# Local Content Utilization and Product Quality Standards Promotion for Industrial and Machine Tools Processes Application

[1]Joshua Tumba
[1]Department of Mechanical Engineering, Federal Polytechnic Mubi, Adamawa, Nigeria

**Citation**: Tumba J. (2022) Local Content Utilization and Product Quality Standards Promotion for Industrial and Machine Tools Processes Application, *International Journal of Engineering and Advanced Technology Studies*, Vol.10, No.4, pp.7-19

**ABSTRACT:** *The research titled, local contents utilization and product quality standards promotion for industrial and machine tools processes application used oils of plant origin; Mahogany Seed Oil (MSO) and Cashew Nut Oil (CNO) to produce cutting fluids. These oils were used as base oils to formulate cutting fluids and were used in straight turning of low carbon steel through factorial design of experiment. Their performances in terms of resulting surface roughness (Ra) of machined samples) and heat dissipation tendency was evaluated. Also, the determination of some characteristics of the formulated cutting fluids was carried out. The two vegetable oils extracted were mixed with water in an appropriate ratio separately. The oil – water mixtures were finally blended with the necessary additives to obtain the various cutting fluids. Before machining, the flash points, viscosities and acidities of the cutting fluids were determined. During machining, the tool – work interface temperatures were recorded using digital thermocouple and the Ra of the machined samples was evaluated afterward using scanning electron microscope (SEM) The performances and some characteristics of the formulated cutting fluids were compared with that of a control sample (CS). The heat removal ability was best achieved by MSOCF being locally available vegetable oil-based cutting fluid attaining a temperature of 32°C at the highest cutting speed of 80mpm. Similarly, CNOCF produced the best surface roughness which range between 1.0675µm and 1.5715µm for all levels of cutting speeds. Besides the same MSOCF proved to be the safest from fire hazard with the highest flash point of 237°C. CNOCF has the highest viscosity at 40°C and 80°C being 134cp and 96cp. MSOCF was found to be the best among the cutting fluids in conducting heat away from tool-work piece interface and was followed by CNOCF. From the foregoing, it can be concluded that locally available vegetable oils can be used in the production of cutting fluids for machining operations. Hence, the vegetable oils cutting fluids can then conveniently substitute the conventional (mineral oil based) cutting fluids for all machining processes and operations under various operating conditions as coolants and lubricants. They could also be synergized to compete favorably with mineral based cutting fluids.*

**KEYWORDS***:* cutting fluids, heat, local contents, machine tools processes, surface roughness and turning.

## INTRODUCTION

The oil rich seeds of many of our local trees including those sampled for the research are laying waste especially in the study area (Nigeria). Mahogany seed oil (MSO) is only extracted mostly by villagers which is used for medicinal purposes or producing traditional body lotions, cashew nut oil (CNO) is rarely extracted. The cutting fluids used for machining processes application are mostly mineral oil based (Badau et al., 2016). This research is intended to formulate mechanical machining cutting fluids to be used as alternative coolants and lubricants from plant seeds. Cutting fluids function in dual capacity as coolant and lubricant and all depends on temperature, cutting speed and type of machining operation; usually at high cutting speed, cutting fluid acts as coolant thus cools the cutting zone and at low cutting speed, it acts as lubricants thus reducing the formation of Built-Up-Edge (BUE) and improves surface roughness (Ra) (Saleem et al, 2013. This could substitute the conventional expensive mineral oil-based cutting fluids which are not easy to come by in most of our National Technological based Educational Institutions (Baba 2018).

Cutting fluids are readily available in commercial quantities to enhance machining performances in industries. Over the years minerals, synthetic and semi synthetic cutting fluids were basically used but today vegetable based cutting fluids is about to take the lead for obvious reasons of easy disposal and biodegradability (Kuram et al., 2013).

Cutting fluids are meant to improve cutting performance. The temperature reduction tendency of cutting fluids depends on their thermal properties (specific heat and thermal conductivities). Another important function of cutting fluids is lubrication. This function reduces the amount of heat generated by friction and others include good lubricating properties, high cooling point, low viscosity to prevent free flow of cutting fluid, chemically stable, non-corrosive, high flash points, Allergy free, less expensive and low cost (Kuram et al., 2013).

Vegetable oils are triglycerides (glycerol molecules) with three long chain fatty acids of similar features attached with a hydroxyl group via esters linkages. The triglycerides structures give vegetable oils desirable properties of lubricants. Vegetable oils have higher Viscosity Index and perform better than other oils. Vegetable oil performed a great cooling effect and lubrication similar to other coolants. The vegetable oil easily removed heat produced during operation and gives proper lubrication thus reducing friction and wear, hence improving tool life and surface roughness (Ra) (Saleem et at, 2013).

Vegetable oils have a higher flash point, which reduce smoke formation and fire hazard. Higher flash point value allows using the cutting fluid in high temperature conditions (Baba et al., 2018).Viscosity is another oil property that has an important effect on machining processes. Vegetable oils have a high natural viscosity as the machining temperature increases. Viscosity is the resistance to flow of oil and is affected inversely by temperature. Viscosity has considerable influence on the properties of a cutting fluids. Higher viscosity improves the lubrication abilities of the fluids and decreases the cooling performance. Similarly lower viscosity provides better cooling performance and easier removal of solid particles. The viscosity of vegetable oils drops more slowly than that mineral oils as the temperature falls, vegetable oils remain more fluid than mineral oils, facilitating quicker drainage from chips and work pieces. The higher viscosity index of vegetable oils ensures that vegetable oils will provide more stable lubricity across the operating temperature range (Saleem et al., 2013).Vegetable oil molecules are quite homogeneous in size but mineral oil molecules vary in size. Consequently, the properties of mineral oil such as viscosity, boiling temperature are more susceptible to variation. (Badau et al., 2016).

A lubricant on the other hand is material usually liquid sandwiched between mating parts or surfaces to minimize friction between them thereby improving efficiency and reducing wears. Lubricants is meant to perform the following functions: keep moving parts apart, minimizing friction, transferring heat away, do away with contaminants and debris, transmit power, provides seals for escaping gases and eschew the risk of smoke and fire (Tumba, 2015).

Cutting fluids function in dual capacity as coolant and lubricant and all depends on temperature, cutting speed and type of machining operation; usually at high cutting speed, cutting fluid acts as coolant thus cools the cutting zone and at low cutting speed, it acts as lubricants thus reducing the formation of Built-Up-Edge (BUE) and improves surface roughness (Ra) (Saleem et al, 2015).

The condition applied to turning operation include varying the cutting speed and feed rate while keeping the other cutting parameter like depth of cut constant. It was found out that increase in cutting speed causes decrease in tool life and improves Ra (Demirbas, 2013).Increasing the productivity and the quality of the machined parts are the main challenges of metal-based industry; there has been increased interest in monitoring all aspects of the machining process. Surface finish is an important parameter in manufacturing engineering. It is a characteristic that could influence the performance of mechanical parts and the production costs. The ratio between costs and quality of products in each production stage has to be monitored and immediate corrective actions have to be taken in case of deviation from desired trend (Adeel et-al., 2010).

Machining operations tend to leave characteristic evidence on the machined surface. They usually leave finely spaced micro- irregularities that form a pattern known as surface finish or roughness. The quality of the finished product, on the other hand, relies on the process parameters; surface roughness is therefore, a critical measure in many mechanical products (Thamma, 2008).Whatever may be the manufacturing process, an absolutely smooth and flat surface cannot be obtained. The machine elements or parts retain the surface irregularities left after manufacturing. The following are the various levels of surface finish (Sharma, 2005 and Davim, 2013). 0.10μm - it is mirror like surface which is free from any kind of visible marks. It is a very high-cost finish which is produced by processes such as lapping, honing and precision grinding. Such a finish is used typically in high quality bearings (Davim, 2013). Also, grinding and honing surface-finishing processes yield surfaces with a surface roughness in the range of 0.1-1.6μm 0.20μm. it is scratch-free, close tolerance finish that is obtained by diamond turning, boring and precision grinding. This type of finish is used for parts like the internal diameter of hydraulic cylinders, pistons, journal bearings and cam faces .0.40μm- such a surface is also produced by precision grinding processes using diamond tools. It is typically used in: hydraulic applications, static sealing rings, heavily loaded bearings and rapidly rotating shaft bearings

0.80μm- it is a fine surface finish produced by various machining operations (turning, drilling, and milling) performed very carefully, followed by grinding or broaching. Such a finish is used for parts subjected to stress concentration and vibrations such as teeth and brake drums. 1.60μm- this is high quality surface finish produced by turning, milling etc. and without subsequent operations. It is used for parts with fairly close tolerances but where fatigue is not a likely problem, such as ordinary bearings and ordinary machine parts (Kwon, 2004). 3.2μm. Such a surface produced by high quality machining use light cuts, fine feeds and sharp tools in the finishing pass. It finds applications in lightly loaded bearing surface and moderately stressed parts but not for sliding surfaces . 6.25µm- this surface finish results from ordinary machining operations using medium feeds. It finds uses in the surface of non-critical parts

Typical cases can be clutch disk faces: 3.2µm; brake drums: 1.6 µm; crankshaft bearing: 0.40µm: Bearing Balls: 0.02µm.

## MATERIALS AND METHODS

### Materials

The following are some of the many materials needed for the research.

***Mahogany seed oil cutting fluid (MSOCF)***

This is a formulated cutting fluid from Mahogany seed oil (MSO)

***Cashew Nut oil cutting fluid (CNOCF)***

This is a formulated cutting fluid from Cashew Nut oil (CNO)

***Detergent***

This is also called washing soda and it is used as emulsifier

***Sulfur and Chlorine***

The two are used as extreme pressure agent.

***Phenol***

Phenol is used as disinfectant

***Sodium Hydroxide (NaOH) or Potassium Hydroxide (KOH)***

Used as a base for titration

***Water***

Used as a solvent

***Phenolphthalein***

Used as an indicator in titration

***Mild steel bar***

Solid cylindrical work piece of mild steel with chemical composition as shown in

Table 1. The work piece has a cross sectional diameter of 38mm and a length of 750mm. All test samples will be produced from it

.

Print ISSN: 2053-5783(Print)
Online ISSN: 2053-5791(online)

*Table 1: Chemical Composition of work piece*

| ***Material*** | ***C*** | ***Si*** | ***Mn*** | ***P*** | ***S*** | ***Fe*** |
|---|---|---|---|---|---|---|
| Mild Steel | 0.2860 | _ | 0.0500 | 0.0020 | 0.0001 | Bal. |

***Control Sample***

Mineral oil based cutting fluid will be used as a control sample. It is also called soluble oil because when mixed with water it forms a white solution known as slurry or suds (Saleem et al 2013).

**Equipment and Tools**

1 Centre Lathe machine (E3N-01 Centre Lathe)

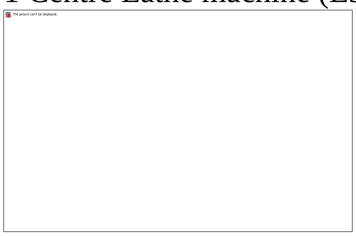

*Plate 1: E3N-01 Lathe Machine*

2. Scanning Electron Microscope (SEM)

*Plate 2: LEO 1400 Series Scanning Electron Microscope*

3. Others are single point cutting tool (HSS), thermocouple, Stop watch, beakers, measuring cylinders, vernier caliper, Ostwald viscometer, burette, pipette, comical flask, oil extraction machines or device.

**Experimental Deign**

Factorial design will be used for the research expressed as

$$l^f \times n \qquad (1)$$

Where; $l = levels, f = factors\ and\ n = number\ of\ replications$

The machining parameters will be taken at four (4) levels, single factor and will be replicated twice. This means that, eight (8) experiments will be run for each cutting fluid and thirty two (32) for the entire research with dry machining inclusive. Machining principal elements – cutting speed (Cs), Depth of Cut (Dc) and Feed rate (Fr) and their levels are shown in Table 2

*Table 2: Levels of Machining Principal Elements*

| Sample | Cs (mpm) | Dc (mm) | Fr (mm/rev) | Av.Ra (µm) | Tav (°C) |
|---|---|---|---|---|---|
| A (Control Sample) | 50 | 0.4 | 0.275 | | |
| | 60 | 0.4 | 0.275 | | |
| | 70 | 0.4 | 0.275 | | |
| | 80 | 0.4 | 0.275 | | |
| B.MSOCF (Mahogany seed oil cutting fluid) | 50 | 0.4 | 0.275 | | |
| | 60 | 0.4 | 0.275 | | |
| | 70 | 0.4 | 0.275 | | |
| | 80 | 0.4 | 0.275 | | |
| C.CNOCF (Cashew nut oil cutting fluid | 50 | 0.4 | 0.275 | | |
| | 60 | 0.4 | 0.275 | | |
| | 70 | 0.4 | 0.275 | | |
| | 80 | 0.4 | 0.275 | | |
| D. (Ecological Machining) | 50 | 0.4 | 0.275 | | |
| | 60 | 0.4 | 0.275 | | |
| | 70 | 0.4 | 0.275 | | |
| | 80 | 0.4 | 0.275 | | |

## METHODS

### *Cutting Fluid Formulation*

After seed mobilization and oil extraction from the seeds, cutting fluids were formulated using the guide provided by Baba (2018).

### *Machining*

Machining is a vital part of the production process in the manufacturing industries. Turning operation was carried out on the mild steel to produce shaft of various diameters. The conditions applied during the turning operation include varying the cutting speed (Cs) and the feed rate (Fr) while keeping other cutting variables like depth of cut (Dc) constant. Work piece will be machined by finish turning operation with different machining parameters at different levels using the cutting fluids. The turning will be done between centers using single point cutting tool (Demirbas, 2013).

### *Temperature Measurement during Machining*

This is meant to test the performance of the formulated cutting fluids. AISI 1028 Steel samples of lengths 750mm and cross-sectional diameter of 38mm which were straight turned between centers on E3N-01 lathe machine using High Speed Steel (HSS) tools of the same tip configurations. The control sample and the other cutting fluids will be handled with different turning tools. Every experiment would be ran for at least ten (10) minutes. Cutting fluid was automatically supplied to dissipate the heat generated at the tool/work interface. The temperature at the tool/work interface was measured with the aid a digital thermocouple (Tumba et al., 2017)

***Surface Roughness Determination***

The dimension of the turned work piece could not be accommodated by the lens of a scanning electron microscope (SEM) for the production of samples image metallography. Hence the metal samples will be resized (down sized) for accommodation by the SEM. The metallographic images of the machined work pieces will be subjected to an Amscope for surface roughness data generation and subsequently the surface roughness will be evaluated quantitatively (LEO, 1998).

***Acidity Determination***

The Acidic Value of all cutting fluids with the control sample inclusive will be determined by titration. 0.1M of KOH was used as a base for the titration with about 5ml of each sample and phenolphthalein as an indicator. The value of the acidic content will tell which one will be more susceptible to corrode the steel samples (Lawal et al., 2007).

***Flash Point Determination***

This measurable parameter will be determined using the methods and equipment specified by Valank (2014).

***Viscosity Determination***

The viscosities of all cutting fluids will be determined using Ostwald apparatus and Ostwald equation as shown in equation 1 (Tumba, et al., 2017)

$$\boldsymbol{v = mt\left(\frac{v_r}{m_r t_r}\right)} \qquad (2)$$

Where; $v$ = Viscosity of fluids to be determined
m = Mass of fluids to be determined
t = Time taken by fluid to flow down
vr = Viscosity of reference fluid
$m_r$ = Mass of reference fluid
tr = Time taken by reference fluid to flow down.

## RESULTS AND DISCUSSION

### Surface Roughness

*Table 4: Resulting Surface roughness (Ra)*

| Sample | Cs (mpm) | Dc (mm) | Fr (mm/rev) | Av.Ra (μm) |
|---|---|---|---|---|
| A (Control Sample) | 50 | 0.4 | 0.275 | 2.6035 |
| | 60 | 0.4 | 0.275 | 2.6400 |
| | 70 | 0.4 | 0.275 | 2.7060 |
| | 80 | 0.4 | 0.275 | 2.8190 |
| B.MSOCF (Mahogany seed oil cutting fluid) | 50 | 0.4 | 0.275 | 2.1000 |
| | 60 | 0.4 | 0.275 | 2.1500 |
| | 70 | 0.4 | 0.275 | 2.2220 |
| | 80 | 0.4 | 0.275 | 2.4567 |
| C.CNOCF (Cashew nut oil cutting fluid | 50 | 0.4 | 0.275 | 1.5715 |
| | 60 | 0.4 | 0.275 | 1.2738 |
| | 70 | 0.4 | 0.275 | 1.2378 |
| | 80 | 0.4 | 0.275 | 1.0675 |
| D. (Ecological Machining) | 50 | 0.4 | 0.275 | 10.312 |
| | 60 | 0.4 | 0.275 | 9.8003 |
| | 70 | 0.4 | 0.275 | 9.7173 |
| | 80 | 0.4 | 0.275 | 9.1299 |

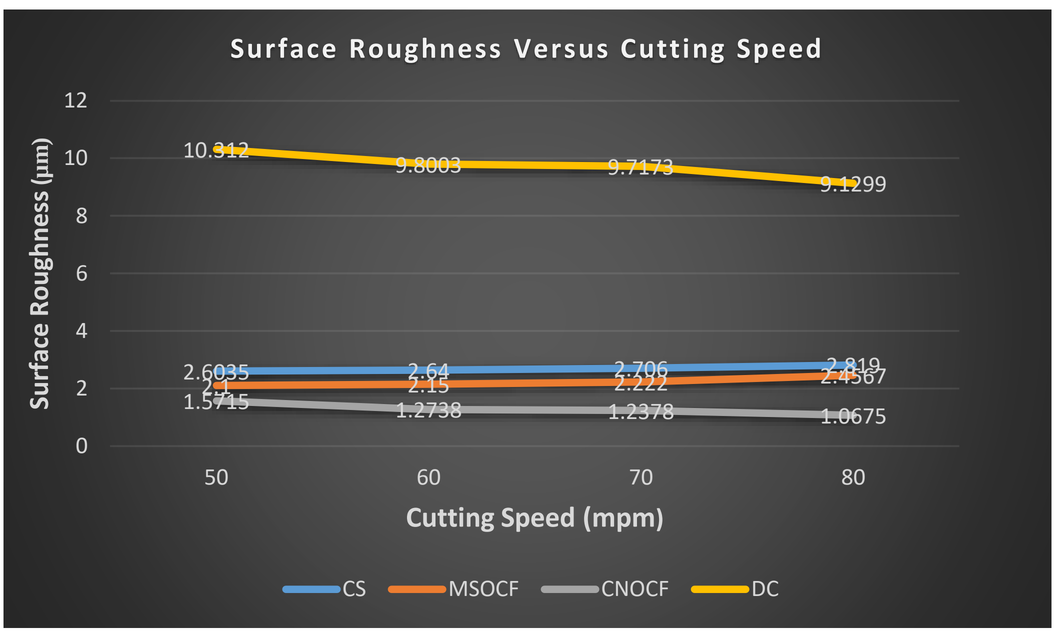


*Figure 4: Graphs of surface roughness versus cutting speeds*

The metallographic surfaces and the image profiles of all machined samples with the designed machine process parameters were obtained with the aid of SEM and the most fluctuating ones (very fine to very rough profiles) are presented in plates 3 and 4

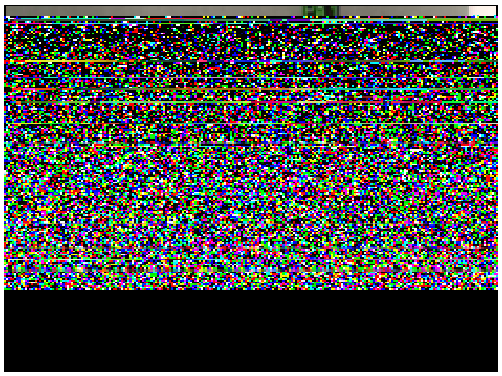

*Plate 3: Very Smooth Profile*

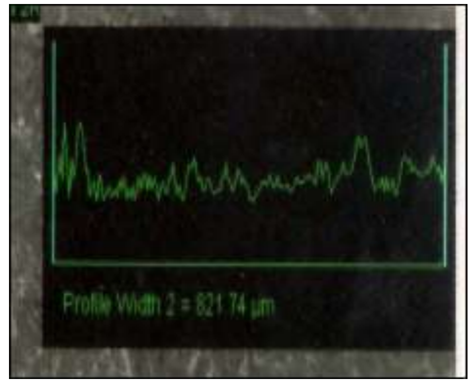


*Plate 4: Very Rough profile*

From the metallographic surfaces and the profiles, the surface roughness data were generated with the aid of an Amscope software as presented in Table 4 and Figure 4 (LEO 1998). It is evident from the surface roughness data that surface roughness resulting from machining with vegetable oil based cutting fluids is very good. The surface roughness resulting from machining with CNOCF is outstanding among all the cutting fluids including the control sample. The levels of Ra generated by CONCF are 1.5715 µm, 1.2738 µm, 1.2378 µm and 1.0675µm This is because cutting fluids with high viscosity remove chips from tool - work piece interface quickly to prevent a finished surface especially at high cutting speeds and feed rate, where greater amount of chips are generated in machining. This is in consonant with d result obtained by Demirbas (2013). This also is because vegetable oil is oilier in suspension than mineral oil. Besides, vegetable oil have more lubricating tendency and it has long and heavy molecules that are dipolar in nature. Besides, as regards the effects of cutting speed on surface roughness, the results show that surface roughness increases with increase in cutting speed for cutting fluids as reported by Sharma 2005 and Thomas 1997. The levels of surface roughness obtained from machining with CNOCF is in agreement with the levels presented by Kwon et al., [2004] (1.0170µm – 1.6715µm). This is followed by MSOCF having the range of Ra between 2.1000µm and 2.4567µm. The MSOCF (B) and CNOCF (C) can be synergized to get best as the results obtained from the two cutting fluids have close margins (Demirbas, 2013).

**Work – Tool Interface Temperatures**

The work piece was turned with the prescribed machine principal elements at all levels using all the cutting fluids and the various work – tools interface temperatures as recorded by a digital thermocouple is presented in the Table 3

*Table 3: Average Temperatures Attained During Machining*

| Sample | Cs (mpm) | Dc (mm) | Fr (mm/rev) | Tav (ºC) |
|---|---|---|---|---|
| A (Control Sample) | 50 | 0.4 | 0.275 | 30 |
| | 60 | 0.4 | 0.275 | 33 |
| | 70 | 0.4 | 0.275 | 36 |
| | 80 | 0.4 | 0.275 | 38 |
| B.MSOCF (Mahogany seed oil cutting fluid) | 50 | 0.4 | 0.275 | 27 |
| | 60 | 0.4 | 0.275 | 29 |
| | 70 | 0.4 | 0.275 | 30 |
| | 80 | 0.4 | 0.275 | 32 |
| C.CNOCF (Cashew nut oil cutting fluid | 50 | 0.4 | 0.275 | 26 |
| | 60 | 0.4 | 0.275 | 29 |
| | 70 | 0.4 | 0.275 | 33 |
| | 80 | 0.4 | 0.275 | 36 |
| D. (Ecological Machining) | 50 | 0.4 | 0.275 | 50 |
| | 60 | 0.4 | 0.275 | 52 |
| | 70 | 0.4 | 0.275 | 70 |
| | 80 | 0.4 | 0.275 | 86 |

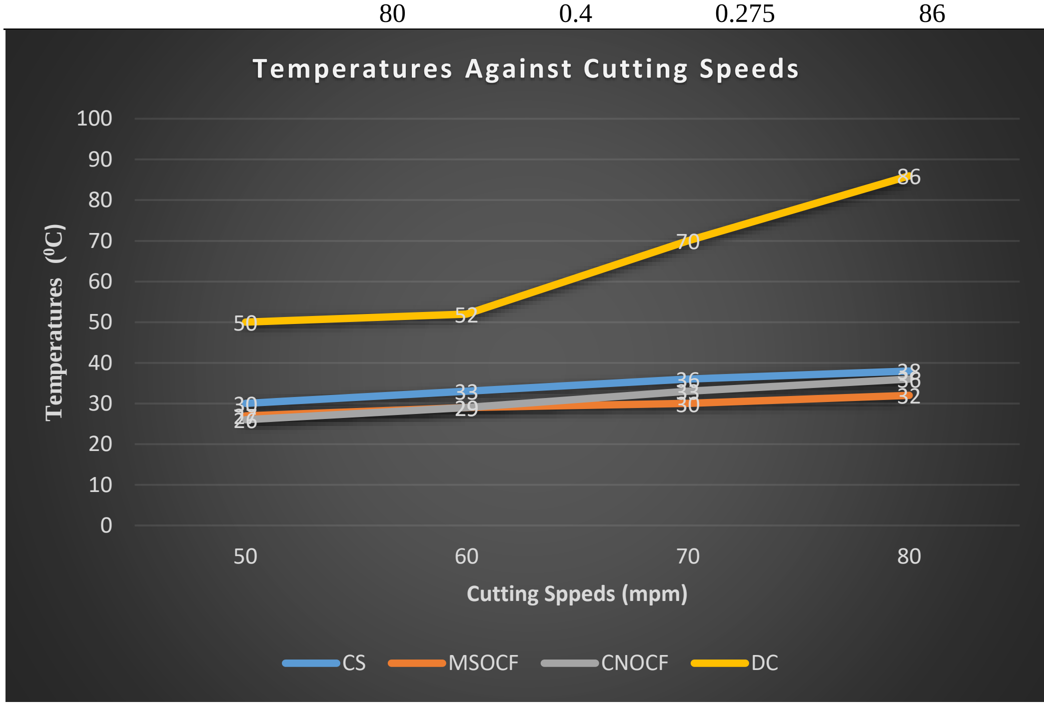


Figure 3: Graphs of Temperatures versus Cutting Speeds

The work piece was straight turned between centers of lathe machine using single point cutting tool (HSS) within the range of machining parameters specified by ASTM for finish turning operations. To measure heat generated using digital thermocouple during the turning operation the cold junction of the thermocouple was placed in contact with a freezing ice while the tip in contact with the tool – work interface and are moved together automatically along the machine bed as the machining is done as suggested by Badau (2016).

The entire experiment was carried out as designed using all the cutting fluids. From Table 3 and Figure 3 it can be seen that for all cutting fluids, the tool –work interface temperatures increase with increase in cutting speed. This is in consonant with a report by Baba (2018). Besides, CNOCF being vegetable oil based cutting fluid performs better in terms of heat removal than all the cutting fluids including the control sample which is a mineral oil based cutting fluid contrary to the work by Kuram and Ozcelik 2013. This may be due to the presence of triglycerides which are glycerol molecules in vegetable oils and also having greater wettability as suggested by Kuram and Ozcelik (2013).This may also be due to good thermal properties (specific heat and thermal conductivity) possessed by vegetable oils (Adeel et al., 2010) This is followed by MSOCF attaining the highest temperature of 32$^oC$ at the cutting speed of 80mpm. That means that the two vegetable oil based cutting fluids could competes favorably and they could be synergized to get the best result as suggested by Lawal et al (2007).

**Viscosities of Cutting Fluids**

The viscosities of all the cutting fluids were determined at 40$^oC$ and 80$^oC$ and are shown in Table 5

*Table 5: Viscosities of Cutting Fluids*

| Cutting Fluids | Viscosities at 40$^oC$ (Cp) | Viscosities at 80$^oC$ (Cp) |
|---|---|---|
| A (Control Sample) | 102.43 | 56.66 |
| B.MSOCF (Mahogany Seed Oil Cutting Fluid) | 122.44 | 87.76 |
| C.CNOCF(Cashew Nut Oil Cutting Fluid) | 134.00 | 96.00 |

Viscosity as an oil property has a significant impact on machining processing as reported by Badau et al (2016). Vegetable oils have a high natural viscosity as the machining temperature increases as reported by Badau et al (2016) and Kuram and Ozcelik (2014). The viscosity of vegetable oils drops more slowly than that mineral oils as the temperature falls, vegetable oils remain more fluid than mineral oils facilitating quicker drainage from chips and work pieces. The higher viscosity index of vegetable oils ensures that vegetable oils will provide more stable lubricity across the operating temperature range. Vegetable oil molecules are quite homogeneous in size but mineral oil molecules vary in size. Consequently, the properties of mineral oil such as viscosity, boiling temperature are more susceptible to variation. Vegetable oil has higher boiling point and greater molecular weight and this results in less loss from vaporization and misting. The viscosities of all the cutting fluids are presented in table 5. The results places CNOCF first in terms of viscosity even at higher temperature of 80$^oC$ dropping to 96.00Cp. This is followed by MSOCF dropping to a value of 87.76Cp at 80$^oC$ from 134Cp at 40$^oC$ confirming the statement of Kuram and Ozcelik 2014.

**Flash Points of Cutting Fluids**

Table 6 shows the Flash points of all the cutting fluids

*Table 6: Flash Points of Cutting Fluids*

| Cutting Fluids | Flash points (ºC) |
|---|---|
| A (Control Sample) | 227 |
| B.MSOCF (Mahogany Seed Oil Cutting Fluid) | 237 |
| C.CNOCF( Cashew Nut Oil Cutting Fluid ) | 209 |

The cutting fluids flash points are presented in table 9. This shows that all the cutting fluids are very safe for use without the risk of fire hazard. MSOCF have the highest flash points (237ºC) and this proves to be the safest in use. The flash points for all mineral oils is 226ºC as reported by Dolan, 1992 and Baba et al., 2018

**Acidities of Cutting Fluids**

The Acidities of all the cutting fluids as determined by titration are tabulated in table 7

*Table 7: Acidity of Cutting Fluids*

| Cutting Fluids | Acidity (g/dm$^3$) |
|---|---|
| A (Control Sample) | 4.01 |
| B.MSOCF (Mahogany Seed Oil Cutting Fluid) | 1.80 |
| C.CNOCF( Cashew Nut Oil Cutting Fluid ) | 2.50 |

The Acidities of all the cutting fluids are presented in Table 10. Monkey Bread Seed Oil Cutting Fluid (MBSOCF), Mahogany Seed Oil Cutting Fluid (MSOCF) and Cashew Nut Oil Cutting Fluid (CNOCF) with the acidic values of 1.06g/dm$^3$, 1.08g/dm3 and 2.50g/dm$^3$ respectively have the least tendency to corrode metallic surfaces. This is similar to the result obtained by Lawal at al 2007.The control sample has the tendency to corrode metallic surface as its acidic value stands at 4.01g/dm$^3$.

## CONCLUSION

Vegetable oils based cutting fluids formulated from mahogany and cashew oils were used in the turning of AISI 1028 steel and their performances were relatively evaluated alongside that of a control sample of crude petroleum (mineral oil based) cutting fluid. From the experiments conducted, it can be concluded that vegetable oils can be used in the production of cutting fluids which serve as an alternative coolants and lubricants in machine tools processes. MSOCF was found to be the best among the cutting fluids in conducting heat away from tool-work piece interface. It was followed by CNOCF. Vegetable oils which have the advantage of being biodegradable, less toxic, availability and cheapness coupled with their efficient performance in machining operations can conveniently substitute the conventional (mineral oil based) cutting fluids for all machining operations under various operational conditions. Besides, vegetable oil based cutting fluids are found to be the safest regarding fire hazard, they relatively remain more fluid under the operating conditions and shows the least tendencies for corroding metallic surfaces especially MSOCF

Print ISSN: 2053-5783(Print)
Online ISSN: 2053-5791(online)

**REFERENCES**

Adeel, H.S., Ismail, N., Wong, S.V. and Abdul Jalil, N.A. (2010): Optimization of Cutting Parameters Based on Surface Roughness and Assistance of Work piece Surface Temperature in Turning Process, *American Journal of Engineering and Applied Sciences, 3 (1), 102-108.*

Baba, M.T., Joshua, T. and Issa, K.A. (2018): Formulation and Performance Assessment of Fixed Oils Based Cutting Fluids in Machining Operation, *International Journal of Mechanical Engineering, International Academy of Science, Engineering and Technology India 7(6), 13-21*.

Badau, H.J., Onyekavhukwu, E.K and Garba, A. (2016): Performance Assessment of Fixed Oils Based Cutting Fluids in Machining Operation *HND Research thesis, Department of Mechanical Engineering, Federal Polytechnic Mubi, Unpublished*

Davim J.J. (2013): Green Manufacturing Procesess and Systems, Material Forming Machining and Tribology, Springer-Verlag Berlin Heidelberg.

Demirbas, E. (2013): Environmentally Friendly Machining: Vegetable Based Cutting Fluids, *Department of chemistry, Gebze Institute of Technology, 41400 Gebze Kocaecli, Turkey*.

Dolan, J.A. (1991): *Motor Vehicle Technology and Practical work*, Heinemann Educational Books, London, p8.

Kuram, E. And Ozcelik, B.(2013**)**: Environmentally Friendly Machining: Vegetable Based Cutting Fluids, *Department of Mechanical Engineering, Gebze Institute of Technology, 41400 Gebze Kocaecli, Turkey*.

Lawal, S. A., Abolarin, M. S., Ugheoke, B. I. and Onche, E. O. (2007): Performance Evaluation of Cutting Fluids Developed from Fixed Oils. *Leonardo electronic Journal of practices and Technology*, *10*, 137-144.

LEO (1998): A Comprehensive guide for the operation and maintenance of Scanning Electron Microscope.

Saleem, M.S., Khan, M.Z., and Zaka, M.Z. (2013): Vegetable Oil as an alternate cutting fluid while performing Turning Operations on a Lathe Machine using Single Point Cutting Tool, *International journal of Technical Research and Applications, 1(5), 103- 105.*

Sharma, P.C. (2005): *A Textbook of Production Engineering*, S.Chand and Co., New Delhi, 412- 416.

Thamma, R. (2008). Comparison Between Multiple Regression Models to Study Effects of Turning Parameters on the surface roughness, *Proceedings of the 2008 IAJC –IJME International Conference, Paper 133.*

Tumba, J. (2015): Effects of Machining Parameters on Surface Roughness of Mild Steel Products, M. Engineering Thesis, Department of Mechanical Engineering, Federal University of Technology Yola, unpublished.

Tumba, J., Baba, M.T. and Badau, J.H. (2017): Formulation and Performance Assessment of Fixed Oil Based Cutting Fluids in Turning of AISI 1027 Steel, *Conference and AGM of the Nigerian Society of Engineers (NSE), "Diversification of Nigeria Economy: Engineering Perspectives"Abuja 20th – 24th November, 2017, P 56.*

Valank, J.B., Vishal, M., Gautam, V., Vijay, P. and Rathod, P. (2014): Vegetable Based Cutting Fluids For Sustenable Machining processes, *International Journal of Emerging technologies and Applications in Engineering, 7(1), 79.*