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Optimization of Process Parameter in Precision Turning On Hytech CNC Lathe by Using Taugchi Method: A Review

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Abstract:-- **The machining processes is commonly used by manufacturing industries in order to produce precision component and very intricate products in a short time. The selection of the process parameter for optimizing and evaluate the results in machining operation is a very difficult task so here we select the some important parameter for optimizing the results and improve the efficiency. The process parameter are namely surface roughness, tolerance and cutting parameter like as cutting speed and dept of cut and feed rate and other parameter on Hytech CNC lathe machine which is to be taken for the study. This present work is carried out on turning process parameter on Hyper CNC lathe by using Taguchi method. The main objective of the present paper is to build a model to facilitate optimization problems in manufacturing processes. Due to improvement in the machining processes, a special concentration has been given on the life of a tool. To achieve that, the best way is to coat the tool with PVD and CVD techniques. By doing so an optimized machining condition under coated tool can be obtained to improvise the output parameters like tool life, surface finish etc. This paper provides literature review on machining parameters, such as cutting speed (Vc), feed (f) and depth of cut (t), and surface roughness and close tolerances of different material. This paper reviews the optimization of cutting parameters for surface roughness in the turning process. Surface roughness is one of the most commonly used criteria to determine quality and smoothness, tolerances of a turned surface. Taguchi method is a powerful tool to design optimization for quality. It is used to find the optimal cutting parameters such as cutting speed, feed rate, depth of cut and nose radius as the overall cost can be reduced. This paper gives some background of optimization technique applied to various turning processes for improving surface roughness.**

Index Terms:- Turning Operation, Surface Roughness, The Taguchi Approach, Taguchi Loss Function, Speed, Feed and Depth of Cut, Optimization.

I. INTRODUCTION

Turning is a form of machining, a material removal process, which is used to create rotational parts by cutting away unwanted material. The turning process requires a turning machine or lathe, workpiece, fixture, and cutting tool. The workpiece is a piece of pre-shaped material that is secured to the fixture, which itself is attached to the turning machine, and allowed to rotate at high speeds. The cutter is typically a single-point cutting tool that is also secured in the machine, although some operations make use of multi-point tools. The cutting tool feeds into the rotating workpiece and cuts away material in the form of small chips to create the desired shape.

Turning is used to produce rotational, typically axi-symmetric, parts that have many features, such as holes, grooves, threads, tapers, various diameter steps, and even contoured surfaces. Parts that are fabricated completely through turning often include components that are used in limited quantities, perhaps for prototypes, such as custom designed shafts and fasteners. Turning is also commonly used as a secondary process to add or refine features on parts that were manufactured using a different process. Due to the high tolerances and surface finishes that turning can offer, it is ideal for adding precision rotational features to a part whose basic shape has already been formed.

II. LITRATURE REVIEW

Brewer & Rueda (1963) [1] carried out simplified optimum analysis for non- ferrous materials. For the cast iron (CI) and steels, they were employed the criterion of reducing the machining cost. A number of monograms worked out to facilitate the practical results of the most economic machining conditions. They pointed out to the difficult-to-machine materials have a restricted range of the process parameters over by which the machining to be carried out for any attempt of optimizing their costs are artificial.

Wu (1982) [2] has reported that thousands of engineers have performed tens of thousands of experiments based on his teachings. Sullivan reports that Taguchi has received some of Japan's most prestigious awards for the quality achievement and including Deming prize. In 1986, Taguchi had received the most prestigious prize from the International Technology Institute – The Willard F. Rockwell Medal for the Excellence

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in the field of Technology. Taguchi's major contribution has involved combining engineering and statistical methods to achieve the rapid improvements in product cost and quality by optimizing the product design and the manufacturing processes.

Ghosh (1990) [3] remarked that Taguchi's ideas are also being used in many others US companies such as Ford and Xerox. There are many courses on the robust parameter design which is offered by the organizations like American Supplier Institute, Rochester Institute of Technology, and the Center for Quality and to Improvement the Productivity at the University of Wisconsin in Madison.

Agapiou (1992) [4] formulated single-pass and multi-pass machining operations. Production cost and the total time taken as the objectives and a weighting factor had assigned to prioritize of the two objectives in objective function. He optimized the number of passes and the depth of cut, cutting speed and feed rate in his model during operation, through which a multi- stage solution process was called dynamic programming. Several physical constraints considered and then applied in his model. In solution methodology, every cutting pass is independent of the previous pass of the product; hence optimality for each pass is not reached simultaneously and closely.

Juang and Tarng [2002] [5] used this method for process parameter selection for optimizing the weld pool geometry of the tungsten inert gas welding (TIG) of the stainless steel. They found that front height, front width, back height and back width of the weld pool affected the weld pool geometry significantly.

Benardos and Vosniakos [2002] [6] used this method for the prediction of surface roughness in CNC milling using neural networks and found that depth of cut, the feed rate per tooth, the cutting speed, tool wear, use of cutting fluid and the three components of the cutting force are the influential factors for the surface roughness.

Dhavlikar et al., [2003] [7] used this method to determine the robust condition for minimization of out roundness error of work pieces for center less grinding operation. with the confirmation runs.

III. PROBLEM STATEMENT

The problem has to be find an optimum set of conditions that were to produce minimum dimensional tolerance and smooth surface and all set of parameter which is to be taken in this study.

IV. PROBLEM DESCRIPTION

The step turning operation was used and it was required to work on the external diameter which was 30 mm. The upper and lower deviations were taken as 5 microns. This corresponds to,
Total tolerance = +5-(-5) = 10 microns.

V. OBSERVATION AND RESULTS

Optimizing the process parameter in precision turning on Hytech CNC lathe by using Taugchi method in International Research Journal of Engineering and Technology (IRJET) by Sakeel, Nausad khan and Rupesh kumar.

Analysis Of Results: In the Taguchi method the results of the experiments are analyzed to achieve one or more of the following three objectives:

a) To establish the best or the optimum condition for a product or a process.
b) To estimate the contribution of individual factors.
c) To estimate the response under the optimum conditions.

Studying the main effects of each of the factors identifies the optimum condition. The process involves minor arithmetic manipulation of the numerical result and usually can be done with the help of a simple calculator. The main effects indicate the general trend of the influence of the factors. Knowing the characteristic i.e. whether a higher or lower value produces the preferred result, the levels of the factors, which are expected to produce the best results, can be predicted.

The knowledge of the contribution of individual factors is the key to deciding the nature of the control to be established on a production process. The analysis of variance (ANOVA) is the statistical treatment most commonly applied to the results of the experiment to determine the percent contribution of each factor. Study of the ANOVA table for a given analysis helps to determine which of the factors need control and which do not.

In this study, an L9 orthogonal array with four columns and nine rows was used. This array has eight degree of freedom and it can handle three design parameters. Each parameter is assigned to a column, nine parameters combination being available. Therefore only nine parameters are required to study the entire parameter space using the L9 orthogonal array.

Graphs Obtained: The following graphs have been plotted by the use of MINITAB software:

1)Main Effect plots for S/N ratios for Dimensional Tolerance.

2)Main Effect plots for Means for Dimensional Tolerance.

Calculation For The Contribution Of Individual Fact:The calculation has made for the following:

A factor that can be pooled and the factor with the most influencing the variation of results and the C.I. for the optimum performance.

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Calculation For Dimensional Variation

The total of result is

T=1.192263+1.311+1.157+1.564+1.72+2.10862+1.28565+1.3048+1.85

=13.493333

The Total of effects of factors Effect of factor A (Speed)

A1 =1.192263+1.311+1.157 = 3.660263

A 2 =1.564+1.72+2.10862 =5.39262

A3 = 1.28565+1.3048+1.85 =4.44045

Effect of factor B (feed)

B1 = 1.192263+1.564+1.28565=4.041913

B2= 1.311+1.72+1.3048 =4.3358

B3 = 1.157+2.10862+1.85 =5.11562

Effect of factor C (Depth of cut)

C1 =1.192263+1.72+1.85= 4.762263

C2 =1.311+2.10862+1.28565= 4.70527

C3 =1.157+1.564+1.3048= 4.0258

Annova Calculations

Total DOFs (Degree Of Freedom) = No. of results – 1

= 9 – 1 = 8

DOF of Factor A = Levels of factor A – 1

= 3 – 1 = 2

DOF of Factor B = Levels of factor B – 1

= 3 – 1 = 2

DOF of Factor C = Levels of factor C – 1

= 3 – 1 = 2

DOF of error term = Total DOFs – Total of all factors DOFs

= 8 – (2+2+2) = 8 – 6 = 2

The correction factor (C.F.) is used for calculation of all sums of squares. It remains constant for all factors, as it is composed of fixed quantities (T and N).

C.F. = T2 / N = (13.493333)2 / 9 = 20.230004

The total sum of squares is calculated independently

ST = (X1 2 + X2 2 + X3 2 + X4 2 + X5 2 + X6 2 + X7 2 + X8 2 + X9 2) – C.F.

= 21.10753 - 20.230004

= 0.8775304

Now, The factor sum of squares

SA = (A1 2 + A2 2 + A3 2) / 3 – C. F.

= 62.19547 / 3 - 20.230004 = 0.50182

SB = (B1 2 + B2 2 + B3 2) / 3 – C. F.

= 61.30579 / 3 - 20.230004 = 0.2052595

SC = (C1 2 + C2 2 + C3 2) / 3 – C. F.

= 61.02578 / 3 - 20.230004 = 0.1119228

Sum of square for error term SE = ST – (SA + SB + SC)

= 0.8775304 – (0.50182+ 0.2052595+ 0.1119228)

=0.058528

Mean squares (or variance) i.e. sum of squares per DOF VA = SA / fA

=0.50182 / 2 = 0.25091

VB = SB / fB

= 0.2052595 / 2 = 0.1026298

VC = SC / fC

= 0.1119228 / 2 = 0.0559614

Mean variance for error term

VE = SE / f E = 0.058528 / 2 = 0.029264

Consequently, F – ratios for the factors will be, FA = VA / VE

= 0.25091 / 0.029264

= 8.5740113

FB = VB / VE

= 0.1026298 / 0.029264

= 3.5070288

FC = VC / VE

= 0.0559614 / 0.029264

= 1.9122943

Percent influence of factor, calculations: PA = SA / ST

= 0.50182 / 0.8775304

= 57.185487 % PB = SB / ST

= 0.2052595 / 0.8775304

= 23.390586 % PC = SC / ST

= 0.1119228 / 0.8775304

= 12.754296 %

Percent influence of error term,

PE= 100 - (PA + PB + PC) %

= 100 – (57.185+23.39+12.7543)

= 6.6696305 %

VI. VERIFICATION OF RESULT

For the dimensional tolerance of the outer diameter The standard deviation for dimensional variation was found out to be 1.15 microns. [Using the Parameter combination A2B3C2]

It was found out the component manufactured by the above method conformed well to the specification of the customer both with respect to the dimensional tolerance and the surface roughness.

Figure 1: Main Effect plots for S/N ratios for Dimensional Tolerance.

Figure 2: Main Effect plots for Means for Dimensional Tolerance

VII. CONCLUSION

In this paper present study it is to be found out that the parameter design of the Taguchi method provides a simple, systematic and efficient methodology for the optimization of process parameters. Based on the maximum percentage contribution of cutting speed and feed rate is and depth of cut in descending order and that the error for minimum dimensional tolerance. In this study it is to be found out that the all process parameter which is to be taken in study is to be greatly improved.

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