



Study on process parameters for CNC turning using Taguchi Methods for EN8 alloy steel with Coated/Uncoated tool inserts

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Abstract: The tool inserts, coated/uncoated offers a certain degree of control on the desired rate of material removal or the surface roughness to an extent. This work will help to compare the results in terms of effectiveness of the performance of coated and uncoated tool inserts by varying process parameters at dry cutting condition. Levels shall be manipulated over the given range of operation while results would be recorded for analysis further. ANOVA & Taguchi methods are being considered to address the statistical treatment to the data. Significant input parameters shall be identified through the analysis of this data and the Design of experiments shall be performed to seek solution towards finding an optimal setting for the operation. The result shall be validated for a single optimal setting recommended towards the concluding phase of this work.

Keywords: Turning, Taguchi methods, ANOVA, coated/uncoated inserts, surface roughness

I. Introduction

Metal cutting is one of the vital processes and widely used in engineering industries. Highly competitive market requires highly products at minimum cost. Products are manufactured by the transformation of raw material. To improve productivity with good quality of the machined parts is the main challenges of metal industry; there has been more concern about monitoring all aspects of the machining process. High speed machining can be used to machine parts that require the removal of significant amount of materials and to machine long, thin webs. The need throughout industry and defence establishment to reduce costs and increase productivity has created new interest in high speed machining. The grey relational analysis is based on grey system theory can be used for solving the complex interrelationships among the multiple responses. A GRG is determined to evaluate the multiple responses.

Figure.1 Uncoated and Coated tool inserts



Figure 2 Insert holder tools



II. Literature Survey

P. Jayaraman et al. [1] have used grey relational analysis to perform multi objective optimization of surface roughness, roundness and MRR in turning of AA6063 T6 aluminium alloy and determined that cutting speed is the most influencing parameter affecting combined grey relational grade followed by depth of cut and feed rate. A grey relational grade (GRG) is determined from the grey analysis. Optimum levels of parameters have been identified based on the values of grey relational grade and then the significant contribution of parameters is determined by ANOVA.

Dr. C. J. Rao et al. [2] the feed rate has significant influence both on cutting force as well as surface roughness. Depth of cut has a significant influence on cutting force, but has an insignificant influence on surface roughness. The interaction of feed and depth of cut and the interaction of all three cutting parameters have significant influence on cutting force, whereas, none of the interaction effects are having significant influence on surface roughness produced.

Shreemoy Kumar Nayak et al. [3] was investigated the influence of different machining parameters such as cutting speed (V_c), feed (f) and depth of cut (t) on different performance measures during dry turning of AISI 304 austenitic stainless steel. ISO P30 grade uncoated cemented carbide inserts was used as a cutting tool for turning. Three important characteristics of machinability such as material removal rate (MRR), cutting force (F_c) and surface roughness (R_a) was measured.

Anders Nordgren et al. [4] The plastic deformation of tools is one of the most important wear modes in metal cutting. Such deformation changes the geometry of the cutting edge, which often results in accelerated tool wear, increased cutting forces, risk of tool failure, vibrations and poor dimensional accuracy and surface finish.

S. J. Raykar et al. [5] the high speed turning is emerging as a key manufacturing technology in aerospace industry. High speed turning is generally performed on the order of five to ten times the conventional cutting speed. It has several advantages such as reduction in cutting forces and temperature, low power consumption, improvement in surface finish, low stress components, burr-free surfaces, better dimensional accuracy, and better part quality.

V. Bushlya et al. [6] presents results of superalloy machinability study with uncoated and coated PCBN tools aiming on increased speed and efficiency. Aspects of tool life, tool wear and surface integrity were studied. It was found that protective function of the coating, increasing tool life upto 20%, is limited to low cutting speed range.

Harsh Y Valera et al. [7] study of power consumption and roughness characteristics of surface generated in turning operation of EN-31 alloy steel with TiN+AL₂O₃+TiCN coated tungsten carbide tool under different cutting parameters. The study shows the influence of three cutting parameters like spindle speed, depth of cut and feed rate affecting surface roughness as well as power consumption while turning operation of EN-31 ALLOY steel. Coating is also used on cutting tools to provide improved lubrication at the tool/chip and tool/work piece interfaces and to reduce friction, and to reduce the temperature at the cutting edge. During machining, coated carbide tools ensure higher wear resistance, lower heat generation and lower cutting forces, thus enabling them to perform better at higher cutting conditions than their uncoated counterparts.

SurajJadhav et al. [8] have used grey relational analysis to perform multi-objective optimization of surface roughness & MRR in turning of EN24 alloy steel with coated / uncoated tool inserts. From, it is concluded that spindle speed & depth of cut are prominent factors which affect the turning of EN24 alloy steel. Optimum level of parameters has been identified based on values of grey relational grade & then the significant contribution of parameters is determined by ANOVA.

III. Concluding Remark

From the literature survey it is concluded that, surface roughness and material removal rate are the important response variables in the modern CNC machining industry. Many researchers investigate the effects of cutting speed, feed rate, and depth of cut in CNC turning operation performed on various materials. The various optimization techniques are use for minimization of surface roughness and maximization of material removal rate. The geometry of the insert, its composition and coating on its working surface influences the rate of material removal . From the literature review it is found that optimization is one of the effective techniques used in manufacturing area to get at the best manufacturing conditions, which is essential requirement for industries towards manufacturing of quality products at minimum cost. The cutting parameters (Depth of cut, Feed rate , temperature and cutting speed) have considerable effects on tool life.

IV. Problem Definition

Turning refers to the machining operation effected by chip removal from the stock of the raw material using a CNC machine. The control parameters for the operation need to be optimized to effect the best response in terms of surface roughness or the temperature at the cutting tip. The desired value of surface roughness should be attempted while optimizing the resources assigned to the operation. If the surface speed of the turning operation is increased, a favorable surface roughness could be realized but at the cost of lower tool-life (due to increased

cutting temperature) or any other side effects of maintaining a high surface speed. Similarly, the use of coated tool inserts could be beneficial but the increased purchase cost should be negated with the realization of the additional benefit in using coated inserts. The rate of material removal consequently the production rate is influenced by the choice of the levels assigned for these control parameters. Work needs to be undertaken for determining optimum levels for the significant parameters to ensure that the process does not run on sub-optimal setting leading to reduced production and/or increased rejections in terms of response parameters.

V. Workpiece Material and Tool Inserts

EN8 alloy steel -

Tensile Strength – 850/1000 N/mm²

C	SI	MN	S	P	Cr	Mo	Ni
0.410	0.163	0.827	0.021	0.035	0.005	0.001	0.000

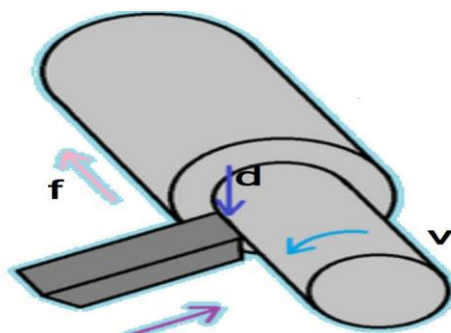
Applications of EN8 alloy steel:

- Crank Shaft
- Connecting rod

Tool inserts - The uncoated i.e. Cemented Carbide insert and Coated i.e. PVD coated TiAlN insert using for machining of EN8 alloy steel.

VI. Parameters

Figure 3 Principle of metal cutting



A) Input Parameters:

- Cutting Speed v (m/min)
- Feed Rate f (mm/rev.)
- Depth of Cut d (mm)

B) Output Responses:

- Surface Roughness- Surface roughness tests are to be conducted on all the samples, after each of the trials.
- Material Removal Rate (MRR) – The material removal rate of the work piece is measured by ratio of the difference between weight of the workpiece before and after machining to the machining time that is achieved.

VII. Methodology

1. The literature reviewed on effect and optimization of different machining parameters speed, feed, depth of cut flutes for minimum surface roughness and maximum material removal rate in turning operation.
2. The experiments will be planned according to Taguchi design of experiments method to find the effect of machining parameters i.e. speed, feed and depth of cut on response variables under study.
3. The surface roughness and material removal rate for different combinations of speed, feed, and depth of cut will be measure.
4. The experimentation will be done on CNC machine for EN8 alloy steel workpiece. The surface roughness and material removal rate will be measured.
5. For the analysis purpose, 'Minitab' Software shall be used. In this research work, we shall use the tools such as Taguchi Method/ANOVA.
6. Optimization of process parameters will be carried out by using suitable techniques.

7. The result and discussion carried out from observed data.

VIII. Expected Outcome

This research work will help to compare the results in terms of effectiveness of the performance of coated and uncoated tool inserts by varying process parameters at dry cutting condition. The tool inserts, coated or uncoated

offers a certain degree of control on the desired rate of material removal or the surface roughness to an extent. This work pursues the quest for realizing the optimal values for the significant process parameters that bears an influence on the response parameters.

IX. Conclusion

The literature review suggests that the critical parameters for turning operation could be listed as Speed, Feed and Depth of cut. While the maximum allowable cutting speeds could be referred from the catalogue of the tool manufacturers, the feed and depth of cut could be arrived at upon experimenting with the test samples. Coated and uncoated tool inserts from well-known manufacturer shall be used for the experiment. Analysis is considered using Statistical treatment for the data with DOE tools. EN8 being a steel finding wide applications in Engineering industry, has been identified as the material for the Test Piece for pursuing this research work.

X. References

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