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OPTIMIZATION OF PROCESS PARAMETERS FOR HCHRCR IN CNC TURNING MACHINE USING TAGUCHI METHOD

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ABSTRACT

The influence of machining parameters on surface roughness and material removal rate is examined by utilizing TAGUCHI METHOD. Mainly variables are spindle speed, depth of cut and feed rate, which are influence on the surface roughness and material removal rate are to be examined and also analyzed. Analysis of variance techniques are effective tools for analyze and optimize the cutting parameters. Primarily experimentation has been conducted on HCHCR using CNC turner with carbide tip tool and experimental results are taken for preparing of the TAGUCHI METHOD. Next, The experimental results are analyzed by using

The present paper describe the predicting of surface roughness (Ra) and material removal rate (MRR).An orthogonal array, L9 TAGUCHI METHOD is applied study the performance characteristic of turning process. Surface roughness and metal removal rate has been considered as performance characteristic. TAGUCHI METHOD of response variable, by considering three variables such as speed, feed and depth of cut. Based on Taguchi, design of experiments and L9 orthogonal array will be selected for conducting turning experiments. Three factors are considered at three different levels for orthogonal array L9design

KEYWORDS: Taguchi Method, surface roughness, L9 orthogonal array, CNC Machine

INTRODUCTION

Optimal cutting parameters for each performance measure were obtained employing Taguchi techniques. The orthogonal array, signal to noise ratio and analysis of variance were employed to study the performance characteristics in dry turning operation.

Taguchi method has shown that the depth of cut has significant role to play in producing higher MRR and insert has significant role to play for producing lower surface roughnes S.S.Chaudhari has investigated a single characteristic response on optimization model based on Taguchi Technique and developed to optimize process parameters, such as spindle speed, federate, depth of cut, and nose radius of single point cutting tool. Taguchi's L9 orthogonal array is selected for experimental planning. The experimental result analysis showed that are the combination of higher levels of spindle speed, depth of cut and federate is essential to achieve simultaneous maximization of material removal rate and minimization of surface roughness. Kanase Tanaji. S and Jadhav Conducted experiments on a CNC turning Centre for machining the different work pieces material with different types of cutting tool inserts with a set of values for the given parameters. The process would be repeated for different values of the parameters while keeping the other constant.Taguchi method is used for finding the optimized solution. Ranjeet Kumar has studied Analysis of Surface Roughness and Material Removal Rate for High Carbon High Chromium for the HCHCR by Taguchi method. K. Nagendrana, S. Sathisha et.al. were presented Rathnaraja comparison of HCHCR Steel and Carbide Punch and Die Increase its Strength. Anwarul Haque, and A. B. Amale explained and simulated Multiple Optimization of Wire EDM Machining Parameters Using Grey Based Taguchi Method for Material HCHCR. Naveen Beri has identify and analyzed the effect of process input on output factor by Taguchi methodology.

Prof. Atul dhale and Fahim khan proposed AE as non-contact and indirect technique for in-process surface roughness assessment in turning. Three cutting conditions dry cut, cutting with water as coolant and normal coolant were used. Optimal cutting parameters for each performance measure were obtained employing Taguchi techniques. The orthogonal array, signal to noise ratio and analysis of variance were employed to study the performance characteristics in dry turning operation.

ANOVA has shown that the depth of cut has significant role to play in producing higher MRR and insert has significant role to play for producing lower surface roughness.

Harsimran Singh Sodhi and Harjot Singh Discusses an investigation into the use of Taguchi Parameter Design for the optimizing surface roughness generated by a conventional lathe. Control parameters being consider in this paper are cutting speed, feed rate and depth of cut. After experimentally turning sample work pieces using the selected orthogonal array and parameters, this study expected to produce an optimum combination of controlled parameter for the surface roughness. Taguchi method is used for find out optimal cutting parameters for surface roughness (Ra) in turning. Regression models are developed and validated to predict the surface roughness and AE Signal value.

METHODOLOGY

Statement of the Problem

There are more uses of HCHCR (high carbon and high chromium). This mainly used in thread rolling dies, punches, draw plates, cutters, measuring tools, pressure casting moldings, blanking. The mass industrial growth and demand of aluminum leads to the problem of selecting appropriate machining process from a several alternatives. The machining of aluminum with CNC machining is desirable, thus comes the need of tuning process. In order to further find the matter the explore a orthogonal array study of a turning operation on a process in HCHCR rod, diameter of work piece27.5mm. Length of the HCHCR 90mm.

Objectives

In this many research's various materials high carbon high chromium, coated tool in the present work effecting of studying.

1. Optimizing the process parameters which are effect on surface finish.
2. To determining the ultimate estimation of procedure parameters for Metal removal rate and Surface Roughness.
3. Find the better combination for surface roughness, material removing rate with affecting parameters like spindle speed, depth of cut, feed.

Present scope of study

1. Current study involves experimental work on optimization of CNC turning.
2. Analyze the turning process by optimization results.
3. Study various process parameters effect on the work piece.

Selection of process parameters

Turning is the removal of metal from the external measurement of a revolving barrel shaped work piece. Turning is utilized to decrease the distance across of the work piece, normally defined measurement, and to delivers a smooth complete on the metal. The work piece will be turned so touching sections have various widths. Turning is the machining operation that delivers barrel shaped parts. In this machining of an outer surface:

- The work piece turning on machine.
- The single point cutting tool and.
- The sharing sustenance is parallel to the work part of the middle and at a separation.

That will be displacing the external surface of the work piece.

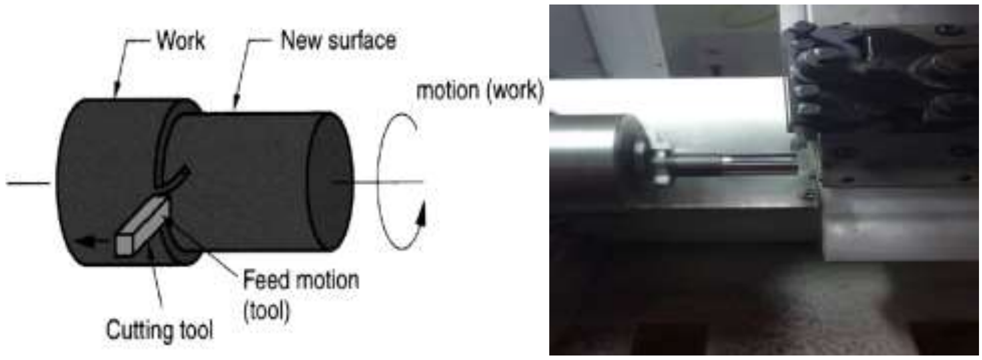

Fig-3.1 Cylindrical turning operation on lathe

The Turning is taper in basically similar, but the path way cutter remains an angle to the work portion.

Process Parameters in Turning Operation and their Effects:

- Spindle Speed
- Feed rate, and
- Depth of cut

The additional elements such a caring of material and type of is tool used high effect.

The Spindle speed (V) rotation of spindle of tool is which the metal is removed by movement of toll. It is expressed in m/minute.

Spindle speed=$\frac{\pi dn}{1000}$ m/min

Where d=diameter of the work piece
n= it is r.p.m of the work

In the British system ,Spindle speed is expressed in feet per minute and diameter of the work in inches.

Spindle speed=$\frac{\pi dn}{60}$ $revolution/min$

Diameter in terms of mm and speed in r.p.m..

Spindle speed regularly characterizes a rotational development. Cutting face expected in cycles for every moment (rpm). The energetic device for a specific turning operation is the surface cutting velocity at which the work piece material is moving quickly the cutting instrument.

The cutting speed to the tool life is expressed by the formula. We can increase the tool life by increasing the the tool temperature and softness the tool material.

$VT^n = C$

Where,

V = spindle speed in rpm, T = instrument life time in minutes
n = the supporter depending on the instrument and Work part
C= constant which is numerically equal to the Cutting speed that gives a tool life of one minute

Feed rate

The feed is defined as the advance movement of the tool. And it is expressed in terms of mm per minute. Increased feed reduces cutting time .but increased feed Greatly reduces the tool life .it is depends up on the size and shape , strength and method of holding the Component , the tool shape and its setting as regards overhang, the rigidity of the machine ,depth of cut, Power available .

Federate may be as low as 0.0125mm/rev and with the substantial slicing up to 2.5 mm/rev. the bigger the sustenance and more important one is the cutting energy for every unit range of chip-device contact on the rake face and work-apparatus contact on the flank face.

Cutting temperatures and subsequently the characteristic types of wear are expanded. Temperature is most as nutrition is raised at any cutting velocity. It has been examined that impact of progressions in spread upon apparatus life is moderately slighter than that geometry and work-piece material, the feed rate has got the most elevated impact on the particular cutting safety and therefore on the cutting zone cool.

The impact of hardware life on feed and understanding if cut is given by

$$V=\frac{257}{T0.19 \times s0.36 \times t0.08} \text{m /min}$$

Where s = feed in mm/min, t = distance of cutting in mm

Depth of cut

It is defined as The difference between finished metal to un finish metal thickness. It is expressed in terms of mm. We can vary the depth of cut after zero finished portion of the sequence to over 2.5mm.if the cut is increased the temperature also increases. By increasing depth of cut toll life will decrease to some extent by accelerating the abrasive, adhesive and diffusion types of tool wear. The research work, the best points of cutting velocity, feed level and depth of cut.

Process Failure Analysis

The significant failures modes in turning process high use and failure location of metal working hardware is an issue of high significance in modern applications. The operation in an undesirable mode can result in poor generation quality. In material additionally in great reasons apparatus disappointments and problems to the machining. The materials have strength to weight ratio, high strength, toughness and other improved properties.
The high strength natural to HCHCR and its composites has pressed a wide and extended scope of successful applications which request irregular amounts of solid implementation in operation and outstanding corrosion resistance. Failures are accrued in areas automotive, machine shafts, axles and additional main productions.
In the principal part of these designing applications titanium has displaced weightier, less practical materials. Planning with HCHCR considering all components has brought about dependable, monetary and stronger general purpose shafts and parts, which by and large have significantly exceeded performance and direction life requirements.

Regular machining of titanium graphite's influences only smaller higher than those required machining steel, however the composites have metallurgical qualities that make them kind of harder to machine than steels of comparable hardness on traditional machine devices.

A heavy portion of titanium's material attributes make it lavish and hard to machine. The qualities and HCHCR Materials are used for the thread rolling dies, cold extrusion tools and dies, punches draw plates and dies, cutter measuring tools, pressure casting moulds, blanking reamer, finishing rolls for tire mills. This material has dimensional stability with added wear resistances coupled with excellent edge holding qualities.

Chemical Compositions

ELEMENTS	% COMPOSITION
Carbon (c)	2.00-2.25
Manganese(Mn)	0.70
Silicon(Si)	0.65
Chromium (Cr)	10.20-11.50
Nickel (Ni)	0.30
Tungsten (W)	1.00
Copper (Cu)	0.25
Sulphur (S)	0.03
Iron (Fe)	Remaining

Specimen Details : HCHCR

Length of work piece : 90 mm
No. of work pieces : 9
Diameter of work piece: 27.5mm

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Signal to noise ratio(S/N)

The control figures that may help decreased variety and improved quality could be immediately identified by taking a look at the sum variety display as a reaction. Analysis in this content has tended to which components may be influencing the normal reaction. Orthogonal show has made a change of the replication information to an alternate price which is a measure of the variety present. The change is signal to noise(S/N) proportion. A few S/N degrees available believing upon the category of characteristic:

a. Lower is better

In turning process, the response characteristics such as cutting speed, feed, roughness on surface and power can be smaller for the better quality.

$S/N=-10\log_{10}\left(\frac{\sum y^2}{n}\right)$

***b.* Higher is better**

In turning process, the response characteristics such as material removal rate can be larger quality.

$S/N=-10\log_{10}\left(\frac{1}{n}\sum\frac{1}{y2}\right)$

***c.* Nominal is better**

It is utilized the nominal or object value and difference as regards the value is nominal is the best.

$S/N=-10\log\frac{1}{n}\sum(yi-S)2$

Where y_i is the value of the nominal is better and S is the largest value.

EXPERIMENTATION

Introduction

Now days there have been in increases in the research interest in the applications of Taguchi method the relations among the cutting conditions on the process limitations during the machining method.

The input parameters speed, feed and depth of cut and the output parameters are metal removal rate (MRR) and surface roughness (Ra).

About the Facility of Machine

FLEXTURN MTAB available at Madanapalle institute of technologically and science, Madanapalle the spindle speed ranging from 150-4000 rpm and the shaft power of 3.7kw. The rating on feed should 0- 5000mm/min.

Selection of materials

While doing machining process selection of material plays vital role .Apart from that Turning process can be done on many materials such as cast iron, mild steel and their alloys HCHCR and its alloys are used in a variety of cast iron and conditions of heat treatment. Round rods and some examples of wrought form, while castings are rotation and turning operation. HCHCR Metal bar (of diameter 28mm and length 90mm)

The material selection for experimental procedure is HCHCR; the outside diameter of the rod (D) is 28mm and the length of work piece is 90mm. The working of materials is using HCHCR and his chemical composition and hardness are testing and rigidity importance of create towards 45HRC.

Chemical compositon of HCHCR

ELEMENTS	% COMPOSITION
Carbon (c)	2.00-2.35
Manganese (Mn)	0.60
Silicon (Si)	0.60
Chromium (Cr)	11.20-12.50
Nickel (Ni)	0.30
Tungsten (W)	1.00
Copper (Cu)	0.25
Sulphur (S)	0.03
Iron (Fe)	Remaining

Input Variables

Table Feasible Ranges of input variables

S.NO	Control factor	Unit	Level 1	Level 2	Level 3
1	Speed(X)	Rpm	1000	1500	2000
2	Feed(Y)	mm/min	40	50	60
3	Depth of cut(Z)	Mm	0.4	0.8	1.2

Taguchi's L_9 Orthogonal Array

Exp.no	Input parameters			Output Parameters		S/N Ratio (Ra)	MEAN (Ra)	S/N Ratio (MRR)	MEAN (MRR)
	Speed	Feed	Doc	Surface Roughness (Ra)	MRR				
1	1000	40	0.4	1.325	1.750	-3.8185	1.5375	4.86076	1.75
2	1000	50	0.8	2.121	3.100	-8.4846	2.6105	9.82723	3.1
3	1000	60	1.2	2.748	7.350	-14.883	5.0490	17.3257	7.35
4	1500	40	0.8	0.786	4.870	-10.852	2.8280	13.7505	4.87

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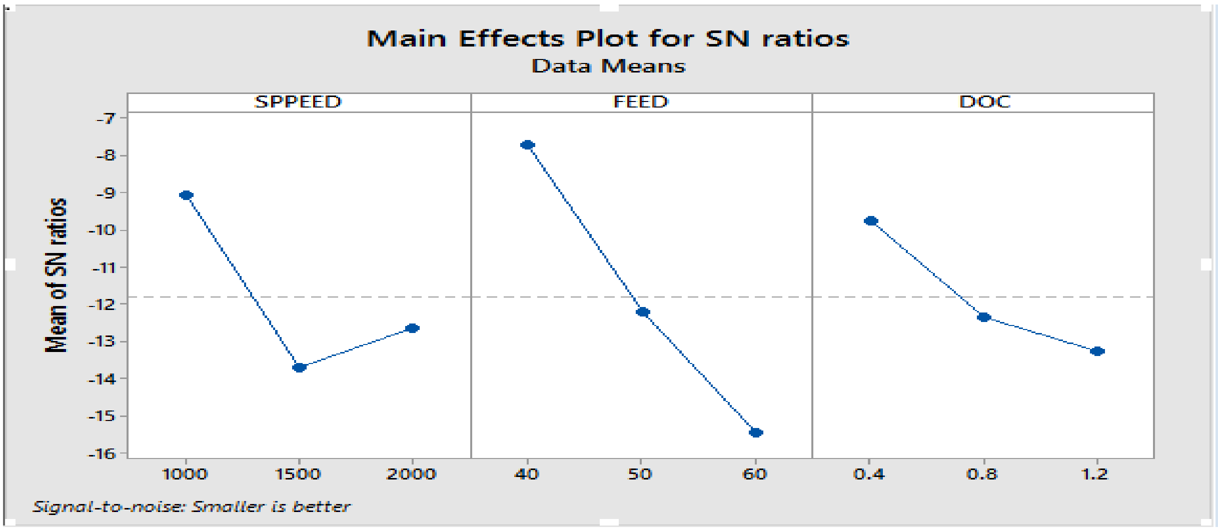
5	1500	50	1.2	2.415	9.110	-16.475	5.7625	19.1903	9.11
6	1500	60	0.4	2.986	6.227	-13.774	4.606	15.8855	6.227
7	2000	40	1.2	0.873	3.650	-8.477	2.2615	11.2458	3.65
8	2000	50	0.4	1.289	5.260	-11.662	3.2745	14.4197	5.26
9	2000	60	0.8	3.011	10.52	-17.772	6.7655	20.4403	10.52

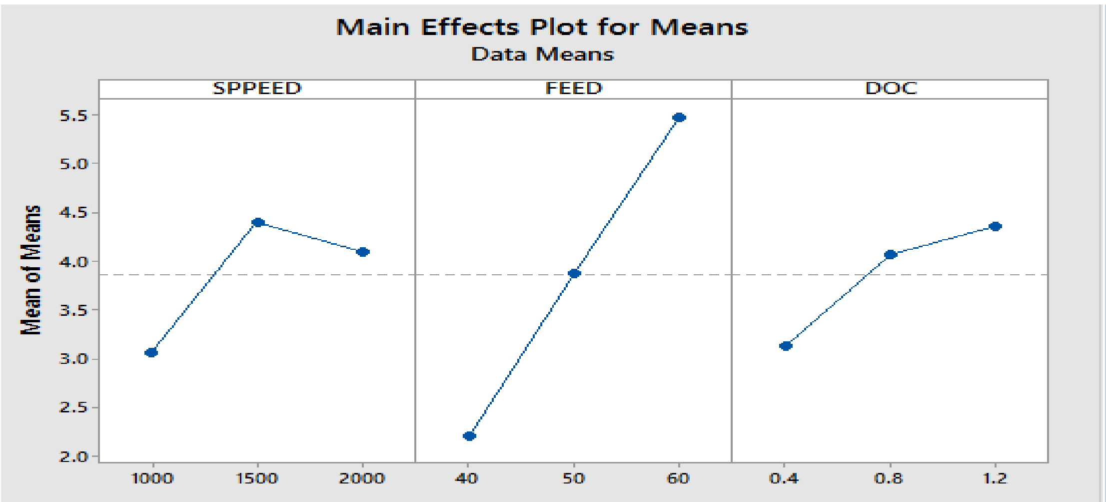
S/N-Signal to noise ratio

RESULTS AND CALCULATIONS

Effect of Parameters on surface roughness Main effects plots analysis for Ra:
Graph for surface roughness to s/n ratio



Graph for surface roughness to mean of means



Taguchi's method uses the statistical measure of performance called signal to noise ratio (S/N), which is the function of desired output to serve as objective for optimization. The ratio "smaller the better" was used for the measuring of wear. The optimal conditions of minimum surface roughness was seen when speed was 1500 feed was 40 and depth of cut was 0.8

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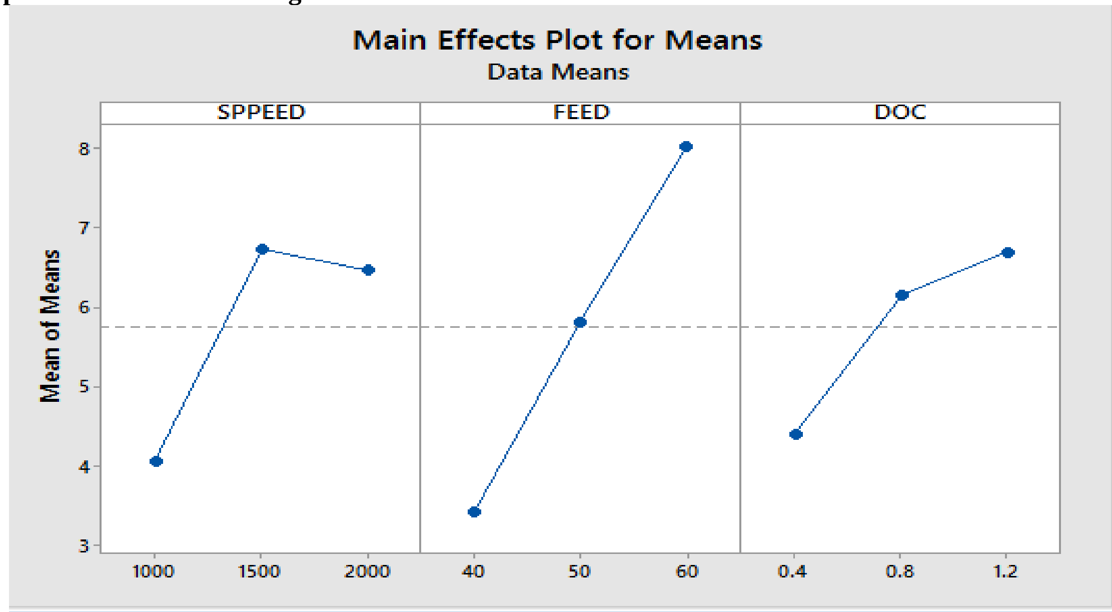
The depth of cut has a low significant effect on the surface roughness .t can be seen that the significant parameter is speed and feed as it has the highest slope the main effects plots for S/N ratio as shown in graph.

Graphs for material removing rate to means



The metal removing rate for HCHCR increases with increases of speed, feed, depth of cut. But the feed and depth of cut has a most significant effect on the removal of metal from the start the main effects plots the S/N ratio and means as shown in figure. The optimal values for the best material removing rate are speed 2000 feed 60 and depth of cut is 0.8

S.NO	Parameter	Optimal value for surface roughness(Ra)	Optimal values for values for MRR
1	Speed	1500	2000
2	Feed	40	60
3	DOC	0.8	0.8

CONCLUSION

The influence of surface roughness and MRR for the CNC turning operation on HCHCR and also optimizing the process parameter such as speed, feed, and depth of cut. Using Taguchi method were performed and the following conclusion are observed.

1. The practical benefit of this study is that the use of obtained optimal condition impresses the MRR, reduce surface roughness.
2. MRR at optimum condition is increased with increasing DOC and speed
3. The optimum condition for surface roughness was observed that speed 1500 feed 40 depth of cut 0.8

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