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OPTIMISING CUTTING PARAMETERS FOR HOT TURNING ON EN31 MATERIAL

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Abstract— **In any type of machining process the surface roughness plays an important role. In these the product is judge on the basis of their (surface roughness) surface finish. In machining process there are four main cutting parameter i.e. cutting speed, feed rate, depth of cut, spindle speed. For obtaining good surface finish, we can use the hot turning process. In hot turning process we heat the workpiece material and perform turning process multiple time and obtain the reading. The taguchi method is design to perform an experiment and L18 experiment were performed. The result is analyzed by using the analysis of variance (ANOVA) method. The result Obtain by this method may be useful for many other researchers.**

Keywords— **Hot turning, Temperature measure, Machinability, Taguchi and ANOVA method, Surface roughness, High carbon alloy steel.**

I. INTRODUCTION

As due to technological development in industries the world require high strength and hardness material. these type of material is difficult to machining on the conventional lathe machine, which damage tool and surface finish obtain is not so good. These also proved to be costly. So we can overcome these problem by using hot turning process which give good surface finish. The process of heating the work piece material to make it softer and obtain the good surface finish is called hot turning.

Heating methods

A heating of material has different ways. They are
1) A butane gas (C4H10) flame are used for heating EN- 31 material.
2) The electronics device infrared thermometer is sensing the temperature. It is used for the measure the temperature.

Cutting Parameter For Hot Turning Process.

Cutting speed (Vc), feed rate (fs), depth of cut (dc) and workpiece temperature (°C) these are the major factor of hot turning process.
A) Cutting speed (Vc)
Cutting speed always refer to the spindle of workpiece. It is expressed
In meter per minute **(m/min).**
The standard formulae of cutting speed **(Vc) = π*D*S/10000**
B) Feed Rate (fs)
The feed rate is expressed in mm of tool advancement per revolution Of the spindle, or **mm/rev**.
Fs=S*f*N
C) Depth of cut it is measure for **mm**

For the experimental work we select the EN31 alloy steel as work piece material these material has a property of high strength degree of hardness with compressive strength and abrasion resistance.

II. CHEMCAL COMPOSIION OF EN-31 MATERIAL IS SHOWN IN FOLLOWING

Table no. 1 Chemical compositions of EN-31

C	Mn	Cr	S	Si	P
0.90-1.20%	0.30-0.75%	1.00-1.60%	0.050% max	0.10-0.35%	0.050% max

The hot turning is done on EN31 material which use as tool material and high speed steel is use as a workpiece material. A butane gas can is used for heating the workpiece material, the temperature of workpiece surface is measured by using temperature sensing device is Called as infrared thermometer. It measure temperature without coming in contact with the object. The experiment is carried out on different levels.
Taguchi **L18** orthogonal array is considered for experimentation and input parameter are assigned to surface roughness column. For these reasons there have been research development with the objective of optimizing the cutting condition to the good surface finish.
The high operating temperature effect on the material while turning operation and process the softness on which makes the machining process easier and increases the tool life.
The observed low surface roughness with increase of cutting speed.

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Surface methodology is used for modeling and optimizing of surface roughness in lathe machining.
An optimal machining parameter can easily using response surface methodology.
A response surface method (RSM) is more practical economical to use are considered as most important are used the independent variable is the experiment response.
Machining, quality of the part can be achieved only proper cutting conditions. RSM is the collection of mathematical and statistical techniques that are useful for modeling and analysis of problem.

Tool Information:-
We use high speed steel as a tool material the life of the is depend on the proper selection of the proper cutting speed and feed rate. While depth of cut and workpiece has less effect.

III. TAGUCHI METHOD

Taguchi method is an important tool by which we can design a high quality system. The good optimized parameter can be obtain by these method. For obtaining these condition it required the use of the strategically designed of experiment taguchi method is easy to adopt for uses with limited knowledge of statistics, Hence has a good popularity in engineering and scientific community.

Designing an experiment-

The design of experiment involves the following steps

1. Select the independent variables
2. Select of number of level setting for independent variable
3. Select the orthogonal array
4. Independent variables to each column
5. The conducting the experiments
6. The analyzing the data

1. Select the independent variables.

The knowledge of the process under the investigation is importance for identifying factor to influence outcome. The experiment is generally involved in the project.

2. Select of number of level setting for independent variable.

The independent variable number of level for each variable decided.

A number of level depends on how the performance parameter is affected due to different level. The higher level depending on whether the relationship is quadratic cubic order. The independent variable and the performance parameter, choose second level.

A after analyzing experiment data, one can decide whether the assumption of level is right or not these based on the percent of contribution and the error calculations.

3. Select the orthogonal array.

The orthogonal array, the minimum number of experiments to be conducted fixed based on the total number of degree of freedom in the study. Minimum number of experiments that must be run to study the factor more the total degree of freedom available. These experiment to understand the influence of four different independent variable with each variable having three set values an L18 orthogonal array might be right choice. Interaction between the material and temperature.

4. Independent variables to each column.

These method conducting the experiment the knowledge of the process under the investigation important for identifying the factor.

A comprehensive factor input to the experiment is involved in the project.

5. The analyzing the data

These experiment is the combination three different factor level, in the values of each level of particular independent variable is calculated sum of square deviation of a particular variable indicate performance parameter is sensitive to change setting.

The conducting the sensitivity analysis and performing an analysis of (ANOVA).

Confirmation experiment is conducted to verify the optimal process parameter obtained from the parameter design. In this paper, the cutting parameter design by the based on taguchi method these method obtained optimal machining performance in hot turning.

Nominal is the best $S/N=10\log\left(\frac{\bar{y}}{s_y^2}\right)$

Larger is the better : $S/N_L = -10\log\left(\frac{1}{n}\sum_{i=1}^{n}\frac{1}{y_i^2}\right)$

Smaller is the better:

$S/N_S = -10\log\left(\frac{1}{n}\sum_{i=1}^{n} y_i^2\right)$

Where $\bar{y}$, is the average of observed data, S_y^2 is the variance of y, n is the number of observations and y is the observed data.

The S/N ratios are expressed on a decibel scale. Use the objective S/N_T is to reduce variability around a specific target, The system is optimized the response is large as possible S/N_L,

S/N_S system is optimized response is as small as possible. Produce minimum surface roughness (RA) in a turning

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operation. RA minimum surface roughness in a turning operation.

The use of the parameter design of the taguchi mixed level design to optimize a process.

Identify the performance characteristics and select process parameters to be evaluated.

Determine the number of levels for the process A parameters and possible interactions between the process parameters.

The appropriate orthogonal array and assignment of process parameters to the orthogonal array. Conduct the experiments based on the arrangement of the orthogonal array.

The calculate total loss function and the S/N ratio.

Analyze the experimental results using the S/N ratio and ANOVA.

Select the optimal levels of process parameters.

Verify the optimal process parameters through the confirmation experiment.

IV. PROCEDURE OF EXPERIMENTATION

The experimental performance of hot turning is carried out on the centre lathe machine.
The experiment is performed on the EN31 alloy Steel which used as a workpiece material. these work piece is heated by using the butane gas can under different temperature the size of workpiece material is 40 * 70 mm diameter is 40 mm and length is 70 mm this process size diameter is 38.5 mm the workpiece is heated at three different temperature that is 200˚ 300˚ and 400˚c .
When we heated the workpiece material heat reduce the it is shear strength due to which material get softer. The hot turning test were perform on the workpiece at different cutting speed, feed rate, and depth of cut, the summary of experiment it were is shown in table no. 2

Level	Spindle Speed (rpm)	Depth of cut (mm)	Work piece Temperature (˚c)
1	75	0.25	200˚
2	150	0.5	300˚
3	-	0.75	400˚

Table no.2 Machining setting used in the experiments.

The temperature at workpiece is measured by Infrared sensor without coming in contact with workpiece the temperature measurement of the range of this device is -50˚ to 550^0c has LCD display and power source of 9 volt battery and the whole experiment is carried out.

SURFACE ROUGHNESS
The purpose of hot turning process is to produce the lower surface roughness of the parts. Surface roughness is important factor to judge the cutting performance. proper selection of the cutting parameters and tool can produce larger to performs and good surface finish, hence design of experiments by Taguchi method on cutting parameter was added to study the surface roughness the cutting parameters select are as in table number the study done by Taguchi method is only for form surface roughness the research show the purpose to demonstrate the use of Taguchi parameter design in order to identify the optimum surface roughness with particular combination of cutting parameters the result where obtained by design expert software this software give the following equation and ANOVA table for surface roughness is given Table No. 4

Source	DF	Seq. SS	Contribution	Adj. SS	Adj. MS	F-Value	P-Value
Regression	3	53.82	78.48%	53.82	17.940	17.01	0.000
Spindle Speed	1	10.01	14.59%	10.01	10.005	9.49	0.008
Temperature	1	16.87	24.60%	16.87	16.874	16.00	0.001
Depth of cut	1	26.94	39.28%	26.94	26.940	25.55	0.000
Error	14	14.76	21.52%	14.76	1.054		
Total	17	68.58	100.00%				

Table no. 3 General Linear Model: Surface Roughness(RA) versus Spindle Speed, Temperature, Depth of cut

Equation obtained Taguchi method.
Regression Equation of Surface Roughness(RA)=-2.67
+ 0.01988Spindle Speed + 0.01186Temperature
+ 5.99Depth of cut

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Sr. No.	**Spindle speed** (RPM)	**Temperature** (˚c)	**Depth of cut** mm	**Surface Roughness** (micro-m)
1	75	200	0.25	2.29
2	75	200	0.5	3.87
3	75	200	0.75	5.96
4	75	300	0.25	4.28
5	75	300	0.5	4.36
6	75	300	0.75	5.48
7	75	400	0.25	6.58
8	75	400	0.5	6.68
9	75	400	0.75	8.84
10	150	200	0.25	3.95
11	150	200	0.5	7.04
12	150	300	0.75	7.81
13	150	300	0.25	5.80
14	150	300	0.5	6.81
15	150	300	0.75	7.30
16	150	400	0.25	5.39
17	150	400	0.5	6.78
18	150	400	0.75	10.88

Table no. 4 Experimental design using the L18 orthogonal result

Level	**Spindle speed**	**Temperature**	**Depth of cut**
1	-14.05	-13.53	-13.00
2	-16.44	-14.90	-15.21
3		-17.30	-17.51
Delta	2.39	3.76	4.51
Rank	3	2	1

Table no.3 Response Table for signal to noise ratio Smaller is better.

In fig. no.1 values of parameter for minimum range are; spindle speed = 75 rpm; depth of cut=0.25 mm Temperature = 200^{0}c (corresponding to lowest Ra in each case). Generally minimum values of Ra given parameters. As the speed increases. And also in case of temperature and depth of cut it increases with increase in temperature or depth of cut.
So from the graph we conclude that minimum RA obtained at speed=75rpm; depth of cut=0.25mm and Temperature=200˚c

Confirmation tests

The confirmation testis for validating the conclusions drawn during the process of study.
Optimal level of the process parameters is selected, the final step is to predict and verify the improvement of the performance characteristics using the optimal level of the process parameter.
This is based on the S/N on the analysis the optimal process parameter for surface Roughness (RA) determine as follows:- spindle speed at level 1 (75rpm); Temperature at level 1(200˚c) ; and depth of cut at level 1 (0.25mm).
The depth of cut is found to be most influencing factor affecting surface roughness (RA) followed by temperature and spindle speed.
Fig no.2. And Fig no.3 shows the plot of main for SN ratio and the interaction plot for surface roughness (RA).
From the main effect plot of SN ratio observed that the order of process parameters that influences the surface roughness are depth of cut followed by speed and temperature optimal result could be found out from the main effect plot selecting the highest level of SN ratio values from the response table of ratio of RA.

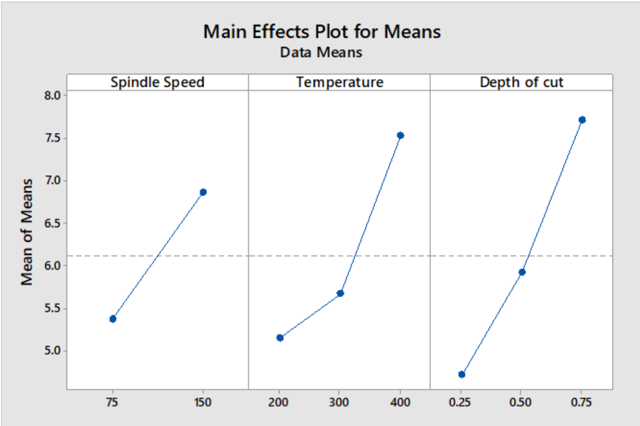

Fig. 1. Main effect plot for Means

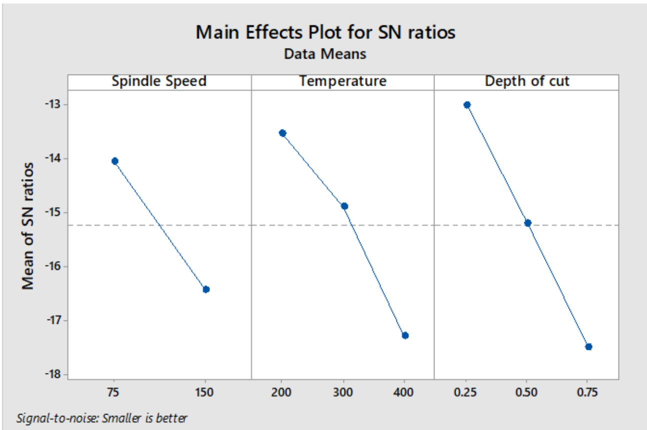

Fig. 2. Main effect plot for SN ratio

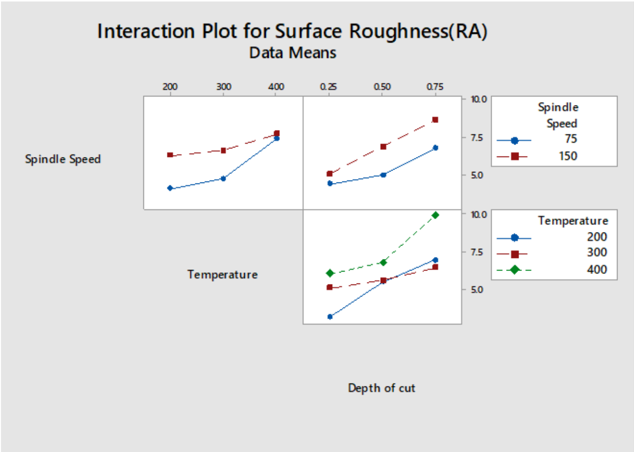

Fig. 3 Interaction plot for RA

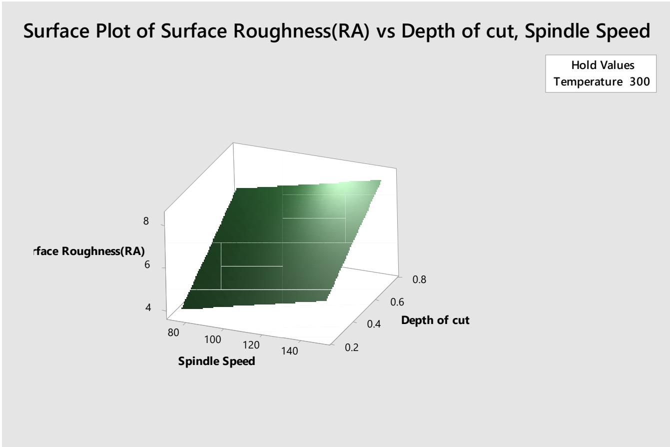

Fig. 5. Surface plot of surface roughness vs. Doc, spindle speed

Fig no. 4 Illustrates the surface model for surface roughness by wearing the two variable spindle speed and temperature the figure indicates that the surface roughness increases with increase of temperature. Contrary to the temperature, the surface roughness increases with increase of spindle speed.

Fig. 5 shows the effect of spindle speed with respect to depth of cut on surface roughness. From the fig., it has been asserted that the increase of spindle speed increases the surface roughness, whereas the increase of depth of cut increases the surface roughness.

Fig. 6 shows the influence of temperature and depth of cut on surface roughness. It can be asserted that the increase in temperature and depth of cut increases the surface roughness.

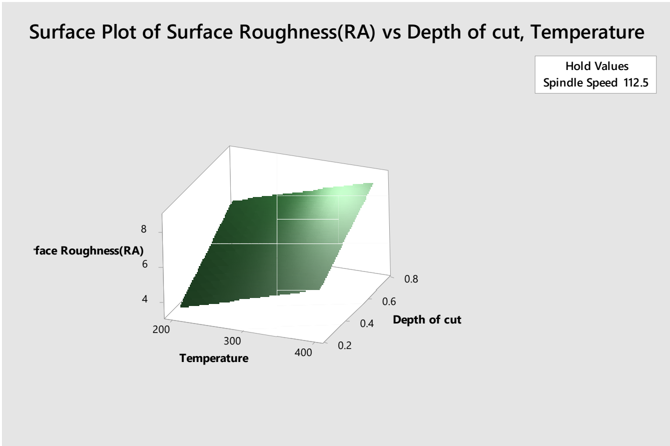

Fig. 6. Surface plot of surface roughness vs. DOC temperature.

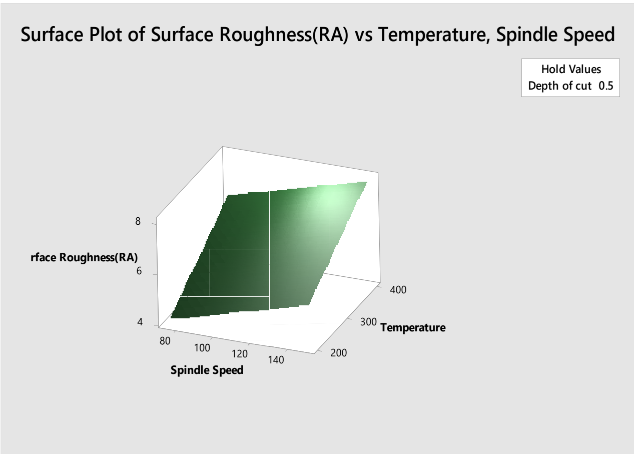

Fig. 4. Plot of surface roughness vs. Temperature, Spindle speed

V. CONCLUSION

The following conclusion have been derived by applying the grey analysis on hot turning of high carbon alloy steel.
The experimental result clearly show that a spindle speed 75 rpm, feed rate (FDs) at 0.4 mm/rev, workpiece temperature 200^0c, Will give the optimum result for hot turning of EN31 material.
Based on the Taguchi method and ANOVA, depth of cut has a dominant effect of almost 49.16% in contribution ratio, workpiece n temperature has 24.17% and spindle speed 14.27% influence on the surface roughness, tool life, and metal removal rate in hot turning of high carbon alloy steel . The machining parameter set at their optimum levels can ensure significant improvement in the process parameter.

VI. REFERENCE

1 A.K. Parida, K. Maity, Numerical and Experimental Analysis of Specific Cutting Energy in Hot Turning

of Inconel 718, Measurement (2018), doi: https://doi.org/10.1016/j.measurement.2018.10.033

2 N. Tosun Æ L. Ozler, Optimisation for hot turning operations with multiple performance characteristics

3 Asit Kumar Parida a,Kalipada Maity, Modeling of machining parameters affecting flank wear and surface roughness in hot turning of Monel-400 using response surface methodology (RSM)

4 Bin Zou & Huijun Zhou & Chuanzhen Huang & Kaitao Xu & Jun Wang, Tool damage and machined-surface quality using hot-pressed sintering Ti(C7N3)/WC/TaC cermet cutting inserts for high-speed turning stainless steels

5 Guolong Zhao, Fabrication and cutting performance of reactively hot-pressed TiB2-TiC-SiC ternary cutting tool in hard turning of AISI H13 steel.

6 Asit kumar Parida and kalipada maity 2019, Modelling of machine parameters affecting flank wear and surface roughness in hot turning of Monel-400 using response surface methodology.

7 A.K. Parida, K. P. Maity, Optimization of multi responses in hot turning of Inconel 625 alloy using DEA-Taguchi approach 2016

8 A.K Parida & Kalipada Maity; Effects of nose radius on forces and process parameters in hot machining of Inconel 718 using finite element analysis 2016

9 Varun Shekhar, School of mechanical &building science, VIT University 2016

10 A. K. Parida, K. P. Maity; Finite element method and experimental investigation of hot turning 2016

11 Pradeep Kumar and S.R Chauhan ; Machinability study of finished running of AISI H13 hot working die tool Steel with CBN 2015

12 Varun Shekhar, School of mechanical &building science, VIT University Experiment Investigation by using Hot turning for die steel. 2016

13 S. Ramganathan, T. Senthilvlan,G. Sriram;Evalution of maching parameter of hot turning of stainless steel applying ANN and RSM. 2013

14 R. Suresh, S. Basavarajappa, G.L. Samuel;Some studies on hard turning of AISI 4340 steel using multilayer catedd carbide tool. 2012

15 Ilhan Asilturk,Technical education Faculty Determining the effect of cutting parameters on surface roughness in hard turning using the Taguchi Method.; 2011

16 S.Ranganathan T. senthivelan Multi-response optimization of machining parameters in hot turning using grey analysis 2011

17 Dinesh G. Thakur, B. Ramamoorthy, L. Vijayraghvan Effect of cutting parameter on the degree of work hardning and tool life during hingh speed maching of inconel 718; 2011

18 S. Ranganathan , T. senthilvelan and G. sriram 2010 Ecaluation of maching parameters of hot turning of stainless steel 316 by applying ANN and RSM

19 Saeed Zare Chavoshi , mehdi Tajdari 2010 Surface roughness modeling in hard turning operation of AISI 4140 using CBN cutting tool.