



e-ISSN: 2319-8753 | p-ISSN: 2320-6710

IJIRSET

International Journal of Innovative Research in
SCIENCE | ENGINEERING | TECHNOLOGY



INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

Volume 10, Issue 6, June 2021

ISSN INTERNATIONAL
STANDARD
SERIAL
NUMBER
INDIA

Impact Factor: 7.512



9940 572 462



6381 907 438



ijirset@gmail.com



www.ijirset.com

Evaluation of Oil-in-Water Emulsion Cutting Fluids Developed from Selected Seeds Oil

Ipilakyaa T. Daniel¹, Ashwe Abugh², Idris N. Adeniran³

Department of Mechanical Engineering, Joseph Sarwuan Tarka University, Makurdi, Benue State- Nigeria^{1,2,3}

ABSTRACT: The Evaluation of oil-in-water emulsion cutting fluids developed from selected seeds oil was carried out. The study highlights yellow oleander seed oil, castor seed oil and *jatropha* seed oil as base oils for possible cutting fluids during machining processes. The properties of formulated cutting fluids were investigated. The result of mechanical properties test carried out on the workpiece material indicates that the optimum value obtained from tensile strength test was 466 N/mm², the hardness value 126 BHN, the yield strength value 371 N/mm² while the percentage elongation was 20%. Formulation of oil-in-water with addition of some additives was carried out. Viscosities and pH value of the formulated cutting fluids were also analyzed. All the pH value obtained for the developed emulsion cutting fluids were above 7.0. Because a decrease in the pH value of cutting fluid of less than 7.0 cannot be used to machine material that is ferrous base. The average viscosities of the developed cutting fluids were found to be 1.29 cSt at 40 °C for *jatropha* and 1.30 cSt at 40 °C for castor based. Yellow oleander based cutting fluid had viscosity of 1.34 cSt at 40 °C while mineral oil cutting fluid was 2.95 cSt at 40 °C. Low viscosity means high viscosity index, the formulated cutting fluid has tendency to be fluid at higher temperature than the mineral oil fluid (ISO.VG.37). From the experiment carried out on CNC Lathe for turning operation, the results indicate that the best cutting conditions were obtained for yellow oleander oil-based cutting fluid has the lowest surface roughness value of 0.22 µm with 39.7 °C than castor oil based with values of 3.08 µm with 56.2 °C and *jatropha* based with 3.18 µm values with 55.1 °C. The result of Analysis of Variance (ANOVA) shows that there is significance difference between *jatropha* and castor oil at 95% confidence based cutting fluids when compare with mineral oil-based cutting fluid at various input parameters and there is no significance difference between yellow oleander oil and mineral oil for both cooling properties and surface roughness.

KEYWORDS: Cutting fluid, Mineral oil, *Jatropha* oil, Castor oil, Yellow oleander.

I. INTRODUCTION

Cutting fluid is a type of coolant and lubricant designed specifically for metalworking and machining processes [1]. The first study about cutting fluid had been determined by Northcott in 1868 with a book entitled “A treatise on lathes and turning”. He observed that the use of cutting fluids improved tool life. In 1883, Taylor used water in machining and demonstrated the importance of water as a cutting fluid and observed that cutting speed could be increased up to 40% without reducing tool life by applying large amounts of water in the cutting zone [2,3]. Cutting fluids increase the tool life and improve the efficiency of the production systems providing both cooling and lubricating the work surface. Salete and Joao [4] opined that the use of cutting fluids reduce the negative effects of the heat and friction on both tool and workpiece and they produce three positive effects in the process: heat removal elimination, lubrication on the chip-tool interface and chip removal. Similar conclusion was drawn by Shirbhate [5] where it was postulated that the cutting fluid cools the tool and workpiece to avoid loss of hardness and wear resistance, acts as lubricant at chip-tool interface and work-tool interface and hence preventing welding between contact surfaces thereby decreasing the cutting temperature, improve the tool life and flushing of chip to protect surface finish. According to Abu [6] a proper coolant can perform useful functions like: reduce friction between chip-tool and workpiece; reduce the temperature of the tool and workpiece; flushing of chip to protect surface finish; reduce the power required in cutting; reduce possible corrosion on both the work and machine; help prevent welding of the chip to the tool; increase tool life; and improve the surface finish. Cutting fluids should have the following properties to fulfill their functions properly: good lubricating properties; high cooling capacity; low viscosity to provide free flow of cutting fluid; chemically stable; non-corrosive; high flash point to reduce fire risks; allergy free; less evaporative; should not have deleterious effects on the operator by omitting bad odour or causing skin irritation; harmless to the machine and low cost. Many types of cutting fluids namely; Straight oils, Soluble oils, Synthetic and Semi-synthetic are widely used in metal cutting processes [7].

Although, these cutting fluids are beneficial in the industries, their uses are being questioned nowadays as regards to health and environmental issues. It has however been observed according to Lawal *et al.* [8] that most of the metal working fluids are mineral oil-based fluids and despite their widespread use, they pose significant health and environmental hazards throughout their life cycle. Moreover, high flow rate of cutting fluids leads to environmental degradation like soil pollution, health hazards and most important wastage disposal of cutting fluids. However, when inappropriately discharged, cutting fluids may damage soil and water resources, causing serious environmental impacts and also, on the shop floor, the machine operators may be affected by the negative effects of cutting fluids, such as skin and respiratory problems. Today to diminish the negative effects associated with cutting fluids, researchers have developed new bio based cutting fluids from various vegetable oils. According to Kuram *et al.* [9] bio-based cutting fluids developed from various vegetable oils have the potential to reduce the wastage treatment costs due to their inherently higher biodegradability and may reduce the occupational health risks associated with petroleum-oil based cutting fluids since they have lower toxicity. Lawal *et al.* [10] opined that vegetable oil primarily consists of triglycerides structure which provides desirable qualities for boundary lubrication when used as cutting fluid. They further explained that it provides high strength lubricant films that interact strongly with metallic surfaces, reducing both friction and wear due to their long polar fatty acid chain. It has however been observed according to Kuram *et al.* [11] that cooling effect can be done best by water with low cost because water is cheap, supplied easily and its low viscosity provides it to flow at high rates but its lubrication properties are very low. Moreover, the reason why water is used as the base in cutting fluids is that it possesses high specific heat and thermal conductivity. Sharafadeen and Jamiu [12] also affirm that since water is a very poor lubricant when used alone and causes rusting, soluble oils or chemicals that improve lubrication prevent corrosion and provide other essential qualities must be added in order to transform water into a good metalworking fluid. Mike [13] advocated that oil-in-water emulsion is an emulsion where water is the continuous phase. Kayode [14] reported that oil-in-water emulsions have these advantages; nonflammable; good availability; quick acting; cheap; low toxicological risk and moderate rust protection. Lawal *et al.* [15] Concluded that intimate mixture of natural oil and water give best lubrication and cooling during machining operation and the higher percentage of water in the formulation would bring the benefit of high thermal conductivity of the cutting fluid during machining process.

A recent study by Sathisha *et al.* [16], determined the effects of cutting fluids and machining parameter on turning of mild steel using soluble oil and Palm oil as cutting fluid with two cutting tools (HSS and Carbide tip tool). They concluded that longer tool life and higher surface finish quality and better dimensional accuracy were achieved during the turning operation when used tungsten carbide tool with soluble oil and palm oil as coolant compared to dry machining. Conclusively, Chandrakar and suhane [17] observed from previous researchers that edible vegetable oil has been tested as metal working fluid and there is a need to test of non-edible oil such as *Jatropha*, castor, Neem oils as cutting fluids. In this present work, assessment of selected seed oils (*Jatropha*, Castor and Yellow oleander oil) with no apparent nutritional value had been evaluated as based material for Oil-in-Water Emulsion cutting fluid for turning operation of mild steel with coated carbide tool which was performed on CNC Lathe machine.

II. MATERIALS AND METHODS

2.1 Materials

The materials and equipment used in carrying out this work included mild steel round bar (AISI 1018 with chemical composition as stated in Table 1) of 30 mm diameter and 400 mm long sourced from Ajaokuta Steel Company Limited (ASCL), Ajaokuta, Kogi State-Nigeria, ENC-2060 CNC Lathe machine, coated carbide cutting tool insert with an ISO designation of TNMG 160404, surface roughness tester model SRT 6200, digital pH meter model PHS-3C, Fluke 59 Max + Infrared thermometer, hardness testing machine, micrometer screw gauge, hotplate monotherm model Brentwood 221101, magnetic stirrer, stop watch, viscometer bath model 1000m, beakers graded in (ml) and digital weighing balance.

Table 1: Chemical Composition of the Mild Steel Used (AISI 1018)

Element	C	Mn	Si	P	S	Ni	Cr	Mo	Cu	Fe
Weight(%)	0.18	0.53	0.19	0.02	0.02	0.03	0.06	0.01	0.07	98.9

2.1.2 Cutting fluids

The cutting fluids used for this investigation were sourced from three non-edible vegetable oils; yellow oleander oil, castor oil and *Jatropha* oil. Yellow oleander oil and *Jatropha* oil were sourced from Makurdi, Benue State and Castor seed oil was sourced from Baddegi, Niger State all in Nigeria. Mineral based cutting fluid: ISO.VG.37 was used as control experiment. The formulation of oil-in-water cutting fluids was carried out with the following additives:

- (i) Emulsifier (Sodium Petroleum Sulphonate): The main function of emulsifiers is to disperse the oil in water in order to make a stable oil-in-water emulsion.
- (ii) Antioxidant (Juice of lemon fruits): The lemon fruit was used because of its high vitamin C content to serve as possible antioxidant.
- (iii) Biocide (triazine): Bactericide was added to impede action of biodegradable organism.
- (iv) Corrosion Inhibitor (banana sap; banana plant juice and its pulping liquor obtained from banana stem): The anti-corrosion material was banana plant juice to prevent corrosion.
- (v) Distilled water (laboratory made).

2.2 Methods

2.2.1 Formulation of Oil-in-Water Emulsion cutting fluids

The cutting fluids were formulated using Table 2. For castor oil based, 250 ml (25%) of the oil was used, distilled water 550 ml (55%), emulsifier 100 ml (10%), antioxidant agent 40 ml (4%), anticorrosive agent 40 ml (4%) and biocide 20 ml (2%) as base material for oil-in-water emulsion cutting fluid at Chemical Laboratory of ASCL. For the formulation of *Jatropha* oil; 300 ml (30%) of the oil was used, distilled water 500 ml (50%), emulsifier 100 ml (10%), antioxidant agent 40 ml (4%), anticorrosive agent 40 ml (4%) and biocide 20 ml (2%). Lastly, for yellow oleander oil; 200 ml (20%) of the oil was used, distilled water 600 ml (60%), emulsifier 100 ml (10%), antioxidant agent 40 ml (4%), anticorrosive agent 40 ml (4%) and biocide 20 ml (2%). The formulation of the cutting fluids was done by mixing of an appropriate measure of each various oils and distilled water first in a separate beaker of 1 litre capacity. The emulsifier (sodium petroleum sulphonate) was added to prevent separation of water from oil. Juice of fruits was immediately added to the prepared samples. The lemon fruit was used because of its vitamin C content to serve as possible antioxidant. Bactericide (triazine) was added to impede the action of biodegradable organism while anticorrosive agent (banana plant juice, was added to oil-in-water to prevent corrosion. The whole mixture (100% each) was stirred together at 100 rpm for 15 minutes at room temperature using magnetic stirrer with hot plate. The pH value and viscosity of developed oil-in-water emulsion cutting fluids were determined.

Table 2: Percentage composition of formulated vegetable oils cutting fluids

Cutting fluids	Base oil (%)	Water (%)	Emulsifier (%)	Antioxidant Agent (%)	Anticorrosive Agent (%)	Biocide (%)	Total (%)
<i>Jatropha</i> oil	30	50	10	4	4	2	100
Castor oil	25	55	10	4	4	2	100
Oleander oil	20	60	10	4	4	2	100

2.2.2 Mechanical Performance Evaluation

The machining experiment was conducted on CNC (Computer Numerical Control) Lathe machine model 2060 ENC. The cutting tool material selected was coated carbide tool insert with an ISO designation of TNMG 160404. The workpiece material selected was mild steel round bar which was cut to 400 mm length and 30 mm diameter. Experiments were conducted for turning operation with cutting speeds (100, 150, 200 and 250 rpm) and feed rate (0.10, 0.15, 0.20 and 0.25 mm/rev) and depth of cut (0.2, 0.3, 0.4 and 0.5 mm) at 15 minutes each. Each cutting fluid (*jatropha oil*, castor oil, yellow oleander oil and ISO.VG.37) was applied to cutting zone where cooling and lubrication is required. Surface roughness and temperature were chosen as output parameters for evaluation, using the three developed vegetable oil-based cutting fluids and mineral oil-based cutting fluid as reference. A portable surface roughness tester used to measure the surface roughness of the workpiece material after each experimental run. To know the effect of cutting parameters (cutting speed, feed rate and depth of cut) on Surface roughness for all the developed cutting fluids and ISO.VG.37, the cutting speeds in (rpm) were varied and depth of cut (mm) and feed rate (mm/rev) were kept constant. While one of the parameters (speed, feed and depth of cut) was selected and varied, the other two were kept constant and surface roughness was taken for each experimental run. In order to evaluate the ability of each formulated cutting fluid to conduct heat away from the work zone, a fluke infrared thermometer was used to measure the temperature right at the point where the tool tip made contact with the workpiece during chip removal. The average temperature obtained was recorded for each formulated cutting fluid was compared with that of mineral oil. The instrument used to measure the tool tip-workpiece interface temperature is fluke 59 Max + Infrared thermometer.

2.2.3 Experimental Procedure

The workpiece material (mild steel round bar) of 400 mm long and 30 mm diameter was machined on a CNC Lathe, using the formulated cutting fluids and the mineral fluid for performance evaluation. The workpiece was centered on CNC Lathe before the test procedure started. Three different test-procedures were employed. First, the cutting speed (rpm) was varied (100, 150, 200, 250) while the feed rate was kept constant at 0.15 mm/rev and the depth of cut at 0.2 mm. During this phase, the formulated cutting fluids were applied directly on the workpiece tool interface and the surface roughness variations were measured using surface roughness tester. In the second phase, the cutting speed was kept constant at 100 rpm and the depth of cut at 0.2 mm while the feed rate varied at 0.1, 0.15, 0.2, 0.25 mm/rev. Lastly, the cutting speed and feed rate were constant at 100 rpm and 0.15 mm/rev respectively, while the depth of cut was varied at 0.2, 0.3, 0.4, 0.5 mm. At the end of the third processes, the surface roughness tester was used to measure the surface finish and analysis of variance (ANOVA) was used to determine the contribution of each cutting parameters and cutting fluids on surface roughness and temperature.

III. EXPERIMENTAL RESULTS

3.1 Viscosity

The viscosity of the formulated oil-in-water emulsion cutting fluids and mineral oil cutting fluid were analyzed and the viscosity accounts for the effectiveness of a liquid fluid to perform both lubrication and cooling at the same time formulated. The average viscosity of the formulated cutting fluids were found to be 1.29 cSt at 40 °C for *jatropha* and 1.30 cSt at 40 °C for castor based. Yellow oleander based cutting fluid had viscosity of 1.34 cSt at 40 °C while mineral cutting fluid (ISO.VG.37) was 2.95 cSt at 40 °C.

Among the developed cutting fluids, yellow oleander has the highest viscosity value which would provide a better surface roughness during machining process compared to any other developed cutting fluids values, because Lawal et al. [10] clearly stated that, the higher the viscosity (the lubricating ability) the lower the surface roughness.

3.2 pH Value for Developed Cutting Fluids and Mineral Cutting Fluid

The results of the pH values are as shown in Table 3. All the pH values for the developed emulsion cutting fluids were above 7.0. Because a decrease in the pH value of cutting fluid of less than 7.0 cannot be used to machine material that is ferrous base Lawal et al. [10]. The pH value for yellow oleander (9.70), castor based (9.12), *jatropha* based (9.08) and the mineral based has pH (10.60).

Table 3: The pH value of formulated vegetable cutting fluids and mineral cutting fluid

Cutting fluid	pH sample
<i>Jatropha</i> oil based	9.08
Castor oil based	9.12
Oleander oil based	9.70
Mineral oil (ISO.VG.37)	10.60

3.3 Effect of Cutting Parameters on Surface Roughness

To specify performance of cutting fluids, average value of the surface roughness for each cutting fluid was analyzed. The average value of surface roughness was measured after 15 minutes of machining time. The results indicated that the cutting conditions obtained for yellow oleander based cutting fluid and mineral oil (ISO.VG.37) were higher than other formulated vegetable oils based cutting fluids (*jatropha* oil, castor oil). Yellow oleander based cutting fluid showed the lowest surface roughness value of 0.22 μm compare with mineral based with 0.25 μm . Castor oil with 3.08 μm and *jatropha* oil with 3.18 μm as shown in figures 1, 2, 3 and 4 indicates better lubrication characteristics than formulated yellow oleander-based oil and mineral oil (ISO.VG.37).

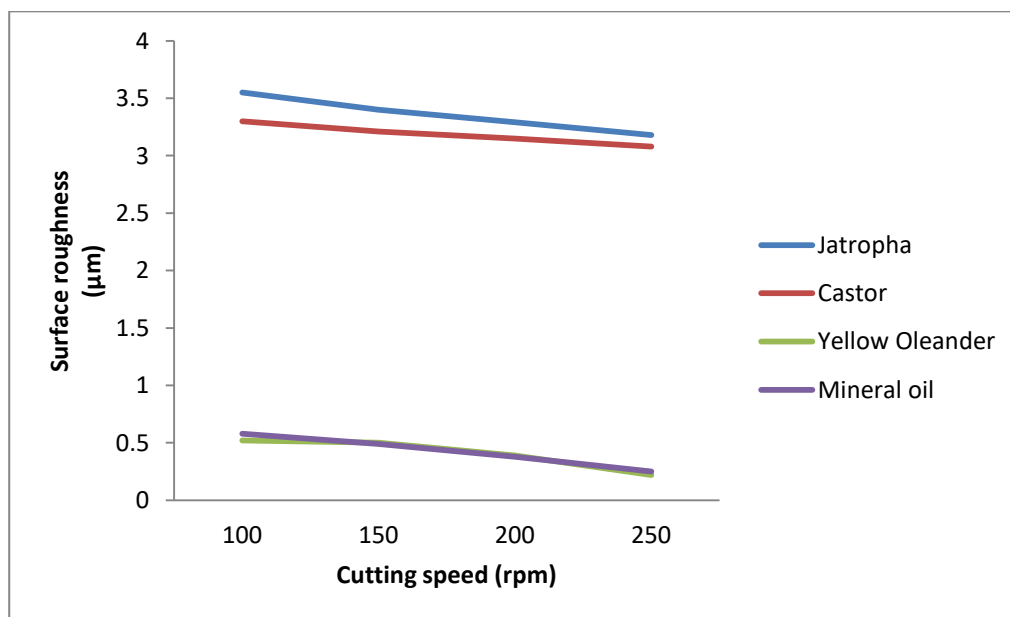


Figure 1: Effect of Cutting speed on Surface roughness of the developed cutting fluids

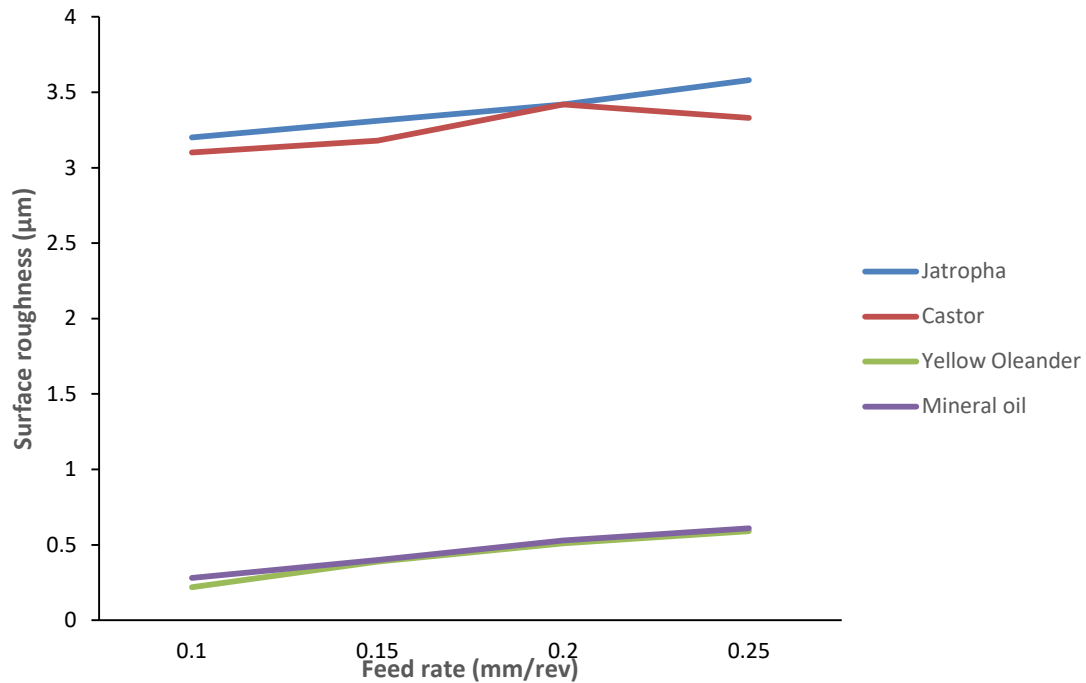


Figure 2: Effect of Feed rate on Surface roughness of the developed cutting fluids

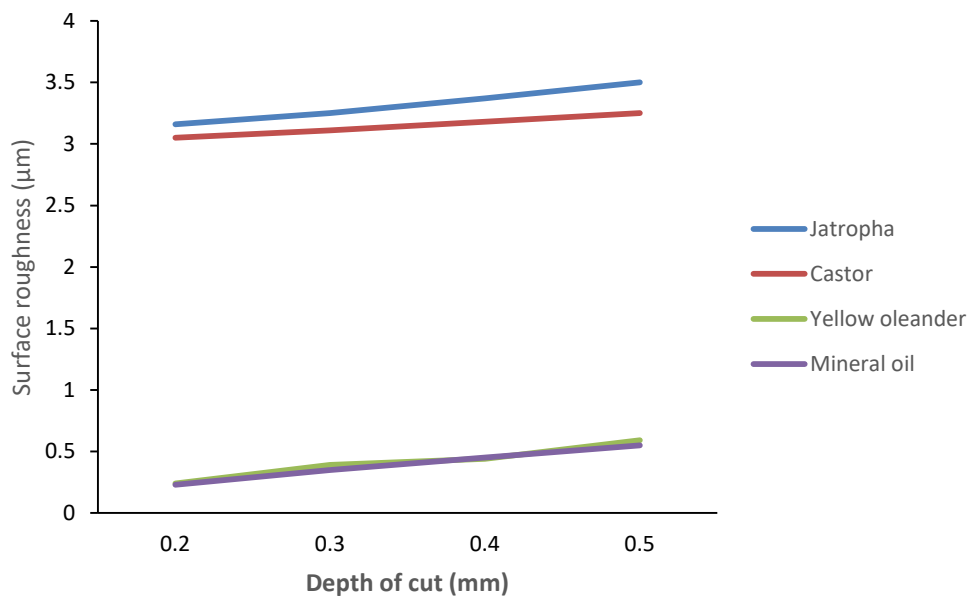


Figure 3: Effect of Depth of cut on Surface roughness of the developed cutting fluids

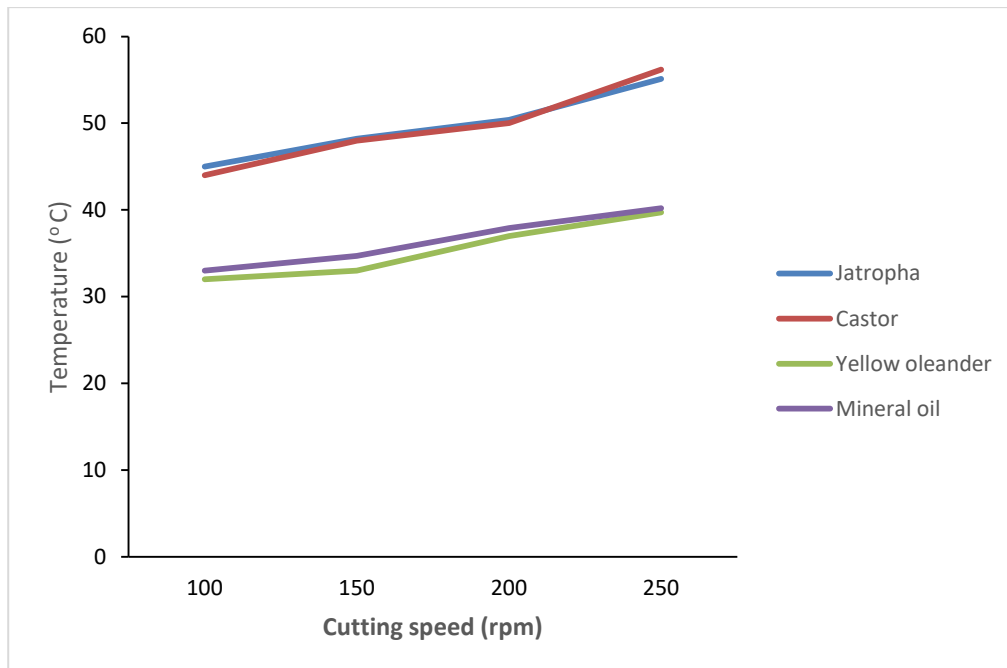


Figure 4: Effect of Cutting speed on Temperature of the developed cutting fluids

As the cutting speed increases the difference between surface roughness of vegetable oil based and mineral oil-based decreases (Figure 1). The results showed that cutting fluids have influence over feed rate, cutting speed and depth of cut. The results of the experiments were subjected to the analysis of variance (ANOVA) to determine the significant factors of the Surface roughness. The results show that there is significance difference between Castor oil-based cutting fluid when compare to mineral oil-based cutting fluid (Figure 4) because p-value is less than 0.05 ($p = 5.73E-08$). Also, when compare Jatropa oil-based cutting fluid to mineral oil-based cutting fluid (Figure 4), there is significance difference between them because p-value is less than 0.05 ($p = 1.5145E-07$). However, there is no significance difference between yellow oleander oil-based cutting fluid and mineral oil-based cutting fluid (Figure 1) because p-value is greater than 0.05 ($p = 0.865486$). This shows that yellow oleander oil-based cutting fluid perform better than others formulated vegetable (jatropa and castor oils) cutting fluids. From figures 1, 2 and 3, it is observed that the coated carbide tool with formulated oleander oil-based cutting fluid would give higher surface finish quality, less temperature, longer tool life, better dimensional accuracy hence be recommended for all the machining parameters (cutting speeds, feed rates and depth of cut) and best formulated vegetable oil based to be used as cutting fluid.

3.4 Effect of Cutting Parameters on Temperature

The results of the experiments were subjected to the analysis of variance (ANOVA) to determine the optimum and significant factors that affect the temperature of the cooling properties. The results show that there is significance difference between Castor oil-based cutting fluid when compare to mineral oil-based cutting fluid (Figure 4) because p-value is less than 0.05 ($p = 0.004782$). Also, when compare Jatropa oil-based cutting fluid to mineral oil-based cutting fluid (Figure 4), there is significance difference between them because p-value is less than 0.05 ($p = 0.002538$). However, there is no significance difference for the factors that affect the temperature of the cooling properties between yellow oleander oil-based cutting fluid and mineral oil-based cutting fluid (Figure 4) because P-value is greater than 0.05 ($p = 0.68502$). This shows that yellow oleander oil-based cutting fluid perform better than others formulated vegetable (jatropa and castor oils) cutting fluids in terms of cooling which make it the best formulated cutting fluids.

IV. CONCLUSION

The vegetable oil-in-water emulsion cutting fluids formulations (oleander oil based, castor oil based and jatropa oil based) have been evaluated, which could be used to improve the surface roughness and less cutting temperature during turning operation of mild steel with coated carbide tool and the pH values for oleander oil (9.70), castor oil (9.12) and jatropa oil (9.08) cutting fluids are within the acceptable level required to avoid corrosion during machining process and does not pose any health hazard to worker. Cooling and lubrication in machining are important in reducing the

severity of the contact processes at the cutting tool-workpiece interface. Currently, it has been established that ecology-friendly vegetable-based oils could successfully replace petroleum-based mineral oils as cutting fluids, considering the subject from performance, cost, health, safety and environmental points of view. It is observed from previous researchers that edible vegetable oil has been tested as cutting fluid. Non edible oil been used in this present work has a great potential as cutting fluid. This indicates that the non-edible vegetable oil can also be used as cutting fluid. It can be concluded that, the non-edible vegetable based cutting fluid derivatives possess good properties and stands next to the cutting fluids derived from petroleum products.

REFERENCES

- [1] M.M. Rahman, M. Hassan and M.A. Al-Bari, "An Optimize System of Using Cutting Fluid in Machining Operation for Light Work Machine Shop", International Journal of Engineering and Applied Sciences. 4(11): 1-8, 2012.
- [2] E. Kuram, B. Ozcelik, and E. Demirbas, "Effects of the Cutting Fluid Types and Cutting Parameters on Surface Roughness and Thrust Force", Proceedings of World Congress on Engineering. London, U.K. 2(1): 1-2, 2010.
- [3] E. Kuram, B. Ozcelik, and E. Demirbas, "Environmentally friendly Machining: Vegetable Based cutting fluids". In: Davim, J.P. (ed.). Green Manufacturing Processes and Systems, Materials forming, Machining and Tribology. Springer-Verlag Berlin Heidelberg. pp 23-24, 2013.
- [4] M.A. Salate and F.G.O. Joao, "Vegetable based cutting fluid-An environmental alternative to grinding process", Proceedings at 15th CIRP International Conference on Life Cycle Engineering, Brazil. pp 1-4, 2008.
- [5] D.V. Shirbhate, "Theory of Metal Machining", John Wiley and Sons, inc. 121pp, 2002.
- [6] J.O. Abu, "Manufacturing Engineering and Production Management", Aboki Publishers. pp 289-291, 2011.
- [7] E. Kuram, B. Ozcelik, and E. Demirbas, "Environmentally friendly Machining: Vegetable Based cutting fluids". In: Davim, J.P. (ed.). Green Manufacturing Processes and Systems, Materials forming, Machining and Tribology. Springer-Verlag Berlin Heidelberg. pp 28-29, 2013.
- [8] S.A. Lawal, I.A. Choudhury, and Y. Nukman, "Application of Vegetable oil-based metalworking fluids in machining ferrous metals", International Journal of Machine tools and Manufacture. 9(3): 1-12, 2011.
- [9] E. Kuram, B. Ozcelik and E. Demirbas, "Effects of the Cutting Fluid Types and Cutting Parameters on Surface Roughness and Thrust Force", Proceedings of the World Congress on Engineering. London, U.K. 2(1): 2-3, 2010.
- [10] S.A. Lawal, I.A. Choudhury and Y. Nukman, "An Assessment of the Physico-Chemical Properties of Melon Seed (Citrulus lanatus) Oil as Base Material for Oil-in-Water Emulsion Cutting Fluid", Advanced Materials Research. Trans Tech Publications, Switzerland. 576: 293-295, 2012.
- [11] E. Kuram, B. Ozcelik and E. Demirbas, "Environmentally friendly Machining: Vegetable Based cutting fluids", In: Davim, J.P. (ed.). Green Manufacturing Processes and Systems, Materials forming, Machining and Tribology. Springer-Verlag Berlin Heidelberg. Pp 27-28, 2013.
- [12] K.K. Sharafadeen and K.O. Jamiu, "Performance Evaluation of Vegetable Oil-Based Cutting Fluids in Mild Steel Machining", International Institute for Science, Technology and Education. 3(9): 35-36, 2013.
- [13] J. Mike, "Machinery Lubrication", Glossary Terms. Noria Corporation. <http://www.machinerylubrication.com/Glossary>.
- [14] S. Kayode, "Predictive Maintenance through Industrial Lubrication", Lube services Associates Lagos, Nigeria. Pp 317-318, 2003.
- [15] S.A. Lawal, I.A. Choudhury and Y. Nukman, "An Assessment of the Physico-Chemical Properties of Melon Seed (Citrulus lanatus) Oil as Base Material for Oil-in-Water Emulsion Cutting Fluid". Advanced Materials Research. Trans Tech Publications, Switzerland. 576: 293-294, 2012.
- [16] K.G. Sathisha, V. Lokesh and P. Priyesh, "Effects of Cutting Fluids and Machining Parameter on Turning of Mild Steel", National Conference on Advances in Mechanical Engineering Science. 2231: 406-410, 2016.
- [17] J.K. Chandrakar and A. Suhane, "The Prospects of vegetable-based oils as metal working fluids in Manufacturing Application" International Journal of Engineering Research and Technology. 3(5): 2196-2202, 2014.



**Impact Factor:
7.512**



INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

 9940 572 462  6381 907 438  ijirset@gmail.com



www.ijirset.com

Scan to save the contact details