# Experimental Investigation of Cylindrical Grinding Process Parameters for Different Cutting Fluids Using Taghuchi and Regression Analysis

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*Abstract*--- 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. In cylindrical grinding process the surface of material is grinded and removed by the use of cutting fluid. Using the cylindrical grinding machine the surface finishing is possible by using different input parameter as cutting fluids, work piece speed, depth of cut, no of passes and wheel speed etc, and get the changes in output parameter like material removal rate, surface finish and temperature. To optimization of all these parameters with multiple performances characteristic based on the regression analysis. Taguchi method of orthogonal array will be performed to determine the best factor level condition. By analyzing S/N ratios, it will be observed that which parameter has more effect on responses of input parameter to the output parameter.

**KeyWords**: - cylindrical grinding, regression analysis, S/N ratios, surface roughness, MRR

## I. INTRODUCTION

Grinding is a subset of cutting, as grinding is a true metal-cutting process. Each grain of abrasive functions as a microscopic single-point cutting edge, although of high negative rake angle, and shears a tiny chip that is analogous to what would conventionally be called a "cut" chip. A wide variety of machines are used for grinding:[01]

1. Surface grinding machine
2. Cylindrical grinding machine
3. Internal grinding machine
4. Tool and cutter grinding machine

## II. CYLINDRICAL GRINDING PROCESS

Cylindrical grinding is also called center-type grinding. It is used to grind the cylindrical surfaces and shoulders of the work piece. The work piece is mounted on centers and rotated by a devise known as a drive dog or center driver. The abrasive wheel and the work piece are rotated by separate motors and at different speeds. The table can be adjusted to produce tapers. The wheel head can be swiveled. [01]

### *A.* Cylindrical Grinding Process

The cylindrical grinder is a type of grinding machine used to shape the outside of an object. The Cylindrical grinder can work on a variety of shapes; however the object must have a central axis of rotation. This includes but is not limited to such shapes as a cylinder, an ellipse, a cam, or a Crankshaft. Cylindrical grinding is defined as having four essential actions: [02]

- The work (object) must be constantly rotating
- The grinding wheel must be constantly rotating
- The grinding wheel is fed towards and away from the work
- Either the work or the grinding wheel is traversed with respect to the other.

## III. LITERATURE SURVEY

Literature review provides the scope and future work for the present study. it works as guide to run this analysis. Literature review plays important role to get information about the dissertation work. Literature review includes different study on cylindrical grinding processes for better surface finish with different fluids by using parametric analysis, and effect of fluids.

M.janardhan et. al. "determination and optimization of cylindrical grinding process parameters using taguchi method and regression analysis". author proposed that in cylindrical grinding metal removal rate and surface finish are the important responses. authors has used orthogonal array and anova method in order to improve the productivity of process and quality of surface of high alloy refractory material and mild steel obtained by taking various parameter. They have resulted reveals that feed rate, depth of cut are influences predominantly on the output responses metal removal rate (MRR) and surface roughness (Ra).[03]

Jae-seob kwak et. al. "an analysis of grinding power and surface roughness in external cylindrical grinding of hardened scm440 steel using the response surface method" author has discussed to analyses the power and surface roughness during the grinding of steel in external grinding. in this study, the response surface method was applied for analyzing the grinding power and the surface roughness in the external cylindrical grinding of the hardened scm440 material by using the grinding parameters. The second-order response surface models for the grinding power and the surface roughness in the external cylindrical grinding were developed. Therefore, it is possible to predict the grinding power and the surface roughness before conducting grinding. Based on experimental results the main conclusions are the following:

- Increasing the depth of cut affected the grinding power more than increasing the traverse speed. in addition, increasing the depth of cut changed the maximum height of the surface roughness more than the centerline average height
- By using the grinding parameters, the second-order response surface models for the grinding power and the Surface roughness in the external cylindrical grinding were developed. therefore, it is possible to predict the grinding power and the surface roughness before conducting grinding.[04]

George et. al."Study on surface roughness and its prediction in cylindrical grinding process based on Taguchi method of optimization" author proposed that the working of cylindrical grinding machine and effect process parameter on surface Roughness. It also formulates an empirical relationship between the surface roughness values and the input parameters. Taguchi parametric optimization is used for the optimization process. Following conclusions can be drawn from it.

- Grinding process and various parameters affecting surface roughness are studied and analyzed.
- Surface roughness value measurement using Mitutyo surftest surface roughness tester is studied.
- Empirical equation relating various process parameters is formulated. regression equation is formulated.
- optimum values of depth of cut, hardness, and speed which gives minimum surface roughness are found out using Taghuchi optimization technique [05]

C.K. dhinakarraj, et. al."Prediction of surface roughness and roundness error in cylindrical grinding by artificial neural network". Author proposed that surface roughness is a most effective parameter in grinding machine. They have used artificial neural network for prediction of surface roughness. They used spindle speed, feed rate, and depth of cut as three input parameter for modeling using ANN to predict output roughness and roundness error. He used silicon carbide wheel for grinding. He gets minimum error in output as compare to theoretical works [06]

kiran kumar et. al "Optimization of cylindrical grinding process parameters for AISI 5120 steel using taguchi method" they have discussed that today surface roughness is required with closer tolerances. 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 respectively the experiments were conducted on cylindrical grinding machine using EN8 material (BHN=30-35) and he found that the feed rate played vital role on responses surface roughness and metal removal rate than other process parameters [07]

Deepak pal, et. al "optimization of grinding parameters for minimum surface roughness by Taguchi parametric optimization technique". They have discussed that surface finish is the important output responses in the production with respect to quantity and quality respectively. He predicted optimal values for Ra for cylindrical grinding process is 1.07 Ra respectively. They concluded that there is decreases surface roughness as material hardness increased. the roughness decreases when speed is changed from 100 to 160 rpm and again decreases when speed changed to 200 rpm.[08]

M. kiyaka, et. al "a study on surface roughness in external cylindrical grinding" they have carried out experimental study in dry and wet (%5 emulsion cutting fluid) machining conditions using aisi1050 steel at various work piece speeds and feed at constant wheel speed and grinding depth. He had as a concluded, to obtain better surface quality in dry grinding should be completed at high work piece speed and low feed. However, in wet grinding, both work piece speed and feed should be kept low for a lower surface roughness. They have concluded that conclusion, to obtain better surface quality in dry grinding should be completed at high work piece speed and low feed. However, in wet grinding, both work piece speed and feed should be kept low for a lower surface roughness [09]

P chock lingam, et. al "effect of coolant on cutting forces and surface roughness in grinding of CSM GFRP". Author has presents a comparative study on dry and wet grinding through experimental investigation in the grinding of CSM glass Fiber reinforced polymer laminates using a pink aluminum oxide wheel. An effective coolant was sought in this study to minimize cutting forces and surface roughness for GFRP laminates grinding the design of experiment with a central composite design with 8 factorial, 6 axial points and 1 centre points was adopted. The speed, feed and depth of cut were chosen as process factors in their work.[10]

Dinesh setti, et. al "application of Nano cutting fluid under minimum quantity lubrication (MQL) technique to improve grinding of ti – 6al – 4v alloy". author has explained the minimum quantity lubrication (MQL) technique and the use of a nano fluid use of a nanofluid use of a nanofluid use of a nanofluid the experimental results showed that nanofluid MQL could significantly reduce grinding forces and enhance surface quality it was also observed that higher volumetric concentration of nano particles were not that effective in reducing grinding forces.[11]

Cong Mao, et. al "experimental investigation of surface quality for minimum quantity oil water lubrication grinding". They have proposed that conventional grinding fluid has negative influences on the working environment in terms of the health of the machine operator. Furthermore, the using of grinding fluid is seen to increase production cost due to fluid purchase and disposal. one attractive alternative is the minimum quantity lubrication (MQL) grinding. In this study, oil–water was applied in the MQL grinding and the grinding results were compared with those of wet, dry, and pure oil MQL grinding. it is found that MQL grinding in comparison to dry grinding significantly enhances grinding performance in terms of improving the quality of the ground work piece and reducing grinding temperature and forces. Compared with pure oil MQL grinding, the grinding temperature and the thickness of the affected layer for oil–water MQL grinding are lower. However, the tangential force and surface roughness for oil–water MQL grinding are higher than that for pure oil MQL grinding. This indicates that the former has a better cooling condition than the latter, but the lubrication capacity is contrary [12]

S.B.ubale, et. al"optimization of cylindrical grinding process parameters for AISI 1040 steel using Taguchi Method". The main objective of author is to arrive at the optimal grinding conditions that will minimize surface roughness and maximize metal removal rate when grinding AISI 1040 steel. Empirical models were developed using design of experiments by Taguchi l9 orthogonal array and the adequacy of the developed model is tested with Anova. They have concluded that to achieve the maximum metal removal rate of AISI 1040 steel, employ higher depth of cut of 400 µm, moderate work speed of 224 rpm with minimum number of passes of 03 and high grinding wheel speed of 910 rpm. [13]

Emel kuram, et. al "environmentally friendly machining: vegetable based cutting fluids" authors have discussed that cutting fluids are beneficial in the industries, their uses are being questioned nowadays as regards to health and environmental issues to minimize the adverse environmental effects associated with the use of cutting fluids, the hazardous components from their formulations have to be eliminated or reduced to the acceptable level.[14]

Jose Augusto, et. al "Analysis of the influence of spark out time on grinding using several lubrication/cooling methods". Author state that spark out time proved an important parameter in plunge cylindrical grinding. He proved that the longer spark out time leads to decrease in tangential forces, wheel diametrical wear and surface roughness using MQL method. This stable values of this forces lay within the range of 12.0 to 18.0 Newton with regards to surface roughness, RA the MQL technique lead to high value in compression with the other two methods.[15]

## IV. Result And Discussion

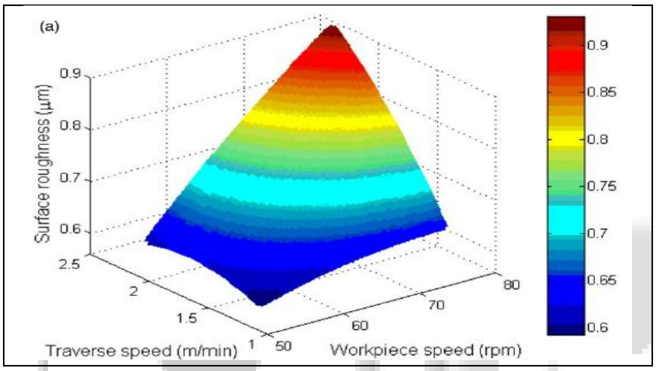


Fig.1 : response surface plot of surface roughness according to change of work piece speed and traverse speed.

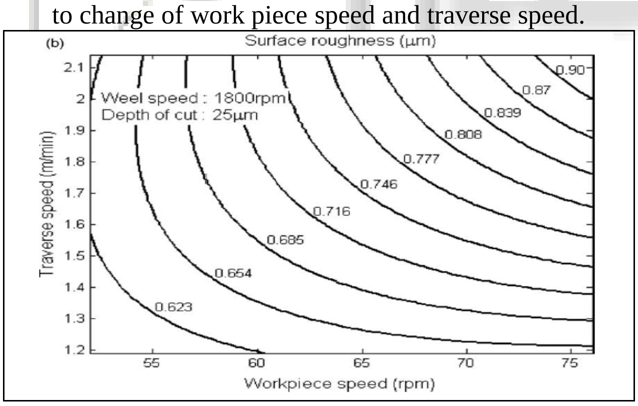


Fig. 2: contour plot of grinding surface roughness according to change of work piece speed and traverse speed.

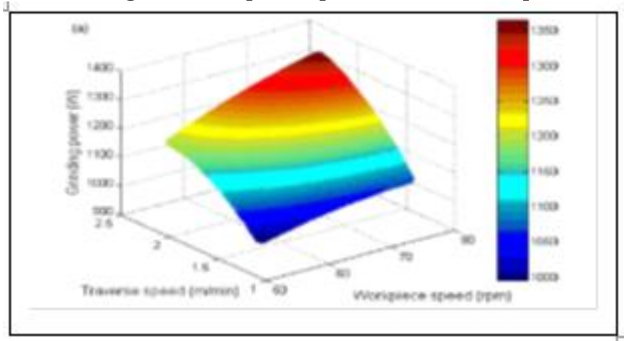

Fig. 3: Response surface plot of grinding power according to change of work piece speed and traverse speed.

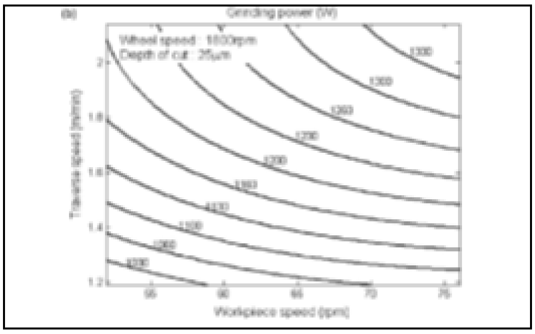

Fig. 4: contour plot of grinding power according to change of work piece speed and traverse speed.

## V. Conclusion

The effects of different work piece speed and traverse speed on the surface roughness and grinding power of cylindrical grinding were investigated, with the following results.

1. The surface roughness became maximum for either higher traverse speed or a higher work piece speed and minimum for lower traverse speed or a lower work piece speed.
2. Power values increased under higher traverse speed and higher work piece speed and resulted in a dark red color in the power zone.
3. The 3D plot of the surface roughness, as represented in "Fig. 1" shows a more rapid change than the grinding power according to the work piece speed and the traverse speed. The surface roughness was dominantly affected by the change of the work piece speed.
4. 4.The surface roughness and power values of cylindrical grinding could be predicted and estimated by response surface method This prediction of two grinding performances can help cylindrical grinding achieve varied requests and applied to the grinding and surface finishing industry.
5. It was found that good surface finish is obtained during the cylindrical grinding process with optimum grinding conditions.
6. The optimum parameters of cylindrical grinding process to overcome the problem of poor surface finishing.

This above literature focuses on the literature study done on the review of related journal-papers, articles available as open literature. This literature covers the cylindrical process of input parameter such as cutting fluids, work piece speed and its effect on output parameter with the different methods. From this literature review, it is lake with proper justification for optimization of process parameters of cylindrical grinding using regression analysis. Measurement will carry out and analysis will done using regression analysis. The conclusive remarks are very beneficial to the industry people.

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