International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 05 Issue: 10 | Oct 2018 www.irjet.net p-ISSN: 2395-0072

A Review on: Parametric study for Optimization of CNC turning process parameters for surface roughness using ANOVA

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Abstract - *Now a day's achieving a good Surface Finish is the main focus in the metal cutting industry during turning processes. The present work is to review the work done by researchers in the field of turning process parameters, to investigate the effect of speed, cutting speed (feed) and depth of cut in computer numeric control i.e. CNC machine. The study will enlighten us with the current trends of the research in the field of ANOVA and CNC Turning.*

Key words: CNC Machine, ANOVA Software, Turning process parameters.

1. INTRODUCTION

CNC turning is that the foremost wide used machine for manufacturing diametric form work piece in shorter time at affordable price with high surface finish and precise dimensions. It's extremely desired that product having good surface finish made in short time. The surface finish quality of product is generally determined in terms of the measured surface roughness. Surface roughness usually depend upon the cutting parameters such as: cutting speed, feed rate and depth of cut.

Proper choice of the management factors for the experiment is very important so as to supply the parts with smart surface end and high tolerance in brief time. Within the previous few decades, lots of labor has been dole out to boost the standard of the merchandise and potency in machining. Still varied aspects associated with this paper area unit however to be explored.

1.1 Effect of Speed, feed, Depth of cut on Turning:

Feed, speed, and depth of cut have a direct effect on productivity, tool life, and machine requirements. Therefore, these elements must be carefully chosen for each operation. Whether the objective is rough cutting or finishing will have a great influence on the cutting conditions selected. The phrase speeds and feeds or feeds and speeds refer to two separate velocities in machine tool practice, cutting speed and feed rate. They are often considered as a pair because of their combined effect on the cutting process. Each, however, can also be considered and analyzed in its own right.

Cutting speed (also called surface speed or simply speed) is the speed difference (relative velocity) between the cutting tool and the surface of the work piece it is operating on. It is expressed in units of distance along the work piece surface per unit of time, typically surface feet per minute (sfm) or meters per minute (m/min). Feed rate (also often styled as a solid compound, feed rate, or called simply feed) is the relative velocity at which the cutter is advanced along the work piece; its vector is perpendicular to the vector of cutting speed. Feed rate units depend on the motion of the tool and work piece; when the work piece rotates (e.g., in turning and boring) the units are almost always distance per spindle revolution (inches per revolution) [in/rev or ipr] or millimeters per revolution [mm/rev]). When the work piece does not rotate (e.g., in milling), the units are typically distance per time (inches per minute) [in/min or ipm] or millimeters per minute [mm/min]), although distance per revolution or per cutter tooth are also sometimes used.

Fig1.0 CNC Machine

2. LITERATURE SURVEY

KomsonJirapattarasilp and ChoobunyenKuptanawin presented paper on, "Effect of Turning Parameters on Roundness and Hardness of Stainless Steel: SUS 303". Stainless steel JIS:SUS 303 is widely used for automotive part. This part is mostly manufactured by turning operation. However, turning parameters could be affected to roundness and hardness of work pieces. The purpose of

this research was to study factors, which were affecting to roundness and hardness of stainless steel turning. Cutting tool was inserted carbide coated TiCN+Al2O3+TiN with polycrystalline vapor deposited (PVD) cutting tools. Experimental design was conducted as two factors and three levels. The parameters were consisted of cutting speed at 100, 150 and 200 m/min. Feed rate was setting at 0.08, 0.12 and 0.16 mm./rev. Furthermore, the experiment was done by turning with cooling and non-cooling. The results showed that only one factor affected to roundness was cooling condition. It means that cooling would cause on better roundness than non-cooling. On the other hand, cutting speed and feed rate was not affected to roundness. Moreover, the hardness of specimens was not increasing after turning. The studied parameters were not affected to hardness after turning significantly. [1]

Puneet Kumar, Ashwani Kumar Dhingra, and Pankaj Kumar presented paper on, "optimization of process parameters for machining of mild steel en 18 by Response surface methodology". Present work considers the parametric optimization of CNC MAX MILL machining for Mild Steel (EN18) with Cemented Carbide as cutting tool under constant flow of coolant. The machining cutting parameters (cutting speed, feed rate and depth of cut) optimized to evaluate high material removal rate and minimum surface roughness. Response surface method interpreted the experiment data with the help of Design of experiment. Analysis of variance (ANOVA) shows the different parameters which provide the significant impact on the values of surface roughness and material removal rate. The optimum solution of Material Removal Rate (MRR) and Roughness (SR) can be found at the cutting speed of 4186 rpm, feed rate of 1831 mm/min. and depth of cut of 0.60 mm. [2]

WahidaNawrin, TanzinaAfrin, Md.Ashikuzzaman, and Md.GolamKibria presented paper on "Optimization of Process Parameters for Turning of Mild Steel in Minimum Quantity Lubrication (MQL)" . In this experimental study, an attempt is made to obtain optimum cutting parameters for turning of mild steel on the basis of surface roughness and surface temperature. Optimization of cutting parameters is very important to obtain a good machining quality of surface and to inhibit the increase of temperature. Minimum Quantity Lubrication (MQL) has been introduced to avoid excessive use of cutting fluid. The parameters considered here are cutting speed, feed and depth of cut. Optimal cutting parameters for each performance measure were obtained employing Taguchi experimental method. To study the performance characteristics in turning operation Analysis of Variance (ANOVA) was employed. It is found that cutting speed and feed has significant effect on both surface roughness and temperature. [3]

CarmitaCamposeco-Negrete presented paper on "Optimization of cutting parameters for minimizing energy consumption in turning of AISI 6061 T6 using Taguchi methodology and ANOVA". Machine tools are responsible for environmental impacts owing to their energy consumption. Cutting parameters have been optimized to minimize cutting power, power consumed or cutting energy. However, these response variables do not consider the energy demand that ensures the readiness of the machine tool. The present paper outlines an experimental study to optimize cutting parameters during turning of AISI 6061 T6 under roughing conditions in order to get the minimum energy consumption. An orthogonal array, signal to noise (S/N) ratio and analysis of variance (ANOVA) were employed to analyze the effects and contributions of depth of cut, feed rate and cutting speed on the response variable. A comparison was done to highlight the importance of correctly selecting the response variable to be analyzed, due to the difference of the values of cutting parameters needed to optimize cutting power, cutting energy, power consumed and energy consumed during the machining process. Additional, the relationship between cutting parameters, energy consumption, and surface roughness was analyzed in order to determine the levels of the cutting parameters that lead to minimum energy consumption an minimum surface roughness. The results of this research work showed that feed rate is the most significant factor for minimizing energy consumption and surface roughness. Nevertheless, the level of this factor needed to achieve minimum energy consumption is not the same as the one needed to obtain minimum surface roughness. Higher feed rate provides minimum energy consumption but will lead to higher surface roughness. [4]

K.Manilavanya, R.K.Suresh, A.Sushil Kumar Priya, V.Diwakar Reddy presented paper on, "Optimization of Process Parameters in Turning Operation of AISI-1016 Alloy Steels with CBN Using Taguchi Method and Anova". This paper investigates the parameters affecting the roughness of surfaces produced in the turning process for the material AISI-1016 Steel. Design of experiments was conducted for the analysis of the influence of the turning parameters such as cutting speed, feed rate and depth of cut on the surface roughness. The results of the machining experiments for AISI-1016 were used to characterize the main factors affecting surface roughness by the Analysis of Variance (ANOVA) method. The feed rate was found to be the most significant parameter influencing the surface roughness in the turning process. [5]

Yacovsahijpaul, Gurpreetsingh presented paper on, "Determining the Influence of Various Cutting Parameters on Surface Roughness during Wet CNC Turning of AISI 1040 Medium Carbon Steel. The purpose of this experimental investigation was to analyze the effect of controlled cutting parameters namely cutting speed, feed rate, depth of cut, cutting fluid concentration and two cutting fluids with different base oils on surface roughness (Ra) of EN8 or AISI 1040 steel during turning operation by applying design of experiments, custom design method,

analysis of variance, leverage plots and desirability profiling using JMP software to optimize surface roughness during wet CNC turning operation. The analysis reveals that feed rate has the most significant effect on surface roughness (Ra) and value of surface roughness does not significantly differ for two different cutting fluids used. [6]

Parshvam Jain *, Ranganath M S, Vipin, R. S. Mishra, Sushil Kumar, Karan Singh Tanwar presented paper on "Optimization of Machining Parameters for Turning Mild Steel Using Design of Experiment". In this paper, optimized value of cutting parameters (i.e. feed rate, cutting speed and depth of cut) and also the dominating parameter which affects the roughness of a surface produced during the turning process for mild steel are examined. Surface roughness is the quality characteristic; better surface finish affects the efficiency, performance, maintenance cost for any kinematic mechanism. So, surface roughness is very important quality characteristic. Mathematical tools taguchi method and ANNOVA (Analysis of variance) are employed to investigate the optimized value of cutting parameters for high grade of surface finish. Feed rate and cutting speed are identified as the most influential cutting parameters on surface roughness. [7]

Vijay Bhagora, Prof. Saurabh p. Shah presented paper on "Modelling and Optimization of Process Parameters for Turning Operation on CNC Lathe for ASTM A242 Type-2 Alloy Steel by Artificial Neural Network and Regression Analysis – A Review Paper". The purpose of this project is focused on the modelling of cutting conditions to get lowest surface roughness in turning ASTM A242 TYPE-2 ALLOYS STEEL by Artificial neural network and Regression Analysis method on the CNC lathe. The process of metal Cutting has been well researched over the years, relatively small research has been carried out on the cutting of alloy of ASTM A242 grade materials. In this study, the effect and modelling of machining parameters cutting speed, feed rate and depth of cut and Tool nose radius on surface roughness will be checked. [8]

N. ZeelanBasha, S. Vivek presented paper on "Optimization of CNC Turning Process Parameters on ALUMINIUM 6061 Using response surface methodology". This paper presents the effect of process parameter in turning operation to predict surface roughness. The turning process by using CNC turning lathe is widely used in industry because of its versatility and efficiency. Applications of the turning process can be found in many industries ranging from large engine manufactures to small die shops. The parameters that affect the turning operation are vibration, tool wear, surface roughness etc. Among this surface roughness is an important factor that affects the quality in manufacturing process. The main objective of this paper is to predict the surface roughness on aluminum 6061, by optimizing the input parameters such as spindle speed, feed rate and depth of cut by using coated carbide tool. A second order mathematical model is developed using regression technique and optimization is carried out using Box-Behnken of response surface methodology. The application of response surface methodology for optimizing the input parameters such as spindle speed (rpm), feed rate (mm/min) and depth of cut (mm), the output parameter surface roughness can also be optimized for economical production. Study attempts the application of response surface methodology to find the optimal solution of the cutting conditions for giving the minimum value of surface roughness using design-expert 8.0 software. [9]

Mahendra Korat, Neeraj Agarwal presented paper on "Optimization of Different Machining Parameters of En24 Alloy Steel in CNC Turning by Use of Taguchi Method". The present paper outlines an experimental study to optimize the effects of cutting parameters on surface finish and MRR of EN24/AISI4340 work material by employing Taguchi techniques. The orthogonal array, signal to noise ratio and analysis of variance were employed to study the performance characteristics in turning operation. Five parameters were chosen as process variables: Speed, Feed, Depth of cut, Nose radius, Cutting environment (wet and dry). The experimentation plan is designed using Taguchi's L18 Orthogonal Array (OA) and Minitab 16 statistical software is used. Optimal cutting parameters for, minimum surface roughness (SR) and maximum material removal rate were obtained. Thus, it is possible to increase machine utilization and decrease production cost in an automated manufacturing environment. [10]

Jadhav J.S., Jadhav B.R. presented paper on "Experimental study of Effect of Cutting Parameters on Cutting Force in Turning Process". The purpose of this paper is to study the effect of cutting parameters on cutting force (Fc) & feed force in turningProcess. Experiments were conducted on a precision centre lathe and the influence of cutting parameters was studied usinganalysis of variance (ANOVA) based on adjusted approach. Based on the main effects plots obtained through full factorialdesign, optimum level for surface roughness and cutting force were chosen depth of cut, and the interaction of feed and depth ofcut significantly influenced the variance. In case of surface roughness, from the three levels of cutting parameters considered Linear regression equation of cutting force has revealed that feed, the influencing factors were found to be feed and the interaction of speed and feed. As turning of mild steel using HSS is one among the major machining operations in manufacturing industry, the revelation made in this research would significantly contribute to the cutting parameters optimization. [11]

Dr. N. Lakshmana Swamy presented paper on "Optimizing Surface Roughness in Turning Operation Using Taguchi Technique and Anova". The objective of this paper is to obtain an optimal setting of Turning parameters (Cutting speed, Feed and Depth of Cut) which results in an optimal value of Surface Roughness while

machining Al 6351-T6 alloy with Uncoated Carbide Inserts. Several statistical modelling techniques have been used to generate models including Genetic Algorithm, Response Surface Methodology. In our study, an attempt has been made to generate a model to predict Surface Roughness using Regression Technique. Also an attempt has been made to optimize the process parameters using Taguchi Technique. S/N ratio and ANOVA analysis were also performed to obtain significant factors influencing Surface Roughness. [12]

3. CONCLUSION

In the present work the researchers have conducted studies on process parameters and impact on surface hardness and roughness.

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