A Review on Study of Cylindrical Grinding Process Parameters of Hardened Material Using Response Surface Methodology

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***Abstract* - Cylindrical grinding is a metal cutting process. It comes under finishing process. For that purpose Metal removal rate and surface finish are the major output parameters in the manufacture to maintain quantity and quality respectively. CNC cylindrical grinding machine is used for performing the experiments with L9 Orthogonal array with input machining parameters as work speed, feed rate and depth of cut. The surface roughness will be studied in mathematical model by using response surface methodology (RSM). To check the validity of the model Analysis of variance (ANOVA) will used. By using design of experiments, Low and high value for work speed and feed rate and depth of cut can be decided. The influences of all decided input parameters on surface roughness can be studied based on the developed mathematical model. Accuracy of the model can be checked with the testing data. The new model can be used in the different manufacturing firms by selecting right combination of machining parameters to achieve an optimal metal removal rate (MRR) and surface roughness (Ra).The results will show that feed rate, depth of cut and speed are influencing parameters on the output responses i.e. metal removal rate (MRR) and surface roughness (Ra). The results would be further confirmed by conducting confirmation experiments.**

***Keywords* - Material Removal Rate (MRR), Surface Roughness (Ra), Surface Response Methodology**

I. INTRODUCTION

Now a day's in a manufacturing, the main objective is optimised cost and quality of parts within less duration. Machining is a major manufacturing process of nearly every product of the modern civilization. Main machining operations are turning, drilling, thread cutting, milling, grinding etc. Among them grinding has been employed in manufacturing for more than 100 years. It is a manufacturing process involved with material removal, and — frequently the last operation performed on a work-piece. The applications of grinding are mostly for manufacture goods with high degree of accuracy and precision. Final shape and finish of the part depends on this operation. The cylindrical grinder is one of the most important and most common grinding machines. Cylindrical grinders are used on the work pieces that are symmetrical about an axis of rotation. The grinding of an outer surface of a work piece around an axis of rotation with the part held between centres is performed in external cylindrical grinding operation and it is an efficient and effective method of achieving exceptional roundness and good surface finish.

Surface roughness is a measure of the scientific value of a product and a factor that very much influences built-up cost. Excessive surface roughness may degrade the performance of the output work and work-piece quality suffers. So it is very essential to diagnose and check surface roughness. To achieve this goal, understandings relating to the effects of machining conditions and machining parameters on surface quality have to be precise and clear. Study in this regard is still being continued. In so far the effects of process parameters on surface finish are concerned, there has been a bit of experimental study, but more extensive research is necessary.

Good surface roughness values and high MRR may obtain through process optimization, which needs a deep knowledge of the phenomenon, mainly concerning between the process parameters and output characteristics. The aim of the work is to study the effects of processes parameters on surface roughness as well as by using response surface methodology (RSM) cum genetic algorithm (GA) with hybrid function in cylindrical traverse cut grinding operation while machining of glass fibre reinforced epoxy composite (GFREC) material. The present work is designed to make out the consequence of cutting conditions on surface roughness and MRR of the job through experiments and using MINITAB's Box-Behnken experimental design and response surface methodologies have been used to find out the optimal cutting conditions to get high quality surface finish.

II. LITERATURE REVIEW

The present work is concerned with cylindrical grinding of hardened material. For the purpose, a no. of journal papers, conference papers, books, websites and thesis have been studied. In the following paragraphs an experimental study has been carried out, in the context of the above mentioned matters.

2.1. Experimental Study

M.Melwin Jagadeesh Sridhar et al (2014) OHNS steel is a widely preferred material for manufacturing of Die blocks, fasteners, automotive components and cutting tools. Metal removal rate is an important performance factor to be considered in grinding process. Research activities that include experimental work and statistical analysis help in improving quality standards of manufacturing of components. Surface quality of OHNS steel after cylindrical grinding process is proposed to be studied in this experimental work using L9 orthogonal array selected for three levels and three input parameters. The inputs parameters are considered in this Experimental study are work speed, depth of cut and number of passes and response parameter is metal removal rate (MRR) during cylindrical grinding process. Higher metal removal rate is the main objectives of this machining process. The different machining parameters of OHNS steel of cylindrical grinding process are optimized by Signal to noise ratio and analysed by Analysis of variance (ANOVA's).

K Mekala et al (2014) stated that Austenitic stainless steel produces good surface finish.

Taranveer Singh et al (2014) found that good surface finish is obtained during the cylindrical grinding process with optimum grinding conditions. The wheel speeds, depth of cut and number of passes have very less effect on surface roughness.

Suleyman Ne1eli (2012) determined the optimum conditions to minimize wheel vibration were determined to be 0.01 mm depth of cut, 0.249 mm rev(1 feed rate and 175 rpm work piece revolution with a predicted Vb of 1.089 mV/g. For surface roughness, the optimum condition was determined to be 0.01 mm depth of cut, 0.2 mm rev-1feed rate and 275 rpm work piece revolution with a predicted Ra of 0.145 Pm. This robust optimization can increase production rate and decrease grinding costs.

Sandeep Kumar (2015) determined that work piece speed contributes maximum 38.95 % percentage contribution, grinding wheel speed contributes 14.85 %, feed rate contributes 12.85% and depth of cut has least contribution about 9.80% towards the material removal rate. The optimized parameters for material removal rate are grinding wheel speed 1800 rpm, work piece speed 155 rpm, feed rate 275 mm/rev and depth of cut .04mm.

Jae-Seob Kwak et al (2006) from experimentation it is seen that by 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 centreline average height. After several spark-outs, the grinding power went down to near the driving power but, in certain cases, the desired surface roughness was not obtained.

G. F. Li et al (2002) presented an optimum strategy permitting burn to appear in the rough grinding stage, but where the burning layer can be accumulated in the following finishing stage. On the basis of the basic grinding models, the objective function and constraint functions for multi- cylinder optimum grinding process have been built in this study. Author stated that optimum system for cylindrical plunge grinding process to minimize production time. The results of the experiments confirm the exactitude of the optimum models and the feasibility of the optimum strategy.

Jun Qian et al (2000) stated that optimum system for cylindrical plunge grinding process to minimize production time.

Hemant S. Yadav and R. K. Shrivastav (2014) found that the developed model is significant. From experimentation it is suggested that for given type of steel material keeping coolant nozzle angle at 450 and medium flow rate of 0.037 lit/sec gives better cooling effect which lead to improve both productivity and surface quality. The present work aims at optimizing process parameters to achieve surface quality and high material removal rate in SAE 8620 steel material. Response surface method a powerful tool in design of experiments is used for optimization process.

2.2. Research Gaps

- From the above literature survey we find that there are many researches done on optimization techniques for process parameter like surface roughness and material removal rate separately.
- But I found that there are very few researches done on combined output parameters of surface roughness and material removal rate which can be done using response surface methodology by considering the input parameters like work speed, wheel speed, depth of cut.

2.3. Objectives

- Proper selection of material: OHNS Die Steel
  - Ready availability and low in cost.
  - Less size change than the water-hardening steels.
  - Easier to harden throughout the work piece and are at least equally tough.
- Experimental study at IGTR/ Prashant Engg. Works
- Data will be analysed by RSM (Response Surface Methodology)

III. EXPERIMENTAL SETUP

For studying the effect of various process parameters on surface roughness and MRR in cylindrical grinding of OHNS material in the present work experiments will be conducted on cylindrical grinding machine The process parameters considers for present study are: feed, depth of cut, and work speed. Three levels of parameters have been used during grinding. So that response surface methodology (RMS) can be utilize for analyses of the observed data.

The experimental set up will be used for the present study is shown in Fig. 1. The experimental set consists of several systems, such as grinding wheel, tail stock, head stock, work table and cooling system.

Schematic diagram of experimental set-up is shown in the Fig. 2.

Fig. 1. Photographic view of the grinding machine

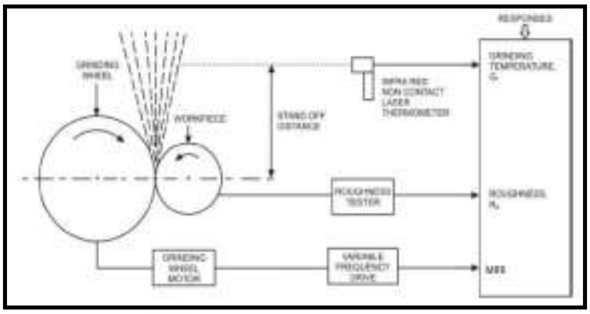

Fig. 2.Schematic diagram of the experimental set-up

3.1. Process Variables

The process parameters chosen for the present study are cutting speed (rpm), feed rate (mm/s) and depth of cut (mm). The machine used for present study, depending upon its capacity the selection of the values of the process variables is limited. The three levels of the first two parameters have been selected at an equal spacing whereas the spacing for the third factor is not equal. The parameters that were kept constant during this study are grinding wheel speed, wheel type, number of passes in grinding, diameter of work piece, and diameter of wheel.

IV. CONCLUSION

From the above literature review we find that there are many researches done on optimization techniques for process parameter like surface roughness and material removal rate separately. But I found that there are very few researches done on combined output parameters of surface roughness and material removal rate which can be done using response surface methodology by considering the input process parameters like work speed, wheel speed, depth of cut.

REFERENCES

[1] M. Melwin Jagadeesh Sridhar, M. Manickam and V. Kalaiyarasan, "Optimization of Cylindrical Grinding Process Parameters of OHNS Steel (AISI 0-1) Rounds Using Design of Experiments Concept", International Journal of Engineering Trends and Technology, Volume 17, pp 109-114, Nov. 2014

[2] K Mekala, J Chandradas, K Chandrasekaran, T T M Kannan, E Ramesh and R NarasingBabu, "Optimization Of Cylindrical Grinding Parameters Of Austenitic Stainless Steel", International Journal of Mechanical Engineering and Robotic Research(IJMERR), pp 208-215, 2014

[3] M. Ganesan, S. Karthikeyan& N. Karthikeyan, "Prediction and Optimization of Cylindrical Grinding Parameters for Surface Roughness Using Taguchi Method", IOSR Journal of Mechanical and Civil Engineering, pp 39-46, 2014

[4] Taranveer Singh, KhushdeepGoyal, Parlad Kumar, "To Study the Effect of Process Parameters for Minimum Surface Roughness of Cylindrical Grinded AISI 1045 Steel", Manufacturing Science and Technology, pp 56-61, 2014

[5] Suleyman Ne1eli,_Dlhan Asilturk and LeventCelik, "Determining the optimum process parameter for grinding operations using robust process", Journal of Mechanical Science and Technology, pp 3587- 3595, 2012

[6] M.A. Kamely, S.M. Kamil, and C.W. Chong, "Mathematical Modeling of Surface Roughness in Surface Grinding Operation", World Academy of Science, Engineering and Technology, pp 824- 827, 2011

[7] Lijohn P George, K Varughese Job and I M Chandran, "Study of Surface Roughness and its Prediction in Cylindrical Grinding Process based on Taguchi Method of Optimization", International Journal of Scientific and Research Publications, pp 1-5, 2013

[8] Sandeep Kumar and Onkar Singh Bhatia, "Review of Analysis & Optimization of Cylindrical Grinding Process Parameters on Material Removal Rate of En15AM Steel", PP 35-43, 2015

[9] Jae-SeobKwak, Sung-Bo Sim, Yeong-DeugJeong, "An analysis of grinding power and surface roughness in external cylindrical grinding of hardened SCM440 steel using the response surface method", International Journal of Machine Tools & Manufacture, pp 304- 312, 2006

[10] G. F. Li, "Multi-parameter optimization and control of the cylindrical grinding process", Journal of Mechanical Science and Technology, pp 232-236, 2002

[11] Jun Qian, Wei Li, Hitoshi Ohmori, "Cylindrical grinding of bearing steel with electrolytic in-process dressing", Precision Engineering, pp 153–159, 2000
[12] Hemant S. Yadav and Shrivastav, "Effect of Process Parameters on Surface Roughness and Mrr in Cylindrical Grinding using Response Surface Method", International Journal of Engineering Research & Technology, pp 1384- 1388, 2014
[13] I.S. Jawahir, E. Brinksmeier, R. M. Saoubi, D.K. Aspinwall, J.C. Outeiro, D. Meyer, D. Umbrella, A.D. Jayal, "Surface integrity in material removal processes: Recent advances", CIRP Annals - Manufacturing Technology, 60 (2011) 603–626
[14] T. Tawakoli, A. Rasifard, M. Rabiey, "High-efficiency internal cylindrical grinding with a new kinematic", International Journal of Machine Tools & Manufacture, 47 (2007) 729–733
[15] M.Janardhan and Gopal Krishna, "Determination And Optimization Of Cylindrical Grinding Process Parameters Using Taguchi Method And Regression Analysis", International Journal of Engineering Science and Technology, 2011
[16] H. Saglam, "An experimental investigation as to the effect of cutting parameters on roundness error and surface roughness in cylindrical grinding", International Journal of Production Research, 2005