International Journal of Advanced Research and Development
ISSN: 2455-4030
Impact Factor: RJIF 5.24
www.advancedjournal.com
Volume 3; Issue 2; March 2018; Page No. 761-764

Evaluation of palmolien oil in water-emulsion while machining SS202 material with coated carbide tool

Kunj Patel A, Vikas Ramoliya B, Bhaumik Prajapati C*, Akash Shukla D
Department of Mechanical Engineering, Vadodara Institute of Engineering, Gujarat Technological University, Vadodara, Gujarat, India

Abstract
The purpose of this paper is to investigate the performance of two cutting oils, vegetable-based cutting fluid developed from palmolien oil and commercial type (semi-synthetic), for surface roughness during machining of SS202 austenitic stainless steel with coated carbide tool. Metalworking fluids (MWFs) acts as cooling and lubrication agent at the cutting zone in the machining process. There are now several types of metalworking fluids in the market but the mostly use water emulsion metalworking fluids. The use of mineral based cutting fluid in machining process induces negative effects especially on the environment, worker's health and the machining cost itself. Metalworking fluids shown impact on tool wear, surface roughness, temperature and also other parameters.

Keywords: surface roughness, SS2022, palmolien oil, tool wear, minimum quantity lubrication (MQL), metal cutting fluids, vegetable oil based cutting fluid

1. Introduction
In CNC-NC and Lathe machine there are various machining done also various material are used. Vegetable-based cutting oils showed better performance, than the semi-synthetic and mineral-based cutting fluids. The minimum surface roughness as well as tool wear was obtained with vegetable-based cutting oil [1]. Industrial workers can be exposed to the cutting fluids through the inhalation of aerosols (mists) and by skin contact with the fluid, which causes allergic reactions and respiratory illnesses such as asthma. Due to these drawbacks, the industry has begun eliminating or limiting the amount of cutting fluid [2]. Lubricity is a major advantage of vegetable oil based cutting fluids due to the minor polar charge on the Vegetable oil which draws the vegetable oil's molecule to a metallic surface and makes it tenacious enough to resist being wiped off [3]. Bio-based oils have been used in wide applications such as automotive lubricant, bio-fuel, hydraulic oil, grease and metalworking fluids. Bio-based oils from soybean, rapeseed, sunflower, palm oil and coconut have been extensively studied for lubricant applications [4]. Enormous use of mineral-based oils created many negative effects on environment. The major negative effects is particularly linked to their use, which results in surface water and groundwater contamination, air pollution, soil contamination, and consequently agricultural product and food contamination [5]. Cutting fluids or metalworking fluids (MWFs) are extensively used to cool and lubricate, flush away chips, and inhibit corrosion during machining operations such as drilling, turning, and grinding [6].There are different machining done in different conditions which dry machining and near to dry machining. This near to dry machining is called as minimum quantity lubrication (MQL) and cryogenic machining. There are many researchers that have been doing researches about MQL technique. They were reported that the average cutting temperature could be reduced by 5-10% compared to dry machining [7].Vegetable oil having many advantages like operator friendly, easy availability biodegradability and affordability. Palmolien oil for instance has high oxidative stability and more than 90% of fatty acids of palmolien oil are saturated. Viscosity of palmolien oil is 79.70 while its flash point is 593k and poor point 277k [8].

2. Existing work
Erween A. Rahim and Hiroyuki Sasahara described that the palm oil provides effective lubricating and cooling due to its high viscosity, thereby representing a more commercially viable lubricant for MQL application in the machining process [10].The authors S A LAwal, I A Choudhury and Yussof Nukman described that vegetable oil in-water emulsion cutting fluids to improve the surface roughness and cutting force during turning of AISI 4340 steel with coated carbide tools [11]. The authors E. A. Rahim *et al*. [12] proposed the cutting temperature was reduced 10% to 30% for the MQL condition compared to dry condition. The reduction of temperature improved the tool life thus contributes to the sustainable manufacturing. Subsequently, it can be expressed that strategies proposed by many authors the three parameters for machining: Surface roughness, Tool wear and Temperature. The authors Martin B.G Jun et.al [13] purposed that the emulsion of water with oil were made by using the ultrasonic atomisation method for this method they get perfect ration and perfect mixture of oil and water emulsion.

3. Experimental Procedure
The horizontal milling machining carried out on H.M.M. 3431 with maximum power 1.6 kW and 1440 rpm spindle speed. All slot were made with coated carbide tool (P30) which initial weight 4.380 gm. The Workpiece material used during machining was slab of Stainless Steel 202 (SS202). Which length, width, and thickness of 100 mm, 100 mm, 25 mm

respectively. Some mechanical properties of SS202 described in Table 1.

Table 1: Mechanical Property of SS202 [9]

Properties	Metric	Imperial
Tensile strength	515Mpa	74694 psi
Yield strength	275MPa	39990 psi
Elastic modulus	207GPa	30000 psi
Poisson's Ratio	0.27-0.30	0.270.30
Elongation at brake	40%	40%

The workpiece mounted on the bad of milling machine as shown in figure 1. The cutting parameters selected for the experimental work are shown in Table 2. For spray the water emulsion with palmolien oil utilized nozzle. We used manual flow for spray cutting oil. Milling tool is utilised for making slot on workpiece. Also synthetic oil used for experimental work. We used Gulf Emulsion NA Cutting oil as a synthetic coolant, Synthetic oil and palmolien oil's physical characteristics are shown in Table 3.

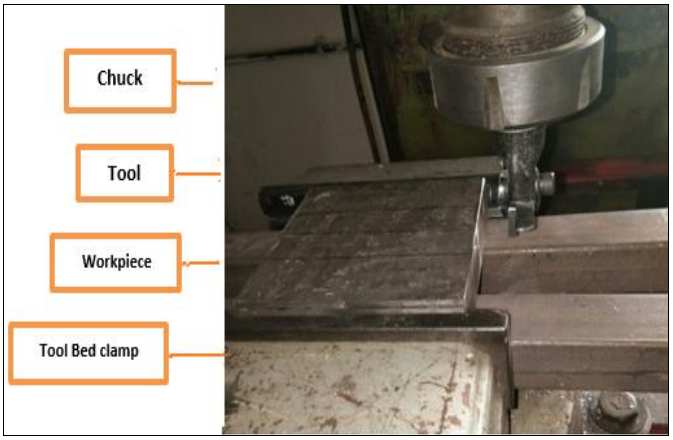

Fig 1: Experimental Setup

Table 2: Cutting Parameters

Feed Rate, f (mm/rev)	Feed Rate, f (mm/rev)
Depth (mm)	Depth (mm)

Table 3: Physical characteristics of MQL Oil

Lubricant Type	Synthetic oil	Palm Oil
Density (g cm^{-3})	0.88	0.91
Viscosity (mm^2 s^{-1})	55	40
Viscosity index	205	190

The slot with and depth on SS202 slab was (Thickness and Depth).Slotted workpiece surface roughness was measured using a surface roughness tester TR100. The measurement was taken at two different slots. From the average surface roughness we take one cut-off of surface roughness. For measuring the tool wear we using coated carbide insert (P30). Figure 2 shown the coated carbide insert.

Fig 2: Coated carbide Insert (P30)

We used Taguchi method for measuring the tool wear. Before machining the mass of the carbide insert is 4.380 gm. and after machining the mass of the carbide insert are consider for measuring the tool wear. Here, we used Insert type milling tool. In this tool two sides two different inserts are used which done milling machining on the workpiece. Figure 3 shown insert tool.

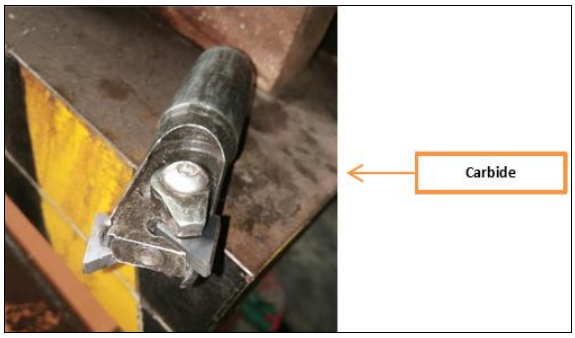

Fig 3: Coated carbide insert tool for machining

Carbide Insert tool widely used in the machining. There are many carbide insert are used. Here, we used P30 coated carbide insert which properties are shown In Table 4. In the machining we produced depth of the slot was 3 mm. In both cases we used manual flow of the coolant. We used surface roughness tester of testing the material surface after machining. Figure 4 is shown the surface roughness tester.

Table 4: Properties of carbide tool insert

Hardness (HRA)	91.3 Ra
Density	12.27 g/cc
Transverse Rupture(TRS)	310 ksi

Fig 4: Surface Roughness Tester

4. Result and Discussion

Surface Roughness

The surface roughness variation measured in different two phase. In first phase we used palmolien oil and in second phase we used Gulf Emulsion NA. For both phases we used different slab of SS202 material. For both phases we took total six readings, three for palmolien oil and three for Gulf Emulsion NA. Figure 5 shows readings for palmolien oil and Figure 6 shows readings for Gulf Emulsion NA.

Fig 5: Readings for Palmolien oil

As shown in figure 5 there we get three different reading 0.29 µm, 0.31 µm and 0.30 µm while using Palmolien oil as machining coolant.

Fig 6: Readings for Gulf Emulsion NA

As shown in figure 6 there we get three different reading 0.35 µm, 0.42 µm and 0.35 µm while using Gulf Emulsion NA as machining coolant. Table 5 shows complete difference of surface roughness while using two different coolants.

Table 5: Observation Table

Coolant Type	Re-1 (µm)	Re-2 (µm)	Re-3 (µm)
Palmolien Oil	0.29	0.31	0.30
Semi-Synthetic coolant	0.35	0.42	0.35

As shown in table 5 Values of the surface roughness were measured for each cutting fluid and the results. Where the minimum and maximum values of surface roughness were obtained with Palmolien oil (vegetable-based cutting oil) and Gulf Emulsion NA (semi-synthetic cutting oil), respectively, under the same operating conditions as well as same machining. From the above result we can say that the surface roughness is good while using Palmolien oil (Vegetable based oil) compare to the synthetic and semi-synthetic coolant.

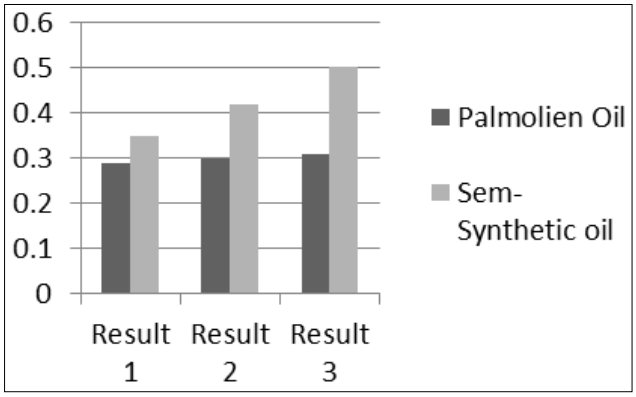

Fig 7: Result comparison of Palmolien oil and Semi-synthetic oil

Tool Wear

Cutting fluid is also produce effect on tool wear. For measurement of tool wear we used carbide insert. Carbide insert density is 12.57 gm/cc. Table 6 shown the result of carbide insert before machining and after machining with two different cutting fluids.

Table 6: Observation table of carbide insert mass

Cutting fluids	Mass before machining(gm)	Mass after machining(gm)
Palmolien oil	4.438	4.430
Semi-Synthetic oil	4.438	4.420

As shown in figure the mass loss of the insert after machining is more in semi-synthetic oil compare to palmolien oil.
For measuring the tool wear we used equation,

$$Tool\ wear = \frac{(mass\ of\ insert\ before\ machining * mass\ of\ insert\ after\ machining)}{density\ of\ cutting\ fluid}[14]$$

From above equation we calculate tool wear for different cutting fluids. The tool wear of carbide insert during use of Palmolien oil is 21.3609 gmcm³ and during used of semi-synthetic cutting fluid is 24.1873 gmcm³.
So, from above calculation we saw that the tool wear of carbide insert is more in semi-synthetic cutting fluid compare to Palmolien oil (vegetable oil).

5. Conclusion

1. Palmolien oil cutting fluid show better performance than the semi-synthetic and mineral-based cutting fluids. Using the Palmolien oil cutting fluid produce good surface roughness compares to Gulf Emulsion NA (Semi-Synthetic) cutting fluid.
2. Palmolien oil cutting fluid not produce any harmful gases so it's not produce any harmful effect on workers as well as environment compare to Semi-synthetic and synthetic cutting fluid.
3. Machining cost also decrease because of palmolien oil price is less compare to Semi-synthetic and Synthetic

cutting fluids.

4. Tool wear during use of Palmolien oil is 21.3609 gmcm³ and during used Emulsion NA 24.1873 gmcm³. So, tool wear is reduce while use of Vegetable oil as a coolant compare to Synthetic and Semi-Synthetic coolant.
5. Surface roughness is 0.31 µm during used of Palmolien oil as a coolant and 0.42 µm during used of Emulsion NA as a coolant. So, Surface roughness also reduce in Vegetable oil compare to Synthetic and Semi-Synthetic oil as a coolant.

6. References

1. Kunj Patel, Vikas Ramoliya. The evaluation of vegetable oil emulsion while machining with coated carbide tool Journal of Materials & Metallurgical Engineering. 2017; 7(3):26-34.
2. Erween A. Rahim and Hiroyuki Sasahara analyse surface integrity when drilling Inconel 718 using palm oil and synthetic Easter under MQL condition (2011). University Tun Hussein Onn Malaysia, Malaysia. Published al. 2014; 11:28.
3. Prakash MVRD. Performance Evaluation of Different Tools in Turning of Ti-6Al-4V Alloy under Different Coolant Condition, International Journal of Science and Research (IJSR), 2014.
4. Talib N. performed Evaluation of Chemically Modified Crude Jatropha Oil as a Bio-based Metalworking Fluids for Machining Process University Tun Hussein Onn Malaysia, 86400 Batu Pahat, Johor, Malaysia. Procedia CIRP. 2015; 26:346-350.
5. Birova A, Pavloviova A, Cvengro J. Lubricating oils based on chemically modified vegetable oils. J Synth Lubr. 2002; 18:291.
6. Yanqiao Zhang. performed Use of vegetable oil in water emulsion achieved through ultrasonic atomization as cutting fluids in micro-milling Journal of Manufacturing Processes G Model JMP. 2014, 240.
7. Dhar NR, Ahmed MT, Islam S. An experiment investigation on effect of minimum quantity lubrication in machining AISI 1040 steel, International Journal of Machine Tools & Manufacture. 2007; 47:748-753.
8. Shyhaa I, Gariania S. Bhattia evaluation of cutting tools and working conditions effects when cutting Ti-6Al-$V using vegetable oil-based cutting fluids Northumbria University at Newcastle upon Tyne, NE1 8ST, UK Procedia Engineering. 2015; 132:577-584.
9. Staineless Steel Grade (UNS20200), www.AZOmaterial.com {Articles}, 2002.
10. Erween A. Rahim and Hiroyuki Sasahara analyse surface integrity when drilling Inconel 718 using palm oil and synthetic Easter under MQL condition University Tun Hussein Onn Malaysia, Malaysia. Published at April. 2011-2014.
11. Lawa SA, Choudhury LA, Nukman Y. evaluation about vegetable oil-based metalworking fluids in turning process Published online: at London, 2012.
12. Rahim EA, Ibrahim MR, Rahim AA, Aziz S, Mohid S. investigation of Minimum Quantity Lubrication (MQL) as a Sustainable Cooling Technique. University Tun Hussein Onn Malaysia, 86400 BatuPahat, Johor, Malaysia, Procedia CIRP, 2015, 351-354.
13. Geoff Burton, Chan-Seo Goo, Yanqiao Zhang, Martin BG. jun use of vegetable oil in water emulsion achieved through ultrasonic atomization as cutting fluids in micro-milling Manuf Process. University of Victoria, Victoria, BC, Canada. 2014; 16(3):405-413.
14. Venkatesh R, Dr. Vaddi seahagiri Rao, Dr. Arunkumar N, Sunil Biswas R. Shoban kumar investigate wear analysis on silicon carbide coated HSS pin on SS Disc Substrate. Procedia Material Science. 2015; 10:644-650.