF	Adj SS	Adj Ms	F-Value	P-Value
Table speed (mm/min)	2	0.01582	0.007909	3.32	0.107
Error	6	0.01431	0.002386	*	*
Total	8	0.03013		*	*

Model Summary

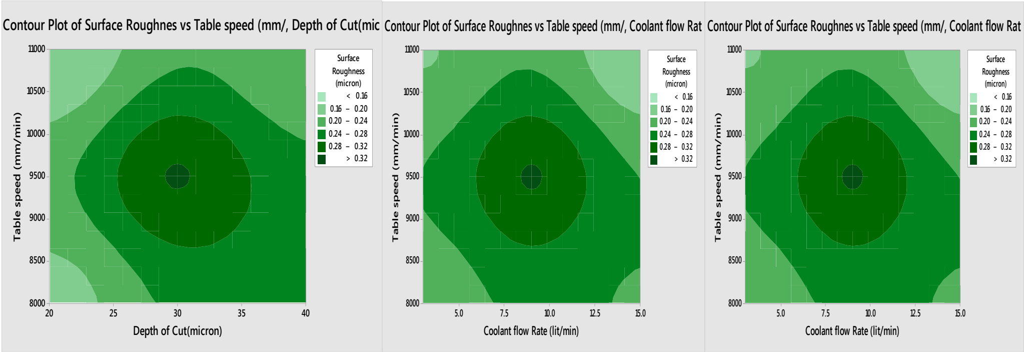
Table 6:- Model Summery

S	R-Sq	R-sq(adj)	R-sq(pred)
0.0488424	52.50%	36.66%	*

Regression Equation

Surface Roughness (micron) = 0.268 - 0.000015 TS + 0.00320 DOC - 0.00037 CFR

Contour Plot



(a) (b) (c)

Fig.4 :-Conture Plot (a)Surface roughness Vs Table speed and depth of cut (b) Surface roughness Vs table speed and coolant flow rate (c) Surface roughness Vs depth of cut and coolant flow rate.

EN-31 with Hardening

Table 7:- L9 orthogonal array with Ra values for EN31 (with hardening)

Sr. No	Table speed (mm/min)	Depth of cut (micron)	Coolant flow rate (lit/min)	Ra	S/N ratio (dB)
1	11000	20	3	0.175	24.7
2	8000	40	3	0.232	22.2
3	8000	20	3	0.206	23.3
4	11000	40	3	0.222	22.6
5	8000	20	15	0.164	25.2
6	11000	40	15	0.187	24.1
7	11000	20	15	0.153	25.8
8	8000	40	15	0.313	19.6
9	9500	30	9	0.322	19.4

Table 8:- Response Table for Signal to Noise Ratio

Level	Table speed (mm/min)	Depth of Cut (micron)	Coolant Flow rate (lit/min)
1	11.52	13.51	12.17
2	12.88	12.88	12.88
3	13.69	11.69	13.04
Delta	2.17	1.82	0.87
Rank	1	2	3

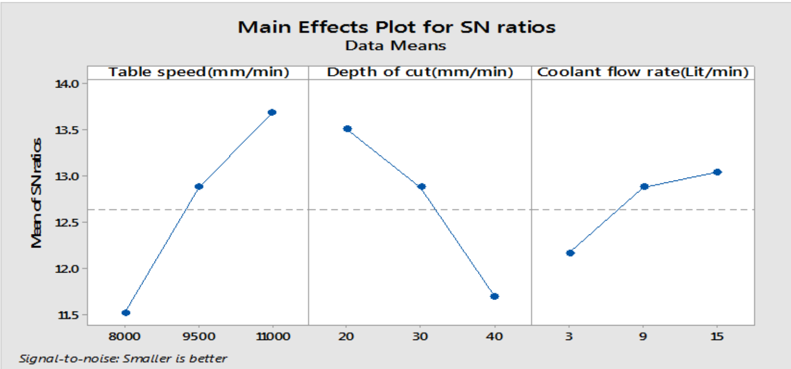


Fig. 5 Main effect plot for SN ratio

From Table 8, it is clearly observed that table speed contributes the highest effect (Delta = 2.17) on the surface roughness followed by depth of cut (Delta = 1.82) and coolant flow rate (Delta = 0.87) respectively. It can conclude that table speed is the most dominant factor affecting the surface roughness quality. Depth of cut comes under rank 2 and coolant flow rate at rank 3.

Analysis of Variance

Table 9:-Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Table speed (mm/min)	2	0.007618	0.003809	2.52	0.161
Error	6	0.009073	0.001512		
Total	8	0.016691			

Modal Summery

Table 10:- Model Summery

S	R-Sq	R-sq(adj)	R-sq(pred)
0.038861	45.64%	27.52%	

Regression Equation

Surface roughness (Ra) = 0.3679 - 0.00185 CFR + 0.002663 DOC - 0.000020 TS

Contour Plot

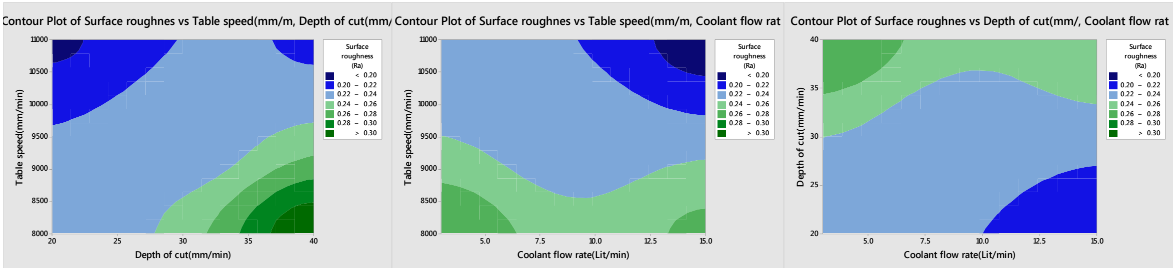


Fig. 7:-Conture plot (a) Surface roughness Vs table speed and depth of cut (b) surface roughness Vs table speedand coolant flow rate (c) surface roughness Vs depth of cut and coolant flow rate.

Table 11: Optimized cutting parameters

Parameter	Without hardening	With hardening
Table speed (mm/min)	11000	8000
Depth of Cut (micron)	0.040	0.020
Coolant Flow Rate (lit/min)	15	15
Roughness	0.198	0.164

IV Conclusion

The effects of the table speed, depth of speed and coolant flow rate on surface roughness were studied using MINITAB software. Taguchi method was used to design the experiments and optimization. The result shows are summarized as below:

1. For EN-31 material in case of without hardening, the mean average roughness shows that depth of cut contributes highest effect on the surface roughness, followed by table speed and coolant flow rate.
2. For EN31with hardening, the mean average roughness shows that table speed contributes highest effect on the surface roughness, followed by depth of cut and coolant flow rate
3. From SN ratio and mean effect plot for SN ratio, it was found that for EN-31 without hardening case, the good surface quality can be achieved at the highest table speed of 11000 mm/min, lowest depth of cut of 0.020 micron and coolant flow rate of 15 lit/min. For EN31 with hardening, table speed at 11000 mm/min, lowest depth of cut of 0.020micron and coolant flow rate of 15 lit/min lead to optimal surface roughness value.
4. The analysis shows the significant factors for EN-31 material which is generally used in engineering application, the better results found if the optimized parameters are used for surface grinding machine which can minimize the surface roughness and consumption of coolant flow rate. This work result is major contribution for the manufacturing industry especially machining of EN31 with the surface grinding machine.

References

[1]. Halil Demir, Abdulkadir Gullu, Ibrahim Ciftci (2010), "An Investigation into the Influences of Grain Size and Grinding Parameters on Surface Roughness and Grinding Forces when Grinding", International Journal of Mechanical Engineering vol.56, pp. 447-454.

[2]. M. Aravind, Dr. S. Periyasamy (2014), "Optimization of Surface Grinding Process Parameters By Taguchi Method And Response Surface Methodology", International Journal of Engineering Research & Technology, vol.3, Issue 5, pp. 1721-1727.

[3]. D.P. Adler, W. W-S Hii, D.J. Michalek, and J.W. Sutherland, "Examining the Role of Cutting Fluids in Machining and Efforts to Address Associated Environment/ Health Concerns".

[4]. T. Yoshimi, S. Oishi, S. Okubo, H. Morita [2010], "Development of Minimized Coolant Supply Technology in Grinding", JTEKT Engineering Journal English Edition No. 1007E: 54-59.

[5]. Yanbin Zhang, Dongkun Zhang, Xiaowei Zhang (2015), "Experimental research on the Influence of the jet parameters of minimum quantity lubrication on the lubricating Property of Ni-based alloy grinding", DOI 10.1007/s00170-015-7381-y.

[6]. Rajni B. Kinalkar, M. S. Harne (2014), "A Review on Various cooling system employed in Grinding", IJITEE ISSN: 2278-3075, Volume-4, Issue-1, pp.28-35.

[7]. Kuan-Ming Li, Cheng-Peng Lin (2011), "Study on minimum quantity lubrication in micro Grinding", DOI 10.1007/s00170-011-3789-1.

[8]. M. N. Morgan, L. Barczak (2011), "Temperatures in fine grinding with minimum quantity Lubrication (MQL)", DOI 10.1007/s00170-011-3678-7.

[9]. Z. W. Zhong, V. C. Venkatesh (2008), "Recent developments in grinding of advanced Materials", DOI 10.1007/s00170-008-1496-3.

[10]. Yanbin Zhang, Dongkun Zhang, Xiaowei Zhang (2015), "Experimental research on the Influence of the jet parameters of minimum quantity lubrication on the lubricating Property of Ni-based alloy grinding", DOI 10.1007/s00170-015-7381-y.