

Retraction

Retracted: Experimental Study on Surface Roughness and Flank Wear in Turning of Nimonic C263 under Dry Cutting Conditions

Journal of Nanomaterials

Received 11 July 2023; Accepted 11 July 2023; Published 12 July 2023

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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

- (1) Discrepancies in scope
- (2) Discrepancies in the description of the research reported
- (3) Discrepancies between the availability of data and the research described
- (4) Inappropriate citations
- (5) Incoherent, meaningless and/or irrelevant content included in the article
- (6) Peer-review manipulation

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

References

- [1] J. F. Xavier, B. Ravi, D. Jayabalakrishnan, C. Ezilarasan, V. Jayaseelan, and G. Elias, "Experimental Study on Surface Roughness and Flank Wear in Turning of Nimonic C263 under Dry Cutting Conditions," *Journal of Nanomaterials*, vol. 2021, Article ID 2054399, 11 pages, 2021.

Research Article

Experimental Study on Surface Roughness and Flank Wear in Turning of Nimonic C263 under Dry Cutting Conditions

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Received 2 September 2021; Revised 21 September 2021; Accepted 27 September 2021; Published 12 October 2021

Academic Editor: Karthikeyan Sathasivam

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Aircraft component manufacturing sector is looking for high precision machining in aircraft components. The present work explores the operability of green manufacturing of Nimonic C263 using dry turning. Nimonic C263 is tough to turn owing to its inherent quality like low conductivity and more work hardening. Therefore, in order to improve this machined surface/integrity, the controlling factors were optimized based on desirability approach for minimum of surface roughness and flank wear during turning of this alloy using CBN insert. L27 orthogonal array was chosen to carry out the experiment. The effects of controlling factors, such as cutting speed (V), feed rate (S), and cut penetration/depth of cut (a_p) on the outputs, were also explored. The feed rate was a major impact to affect surface finish and flank wear. The average error percentage between the experimental and RSM models for surface finish was 4.76 percent and 2.79 percent for flank wear.

1. Introduction

High strength alloy Nimonic C263 has been extensively used in many decisive parts of aircraft. Due to the excellent mechanical properties, fatigue strength, and creep properties, this alloy is used in a high-temperature environment. However, FCC structure, gamma precipitates presence in this alloy cascades into the group of difficulty-to-cut materials as of its lower thermal conductivity and higher work hardening rate, which would damage the tool. Therefore, the machining of this hardened alloy is considered an important one for aircraft part manufacturers to ensure the quality of the parts. These factors depend on process parameters such as cutting swiftness, feed rate, and penetration of cut.

Ti-6Al 4V-ELI alloy was machined by Kechagias and colleagues [1] to determine the cutting force and surface roughness and the properties of machining aspects such as cutting speed, feed rate, and depth of cut on machining performances. For the experimental trials, L27 was used as a full factorial design. There is a consensus among experts that cutting speed should be set at 600 revolutions per minute, the feed rate should be 0.10 mm/rev, and the cut depth should be 0.50 mm. PCBN inserts with enhanced high toughness were used to finish turn the difficult to cut metal Inconel 716, and the machining attributes were evaluated. The PCBN insert was found to be the best to get quality surface finish. PCBN inserts with enhanced high toughness were used to finish turn the difficult to cut metal Inconel 716, and the machining attributes were

evaluated. The PCBN insert was found to be the best to get quality surface finish [2].

Ramesh et al. [3] investigated the machinability of titanium-based metal matrix composite during turning using CBN inserts. They have reported that the wear zones on the flank face were identified in turning this material at high cutting speed using CBN such as black and white zones. Debonding of attached materials from the tool was caused by abrasion and oxidation mechanisms that were discovered. Ren et al. [4] conducted dry machining experiments on Ti-6Al-0.6Cr-0.4Fe-0.4Si-0.01B (TC7) utilizing PCD and PCBN tools. They have investigated the machining performance of TC7 and the wear mechanism of PCD and PCBN tools. The wear of PCBN was more serious than PCD insert, and the adhesion-dissolution-diffusion mechanisms were also reported.

Das et al. [5] used an experimental trial on AISI 4340 steel that was conducted utilizing a multilayer-coated CVD (TiN/TiCN/Al₂O₃/TiN) carbide tool using a three-level factorial design employing Taguchi's L9 orthogonal array (OA). At varying levels of machine settings, they have noticed changes in surface shape and insert wear. They discovered that feed rate influenced surface roughness and flank wear more than other parameters, and that abrasion wear due to rubbing was the most common type of wear. Further, they have concluded that this coated tool can be effectively used in place of CBN and ceramic tools. Padhan et al. [6] have evaluated the machining performance in turning austenitic stainless steel Nitronic 60 under dry, compresses-air cooled machining environment, flooded, and minimum quantity lubrication. As SiAlON turned the steel, the cutting force, tool wear, cutting temperature, and surface roughness were evaluated. They came to the conclusion that the MQL technique increased and enhanced the machining performance of their machines. Cutting force and surface roughness decreased as cutting speed increased, while a force, roughness, and temperature increased when feed rate increased; yet, tool wear decreased.

CBN tool hard turning of maraging steel was optimized by [7], and they have used L27 orthogonal array to conduct experimental trails and reported that surface roughness and flank wear were affected by feed rate compared to other parameters. Further, DEFORM 3D software was used to simulate the temperature distribution at optimal machining condition, and 885°C was observed. Vinothkumar et al. [8] have reported the machining attributes in turning Inconel 718 alloy under dry and atomic spray cutting fluid using PVD coated carbide insert. They have concluded that the ASCF technique has an improved surface finish and reduced tool wear by about 17-34% compared to dry. These reductions were reported owing to the lubrication effect in the tool interface. Singh et al. [9] conducted turning trails on AISI 316L in a dry turning environment. Several process factors were selected for study: cutting speed, feed rate, cutting depth, and tool nose radius. Outputs included cutting force, tool flank wear, and surface roughness. To decrease tool wear and surface roughness, the process parameters were modified based on a desirability approach. According to them, the workpiece and tool develop contact at high nose radius levels, resulting in flank wear proportionate to the depth of cut. Rebecka et al. [10] have studied the wear mech-

anisms in turning difficult-to-cut alloy using PCBN and PCD insert, and it was observed that the fracture on the flank face was caused owing to deterioration mechanism. It is further found that PCD performed well compared to PCBN in view of life of the tool.

Volodymyr Bushlya et al. [11] conducted turning process at high speed on Inconel 718 using CBN insert, and they have reported that diffusion with boron and nitrogen wear mechanisms was found on the rake [11]. Wei Fan [12] reviewed the performance of carbide, ceramics, and CBN inserts on machining aeroalloys in terms of cutting tool failure, cutting tool material, cutting tool geometry, and chip morphology. PCBN insert retains its hardness at high temperature; however, it possesses two major limitations such as crack in insert and difficult in chip breaking. Lubin et al. [13] stated that tool wear and worst chip break are the two limitations of the PCBN inserts. Turning experimental trails were carried out on super alloy GH4169 using PCBN at supplying various pressure ranges cooling and machining attributes such as flank wear and cutting force were observed. The flank wear and cutting force were controlled by supplying high pressure cooling. Owing to great hardness, CBN inserts are recommended to machine the difficult-cut alloys; however, the control over flank wear was found to be major challenges. The abrasive wear mechanism was found to be major compare to addison and diffusion in turning process using CBN inserts. No scratches and marks were found on the machined surface during machining at high speed owing to high-temperature generation in the cut zone [14]. The properties and characteristics of inserts are main factors in the machining processes to get reliability. In view of machining performance, the CBN insert showed good results compared to ceramic during machining of super alloys, and the cutting temperature was more as the level of sped and depth of cut increases followed by feed rate [15].

Pardeep Kumar et al. [16] conducted turning experiment on AISI H13 using various CBN grades, and the parameters like work material hardness, cutting speed, and feed were found to be predominant factor on surface roughness and cutting forces. Further, it has been found that the CBN-10 grade found to be best than CBN-600 grade and CBN BNC-300 grade.

From the state of the art, it was identified that rapid tool wear during machining of any alloy would affect severely on the outputs, which also affects the integrity of the machined surface. There is also an inadequate research in dry tuning of Nimonic C263 using CBN insert. Therefore, appropriate tool material and geometry should be explored to get minimum of flank wear and enhanced the integrity. Therefore, strive is taken to study experimentally the effects of the factors on surface finish and flank wear in dry turning of Nimonic C263 using CBN. RSM was used to make a model to predict the machining attributes, and that model would also be benefited to predict the values of these attributes before the actual experiments.

2. Materials and Methods

The workpiece was made of Nimonic C263 alloy. The diameter of the work piece was 70 millimeters. The weight percentage of the chemical composition of Nimonic C263 and

TABLE 1: Chemical composition of Nimonic C263 and nomenclature of insert CBN.

S.no	Composition	Weight %	Nomenclature of CBN insert	
1	Ni	52.49	Back rake angle	-6°
2	Si	0.19	Side rake angle	-6°
3	Mn	0.46	End relief angle	-6°
4	Cr	20	Side relief angle	-6°
5	Mo	6.29	End cutting edge angle	5°
6	Cu	0.07	Side cutting angle	-5°
7	Fe	1.0	Nose radius	0.8 mm
8	Co	16.7	Tool holder	PCLNR 2020 K12
9	Ti	1.94		
10	Al	0.48		
11	Nb	0.04		
12	W	0.15		
13	V	0.02	CBN insert	Sandvik CNGA 120 408S01030A, 7025 grade
14	C	0.02		
15	S	0.001		
16	Ta	0.007		

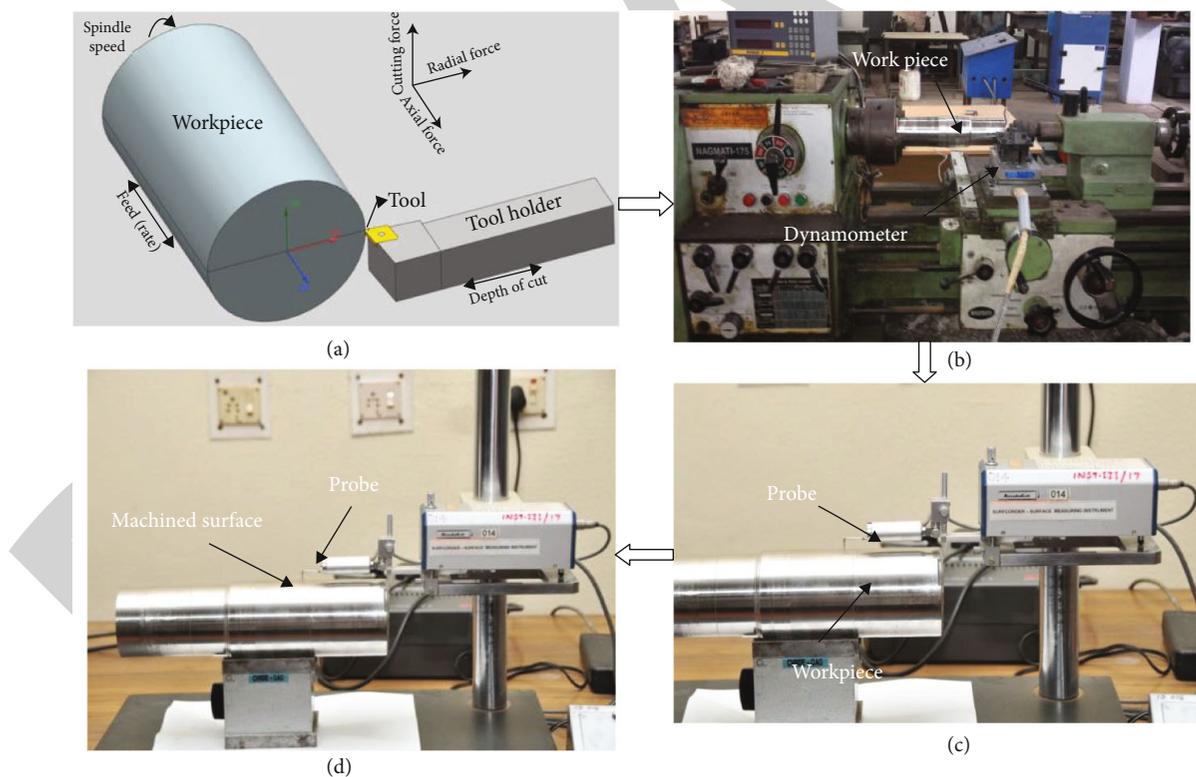


FIGURE 1: Experimental details: (a) turning setup, (b) experimental setup, (c) surf coder, and (d) tool maker microscope.

insert details of CBN are shown in the Table 1. According to a recent study, nickel-based alloys can be machined using materials such as CBN. Tools made from CBN have better thermal conductivity than carbide and ceramic cutting tools, allowing them to maintain their cutting wedge for longer

periods, function at faster cutting speeds, and produce superior surface finish [16].

The schematic view of the turning process, the experimental set-up, surface finish, and tool wear measurement are shown in Figure 1. The surface roughness and flank wear

TABLE 2: Parameters for machining.

S. No.	Control constraints	Units	Levels		
			L-1	L-2	L-3
1	V	m/min	80	125	190
2	S	mm/rev	0.055	0.096	0.159
3	a_p	mm	0.25	0.50	0.75

TABLE 3: Results from both experimental and RSM-modeled studies.

S. No.	Controlling factors			Experimental values		RSM values		% age error expt. vs. RSM	
	V	S	a_p	R_a (μm)	VB (mm)	R_a (μm)	VB (mm)	R_a (μm)	VB (mm)
1	80	0.055	0.25	2.55	0.30	2.51	0.301	1.56	0.33
2	80	0.055	0.50	2.2	0.32	2.34	0.317	5.98	0.93
3	80	0.055	0.75	2.35	0.34	2.18	0.338	7.23	0.58
4	80	0.096	0.25	2.8	0.33	2.88	0.329	3.04	0.30
5	80	0.096	0.50	2.6	0.35	2.71	0.348	4.05	0.57
6	80	0.096	0.75	2.4	0.36	2.56	0.372	6.25	3.22
7	80	0.159	0.25	3.1	0.38	3.02	0.362	0.33	4.73
8	80	0.159	0.50	3	0.39	2.87	0.385	4.33	1.28
9	80	0.159	0.75	2.8	0.40	2.73	0.413	2.50	3.14
10	125	0.055	0.25	2.25	0.29	2.18	0.291	3.11	0.34
11	125	0.055	0.50	2.1	0.31	2.00	0.306	4.76	1.29
12	125	0.055	0.75	1.7	0.33	1.85	0.326	8.10	1.21
13	125	0.096	0.25	2.65	0.30	2.67	0.315	0	4.76
14	125	0.096	0.50	2.55	0.345	2.49	0.333	0.74	3.47
15	125	0.096	0.75	2.65	0.365	2.34	0.356	11	2.46
16	125	0.159	0.25	2.93	0.32	2.96	0.342	1.01	6.43
17	125	0.159	0.50	2.6	0.36	2.80	0.364	7.14	1.09
18	125	0.159	0.75	2.5	0.41	2.66	0.391	6.05	4.63
19	190	0.055	0.25	1.6	0.42	1.76	0.393	9.09	6.42
20	190	0.055	0.50	1.65	0.38	1.58	0.407	4.24	6.63
21	190	0.055	0.75	1.45	0.42	1.41	0.426	2.75	1.40
22	190	0.096	0.25	2.65	0.39	2.43	0.412	8.30	5.33
23	190	0.096	0.50	2.15	0.45	2.25	0.429	4.44	4.66
24	190	0.096	0.75	1.9	0.46	2.09	0.451	9	1.95
25	190	0.159	0.25	2.8	0.45	2.94	0.430	4.7	4.44
26	190	0.159	0.50	2.95	0.44	2.77	0.451	6.10	2.43
27	190	0.159	0.75	2.7	0.47	2.62	0.477	2.96	1.46

were measured by surf coder and universal measuring microscope (UMM).

A factorial three-factor-three-level design was used in the experiment. The cutting speed, feed rate, and cut depth were all taken into account as controlling factors. The turning environment was dry during the experiment. In this experiment, L27 OA was arranged in an orthogonal array. These parameters are stated in sequence in Table 2. A software package called Design Expert was used to model and analysis the impact of parameters.

3. Modeling of Machining Parameters

3.1. Regression Analysis. Table 3 presents experimental results and RSM-modeled values for surface irregularities and wear of the flank. The regression model was developed to evaluate the surface roughness and flank wear as given in equations (1) and (2). Tables 4 and 5 show the results of the ANOVA for surface roughness and flank wear. From the ANOVA, roughness is influenced most by feed rate, followed by other parameters. However, the speed was the

TABLE 4: Surface irregularity: an analysis of variance (R_a - μm).

S. No.	Source	DOF	Seq-SOS	Adj MS	F	% contribution
1	Model	9	4.86	0.54	18.24	
2	V	1	0.79	0.79	26.71	14.71
3	S	1	3.14	3.14	106	58.47
4	a_p	1	0.46	0.46	15.43	8.56
5	$V \times S$	1	0.34	0.34	11.55	6.33
6	$V \times a_p$	1	7.654E-004	7.654E-004	0.026	0.014
7	$S \times a_p$	1	5.402E-004	5.402E-004	0.018	0.00010
8	V^2	1	4.730E-003	4.730E-003	0.16	0.088
9	S^2	1	0.066	0.066	2.23	1.22
10	a_p^2	1	6.000E-004	6.000E-004	0.020	0.0111
11	Residual	17	0.50	0.030		9.31
12	Total	26	5.37			100%

R-sq-97%

TABLE 5: Wear flank (VB-mm).

S. No.	Source	DOF	Seq SOF	Adj MQ	F	% contribution
1	Model	9	0.069	7.675E-003	25.70	
2	V	1	0.027	0.027	91.84	36.48
3	S	1	0.014	0.014	46.59	18.91
4	a_p	1	7.852E-003	7.852E-003	26.29	10.61
5	$V \times S$	1	3.971E-004	3.971E-004	1.33	0.536
6	$V \times a_p$	1	1.335E-005	1.335E-005	0.045	0.018
7	$S \times a_p$	1	1.900E-004	1.900E-004	0.64	0.25
8	V^2	1	0.014	0.014	45.45	18.91
9	S^2	1	5.139E-008	5.139E-008	1.721E-004	0.00006944
10	a_p^2	1	3.750E-005	3.750E-005	0.13	0.050
11	Residual	17	5.077E-003	2.987E-004		6.86
12	Total	26	0.074			100%

R-sq-95%

TABLE 6: Optimization goals and limits.

S. No.	Parameter and Result	Goal	Minor limit	Greater limit	Inferior weight	Superior weight	Significance
1	V-m/min	Is in variety	80	190	1	1	3
2	S-mm/rev	Is in choice	0.055	0.159	1	1	3
3	a_p -mm	Is in choice	0.25	0.75	1	1	3
5	R_a - μm	Minimalize	1.45	3.1	1	1	3
6	VB-mm	Minimalize	0.29	0.47	1	1	3

TABLE 7: Greatest global solutions for optimization.

Solution No.	V-m/min	S-mm/rev	a_p -mm	R_a - μm	VB-mm	D value
1	135	0.055	0.597	1.867	0.321	0.787
2	135	0.055	0.598	2.16	0.299	0.787
3	135	0.055	0.590	2.15	0.301	0.787

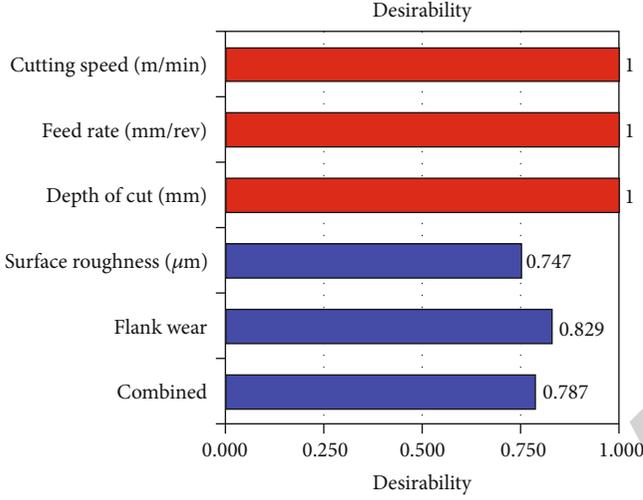
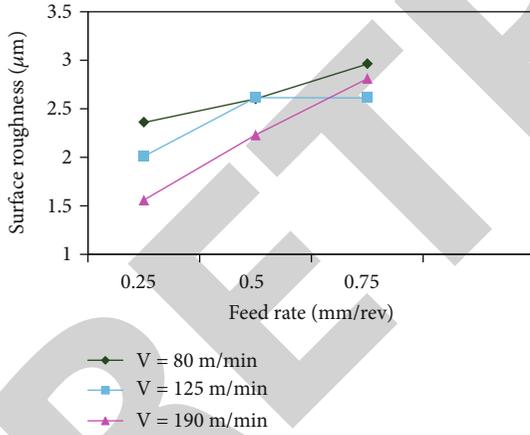
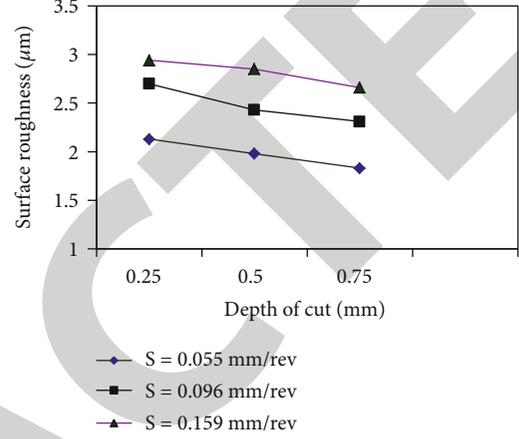


FIGURE 2: Desirability histogram.

FIGURE 3: Impact of "V," Vs, and "S" on R_a .

most predominant factor in spoiling status of the flank wear, followed by other factors.

$$\begin{aligned} \text{Surface roughness } R_a, (\mu\text{m}) = & +3.09 - 0.01 \times V + 7.63 \times S - 0.77 \\ & \times ap + 0.05 \times V \times S - 5.77657E \\ & - 004 \times V \times ap + 0.49 \times S \times ap \\ & + 9.65208E - 006 \times V^2 - 36.08 \\ & \times S^2 + 0.16 \times ap^2, \end{aligned} \quad (1)$$

FIGURE 4: Impact of " a_p ," Vs, and "S" on R_a .

$$\begin{aligned} \text{Flank wear VB, (mm)} = & +0.43971 - 3.45937E - 003 \\ & \times V + 0.62419 \times S + 0.02 \times ap \\ & - 1.92528E - 003 \times V \times S \\ & - 7.62943E - 005 \times V \times ap \\ & + 0.29 \times S \times ap + 1.63515E \\ & - 005 \times V^2 + 0.03 \times S^2 + 0.04 \times ap^2. \end{aligned} \quad (2)$$

4. Parametric Optimization

For the multiresponse optimization, the RSM-based desirability was utilized to optimize the factors for minimum of flank wear and surface roughness in turning of this alloy. When optimizing, a variety of goals are taken into consideration. A goal, lower and upper limits, and weights and importance of components are listed in Table 6. These three elements and reactions are included in the goals. "Minimize" aims to surface roughness and flank wear. "Within range" is the goal when it comes to all other aspects. A goal's desirability function could be adjusted by assigning it a weight. Table 7 shows the five best solutions to the multiresponse optimization problem using cubic boron nitride. Figure 2 shows the desirability histogram for the best choice. Causes and responses are treated independently when calculating the desirability score. There are three bars for the input parameters and four to five bars for required surface roughness and flank wear values. Three bars indicate the input parameters. Last but not least, the eighth bar represents the aggregate desirability value.

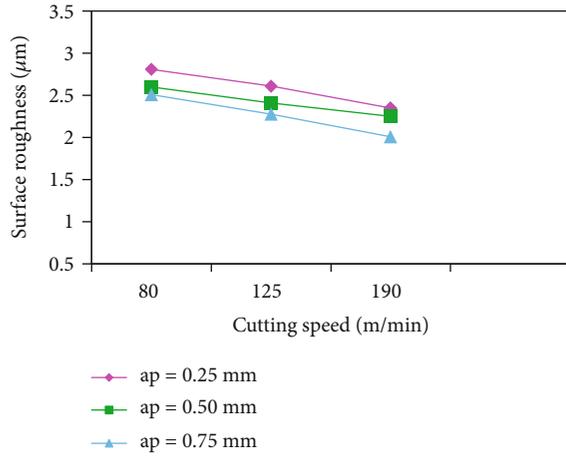


FIGURE 5: Impact of “V”-Vs-“ a_p ” on R_a .

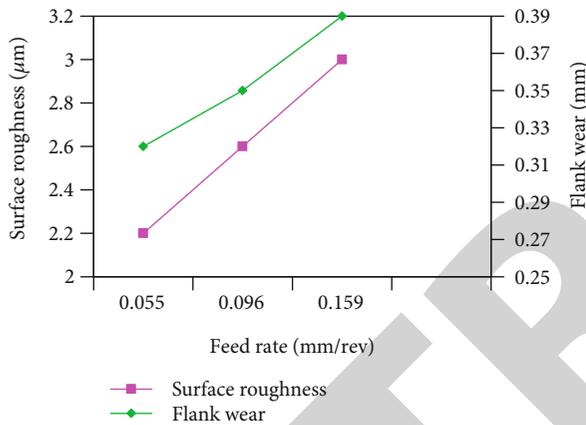


FIGURE 6: Impact of “S” at V=80 m/min and a_p 0.50 mm on VB and R_a .

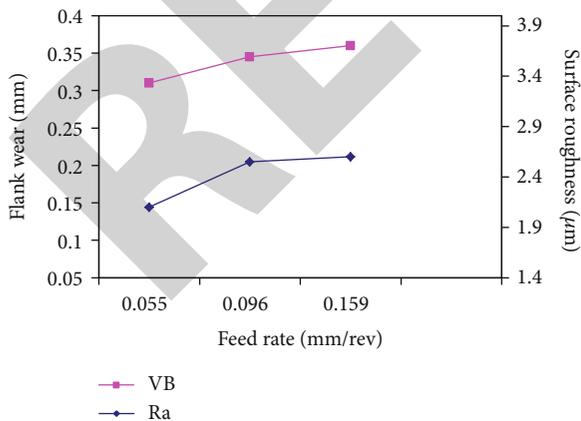


FIGURE 7: Impact of “S” at V=125 m/min and a_p 0.50 mm on VB and R_a .

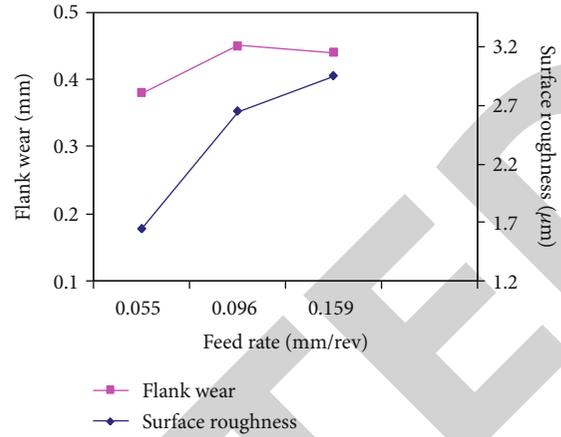


FIGURE 8: Impact of “S” at V=190 m/min and a_p 0.50 mm on VB and R_a .

5. Consequence of Progression Parameters on Machining Attributes

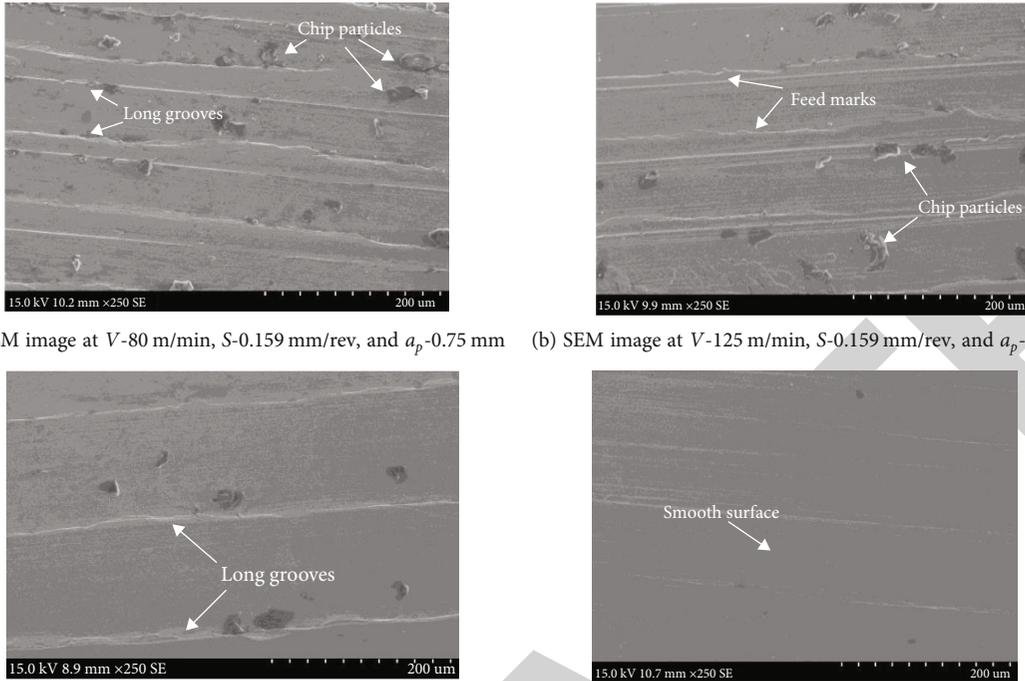
The consequence of process limitations on retorts such as surface irregularities and wear of flank was estimated and appraised when Nimonic C-263 alloy was turned using cubic boron nitride.

5.1. Surface Roughness Analysis. At varying speeds and feed rate, Figure 3 shows the change in the rate of surface roughness, and it is evident that the surface finish reduces with increasing feed rate. The surface finish is improved as the speed level increase at low feed rate, and the same findings were reported by [17]. Figure 4 shows that both feed rate and depth of cut affect surface roughness. If feed rate increases, surface roughness increases, but if cut depth is increased and feed rate decreases, surface irregularity is significantly reduced. As the depth of the incision increased, the surface roughness decreased.

A reduction in surface roughness can be expected due to work hardening the layer surface at a deeper cut. As increasing the cut depth and speed improves the surface finish and is shown in Figure 5, at high cut depth and speed, the roughness is lower than the roughness observed at low speed and cut depth. The feed rate is a critical aspect that requires more consideration than cutting speed and depth of cut, because at high feed, the worn flank is rubbed, and the roughness changes dramatically.

At all cutting speeds, surface roughness tends to grow. Enroute the limited thermal conduction of the Nimonic C-263 alloy causes heat to be generated at points where the tool and work are in contact. The higher import of the feed rate followed by speed and cut depth designates the rubbing action on flank face, and the surface irregularities are associated on the machined surface. The roughness seems to increase when the level of flank wear increases at all range of the speed, and it is evidently illustrated in Figures 6–8; also, the heat at tool-work contact zone is generated more owing to low thermal conductivity of Nimonic C263.

The micrograph of the machining shallow under different cutting settings is shown in Figure 9(a)–9(d). There is a



(a) SEM image at $V=80$ m/min, $S=0.159$ mm/rev, and $a_p=0.75$ mm (b) SEM image at $V=125$ m/min, $S=0.159$ mm/rev, and $a_p=0.75$ mm

(c) SEM image $V=190$ m/min, $S=0.096$ mm/rev, and $a_p=0.75$ mm (d) SEM image $V=190$ m/min, $S=0.159$ mm/rev, and $a_p=0.75$ mm

FIGURE 9: (a)–(d) SEM micrographs of machined surface at different cutting conditions using CBN insert.

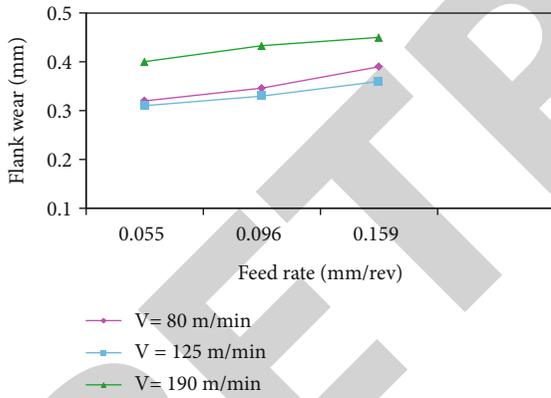


FIGURE 10: Impact of “S,” Vs, and “V” on “VB”-mm.

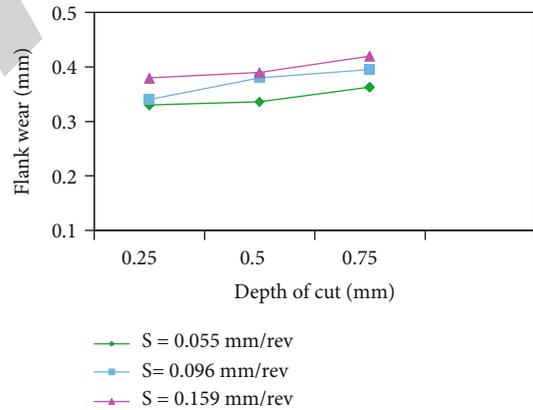


FIGURE 12: Impact of “ a_p ,” Vs, and “S” on “VB”-mm.

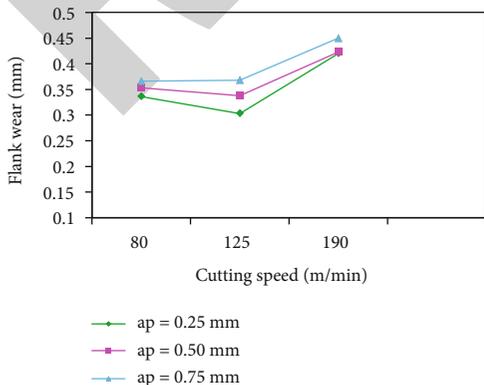


FIGURE 11: Impact of “V,” Vs, and “ a_p ” on “VB”-mm.

smear surface as well as feed marks and chip particles. Many of these surface conditions are related to stresses, and temperature increases in the cutting zone, as well as distortion on the flank face and observance of the work portion substantial to its surface as a whole. Owing to the pressure weld between the tool and the chip, which may erratically resolve and scrape the machined surface, the chip may attach to the tool surface at lower cutting speeds. Another possibility is that the tool material was periodically removed, resulting in an increase in wear and the resulting degrading of the machined surface, as seen in Figure 9(a)–9(d). The metal is easier to remove when it is heated up at a high cutting speed [14]. This is accredited to the fact that increasing the speed, causing rise in temperature in the cutting zone, thereby dropping the surface

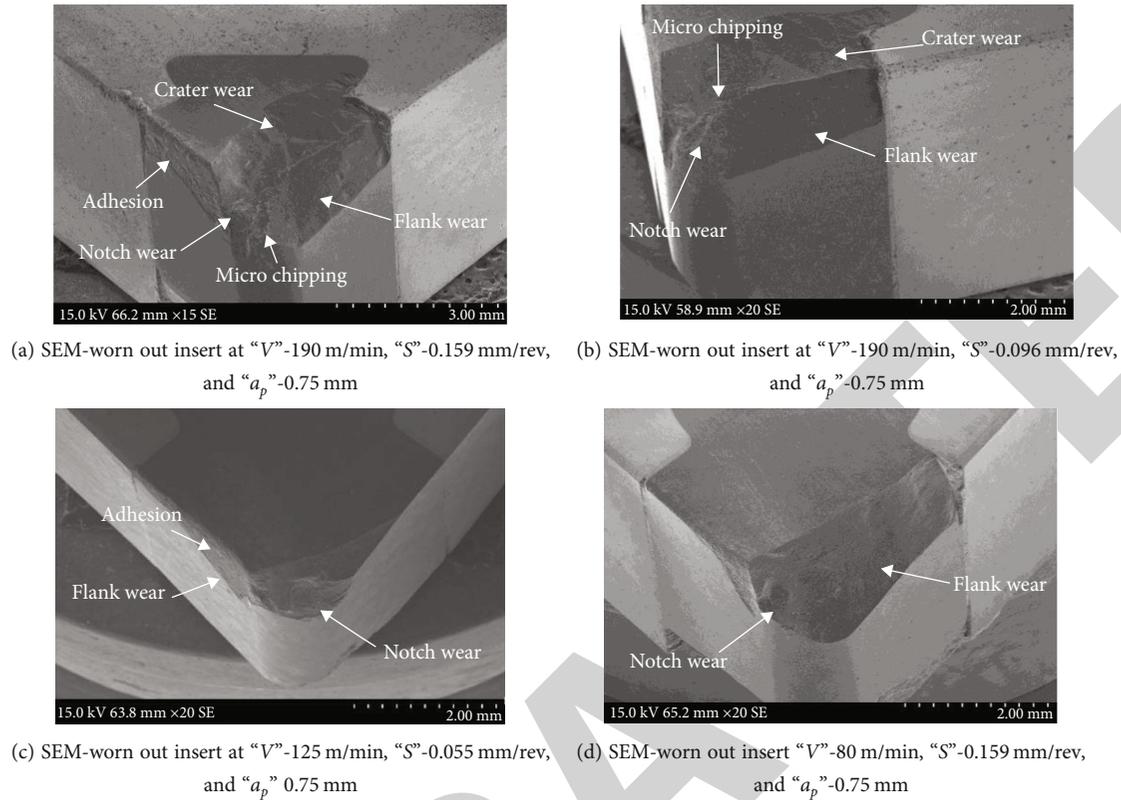


FIGURE 13: (a)–(d) SEM-worn out cutting edge observed at various levels of parameters while turning Nimonic C263 using CBN.

TABLE 8: Plan of the confirmation experiments and results for cubic boron nitride insert.

Sol.No	V-m/min	S-mm/rev	a_p -mm	Predicted	R_a - μm		VB-mm	
					Experimental values	Predicted	Experimental values	
1	135	0.055	0.597	1.867	1.75	0.321	0.315	
2	135	0.055	0.598	2.16	2.25	0.299	0.290	
3	135	0.055	0.590	2.15	2.05	0.301	0.310	

roughness, and improving exterior texture, as seen from the micrograph given in Figure 9(a)–9(d).

5.2. Consequence of Machining Restrictions on Flank Wear.

Figure 10 shows how feeding rate influences flank wear at dissimilar cutting rates. Feed rate has a bigger effect on flank wear than cutting speed, as shown in the graph. The least amount of flank wear is produced by low feed rates and moderate cutting speeds. In comparison to cutting depth, flank wear increases much more slowly with cumulative cutting speed. The gradual degradation to the cutting edge and the resulting upsurge in interaction area among the cutting edge and the machined work surface could be responsible for the increased flank wear with higher penetration of cut. Cut speeds in the middle range and depths of cut in the lower range result in decreased flank wear as shown in Figure 11. With reference to Figure 12, the rates of flank wear increase as level of feed rate and depth of cut increases. However, the rate of increase of the flank wear is affected lot by feed compare to cut depth.

The observed flank wear at high feed and cut depth is 0.42 mm; it is remarkable more than the flank wear of 0.33 mm, which is seen at a minimum level of feed and cut depth. Therefore, it is found that, during turning Nimonic C-263 alloy with a cubic boron nitride, cutting speed and feed rate significantly impact and the impact of the parameters on flank wear can be seen in SEM images as shown in Figure 13(a)–13(d). The buildup edge and wear of the flank are treated as major pattern of failure in machining the alloys using CBN insert [12]. Adhesion, abrasion, diffusion, and microchipping [11, 12] are the primary wear processes identified in machining Nimonic C-263 with a cubic boron nitride insert, as evident in Figure 13(a)–13(d).

6. Confirmation Experiment for Optimal Solution Using Cubic Boron Nitride Insert

CBN inserts were utilized to confirm the optimal solutions provided by the desirability technique in dry turning the Nimonic C263 alloy. The optimal experimental condition is set as 135 m/min cutting speed, and 0.055 mm/rev feed rate,

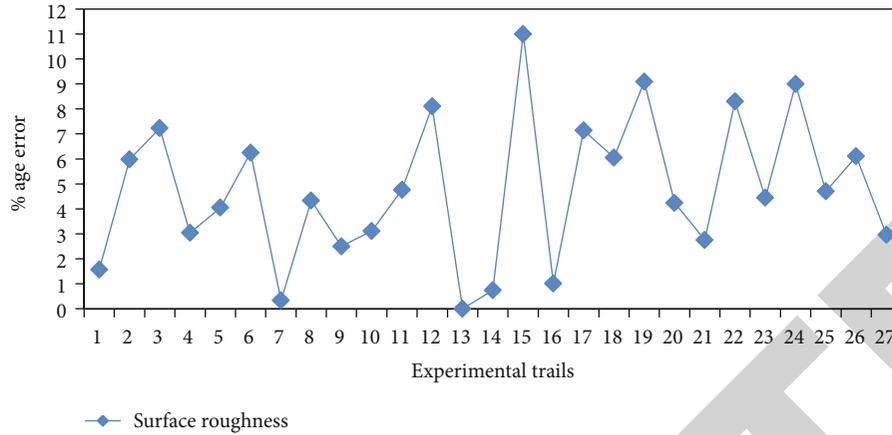


FIGURE 14: % age error: expt. vs. RSM- R_a (μm).

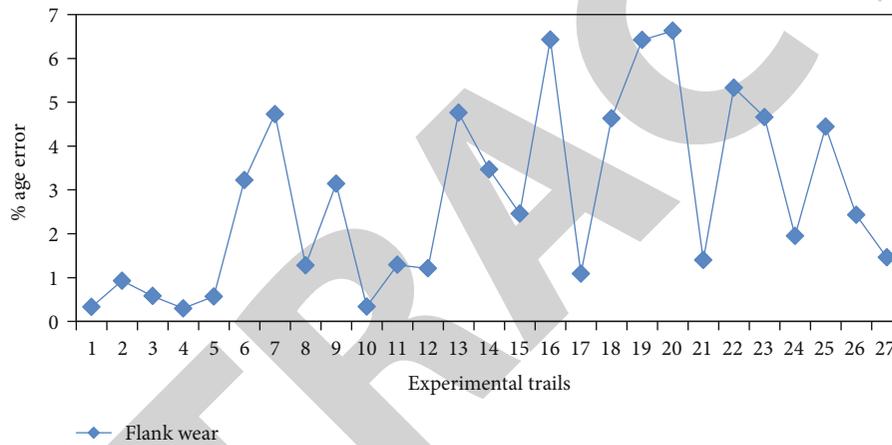


FIGURE 15: % age error: expt. vs. RSM-VB (mm).

and 0.597 mm cutting depth. The predicted values of surface roughness and flank wear obtained from the optimal condition are shown in the Table 8, and the forecasted values were found to be close to the experimental trail values.

The % age error among the experimental and RSM predicted values of surface roughness and flank wear is shown in Figures 14 and 15, respectively. The average percentage error for surface finish and wear of the flank was found to be 4.76 percent and 2.79 percent, respectively. As a result, using the RSM model, roughness and flank wear can all be forecasted with 95 percent confidence.

7. Conclusion

The following findings have been drawn based on experimental work and analysis performed on Nimonic C 263 alloy utilizing CBN inserts.

- (i) The developed RSM model was verified, which is close to the value experimental trail values. It shows the average % age error 4.76% and 2.79% for roughness and wear of the flank, respectively

- (ii) Optimum of surface finish and wear of the flank was obtained as multiresponse optimization at V -135 m/min, S -0.055 mm/rev, and a_p -0.597, and the predicted values were validated

- (iii) Adhesion, abrasion, and microchipping were found to be wear mechanism while turning Nimonic C263 with CBN

- (iv) Feed rate badly affects the cutting edge of the insert followed by speed and depth of cut

- (v) High feed rate and low speed badly affect the surface regularity. However, the roughness is reduced at high cut depth, high level of speed, and low feed rate in turning Nimonic C263 with CBN

- (vi) The surface roughness observed at low speed and high feed rate was found to be 47% higher than the surface roughness observed at high cutting speed and low feed rate

- (vii) The flank wear observed at high cutting speed and high feed rate was found to be 31% more than the

flank wear observed at medium speed and at low feed rate

- (viii) SEM analysis reveals lengthy grooves, chip particles, and feed marks

Data Availability

The data used to support the findings of this study are included within the article.

Conflicts of Interest

The authors declare that they have no conflicts of interest regarding the publication of this paper.

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