Scientific Journal Impact Factor (SJIF) : 3.518
International Journal of Modern Trends in Engineering and Research
ISSN (ONLINE) : 2349 - 9745
ISSN (PRINT) : 2393 - 8161

COMPARISON OF MAIN EFFECT OF COTTON SEED OIL AND NANOBORIC FLUID ON SURFACE ROUGHNESS

Mohd.Shakeeb[1] and R.D.Shelke [2]

[1]P.G. Student, Department of Manufacturing Engineering, Everest College of Engineering and Technology,Aurangabad,Maharashtra,India

[2]Head of Department, Mechanical Engineering , Everest College of Engineering and Technology,Aurangabad,Maharashtra,India

Abstract— Cutting fluids plays an important role in effectiveness of surface roughness.The cutting fluid improves the tool life, surface conditions of the work-piece and the process as a whole.surface roughness plays a major role in increasing productivity.In the present work two cutting fluids ie Cottonseed oil and Nano Boric fluid with 3% volume Boric acid powder of 50um size are used.The performance of Cottonseed oil is compared with Nano Boric fluid on on surface roughness in turning OHNS Steel.

Keywords— Nano Boric fluid, Cotton seed oil, O.H.N.S steel, Surface Roughness.

I. INTRODUCTION

In machining, mineral, synthetic and semi-synthetic cutting fluids are widely used but, recently, uses of vegetable based cutting fluids have been increased. Although, these cutting fluids are beneficial in the industries, their uses are being questioned nowadays as regards to health and environmental issues.Cutting fluids are contaminated with metal particles and degradation products which diminish the effectiveness of cutting fluids. To minimize the adverse environmental effects associated with the use of cutting fluids, the hazardous components from their formulations have to be eliminated or reduced to the acceptable level. In addition, mineral based cutting fluids are going to be replaced with vegetable based cutting fluids since they are environmentally friendly[1]. Although metal working fluids are one of the most significant factors in machining; it also has many detrimental effects. Most of the fluids used in machining operation contain environmentally harmful or potentially damaging chemical constituents. Their application has several adverse effects such as environmental pollution, dermatitis to operators, water pollution and soil contamination during disposal. These fluids are difficult to dispose and expensive to recycle. Therefore, alternative has been sought to minimise the use of metal working fluid or use of biodegradable fluids in machining operations[2] M.Venkata Ramana etal (2011) has presented performance evaluation and selection of optimal parameters in turning of Ti-6AL-4V alloy under different cooling conditions and result was compared with dry, flooded, servo cut oil with water and flooded with synthetic oil coolant conditions. The cutting performance of Ti-6AL-4V alloy with synthetic oil is found to better when compared to dry and servo cut oil with water in reducing surface roughness[3]. The result obtained for the surface roughness of three cutting fluids i.e servo cut oil ,cotton seed oil and soya bean oil was in close proximity with each other as there is hardly difference of 1% to 10% and feed was found to be most significant factor for surface roughness[4]. P. N. L. Pavani, R. Pola Rao and S. Srikiran (2015) made comparison of tip temperature, surface roughness, and cutting forces with regard to cutting speed under dry, wet, and coconut oil mixed with 3% wt boric and soyabean oil mixed with 2% wt boric acid.During experimentation, the optimum weight percentages of boric acid powder for coconut and soybean oils were found at 3% and 2% The experimental results are compared for both dry and wet machining conditions. M. Nalbant H.Gokkaya, G. Sur (2007) found that temperature generation at the cutting tool tip is reduced to a higher extent and surface finish of work material is improved compared with dry and wet machining conditions[5] The research demonstrates how to use Taguchi parameter design for optimizing machining performance with minimum cost and time to industrial readers[6].Optimum machining parameters of turning operations are greatly influenced with concern along with manufacturing environment.In their experimental work, turning parameters on OHNS steel with different cutting parameters like cutting speed, feed and depth of cut and response parameters like surface roughness and metal removal rate were studied. Mainly surface roughness where investigated employing L9 orthogonal array using taguchi's design of experiments[7].Y.Shokoohi, E.Shekarian (2016) In their study various machining processes and nanofluids were introduced and effect of nano fluids on cutting parameters cutting forces, surface roughness, tool- workpiece temperature, tool wear and environmental aspects) were reviewed. Present analysis illustrate that not only using nanofluids influence on machining parameters but also type of nanoparticle and base fluid, size of nanoparticle and concentration of particles in base fluid are important too.The research showed that utilizing nanofluids as coolant and lubricant lead to lower tool temperature, tool wear, higher surface quality and less environmental dangers. However, high cost of nanoparticles, need for particular devices, clustering and sediment are negative aspects of nanofluids applications in metalworking operations[8].

II. EXPERIMENTAL SETUP

2.1 Selection of work material

The work piece material used is O.H.N.S steel in the form of round bars of 20 mm diameter and length of 60 mm.

Table.2.1 chemical composition of O.H.N.S Steel

C	Mn	Cr	W	V
0.95	1.15%	0.5%	0.5%	0.2%

Table 2.2 Mechanical properties of O.H.N.S Steel

Max. stress N/mm²	Yield stress N/mm²	Proof stress N/mm²	Elongation %	Impact strength (j)	Hardness value (brinell)
950	465	480	10	25	288

Applications of OHNS steel material are blanking and punching dies,punches, Rotary shear blades, Thread cutting tools, Milling cutters, Reamers, measuring tools,gauging tools, wood working tools, broaches, chasers,Lay shafts, Wheel axle, gears etc.

2.2. Selection of Insert

Based on Literature survey, the Tool selected for this process was TNMG 160404 HQ

2.3. Selection of lubricant

Selection of cutting fluid is important in order to maintain better tool life, less cutting forces, lower power consumption, high machining accuracy and better surface integrity etc. Here Cottonseed oil is used as cutting fluid which is a vegetable oil and environment friendly cutting fluid and cotton seed oil based nano boric fluid .

2.4. Preparation of Nano boric fluids

In this work Nano boric cutting fluid is prepard by adding 3% by volume nano boric acid particles. 3% by volume of Nano boric fluid = 100 ml of cottonseed oil + 3gm of Nano boric acid particles. This composition is mixed by a Magnetic stirrer.

2.5. Selection of process parameter

Input process parameters were selected after studying the literature survey for wet machining conditions. Cutting speed (Vc), cutting feed (f) and Depth of cut (dc) were the input parameters chosen for present work. To investigate the effect of input parameters under wet conditions on O.H.N.S Steel machining technique. The output parameters chosen were Surface Roughness (Ra) to investigate the effect of input parameters for turning on O.H.N.S steel.

III.METHODOLOGY

In this work, Taguchi robust design methodology is used to obtain the optimum conditions for lower surface roughness in turning of O.H.N.S Steel using cotton seed oil and nano boric fluid in wet conditions. The experiments were performed on the basis of Taguchi's L9 array method. Statistical software Minitab-16 is used to obtain results for analysis of mean (ANOM) and Analysis of variance (ANOVA). The experiments are carried out on a high speed CNC Lathe, Midas 8i (GALAXY make) at different cutting velocities, feed and depth of cut under wet conditions. The ranges of cutting parameters have selected based on the tool manufacturer recommendation mentioned in the table 4 and as per industrial expert advices. the surface roughness has been measured by MITUTOYO make SURFTEST-SJ 210 surface roughness tester during different machining condition and different cutting fluids for the comparison purpose. The experimentations have been conducted in two different phases in first phase surface roughness performance conducted by cotton seed oil at variable cutting velocity ,feed and depth of cut has been compared with surface roughness performance conducted by nano boric fluid in second phase at same cutting conditions.
The selected levels of input parameters which are as follows.

Table 3.1: Selection of Levels

Parameters	Level 1	Level 2	Level 3
Speed (rpm)	1000	1250	1500
Feed (mm/rev)	0.06	0.04	0.02
DOC (mm)	0.5	0.7	0.9

IV. RESULTS AND DISCUSSION

4.1 For Cottonseed oil

Table 4.1.1: Experimental results for Cottonseed Oil

Speed	Feed	Depth of cut	Surface Roughness (μm)	S/N Ratio
1000	0.06	0.5	0.492	6.16070
1000	0.04	0.7	0.463	6.68838
1000	0.02	0.9	0.467	6.61366
1250	0.06	0.7	0.519	5.69665
1250	0.04	0.9	0.496	6.09037
1250	0.02	0.5	0.458	6.78269
1500	0.06	0.9	0.543	5.30400
1500	0.04	0.5	0.487	6.24942
1500	0.02	0.7	0.466	6.63228

4.1.1 Experimental results for surface roughness

Table 4.1.1 shows the values of the responses obtained from the experimental runs, designed by Taguchi method, the corresponding value of S/N Ratio is mentioned for each run.

Table no.4.1.3 and Figure no.4.1.1 indicates the signal to noise ratio. In this table highest signal to noise ratio indicates that, this particular input is favourable on the output. From the graph it is observed that for best surface roughness the optimum value levels are Speed 1000 rpm, Feed 0.02mm/rev, Depth of cut 0.5 mm. It is observed that the most influencing parameter from these three is feed followed by speed and then depth of cut.

Table no :4.1.2 Analysis of variance (ANOVA)

Source	DF	Seg SS	Adj SS	Adj MS	F	P
S	2	0.28620	0.28620	0.14309	15.82	0.059
F	2	1.41191	1.41191	0.705957	78.05	0.013
D	2	0.27257	0.27257	0.136286	15.07	0.062
Residual Error	2	0.01809	0.01809	0.009045		
Total	8	1.98877				

Table no.4.1.3. Signal to Noise ratios Smaller is better

Level	Speed	Feed	Depth of Cut
1	6.488	6.676	6.398
2	6.190	6.343	6.339
3	6.062	5.720	6.003
Delta	0.426	0.956	0.395
Rank	2	1	3

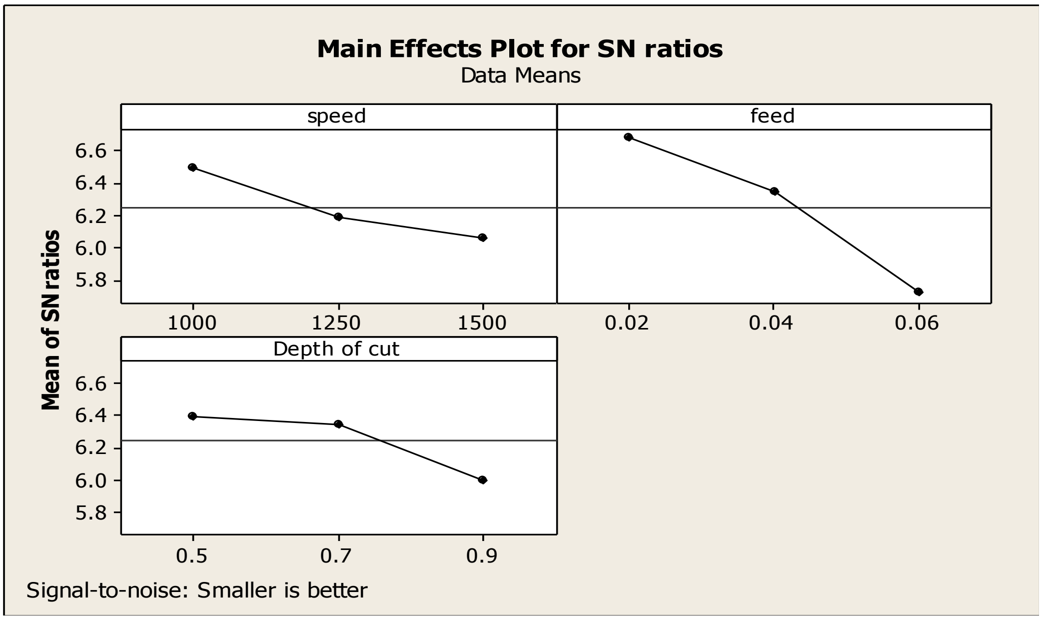

Figure 4.1.1:.Main Effect Plot for Signal to noise ratios

 ISSN (Online):2349–9745 ; ISSN (Print):2393-8161

4.2. For Nano fluids

Table 4.2.1:. Experimental results for Nano fluid.

Speed	Feed	Depth of cut	Surface Roughness (µm)	S/N Ratio
1000	0.06	0.5	0.308	10.2290
1000	0.04	0.7	0.294	10.6331
1000	0.02	0.9	0.288	10.8122
1250	0.06	0.7	0.328	9.68252
1250	0.04	0.9	0.320	9.89700
1250	0.02	0.5	0.295	10.6036
1500	0.06	0.9	0.333	9.55112
1500	0.04	0.5	0.315	10.0338

4.2.1. Experimental results for surface roughness.

Table 4.2.1 shows the values of the responses obtained from the experimental runs, designed by Taguchi method, the corresponding value of S/N Ratio is mentioned for each run.Table no.4.2.3 and Figure no.4.2.1 indicates the signal to noise ratio. In this table highest signal to noise ratio indicates that, this particular input is favourable on the output. From the graph it is observed that for best surface roughness the optimum value levels are Speed 1000 rpm, Feed 0.02 mm/rev, Depth of cut 0.5mm. It is observed that the most influencing parameter from these three is feed then followed by speed and at last the depth of cut.

Analysis of variance (ANOVA)

Table 4.2.2. Analysis of Variance for Signal to Noise Ratios

Source	DF	Seg SS	Adj SS	Adj MS	F	P
S	2	0.52294	0.52294	0.261470	46.43	0.021
F	2	1.01974	1.01974	0.509868	90.54	0.011
D	2	0.07717	0.07717	0.038587	6.85	0.127
Residual Error	2	0.01126	0.01126	0.005632		
Total	8	1.63111				

Response Table for signal to Noise Ratios (smaller is better)

Table 4.2.3: Signal to Noise Ratios - Smaller is better

Level	Speed	Feed	Depth of Cut
1	10.558	10.644	10.289
2	10.061	10.188	10.277
3	10.034	9.821	10.087
Delta	0.525	0.823	0.202
Rank	2	1	3

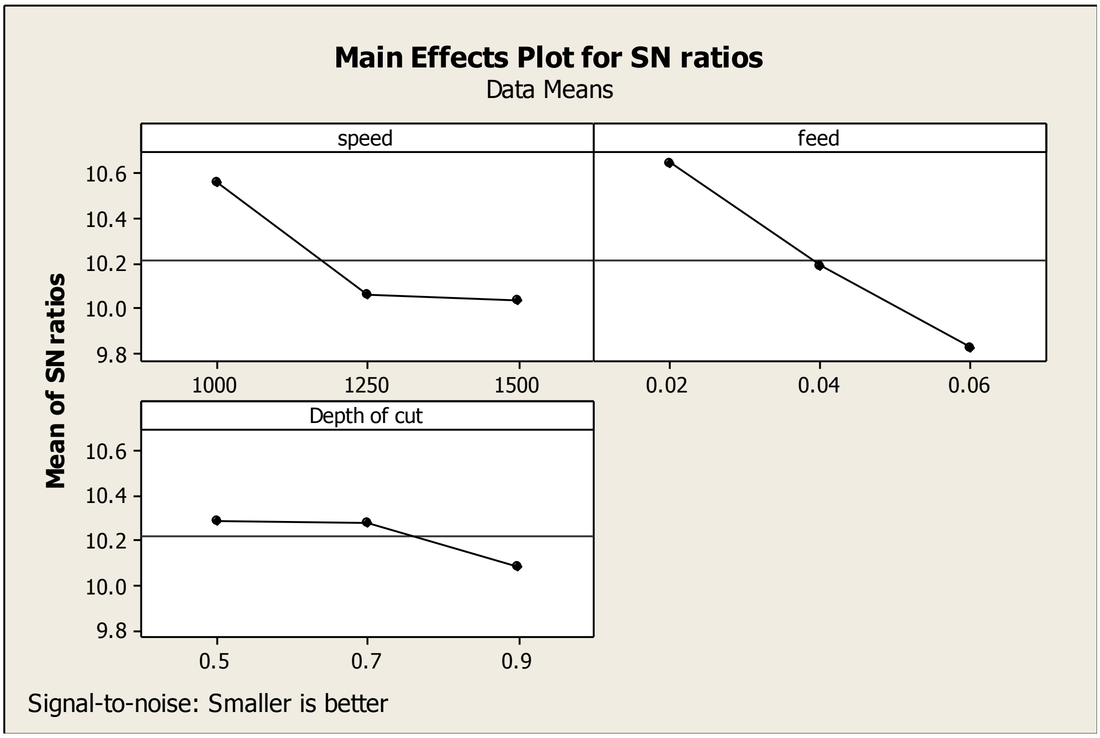

Figure 4.2.1:. Main Effect Plot for Signal to Noise Ratio

4.3. Comparison of performance of cottonseed oil and Nanoboric fluid used on Surface Roughness .

4.3.1. Surface Roughness (μm)

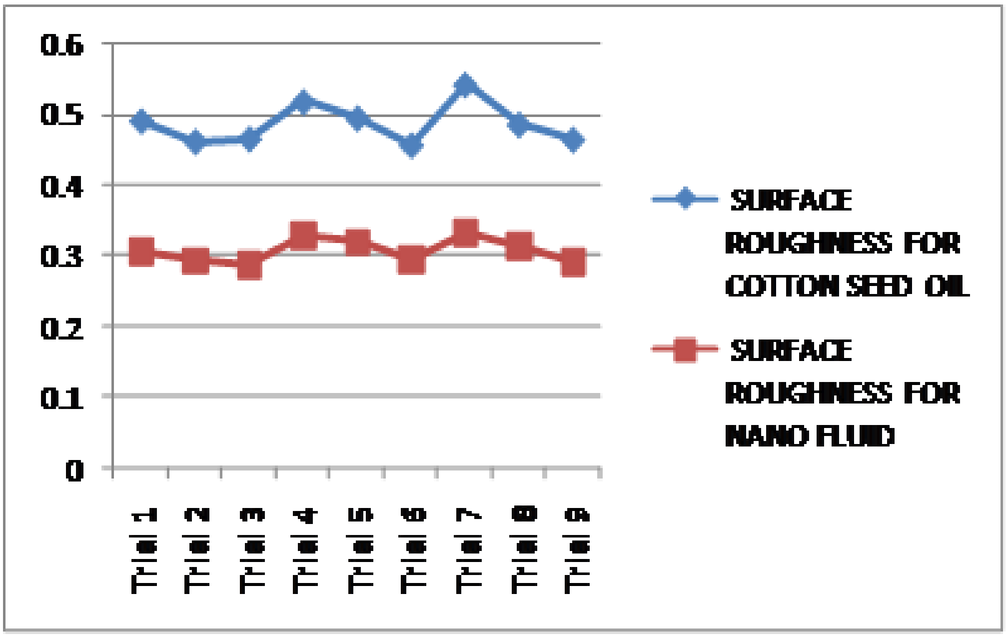

Figure 4.3.1:. Comparison graph for surface roughness

From the figure 4.3.1 it is observed that at each experiment the value of surface roughness when used Nano boric fluid is comparatively low as compared with Cottonseed oil . The smooth surface finish were obtained while using nano boric fluid.

V. CONCLUSIONS

In the present work, a comparative study of the performance of Cottonseed oil and Nano boric fluid lubricant in CNC turning on O.H.N.S steel was performed through experimentation. Speed, feed and depth of cut have been varied in a wide range to study their effect on surface roughness (Ra) using cottonseed oil and nanofluid as different lubricants. The final conclusions drawn are as follows:

- These experiments show that Surface Roughness reduced significantly by machining O.H.N.S steel using Nanoboric fluid (i.e. 3 Vol. % of Nano boric acid in cottonseed oil) as compared to cottonseed oil.
- The percentage of error between the predicted and experimental values of the multiple performance characteristics during the confirmation experiments is less than 5 % as it is within limit.
- Optimal parameters for surface roughness using cottonseed oil was at Speed 1000 rpm, Feed 0.02 mm/rev, Depth of cut 0.5mm.
- Optimal parameters for surface roughness using nano boric fluid was at Speed 1000 rpm, Feed 0.02mm/rev, Depth of cut 0.5mm.

Feed rate is found to be most significant factor on surface roughness followed by speed and then depyh of cut when used with cottonseed oil and nano fluid.

REFERENCES

[1] Emel Kuram, Babur Ozcelik and Erhan Demirbas“Environmentally Friendly Machining:VegetableBased Cutting Fluids, Machining and Tribology”, DOI: 10.1007/978-3-642-33792-5_2,© Springer-Verlag Berlin Heidelberg (2013).
[2] Yuzan Yu, Yugao Guo, Lei Wang & Enqi Tang "Development of Environmentally Friendly Water-Based Synthetic Metal-Cutting Fluid" Modern Applied Science Vol. 4, No. 1(2010).
[3] M Venkata Ramana.,K.srinivasulu & G.Krishna Mohan Rao. "Performance evaluation and selection of optimal parameters in turning of Ti-6AL-4V alloy under different cooling conditions".International journal of innovative technology & creative engineering vol.01 (2011).
[4] J.B.Shaikh, J.S.Sidhu., "Experimental Investigation and Optimization of process Parameters in Turning of AISI D2 Steel using Different Lubricant".
[5] International Journal of Engineering and Advanced Technology (IJEAT) ISSN: 2249 – 8958, Volume-3, Issue-5, June 2014.
[6] P. N. L. Pavani, R. Pola Rao and S. Srikiran., "Performance evaluation and optimization of nano boric acid powder weight percentage mixed with vegetable oil using the Taguchi approach",Journal of Mechanical Science and Technology 29 (11) (2015)
[7] M. Nalbant, H.Gokkaya, G. Sur,"Application of Taguchi method in the optimization of cutting parameters for surface roughness in turning", Elsevier, Science Direct, Materials and Design 28 (2007) 1379–1385
[8] S. Khandekar, M. Ravi Sankar, V. Agnihotri, J Ramkumar Nano Cutting fluid for enhancement of Metal Cutting Performance, Material and Manufacturing Processses, 27:9, 963- 967 (2012)
[9] N Muthukrishnan, T T M Kannan, M Robert Sahayadoss ,J Madhan, P Vijaya Kumar and R Makesk Kumar, "Optimization of Turning parameters of O.H.N.S (AISI-01) Steel rods using Taguchi methodology". Int. J. Mech. Eng. & Rob. vol. 3, No. 4 Res. 2014.
[10] Y. Shokoohi, E. Shekarian, "Application of Nanofluids in Machining Processes - A Review", Journal of Nanoscience and Technology 2(1) (2016) 59–63
[11] Kamal Hassana, Anish Kumar, M.P.Garg, "Experimental investigation of Material removal rate in CNC turning using Taguchi method", International Journal of Engineering Research and Applications Vol. 2, Issue 2,Mar-Apr 2012, pp.1581-1590
[12] Saidur R, Leong K Y, and Mohammad H A, (2011)," A review on application and challenges of nanofluids, Renewable and Sustinable energy"Rev., 15(3), 1646-1668.
[13] Dhar N.R.and M.Khan , "A study of effect of MQL on temperature ,force ,tool wear and product quality in turning of AISI 9310 steel" . Net field wise seminar on manufacturing and material processing, Issue 02 (2006) pp30-35.
[14] Settu.S,Murugabalaji.V, Manikandan.S "Vegetable Oil Based Nano Cutting Fluids and its Applications In Reduction Of Tool Wear - A Review" IJRASET 2015: Volume 3 Issue XI, November 2015ISSN: 2321-9653