Review on Optimization of Cylindrical Grinding Parameters of Mild Steel Rod (EN19) By Taguchi Method.

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ABSTRACT

The manufacturing process of cylindrical grinding has been established in the mass production of slim, rotationally symmetrical component. Due to the complex set-up, which results from the large sensitivity of this grinding process to a multiplicity of geometrical, kinematical&dynamical influence parameters, cylindrical grinding is rarely applied with limited-lot production. The important qualities of this grinding process are the at the same time opinion and machining of the work part on its periphery.Cylindrical grinding is an essential process for final machining of components requires smooth cylindricals and precise tolerances. As made a comparison with other machining processes grinding is high priced of great value operation that should be made use of under most good conditions. Although widely used in industry, grinding remains perhaps the least understood of all machining processes. The proposed work takes the following input process parameters namely Work speed, Depth of cut and Feed. The main objective of this work is to predict the grinding behavior and achieve optimal operating process 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, 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 cylindrical roughness. In order to optimize these values Taguchi method, regression analysis and ANOVA is used.

Keywords—ANOVA, depth of cut, feed rate, cylindrical grinding, Taguchi method, Work speed.

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1. INTRODUCTION

Grinding is a material removal Process and cylindrical generation process used to shape and finish components made of metals and other materials. The precision, cylindrical finish 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 cylindrical. The grinding wheel is made ofabrasive grains held together in a binder. These abrasive grains act as cutting tool, removing tiny chips of material from the work. As these abrasive grains wear and become dull, the increased resistance leads to fracture of the grains or weakening of their bond. The dull pieces break away, revealing sharp grains that continue cutting. The requirement for efficient grinding includes:

- Abrasive component which are harder than the work
- Shock and heat resistant abrasive wheels
- Abrasives that is friable.

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

- Vitrified bonds and a glass-like bond formed of fused clay or feldspar
- Organic bonds, synthetic resins and rubber, or shellac.
- Metal, single-layer bond systems for super abrasive.
- There are various methods of grinding, but the major industrial grinding process are:

- Cylindrical grinding

- Internal grinding

- Centerless grinding

- Cylindrical grinding

In cylindrical grinding, the workpiece is fixed and the grinding wheel rotates with high velocity. Cylindrical grinding produces external cylindricals that may be straight, tapered, or contoured. The basic components of a cylindrical grinder include a wheel head, which incorporate the spindle & drive motor; a cross-slide, which moves the wheel head to and from the workpiece; which locates, holds, and drives the workpiece. The Cylindrical Grinder is mostly used in the finishing process. It is a very accurate tool which uses a stationary, abrasive, rotating wheel to shave or finish metallic cylindricals which is held in place by a vise. Which is the part of a table, or carriage, is moved back and forth under the abrasive wheel. The table of the grinder may be magnetic, which aids in holding the material still. These things having attraction for iron can be toggled with the help of a lever placed on the front side of the grinder. As compared with other machining processes, grinding is costly operation whichshould be utilized under optimal conditions. Although widely used in industry, grinding is the least understood of all the machining processes. The major operating input parameters that influence the output responses are metal removal rate, cylindrical roughness, cylindrical damage, and tool wear etc., are: (i) wheel parameters: abrasive, grain size, grades, structures, binder, shape and dimension, etc., (ii) Workpiece parameters: fracture mode, mechanical properties and chemical composition, etc., (iii) Process parameters: work speed, depth of cut, feed rate, dressing condition, etc., (iv) machine parameters: static and dynamic Characteristics, spindle system, and table system, etc. The proposed work takes the following input process parameters namely Work speed, feed and depth of cut. Alloy 304 is commonly used to rigid flanges; this application requires precise cylindrical roughness because of use in chemical handling pipelines or equipment's. Due to this reason cylindrical grinding for this application requires to be optimum. Hence for this work this application is under consideration. A software package is 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 cylindrical roughness. In order to optimize these values Taguchi method is used. For the optimum control parameters which are obtained from Taguchi S/N ratios analysis.

2.LITERATURE REVIEW

By referring **Dadaso D, Mohite, NeerajTiwari, SandeepSontakke, Udayshankar Mishra (2017**)concludes that Taguchi method to determine the optimal process parameters for grinding wheel dressing process. The concept of ANOVA and S/N ratio has been used to determine the effect and influence of process parameters namely dressing depth of cut, cross feed rate, drag angle of dresser and number of passes that were studied on output responses.

Ankit Kumar, Ravi Patel, Jitendra Kumar Verma(2016) States that, Statistically designed experiments based on Taguchi method are performed using L9 orthogonal array to analyze surface roughness. The results obtained from analysis of S/N ratio and ANOVA were in close agreement.

Naresh Kumar, HimanshuTripathi, SandeepGandotra (2015) proposed that, The input parameters like speed of grinding, feed, has a significant effect on surface roughness, whereas depth of cut has the least effect on surface roughness of C40e steel. The optimized parameters for minimum surface roughness are grinding speed (210 rpm), feed (0.11 mm/rev), and depth of cut (0.04mm). The optimized minimum surface roughness is 0.238 μm that is about 78% of the initial value.

3. OBJECTIVE

The main objective of this work is to predict the grinding behavior and achieve optimal operating processes parameters.Softwares is utilized which integrates these various models to simulate what happens during cylindrical grinding processes. The main purpose in any machining process is to maximize the Metal Removal Rate (MRR) and to minimize the cylindrical roughness (Ra). In order to optimize these values Taguchi method is used.

4. 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 affect the metal removal rate of AISI 304 Austenite stainless steel.

A.Taguchi Method

The Taguchi method helps to reduce the variation in a process through robust design of experiments. The overall objective of thismethod is to produce quality product at low cost to the manufacturer. The Taguchi method was developed by Dr. Genichi Taguchi of Japan who maintains that variation. Taguchi developed a method for designing experiments to find out how different parameters affect the mean and variance of a process performance characteristic that defines how the processes are worked. The experimental design proposed by Taguchi involves us orthogonal arrays (OA) to organize the parameter which affect the processes and the levels at which they should be varies. Instead of testing all the possible combinations, the Taguchi method test pairs of combinations. This allows for the collection of the needful data to determine which parameters mostly affect the product quality with a minimum amount of experimentation, to save time and resources. The Taguchi method is most used when there are an intermediate number of variables (3 to 50), some interactions between variables, and when only some variables contribute significantly. The Taguchi arrays can be derived. Small arrays can be found out manually; large arrays can be derived from deterministic algorithms. Generally arrays can be found out online. The arrays are selected by the number of parameters and the number of level (states). Analysis of variance on the gathereddata from the Taguchi design experiments can be used to select new parameter values to optimize the performance characteristics. 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 used only when the process is carried out with the optimum parameters.One of the most important optimizationtechniques is Taguchi method. The Taguchi approach gives a comprehensive understanding of the individual and combined process parameter from a less number of simulation trials. The Taguchi approach is a form of design of experiments with special application principles. This technique or method helps to studyor find the effect of many variables on the desired quality characteristics most economically.By learning the effects of person factors on the results, the best factor combination can be derived. Taguchi designs experiments by using specially constructed tables known as "orthogonal array" (OA). Orthogonal array is the matrix of numbers arranged in columns and rows. By using these tables the design of experiments very simple and harmony and it requires minimum number of experimental trials to study the all parameter. As a result, time, cost, and labor saving can be achieved. The Taguchi method makes use of generic signal-to-noise (S/N) ratio to quantify the present variation. These S/N ratios are supposed to be used as measure of the effect of noise factors on performance characteristics. S/N ratios take into account both the amount of variation in the response data and closeness of the average response to target. The experimental results are converted into a signal-to-noise (S/N) ratio. Taguchi recommends the use of the S/N ratio to determine the quality characteristics which deviate from the desired values. Usually, there are three categories of quality characteristics in the analysis of the S/N ratio, i.e. the-Smaller-the-best, the-higher-the best, and the nominal-the-better. The S/N ratio for each level of process parameters is enumerated based on the S/N analysis. Regardless of the category of the quality characteristic, a higher 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 recommends the use of the loss function to determine the deviation of the quality characteristic from the appropriate value. The value of the overall loss function is further converted into a signal-to-noise (S/N) ratio. Normally, there are three categories of the quality characteristic in the analysis of the S/N ratio, i.e. the lower-the-best, the larger-the-best, and the more-nominal-the-best. The S/N ratio for each level of process parameters is enumerated based on the S/N analysis. Regardless of the category of the quality characteristic, a larger S/N ratio corresponds to a superior quality characteristic. Therefore, the optimal level of the process parameters is the level with the highest S/N ratio. Moreover, a statistical analysis of variance (ANOVA) is performed to see which process parameters are statistically important. The optimal combination of the process parameters can then be predicted. Finally, a confirmation experiment is performed to verify the optimal process parameters obtained from the process parameter design.

B.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.

EXPERIMENT	**ROTATIONAL SPEED**	**FEED**	**DEPTH OF CUT**
1	A	P	L
2	A	Q	M
3	A	R	N
4	B	P	L
5	B	Q	M
6	B	R	N
7	C	P	L
8	C	Q	M
9	C	R	N

Table1: Experimental design according to L9 orthogonal array.

C.MATERIAL GENERAL PROPERTIES

Alloy EN19 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, EN19 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.

5. APPLICATIONS

Alloy EN19 is commonly used to industries gear, gears, shafts, spindles, gears, bolts, studs and a wide variety of applications where a good quality high tensile steel grade. Some core applications that use Alloy EN19 include:

- Automotive gears and parts
- Shafts
- Towing pins
- Load bearing tie rods
- Oil & Gas industry applications

6. RESULT AND DISCUSSION

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

- An mild steel can produces better cylindrical finish during cylindrical grinding process in grinding process parameters.
- Mild steel has good machinability property.
- In cylindrical grinding the depth of cut and Feed plays a major role and produce maximum metal removal (MRR) rate inAustenitic stainless steel.
- Very high tolerance value can be obtained in cylindrical grinding.

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