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A literature review on optimization of cutting parameters for surface roughness in turning process

Arshad Qureshi[1], Prof Madhukar Sorte[2], Prof S.N. Teli[3]
[1]*Saraswati. College of Engineering kharghar, Navi Mumbai,*
[2]*Head of Dept. Mechanical Engg., MGM college of engg, Panvel.*
[3]*Head of Dept. Mechanical Engg, Saraswati college of Engg, Khargar*

Abstract:- 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 of a turned surface. The surface roughness of a turned surface is an important response parameter. Surface roughness contributes to better function or longer life span. It also contributes to abrasion resistance material and good wear resistance. 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.

Keywords:- Taguchi, Optimization, Turning, Surface Roughness.

I. INTRODUCTION

Manufacturers who are competing in the market want their product to be manufactured at less cost. The setup for machining a component should be effective which takes less time and effort. Optimization of cutting parameters such as cutting speed feed rate and depth of cut gives better surface finish, takes minimum time and produces less tool wear. Turning can be done on lathe machine or by using CNC (computer numerical control) machine. A CNC is commonly used with many other types of machine. In turning process simple single point cutting tools are used.

Taguchi method is one of the most effective systems of offline quality control system. Taguchi method is used where the quality is improved at the design stage instead of controlling it at the manufacturing stage. A customer usually considers several correlated quality characteristics of a product.

Metal cutting is widely used manufacturing process in the industries. The metal cutting studies focus on features of tools and machine parameters which affects the process and output quality characteristics. High speed machining technologies and use of modern machine tools enables the improvement of surface roughness by accurate displacement of tool and good surface finish of the machined surface. High speed machining alone however is not enough to optimize the quality in the manufacturing sector because of the complexities involved in its precise control which make it difficult to employ by the manufacturers. Thus the correct selection of cutting parameters such as feed rate, depth of cut, cutting speed etc generates optimum conditions during machining and becomes the main exigency of manufacturing industry.

1.1 Surface roughness tester:

Surface roughness of a material after turning is measured using surface roughness tester. Surface roughness is an important criteria to find the quality of a surface. It is an important response parameter. Surface finish can be measured using simple surface roughness tester made by Mitutoyo. This is a small, lightweight, and extremely easy to use surface roughness measurement instrument that lets you view surface roughness waveforms right on the colour LCD screen. The colour LCD provides excellent readability and an intuitive display that's easy to negotiate. The LCD also includes a backlight for improved visibility in dark environments. Up to 10 measurement conditions and one measured profile can be stored in the internal memory.

Fig.1 Surface Roughness Tester

1.2 Experiment parameters:

Cutting parameters like feed rate, depth of cut, spindle speed, type of coolant are some of the important parameters which affect the surface roughness. In the turning process the parameters such as cutting speed, feed, depth of cut and type of coolant etc are optimized for better surface finish

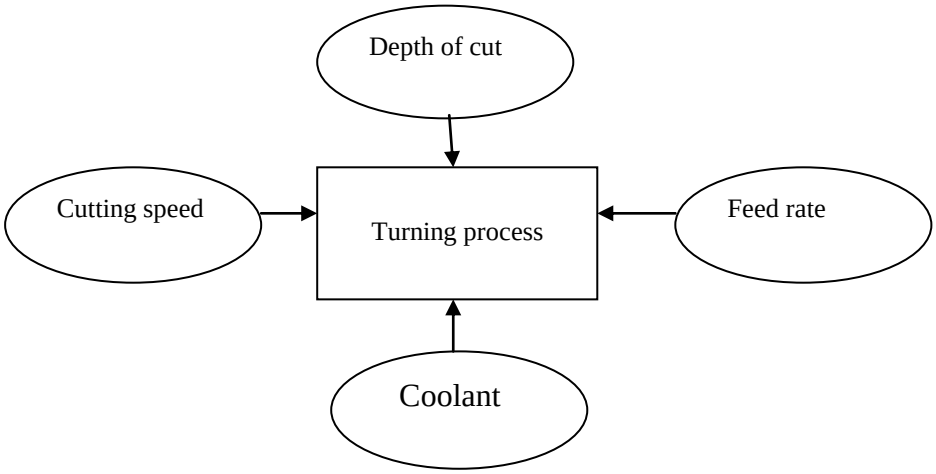

Fig.2: Factors affecting the turning process

II. LITERATURE REVIEW

In [1] Taguchi L9 orthogonal array has been applied for experimental design. S/N ratio and ANNOVA analysis were performed on D3 steel to identify significant parameters influencing tool wear and surface roughness. Results signify the cutting speed to be the most significant factor influencing flank wear.

In [2] the influence of cutting parameters on cutting force and surface finish in turning operations. The authors used work material of 1050 steel (hardness of 484 HV) with tool made of ceramic with an Al203 + Tic matrix (KY1615) .

In [3] evaluation of dry turning of inconel718 using carbide inserts was done using Taguchi's L9 array. Feed rate was found to be the most significant parameter for surface roughness.

In[4] Taguchi method was used to optimize the machining parameters. The influence of process parameters on cutting force and surface roughness during turning of AA2219-TiB2/ZrB2 In situ metal matrix composites was done. L27 orthogonal layout was used for experimentation. The response graph and analysis of variance shows that feed rate has strongest effect on surface roughness and cutting force.

In [5] multi objective optimization of machining parameters during dry turning of IASI 304 Austenite stainless steel was done. Three imp characteristics MRR, cutting force and surface roughness were measured.

In [6] Design of experiment was done to optimize the turning parameters like cutting speed, depth of cut and feed of duplex steel. Duplex steels during machining are generally prone to mechanical strengthening Feed rate and cutting speed have statistically significant effect on surface roughness parameters Ra, Rz where increase of factors effect increase surface roughness but then feed rate is set to level 0.1 mm/rev factor cutting speed has smaller effect.

In [7] an attempt has been made to model and optimize hard turning AISI D3 Hardened steel using response surface methodology. The combined effects of four machining parameters, including cutting speed, feed rate, hardness and tool corner radius investigated. Tool corner radius and feed rate have most influence on surface roughness respectively. Among the interactions effect of feed rate-corner radius, hardness-corner radius and cutting speed-corner radius were significant on surface roughness respectively.

In[8] cutting inserts used are CBN inserts and treated cryogenically at -196 degree Celsius the cutting parameters are cutting velocity with feed rate Cryogenically treated CBN inserts produced less wear on titanium than AISI 440 C steel. Formation of flank wear in titanium alloy was low than AISI 440 C

In [9] Using Taguchi Cutting parameters of red copper tube namely cutting speed, feed rate, and depth of cut are optimized. An orthogonal array, the signal-to-noise (S/N) ratio, is employed to investigate the cutting characteristics using high speed steel W18Cr4V cutting tools. The experiment studies various factors impact on micro groove fin, gets the primary and secondary influence order of each factor to the surface roughness and optimal processing method. To reduce surface roughness, spindle speed should be appropriately reduced; the feed rate and feed per tooth should be increased.

In [10] optimization of cutting parameters in CNC turning of P20 steel was done. The effect of optimization of cutting parameters (cutting speed, feed rate, depth of cut, nose radius and cutting environment) in CNC turning on power consumption is investigated. Taguchi method and response surface methodology was used to compare the power consumption.

In [11] optimization of multiple quality characteristics like tool life, cutting force, surface roughness and power consumption in CNC turning of P20 steel using liquid nitrogen as a coolant. Experiment results indicate that highest desirability could be obtained at low level of cutting speed, feed, depth of cut and high nose radius.

In [12] optimization for surface roughness and MRR in CNC turning was done.SS 316 (austenite steel) was turned in dry environment conditions. An L27 orthogonal array, analysis of variance and grey relation analysis is used.

In [13] Taguchi method was used for studying the machinability of AISI 410 on CNC lathe for surface roughness.L27 orthogonal array , analysis of variance are used in this investigation.

In [14] AE was proposed as an indirect and noncontact technique for in process surface roughness assessment in the turning process. Three cutting conditions dry cut, cutting wit water as a coolant and normal coolant were used for study of EN8 steel. Taguchi method is used to find optimal cutting parameters for surface roughness (Ra) in turning. For prediction of surface roughness and AE signal value regression models are developed

III. CONCLUSION

In this work, attempt has been made to present a literature review on optimization of cutting parameters for surface roughness in turning. The optimal combination of low feed rate and low depth of cut is beneficial for good surface finish. It has been observed that in machining of steel with coated carbide inserts most of the studies concentrated on measurement of surface roughness. Therefore tool performance of tools related to tool wear and cutting forces considering effect of work material hardness and type of coating material is need to be investigated. Future research work can be done on further optimization of cutting parameters. In finish turning there should be use of different coating techniques in tools. Study of the effects of cooling and use of lubricant techniques with coated tools or inserts should be explored in turning applications.

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