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THE PERFORMANCE OF ALUMINA MIXED COCONUT OIL IN TURNING OF SS304 ALLOY

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ABSTRACT

In the present scenario there is avast stipulate for environmental friendly cutting fluids because of severe rule enforced on usage of synthetic cutting fluids prepared by organic oils which creates perilous to the health of machine operators and environment. Ensuing towards this, better and safe cutting fluids are required to overcome these problems.

In this connection, compare to present cutting fluids organic cutting fluids give a better results and also easily available. In these organic cutting fluids coconut oil is the best one.

Coconut oil issafe to use, decomposable and ecologically friendly cutting fluid. Moreover, the performance of coconut based cutting fluids can be improved by addition of micro or nano particles. This present study emphasis on performance and the usage of the nano alumina with coconut oil in turning of stainless steel 304 alloy with minimum quantity of lubrication. L16 design of experiments done with different speeds, feeds, depth of cuts and percentages of alumina varied cutting fluids are the input process variables. Surface finish and material removal rate has been calculated in 16 machining conditions. Based on the results this study clearly reveals thatspeed rate and alumina percentage in coconut oil are the major parameters that have considerable effect on the surface finish. The depths of cut and alumina percentage in coconut oil arethe main parameters that affect the material removal rate.

KEYWORDS: Coconut Oil, Alumina Nano Particles, Turning, Stainless Steel 304 Alloy, MRR & Surface Finish

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Original Article

1. INTRODUCTION

During metal cutting operation, lubricant is commonly required to minimize the effect of friction and heat at the cutting zone. Excessive heat produced at the shear zone because of metal to metal contact which leads to a more surface roughness and tool wear. Because of that problem cutting fluids were using in great extent in metal cutting operations to improve machining performance. Cutting fluids are alienated into different groups that are direct oils, water-based oils and gases. Mostly used cutting fluids in machining operation are the water-soluble oils. These kind of cutting fluids are prepared by mixing of oil in water with a suitable proportion based on machining conditions, material of workpiece and tool material. Conventional cutting fluids are basically petroleum based; the frequent usage of cutting fluids creates environmental pollutions and biological problems to the workers. Moreover, the cutting fluids also deserve a major proportion of the whole machining costs. Mineral oil based cutting fluids creates skin cancer problems to the machine operators and these are not biodegradable. Furthermore, with the deficiency of mineral-based fluid in the imminent, problem will be deficiency in creation of

cutting fluid. So, alternative cutting fluids to be discovered that should have the similar characteristics as mineral-based cutting fluid, biodegradable and nontoxic. Recommendation of executing dry machining environments in metal cutting operation can abolish the need of cutting fluid and subsequently reduce the negative result of consuming mineral based cutting fluid. But, dry machining is only suits for low cutting speeds not suitable for high cutting speeds because resulting in low surface finish and higher tool wear. So, the best approach to producing environmental friendly cutting fluid is by moving the synthetic oil based cutting fluids with vegetable based oils for cutting fluid. Vegetable oils have good lubrication property. Not only that, vegetable based cutting fluids generally have good wettability characteristics, these are maintaining viscosity stable at elevated temperature. This property helpful in metal cutting operation, more heat will be generated at cutting zone in high speed machining processes; therefore unchanging fluid viscosity is desired. Moreover, the most essential characteristics of vegetable oil to develop as a cutting fluid are degradable and non-toxic nature. Vegetable based oils can implement as cutting fluid in metal cutting operation. M. A. Malady et al. have found that use of the boric acid additives with vegetable based oil in machining operation in evaluation to conventional fluid. They concluded that the vegetable oil beats conventional cutting fluid performance in turning operation. Shrikant U, et al. found that vegetable based fluids efficient in creating enhanced surface finish, reduced tool damage than conventional oils during machining operation. However, enhancement of the green cutting fluid improved by adding nano particles like alumina, molybdenum di sulphide, graphene, carbon nanotubes, etc. Enhancement from adding nano particle mixed cutting fluid in the following of heat extraction capability, workpiece surface finish and cutting tool life. The reason behind this is solid particles have more thermal conductivity than the fluids and having low coefficient of friction. Besides that nano particles like aluminium oxide and graphene are eco-friendly behaviour and do not create danger to machine operators, agreeing to the Green manufacturing systems, which is required in forming a green lubrication in metal cutting operation. The aim of the work is to evaluate the usage and assessment of nano alumina particles mixed coconut fluid lubricant in turning 304 stainless steel. Alumina nano particles with 30 nm size and 2.0 %wt. and 4.0 %wt. percent are to be used in minimal quantity lubricant method in turning of SS304 alloy. A performance evaluation among alumina mixed coconut oil lubricant with normal cutting fluid is prepared based on the surface finish and material removal rate with respect to machining conditions. Following paragraphs describe the details of experimentation.

2. EXPERIMENTAL PROCEDURE

2.1 Work Material and Tool Selection

Stainless Steel 304 alloy of hardness 122 BHN with 360 mm length and 50 mm diameter was selected as work piece for examination because it is widely used in automobile industries and home appliances. Main properties of SS304 material are low weight to more strength and corrosive resistance. The tool insert used for the investigation was DNMG 150612 and tool holder used was MDJNR 2020 K15.

2.2 Preparation of Nano Cutting Fluid

Nano alumina particles size of 30nm was added into the coconut oil. Nano Al2O3 particles are selected due to their superior tribological and antitoxic properties. Magnetic stirring method was used for mixing of nano particles in coconut oil. For proper mixing three hours magnetic stirring was done.

Figure 1: Nano Fluid Preparation

2.3 Selection of Cutting Parameters

The selection of process parameters for this investigation was done based on the previous research stated in the area of metal cutting operation with minimum quantity lubrication. The input process parameters were varied at four levels. Table 1 shows the input variables and their levels for the operation.

Table 1: Parameters and their Levels for the Experimentation

Input Parameter	Level 1	Level 2	Level 3	Level 4
Cutting speed [m/min]	1100	1200	1300	1400
Feed [mm/rev]	0.11	0.12	0.13	0.14
Depth of cut [mm]	0.5	0.6	0.7	0.8
Alumina % in oil	0	2	4	6

2.4. Experimental Setup

Figure 1 demonstrates the experimental set up which comprised of a medium obligation SPEED LX-200 SUPER machine with variable feed and speed drive. The minimum cutting fluid arrangement encouraged the autonomous variety of pressure by operator. Material removal rate and Surface finish (Ra) was considered as yield parameter. Surface finish was estimated by utilizing Mitutoyo (SJ-201P) surface finish analyzer.

Figure 2: Experimental Setup

The development of the novel eco-friendly cutting fluid depends on the use of design of experiment (DOE) under the conditions builtup by a Taguchi L16 design matrix. In the coconut oil added alumina nano powder size of 30nm utilizing the optimal weight rate esteem, it is tried under turning process. This turning operation is utilized to decide the performance nano alumina mixed coconut oil cutting fluid by varying the nano alumina percentage. Aluminium oxide

powder is obtained from the nano shell with 99% purity. The objective of this examination is to decide the lower surface roughness and higher material removal rate that can be achieved from utilising nano alumina in- coconut oil in turning operation. The surface finish can decide the performance of cutting fluid being utilized. Surface finish is an index of quality of machining.

2. 5. Design of Experiments

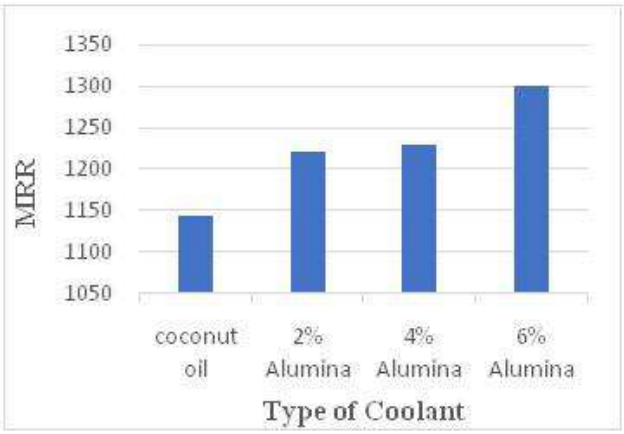
16 run experiments were structured depends on Taguchi technique. The chosen four parameters were changed at four unique levels as appeared in the Table 2.

Table 2: Experimental Data Collected During 16 Run Experiment

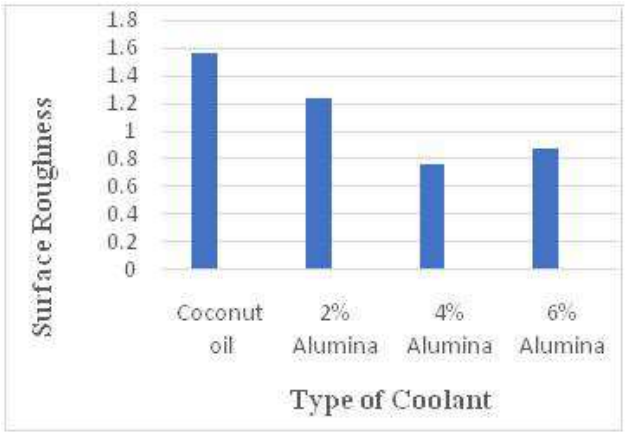
Exp No.	Alumina % in Coconut Oil	Cutting Speed (rpm)	Feed (mm/rev)	Depth of Cut (mm)	Surface Roughness (µm)	MRR (mm^3/min)
1	0%	1100	0.11	0.5	2.18	930.11
2	0%	1200	0.12	0.6	1.56	1013.92
3	0%	1300	0.13	0.7	1.24	1192.89
4	0%	1400	0.14	0.8	1.95	1607.97
5	2%	1100	0.13	0.6	1.57	1244.28
6	2%	1200	0.14	0.5	1.88	1205.32
7	2%	1300	0.11	0.8	1.53	1082.96
8	2%	1400	0.12	0.7	1.47	1182.78
9	4%	1100	0.14	0.7	0.99	1351.81
10	4%	1200	0.13	0.8	1.30	1373.18
11	4%	1300	0.12	0.5	1.08	991.46
12	4%	1400	0.11	0.6	**0.76**	1297.84
13	6%	1100	0.12	0.8	0.84	**1261.01**
14	6%	1200	0.11	0.7	0.87	1254.19
15	6%	1300	0.14	06	0.91	1698.56
16	6%	1400	0.13	0.5	1.14	1208.19

3. RESULTS AND DISCUSSIONS

Experiments were done by using different process parameters and the corresponding material removal rate and surface roughness were measured. Experiments were carried out by varying the percentage of alumina in coconut oil. Graphs are designed for material removal rate and surface roughness against machining parameters.



Graph 1: Material Removal Rate vs Type of Coolant



Graph 2: Surface Finish vs Type of Coolant

3.1 Material Removal Rate

In machining operation material removal rate (MRR) is the amount of material that is expelled per unit time. Higher material removal rate is indexed for higher productivity. From plots of MRR, the MRR linearly increases with increasing the alumina percentage in coconut oil. Time is significant factor for MRR, while increase in cutting speed, workpiece turns with the tool also increased in same time. Material Removal Rate increases with increase in feed, but initially at lower feed rate MRR increased gradually. With increasing the depth of cut MRR also increasing because the maximum thickness of chip can be removed is found to decrease.

3.2 Surface Roughness

Graph 2 shows the roughness values found under the selected four various conditions. Alumina mixed coconut oil has improved surface finish than coconut oil as the existence of nanoparticles always leads to better wettability and heat extraction capacity from machining zone. It is further noted that alumina based cutting fluid has produced a better surface finish than base coconut oil. This would be due to the effective improvement of cooling and lubricating properties of the proposed nano cutting fluid.

3.2 Micro Structural Observation

The microstructure of machine work surface was performed for evaluation of the surface quality gets utilizing MQL process. The examples were examined with scanning electron microscope. Hitachi S-3400N with an quickening voltage of 10.0 kv. Etching of the example was done in a blend made out of ethyl alcohol and nitric acid. The two examples chose for microstructure examination with low value of surface finish and high value of surface finish.

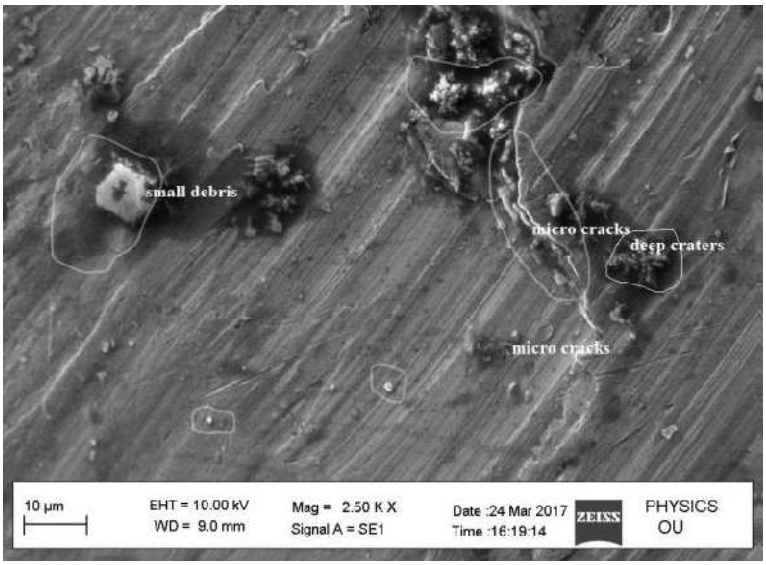


Figure 3: Micro Structure of the Machined Sample at Experiment No 1, Low Surface Finish

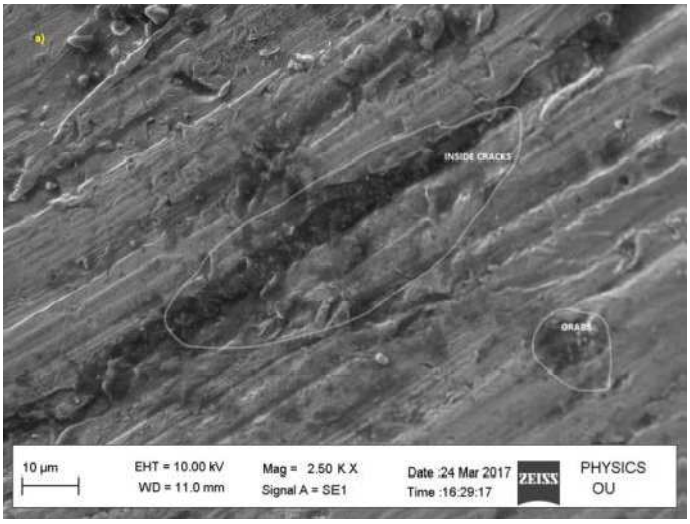


Figure 4: Micro Structure of the Machined Sample at Experiment No 14, High Surface Finish

4. CONCLUSIONS

- The performance of nano cutting fluid was examined in turning SS304 alloy with cemented carbide tool.
- Addition of Al2O3 nanoparticles to the coconut oil results in considerable reduction in surface roughness and improved material removal rate as compared to conventional MQL (not including additives).
- Chips obtained under conventional MQL was mostly continuous in nature while those obtain under nanofluid lubricating environment were of broken type.
- Since nanofluid lubrication has clearly established significant decrease in consumption of lubricant as well as the cutting power while improving surface quality, this technique has been demonstrated as an environmentally friendly sustainable manufacturing or green manufacturing.

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