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"A STUDY ON OPTIMIZATION OF GRINDING PROCESS"

***Avinash Kumar* [1], *Arun Patel* [2]**

[1] *M Tech Part Time Scholar, Department of Mechanical Engineering, NIIST Bhopal, Madhya Pradesh, India*

[2] *Head & Associate Professor, Department of Mechanical Engineering, NIIST Bhopal, Madhya Pradesh, India*

ABSTRACT

In Grinding process, the major factors whose selection contributes to grind the product as they affect the surface roughness and quality to a larger are material hardness, work piece speed, grinding wheel grains. The purpose of this thesis is efficiently determine and the optimum grinding parameter for achieving the minimum surface roughness in the range of parameters. In order to meet the purpose in terms of both efficiency and effectiveness, this study will utilize the Taguchi parameter design methodology. The study includes selection of parameters, utilizing an orthogonal array, conducting experiment runs, data analysis, determining the optimum combination, finally the experimental verification and comparison by regression modeling. Material hardness, work piece speed and grinding wheel grain are taken as controlled parameters in this study. The Taguchi suggested use of orthogonal array (OA) , in the experiment implementation stage, to investigate and predict noise factors which might affect the quality of given product during the product manufacturing phase. Through OA experiment analysis, the quality influencing factors of a product can then be identified, controlled, and hence compensated during early product design stage.

Key Words: *Grinding process, OA, work piece speed, surface roughness, noise factors.*

I. INTRODUCTION

Quality and productivity play significant role in today's manufacturing market. From customers' view point quality is very important because the extent of quality of the procured item (or product) influences the degree of satisfaction of the consumers during usage of the procured goods. Therefore, every manufacturing or production unit should concern about the quality of the product. Apart from quality, there exists another criterion, called productivity which is directly related to the profit level and also goodwill of the organization. Every manufacturing industry aims at producing a large number of products within relatively lesser time.

Increasing the productivity and quality of the machined parts are the main challenges of metal based industry, there has been increased interest in monitoring all aspect of machining process. Surface finish is an important parameter in manufacturing engineering. It is characteristic that could influence the performance of mechanical parts and production cost. Surface roughness has become the most significant technical requirement and it is an index of product quality.
Now a day's manufacturing industry specially concerned to dimensional accuracy and surface finish. In order to obtain optimal cutting parameter manufacturing industries have depended on the hand book based on information which leads to decreased productivity due to sub optimal use of machine capability, this causes high manufacturing cost and low product quality.

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1.1 Grinding Operation

Grinding is the most common form of abrasive machining process widely used. It is a material cutting process which engages an abrasive tool whose cutting elements are grains of abrasive material material known as grit. These grits are characterized by sharp cutting points, high hot hardness , chemical stability and wear resistance. The grits are held together by a suitable bonding material to give shape of an abrasive tool.

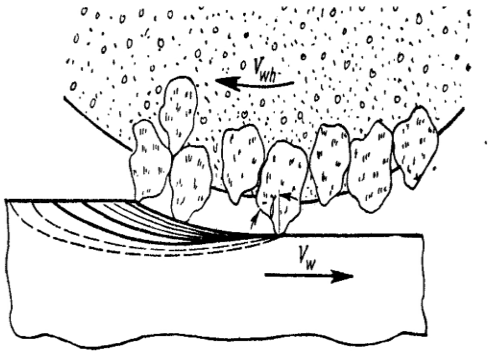

Figure 1 illustrates the cutting action of abrasive grits of disc type grinding wheel similar to cutting action of teeth of the cutter in slab milling. (web resource 1)

1.2 Major advantages and applications of grinding

Advantages

- Dimensional accuracy
- Good surface finish
- Good form and locational accuracy
- Applicable to both hardened and unhardened material

Applications

- Surface finishing
- Slitting and parting
- Descaling, deburring
- Stock removal
- Finishing of flat as well as cylindrical surface

Grinding of tool and cutters and resharpening of the same.

II. Literature Review

Nicolo Belavendram (2001), the author described an introduction to Quality by Design and explained how the various expects can be applied to practical problems. Three qualityloss function , namely , nominal - the- better ,smaller - the better and larger -the- better are discussed. Further the various chapters include the design process , Selection of orthogonal arrays and matrix experiments, Objective functions in robust design and basic analysis of variance .he suggested the simple experimental results for the readers to grasp the underlying principles to look forward to advance quality by design.

M.kiyak , O. Cakir, E.Altan (2003) has describe the influence of machining parameters in external cylindrical grinding process on surface roughness of work piece. The experimental study was carried out in dry and wet (5% emulsion cutting fluid) machining conditions using AISI1050 steel at various workpiece speed and feed at constant wheel speed and grinding depth.the relationship betweengrinding parameters and surface roughness were determined.

M.Janardhan and Dr. A Gopala Krishna (2011) has determined the optimal condition in cylindrical grinding by using taguchi method and regression analysis . The material selected for experiment was EN 8 workpiece is hardened and turned before grinding. The experiment was conducted on cylindrical grinding machine with input variables are variable work speed , feed rate and depth ofcut and output is surface roughness and MRR.

L'ubica ELEKOVA , Zdenko LIPA (2009) the author has described two basic types of abrasive belts,which most used in practice .The first type is conventional abrasive , used for a long period and is currently applied because of its relatively low price. The second type described is structured abrasive ,which found mainly for their good properties.

Samuel Karanja Kabini, Dr.Bernard Wamuti Ikua (2011) the author has develop a theoretical model for the prediction chatter vibration in cylindrical grinding. The model is based on geometric and dynamic interaction of work piece and the grinding wheel. The model is validated with a series of experiments. Results show that variation in grinding wheel and work piece speeds, and feed lead to changes in the vibration modes of vibration.

E.Brinksmeier ,H.K. Tonshoff , Czenkusch (1998) the author describes different methods for modelling and optimization process. First the product quality characterizing quantities have to be measured . Afterwards different model types e.g. physical – empirical basic grinding models as well as empirical process models based on neural networks, fuzzy set theory and standard multiple regression methods are discussed for an off-line process conceptualization and optimization using a genetic algorithm. The assessment of grinding process results , which build the individuals in the genetic algorithm's population is carried out using a target tree method. The methods presented are integrated intoan existing grinding information system, which is part of a three control loop system for quality assurance.

A.J. Shih, M.B. Grant (1998) ,the author describe that high wheel speed can significantly reduces grinding forces and specific grinding energy for zirconia grinding. A method to reduce the wheel speed during truing was investigated and its benefits to lower the grinding forces was aquantified.

S. Thamizhmanii, S. Saparudin, S. Hassan (2007) – Purpose of this research work is focussed on the analysis of optimum cutting condition to get lower surface roughness in turning operation by Taguchi method.

Caldeirani Filho J (2001) – The main goal of this work is to study the influence of cutting conditions - cutting speed, feed velocity and feed per tooth - on tool life and surface finish of the workpiece in the face milling of flat surfaces. Aiming to achieve this goal, several milling experiments were carried out with different cutting speeds, feed velocities and feeds per tooth. In the first phase of the experiments, cutting speed was varied without varying feed velocity, which caused a variation in feed per tooth. In the second phase of the experiments, cutting speed and feed velocity were varied in such a way that feed per tooth was kept constant. Tool flank wear and surface roughness of the workpiece were measured as cutting time elapsed. The main conclusions of this work are that a) cutting speed has a strong influence on tool life, regardless of whether feed velocity or feed per tooth varies and b) an increase in surface roughness of the workpiece is not closely related to an increase in wear of the primary cutting edge.

Sijo M. T. and Biju. N (2010) – In this research paper Taguchi parameters optimization methodology is applied to cutting parameters in turning. The turning parameters evaluated are cutting velocity, feed rate, depth of cut, nose radius of tool and hardness of material each at two levels. The result of analysis shows that the feed rate, cutting velocity and nose radius have present significant contribution on the surface roughness and depth of cut and hardness of material have less significant contribution on the surface roughness.

Mr. Akshay Bhole et al (2019) In machining operations, one of the most important machining processes is grinding process. It is responsible for producing discrete components with high precision which accounts for one fourth of the total expenditure of machining processes in industrialized nations. So it is very important for us to understood grinding process to improve surface finishing of products. Many researchers and investigators had proved that parameters such

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as work speed, wheel speed, depth of cut, feed rate, number of passes, etc are responsible for the effect on grinding process. Every parameter should have optimum value for better surface finish. Design of experiments is the best concept for optimization of parameters at the earliest stage of the processes. In this project, response variable selected is surface finish and input parameters selected are depth of cut, feed rate, work speed. Fractional factorial design is to be done by selecting orthogonal array for three factors and their three levels. Optimum grinding process parameters are to be selected using S/N ratios in Minitab software and ANOVA is to be done for identifying most dominating factor among all three parameters.

Fengping Li et al (2020) Surface roughness and the material removal rate (MRR) are two important indicators during the grinding process. The former determines the surface quality while the latter reflects the grinding efficiency directly. In this paper, the two indicators are taken into consideration simultaneously and differently by converting them into a comprehensive goal with using weighting objective method. A prediction model was established for each comprehensive goal with each different combination of surface roughness and MRR weighting coefficient. The optimal value of abrasive size, contact force, belt linear speed, and feed speed were obtained under different grinding situations by using a central composite design (CCD) combined with response surface analysis. The experimental results showed that the comprehensive goal can be used effectively as an indicator to control the grinding performance and improve the optimization process.

Tran Thi Hon et al [2020] Nowadays, surface grinding plays an important role in industry due to the growing demand for increasingly accurate parts with a low production cost. The efficiency of this process is affected by the process parameters such as dressing feed rate (S), rough dressing depth (ar), rough dressing times (nr), fine dressing depth (af), fine dressing times (nf), and non-feeding dressing (nnon). etc. In this paper, the optimization of dressing parameters in surface grinding SKD11 tool steel is presented. The aim of the study is to find the most appropriate value set of dressing parameters to minimize the normal cutting force (Fy). In order to solve the problem, the Taguchi method is employed. Based on an orthogonal array L16(44 × 22), sixteen experiments have been conducted. By analyzing the experimental results, an optimal solution of the optimization problem has been solved, presenting the most appropriate dressing parameters as follows: ar = 0.015 mm, nr = 1 times, af = 0 mm, nf = 0 times, nnon = 0 times, S = 1.8 m/min. The discovered technology mode has been applied into the actual machining process and the outcome shows a much better result in comparison with the default setting modes with the difference between the model values and the real values of the mean normal cutting force controlled within 3.01% of the ranges.

III. METHODOLOGY

Taguchi Technique

In early 1950's, Dr. Genichi Taguchi, "The Father of Quality Engineering," introduced the concept of off-line quality control techniques known as Taguchi parameter design. Offline quality control are those activities which were performed during the Product (or Process) Design and Development phase. Genichi Taguchi is a Japanese engineer, who has been active in the improvement of Japan's products and processes since the late 1940's. He has developed both a philosophy and methodology for the process of product quality improvement that depends heavily on statistical concepts and tools, especially statistically designed experiments. Many Japanese firms have achieved great success by applying his methods. It has been reported that thousand of engineers have performed tens of thousands of experiment based on his teaching. The Taguchi method is statistical tool, adopted experimentally to investigate influence Material hardness. Work piece speed and grinding wheel grain size on surface roughness. Many researchers developed many mathematical models to optimize parameters to get the minimum roughness in target achievement by various processes. The variation in the Material hardness. Work piece speed and grinding wheel grain size change in surface roughness. Here the Taguchi design of experiments is used to optimize the considered parameters. Taguchi method is a powerful tool for the design of high quality systems. It provides simple, efficient and systematic approach to optimize designs for performance, quality and cost. Taguchi method is efficient method for designing process that operates consistently and optimally over a variety of condition. To determine the best design it requires the use of a strategically designed experiment Taguchi approach to design of experiments is easy to adopt and may be applied for users with limited knowledge of statistics, hence gained wide popularity in the engineering and scientific community. Taguchi

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method is especially suitable for industrial use, but can also be used for scientific research. Taguchi parameter design is based in the concept of fractional factorial design but the Taguchi parameter design only conducts the balanced (orthogonal) experimental combinations, which makes the Taguchi design even more effective than fractional design. Taguchi has received some of Japan's most prestigious award for Quality achievements including the Deming Prize. In 1986; Taguchi received the most prestigious price "The Williard F. Rockwell medal" for excellence in technology from the International Technology Institute. Since 1983, after Taguchi's association with the top companies and institute in USA (AT & T), Bell Laboratories, Xerox, Lawrence Institute of Technology, Ford Motor Company etc., the concept provided major contribution and has involved the combination of engineering and statistical methods to achieve rapid improvements in cost and quality by optimizing product design and manufacturing process. Taguchi methods have been called a radical approach to quality experimental design and engineering. The term Taguchi method refers to parameter design, tolerance design, the quality loss function, design of experiments, using orthogonal arrays and methodology applied to evaluate measuring system.

IV. CONCLUSION

The thesis has discussed an application of Taguchi method for optimizing the grinding parameters in grinding operation and indicates that the Taguchi design of experiment is an effective way of determining the optimal grinding parametersfor surface roughness.

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