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"An Optimization Studies on Effect of Process Parameters on Out Put Parameter While Grinding Mild Steel Material in Numerical Control Surface Grinding Machine"

Sibabrata Mohanty*, Silla subrat kumar, Manoranjan tripathy***, & P. Kiran kumar patra******

**Assistant Professor, Department of Mechanical Engineering, Gandhi Institute of Engineering and Technology, Gunupur, Rayagada Odisha,*
*** B.Tech Final year Mechanical Students, Gandhi Institute of Engineering and Technology, Gunupur, Rayagada Odisha,*
**** B.Tech Final year Mechanical Students, Gandhi Institute of Engineering and Technology, Gunupur, Rayagada Odisha,*
***** B.Tech Final year Mechanical Students, Gandhi Institute of Engineering and Technology, Gunupur, Rayagada Odisha,*

ABSTRACT

Surface grinding is used to produce a smooth finish on flat surfaces. It is a widely used abrasive machining process in which a spinning wheel covered in rough particles (grinding wheel) cuts chips of metallic or non metallic substance from a work piece, making a face of it flat or smooth. Surface grinding is the most common of the grinding operations. It is a finishing process that uses a rotating abrasive wheel to smooth the flat surface of metallic or non metallic materials to give them a more refined look or to attain a desired surface for a functional purpose. In this study, the Taguchi method that is a powerful tool to design optimization for quality is used to find the optimum surface roughness in grinding operations. An orthogonal array, a signal-to-noise (S/N) ratio, and an analysis of variance (ANOVA) are employed to investigate the surface-roughness characteristics of Mild Steel Plates in Numerical control Surface grinding Machine.

Keywords: *Surface Grinding, surface roughness L9 orthogonal array, and ANOVA, S/N Ratio. Mean.*

1.0 INTRODUCTION

Grinding is one of the most popularly used surface finishing process characterized by excellent process capabilities in terms of surface finish and material removal rate. It has wide applications in manufacturing industry as it can handle a wide variety of work piece materials and forms. Grinding is an abrasive machining process that uses a grinding wheel as the cutting tool. Grinding can be considered as subset of cutting that is mainly used for surface finishing operations. Depending upon the type of requirement different types of grinding are taken into account. It can very fine finishes and very accurate dimension. Surface finish, also known as surface texture or surface topography, is the nature of a surface as defined by the 3 characteristics of lay surface roughness, and waviness. It comprises the small local deviations of a surface from the perfectly flat ideal (a true plane).Surface texture is one of the important factors that control friction and transfer layer formation during sliding. Considerable efforts have been made to study the influence of surface texture on friction and wear during sliding

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conditions. Surface textures can be isotropic or anisotropic. Sometimes, stick-slip friction phenomena can be observed during sliding depending on surface texture. In this study the wheel speed (*V*), the rate of feed (*F*) and the depth of cut (*D*) were selected as variable parameters. Other process parameters were fixed. The above parameters of grinding were analyzed and optimized with the Taguchi method using the experimentally obtained surface-roughness (Ra) results. Confirmation experiments were conducted at the optimum level to verify the effectiveness of the Taguchi approach.

2. EXPERIMENTAL STUDIES

Work piece Material and Grinding Machine

Finishing operation will be performed on Mild Steel of 100X50X6 mm. Experiments were performed using a Numerical Control Surface Grinding machine. The intense heat generated during the grinding due to a relatively high friction impairs the work piece quality by inducing thermal damage. Therefore, the cooling and lubrication play a decisive role in grinding. In this study, a cutting fluid was used as a coolant in order to cool the work piece and, hence, to prevent the thermal damage of the work piece. The initial grinding parameters were selected as follows: the wheel speed (*V*) of 1000 r/min; the feed rate (*F*) of 25 m/min and the depth of cut (*D*) of 0.10 mm.

Figure 1: Experimental grinding machine

Symbol	Grinding parameter	Unit	Level 1	Level 2	Level 3
V	Wheel speed	r/min	1000	1500[a]	2000
F	Rate of feed	m/min	20	25[a]	30
D	Depth of cut	mm	0.05	0.10[a]	0.15

Table 1: Grinding parameters and their levels

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Each grinding parameter is assigned to a column, having nine grinding-parameter combinations available. There-fore, only nine experiments are required to study the entire parameter space using the L_9 orthogonal array. The experimental layout for the three grinding parameters using the L_9 orthogonal array is shown in **Table 2**. Since the L_9 orthogonal array has four columns, one column of the array is left empty for the error of the experiments; orthogonality is not lost by keeping one column of the array empty. To increase the sensitivity of the results each experiment in the L_9 orthogonal array was repeated three times.

Experiment number	Grinding parameter level		
	V/(r/min) Wheel speed	*F*/(m/min) Rate of feed	*D*/mm Depth of cut
1	1	1	1
2	1	2	2
3	1	3	3
4	2	1	2
5	2	2	3
6	2	3	1
7	3	1	3
8	3	2	1
9	3	3	2

Table 2: Experimental layout of the L_9 orthogonal array

Experimental results were transformed into a signal-to-noise (S/N) ratio. There are three categories of quality characteristics, i.e., the-lower-the-better, the higher-the-better, and the-nominal-the-better. In the present study the-lower-the-better quality characteristic was selected for the surface roughness. S/N ratio was determined by using Minitab Software.

EXPERIMENT NO	PROCESS PARAMETERS			*Ra* (µm)	S/N ratio
	V(r/min)	Feed(m/min)	Depth of Cut(mm)		
1	1000	20	0.05	0.19	14.4249
2	1000	25	0.10	0.30	10.4576
3	1000	30	0.15	0.54	5.35212
4	1500	20	0.10	0.26	11.7005
5	1500	25	0.15	0.30	10.4576
6	1500	30	0.05	0.20	13.9794
7	2000	20	0.15	0.48	6.37518
8	2000	25	0.05	0.38	8.40433
9	2000	30	0.10	0.40	7.95880

Table 3: Value of S/N ratio

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3.0 RESULT AND ANALYSIS

3.1 Taguchi Analysis:-

- **Response Table for Signal to Noise Ratios**

Smaller is better

Level	V(r/min)	Feed(m/min)	Depth of Cut(mm)
1	10.078	10.834	12.270
2	12.046	9.773	10.039
3	7.579	9.097	7.395
DELTA	4.466	1.737	4.875
RANK	2	3	1

- **Response Table for Means**

Level	V(r/min)	Feed(m/min)	Depth of Cut(mm)
1	0.3433	0.3100	0.2567
2	0.2533	0.3267	0.3200
3	0.4200	0.3800	0.4400
DELTA	0.1667	0.0700	0.1833
RANK	2	3	1

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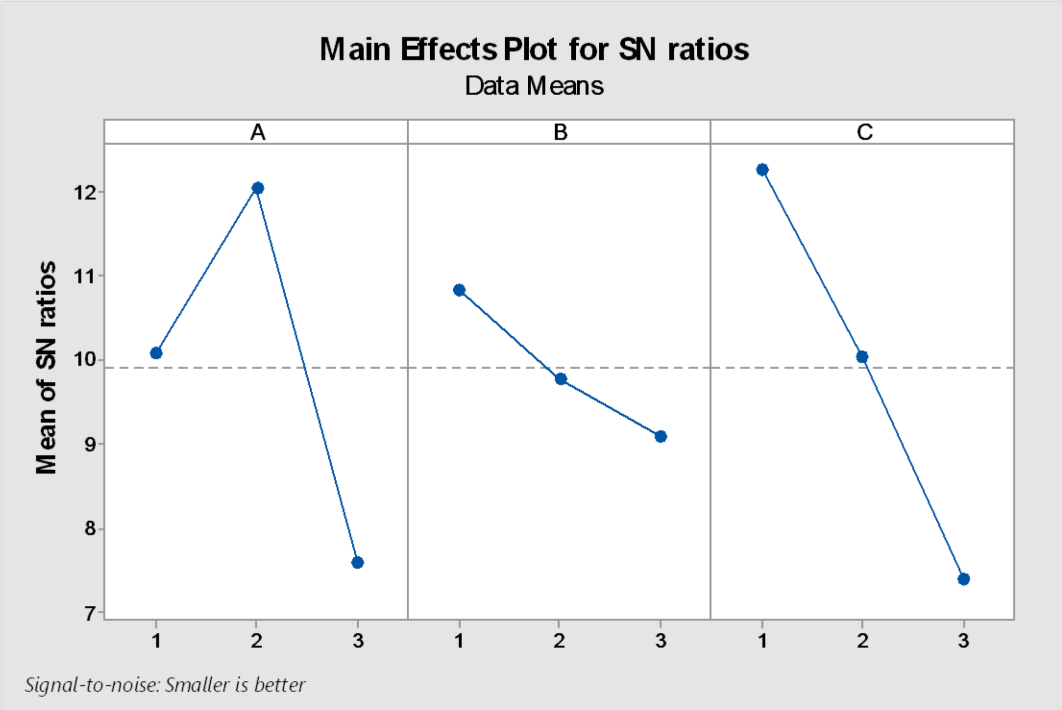

3.2 Results of ANOVA for the grinding parameters

Linear Model Analysis: SN ratios versus A, B, C

Estimated Model Coefficients for SN ratios

Term Coef SE Coef T P

Constant	9.9012	0.7342	13.486	0.005
A 1	0.1770	1.0383	0.171	0.880
A 2	2.1447	1.0383	2.066	0.175
B 1	0.9324	1.0383	0.898	0.464
B 2	-0.1280	1.0383	-0.123	0.913
C 1	2.3684	1.0383	2.281	0.150
C 2	0.1378	1.0383	0.133	0.907

S = 2.203 R-Sq = 87.9% R-Sq(adj) = 51.5%

Analysis of Variance for SN ratios

Source	DF	Seq SS	Adj SS	Adj MS	F	P
A	2	30.064	30.064	15.032	3.10	0.244
B	2	4.598	4.598	2.299	0.47	0.678
C	2	35.728	35.728	17.864	3.68	0.214
Residual Error	2	9.703	9.703	4.851		
Total	8	80.093				

Linear Model Analysis: Means versus A, B, C

Estimated Model Coefficients for Means

Term	Coef	SE Coef	T	P
Constant	0.338889	0.02857	11.863	0.007
A 1	0.004444	0.04040	0.110	0.922
A 2	-0.085556	0.04040	-2.118	0.168
B 1	-0.028889	0.04040	-0.715	0.549
B 2	-0.012222	0.04040	-0.303	0.791
C 1	-0.082222	0.04040	-2.035	0.179
C 2	-0.018889	0.04040	-0.468	0.686

S = 0.08570 R-Sq = 87.4% R-Sq(adj) = 49.6%

Analysis of Variance for Means

Source	DF	Seq SS	Adj SS	Adj MS	F	P
A	2	0.041756	0.041756	0.020878	2.84	0.260
B	2	0.008022	0.008022	0.004011	0.55	0.647
C	2	0.052022	0.052022	0.026011	3.54	0.220
Residual Error	2	0.014689	0.014689	0.007344		
Total	8	0.116489				

4. CONCLUSION

In this study, an application and adaptation of the Taguchi optimization and quality-control method were established for the optimization of the surface roughness in a grinding process. The Taguchi method provides a systematic and efficient methodology with fewer

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experiments and trials. The experimental results obtained in this study showed that the depth of cut and the wheel speed have significant effects on the surface roughness. The rate of feed has a lower effect on the surface roughness. The contribution order of the grinding parameters including the depth of cut, the wheel speed and the rate of feed is 50 %, 40 % and 10 %, respectively. A change made to all the grinding parameters significantly changes the surface roughness. The optimum grinding-parameter combination for the Mild steel includes the wheel speed (*V*) of 1 500 r/min and the depth of cut (*D*) of 0.05mm.Through ANOVA the model Conformity has been found to be 87.4% for mean and 87.9% for S/N ratio.

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