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Investigation of Performance of Turning of Austenitic Stainless Steel AISI 201 with Nano Boric Acid Suspended in Coconut Oil

Performance of Turning with Nano Boric Acid

Ashvinkumar Kapadiya[1], Vivek Brahmbhatt[2], Vishal Solanki[3]

[1]*Mechanical Engineering, Sigma Institute of Engineering*
[2]*Mechanical Engineering, Sigma Institute of Engineering*
[3]*Mechanical Engineering, Sigma Institute of Engineering*

Abstract — *In the beginning, conventional cutting fluids are used in machining process like turning and these leads to have better performance of machining. As cutting operation become severe the cutting fluid complexity increases. This is focused here on user friendly and ecofriendly cutting fluid use while machining. Machining with this type of fluids give better performance and better heat dissipation to protect tool and work piece from the overheating. From earlier research one of the options for that is coconut oil which is better above point of view and it's having higher thermal and oxidative properties. This coconut oil can be used with Nano particle which raise the heat carrying capacity while machining with hard material. Fluid mainly used in hard material machining like stainless steel, cooper etc. Main focus of this investigation will be on flank wear and surface roughness of work. In this work we also found that coconut oil having 0.5 % Nano boric acid suspended in coconut oil is suited best among the all experimental trial and having lower surface roughness and flank wear.*

Keywords- *Nano Boric Acid, Coconut Oil, Turning Process, Surface Roughness And Flank Wear*

I. INTRODUCTION

This research work is carried out to study behavior of coconut oil with Nano solid lubricant particle of boric acid. Coconut oil is user friendly and eco-friendly and having oxidative properties and higher heat carrying capacity. Nano boric acid suspended in coconut oil will increase heat carrying capacity that reduces flank wear and surface roughness. Results are put into ANOVA software to check significance of Nano cutting fluid and it favors Nano cutting fluid variation is most significant.

II. BACKGROUND

Time study and cutting force were examined by Vamsi [4] when he has carried out the research in machining. He has taken solid lubricants graphite and boric acid in SAE 40 oil to carry out for investigation and measured the time taken by all the machining and compared them. Tool used with thermocouple measured the tool temperature to identify cutting temperature. He has compared conventional fluid with his investigation and concluded that boric acid and graphite are more efficient than them. He also found improved quality of product with considerable decrease in surface roughness. Percentage of the graphite in SAE 40 oil best performance found in 20% graphite in SAE 40 oil. This research also lead to use the cutting fluid in liquid form is better due to decrease in surface roughness of the work piece.

Before one decade, machining carried out for austenitic steel AISI 1010 with three different tools to identify the tool selection [1]. Cemented carbide tool used for machining are one carbide tool and other two are coated with Al_2O_3 and TiN. Mainly this study achievement was lower the chip ratio showing less strain instead of bulk strain. This result in tangential force in all experimental condition is higher than other forces. It also concluded that when cutting speed increase then it also affect the quality of product and increase the surface roughness. High productivity obtained in cutting speed and feed rate of 280 m/min and 0.28 mm/rev. Research given result says that the carbide coated tool are better performance and this lead to better surface finish and lower in flank wear.

Jaydas [2] has investigated different cutting fluid coconut oil, sesame oil, sunflower oil and 2T oil for best thermal and oxidative properties. Comparison carried out with the help of TGA (Thermo- Gravimetric Analysis). Temperature of cutting tool measured to draw the TGA curve and compared with different cutting fluids on TGD (Derivative Thermo-Gravimetric Analysis). Also change of mass studied when antioxidant are added to cutting fluid. Coconut oil shows less thermal stability then other vegetable oil due to less fatty acid and less weight gain while ant oxidative environment. Research leads use eco-friendly coconut oil for better surface finish

Software implementation and identifying affecting machining in percentage wise analysis carried out in ANOVA [3]. Performance of coconut oil was examined to have less surface roughness and flank wear. Performance investigated that effect of different parameters cutting speed, feed rate, depth of cut are 46.49%, 38.73, and 10.73% respectively. Coconut oil is selected because of thermal and oxidative properties. ANOVA analysis also give preference while changing the cutting parameters that will affect the performance of the cutting tool

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Cutting fluid used while machining is essential when they are applied they may react with work or at high temperature it may produce gas. Cutting fluid used must be eco-friendly and user friendly to overcome hazards and accident [5]. Focusing on that Nano cutting fluid is prepared for machining the AISI 1040 to identify its thermal conductivity, specific heat, and heat transfer co-efficient with variation in suspended Nano boric acid percentage in different cutting oil. 0.5% Nano boric acid best suited for considerable decrement in surface roughness and cutting temperature.

Coconut oil and SAE 40 oil are investigated with suspension of Nano boric acid with varying percentage of it by [6]. This investigation was carried out to increase the heat carrying capacity of cutting fluid from cutting zone. Variation in percentage of Nano boric acid gives difference in surface roughness, cutting temperature and flank wear. Cutting fluid with 0.5% Nano boric acid suspension was found the best among variation taken in investigation. In this investigation also found that SAE 40 oil is better without Nano boric acid and coconut oil shows better performance than SAE 40 oil.

Coconut oil also shows its best performance with Nano boric acid while machining AISI 304 Austenitic stainless steel [7]. Suspension of Nano particle of boric acid increase thermal conductivity and heat transfer co-efficient while machining. Increase in percentage of Nano boric acid in coconut oil surface roughness, flank wear, and tool temperature is decrease compare to base oil and among all the investigation 0.5% suspension performs best.

III. METHODOLOGY

1. Material Selection

On the basis of literature review we found that best suited material for our work is austenitic stainless steel AISI 201. This material has same properties that of AISI 301 and it has ability replace AISI 301 material.

2. Trial and Error method to find out Variable values

Experimental condition from varying different parameters on the basis of trial and error method firstly the work piece is tested under different condition and got the final variables that can affect the machining main concentration on percentage of Nano boric acid suspended in coconut oil. For finding out best most affecting parameters over 70 tests was carried out.

Variable	First	Second	Third
Nano boric acid	0.30	0.50	1.00
Depth of cut	0.50	0.80	1.00
Feed Rate	0.10	0.20	0.25

Table-1. Variable values for the experiment

3. Generation of DOE in Minitab Software

To define all design of experiments and they can be calculated by feeding values in Minitab Software. In Minitab factorial design of experiment is used for generating DOE and this will give values of the variances those who are taken while machining one experiment.

4. Experiments carried out according to DOE

As per DOE generated testing is done for flank wear and surface roughness of tool and work respectively. Result obtained from that is in given table . Cutting temperature range for this investigation was 250° C to 290° these results are obtained by experiment on AISI 201 material of 50 mm diameter. DOE values are taken for conducting experimental work 27 experiment done while machining of AISI 201 turning. Material examines under this DOE on CNC machine. Programmed and turning carried out. Investigation carried with help of carbide tool. After experimental work tool is examined for flank wear and material is examined for surface roughness and found following readings given in table

Sr. No.	% Nano Particle suspended	Depth of cut	Feed Rate	Flank Wear	Surface Roughness
1	0.50	0.50	0.10	0.041	2.33
2	0.50	0.80	0.10	0.044	2.36
3	0.50	1.00	0.10	0.047	2.39
4	0.50	0.50	0.20	0.050	2.42

5	0.30	0.50	0.10	0.053	2.53
6	0.50	0.80	0.20	0.053	2.45
7	0.30	0.80	0.10	0.056	2.56
8	0.50	1.00	0.20	0.056	2.48
9	0.30	1.00	0.10	0.058	2.59
10	0.50	0.50	0.25	0.059	2.51
11	0.30	0.50	0.20	0.061	2.62
12	1.00	0.50	0.10	0.062	2.65
13	0.50	0.80	0.25	0.062	2.54
14	0.30	0.80	0.20	0.063	2.65
15	1.00	0.80	0.10	0.065	2.68
16	0.50	1.00	0.25	0.065	2.57
17	0.30	1.00	0.20	0.066	2.68
18	1.00	1.00	0.10	0.067	2.71
19	0.30	0.50	0.25	0.068	2.71
20	1.00	0.50	0.20	0.070	2.74
21	0.30	0.80	0.25	0.071	2.74
22	1.00	0.80	0.20	0.072	2.77
23	0.30	1.00	0.25	0.073	2.77
24	1.00	1.00	0.20	0.075	2.80
25	1.00	0.50	0.25	0.077	2.83
26	1.00	0.80	0.25	0.080	2.86
27	1.00	1.00	0.25	0.082	2.89

Table-2. Surface Roughness and Flank wear as Results

5. Analysis of variance in MINITAB to find out most effective parameters

As to find out the parameter which is more effect on our experimental reading among three variance taken by us namely % of Nano boric acid Suspension, feed rate and Depth of cut. Result analyzing is done to check which factor is more affect to work surface roughness and flank wear. Result is analyzed in MINITAB software by fully nested ANOVA and step of that is given below:

First Step: Select Stat→ Fully nested ANOVA

Responses are those whose are our result or for what variance of analysis is going to carried out and factors are those variance taken for result. Wear and surface roughness are the result of experiment so they are taken as responses of the investigation. Responses can be taken individual are combine as per our responses number.

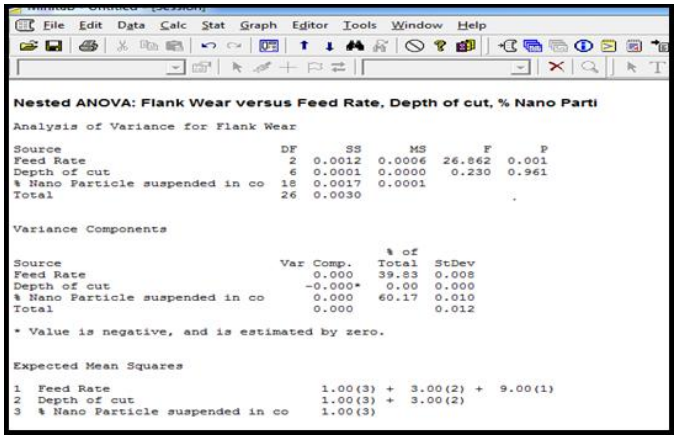
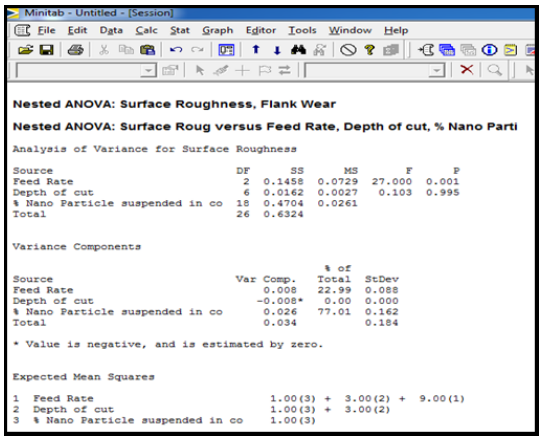


Figure-1. Analysis of Variance for Flank Wear



Minitab - Untitled - [Session]

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Nested ANOVA: Surface Roughness, Flank Wear

Nested ANOVA: Surface Roug versus Feed Rate, Depth of cut, % Nano Parti

Analysis of Variance for Surface Roughness

Source	DF	SS	MS	F	P
Feed Rate	2	0.1458	0.0729	27.000	0.001
Depth of cut	6	0.0162	0.0027	0.103	0.995
% Nano Particle suspended in co	18	0.4704	0.0261		
Total	26	0.6324			

Variance Components

Source	Var Comp.	% of Total	StDev
Feed Rate	0.008	22.99	0.088
Depth of cut	-0.008*	0.00	0.000
% Nano Particle suspended in co	0.026	77.01	0.162
Total	0.034		0.184

* Value is negative, and is estimated by zero.

Expected Mean Squares

1	Feed Rate	1.00(3) + 3.00(2) + 9.00(1)
2	Depth of cut	1.00(3) + 3.00(2)
3	% Nano Particle suspended in co	1.00(3)

Figure-2. Analysis of Variance for Surface Roughness

Among all the reading Nano boric suspension affect the turning process by 77.01% for surface roughness and 60.17% for flank wear. This analysis says that boric acid suspension affects the turning process more than other variance.

6. Graph generation for finding out best suited proportion of Nano boric acid

This analysis says that boric acid suspension affect the turning process more than other variance for finding out best result suited among variance taken in boric acid suspension graphs are generated to find out from table-2.

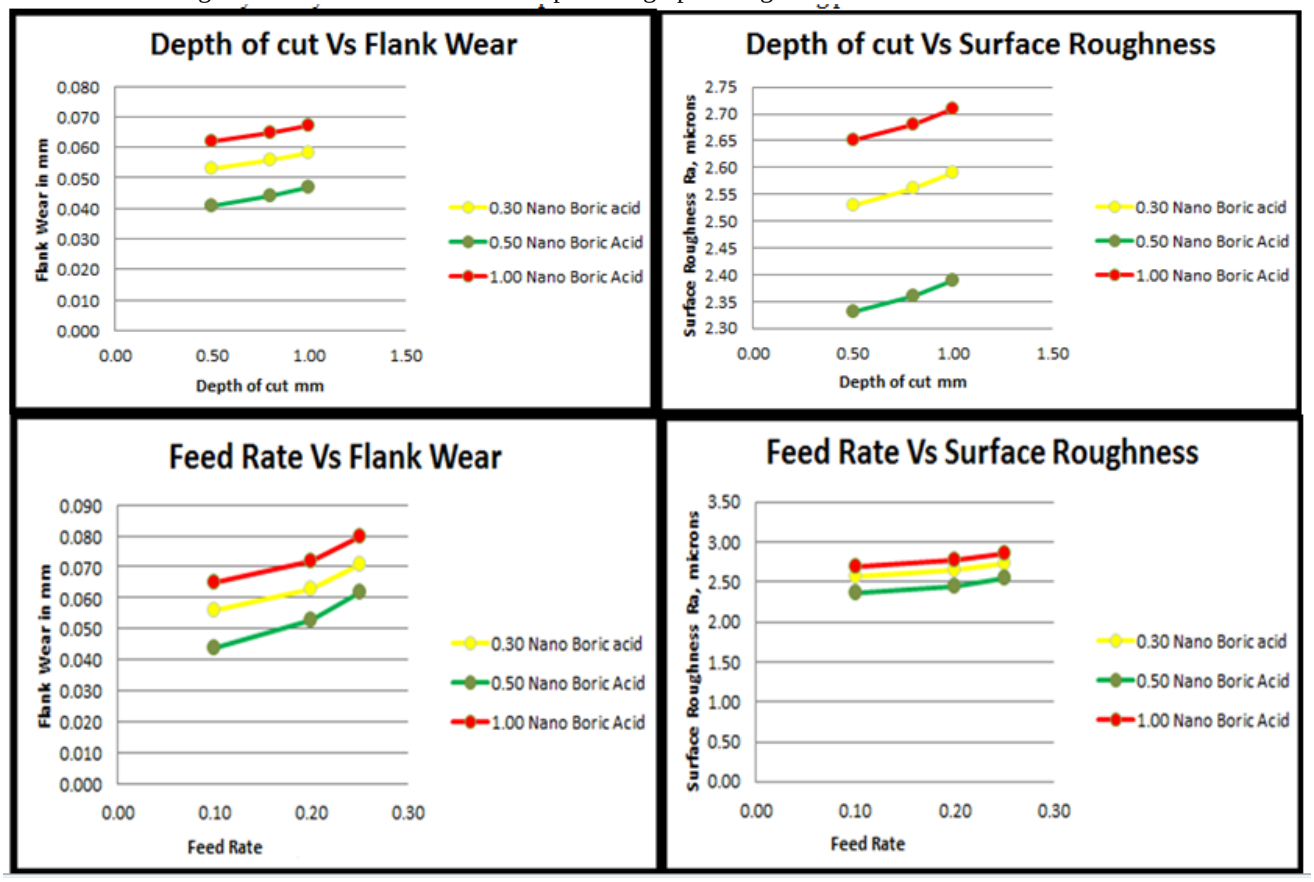

Figure-3. behaviour curve when feed rate or depth of cut kept constant

Graph shows behaviour curve when depth of cut is kept constant green line 0.50 % Nano boric acid suspension gives lowest surface roughness Figure-3.

7. Results

a) Investigation done on AISI 201 gives lower flank wear and surface roughness.
b) Calculations shows that increase in depth of cut implies on surface roughness and flank wear and their values are increase.

c) Calculations shows that increase in feed rate also increase surface roughness and flank wear.
d) Percentage of addition of Nano boric Acid is significantly essential in order achieve lower surface roughness and flank wear.
e) Among all the reading Nano boric suspension affect the turning process by 77.01% for surface roughness and 60.17% for flank wear. Nano boric acid is essential among all the variables from table
f) In all experimental investigation 0.5 % Nano boric acid suspension in coconut oil gives best result among all the variance from figure

IV. CONCLUSION

g) Within frame work of investigation following conclusion are made and enlisted below.
h) The defined surface roughness and flank wear has been observed in the obtained results of the conducted set of experiments.
i) Experimental results show that Nano boric acid, feed rate and depth of cut influence the surface roughness and flank wear in case of turning of AISI 201.
j) Among all the reading Nano boric suspension affect the turning process by 77.01% for surface roughness and 60.17% for flank wear. Nano boric acid is essential among all the variables.
k) In all experimental investigation 0.5 % Nano boric acid suspension in coconut oil gives best result among all the variance.
l) The developed model has a scope of application in small/medium scale industries where costly characterization is not viable and provides the control parameters to obtain a good quality of work so no need to doing trial and error for any new combination of diameters. That saves time and contributing in cost reduction.

V. FUTURE SCOPE

Investigation carried out in this study can be done further extension on following topics:

a. In this investigation some parameters like change of diameter and temperature study.
b. Many Nano particle is available in market and that can be replaced by boric acid and investigation carried out to find out the efficient Nano particle.
c. Cutting fluid like SAE 40, Sesame oil comparison with coconut oil done to find out efficient cutting fluid.
d. Change in material can lead to derive the machining of that particular material under the same situations or different one.

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