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# Effects of Using Neem Oil as Base in Cutting Fluid for Machining Operations In Adamawa State Polytechnic, Yola

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***Abstract:*** *The study investigated the effects of using neem oil as base in cutting fluid for machining operation in Adamawa state polytechnic., 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. The 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 whereas minimum surface roughness and best surface quality was obtained using neem seed oil as cutting fluid as compared to straight oil and soluble oil cutting fluid in turning operation of mild steel work piece using HSS cutting tool. The least surface roughness was achieved at spindle speed of 540 rpm using neem seed oil. It was the most effective in reducing surface roughness as spindle speed increased. Neem seed oil had the best surface quality at feed rates lower than 0.2 mm/rev, while the highest surface roughness was observed at feed rate of 1.0 mm/rev and spindle speed of 58 rpm during turning operation.*

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## I. Introduction

In machining process, one of the most significant technical requirements of customer is the surface finish of products. A reasonably good surface finish is desired to improve the tribological properties, fatigue strength, corrosion resistance and aesthetic appeal of the product. The challenge of modern machining industries is focused mainly on the achievement of high quality, in terms of work piece dimensional accuracy, surface finish, high production rate, less wear on the cutting tools, economy of machining in terms of cost saving and increase the performance of the product with reduced environmental impact. (Alessandro, 2011).

The neem tree *(AzadirachtaindicaJuss.)* 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 (Lew, 2012). It is also ubiquitous in Northern Nigeria, and fairly found in Western Nigeria, where it is popularly referred to as DogonYaro. It is a tree in the mahogany family with broad dark stem and widely spread branches. It grows above 20m – 25m 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 as a coolant. 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 (Nuhu, Jovita,& Danladi,2016).

The primary function of the cutting fluids in metal machining operations is to serve as a coolant as well as a lubricant. It is generally agreed that the application of cutting fluids can prolong the tool life and results in good surface finish by reducing thermal distortion and flushing away of machined chips. The goal in all conventional metal-removal operations is to raise productivity and reduce costs by machining at the highest practical speed along with long tool life, and minimum downtime, and with the production of surfaces of satisfactory accuracy and finishing (Rao, 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 fluid is designed especially for metal machining process. Cutting fluids are very important in machining process. Cutting fluid is a type of coolant and lubricant used to reduced friction. Cutting fluids are also used to carry away excessive heat in machining operations which can cause damage to the microstructure of

metals. Proper use of coolants can also help improve work piece quality and dimensional accuracy (Meenu, & komesh,2014).

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 (Kuram,,Ozcelik,&Simsek,2011).

Nuhu, Jovita&Danladi (2016) carried out a research on Comparative Performance of Neem Seed, Water Melon Seed and Soluble Oils as Metal Cutting Fluids in the Department of Mechanical Engineering, Federal University of Technology, Minna, and Department of Mechanical Engineering, Nigerian Defense Academy, Kaduna, Nigeria. The 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. the study is related to this study where neem oil is used as cutting fluid to find its effects on temperature reduction, surface roughness of mild steel work piece at different depth cut and spindle speed in relation to water melon and soluble oil as cutting fluid. In this study straight oil, soluble oil and neem oil were compared to find their effects on tool wearing, surface roughness and temperature using HSS cutting tool.

Sanusi, Bello, Akindapo and Olaitan (2015) conducted a research aimed to evaluate the performance of neem seed oil as a cutting fluid in orthogonal machining of aluminium-manganese alloy 3003, carbide cutting tool insert was used as a cutting tool under different machining parameters of spindle speed, feed rate and depth of cut with different types of cutting fluids (neem seed oil and soluble oil) as well as dry machining. The results were obtained in terms of the average surface roughness of the machined workpiece and flank wear under different cutting parameters (spindle speed, feed rate and depth of cut). The results indicated that the neem seed oil cutting fluid reduced the surface roughness by 39% and 22% as compared to dry turning and soluble oil cutting respectively. It was established from the results that the neem seed oil cutting fluid reduced the flank wear by 72% and 56% as compared to dry turning and soluble oil cutting respectively. Based on the study, it can be concluded that neem seed oil cutting fluid facilitates a better surface finish and substantial reduction in tool wear when compared with dry and soluble oil machining. The study is related to this study in a place where soluble oil neem oil where used as cutting fluid and the result are based on flank wear of the cutting tool, and surface roughness of the workpiece. This study uses mild steel work piece and high speed steel cutting tool to find the effect of neem oil, soluble oil and straight oil as cutting fluid in temperature reduction, surface roughness and tool wear in teaching machining operation.

Berkani, Bouzid, Bensouili, Yallese, Girardin, and Mabrouki(2015) conducted a research titled model and optimization of tool wear and surface roughness in turning of austenitic stainless steel using response surface technology in Guelma University, Algeria. The study found out the effect of flank wear, surface roughness, and lifespan in finish turning of AISI304 stainless steel using multilayerTi(C,N)/Al2O3/TiN coated carbide inserts. The machining experiments are conducted based on the response surface methodology (RSM). Combined effects of three cutting parameters, namely cutting speed, feed rate and cutting time on the two

performance outputs (i.e. VB and Ra), and combined effects of two cutting parameters, namely cutting speed and feed rate on lifespan (T), are explored employing the analysis of variance (ANOVA).The relationship between the variables and the technological parameters is determined using a quadratic regression model and optimal cutting conditions for each performance level are established. The results show that the flank wear is influenced principally by the cutting time and in the second level by the cutting speed. In addition, it is indicated that the cutting time is the dominant factor affecting work piece surface roughness followed by feed rate, while lifespan is influenced by cutting speed. The study is related to this study where tool wear and surface roughness are measured, and the method of data analysis. This study uses cutting fluids in finding out the effect of temperature, surface roughness and tool wear on high speed steel cutting tool in turning operations.

Mithun and Potdar (2015) Studied the effect of Vegetable oil based cutting fluid on machining characteristics of AISI 316L Steel in the Department of Mechanical Engineering, A.G.Patil Institute of Technology, Solapur University Maharashtra,India. In the study the properties of the non-ionic surfactants have been identified to formulate vegetable based cutting fluid (VBCF) of castor oil for the formation of emulsion as non –conventional lubricant. The mineral oil based cutting fluid emulsion is also used for turning operation as conventional lubricant. Experimentation has been carried out for different combinations. Cutting fluid, cutting velocity, feed rate and depth of cut are considered as machining parameters. Then machining with conventional and non-conventional lubricants in wet condition has been carried out upon SS 316 L work piece with carbide cutting inserts tool, to evaluate cutting forces and tool wear. There was no statistical tool used in this study. Rather, the readings were taking on face value. The results show that non-conventional lubricant performs better than conventional cutting fluid. The study is related to this study where cutting fluids is used find the effect of vegetable oil on AISI 31L steel during machining operation (turning) at different cutting velocity and feed rate. But the present study uses neem oil soluble oil and straight oil as cutting fluid in machining of mild steel work piece using high speed steel cutting tool to find out the effects of neem oil in reducing temperature, tool wear and surface roughness of the work piece.

## II. Materials And Methods

The materials, tools, equipment and methods that are used for the study are presented in the following sub headings:

1. Materials used for the study
2. Instrument for data collection
3. Method of data analysis

## III. Materials That Were Used For The Study*:*

The materials used for the study include:

i. Lathe machine – a Colchester lathe machine Type 400-1500, with maximum power consumption of 6kW, maximum current of 13A.

i. Circular mild steel bar (AISI 102) – of diameter Ɵ40mm by 100mm long work pieces.

ii. Soluble oil cutting fluid

iii. Straight oil cutting fluid.

iv. Neem oil cutting fluid.

**Instrument use for the experiment**

The instruments used for the study are thermocouple, portable vernier caliper and dial gauze Surface roughness tester.

## IV. Results And Discussion

**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.**

| S/NO. | Cutting fluids | Mean readings$^{o}$C |
|---|---|---|
| 1. | Neem oil | 36.37 |
| 2. | Soluble oil | 38.30 |
| 3. | Straight oil | 41.59 |

The ambient environmental Temperature during the machining period was $34^{O}$C.

Spindle speed = 180 rpm/min.

Length of cut = 9 mm.

Feed rate = 0.2 mm, 0.4 mm, 0.6 mm, 0.8 mm, 1.0 mm.

Table above shows the effect of neem oil as cutting fluid in terms of temperature reduction at different feed rate see table 2, it is seen form table 1 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$^{o}$C while soluble oil cutting fluid has 38.30$^{o}$C and straight oil cutting fluid has the highest mean temperature readings of about 41.59$^{o}$C. Therefore neem oil as base cutting fluid possesses high effects in temperature reduction.

**Table 2:DIFFERENT FEED RATE**

| Cutting Fluid | Readings | Spindle speed: 58 rpm Feed rate: 1.00 mm | Spindle speed: 85 rpm Feed rate: 0.8mm | Spindle speed: 125 rpm Feed rate: 0.6mm | Spindle speed: 180 rpm Feed rate: 0.4mm | Spindle speed: 280 rpm Feed rate: 0.2mm | Spindle speed: 540 rpm 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$^{o}$C
Length of cut: 9.00 mm

**Table 3: Surface Roughness (Finish) (mm) of the Workpiece under a Variety Feed Rate during Turning Operation Using Neem Oil, Soluble Oil and Straight Oil as Cutting Fluid.**

| S/NO. | Cutting fluids | Mean readings (mm) |
|---|---|---|
| 1. | Neem oil | 0.41 |
| 2. | Soluble oil | 0.64 |
| 3. | Straight oil | 0.43 |

Table 3 reveled that there was no significant difference in the mean readings of tool wearing when using neem oil, soluble oil, and straight oil as cutting fluid in reducing wear on high speed steel cutting tool during machining operation (turning) at variety of feed rate which is consistent with Sanusi's et al. (2015) view, who asserted that neem seed oil cutting fluid reduced tool wear by 70% and 50% as compared to soluble oil.

There was no significant difference in the mean readings of work piece surface roughness (finishing) when using neem oil, soluble oil, and straight oil as cutting fluid using high speed steel cutting tool in teaching and machining operation (turning) at different feed rate. These was uphold and is in line with Sanusi et al. (2015) who declared that neem seed oil cutting fluid reduces surface roughness by 30% and 22% when compared with soluble oil
cutting fluid.

**Figure1: A graph of temperature against feed rate**.

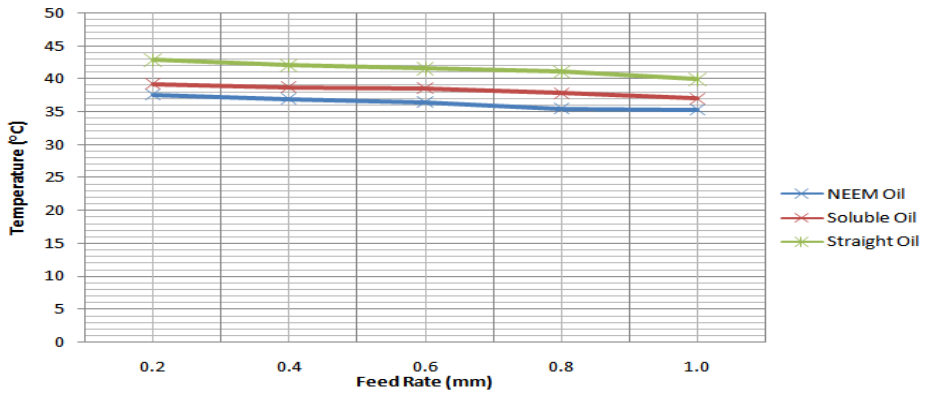

**Figure1.** Variations of Temperature with Neem Oil, Soluble Oil and Straight Oil as Cutting Fluid under Different Feed Rates.

Figure 1 shows that neem oil was more effective in temperature reduction than soluble oil and straight oil at different feed rates and spindle speed and constant length of cut. Therefore in line with table one and figure 1 neem oil was found to be the best cutting fluid in reducing temperature on mild steel during turning operations at different feed rate.

## V. Conclusion

The 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 whereas minimum surface roughness and best surface quality was obtained using neem seed oil as cutting fluid as compared to straight oil and soluble oil cutting fluid in turning operation of mild steel work piece using HSS cutting tool. The least surface roughness was achieved at spindle speed of 540 rpm using neem seed oil. It was the most effective in reducing surface roughness as spindle speed increased. Neem seed oil had the best surface quality at feed rates lower than 0.2 mm/rev, while the highest surface roughness was observed at feed rate of 1.0 mm/rev and spindle speed of 58rpm during turning operation.

Lower tool wear values were obtained with soluble oil and high tool wear was achieved at spindle speed of 540 rpm using Neem oil. Soluble oil possess the highest value in terms tool wear, followed by neem oil when machining mild steel at a spindle speed of 540 rpm, a feed rate of 0.2 mm/rev and length of cut of 9.00 mm.

Therefore an increase in the spindle speed decreased the surface roughness value. A decrease in spindle speed, feed rate and length of cut increased the surface roughness value. An increase in the spindle speed, increase in the feed rate and length of cut increased the flank wear value.

The significant contribution of neem seed oil in machining of mild steel work piece using HSS cutting tool offered the reduction of temperature of mild steel. This would enhance remarkable improvement in surface roughness (finish) and allow higher spindle speeds, feed rates and length of cut. Such significant reduction was due to its high lubricating property.

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