
Effects of Different Cutting Fluids on Temperature Reduction on Mild Steel during Machining Operations

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ABSTRACT

The growing demand for biodegradable materials has opened an avenue for using vegetable oils such as Neem seed oil, castor oil and water melon seed oil as an alternative to conventional cutting fluids. In this study, some aspects of the turning process on mild steel using HSS cutting tool at variety of spindle speed, feed rate and constant length of cut were observed using Neem seed oil, soluble oil and straight oil in comparison. This study therefore, determined the effect of temperature on cutting fluids (Neem oil, soluble oil and straight oil) when used as cutting fluid for teaching machining operations. Two specific objectives guided the study, two corresponding research questions and two null hypotheses were also formulated. The data collected were analyzed using mean and Analysis of Variance (ANOVA). The findings of the study revealed that, Neem oil remains the best among the three oils in terms of temperature reduction. There was significant difference in the mean temperature readings of Neem oil, soluble oil, and straight oil as cutting fluid in reducing temperature on mild steel work piece when teaching machining operation (turning) using high speed steel cutting tool. It was therefore recommended that machinists should use Neem oil which is biodegradable and non-toxic when used as cutting fluid for machining, since it is operators' and environmentally friendly.

INTRODUCTION

The Neem tree (*Azadirachta indica* Juss) is a native to tropical and semi-tropical regions with origin in Europe and later domesticated in Asia. It is extensively found in India and Indonesia (Yakubu & Bello, 2015). It is also ubiquitous in Northern Nigeria, and fairly found in Western Nigeria, where it is popularly referred to as *Dogon Yaro*. It is a tree in the mahogany family with broad dark stem and widely spread branches. It grows above 20m and produces evergreen leaves with white fragrant flowers and fruits. It is also drought resistant. All parts of the Neem

tree, the leaves, twigs, and the nuts where oil is extracted from, are used both industrially and for medicinal purpose. Neem oil is generally characterized with light to dark brown color, bitter and has a rather strong odor that is said to combine the odors of peanut and garlic (Rajeev, 2009).

Selecting the right cutting fluid is as important as choosing the suitable machine tools, speed and feed. In other words the right cutting fluids always affect the output parameters. In addition, the ability of the cutting fluid to penetrate into the cutting zone is a critical issue; otherwise, the function

of cutting fluid becomes useless. The use of cutting fluid permits higher cutting speeds, higher feed rates, greater depths of cut, lengthened tool life, decreased surface roughness, increased dimensional accuracy, and reduced power consumption (Abou-El-Hossein, 2008).

Cutting fluids, as a component of machining industry, has been introduced and applied for over 100 years. It is believed that W. H. Northcott is probably the first man to mention the improvement in productivity that can be achieved when cutting fluid is applied in machining process. Mineral, vegetable and animal oil have all been introduced, which played important role in enhancing various aspects of machining properties, including corrosion protection, antibacterial protection, lubricity, chemical stability and even emulsibility. However, due to the increasing cost of petroleum products, manufacturers starts to look for some substitutes for oil, which accelerates the development of water-based fluids with different chemical compositions performing different machining tasks. This effort also stimulates the use of synthetic or semi-synthetic water-based fluids that contain only little or even no oil. Study shows that water-based cutting fluids are now used in 80%-90% of all machining applications (Patric, Lawal, Oluwatoyin & Ganiyu, 2010).

Cutting fluids are essential in most metal cutting operations. During metal cutting processes, heat and friction are created by the plastic deformation of metal occurring in the shear zone, when the chip slides along the chip-tool interface. This chip sliding action and frictional effect causes metal to adhere to the tools cutting edge, causing the tool to breakdown, resulting to

inaccurate and poor surface finish of the work piece (Ksar & Oswald, 1990).

The use of cutting fluids repeatedly over the time induces chemical changes of cutting fluids. These changes are due to the environmental effects, contamination from metal chips and tramp oil. The growth of bacteria and yeast becomes environmental hazard and also adversely affects the effectiveness of the cutting fluids. Cutting fluids degrade in quality with use and time and when they lose their quality the disposal of them is mandatory. Waste disposal of cutting fluids are expensive and affect the environment negatively (Carlson, 2006).

Cutting fluids are designed to fulfill one or more of the following conditions; to cool the tool cutting edge and the work piece interface, thereby increasing the resistance of the mating portion to wear, to lubricate the chip and tool edge interface and reduce tool resistance to frictional and abrasion effect, to lubricate area of contact between the workpiece and the tool edge, the tool rake face and the chip, in a situation where the use of expensive form tools became necessary, application of cutting fluids is essential in order to reduce tool wear rate, reduce chances of formation of built up edge, improve surface finish of the machined surface and facilitates flushing of chips away from the cutting zone, thereby making the cutting zone more accessible to cutting tool edge (Lissaman & Martin, 1996).

Machining or metal cutting is most widely used in production technique. Material is removed from a less resistant material called work piece with the help of cutting tool in the machining process. The material cutting process results in removal of tiny parts or layers called chip. The chips are accumulated on the tool face and leave the

work piece material. As a result of this process high normal and shear stress can be generated on the tool face which may cause undesirable effects in machining operation. This may cause heat generation in machining operation which affects the machinability. Nowadays the machining industries are paying attention in improving product quality and productivity at greater cutting velocity and feed rate. It becomes extremely tough to attain both greater cutting velocity and feed rate because they cause very high cutting temperature. As a result of the high cutting temperature, premature failure of the cutting tools occurs in the cutting zone. The premature failure of cutting tool causes poor dimensional accuracy. It also degrades the surface integrity of the product by inducing tensile residual stresses and surface and sub-surface micro cracks. It appears that the cutting fluid in the market now is not meeting the need of machining industries. Therefore there is a need to look for a suitable cutting fluid that will address the effect of high temperature in the cutting zone for improving product quality during machining process (Kamaruzzaman & Jerold, 2011).

According to Kamaruzzaman and Jerold (2011) heat is generated when machining at the cutting point from three sources, those sources are the causes of development of cutting temperature they are:

- i. Primary shear zone: where the major part of the energy is converted into heat
- ii. Secondary deformation zone: at the chip – tool interface where further heat is generated due to rubbing and or shear
- iii. At the worn out flanks: due to rubbing between the tool and the finished surface.

The heat generated is shared by the chip, cutting tool and the blank. The apportionment of sharing that heat depends upon the configuration, size and thermal conductivity of the tool-work material and the cutting condition. Visualizes that maximum amount of heat is carried away by the flowing chip. From 10 to 20% of the total heat goes into the tool and some heat is absorbed in the blank (Cetin, Ozcelik, & Kuram, 2011). With the increase in cutting velocity, the chip shares heat increasingly. The effect of the cutting temperature, particularly when it is high is mostly determined to both the tool and the job. The major portion of the heat is taken away by the chips. But it does not matter because chips are thrown out. So attempts should be made such that the chips take away more and more amount of heat leaving small amount of heat to harm the tool and the job. The possible detrimental effects of the high cutting temperature on cutting tool (edge) are

- i. Rapid tool wear, which reduces tool life.
- ii. Plastic deformation of the cutting edges if the tool material is not enough hot- hard and hot – strong
- iii. Thermal flanking and fracturing of the cutting edges due to thermal shocks
- iv. Built-up edge formation.

The possible detrimental effects of cutting temperature during machining can be as follows:

- a. Dimensional accuracy of the job due to thermal distortion and expansion contraction during and after machining.

- b. Surface damage by oxidation, rapid corrosion and burning
- c. Induction of tensile residual stresses and micro cracks at the surfaces

However, often the high cutting temperature helps in reducing the magnitude of the cutting forces and cutting power consumption to some extent by softening or reducing the shear strength, of the work material ahead the cutting edge. To attain or enhance such benefit the work material ahead the cutting zone is often additionally heated externally. This technique is known as Hot Machining and is beneficially applicable for the work materials which are very hard and harden able like high manganese steel.

According to yahya, Cemal, Cakir & kadir (2015), in metal cutting process, nearly all of the energy dissipated in plastic deformation is converted into heat that, in turn, raises the temperature in the cutting zone. Because heat generation is closely related to plastic deformation and friction the three main sources of heat can be specified when cutting:

- i. Plastic deformation by shearing in the primary shear zone
- ii. Friction on the cutting face
- iii. Friction between the chip and the tool on the tool flank.

Temperature causes dimensional errors on the machined surface. The cutting tool elongates as a result of the increased temperature, and the position of the cutting tool edge shifts toward the machined surface, resulting in a dimensional error of approximately 0.01–0.02 mm. Because the processes of thermal generation, dissipation,

and solid body thermal deformation are all transient, sometime is required to achieve a steady-state condition. Heat is mostly dissipated by the discarded chip, which carries away approximately 60% –80% of the total heat. The workpiece acts as a heat sink drawing 10% –20% of the heat away, and the cutting tool draws away ~10% of the heat. (Cetin, Ozcelik, & Kuram., 2011).

Patrick, Lawal, Oluwatoyin and Ganiyu (2010) conducted a research with soluble oil, water and palm kernel oil as coolants in turning operations. Mild steel was used as workpiece while tungsten carbide and HSS cutting tools were employed as cutter with cutting speed of 355rpm. Turning was done under dry condition and also using three coolants. Temperature and Hardness values after each cut were recorded. There was no statistical tool used in this study. Rather, the readings were taking on face value. The microstructure of the entire specimen was also done and recorded. It was revealed that variation in the Hardness value of the samples with progress in machining time is more with the use of carbide tool compared to the HSS cutter. Samples cooled with water exhibited the highest hardness value. Palm kernel oil performed very well the specific functions of soluble oil as cutting fluid which includes good chip formation, reduction of heat generated and realization of a good surface finish.

Swarup and Kumar (2011) carried out a research in Production Engineering Department, National Institute of Technology Agartala, Tripura, India and Mechanical Engineering Department, Jadavpur University, Kolkata, India. On a topic title study of surface quality during high speed machining using eco-friendly cutting fluid in the study some aspects of the turning

process was carried out on mild steel using 18-4-1 workpiece and HSS cutting tool at different speed-feed-depth of cut combinations by different types of cutting fluids (conventional cutting fluid and vegetable oil based cutting fluids) as compared to completely dry cutting condition have been investigated. Some physical properties of new vegetable oil-cutting fluid have also been studied. The surface roughness properly have been studied under different speed-feed-depth of cut combination with increasing rate of one cutting parameter keeping the other two fixed. Temperature generation at job-tool interface also been measured by infrared thermometer since temperature generation also affects job surface quality. Graphs have been plotted to study the effect of cutting fluid as well as its type on surface property. The result indicate that the use of vegetable oil as cutting fluid improves surface quality compared to the dry machining and also wet machining using conventional cutting fluid.

Nuhu, Jovita & Danladi (2016) carried out a research comparative performance of soluble oil, Neem oil and water melon oils were investigated for application as Cutting fluids in a turning operation using Mild steel and spindle speeds of 250 rpm, 710 rpm and 180 rpm; depth of cut of 1 mm, 0.5 mm and 0.75 mm were used respectively, automatic feed rate and an ambient temperature of 34°C. Some physicochemical properties relating to cutting fluids were also investigated. Results shows that the Specific gravity of Neem seed oil was 0.9304 and Water Melon seed oil was 0.9324. The flash point for Neem seed oil was obtained as 157°C, Water melon seed oil 117°C. Viscosities were obtained as follows; Neem seed oil 8.08 cSt, Water melon seed oil 8.56 cSt. Pour point for Neem seed oil was +8, Water melon seed oil -8. % Wt of Sulphur was

found to be 0.0293 for Neem seed oil, Water melon had -0.0081. pH for Neem seed was 3.6 and Water melon seed oil 5.5. Machining results shows that at 100 % oils, Water melon seed oil produced (54.66°C) and Conventional cutting oil (53°C) are not good as lubricant for metal cutting operations as the temperatures obtained using these oils exceeded the temperature obtained during dry machining at 50°C. The least temperature of 37.33°C was obtained while machining with 25 % Neem seed oil and 75 % water emulsion. All the oils – water emulsion ratios were effective as coolants and comparable to the Conventional cutting oil tested. However, the best surface finish was obtained from the dry machined sample. Amongst the oils tested, 100 % water Melon seed oil produce the best surface finish

Statement of the Problem

Accumulated heat during machining causes the temperature of the tool and the work contact zone to rise at fast rate, directly affecting the surface finished of the product. The resulting high temperature induces metallurgical transformation such as softening of the work piece. The transformation to structural break down in the work piece and the tool material adversely affect the quality of the machined products in terms of dimensional accuracy and surface finish (Swarup & Kumar 2011).

Safian, Noordin, Mohammed, Zainal, Izman & Adnan (2009) asserted that cutting fluid have long been used in machining process to reduce the temperature during machining by spraying the coolant into machining zone directly on the cutting tool and the workpiece. This has the effect of reducing the tool temperature and the workpiece which increases tool life and improves work piece quality. However, the cutting fluids being

used now are environmentally unfriendly, costly and potentially toxic. The recent shift to dry cutting has not completely solved the problem. Dry cutting increases energy cost and requires a capital investment that is too large for most machine shops. The advantages of using cutting fluid have been questioned lately, due to several negative effects; Cutting fluid can cause skin and lung disease to the operator and air pollution to the nature as well as cost of the fluid influence the amount of total machining cost. Elimination of using cutting fluid or dry machining can cause tool wear problems and poor surface finish. Hence, there is a need to source for an alternative bio-lubricant that is operator's friendly (Safian, et al. 2009). Therefore, this study sought to find out the effects of using Neem oil as base in cutting fluid for teaching and machining operation in terms of temperature reduction.

Purpose of the Study

The main purpose of the study was to determine the effects of using Neem oil as base in cutting fluid for teaching machining operations. Specifically, the study was to:

- i. Determine the effects of Neem oil on temperature when used as cutting fluid during machining processes.
- ii. Determine the effect of Neem oil on temperature at different spindle speed.

Research Questions

The following questions guided the study.

- i. What is the effect of Neem oil on temperature when used as cutting fluid during machining process?

- ii. What is the effect of Neem oil on temperature at different spindle speed?

Hypotheses

The following null hypotheses were tested at 0.05 level of significance.

HO₁: there is no significant difference in the mean temperature readings of Neem oil, soluble oil, and straight oil when used as cutting on mild steel workpiece during machining operation.

HO₂: there is no significant difference in the mean temperature readings of Neem oil, soluble oil and straight oil as cutting fluid on mild steel workpiece during machining process.

MATERIALS AND METHODS

The materials used for this study include:

1. Lathe machine – Model: Harrison, Serial No. M300, 5.3 amps, 2.2kw, 380 volts, 50Hz.
2. Cutting tool –facing tool High speed steel (HSS) with 10° rake angle, 9° clearance angle, 1.5mm nose radius with 10mm tool overhang.
3. Thermometer of type 1202146, manufactured by Electronic Temperature Instruments Ltd, UK.
4. Micro-meter screw gauge
5. Mild steel work pieces with diameter 49.50mm

The effect of Neem seed oil, soluble oil, and straight oil on surface temperature of the workpiece at varying spindle speeds, depths of cut and feed rates on the turning of mild steel were carried out on a Harrison lathe machine using a high speed steel (H.S.S) cutting tool.

The experiments were carried out with the following specific procedures using the Neem seed oil soluble oil and straight oil as the cutting fluid.

1. Turning operations of mild steel at varying spindle speeds (58, 85, 125, 180, 260 and 540 rev/min) and at variety of feed rate (1.0, 0.8, 0.6, 0.4, 0.2 mm/rev) and constant depth of cut of 6mm
2. Turning operations of mild steel at varying feed rates (1.0, 0.8, 0.6, 0.4, 0.2 mm/rev) and variety of spindle speed (58, 85, 125, 180, 260 and 540 rev/min) and constant depth of cut of 6mm.
3. Procedures 1, 2 and 3 were repeated using Neem oil, soluble oil and straight oil as cutting fluid.

Immediately (5 seconds) after the turning operation the surface temperature was

measured using the thermocouple thermometer, the temperature value is read off a digital display.

RESULTS

The results of the study are presented in tabular and chart form based on the research questions that guide the study.

Research Question 1: What is the effect of using Neem oil on temperature reduction when used as cutting fluid during machining process (turning)?

Table 1: Temperatures in Degree Celsius (°C) Obtained during Turning Operation under Variety Feed Rate and Spindle Speed with 100% Neem Oil, Soluble Oil and Straight Oil as Cutting Fluid

Cutting Fluid	Readings	Feed rate: 1.00 mm	Feed rate: 0.8mm	Feed rate: 0.6mm	Feed rate: 0.4mm	Feed rate: 0.2mm	Feed rate: 0.2mm
Neem oil	1.	35.30	35.40	36.50	36.89	37.53	39.53
	2.	35.35	35.48	36.52	36.99	37.60	39.52
	3.	35.37	35.46	36.51	36.99	37.59	39.53
Average		35.34	35.45	36.51	36.96	39.53	39.53
Soluble oil	1.	37.01	37.83	38.59	38.83	39.21	40.51
	2.	37.03	37.80	38.59	38.80	39.20	40.50
	3.	37.04	37.82	38.60	38.80	39.31	40.52
Average		37.03	37.82	38.59	38.81	39.24	40.51
Straight oil	1.	39.98	41.05	41.59	42.00	42.89	43.22
	2.	40.00	41.08	41.60	42.01	42.87	43.21
	3.	39.99	41.10	41.59	42.00	42.87	43.21
Average		39.99	41.07	41.59	42.00	42.88	43.21

Ambient temperature: 34°C

Length of cut: 9.00 mm

Spindle speed: 58rpm, 85rpm, 125rpm, 180rpm, 280rpm.

Table 1 shows the effect of Neem oil as cutting fluid in terms of temperature reduction at different feed rate see appendix (iv), it is seen from table one that Neem oil as

base cutting fluid has lower temperature mean readings than soluble oil and straight oil during turning operation. In case of straight oil as cutting fluid, the nature of

variation in the mean temperature readings is highest among the other cutting fluids and for Neem oil base cutting fluids the mean temperature generation is 36.37°C while soluble oil cutting fluid has 38.30°C and straight oil cutting fluid has the highest mean temperature readings of about 41.59°C. Therefore, Neem oil as base cutting fluid possesses high effects in temperature

reduction. Therefore, in line with table 1 Neem oil was found to be the best cutting fluid in reducing temperature on mild steel during turning operations at different feed rate.

Research Question 2: What is the effect of Neem oil on temperature reduction at different spindle speed?

Table 2: Temperatures in Degree Celsius (°C) Obtained during Turning Operation under Variety of Spindle Speed with 100% Neem Oil, Soluble Oil and Straight Oil as Cutting fluid.

Cutting Fluid	Readings	Spindle	Spindle	Spindle	Spindle	Spindle	Spindle
		speed: 58 rpm	speed: 85 rpm	speed: 125 rpm	speed: 180 rpm	speed: 280 rpm	speed: 540 rpm
Neem oil	1.	35.30	35.40	36.50	36.89	37.53	39.53
	2.	35.35	35.48	36.52	36.99	37.60	39.52
	3.	35.37	35.46	36.51	36.99	37.59	39.53
Average		35.34	35.45	36.51	36.96	39.53	39.53
Soluble oil	1.	37.01	37.83	38.59	38.83	39.21	40.51
	2.	37.03	37.80	38.59	38.80	39.20	40.50
	3.	37.04	37.82	38.60	38.80	39.31	40.52
Average		37.03	37.82	38.59	38.81	39.24	40.51
Straight oil	1.	39.98	41.05	41.59	42.00	42.89	43.22
	2.	40.00	41.08	41.60	42.01	42.87	43.21
	3.	39.99	41.10	41.59	42.00	42.87	43.21
Average		39.99	41.07	41.59	42.00	42.88	43.21

Ambient temperature: 34°C

Length of cut: 9.00 mm

Feed rate: 1.00 mm, 0.80mm, 0.60mm, 0.40mm, 0.20mm.

Table 2 shows that there is a difference in temperature reduction at variety of spindle speed as compared to the feed rate, the effect of Neem oil as cutting fluid in terms of temperature reduction at different spindle speeds, indicates that Neem oil as base cutting fluid has lower temperature mean readings than soluble oil and straight oil during turning operation. The nature of

variation in the mean temperature readings is highest in straight oil followed by soluble oil and for Neem oil base cutting fluids the mean temperature generation is 36.89°C while soluble oil cutting fluid has 38.67°C and straight oil cutting fluid has the highest mean temperature readings of about 41.86°C. Therefore Neem oil as base cutting fluid under different spindle speed also possesses

high effects in terms of temperature reduction amongst the soluble oil and straight oil from the results obtained from the experiments. Therefore table 2 shows that Neem oil reduces temperature to great extent irrespective of the spindle speed rate.

Hypothesis 1: there is no significant difference in the mean temperature readings of Neem oil, soluble oil, and straight oil as cutting fluid in reducing temperature on mild steel workpiece during teaching machining operation (turning) using high speed steel cutting tool.

Table 3: Analysis of Variance (ANOVA) of Different Cutting Fluids in Terms Temperature Reduction under Variety of Feed Rate during Turning Operation

Source of variation	SS	df	MS	F cal.	F crit	Remarks
Between groups	69.71	2	34.86	36.01	3.89	Rejected
Within groups	11.62	12	0.967			
Total	81.33	14				

Table 3 shows that significant difference exists between the three cutting fluids Neem oil, soluble oil and straight oil in turning operation of mild steel workpiece. This is evident from the table since f-calculated value was 36.01 which were greater than f-critical value of 3.89 at 0.05 level of significance. Therefore the null hypothesis was rejected. Therefore it can be concluded that, the rate temperature reduction in Neem

oil, straight oil and soluble oil are clearly different, meaning they cool at different rates.

Hypothesis 2: there is no significant difference in the mean temperature readings of Neem oil, soluble oil and straight oil when used as cutting fluid on mild steel workpiece during machining process (turning) using high speed steel cutting tool at different spindle speed.

Table 4: Analysis of Variance of Different Cutting Fluids in Terms Temperature at Different Spindle Speed during Turning Operation

Source of variation	SS	Df	MS	F cal.	F crit	Remark
Between groups	75.97	2	37.98	21.72	3.68	Rejected
Within groups	26.23	15	1.75			
Total	102.19	17				

Table 4 shows that there is significant difference in the mean temperature readings of Neem oil, soluble oil and straight oil when used as cutting fluids in turning operation of mild steel workpiece using HSS cutting tool. This is evident from the table since calculated f-value is 21.72 which is greater than f-critical

value of 3.68 at 0.05 level of significance. Therefore the null hypothesis was rejected. This indicates that, at different spindle speed, Neem oil, straight oil and soluble oil have different rates of temperature control.

1. Therefore Neem oil as base cutting fluid possesses high effects in temperature reduction.
2. Neem oil reduces temperature to great extent irrespective of the spindle speed rate.
3. The rate temperature reduction in Neem oil, straight oil and soluble oil are clearly different, meaning they cool at different rates.
4. At different spindle speed, Neem oil, straight oil and soluble oil have different rates of temperature control.

DISCUSSION

The findings of this study are discussed in the other of research questions raised in the study. The findings related to research question one indicated that Neem oil as base cutting fluid reduces temperature to great extent than soluble oil and straight oil during turning of mild steel workpiece using HSS cutting tool at different feed rate during teaching machining operation. This finding is consistent with Patric, Lawan, Oluwatoyin & Ganiyu (2010), Swrup & Pradip (2011), Nuhu, Jovita & Danladi (2016) works who found out those vegetable oils gives better performance in reducing temperature during turning operation.

The nature of variation in the mean temperature readings as in research question two is highest in straight oil followed by soluble oil. Therefore, Neem oil as base cutting fluid under different spindle speed possesses high effects in terms of temperature reduction when compared to soluble oil and straight oil as obtained from the experiments. The finding of this study is in line with Patric, Lawan, Oluwatoyin & Ganiyu (2010), Swrup & Pradip (2011), Nuhu, Jovita & Danladi (2016) who practically said that vegetable oils gives

better performance in reducing temperature during turning operation at different spindle speed.

The analysis of data relating to null hypothesis one revealed that there was a significant difference in the mean temperature readings of Neem oil, soluble oil, and straight oil as cutting fluid in reducing temperature on mild steel workpiece during teaching machining operation (turning) using high speed steel cutting tool at variety of feed rate. This finding is in line with the result of Safian, Noordin & Zainal (2009) who believed that there exist a significant reduction in temperature when Neem oil is used as cutting fluid during workpiece machining operation.

There was significant difference in the mean temperature readings of Neem oil soluble oil and straight oil as cutting fluid in reducing temperature on mild steel workpiece during machining process (turning) using high speed steel cutting tool at different spindle speed the null hypothesis two was upheld.

RECOMMENDATIONS

Based on the findings of this study, the following recommendations were proffered:

1. The mechanical technology teachers should recommend the use of Neem oil as an alternative cutting fluid for application on various machining and project produced in the school workshops.
2. The Mechanical student's should use of Neem oil as cutting fluid even when the speed of cut is low or high.

CONCLUSION

The major findings to this study serves as the basis for drawing conclusion that

temperature reduction was best obtain using Neem oil as base cutting fluid than soluble oil and straight oil. The significant contribution of Neem seed oil in machining of mild steel workpiece using HSS cutting tool offered the reduction of temperature of mild steel during turning operation at different spindle speed and variety of feed rate.

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