REVIEW ON OPTIMIZATION OF THE PARAMETER IN CYLINDRICAL GRINDING OF AUSTENITIC STAINLESS STEEL ROD (AISI 317 L) BY TAGUCHI METHOD

Amrut Aher
Department of Mechanical Engineering, Pravara Rural Engineering College ,
Loni, Savitribai Phule Pune University, India.

S.B.Belkar
Department of Mechanical Engineering, Pravara Rural Engineering College ,
Loni, Savitribai Phule Pune University, India.

ABSTRACT

The process of center less grinding has been established in the mass production of slim, rotationally symmetrical components. Because of the complex set-up, which results from the large sensitivity of this grinding process to a multiplicity of geometrical, dynamical and kinematical influence parameters, center less grinding is rarely applied within limited-lot production. The substantial characteristics of this grinding process are the simultaneous guidance and machining of the work piece on its periphery. Cylindrical grinding is an essential process for final machining of components requiring smooth surfaces and precise tolerances. As compared with other machining processes, grindings costly operation that should be utilized under optimal conditions. Although widely used in industry, grinding remains perhaps the least understood of all machining processes. The proposed work takes the following input processes parameters namely Work speed, feed rate and depth of cut. The main objective of this work is to predict the grinding behavior and achieve optimal operating processes parameters. A software package may be utilized which integrates these various models to simulate what happens during cylindrical grinding processes. Predictions from this simulation will be further analyzed by calibration with actual data. It involves several variables such as depth of cut, work speed, feed rate, chemical composition of work piece, etc. The main objective in any machining process is to maximize the Metal Removal Rate (MRR) and to minimize the surface roughness value. To optimize these values Taguchi method, ANOVA and regression analysis is used.

KEYWORDS: Cylindrical grinding, Taguchi method, ANOVA, Work speed, feed rate, depth of cut 1 Corresponding Author

INTRODUCTION

Grinding is a process of material removal and surface generation process used to shape and finish components made of metals and other materials. The surface finish and precision obtained through grinding can be up to ten times better than with either milling or turning. Grinding employs an abrasive product, usually a rotating wheel brought into controlled contact with a work surface. The grinding wheel is composed of abrasive grains held together in a binder. These abrasive grains act as cutting tools to removing micro chips of material from the work. As these abrasive grains wear and become dull, the added resistance leads to failure of the grains or weakening of their bond. The dull pieces break away. The requirements for efficient grinding include:

- abrasive components which are harder than work
- heat-resistant and shock abrasive wheels
- abrasives that are friable.

That is, most abrasives used in industry are synthetic. Aluminum oxide is used in three quarters of all the grinding operations, and is primary used to grind ferrous metals. Next is silicon carbide, which is used for grinding softer, high density materials and non-ferrous metals such as cemented carbide or ceramics. Super abrasives, namely cubic boron nitride and diamond, are used about five percent of grinding. Hard ferrous materials are ground with "CBN", while non-ferrous materials and non-metals are best ground with diamond. The grain size of abrasive materials is important to the process. Large grains remove material faster, while smaller grains produce a finer finish. The binders that hold these abrasive grains together include:

- vitrified bonds, a glass-like bond formed of fused clay or feldspar
- metal or single-layer bond systems for super abrasives
- cylindrical grinding
- internal grinding
- center less grinding
- surface grinding

In cylindrical grinding, the work piece rotates about a fixed axis and the surfaces machined and they are concentric to that axis of rotation. Cylindrical grinding produces an external surface that may be either straight, contoured or tapered. The basic components of a cylindrical grinder include a wheel head, which incorporate the drive motor and spindle; a cross-slide, that moves the wheel head to and from the work piece; a headstock, which holds, locates, and drives the work piece; and a tailstock, which holds the other end of the work. The manufacturing process of center less grinding has been established in the mass production of slim, rotationally symmetrical components. Due to the complex set-up, which results from the large sensitivity of this grinding process to a multiplicity of kinematical, geometrical, and dynamical influence parameters, centerless grinding is rarely applied within limited-lot production. The major characteristics of this grinding process are the simultaneous guidance and machining of the work piece on its periphery. Cylindrical grinding is an essential process for final machining of components requiring smooth surfaces with precise tolerances. As compared with other machining processes, grindings costly operation that should be minimized under optimal conditions. Although widely used in industry, grinding remains perhaps the least understood of all machining processes. The major operating parameters that influence the output responses, metal removal rate, surface roughness, tool wear and surface damage etc., are: (i) wheel parameters: abrasives, grain size, binder, grade, structure, dimension and shape etc., (ii) Work piece parameters such as fracture mode, mechanical properties and chemical composition, etc., (iii) Process parameters such as depth of cut, work speed, feed rate, dressing condition, etc., (IV) machine parameters: static and dynamic characteristics, table system and spindle system etc. The proposed work takes the following input processes parameters namely Work speed, feed rate and depth of cut.

LITERATURE REVIEW

By referring Janardhan and Gopala Krishna (2011), conclude that the cylindrical grinding surface finish and metal removal rate are the important responses. The Experiments were conducted on cylindrical grinding machine using EN8 material and he found that the feed rate played important role on responses surface roughness and metal removal rate than other process parameters. Cheol Lee (2009) concluded a control-oriented model for the cylindrical grinding process in the state-space format. A number of experiments were conducted to confirm the dynamic relationships and determine the model coefficients. It is found that number of grinding cycles in batch production can be promptly predicted and the proposed model was analyzed. Alagumurthi et al. (2007) he was work on AISI 3310, AISI 6150 and AISI 52100 are the steel materials having different compositions of carbon by using Al2O3 grinding wheel. Finally, it was concluded that plastic deformation is useful and it dominate only when depth of cut is low; In case of rough grinding, i.e., with moderate depth of cut , plastic deformation effect and brittle fracture are medium; the temperature developed at the contact zone is the main reason for the phase transformation, i.e., austenite to marten site.

OBJECTIVE

The main objective of this work is to predict the grinding behavior and achieve optimal operating processes parameters. A software package may be utilized which integrates these various models to simulate what happens during cylindrical grinding processes

METHODOLOGY

The goal of experimental work is to investigate the effect of grinding parameters with the process parameters of cutting speed, feed rate and Depth of cut influencing the metal removal rate of AISI 317L Austenite stainless steel.

TAGUCHI METHOD

The Taguchi method involves reducing the variation in a process through robust design of experiments. The objective of the method is to produce high quality product at low cost to the manufacturer. The Taguchi method was developed by Dr. Genichi Taguchi of Japan who maintained that variation. Taguchi developed a method for designing experiments to find how different parameters affect the mean and variance of a process performance characteristic that defines how the process is functioning. The experimental design proposed by Taguchi involves using orthogonal arrays to organize the parameters affecting the levels and process at which they should be varies. Instead of having to test all possibilities like the factorial design, the Taguchi method tests pairs of combinations. This allows for gather the necessary data to determine which factors most affect product quality with a minimum amount of experimentation, thus saving resources and time. The Taguchi method is best used when there are an intermediate number of variables, few interactions between variables, and when only a few variables contribute significantly.

The Taguchi arrays can be derived. Small arrays can be drawn out manually; large arrays can be derived from deterministic algorithms. The arrays are selected by the number of parameters as a variables and the number of levels as a states. This is further explained later in this article. Analysis of variance on the collected data from the taguchi method of experiments can be used to select new parameter values to optimize the performance characteristic. The data from the arrays can be analyzed by plotting the data and performing a visual analysis, ANOVA.

It is known that the full economic and technical potential of any manufacturing process can be harnessed only when the process is carried out with the optimum parameters. One of the most important robust optimization techniques is Taguchi method .Taguchi method is a technique for designing and performing experiments to investigate processes in which the output depends on many factors (variables, inputs) without having tediously and uneconomically run of the process using all the possible combinations of values. Thanks to systematically chosen certain combinations of factors it is possible to separate their individual effects. The Taguchi approach enables a comprehensive understanding of the combined and individual process parameters from a minimum number of simulation trials. The quality engineering method proposed by Taguchi gives a new experimental strategy in which a modified and standardized form of design of experiment is used. In other words, the Taguchi approach is a form of DOE with special application principles. The Taguchi technique helps to study effect of many factors (variables) on the desired quality characteristic most economically. By studying the effect of individual factors on the results on grinding parameters, the best factor combination can be determined. Taguchi designs experiments using specially constructed tables known as "orthogonal array" (OA). OA is the matrix of numbers arranged in columns and rows. The use of these tables makes the design of experiments very easy and consistent and it requires relatively lesser number of experimental trials are done to study the entire parameter space. As a result, time, cost, and labor saving can be achieved. The Taguchi method employs a generic signal-to-noise (S/N) ratio to quantify the present variation. These S/N ratios are meant to be used as measures of the effect of noise factors on performance characteristics. S/N ratios take into account both amount of variability in the response data and closeness of the average response to target. The experimental results are transformed into a signal to noise (S/N) ratio. Taguchi recommends the use of the S/N ratio to measure the quality characteristics deviating from the desired values. Usually, there are three categories of quality characteristic in the analysis of the S/N ratio, i.e. the-Smaller-the-better, the-higher-the better, and the nominal-the-better. The S/N ratio for the each level of process parameters is computed based on the S/N analysis. Regardless of the category of the quality characteristic, a greater S/N ratio corresponds to better quality characteristics. Therefore, the optimal level of the process parameters is the level with the greatest S/N ratio.

Taguchi proposed the use of the loss function to measure the deviation of the quality characteristic from the desired value. The value of the average loss function is further transformed into a signal-to-noise (S/N) ratio. Usually, the three categories of the quality characteristic in the analysis of the S/N ratio, i.e. the lower-the-better, the larger-the-better, and the more-nominal-the-better. The S/N ratio for each level of process parameters is computed based on the S/N analysis. Regardless is the category of the quality characteristic, a larger S/N ratio corresponds to better quality characteristic. Therefore, optimal level of the process parameters is the level with the highest S/N ratio. Further, a statistical analysis of variance (ANOVA) is performed to see which process parameters are statistically significant. The optimum combination of the process parameters can then be predicted. Finally, a experiment is conducted to verify the optimal process parameters obtained from the process parameter design.

TAGUCHI METHOD OF ORTHOGONAL ARRAYS

PARAMETERS-3

1. ROTATIONAL SPEED- e.g. A, B, C
2. FEED- e.g. P, Q, R
3. DEPTH OF CUT- e.g. L, M, N

Here there are total three levels for each parameter.

MATERIAL GENERAL PROPERTIES

Alloy 317L is a molybdenum containing, low carbon ASS with increased additions of chromium, nickel, and molybdenum for better corrosion resistance and increased resistance to chemical attack for sulfurous, acetic, formic, citric, and tartaric acids. Due to low carbon content, 317L also provides resistance to sensitization when welded and higher creep, tensile strength and stress to rupture at elevated temperatures. It is non-magnetic in the annealed condition but may become magnetic after welding.

APPLICATIONS

Alloy 317L is commonly used to handle sulfur, pulp liquor, acid dyestuffs, nitrating mixtures and acetylating bleaching solutions, severe coal and oil, and many chemical compounds. Some other applications that use alloy 317L include:

- Paper and pulp handling equipment

- Chemical and petrochemical processing equipment
- Condensers in fossil and nuclear fueled power generation stations
- Food processing equipment
- Textile equipment.

RESULT AND DISCUSSION

After referring papers on cylindrical grinding, I conclude the following:

- An austenitic stainless steel produces better surface finish during cylindrical grinding process in grinding process parameters.
- Very high tolerance value can be obtained in cylindrical grinding.
- In cylindrical grinding the depth of cut play an major role and produce maximum metal removal (MRR) rate in austenitic stainless steel.
- Austenitic stainless steel have good mach inability property.
- The cylindrical grinding optimizes parameters to overcome the problem of poor chip breaking and machining failure.

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