EXPERIMENTAL INVESTIGATION ON HARD TURNING TO FIND OPTIMAL PROCESS PARAMETERS

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ABSTRACT

Hard turning is the one of the recent machining process which replaces the grinding process.The common objective of hard turning is to obtain better surface finish. In this work it focused to perform hard turning AISI52100 steel using tungsten carbide insert in a CNC turning center. The work is carried out experimentally using Taguchi L9 orthogonal array considering process parameters Cutting speed, feed and depth of cut and considering the responses surface finish, MRR and machining time. The Test of hypothesis of the model resulted satisfactorily for the fitness function. It is found that the feed rate is the predominant factor. Further a mathematical model developed using regression analysis which can be used for finding optimized values of cutting speed, feed and depth of cut to obtain surface finish, MRR and machining time using optimization techniques such as GA,PSO,ANN etc.,

KEYWORDS: *Hard turning, Taguchi, L9 orthogonal array, Surface roughness, Regression Analysis, ANOVA.*

INTRODUCTION

Generally, manufacturing process are classified into two types. They are Primary and secondary process. The Casting, Welding, Forging, etc comes under primary manufacturing process and the machining comes under secondary manufacturing process. The selection of objectives of this work includes the following validation.The MRR and the Machining time are the basic critical factors for production time and the Surface Roughness (R_a) is the most important criteria that to be reduced as far as possible because of its effect of leading to failure in the mating parts due to friction. The work material used for the present study is AISI 52100 steel. The chemical composition of the work material are as shown in the table below

C	Mn	Si	S	P	Cr
0.90-1.20	0.30-0.75	0.10-0.35	0.040	0.040	1.00-1.60

Turning is one of the machining processes in which uses single point cutting tool removes unwanted material from the surface of a rotating cylindrical work piece. The cutting tool is fed linearly in a direction parallel to the axis of rotation.

Turning produces three cutting force components,(the main cutting force i.e. thrust force (FZ), which produces in the cutting speed direction, feed force (FX), which produces in the feed rate direction and the radial force (FY), which produces in radial direction and which is normal to the cutting speed). From three force components the cutting force constitutes about 70% to 80% of the total force 'F'. Power consumption may be used for monitoring the tool conditions.

Carbide cutting tools are popular in metal cutting industry for the cutting of several hard materials such as alloy steels, die steels, high speed steels, bearing steels, white cast iron and graphite cast iron. In the past decades there had been great advancements in the development of these cutting tools. Coating is usually provided on cutting tools to provide improved lubrication at the tool/chip and tool/work piece interfaces and to reduce friction and to reduce the temperatures at the cutting edge. During machining, coated tungsten carbide tools ensures higher wear resistance, lower heat generation and lower cutting forces, thus enabling them to perform better at higher cutting conditions than their uncoated counterparts. The use of coated tools are becoming increasingly demanding among the other tool materials.

Surface properties like roughness are critical to the functional ability of machine components. Increased understanding of the surface generation mechanisms can be used to optimize machining process and to improve functional ability of the component. Numerous investigators have been conducted to determine the effect of parameters such as feed rate, tool nose radius, cutting speed and depth of cut on surface roughness in hard turning operation. The surface roughness decreases with increasing nose radius. Large nose radius tools have produced better surface finish than small nose radius tools. Several experiments have been made to optimize and investigated the effects of different parameters affecting cutting forces, surface roughness, tool wear in hard turning of various grade of steels.

It was found that the factors that highly influence the process efficiency and output characteristics are spindle speed, feed rate, depth of cut and cutting environment. Experimental works have been carried out on the above mentioned parameters.

MATERIALS AND METHODS

This analysis deals with the finding the optimal cutting conditions in turning of AISI 52100 steel rod (work piece diameter: 25 mm) using carbide cutting tool in CNC turning centre for nine different values of spindle speed, feed and depth of cut. The details of Levels and Factors are shown in Table.

LEVELS/FACTORS	LEVEL 1	LEVEL 2
Spindle Speed (rpm)	375	1000
Feed (mm/rev)	0.1	0.3
Depth of Cut (mm)	0.5	1.5

The above table which shows the minimum and maximum levels of three different parameters such as Spindle speed, Feed and Depth of Cut of the work material.

EXPERIMENTAL DESIGN

Selection of experimental design is a decision making process which decides the degree of validity of the desired model in finding optimal cutting parameters. This work is carried out using Taguchi L9 orthogonal array methodology.

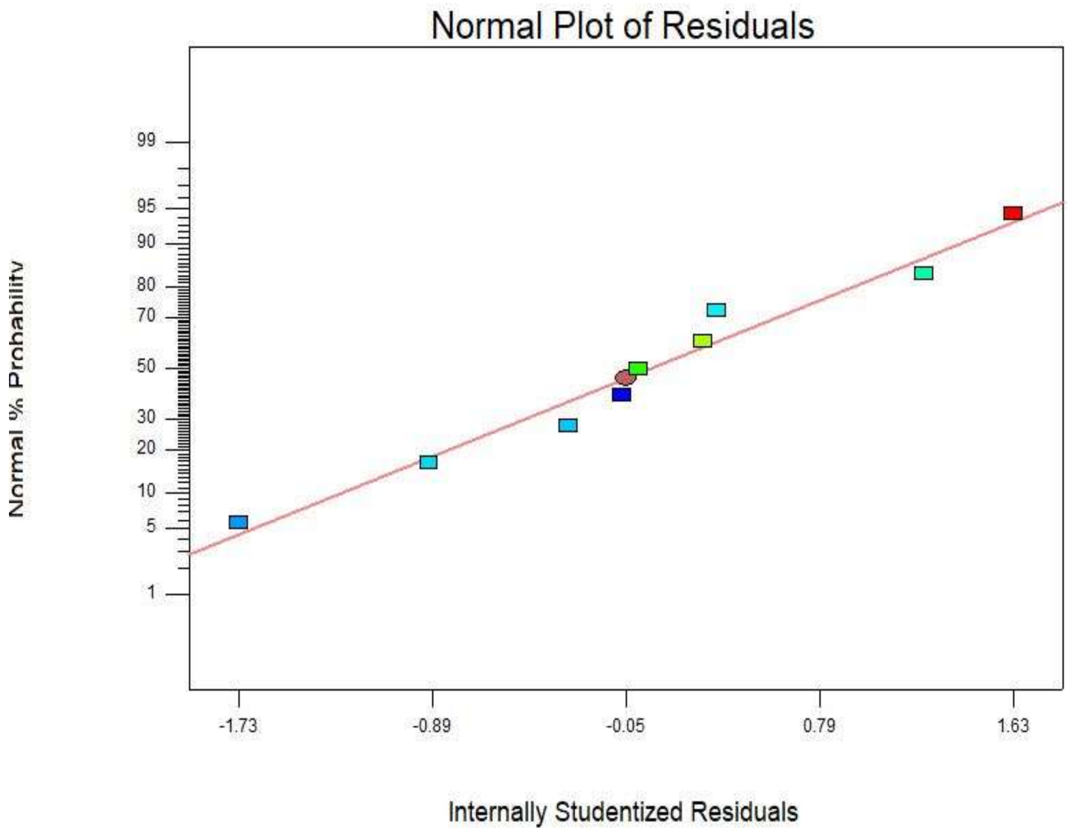
TAGUCHI METHODOLOGY

The Taguchi method involves reducing the variation in a process through robust design of experiments. The overall objective of the method is to produce high quality product at low cost to the manufacturer. The Taguchi method was developed by Genichi Taguchi. He developed a method for designing experiments to investigate how different parameters affect the mean and variance of a process performance characteristic that defines how well the process is functioning. The experimental design proposed by Taguchi involves using orthogonal arrays to organize the parameters affecting the process and the levels at which they should be varied. Instead of having to test all possible combinations like the factorial design, the Taguchi method tests pairs of combinations. This allows for the collection of the necessary data to determine which factors most affect the product quality with a minimum amount of experimentation, thus saving time and resources. The Taguchi method is best used when there is an intermediate number of variables (3 to 50) few interactions between variables, and when only a few variables contribute significantly. The Taguchi L9 orthogonal array technique is used.

DATA COLLECTION

Data collection plays a major role in the statistical analysis of any field, as it decides the progression of the analysis to the best or worst. A proper and suitable data collection leads to good results from analysis. In such focus it is very much essential to choose a well suitable data collection technique for the analysis. In this work, Data collection for the turning process is selected for proceeding with Taguchi L9 orthogonal array methodology. The values predicted using the model in turning of AISI 52100 steel rod using carbide cutting tool has been shown in Table.

W/P NO.	SPINDLE SPEED (rpm)	FEED (mm/rev)	DEPTH OF CUT (mm)	M/C TIME (sec)	SURFACE ROUGHNESS (microns)	MRR (cu.m/min)
1.	1000	0.3	1	31	1.30	0.0003
2.	1000	0.1	1.5	56	0.653	0.00015
3.	700	0.3	0.5	31	1.46	0.000105
4.	375	0.1	0.5	139	0.94	0.0000187
5.	700	0.2	1.5	43	0.91	0.000210
6.	700	0.1	1	78	1.053	0.000070
7.	1000	0.2	0.5	30	0.89	0.0001
8.	375	0.3	1.5	50	1.853	0.0001687
9.	375	0.2	1	73	0.836	0.00075


Normal Plot of Residuals
Normal % Probability
99
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80
70
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5
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0.79
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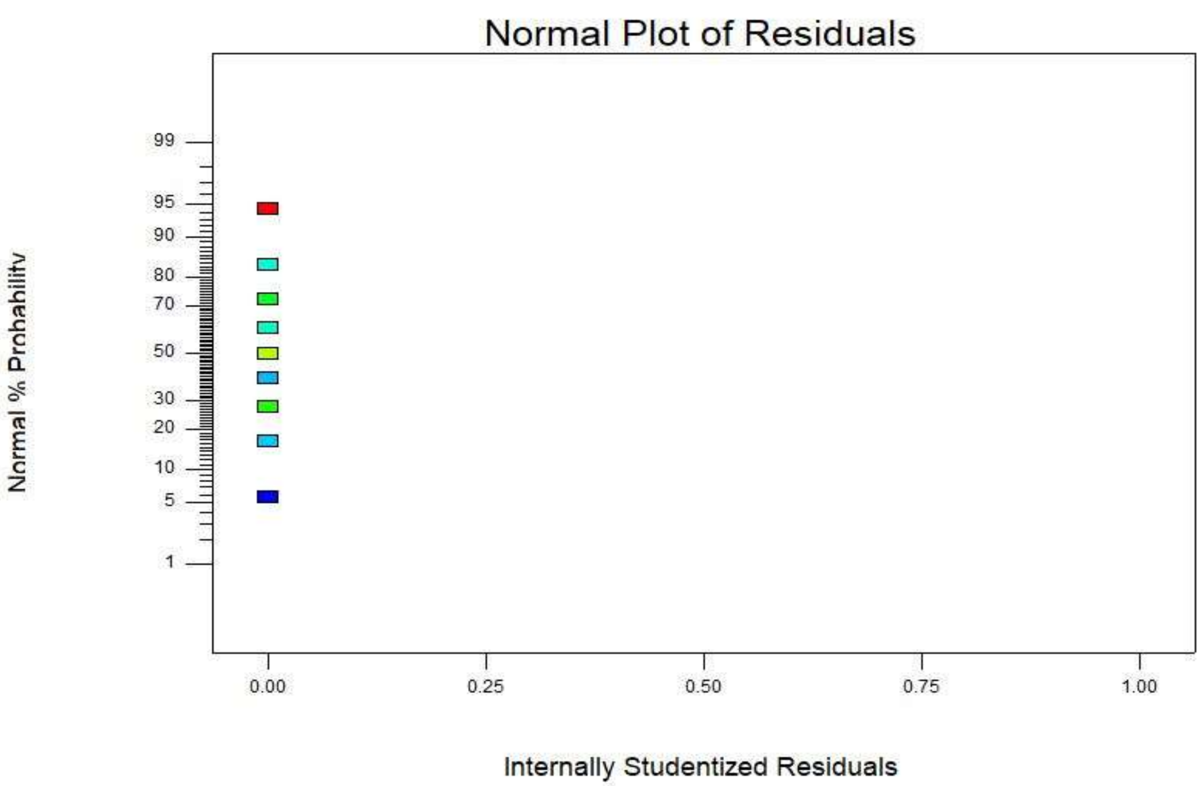
Internally Studentized Residuals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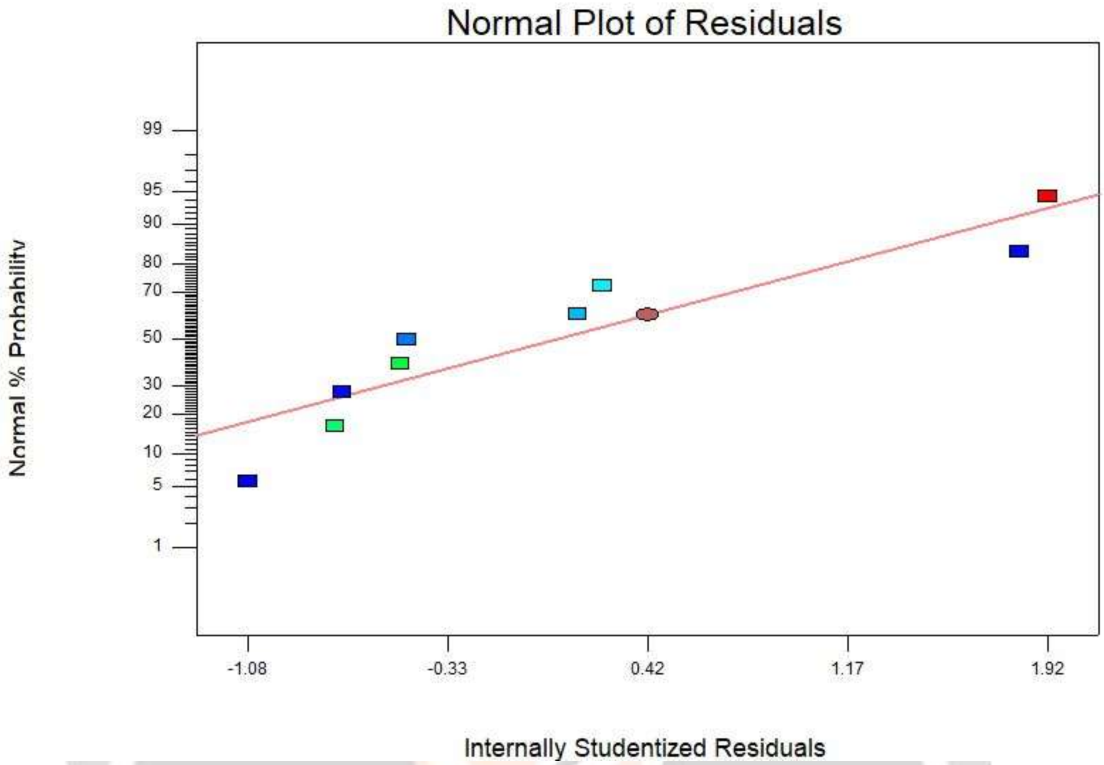

RESULT AND DISCUSSION

From ANOVA, It is predicted that the considered parameters speed, feed and depth of cut are significant for the objective functions Machining time and Surface Roughness.As the Ra value of both Machining time and Surface roughness are greater than 0.8 which ensures the navigation of model through the design space.Machining time decreases considerably increase in Feed. Machining time has negligible influence of depth of cut. Surface roughness is minimum for balance values of Spindle speed, feed and depth of cut.

CONCLUSION

This paper presents the findings of an experimental investigation into the effect of feed, speed and depth of cut on the surface roughness when turning AISI 52100 steel.

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