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# OPTIMIZATION OF TURNING PARAMETERS OF EN24 STEEL ALLOY USING RESPONSE SURFACE METHODOLOGY

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#### Abstract

This work mainly focuses on the experimental optimization of turning parameters primarily based on Surface Roughness and Material removal Rate (MRR) and in this Experiment Central Composite Design is used to enhance Surface Roughness quality .Exclusive Turning parameters such as Cutting speed, Feed, and depth of cut,were examined by using covered Carbide equipment on CNC machines using EN24 (dry and wet machining) , product Roughness, cutting quality and Material Removal Rate were determined.After measuring the surface roughness on the Talysurf test device and obtaining the results, the results were analyzed in Minitab 17 software and the roughness of the EN24 (dry and wet processing) product was examined on the surface. The pathways and its contribution to decision-making ultimately indicate that it negatively affects the issue. All tests were carried out in dry and wet conditions; nine samples were produced under dry conditions and nine samples were produced under wet conditions. In this research the fundamental goal investigation of the various process(input) parameters and performed on a CNC turning machine since it is much improved in compression with different machines in context of accuracy and surface finish .The attention on the properties of the materials alongside the cutting condition of cutting tool and work piece has been made.It is found that the optimum results achieved at feed rate of 0.15 mm/rev 0.25 mm dept of cut and 2000 rpm speed.

KEYWORDS: EN24 steel alloy, RSM, Spindle speed, Feed rate, Depth of cut, Taguchi method, ANOVA,

#### **1.INTRODUCTION:**

Turning is a machining process where a lathe is used to rotate the metal at the same time as tool actions in a liner movement to removes steel along the diameter developing a cylindrical shape. Turning in machining can be done on various machines such as regular machine tools, special machine tools or CNC machine tools. CNC turning uses a computer to control the movement of the cutting tool. It allows complex parts to be created with high speed and precision. CNC turning is especially useful in making parts with complex radial features or where tight tolerances are required. There are many parameters that affect the turning process. Understanding these can help improve the process and achieve the desired results. Some important parameters are Cutting Speed, Feed rate, and Depth of Cut. As shown in Fig 1.1



Fig 1.1 Turning of EN24 on CNC machine

**Tanveer H. B.. (2014)** Response surface. In the study of this method, data are cold,. Cutting speed, feed rate and depth of cut this analysis, it was determined that the biggest factor affecting the discomfort was the feed, speed.

**S.ARizvi (2015)** studied the study to improve the parting limit to achieve better position and different costs during turning using a CNC machine with EN24 steel bars (35 mm dimensions). Create areas such as functional information and synthetic materials. Flue gas deposition (CVD) involves carbide tips as the material. In this study, the boundary information is surface speed, feed velocity and depth of cut

**Mohd.Arif. I (2016)** Concentrated on a writing survey on different variables influencing turning activity. This paper manages the writing audit of different variables that influence the turning activity. In this paper different cycle boundaries like speed, profundity of cut, feed, nose range, and so forth are considered.

**P.B.Patole(2017)** Focused on the investigation and facilitation of cutting boundaries with various materials during MQL turning of AISI 4340 using nanofluids. This article turns to a simple method for limit cycling for minimum oil (MQL) return of AISI 4340 using nanofluids using Dim Social Investigation (GRA). Sixty initial surveys were carried out over the entire project network to refine the optimum level for CNC lathes. Research results for different reactions such as surface roughness and processing were analyzed using Dark Social Grade (GRG). The quality parameters obtained by way of GRA include spindle velocity (seventy five m/min), feed price (0.04 mm/hearth), and cutting depth (0.5 mm)

**M. Mashrat (2018)** Using the help vector regression strategy to build predictive models and the strategy of using genetics to create streamlined models, learned that state roughness boundaries (Ra) are concentrated

nearby. Control measures to achieve these goals are spindle speed, feed and cutting depth, A.D. Pathak, R.S. Wargaan (S.U.) Deokar (2018) Controlling the development of machining parameters such as speed, feed, depth of cut and tool tip length in dry turning of AISI A2 material steel using tungsten carbide inserts.

**Ibrahim et al , (2019)** Box-Behnken's standard coating process was used to turn magnesium alloy material, and the nice running circumstance turned into carried out with a cutting speed of eighty mm/min, a feed price of 0.10 mm/fireplace and a drilling pace of forty five.7071. rpm. UA 31. Turning is done on the lower cutting edge; the lower part caused the tool to wear out and the tool reached the desired value of 0.27728 mm. Use of Compressed Air to Reduce the Temperature of the Work piece and Rotating Tools

Atlanta's et al., (2020) examined the surface roughness and wear trademark in miniature turning of compound Ti-6Ai-4V material, where they got a decent surface completing in miniature turning process utilizing the optimal cutting boundaries and multi objective advancement of miniature turning process through the utilization of reaction surface.

Lam Khanah and van Cuong, (2021) Studied the most useful input parameters for Turning En24 steel alloy. The objective was to research the impact of input factors on the surface roughness and MRR in the course of turning process. The analysis of the consequences decided the impact of input parameters on the surface roughness and elimination fee (MRR). But this research used SR for optimizing the input parameters. Vikas and Marakini (2022) Analyzed the impact of face milling processes at the surface homes of AZ91 magnisium alloy using uncoated carbide inserts. The studies additionally explored cloth behaviour. In addition, a time area evaluation is performed to establish correlation between the machining vibration singles and floor integrity characteristics. This examine inves tigates the device behaviour in surface end.

Silveira et al. (2023) Analyzeed the floor integrity of annealed AISI H 13 steel regarding the effect of face milling parameters and tool grade. This take a look at located that the milling pressure components were in the main stimulated via the depth of reduce and feed in line with parameters. The EN24 steel with wc coated inserts is used on this reseasch.

**Chen et al., 2024):** The focus of discourse is to the enhancement of machinability through the utilisation of coated inserts.Utilising tungsten carbide (WC)-coated inserts in the process of machining EN 24 steel is a strategic decision. WC-Coated inserts are chosen based on their exceptional hardness and resistance to wear.

#### **2 EXPERIMENTATION:**

Research objectives:

- (a) To determine the amount of material to be removed and the Roughness of the Sample surface called Response Surface Methodology (RSM)
- (b) Material, Tool and Turning Parameters

#### 2.1 Material:

COMPOUND	PERCENTAGE %
Carbon	.411
Silicon	.222
Manganese	.640
Phosphorus	.029
Sulphur	.033
Chromium	1.05
Molybdenum	.204
Nickle	1.36
Aluminum	.008
Boron	.0008
Cobalt	.009
Copper	.084
Lead	.000
Titanium	.004
Vanadium	.014
Tungsten	.000

Table 2.1 Chemical composition of EN24

#### **2.2 Cutting Tool:**

Carbide cutting devices, also known as established carbide cutting instruments or tungsten carbide cutting devices are a significant component of CNC machining. It offer high hardness, strength, and wear resistance. This trial uses solidified carbide and coated cutting bits for turning 18 work pieces.



Fig. 2.1 carbide tool tip and cutting tool of CNC machine.

#### 2.3 Trial and Final Run

The carbide cutting tool is used to complete the Trial. At low speed material removal rate is obtained very less as different trails are done and after that with the increase in speed as well as depth of cut, the material removal rate is achieved optimal

S.No.	<b>Parameters</b>	<mark>Units</mark>	<mark>L1</mark>	<mark>L2</mark>	L3
1	Cutting	m/min	1500	1700	2000
	speed				
2	Feed	mm/rev	0.05	0.1	0.15
3	Depth of cut	mm	0.25	0.4	0.6

#### 3. Experimental Setup

Turning is a machining process where a lathe is used to rotate the metal at the same time as tool actions in a liner movement to removes steel along the diameter developing a cylindrical shape. Turning in machining can be done on various machines such as regular machine tools, special machine tools or CNC machine tools. CNC turning uses a computer to control the movement of the cutting tool The sample size which is used in this Experiment was 42mm Diameter and 80mm Length. The experimental equipment is depicted in Fig 3.1.

The levels of each process parameter/factor are shown in Table 5.1



Fig. 3.1 Pictorial view of CNC machine on which experiment is done

#### **3.1 TURNED WORKPIECES**

After machining of all Eighteen work pieces, Nine work pieces on dry machining and Nine work pieces on wet machining were collect the specimens and they are shown in fig 3.2 &3.3 below. Fig 3.2 indicates dry machining turned work pieces and Fig 3.3 indicates wet turned work pieces. The turned work pieces are now used to check the rate of material to be removed and weight loss. Measurement taken by using scale and the dimensions of length of work pieces is 50mm



Fig 3.2. Dry machining turned work pieces



Fig.3.3 Wet machining turned work pieces

#### 4. Analysis Testing

#### 4.1 SURFACE ROUGHNESS MEASUREMENT:

surface Roughness meter (stylus type surface roughness meter to measure the roughness of the sample. There are two main reasons for choosing this surface roughness meter, one is that it is Easy to obtain and the other is that it is Easy to use. The Surface Roughness meter used in this experiment is Talysurf.



Fig 4.1 Surface Roughness test

#### 5. Results and Discussions:

#### 5.1 Optimization of surface roughness:

Table 5.1 depicts the response surface roughness showing SN versus the individual level of each parameter. Figure 5.2 also shows the SN ratio at different levels.

LOWER IS BETTER						
POSITION	SPINDLE SPEED	FEED	<b>DEPTH OF CUT</b>			
01	-4.884	-5.046	-6.169			
02	-4.095	-5.355	-5.335			
03	-6.238	-4.861	-3.759			
Delta	2.188	0.494	2.410			
Rank	2	3	1			

Table 5.1	Roughness,	signal-to-	-noise ratio	, response	table
1				,	

Table 5.1 describes the average value obtained by the Minitab software. This clearly shows that spindle speed, is the most important factor in acquiring the optimal surface as compared to the Two Factors Feed and Depth of cut.



Fig 5.1 Main effect plot for surface roughness for dry Machining

According to the main results of the roughness map, the level with the highest signal-to-noise ratio from each parameter is selected as the best value of the parameter to minimize the Surface Roughness.

Table 5.2: Optimum	values of parameters t	to reduce roughness
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SPECIFICATION	<b>CUTTING SPEED</b>	FEED	DEPTH OF CUT
Unit	Rpm	mm/rev	Mm
POSITION	S2	F1	D3
QUANTITY	1700	0.05	0.6

The delta value and the order in the response display that amongst all parameters, spindle speed has the highest impact at the roughness of the turned work piece, accompanied via feed rate and spindle speed.

### 5.2 Optimization of MRR

. /	Table 5.3	Signal-	to-noise	ratio	response	of MRR
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LARGER IS BETTER							
POSITION	<b>CUTTING SPEED</b>	FEED	<b>DEPTH OF CUT</b>				
1	1.847	1.889	2.178				
2	1.640	1.947	1.951				
3	2.216	1.866	1.573				
Delta	0.576	0.082	0.604				
Rank	2	3	1				



Figure 5.2 Main Representation of MRR signal-to-noise ratio

The Delta value and ranking in the response show that among all parameters, spindle speed has the largest impact on the roughness of turning the work piece, followed by feed rate and spindle speed.

Table 5.4: Best measures to increase MRR							
CIFICATION	<b>CUTTING SPEED</b>	FEED	DEPT				
	Rpm	mm/rev	mm				

<b>SPECIFICATION</b>	<b>CUTTING SPEED</b>	FEED	<b>DEPTH OF CUT</b>
UNIT	Rpm	mm/rev	mm
POSITION	S3	F2	D3
QUANTITY	2000	0.1	0.6

#### **Response Surface Methodology (RSM):**

The method used in this project called Response Surface Methodology (RSM), which is a statistical and numerical method for Statistical Analysis .Planning, interaction improvement, and product development. It is crucial in modern and manufacturing industries, where product quality and display standards are crucial. RSM aims to find the optimal response; identifying compromised ideals for specific Statistical Analysis. It's used for to research the relationship among response variables and capability variables, which include Surface Roughness regression in Minitab-17 software for Dry Machining of EN24 steel. Table 5.5: Estimated Regression for surface Roughness on the specimen for Dry Machining

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<b>StdOrder</b>	Run Order	<mark>Р Туре</mark>	<b>Blocks</b>	Speed	Feed	Depth of	<mark>SR</mark>
						<mark>cut</mark>	
10	1	0	1	1500	0.05	0.250	2.661
11	2	0	1	1500	0.10	0.400	1.234
4	3	1	1	1500	0.15	0.600	1.645
3	4	1	1	1700	0.10	0.250	1.840
12	5	0	1	1700	0.15	0.400	1.908
7	6	1	1	1700	0.05	0.600	1.172
2	7	1	1	2000	0.15	0.255	1.167
5	8	1	1	2000	0.05	0.400	2.700
6	9	1	1	2000	0.10	0.600	2.790

Table 5.5 Surface Roughness obtained on Dry Machining of EN24

Table 5.6 Surface Roughness obtained on Wet Machining of EN24

StdOrder	RunOrder	<b>PtType</b>	<mark>Blocks</mark>	Speed	Feed	Depth of	<mark>SR</mark>
						<mark>cut</mark>	
10	1	0	1	1500	0.05	0.250	1.501
11	2	0	1	1500	0.10	0.400	1.101
4	3	1	1	1500	0.15	0.600	1.098
3	4	1	1	1700	0.10	0.250	1.175
12	5	0	1	1700	0.15	0.400	1.382
7	6	1	1	1700	0.05	0.600	1.305
2	7	1	1	2000	0.15	0.255	0.999
5	8	1	1	2000	0.05	0.400	0.966
6	9	1	1	2000	0.10	0.600	0.561

Table 5.7 SR change analysis of dry processed samples

Terms	Coeff	SE- coef	T- value	P- Value	VIF
Constant v	1.925	0.425	4.53	0.046	
Speed	0.656	0.368	1.78	0.049	1.39
Depth of cut	-0.064	0.368	-0.18	0.025	1.39
Speed*Speed	0.204	0.563	0.36	0.003	1.17
Speed*Speed	-0.089	0.368	-0.24	0.004	1.50
Feed*DOC	-0.067	0.368	-0.18	0.017	2.50

Table 5.8: ANOVA for SR on the specimens for Dry Machining

Source	DOF	<mark>Adj SS</mark>	<mark>Adj MS</mark>	F-value	P-value
Model	6	2.48770	0.41462	0.76	0.031
Linear	3	2.27655	0.75885	1.40	0.013
SPEED	1	1.72134	1.72134	3.17	0.017
FEED	1	0.18490	0.18490	0.34	0.018
DEPTH OF	1	0.01664	0.01664	0.03	0.005
CUT					

Square	1	0.07158	0.07158	0.13	0.010
SPEED*SPE	1	0.07158	0.07158	0.13	0.059
ED					
2-way	2	0.09734	0.04867	0.09	0.010
interaction					
CUTTIN	1	0.03133	0.03133	0.06	0.033
SPEED*FEE					
D					
FEED*DOC	1	0.01796	0.01796	0.03	0.057
Error	2	1.08533	0.54267		
Total	8	3.57303			

Here DOF stands for Degree of Freedom ; It is a measure of the information provided by your Data so as to calculate unknown variables. Here Seq SS represents the Sequential sum of square and Adj SS represents the adjusted sum of Square and Adj MS represents the adjusted mean square . F represents the f value , which is the ratio of the mean square. P represents the p value, indicating that the results obtained are significant.

#### **Regression equation in encoded units**

SR= 5.5 -0.0081 SPEED + 19.9 FEED + 0.40 DEPTH OF CUT + 0.000003 SPEED\*SPEED-0.0071 SPEED\*FEED – 7.7 FEED\*DEPTH OF CUT

Terms	Coef SE	Coef	<b>T-value</b>	<b>P-value</b>	
Constant	1.500	0.234	6.42	0.058	1.3
SPEED	-0.1481	0.0826	1.79	0.059	1.1
FEED	0.0716	0.0826	0.87	0.006	1.3
DEPTH OF	0.0324	0.0826	0.39	0.035	1.2
CUT					
SPEED*SPEED	-0.427	0.248	-1.72	0.003	1.3
SPEED*FEED	0.0904	0.0826	1.09	0.056	1.1
SPEED*DEPTH	-0.0899	0.0826	-1.09	0.035	1.5
OF CUT					
FEED*DEPTH	0.0629	0.0826	0.76	0.026	1.4
OPF CUT					

Table 5.9 Coded Coefficients (Wet Machining)

Source	DOF	<mark>Adj SS</mark>	<mark>Adj MS</mark>	F-value	<b>P-value</b>
Model	7	0.548517	0.078360	1.43	0.013
Liner	3	0.224954	0.074985	1.37	0.044
SPEED	1	0.175528	0.175528	3.21	0.049
FEED	1	0.041041	0.041041	0.75	0.045
DEPTH OF	1	0.008385	0.008385	0.15	0.049
CUT					
Square	1	0.161975	0.161975	2.97	0.037
SPEED*SPEED	1	0.161975	0.161975	2.97	0.035
2-MANNER	3	0.161587	0.053862	0.99	0.012
INTERACTION					
SIPNDLE	1	0.065341	0.065341	1.20	0.048
SPEED*SPEED					
SPEED* DOC	1	0.064620	0.064620	1.18	0.043
FEED*DOC	1	0.031626	0.031626	0.58	0.049
Error	1	0.054615	0.054615		
Total	8	0.603132			

Table 5.10. ANOVA	Table For wet Machining
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Regression equation in encoded units

SR= -18.6+0.0235 SPEED -14.3 FEED + 3.06 DEPTH OF CUT - 0.000007 SPEED\*SPEED

+ 0.00723 SPEED \* SPEED - 0.00205 SPEED\*DOC + 7.19 FEED\*DEPTH OF CUT





Fig. 5.3 Main effect plot on Cutting speed, Feed and Depth of cut.

The effects show that when the speed increases, the roughness first decreases after which increases. As the feed Rate increases, the surface roughness decreases. It decreases as the intensity of cut increases after which step by step increases at certain points.

#### **Counter Graph of SR verse FEED, SPEED**



Figure 5.4. Comparison of SR with Spindle Speed, Feed rate, and Depth of cut :



#### Counter graph of SR



Fig. 5.6 Counter graph of SR



Figure 5.7. Graph of Cutting Speed, Feed, Dept of Cut and SR.

Now same procedure is done on Minitab-17 Software for Wet Machining of EN24 and following data is obtained from the Minitab-17 Statistical Software and the Data is given below

Main displays of spindle speed, feed rate and Depth of cut



Fig 5.8 : Main interaction plot means for Speed, Feed, Depth of cut



Fig 5.9 : Interaction graph of surface Roughness



Fig 5.10 : Counter Graph for Cutting Speed. Feed and Depth of cut



Fig 5.11 : Surface Roughness Graph for Speed, Feed and Depth of Cut



Fig 5.13 : Graph of Cutting Speed, Feed and Depth of Cut

#### 6. Conclusion:

This manuscript is mainly focused on optimization of surface roughness (SR) and combination of different parameters that will produce better Surface Roughness under different conditions. Response Surface Modelling(RSM) is used for modelling of CNC Turning parameters in the Machining of EN24 steel alloy. In this research L18 orthogonal array is used, Nine work pieces for Dry Machining and Nine Work pieces For wet Machining. The results indicates that the model are effective in protecting multiple response in the turning compound

Based on results, Following conclusions are drawn:

- At Dry Machining of EN24, It has been found that Minimum surface Roughness is achieved at S1=1500 (S1=speed of rotation), F1=0.15(F1=Feed rate) and D1=0.6 (D1=Depth of Cut) and Maximum surface Roughness is achieved at S2=1700, F2= 0.05 and D2= 0.6
- At Wet Machining of EN24, Minimum surface Roughness is achieved at S3=2000, F3=0.1 and D3=0.6 and Maximum surface Roughness is achieved at S1=1500, F1=0.05 and D3=0.25
- Material Removal Rate at Dry Machining: Maximum material removal rate is achieved at S3, F2 and D3 and Minimum Material Removal Rate is achieved at S3, F3 and D1
- Material removal Rate at Wet Machining : Maximum MRR is achieved at S1, F3 and D1 and Minimum MRR is achieved at S3, F1 and D2

From the above points it is found that material Removal rate increases as the spindle speed(S) increases and Depth of cut (D) increases and vice versa

#### 7. Future Scope:

- The following functions may be used in future work. The research can be extended to different mechanical devices using other variables, different tools and functional materials.
- In this study, RSM is used for optimization, but in the future, we can also use other statistical methods such as Taguchi, BDS, and FBD, which can be used for optimization. check out the impact of reducing fluid and geometry on surface roughness and metallic removal rate
- This study can be extended to consider many variables such as chip tool interface temperature, machining time, tool wear, different coolants, corner radius and tool geometry, among others.
- Studies can be based on optimizing various machining parameters for specific composite materials

#### **REFRENCES:**

[1]W.H. Yang, Y.S. Tarng, Plan improvement of cutting boundaries for turning activities in view of the Taguchi technique, Diary of Materials Handling Innovation 84 (1998) 122-129.

[2]Ilhan Asilturk, Harun Akkus "Deciding the impact of cutting boundaries on surface unpleasantness in hard turning utilizing the Taguchi technique" Estimation 44 (2011) 1697-1704.

[3]Dr. C. J. Rao , Dr. D. Nageswara Rao, P. Srihari Impact of cutting boundaries on cutting power and surface completion in turning activity Procedia Designing 64 (2013) 1405 - 1415.

[4] M. Durairaj, S. Gowri Parametric Advancement for Further developed Apparatus Life and Surface Completion in MiniatureTurning utilizing Hereditary Calculation Procedia Designing 64 (2013) 878 - 887.

[5] Surendra Kumar Saini, Sharad Kumar Pradhan Enhancement of Multi-Objective Reaction during CNCTurning utilizing Taguchi-Fluffy Application Procedia Designing 97 (2014) 141 - 149.

[6] Sayak Mukherjee, Anurag Kamal, Kaushik Kumar "Enhancement of Material Expulsion Rate During Turning of SAE 1020 Material in CNC Machine utilizing Taguchi Procedure" Procedia Designing 97 (2014)29 - 35

[7] L B Abhang and M Hameedullah Parametric examination of turning process on en-31 steel PrecedeMaterials Science 6 (2014) 1516 - 1523.

[8] Suha K. Shihab\*, Zahid A. Khan, Aas Mohammad, Arshad Noor Siddiqueed RSM Based Investigation of Cutting Temperature during Hard Turning with Multi-facet Covered Carbide Addition Procedia Materials Science 6 (2014) 1233 - 1242.

[9] Cruel Y Valera, Sanket N Bhavsar Trial Examination of Surface Harshness and Power Utilization in Turning Activity of EN 31 Combination Steel Procedia Innovation 14 (2014) 528 - 534

[10] B.Singarvel, T.Selvaraj, R.Jeyapaul (2014), Multi Objective Streamlining in Turning of EN25 Steel
UtilizingTaguchi Based Utility Idea Combined with Head Part Examination, Procedia Designing, 97, 158 165.

[11] P. Jayaraman, L. Mahesh kumar, Multi-reaction Improvement of Machining Boundaries of TurningAA6063 T6 Aluminum Combination involving Dark Social Examination in Taguchi Strategy, Procedia Designing 97 (2014) 197 - 204.

[12] Fredrik Schultheiss, Soren Hägglund, Volodymyr Bushlya, Jinming Zhou, Jan-Eric Ståhl Impact of theleast chip thickness on the got surface harshness during turning activities Procedia CIRP 13 (2014) 67 -71

[13] Murat Sarıkaya, Abdulkadir Güllü "Taguchi plan and reaction surface philosophy based investigation of machining boundaries in CNC turning under MQL" Diary of Cleaner Creation 65 (2014) 604-616.

[14] Dipti Kanta Das, Ashok Kumar Sahoo, Ratnakar Das, B. C. Routara "Examinations on hard turning utilizing covered carbide embed: Dim based Taguchi and relapse system" Procedia Materials Science 6 (2014) 1351 1358.

[15] G.M SayeedAhmeda S. SibghatullahHussainiQuadrib Md SadiqMohiuddin, Advancement of Feed and Outspread Power in Turning Cycle by utilizing Taguchi Configuration Approach, Materials Today: Procedures 2 (2015) 3277 – 3285

[16] Hemant Janina, Jaya Tripathib, RavindraBharilyac, Sanjay Jainc, AvinashKumard\*, Advancement and assessment of machining boundaries for turning activity of Inconel-625, Materials Today: Procedures 2 (2015) 2306 - 2313. [17] Qian Yi a, Congbo Li a, Ying Tang b, Xingzheng Chen, Multi-objective boundary improvement of CNCmachining for low carbon fabricating, Diary of Cleaner Creation xxx (2015) 1-9 16666Vol-8 Issue-3 2022

[18] S.J. Raykar, D.M. D'Addona, A.M. Mane "Multi-objective improvement of high velocity turning of Al 7075utilizing dim social examination" Proceedia ninth CIRP Meeting on Shrewd Calculation in Assembling Designing 33 (2015) 293 - 298.

[19] Ilhan Asiltürk, SüleymanNes\_eli, Mehmet Appearance " Streamlining of boundaries influencing surface Roughness of Co28Cr6Mo clinical material during CNC machine machining by utilizing the Taguchi and RSM techniques" Estimation 78 (2016) 120-128.

[20] Deepak D, Rajendra B "Streamlining of Machining Boundaries for Turning of Al6061 utilizing Powerful PlanRule to limit the surface unpleasantness" Procedia Innovation 24 (2016) 372 - 378.

[21] S.M.Ravi Kumar, Suneel Kumar Kulkarni, Examination of Hard Machining of Titanium Amalgam by TaguchiStrategy, Materials Today: Procedures 4 (2017) 10729-10738.

[22] Prashant D. Kamble, Atul C. Waghmare, Ramesh D. Askhedkar, Shiplap B. Sahara (2017), Multi objective improvement of turning boundaries thinking about shaft vibration by Half breed Taguchi Head part investigation (HTPCA), Materials Today: Procedures, 4, 2077-2084.

[23] Sanchit Kumar Khare, Sanjay Agarwal, Enhancement of Machining Boundaries in Turning of AISI
4340Steel under Cryogenic Condition Utilizing Taguchi Strategy, Procedia CIRP 63 (2017) 610 - 614.

[24] Niranjan D B, G.S.Shivashankar, Sreenivas Rao K V, Praveen R, Enhancement of Cutting Interaction Boundaries on AL6061 Utilizing ANOVA and TAGUCHI Strategy, Materials Today: Procedures 4 (2017)10845-10849.

[25] M. VenkataRamana, Y. ShanmukaAditya , Advancement and impact of cycle boundaries on surface unpleasantness in turning of titanium amalgam Materials Today: Procedures 4 (2017) 1843-1851.

[26] A. Palanisamy, T. Selvaraj, Streamlining of Machining Boundaries for Dry Turning of Incoloy 800H UtilizingTaguchi - Based Dark Social Examination, Materials Today: Procedures 5 (2018) 7708-7715.

 [27] A.Saravanakumar, S.C.Karthikeyan, B.Dhamotharan, V.Gokul kumar, Streamlining of CNC Turning Boundaries on Aluminum Combination 6063 utilizing TaguchiRobust Plan, Materials Today: Procedures 5 (2018)

8290-8298.

[28] M. VenkataRamana and Goutham kumar, Enhancement of Material Expulsion Rate in Turning of AISI 321Treated Steel Utilizing Taguchi Technique, Materials Today: Procedures 5 (2018) 4965-4970.

[29] C.Moganapriya, R.Rajasekar, K.Ponappa, R.Venkatesh, S.Jerome, Impact of Covering Material and Cutting Boundaries on Surface Unpleasantness and Material Expulsion Rate in Turning Cycle UtilizingTaguchiTechnique, Materials Today: Procedures 5 (2018) 8532-8538.

[30] Sayyedsiraj, Displaying of harshness esteem from triboligical boundaries in hard turning of AISI52100steel, Procedia Assembling 20 (2018) 344-349.

[31] Patole P. B, Kulkarni V. V, Advancement of Interaction Boundaries in light of Surface Harshness and Cutting Force in MQL Turning of AISI 4340 utilizing Nano Liquid, Materials Today: Procedures 5 (2018) 104-112.

[32] Diptikanta Das, Sagnik Mukherjee, SauravDutt, BijayaBijetaNayak, Ashok Kumar Sahoo, High velocityturning of EN24 steel - a Taguchi based dim social Methodology, Materials Today: Procedures 5 (2018)4097-4105.

[33] Upinder Kumar Yadav, Deepak Narang&Pankaj Sharma Attri, "Experimental investigation and Optimization of machine parameters for surface roughness in CNC turning by Taguchi method", International Journal of Engineering Research and Application", vol. 2, Issue 4, pp 2060-2065. , 2012

[34] Harish Kumar, Mohd. Abbas, Dr.Aas Mohammad &HasanZakir Jafri, "Optimization of cutting parameters in CNC Turning", Integration Journal of Engineering Research and Applications", vol. 3, Issue 3, pp. 331-334, 2013.



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