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Parametric Study of Cylindrical Grinding Machine-Review

Amit L Dudhatra**, Hardik N Chauhan, Tushar N Khilosia
Department of Mechanical Engineering, Atmiya Institute of Technology & Science, Rajkot, Gujrat, India

Abstract
Manufacturing industry has undergone various changes to meet the requirement of customers and to manufacture the components with accuracy and within time limit. For that, study of different parameters that directly or indirectly affect the manufacturing process need to be studied. This paper is review to study the different parameters of cylindrical grinding machine which affect the final outcome (surface roughness and material removal rate) of the component.

Keywords: *Cylindrical grinding machine, parameters, components accuracy*

****Author for Correspondence*** E-mail: aldudhatra@aits.edu.in

INTRODUCTION

Grinding Process

Grinding is a process of removing the material by means of rotating abrasive wheel which acts as a cutting tool. Rotating abrasive wheel is known as grinding wheel. Grinding is done for machining materials and for obtaining superior dimensional and surface accuracies. Materials having more hardness and difficult to machine by cutting tools can be machined by grinding, or some other abrasive processes. Grinding may be rough (non precision) or precision type depending upon requirement. Non-precision grinding like snagging and off hand grinding is used to remove excess material form castings, forging and other rough pieces. The excess material may be removed by processing the workpieces against rotating grinding wheel or the rotating grinding wheel against the workpiece.

Kinds of Grinding

Grinding may be classified in two groups:
1. Rough or non-precision grinding; and
2. Precision grinding.

Rough Grinding Process

Rough grinders are those grinding machines whose chief work is the removal of stock without any references to the accuracy of the result. They are of following types:
1. Floor stand and bench grinders;
2. Portable and flexible grinders;
3. Swing frames grinder; and
4. Abrasive belt grinders.

Precision Grinding Process

Precision grinders are those that finish parts to a very accurate dimension. Following are the types:
1. Surface grinding;
2. Cylindrical grinding;
3. Internal grinders;
4. Tool and cutter grinders; and
5. Special grinding machine.

Surface Grinding: Surface grinding machines are employed to finish plane or flat surfaces. They are also capable of grinding irregular, curved, convex and concave surfaces. Conventional surface grinders may be divided into two classes: one class has reciprocating tables for work ground along straight lines, while the other covers the machines with rotating work tables for continuous rapid grinding. Surface grinders may also be classified according to whether they have horizontal or vertical grinding wheel spindles.

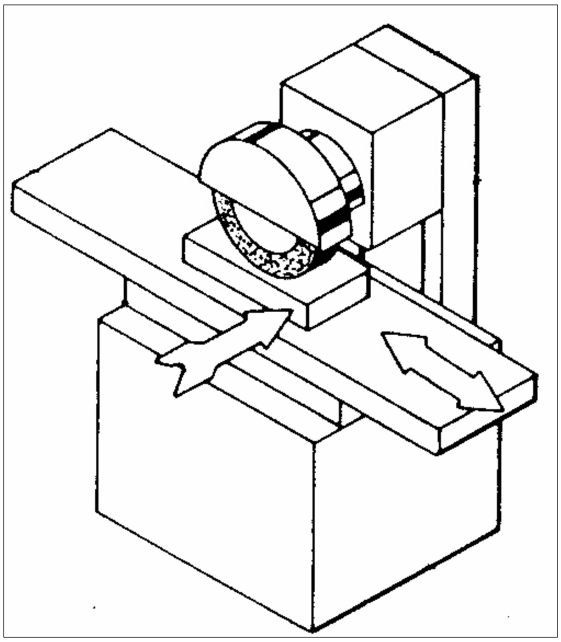

Fig. 1: *Surface Grinder.*

Cylindrical Grinding: Cylindrical grinders are intended primarily for grinding plain cylindrical parts, although they can also be used for grinding contoured cylinders, fillets, and even cams and crankshafts. The work piece is usually held between dead centers and rotated by a dog and driver on the face plate. The work may also be rotated about its own axis in a chuck. There are four movements involved in a cylindrical center-type grinding:

1. The work must revolve,
2. The wheel must revolve,
3. The work must pass the wheel, and
4. The wheel must pass the work.

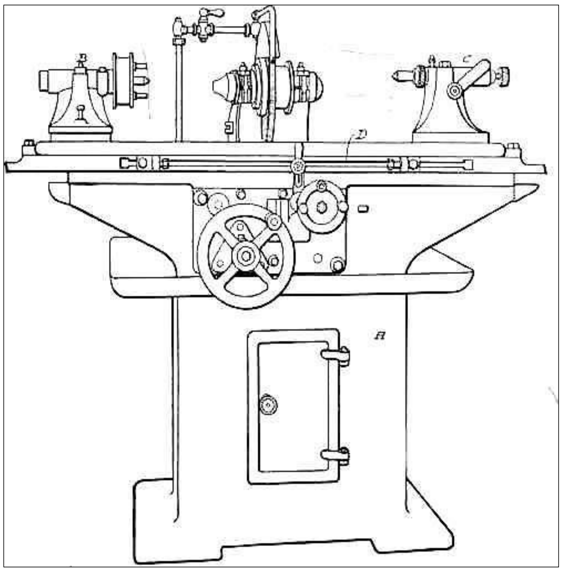

Fig. 2: *Cylindrical Grinding.*

In machines of the cylindrical type, two distinct types of grinding operations are done. In the first, called transverse grinding, the work is reciprocated as the wheel feeds to produce cylinders longer than the width of the wheel face. In the second called plunge grinding, the work rotates in affixed position as the wheel feeds to produce cylinders of a length equal to or shorter than the width of the wheel. There are three different types of cylindrical grinding machine as follows:

1. Universal cylindrical surface grinder;
2. Centre less cylindrical surface grinder; and
3. Plain centre type cylindrical grinder.

LITERATURE REVIEW

Rodrigues *et al.* did analysis for turning mild steel with the help of HSS cutting tool to obtain the effect of feed, speed and DOC on the surface roughness (Ra) and cutting force (Fc) [1]. Impact of cutting parameters was examined utilizing examination of variance (ANOVA). Optimum parameters for cutting force and surface roughness were obtained from the experiment and linear regression equations of cutting force and surface roughness show the effect of parameters.

Makadia was carried out turning of AISI 1040 steel using coated carbide cutting tools and concentrate on the effect of cutting speed, feed rate, depth of cut and tool geometry (tool nose radius) on the surface roughness [2]. Examinations were conducted based on (34) full factorial design. Feed rate is most affected factor on the surface roughness. Interaction effect of cutting conditions and tool geometry on surface roughness is studied form response contour and surface plots. The analysis of results revealed that combination of low feed rate, high tool nose radius and high cutting speed is necessary for minimizing the surface roughness. Response surface optimization shows that the optimal combination of machining parameters are (270.303 m/min, 0.1 mm/rev, 0.3 mm, 0.91 mm) for cutting velocity, feed rate, depth of cut and tool nose radius respectively.

Rawat had attempted to review the literature on optimization of cutting parameters in machining using Taguchi method [3]. The settings of machining parameters were determined by using Taguchi's experimental

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design method. Orthogonal arrays of Taguchi, the signal-to-noise (S/N) ratio, the analysis of variance (ANOVA) are employed to find the optimal levels and to analyse the effect of the cutting parameter.

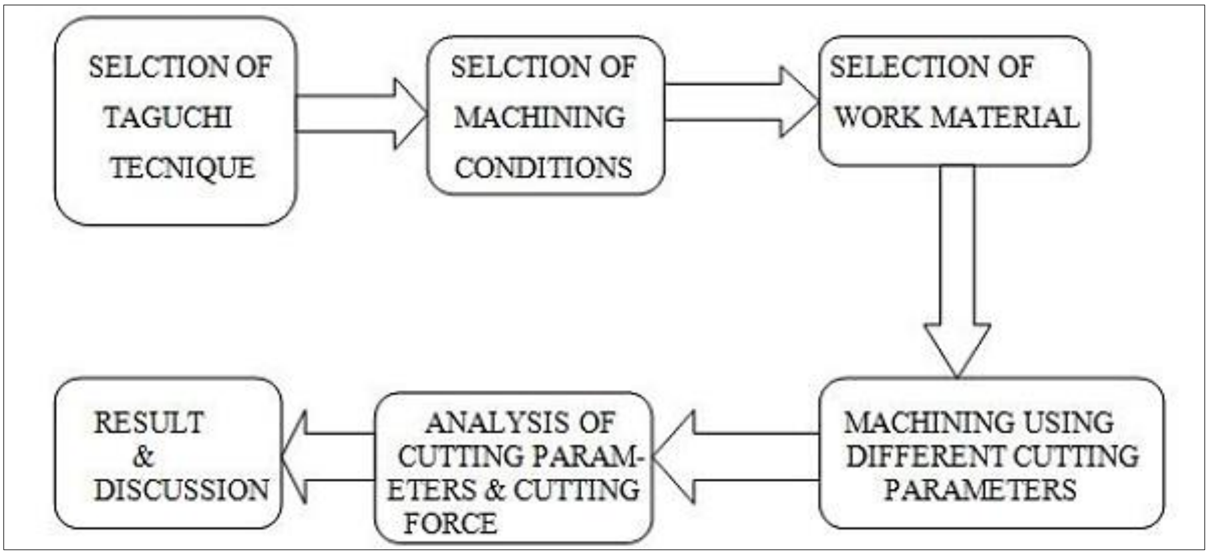

Fig. 3: *Flow Chart of Taguchi Method.*

Table 1: *Review of Papers.*

Sr. no.	Year	Author's Name	Material	Input Parameter	Output Parameter	Most Significant	
1	2014	Nithyanandhan *et al.*	AISI 304	Speed, Feed, DOC	Cutting force, Tool Wear	Speed	DOC
2	2010	Philip Selvaraj D, *et al.*	AISI 304	Speed, Feed, DOC	Surface Roughness	Speed	DOC
3	2013	Samrudhi Rao *et al.*		Overview of Taguchi method, concept and application			
4	2012	Krishnakant *et al.*	EN24 steel	Speed, Feed, DOC	MRR	Speed	Feed
5	2013	Quazi TZ *et al.*	EN24 steel	Speed, Feed, DOC	Surface Roughness, Tool wear, MRR	CNMG Coated insert	CNMG Uncoated Insert
6	2013	Atul Kulkarni *et al.*	SS304	Speed, Feed, Coating thickness of cutting tool	Cutting force, Average flank wear	Speed	Feed
7	1997	Yang WH	Rotating cylindrical workpiece	Speed, Feed, DOC	Tool life, Surface	DOC	Feed
8	2014	Adinarayana M *et al.*	AISI 4340 medium alloy steel	Speed, Feed, DOC	Surface roughness, MRR in mm^3/min, Power consumed in KW Consumed	Feed	DOC
9	2013	Vikas Magdum *et al.*	EN8 steel	Tool shape and material, Speed, Feed, DOC	Cutting force, Thrust force (Ft), Feed Force (Ff)	Thrust force	Feed force
10	2011	Sijo MT *et al.*	Mild steel	Speed, Feed, DOC, Nose Radius, Hardness (BHN)	Surface roughness	Speed, feed	Nose Radius
11	2011	Elso Kuljanic *et al.*	Titanium alloys	Speed, Cutting time	Machinability, Tool Wear	Tool life	Machinability
12	2012	Kompan Chomsamutr *et al.*	AISI 1045	Speed, Feed, DOC	Tool life	Feed	DOC
13	2014	Sunil Kumar Sharma	AISI 8620	Speed, Feed, DOC	Surface roughness	Speed	DOC
14	2014	Shivade Anand S *et al.*	EN8	Speed, DOC	Surface roughness, Tool tip temp	Speed	DOC

Sijo *et al.* in his paper used L8 orthogonal array for experimental work [4].

Table 2: *Cutting Parameters.*

Factors	1	2
Speed (m/min)	30.615	24.492
Feed (mm/rev)	0.274	0.112
DOC (mm)	1.2	0.8
Nose radius (mm)	0.4	0.8
Hardness (BHN)	160	170

Taguchi optimization methodology is utilized to optimize parameters in turning operation. Hardness puts less impact on surface roughness while other parameters like feed, speed and nose radius put major impact on surface roughness of work piece.

Surinderkumar *et al.* Obtained roughness model by using diamond tool with various rack angle and nose radius for machining glass fiber reinforced plastic composite [5]. Genetic algorithm approach was used to optimize the parameters, for that L18 orthogonal array was used for experimentation. 1.1653 μm is the minimum value of surface roughness.

Deepak Pal *et al.* worked on L9 orthogonal array for the experimental work on EN 24, EN 31 and die steel to find the optimum grinding parameters by using cutter grinder machine with aluminum oxide abrasive wheel [6]. Taguchi method of optimization was implemented to minimize the surface roughness (Ra) and input parameters were speed, grinding wheel grades and hardness of material. 1.07 μm is the optimum value of surface roughness.

Nalbant *et al.* carried out turning operation on AISI 1030 steel bar using TiN coated tools by using Taguchi methods of optimization to find the optimal parameters [7]. Signal to noise ratio and analysis of variance is studied for performance characteristics of material.

Mechanical Properties of AISI 1030 Carbon Steel				
Elongation (%)	**Hardness (HB)**	**Tensile Strength (MPa)**	**Yield Strength (MPa)**	**Thermal Conductivity (W/m K)**
31.2	126	463.7	314.3	51.9
Chemical Composition of AISI 1030 Carbon Steel, % Weight				
C	**Si**	**Mn**	**P**	**S**
0.276	0.110	0.610	0.040	0.050

For better surface finish insert radius, feed, DOC were optimized.

Lalwani used response surface methodology in turning of MDN250 steel by coated ceramic tool to find the effect of parameters (speed, feed and DOC) on cutting force and surface roughness [8]. The variation of surface roughness of material was described by a non-linear quadratic model.

George *et al*. chose the L9 orthogonal array for experimental work to find the effect of speed, DOC and hardness on surface roughness [9]. MITUTOYO Surf test SJ-400 was used to find the surface roughness of finished workpiece.

Taguchi method of optimization was implemented to minimize the surface roughness (Ra).

Experiment Plan

Table 3: *Experimental Plan of L9 Orthogonal Array.*

Speed	Feed	Depth of Cut
1	1	1
1	2	2
1	3	3
2	1	2
2	2	3
2	3	1
3	1	3
3	2	1
3	3	2

OBJECTIVE OF PRESENT INVESTIGATION

To analyze the effect of parameters like speed, feed, depth of cut, type of material, working environment on cylindrical grinding process and optimize for enhancement of surface finish and material removal rate on Mild steel material.

CONCLUSION AND FUTURE WORK

From the difference research paper we conclude that Taguchi method can be used for form design of experiment. Signal to noise ratio is used to find out domination of cutting parameters (feed, speed and depth of cut) on to the result (e.g. surface roughness, material removal rate). Process parameters equation was formulated using regression analysis.

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