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EFFECT OF CUTTING PARAMETERS ON CYLINDRICAL GRINDING OF AISI H11 STEEL UNDER DRY CONDITIONS

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Abstract: In this highly competitive environmentSurface finish and dimensional accuracy play a vital role in the today's engineering industry. Cylindrical grinding is one of the important metal cutting processes used extensively in the finishing operations. Metal removal rate and surface finish are the important output responses in the production with respect to quantity and quality. The main objective of this paper is find out set of parameters that minimize the surface roughness and maximize material removal rate for AISI H11 steel. During the experiment investigation, it was observed that with decrease of depth of cut and increase in wheel speed surface finish increase.
Keywords: Cylindrical Grinding, Speed, Feed, Depth of Cut.

1. INTRODUCTION

Grinding is an abrasive machining process that uses a grinding wheel as the cutting tool.Grinding practice is a large and diverse area of manufacturing and toolmaking. It can produce very fine finishes and very accurate dimensions; yet in mass production contexts it can also rough out large volumes of metal quite rapidly. It is usually better suited to the machining of very hard materials than is "regular" machining, and until recent decades it was the only practical way to machine such materials as hardened steels. Various process parameters, which affect the cylindrical grinding operation are depth of cut, material hardness, workpiece speed, grinding wheel grain size, number of passes, material removal rate and grinding wheel speed. Speed and feed are critical factors because increasing the both speed, and feed has an adverse impact on surface roughness but high material removal cause reduction in surface roughness [1]. Rise in infeed, cross feed, and grinding speed showed improvement in surface hardness and surface roughness on En18 steel [2]. Authors found that the depth of cut and workpiece speeds are significant parameters. Depth of cut among these factors found more important whereas the grinding speed, grain size, cutting fluid concentration and number of passes are considered insignificant while grinding heat treated AISI 4140 steel [3].The parameters like coolant inlet pressure, grinding wheel speed, and table speed and nozzle angle showed a positive effect on the micro hardness of the finished mild steel workpiece [4].Cutting fluid like water soluble oil gives better surface finish than pure oil used because the water mixed oil has a lesser viscosity and more flow rate which results smoothing action while grinding En8 steel [5]. The parameters like feed rate, depth of cut and grit size is the primary influencing factors that affect the surface integrity of silicon carbide while grinding. Authors suggestedthatwithanincreaseinfeedrate,thepercentage area of surface damage decreases and is minimally affected by the variation in grit density, within the range considered [6]. The usage of pure oil reduces the grinding force, specific energy, and acoustical emission and roughness values. These characteristics result from the high lubricating power of pure oil, which decreases the friction and reduces the generation of heat in the grinding zone. Therefore, pure oil used as a grinding fluid to obtain high- quality superficial dressing and lower tool wear is the best choice for industrial applications [7].Stetiu and Lal et al. (1974) researched that, in cylindrical grinding, wear rate is an integral part of the process and a wear rate that is too slow can easily be more undesirable in its consequences than a rapid one. The experiments were conducted on an external cylindrical grinding machine and on the cylindrical steel rods. Experimental work pieces were made from 0.5% carbon steel rod of hardness 52 HRc. Aluminium oxide (Al2O3) vitrified bonded grinding wheels having grain size 40 with a medium structure of three different hardness's (Grade J, K & M) were used. The research work was concluded that the hardness of a grinding wheel is the most important property affecting the wear phenomena [8].

2. EXPERIMENTAL PROCEDURES

The workpiece material AISI H13 steel is selected as the workpiece material having diameter 40 mm and length 380 mm. This steel is widely used in industrial application like shafts, axles, spindles, studs, etc. for its excellent mechanical properties. The chemical composition of C40E steel is shown in Table1. The workpiece material is cut into pieces each having approximate length of 380 mm. The workpiece is turned to a diameter of 38 mm using lathe, and the workpiece was divided into four equal parts of 65 mm each as shown in Figure1. The surface roughness of the workpiece is measured before grinding at each regionwiththehelpofRoughnessTestershowninFigure2. To minimize the chance of error, three reading have been taken for each set and the averagevalue of three reading is used for record.

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Table I: Chemical composition of AISI H11 steel (wt %)

Constituent	C	Si	Mn	P	S	Cr	Mo	V
Composition (In %)	0.35	0.92	0.4	0.011	0.026	5.10	1.30	0.6

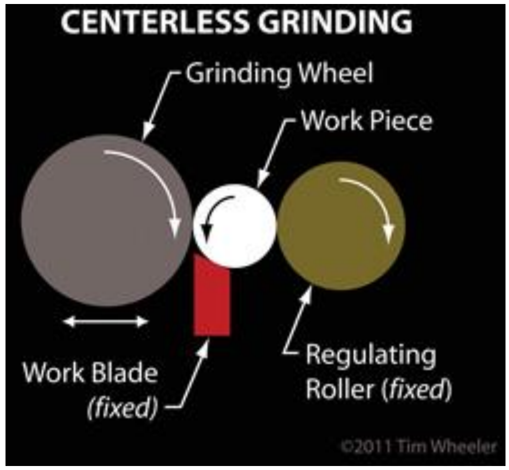

Figure I: Schematic arrangement for experimental setup

The schematic diagram for experimental setup is shown in figure I. A digital weighing machine was used to measure the weight of work piece before and after each cut of grinding. To investigate the parameters of grinding, In this experimental procedure 27 Nos. of experiments by combining most robust set of different four parameters each having three levels. The different sets of combinations are obtained by as per Taguchi's L27 orthogonal array from Minitab software. The combinations of parameters with different levels are given below in table II.

Table II: Process parameters with their values at 3 levels.

Process parameters	Level-1	Level-2	Level-3
Wheel speed (rpm)	1000	1500	2000
Feed Rate (mm/min)	5	10	15
Depth of cut (mm)	0.1	0.2	0.3

As mentioned in table III, in this experimental setup total 9 Nos. of experiments have been performed on surface grinding machine. During each experiment the various parameters and its level combination are obtained as per Taguchi's L9 orthogonal array. The various levels of parameters are combined during every experiment are shown below table III.

Table III: No. of experiments (Taguchi L 9 orthogonal array)

S.No.	Wheel Speed (rpm)	Feed Rate (mm/rev)	Depth of cut (mm)	Surface Roughness (µm)
1	1000	0.5	0.15	0.318
2	1000	0.75	0.25	0.346
3	1000	1.0	0.35	0.368
4	1250	0.5	0.25	0.296
5	1250	0.75	0.35	0.312
6	1250	1.0	0.15	0.324
7	1500	0.5	0.35	0.248
8	1500	0.75	0.15	0.262
9	1500	1.0	0.25	0.294

3. RESULT AND DISCUSSIONS

3.1 Surface roughness:

Surface roughness after cylindrical grinding is measured by using Mitutoyo - Surftest SJ-210 surface roughness tester. One reading are taken in each region. The experimental results for surface roughness obtained using Taguchi optimization technique are given in Table 4.

Table IV: Response Table for Means

Level	Wheel Speed(rpm)	Feed Rate(mm/rev)	Depth ofcut (mm)
1	0.3440	0.2873	0.3013

2	0.3107	0.3067	0.3120
3	0.2680	0.3287	0.3093
Delta	0.0760	0.0413	0.0107
Rank	1	2	3

Table V: Response Table for Signal to Noise Ratios

Level	Wheel Speed (rpm)	Feed Rate (mm/rev)	Depth of cut (mm)
1	9.284	10.879	10.458
2	10.160	10.323	10.142
3	11.459	9.702	10.304
Delta	2.175	1.177	0.316
Rank	1	2	3

The greater value of SN ratio means better performance and hence from the S/N ratio response graphs plotted in Figure III.The most optimal machining parameters are Speed 1500rpm (level 3), Feed Rate 5mm/rev (level 1) and DOC 0.15mm (level 1).

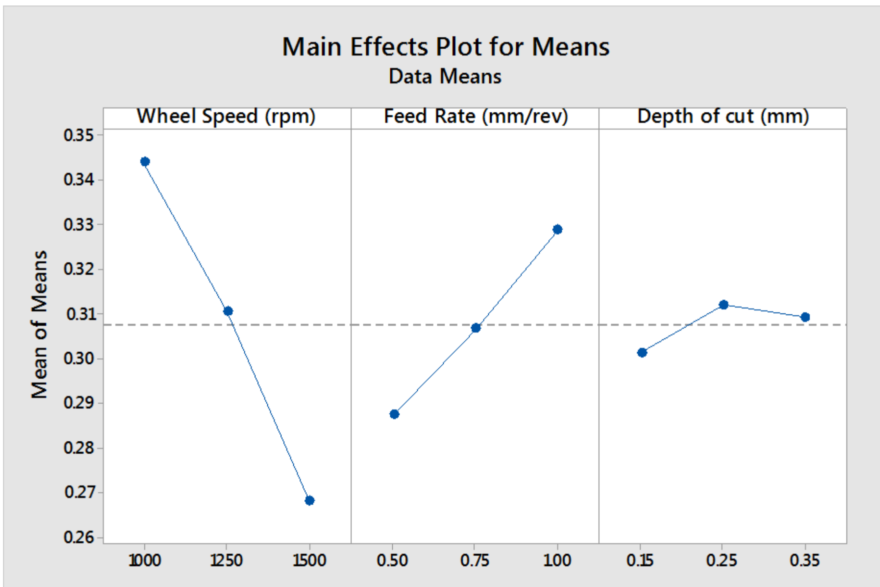

Figure 2 Main effects plot for S/N ratios for Tool wear

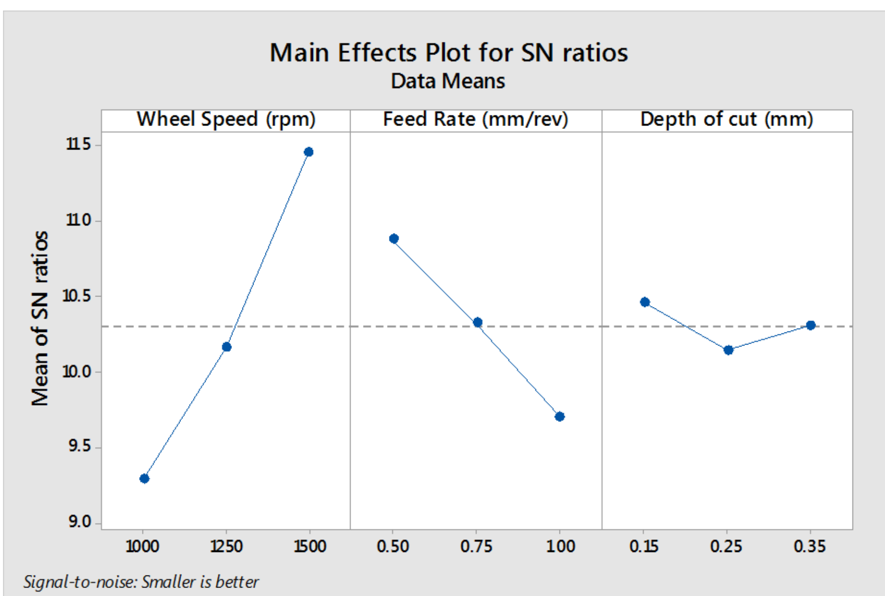

Figure 3 Graphical Representations of S/N Data vs. Depth of Cut, Feed and Speed

4. CONCLUSION AND FUTURE SCOPE
The following sections give the conclusions as obtained from the results of the analysis of S/N Ratio.

5. CONCLUSIONS
Based on the analytical and experimental results obtained in this study following conclusions can be drawn.

1. The input parameters like speed of grinding, feed, has a significant effect on surface roughness, whereas depth of cut has the least effect on surface roughness of AISI H13 steel.
2. The optimized parameters for minimum surface roughness are grinding speed (1500 rpm), feed (0.5 mm/rev), and depth of cut(0.15mm).
3. Most dominating parameter among all is speed of wheel followed by feed rate and least effect of Depth of cut was observed during experimentations.

6. FUTURE SCOPE
In this present study only three parameters have been considered in accordance with their effects on Surface Roughness. There are some other important parameters such as Grinding Wheel Size, Material, Pressure applied with some other outputs like Tool wear, Tool Life, and Power Consumption can also be considered for future work.

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