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Impact of Inconel Surface Roughness on Turning Process Parameters

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Abstract: The nickel-based superalloy Inconel 718 finds widespread use in the aerospace, maritime, nuclear, and steam turbine power plant sectors. The current study employs the taguchi optimization method to fine-tune the Inconel 718 turning process parameters. The response variable that was examined was surface roughness. Within the parameters of the variables under study, the experimental findings show that the recommended mathematical model appropriately describes the performance indicator. Surface roughness is mainly affected by the tool, then by the depth of cut, speed, and feed.

Keywords: Surface roughness, Inconel 718, Anova, signal-to-noise ratio

Introduction

The industrial sector has been under extreme stress due to the rapid pace of technological advancement in recent years. There has been an uptick in efforts by manufacturers to process harder materials, reduce cutting costs, and improve the quality of machined products. Cutting down on machine time while increasing machining speed leads to a highly efficient machine. Tool material chemical stability and softening temperature are the limiting factors in cutting speed when working with hard materials such steels, inconel, titanium, and superalloys [1.1].

Various machines do machining tasks including turning, drilling, milling, etc., but CNC machines are now the most used. For optimal machining efficiency and minimal tool wear, it is necessary to take into account many characteristics such as feed rate, depth of cut, spindle speed, and the kind of tool being used. This means that you'll need to use several instruments to compare tool wear and surface roughness [1].

Machining inconel 718 is a very challenging task. The rapid wear and breakage of cutting tools and other economic losses due to workpiece damage and rejected surface quality are the results of incorrectly selecting machining settings. Machinability qualities are influenced by machining settings and tool shape. Second, the work of Nalbant et al. (2007). Choudhury and El-Baradie (1999) propose a machinability model as a functional connection between the following machining process input parameters: cutting speed, feed, and depth of cut; and tool life, surface roughness, cutting force, power, and material removal rate as output responses.

The metalworking sector makes extensive use of carbide inserts, both coated and uncoated, for the machining of various materials. Each of these inserts has its own set of benefits and drawbacks. Surface roughness, tool wear, and material removal rate are two factors that will be taken into account in this experiment to determine the ideal cutting insert for CNC turning of Inconel 718: coated or uncoated carbide. The machining parameters used in this experiment were feed rate, depth of cut, and spindle speed [3].

Methodology

In current experimentation five process parameters are selected as control factors. The remaining process parameters kept as constant. Controlled and constant parameters are given in table 1 and table 2.

Table 1: Controlled parameters

Sr. No	Controlled parameters
1.	Speed(RPM)
2.	Feed(mm/min)
3.	Tool nose radius (mm)
4.	Depth of cut (mm)

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Table 2: Constant parameters

Sr. No	Constant parameters	
1.	Cutting fluid	W4 CBF
2.	Work material	Inconel 718
3.	Work-piece dimension	25 mm x 65mm
4.	Tool holder	SPMG060204DG

For present experimentation, we use L18 design of experiment. There are four process parameters, three process parameter have three levels and one process parameter have two level there parametric combination as shown in Table 3.

Table 3: Parametric combinations

So.n	Tool	Speed	Feed	Deth of cut
1	T1	S1	F1	D1
2	T1	S1	F2	D2
3	T1	S1	F3	D3
4	T1	S2	F1	D1
5	T1	S2	F2	D2
6	T1	S2	F3	D3
7	T1	S3	F1	D2
8	T1	S3	F2	D3
9	T1	S3	F3	D1
10	T2	S1	F1	D3
11	T2	S1	F2	D1
12	T2	S1	F3	D2
13	T2	S2	F1	D2
14	T2	S2	F2	D3
15	T2	S2	F3	D1
16	T2	S3	F1	D3
17	T2	S3	F2	D1
18	T2	S3	F3	D2

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For the current experimental work, for turning of the Inconel718, the coated carbide tool insert is selected. Experiment were performed on CNC machine.

Results and Discussio

Surface roughness was measured using the Mitutoyo surfaceroughness tester model name sj-210. The arithmetic average roughness value is measured. The surfaces finish value of themachined Inconel 718 bar was measured after completion of one machining.

Specifications:

Traverse Speed: 0.5 mm/sec.Cut off values: 5mm Display: LCD.

Battery: Alkaline 500 Measurements of 5 mm length.

Surface roughness measured on external face of specimen having a stroke length 0.25 x 5 µm. Average of two repetitions for surface roughness is given in table 4

Table 4: Experimental results of surface roughness in µm

Expt. No	Tool	Speed	Feed	Deth of cut	Surface roughness
1	T1	900	0.111	0.4	3.1
2	T1	900	0.138	0.6	2.178
3	T1	900	0.166	0.8	1.926
4	T1	1000	0.111	0.4	3.173
5	T1	1000	0.138	0.6	2.399
6	T1	1000	0.166	0.8	1.74
7	T1	1100	0.111	0.6	2.677
8	T1	1100	0.138	0.8	2.7
9	T1	1100	0.166	0.4	2.9
10	T2	900	0.111	0.8	1.062
11	T2	900	0.138	0.4	0.914
12	T2	900	0.166	0.6	1.17
13	T2	1000	0.111	0.6	0.814
14	T2	1000	0.138	0.8	0.481
15	T2	1000	0.166	0.4	1.1
16	T2	1100	0.111	0.8	0.711
17	T2	1100	0.138	0.4	1.218
18	T2	1100	0.166	0.6	1.41

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Figure 1: Main effect plot of S/N ratio for surfaceroughness

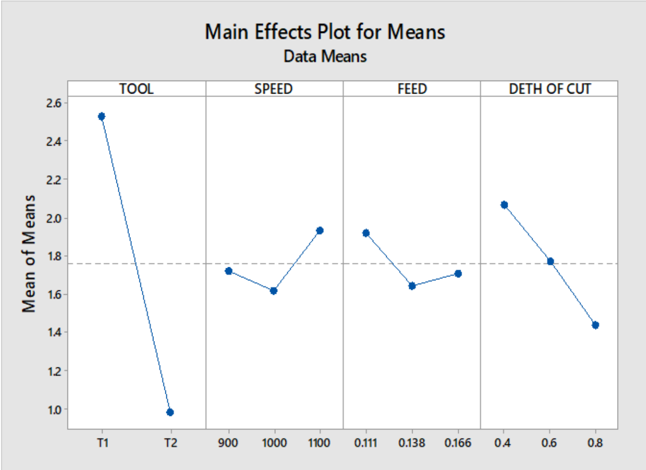


Figure 2: Main effect plot of mean for surface roughness

In main effect plot of S/N ratio for tool war, X-Axis indicates different levels of process parameters and Y-Axis shows average of S/N ratio. It can be observed from figure4.4 that tool wear decreases as speed and feed increases whereas depth of cut increases tool wear also increases. Tool wear is minimum for tool T2.

Table 5: Analysis of variance for surface roughness

Source	DF	Adj.SS	Adj.MS	F value	P value
Tool	1	10.7540	10.7540	113.60	0.000
Speed	2	0.3145	0.1572	1.66	0.238
Feed	2	0.2503	0.1252	1.32	0.309
Depth of cut	2	1.1959	0.5979	6.32	0.017
Error	10	0.9466	0.0947		
Total	17	13.4613			

Table 6: Response Table for S/N Ratios for Ra value,Smaller is better

Level	Tool	Speed	Feed	Depth of Cut
1	-7.9056	-3.8978	-4.0303	-5.1441
2	0.4974	-2.5207	-2.9273	-4.2459
3		-4.6938	-4.1547	-1.7224
Delta	8.4031	2.1731	1.2274	3.4217
Rank	1	3	4	2

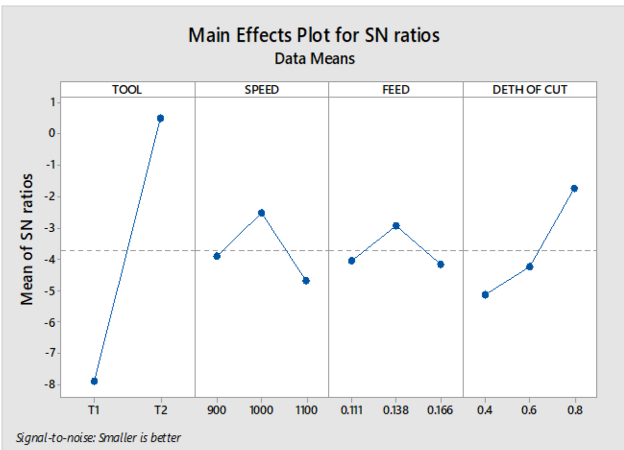
As seen from Table 6 tool is the most influence parameterfor surface roughness followed by depth of cut, speed and feed.

The optimal level for different performance parameters are given below.

a) For surface roughness: -S2-F2-T2-D3

The purpose of the confirmation experiment is to verify the conclusions drawn during the analysis phase. The response was correlated with the factors using the first orderpolynomial. The relationship between surface roughness andprocess parameters

Regression EquationRa value =



1. T1 = 2.96 + 0.001055 *Speed – 3.87* Feed -1.577* Depthof cut.
2. T2 =1.41 + 0.001055* Speed – 3.87* Feed -1.577* Depth of cut.
For this model R^2 value = 92.97%, R^2 (adj) = 88.05% this indicate that the model is desirable and 88.05 %variability is explained by the model after considering significant parameters.
Ra value =1.41 + 0.001055 *1000 – 3.87 *0.138 -1.577 *0.8
= 0.6694µm

Table 7: Confirmation of experiments for surface roughness

	Prediction	Experiment
Level	S2-F2-T2-D3	
Surface roughness (µm)	0.6694	0.62

Experiments are conducted by using optimal level for each parameter. Table 7 shows the comparison of the predicted and the actual responses obtained during experimental trial. The predicated and actually measured response for surface roughness is in good agreement, indicating that optimization of the control parameters was appropriate.

Conclusions

Taguchi's design of experiment is used tool for conducting analysis in current experimentation. Most significant parameters and their contributions for surface roughness is determined with help of ANOVA. The optimal value and optimal level for performance characteristics is also finding out.
The following are conclusions obtained from the experimentation.
From the response table for surface roughness indicates that tool is most influencing factor for surface roughness followed by depth of cut, speed and feed.
The second level of speed is 1000r pm, second level of feed is 0.138 mm/min, third level if depth of cut 0.8 isand tool T2 indicates minimum value of surface roughness.

References

R. Ramanujam et. Al., "A Taguchi based fussy logic approach to determining the influence of cutting parameters on the machinability of Inconel 718 alloy with coated carbide insert"volume 9, issue 6, 2007 ARPN journal of applied and engineering sciences, ISSN 1819-6608,
See catalog number 6110953 for the Tagu T Turn insert master manual.The authors of the 2013 article "Identifying Optimal Process Parameters For Cnc Turning Operation While Performing 'Design of Experiments' For Physical Experimentation" are Suraj Dnyaneshwar Jadhav and Swapnil S. Kulkarni. The article can be found in the International Journal of Advanced Engineering Research and Studies, volume 22, issue 9, issue 9.
"Optimal Cutting Parameters for Turning Operations with Costs of Quality and Tool Wear Compensation" presented by Tamer F. Abdelmaguid and Tarek M. El-Hossainy at the 2012 International Conference on Industrial Engineering and Operations Management in Istanbul, Turkey, July 3–6, 2012.The article "Influence of Cutting Parameters on Turning Process Using Anova Analysis" was published in the Research Journal of Engineering Sciences in 2013. It was written by D.V.V. Krishan Prasad.
"Experimental Study On The Effect Of Cutting Parameters On Surface Finish Obtained In cnc Turning Operation" published in the International Journal of Innovative Research in Science, Engineering and Technology, was written by B. Tulasiramarao, Dr. K. Srinivas, Dr. P. Ram Reddy, A. Raveendrand, and Dr. B.V.R. Ravi Kumar in 2013.Article titled "Optimizing Turning Process by Taguchi Method Under Various Machining Parameters" published in the 2014 edition of the International Research Journal of Engineering and Technology (IRJET) and written by Narendra Kumar Verma and Ajeet Singh Sikarwar.Published in the International Journal of Engineering Research and General Science, Volume 3, Issue 5, 2015, the article "Experimental Study and Parameter Optimization of Turning Operation of Aluminium Alloy-2014" was written by Arjun Pridhvijit and Dr. Binu C Yeldose.A comparative study was published in the Journal of Mechanical Engineering in 2015 by Vikas Pare and published in the field of engineering in Kolhapur, Maharashtra. The study focused on the optimization of process parameters in high speed CNC end milling of composite materials using meta heuristic techniques.