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Comparison of ceramic and coated carbide inserts performance in finish turning of hardened aisi 420 stainless steel

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Comparison of Ceramic and Coated Carbide Inserts Performance in Finish Turning of Hardened AISI 420 Stainless Steel

Highlights

- *Hard turning of AISI 420 stainless steel*
- *Employing Taguchi method for the design of experiment*
- *Employing response surface methodology for analyzing data*
- *Optimization of cutting parameters*
- *Comparison of ceramic and coated carbide inserts*

Graphical Abstract

In this experimental study, the performance of the ceramic and coated carbide cutting tools was compared considering surface roughness in finish hard turning of AISI 420 stainless steel.

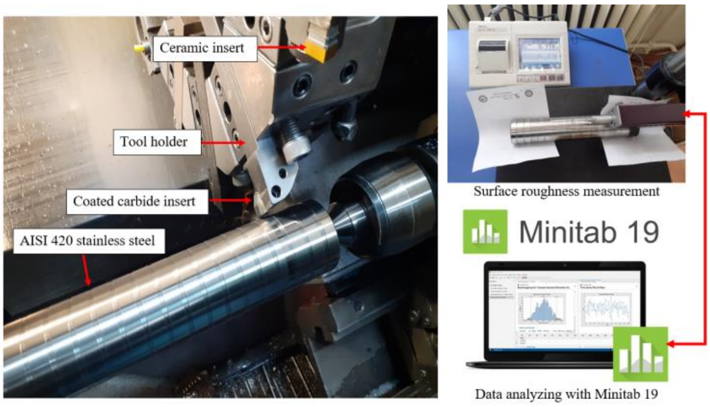

Figure. Experimental Setup

Aim

This study aims to optimize the cutting parameters during finish hard turning of the AISI 420 stainless steel. Besides, the performance of the ceramic and coated carbide inserts was compared.

Design & Methodology

Three different cutting speeds, feed rates and depth of cut have been chosen for performing the hard turning process. The total number of trials was decreased from 27 to 9 using Taguchi. The relation between input and output parameters was obtained using response surface methodology. The analysis of variance was used to determine the most significant parameters on the surface roughness.

Originality

The originality of the presented work is comparing the performance of ceramic and coated carbide insert in the term of surface roughness.

Findings

The findings show that surface roughness is mainly affected by the feed rate in both cutting inserts. Besides, increasing the feed rate increases the surface roughness sharply.

Conclusion

Ceramic inserts exhibited better performance than coated carbide insert in the term of minimum surface roughness.

Declaration of Ethical Standards

The author of this article declares that the materials and methods used in this study do not require ethical committee permission and/or legal-special permission.

Comparison of Ceramic and Coated Carbide Inserts Performance in Finish Turning of Hardened AISI 420 Stainless Steel

Research Article

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ABSTRACT

Martensitic stainless steels have a high carbon amount that can be heat treated to increase their hardness. There are widely used in cutlery, needle valves, shear blades, dental and surgical equipment. In this study finish hard turning was performed on the AISI 420 stainless steel using ceramic and coated carbide inserts under dry cutting conditions. Depth of cut, feed rate, and cutting speed were selected as machining parameters, while surface roughness was chosen as machinability criterion. Taguchi L9 orthogonal array was selected for the design of the experiment to decrease the number of trials for reducing time and cost of manufacturing. The response surface methodology was utilized for determining a relationship among process parameters and output parameter. The analysis of variance results indicates that feed rate is the utmost factor on the surface roughness for both ceramic and carbide inserts with 86.56% and 80.57% contribution, respectively. The developed mathematical models for ceramic and coated carbide inserts are capable to predict surface roughness with 97.07% and 96.13% accuracy, respectively. Based on the desirability function and response optimizer of the RSM, 0.2 mm depth of cut, 250 m/min cutting speed, and 0.05 mm/rev feed rate were selected as optimum machining factors. Finally, the mean surface roughness for ceramic and coated carbide inserts calculated as 0.57 µm and 0.71 µm, respectively. Therefore, the ceramic insert exhibited better performance compared to the coated carbide insert.

Keywords: Surface roughness, AISI 420 stainless steel, ceramic insert, coated carbide insert, RSM.

1. INTRODUCTION

Grade 420 steel is referred to as high-carbon martensitic stainless steel that contains a minimum of 12% chromium. Generally, heat treatments are applied on the grade 420 steel to increase the hardness and corrosion resistance [1]. After heat treatment, AISI 420 stainless steel (SS) reaches high hardness, hence it is required to perform hard turning [2-4] using single-point cutting tools such as ceramic, coated carbide, or cubic boron nitride [5].

The chips formed in AISI 420 SS, which has a very high machinability level if annealed after manufacturing will be easily broken. It is observed that AISI 420 SS reaches a very high surface hardness level after heat treatment. Therefore, some products such as knives, shear blades, needle valves, surgical and dental equipment are produced with AISI 420 SS [6]. In addition, it is used extensively in the machinery industry, food and food production industry, decoration and decorative material production, transportation sector, shafts and pistons, valves, petroleum, and petrochemical fields [7].

Few studies were performed related to the machinability of the stainless steels [8-11]. Other studies focused on the machinability of the hardened steels in turning process [12-14]. Makadia and Nanavati [10] presented the effect of machining factors on the surface roughness in turning of hardened AISI 410 SS with ceramic inserts. The RSM was used to obtain the relationship among input and output factors. According to the results, with an 80% contribution feed was the most influential factor on the surface roughness. The cutting speed and nose radius exhibited a great impact on the output. Besides, the surface roughness was decreased by increasing the nose radius and decreasing the feed rate. Finally, the optimum machining parameters obtained as r = 1.2 mm, f = 0.1 mm/rev, a = 0.3 mm, V = 255.75 m/min).

Bouzid et al. [11] evaluated the impacts of machining factors on the surface roughness parameters during turning of hardened AISI 420 SS with coated carbide insert. They used full factorial design and RSM to find out optimum machining parameters. Based on the results, the “f” is the utmost factor on the “Ra”. They claimed that a combination of low “f”, low “V”, and low “a” minimizes surface roughness.

Bouzid et al. [15] also reported the influence of cutting factors namely, “V”, “f”, and “a” on the cutting forces and surface roughness during turning of hardened AISI 420 SS with coated carbide insert. The results revealed that surface roughness dominantly was affected by feed rate with 81% contribution, whereas cutting forces were impacted by the cutting depth. The optimization of the processing factors was performed using the composite desirability method of response surface methodology. As result, V: 120 m/min, f: 0.08 mm/rev, and a: 0.15 mm depth of cut were found as optimum machining parameter in hard turning of AISI 420 SS using coated carbide insert.

Zerti et al. [16] presented the impacts of input parameters such as f, V, and a, on the responses namely, cutting

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forces, cutting power, surface roughness, and MRR in dry turning of hardened AISI 420 SS having 59 HRC with ceramic inserts. The most significant factors on the outputs were determined employing ANOVA. Besides, the results were evaluated employing RSM and ANN. The results showed the utmost effect of feed on the surface quality with an 80.71% contribution. However, the depth of cut was found to be dominant on the cutting force with a 65.31% contribution. Besides, the cutting depth was the most influential factor on the cutting power and the material removal rate.

In another study, Zerti et al. [17] optimized the cutting factors considering the least surface roughness and cutting forces in turning of hardened AISI 420 SS with ceramic insert under dry cutting conditions. They used ANOVA and Pareto graphs to show the contribution of the cutting speed (Vc), feed rate (f), and depth of cut (ap). As a result, they determined feed rate as the utmost factor influencing the surface quality, whereas "a" has a dominant impact on the cutting forces. Finally, they obtained optimum machining parameters as: f = 0.08 mm/rev, a = 0.141 mm, and Vc = 80 m/min.

Palanisamy et al. [18] investigated the influence of machining parameters such as f: (0.06, 0.12, 0.18 mm/rev), r: (0.4, 0.8, 1.2 mm), and V: (100, 160, 220 m/min) on the cutting forces and surface roughness in turning of hardened AISI 420 SS using tungsten carbide insert with three different nose radius. According to the results of this investigation, the feed rate was the most important parameter on the responses followed by the cutting speed. However, nose radius has the least impact on the responses. The minimum surface roughness of 0.347 µm was measured at V = 100 (m/min), f = 0.06 (mm/rev), and r = 1.2 (mm).

As the previous studies examined different investigations have been performed on different kinds of stainless steels using various cutting tools. However, the number of studies that compared the effect of the ceramic insert and coated carbide insert on the surface roughness during turning of hardened AISI 420 SS is limited. In this study, a, f, and V were selected as the machining factors and surface roughness was chosen as the response parameter. Taguchi's L9 was employed for the DOEs and RSM was used to obtain the relationship among processing parameters and response. The ANOVA was performed to find out the most significant parameters that affect surface roughness. The multiple linear regression equation was developed for predicting surface roughness based on input parameters. Finally, optimum machining parameters were determined using response optimizer of RSM and the graphical comparison between coated carbide and ceramic inserts was presented.

2. MATERIAL and METHOD

In this study, a cylindrical workpiece was used with 50 mm diameter and 250 mm length. in order to distinguish each cutting combinations 18 grooves with 3 mm width and 5 mm depth were opened on the AISI 420 SS workpiece. Thus, the turning length for each combination of the machining parameters calculated as 10 mm. The chemical compositions, physical and mechanical properties of AISI 420 SS are presented in Table 1.

Table 1. Chemical composition, physical and mechanical properties of AISI 420 SS

Chemical composition		
Cr	Mn ≤	Si ≤
12.0-14.0	1.00	1.00
S ≤	P ≤	C ≥
0.03	0.04	0.15
Physical properties		
Density (g/cm^3)	Melting Point (°C)	Specific Heat Capacity (J/Kg·K)
7.8	1450	460
Thermal Conductivity (W/m·K)	Electrical Resistivity (nΩ.m)	Elastic Modulus (GPa)
24.9	550	200
Mechanical properties		
Tensile Strength (MPa, ≤)	Yield Strength (MPa, ≤)	Elongation in 50 mm (%, ≥)
1720	1480	8
Reduction in Area (%, ≥)	Hardness (HRC)	Condition
25	51	Oil quenched from 1038°C and tempered at 316°C

2.1. Heat Treatment

Before heat treatment, two holes were created in the center of the workpiece to eliminate vibration during the turning operation. Firstly, the temperature of the workpiece gradually raised to 660°C in 2 hours using a furnace. Secondly, the temperature increased to 850°C in 2 hours. Finally, the temperature was increased slowly to 1040°C, and this process was carried out in 2 hours. For the cooling process, the method of cooling with nitrogen in a vacuum was preferred. It was initially started with a pressure of 4.0 bar and this value dropped to 3.8 bar towards the end of the process. The cooling process was carried out in 2 hours to eliminate shocking of the material that decreases the fragility of it. In order to remove residual stress from the material, a tempering process was performed for 2 hours at 200°C. The hardness value obtained after the heat treatment was 51 HRC.

2.2. Lathe machine, tool holders, and cutting inserts

The experimental tests were carried out on the GOODWAY GLS-200 CNC Lathe machine. It has ∅380 mm maximum turning diameter, 500 mm maximum processing length, 4200 rpm spindle speed, and 15 kW power.

In this study, two cutting inserts were used to perform the hard turning process under dry cutting conditions. Coated carbide (WPP10S) inserts with WNMG080404-NF designation manufactured by Walter company were mounted on the Takımsan-MWLNR 2525 M08 tool holder. Ceramic inserts (KY4400) with DNGA 150404T01020 designation manufactured by Kennametal were mounted on Walter-DDJNR 2525 M15 tool holder. The coated carbide insert, ceramic insert, and tool holders are presented in Figure 1. Both inserts have 4.76 mm thickness, 12.70 mm inscribed circle, and 0.4 mm nose radius.

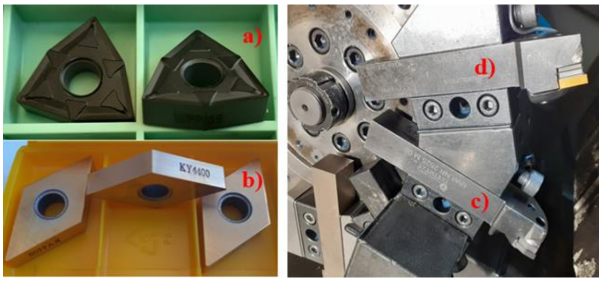

Figure 1. a) Coated carbide and b) ceramic inserts, c) Walter and d) Takımsan tool holders

2.3. Machining parameters

In this study, feed rate, depth of cut, and cutting speed were selected as the machining criteria based on the previous studies and the manufacturer recommendation for the cutting inserts. It is essential to optimize machining parameters to minimize the cost and time of manufacturing. The machining parameters for performing hard turning on AISI 420 SS under dry cutting conditions are given in Table 2.

Table 2. Machining parameters for the hard turning of AISI 420 SS

Machining parameter	Unit	Level		
		1	2	3
Depth of cut (a)	mm	0.2	0.3	0.4
Cutting speed (V)	m/min	150	200	250
Feed rate (f)	mm/rev	0.05	0.08	0.11

2.4. Surface roughness measuring devices

Measurement of surface roughness (Ra) was performed using the Mitutoyo SJ-410 portable device. Three measurements were performed on the three different locations of the workpiece with 120° intervals. Average of these measurements was selected as the final surface roughness. The experimental setup is shown in Figure 2.

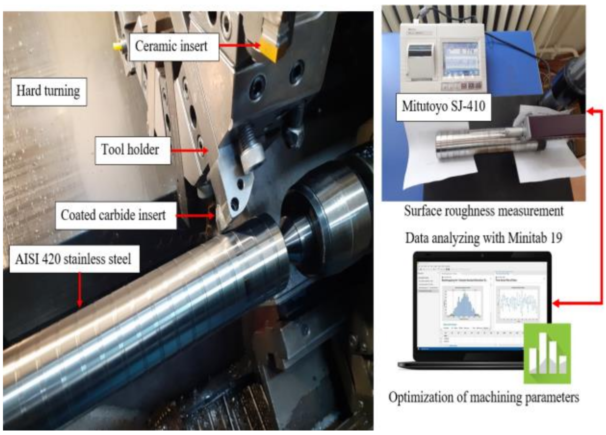

Figure 2. Experimental setup

3. RESULTS AND DISCUSSION

In the presented work, the effect of machining parameters and cutting insert types were investigated on surface roughness in finish hard turning of AISI 420 SS. To reduce the cost and time of manufacturing Taguchi L9 vertical was employed for the design of the experiment for each cutting insert. Therefore, the number of trials decreased from 27 to 9. The RSM was employed to find out the relationship among processing factors and surface roughness. The utmost parameter on the surface roughness was found using ANOVA. Main effects plots showed the impact of processing factors on the surface roughness. The mathematical model was obtained for estimating the response. Finally, a graphical comparison for cutting inserts performance was presented.

The experimental results for the surface roughness using ceramic and coated carbide inserts are presented in Table 3. The surface roughness ranges for ceramic insert were measured as 0.275-0.974 µm, and for coated carbide insert as 0.334-1.278 µm.

Table 3. Experimental results

Trial	Insert	a (mm)	V (m/min)	f (mm/rev)	Ra (µm)
1	Carbide	0.2	150	0.05	0.366
2	Carbide	0.2	200	0.08	0.589
3	Carbide	0.2	250	0.11	0.873
4	Carbide	0.3	150	0.08	0.698
5	Carbide	0.3	200	0.11	1.212
6	Carbide	0.3	250	0.05	0.505
7	Carbide	0.4	150	0.11	1.278
8	Carbide	0.4	200	0.05	0.334
9	Carbide	0.4	250	0.08	0.496
1	Ceramic	0.2	150	0.05	0.275
2	Ceramic	0.2	200	0.08	0.503
3	Ceramic	0.2	250	0.11	0.783
4	Ceramic	0.3	150	0.08	0.594
5	Ceramic	0.3	200	0.11	0.931
6	Ceramic	0.3	250	0.05	0.432
7	Ceramic	0.4	150	0.11	0.974
8	Ceramic	0.4	200	0.05	0.279
9	Ceramic	0.4	250	0.08	0.417

3.1. Analysis of variance results

The ANOVA results for surface roughness considering coated carbide and ceramic tools, respectively are given in Tables 4 and 5. The interactions of the cutting parameters have a negligible effect on the response. Therefore, instead of choosing a full factorial, the linear and square factors have been selected for analyzing the results. Based on the findings, feed rate exhibited a considerable impact on the response with 80.57% contribution for coated carbide insert and 86.56% contribution for the ceramic insert. Other machining parameters have not any influence on the surface quality. Many researchers claimed the important impact of feed on the surface roughness [15-17].

Table 4. ANOVA results for coated carbide insert

Source	DF	Seq. SS	Adj. SS	Adj. MS	F-Value	P-Value	Cont.
Model	6	0.926	0.926	0.154	8.28	0.112	96.13%
Linear	3	0.825	0.825	0.275	14.77	0.064	85.71%
a	1	0.013	0.013	0.013	0.70	0.491	1.36%
V	1	0.036	0.036	0.036	1.96	0.297	3.79%
f	1	0.776	0.776	0.776	41.65	0.023	80.57%
Square	3	0.100	0.100	0.033	1.79	0.377	10.42%
a*a	1	0.044	0.044	0.044	2.38	0.263	4.61%
V*V	1	0.0001	0.0001	0.0001	0.01	0.934	0.02%
f*f	1	0.055	0.055	0.055	2.99	0.226	5.79%
Error	2	0.037	0.037	0.018			3.87%
Total	8	0.963					100.00%

Table 5. ANOVA results for ceramic insert

Source	DF	Seq. SS	Adj. SS	Adj. MS	F-Value	P-Value	Cont.
Model	6	0.541	0.541	0.090	11.06	0.085	97.07%
Linear	3	0.492	0.492	0.164	20.10	0.048	88.25%
a	1	0.001	0.001	0.001	0.24	0.671	0.36%
V	1	0.007	0.007	0.007	0.91	0.441	1.33%
f	1	0.482	0.482	0.482	59.16	0.016	86.56%
Square	3	0.049	0.049	0.016	2.01	0.349	8.83%
a*a	1	0.025	0.025	0.025	3.18	0.217	4.65%
V*V	1	0.0001	0.0001	0.0001	0.02	0.910	0.02%
f*f	1	0.023	0.023	0.023	2.84	0.234	4.16%
Error	2	0.016	0.016	0.008			2.93%
Total	8	0.557					100.00%

3.2. The normal plot of standardized effects

This plot is used to show the direction, importance, and magnitude of the machining parameters. The plot shows the standardized effects concerning the distribution fit line. The factors with a red square are significant and with a blue circle are not significant. The factors that are located at the left side of the fit line have a negative impact on the response, while the factors on the right side have a positive impact on the response.

The normal plot of the standardized effects for surface roughness considering coated carbide and ceramic cutting inserts are given in Figures 3 and 4, respectively. Based on the plot, the feed rate that is further from the fit line is statistically significant. It has also a positive effect on the surface roughness. Other machining parameters namely, cutting depth and cutting speed have not exhibited any impact on the response.

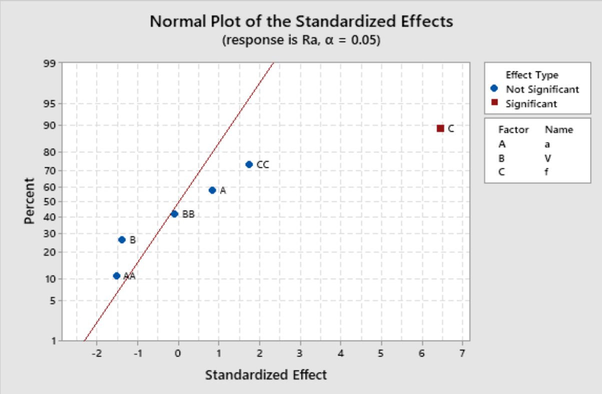

Figure 3. The normal plot of standardized effects (coated carbide)

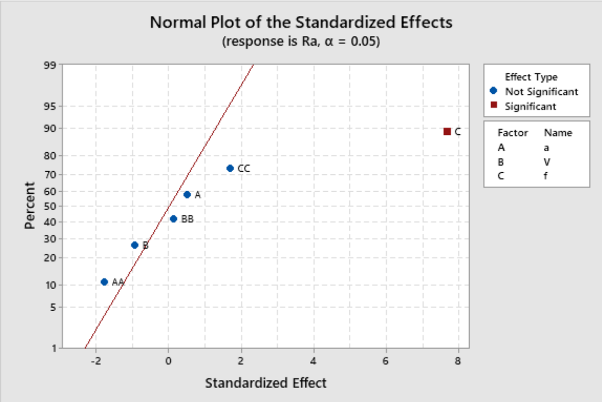

Figure 4. The normal plot of standardized effects (ceramic)

3.3. Main effects plot

The main effects plots for coated carbide and ceramic inserts are illustrated in Figures 5 and 6, respectively. According to this plot, as the feed increases the surface roughness increases dramatically for both cutting inserts. However, increasing the cutting speed decreases the surface roughness slightly. Therefore, a combination of low feed rate with high cutting speed is needed to minimize the surface roughness.

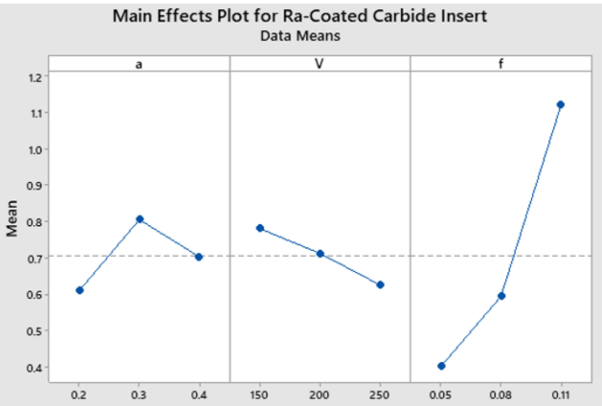

Figure 5. Main effects plot for surface roughness (coated carbide)

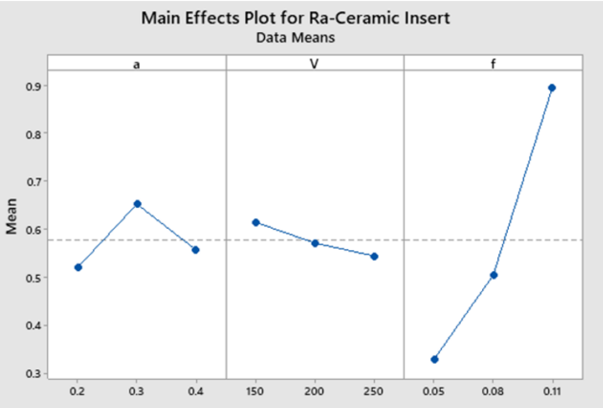

Figure 6. Main effects plot for surface roughness (ceramic)

3.4. The wireframe 3D plots

The wireframe 3D plots show the combined impacts of the machining factors on the surface quality. The plots (a-f and V-f) for coated carbide and ceramic cutting tools, respectively are given in Figures 7 and 8. The holding value for the a-f plot is V = 200 m/min and for the V-f plot is a = 0.3 mm. According to these plots, surface roughness sharply increases by increasing the feed rate value in both inserts. In addition, a minor decrease in surface roughness was observed as the cutting speed increases for both inserts. The depth of cut has not presented any impact on the response. Based on the metal cutting theory, surface roughness has a direct relationship with feed rate. Increasing "f", increases the surface roughness. However, surface roughness has an indirect relationship with "V". Increasing the "V", increases the cutting zone temperature and consequently decreases the cutting forces which results in ease of chip removal, which leads to smoother surface quality. Therefore, a low "f" and high "V" is needed to obtain the least surface roughness.

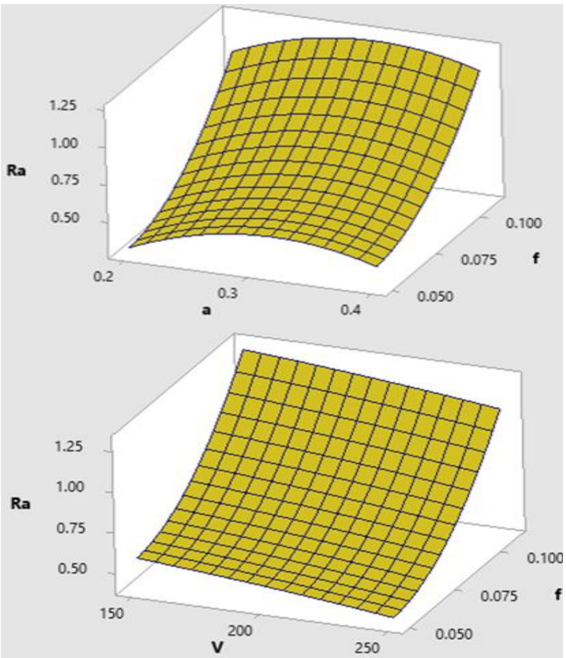

Figure 7. Surface roughness wireframe 3D plot (coated carbide)

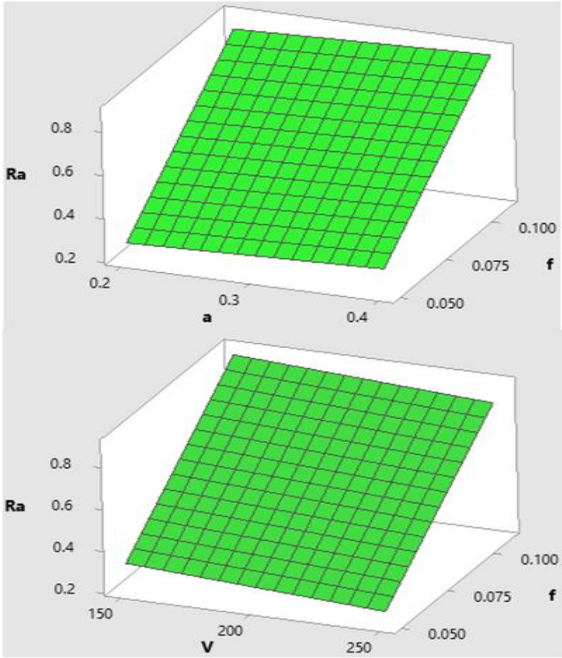

Figure 8. Surface roughness wireframe 3D plot (ceramic)

The comparison of the coated carbide and ceramic inserts in terms of surface roughness is illustrated in Figure 9. Based on this plot, the ceramic insert presented good performance compared to the coated carbide cutting tool for all combinations of machining parameters. The average surface roughness for ceramic insert is 0.57 µm, while for coated carbide cutting tool is 0.71 µm.

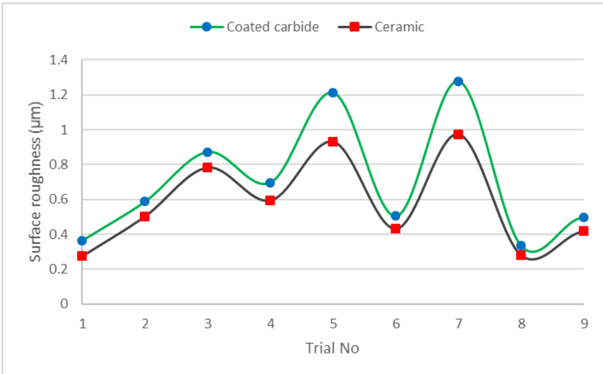

Figure 9. Performance comparison of ceramic and coated carbide inserts

3.5. The mathematical models

The mathematical models for surface roughness were developed using multiple linear regression models of response surface methodology. These models are capable to predict the surface roughness based on the machining parameters. The mathematical models for surface roughness considering coated carbide and ceramic inserts, respectively are given in Equations (1) and (2). The coefficient of determination (R^2) closer to 100% shows the accuracy of the proposed models. In this study, the R^2 for coated carbide and ceramic cutting tools were calculated as 96.13% and 97.07%, respectively.

The mathematical model for surface roughness using a coated carbide cutting tool

$$Ra = -0.38 + 9.41\,a - 0.0001\,V - 17.7\,f - 14.90\,a*a - 0.000004\,V*V + 186\,f*f \quad (1)$$

$R^2 = 96.13\%$

The mathematical model for surface roughness using ceramic cutting tool

$$Ra = -0.22 + 7.01\,a - 0.0020\,V - 9.7\,f - 11.38\,a*a + 0.000003\,V*V + 119.6\,f*f \quad (2)$$

$R^2 = 97.07\%$

3.6. Comparison of the predicted and experimental results

In order to show the accuracy of the proposed mathematical model, the absolute error (AE%) and the average of absolute errors (AAE%) between experimental and predicted results for surface roughness are presented in Table 6. Equation 3 is used to calculate the absolute error (AE%) for the results.

$$AE\ (\%) = \left[\frac{|Exp.\ results - Pred.\ results|}{Exp.\ results}\right] \times 100 \qquad (3)$$

According to the result, the average of absolute errors for coated carbide and ceramic inserts considering the surface roughness is 8.11% and 6.51%, respectively. Based on the results, the presented mathematical model can predict the response with high accuracy.

Table 6. Absolute error (AE %) for experimental and predicted results

Trial No	Coated carbide insert Ra (μm)		
	Exp.	**Pred.**	**AE (%)**
1	0.366	0.380	3.80
2	0.589	0.505	14.2
3	0.873	0.923	5.71
4	0.698	0.761	9.12
5	1.212	1.215	0.20
6	0.505	0.425	15.8
7	1.278	1.211	5.21
8	0.334	0.395	18.2
9	0.496	0.492	0.81
AAE (%)			**8.11**
Trial No	**Ceramic insert Ra (μm)**		
	Exp.	**Pred.**	**AE (%)**
10	0.275	0.305	10.9
11	0.503	0.441	12.3
12	0.783	0.791	1.01
13	0.594	0.611	2.86
14	0.931	0.951	2.14
15	0.432	0.371	14.1
16	0.974	0.919	5.64
17	0.279	0.291	4.30
18	0.417	0.439	5.27
AAE (%)			**6.51**

In addition, the comparison between experimental and predicted results for surface roughness considering the coated carbide and ceramic inserts is depicted in Figure 10.

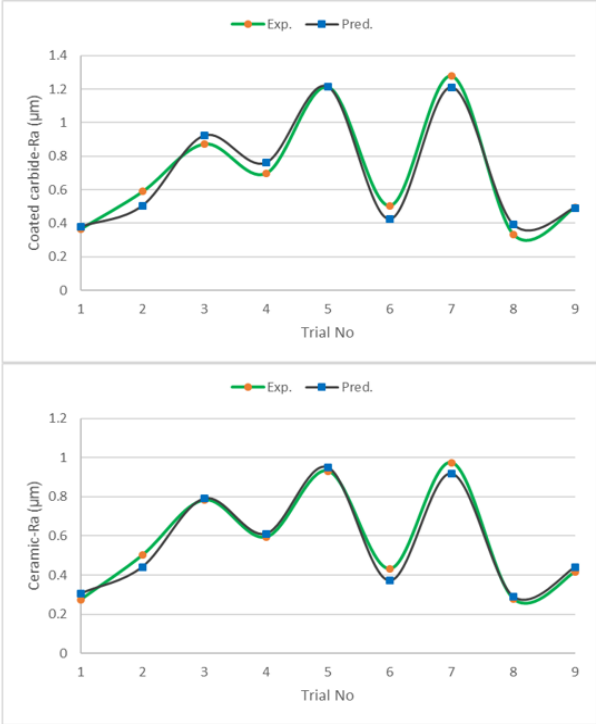

Figure 9. Comparison of experimental and predicted results for coated carbide and ceramic inserts

3.7. Optimum machining parameters

Optimization of the machining parameters to have minimum surface roughness is very important. In this case, the friction in the components that are in contact is decreased and the service life of the components is increased. Response optimizer of the RSM is a useful method to determine the optimum machining parameters. Figures 11 and 12 respectively show the optimization plot for the machining parameters aiming at minimum surface roughness. The composite desirability (D) is a very good indicator to show the accuracy of the optimized parameters. For both inserts, the composite desirability is 1 that shows the response is well optimized. According to Figures 8 and 9, the optimum machining parameters for minimizing the surface roughness are (a = 0.2 mm), (V = 250 m/min), and (f = 0.05 mm/rev). The first level of machining parameters should be selected to decrease surface roughness in finish hard turning of AISI 420 SS with both ceramic and coated carbide cutting tools. The minimum surface roughness of 0.224 μm using coated carbide insert and 0.240 μm using ceramic insert are obtained considering the optimum machining parameters.

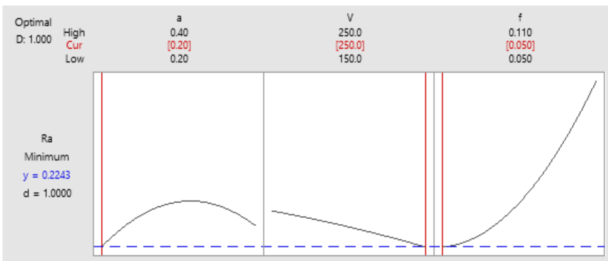

Figure 11. Response optimizer for coated carbide insert

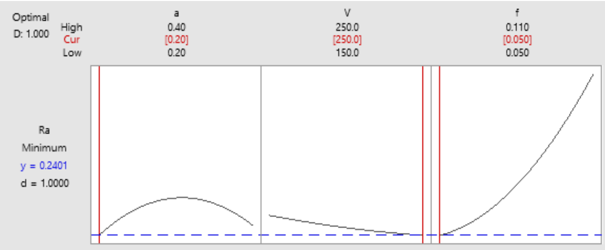

Figure 12. Response optimizer for ceramic insert

4. CONCLUSION

In the presented experimental study, finish hard turning was performed on the AISI 420 SS with ceramic and coated carbide cutting inserts under dry cutting environment to investigate the effects of processing factors and insert type on the surface roughness. The depth of cuts were selected as 0.2-0.4 (mm), cutting speeds were selected as 150-250 (m/min), and feeds were selected as 0.05-0.11 (mm/rev). Taguchi L9 was used for the DOE, hence, the number of trials reduced from 27 to 9. The relationship between machining parameters and surface roughness was determined using RSM. The most effective factor on the response was determined employing analysis of variance. The normal plots of standardized effects and wireframe 3D plots were presented for a better understanding of the dominant factor on the surface quality. The mathematical models were developed for both cutting inserts to estimate the surface roughness based on the process parameters. Finally, optimum machining parameters for minimizing the surface roughness were revealed using the response optimizer of the RSM.

The ANOVA results show the dominant impact of feed over the surface roughness in both inserts. The contribution effect of feed rate on surface roughness for coated carbide is 80.57%, while for ceramic insert is 86.56%. The other machining parameters do not have any effect on the response. The normal plot of standardized effect also proves the significant impact of the feed on the surface quality.

According to wireframe 3D plots for both inserts as the feed increases, the surface quality decreases dominantly. Besides, increasing the cutting speed decreases the surface roughness slightly. The effect of the depth of cut over response is negligible. Increasing the "f" adversely affects the surface quality according to the metal cutting theory. However, increasing the cutting speed affects the surface quality positively due to decreasing the cutting forces because of high cutting zone temperature. Thus, a combination of high "V" with low "f" should be selected for reducing the surface roughness.

The developed mathematical models for coated carbide and ceramic inserts could predict the surface roughness with 96.13% and 97.07% accuracy. Also, a graphical comparison of the coated carbide and ceramic inserts revealed the better performance of the ceramic insert. The mean surface roughness for all combinations in the ceramic insert is 0.57 µm, while for coated carbide insert is 0.71 µm.

DECLARATION OF ETHICAL STANDARDS

The author of this article declares that the materials and methods used in this study do not require ethical committee permission and/or legal-special permission.

AUTHORS' CONTRIBUTIONS

Mohammad Rafighi: Perofrmed the experiments, analyzed the results, and Wrote the manuscript.

CONFLICT OF INTEREST

There is no conflict of interest in this study.

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