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# Investigation of the Effect of Non-Edible Vegetable Oil-Based Cutting Fluids on Energy Consumption in Turning Process

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**Abstract:** Energy crisis is a burning issue worldwide due to the increasing demands for the growing population and industrial activities hence the desire for sustainable manufacturing to mitigate energy usage and environmental effects. It has been documented that energy consumption is one of the major factors that cause environmental effects in the machining industry for instance, carbon emission is linked with energy consumption during machining operations. Most of the studies on power and energy consumption in machining processes focused on modelling and optimization of process parameters. None of the studies investigated the effects of non- edible vegetable oil-based cutting fluids on power and energy saving in machining operations. This study tends to investigate the effect of non-edible vegetable (jatropha and rubber seeds) oil-based cutting fluids on energy consumption in turning AISI 1015 steel as compared to mineral oil-based cutting fluid. Box-Behnken design was used for the turning process while the cutting speed, feed rate and depth of cut were the process parameters. The result shows that the rubber and jatropha seed oils- based cutting fluids reduced energy consumption by 5.64% and 2.18% respectively at cutting speed of 270 m/min as compared to conventional oil. The ANOVA showed that cutting speed is the most significant input parameter that affect the energy consumption, followed by feed rate and depth of cut during the turning of AISI 1015 steel.

## 1. Introduction

Metal cutting has become a very large segment in the industry and in fact, it is very difficult to think of any product that does not directly or indirectly involve some form of metal cutting process. The advancement of our present-day technology is intimately connected with the advancement of our knowledge of the machining process. The process of machining of metals is no doubt the most widely used and versatile of any mechanical processes employed in industry (Abu, 2011). However, the machining industry depends on electrical energy to function and the energy consumption by machine tools is related to environmental impacts (Zein *et al.,* 2011). The drive to achieve sustainable and eco-friendly development in manufacturing is critical to the success of any developing country like Nigeria. Energy crisis is a burning issue worldwide due to the increasing demands for the growing population globally and hence the desire for sustainable manufacturing to mitigate energy usage and environmental effects. It has been documented that energy consumption is one of the major factors that causing environmental effects in machining industry for instance, carbon emission is linked with energy consumption during machining operations (Balogun and Mativenga, 2013). There is a strong view that the level of greenhouse gases (GHG) in the atmosphere partly resulting from industrial processes is rising. Energy consumption by industries is one of the dominant factors contributing to the increase in the GHG (Zein *et al.,* 2011). Therefore, there is need to balance the demand in the growing world population and protection of the environment and this has become a major challenge for modern industries to cope with this demand and at the same time supporting environmental sustainable manufacturing and the way out is holistic approach on the efficient use of electrical energy in the manufacturing process.

The United States Department of Commerce (2007), defined sustainable manufacturing as "the creation of manufactured products that use processes that minimize negative environmental impacts, conserve energy and natural resources, are safe for employees, communities, and consumers and are economically sound". Sustainability is a concept that networks economic, environment and social issues, and as such it needs to be incorporated at all the three levels (economic, environmental and social), and it will be incomplete if in machining, the cutting process lubrication is not considered because of its significance in the sustainability assessment of machining processes (Deiab et al., 2014).

Most Scientists agreed that if pollution and other environmental deterrents continue at their present rates, the result will be irreversible damage to the ecological cycles and balances in nature upon which all life depend. They warn that drastic changes in human behaviour will be required to avert an ecological crisis and to safeguard the healthful environment that is essential to life, and humans must learn that Earth does not have infinite resources which must be conserved, and where possible preserved (Zimmerman *et al.,* 2008). The growth of developing nations depends upon the development of sustainable conservation techniques that protect the environment while also meeting the basic needs of citizens. Theodori *et al.* (2004) stressed the importance of cutting fluid system for sustainable manufacturing research since it translates to simultaneous improvements in health, environment, and economic dimensions are possible and critically necessary. Knowledge is becoming a leading factor of production around the world and the ability to create, master and mobilise knowledge is now the basis of classification of economies. Sustainable development of industries is one of the prerequisites for the economic well-being and prosperity of any nation and the key to the success of modern industrial development is Science, Technology and Innovation (STI) (Bamiro, 2011). Achebo (2011) stressed that due to manufacturing industries over dependence on the use of handbook-based information or old methods, had led to decrease in productivity as a result of sub-optimal use of machining capacity which causes high manufacturing cost and low product quality.

In order to make machining process more ecological, other techniques such as dry cutting, minimal quantity lubrication (MQL), high pressure coolant (HPC) and cryogenic cooling have been accepted as successful. Again, the argument is that, it is not possible to eliminate the use of cutting fluids in machining process because some engineering materials like stainless steel, nickel and titanium and their alloys are difficult-to-cut because they have resistance to chemical degradation, wear and high strength at increased temperatures, pose greater challenge to machining operations (Ezugwu., 2004 and Lawal *et al.,* 2014). Babitsky *et al.* (2012), stressed that the poor thermal conductivity of these hard-to-cut materials leads to the concentration of high temperature at the tool-workpiece and tool-chip interfaces, resulting to tool wear and poor quality of surface finish at elevated temperature due to heat, deformation and microstructural development or changes. Though dry cutting may be seen to reduce energy consumption at lower speed and feed rate as documented in literature, however, it does not seem to address the economic and environmental effects because dry cutting is not suitable for high modern machining and hard-to- cut modern engineering materials such as titanium due to rapid wear or shorten of tool life, increase in surface roughness and environmental pollution. Therefore, the application of cutting fluid in such materials that are essential in modern manufacturing cannot be ignored because it helps to remove the heat generated during machining and consequently results in tool wear reduction rate and prolong the tool life.

From literature, many researchers have investigated the effects of various edible and non-edible vegetable oils-based cutting fluids on output variables such as surface roughness, cutting temperature, tool wear, chip thickness with little or no assessment report on energy consumption which is a key parameter or indicator to sustainable manufacturing. Shin *et al.* (2014) stressed that sustainability performance pointers including energy consumption, coolant usage and disposed waste are emerging as major indicators for improving energy efficiency and reducing environmental burden in machining industry. Energy consumption should be seen as a key performance evaluation of cutting fluids and environmental assessment for sustainable manufacturing because the energy consumption is a function of carbon emission into the atmosphere (Zein *et al.,* 2011). Energy consumption in metal cutting is an important indicator in sustainability analysis because reducing energy consumption of machining can significantly improve the environmental performance of metal cutting processes (Vijayaraghavain and Dornfeld, 2010).

Most of the studies on power and energy consumption reduction in machining processes focused on modelling and optimization of process parameters. None of the studies assessed the role of vegetable oil-based cutting fluids in reduction of power and energy consumption in machining operations. Abhang and Hameedullah (2011) investigated optimization of power consumption by desirability function approach. RSM with factorial design was used to develop second-order quadratic model in turning EN-31 steel material using tungsten carbide tool (ISO-specified). The input parameters were nose radius, depth of cut, feed rate and cutting speed and lathe tool dynamometer was used to measure the cutting force and thereafter, the power was calculated, that is: multiply the cutting force by the cutting speed (Fc*V). They reported that the cutting speed, feed rate, depth of cut and tool nose radius have the most significant influence on power consumption.

Composeco-Negret *et al* (2015) studied optimization of cutting parameters to minimize energy consumption during turning of AISI 1018 steel at constant material removal rate using Robust design. The independent variables were cutting speed, feed rate and depth of cut. They reported that minimum energy consumption can be achieved by the concept of Robust Design and variation of the machining process. Also, Ithipri *et al* (2015) reported modeling the specific energy in turning operations by Taguchi L32 orthogonal array design. AISI 1040 steel material was machined on conventional lathe using carbide inserts (TiN) coated tools. The feed rate, cutting speed and depth of cut were the process variables. A second-order model for specific energy consumption was developed using RSM while, Genetic Algorithm Solver was as well employed as optimization tool for the model. It was reported that the feed rate was the most significant factor with (85.38%), followed by cutting speed (2.85%) and depth of cut (0.58%) respectively. Anand et al (2016) used Design Expert to develop an energy consumption prediction model for turning mild steel, aluminium and brass respectively. The input factors were depth of cut, feed rate and cutting speed. According to their report, there was an appreciable reduction in the energy consumption in all the experimental values.

Olaiya *et al.* (2020) studied parameters optimization of energy consumption in turning of AISI 304 alloy steel. Tungsten coated carbide tool insert and CNC lathe were used for the turning process. The depth of cut, cutting speed and feed rate were the input parameters while energy consumption and surface roughness were the output variables. They reported that the cutting speed was the most dominant influence (38.87%) for wet turning with mineral oil-based cutting fluid, but with vegetable oil-based cutting fluid, the feed rate was the most significant factor (52.44%). Therefore, there is still need for more research in metal cutting that would reveal the basic principles and new concepts for further improvement in order to achieve the desire for sustainable manufacturing. In view of the foregoing, this paper focuses on the effect of non-edible vegetable oil-based cutting fluids on energy consumption during turning of AISI 1015 steel as compared with mineral oil-based cutting fluid.

## 2. Materials and Methods

### *2.1 Materials*

#### *2.1.1 Turning Process Materials and Equipment*

The material for the turning operations is mild steel rod of 600 mm length and 32 mm diameter. The equipment used include: Sumore lathe (Model- SP 21100 -11 Shanghai China), cutting tool holder (PCLNR 2020K12, Wodex), tungsten coated carbide tool inserts (SNMG120408), clamp meter: MS2000G, MASTECH and Digital clamp meter: DT-266, China.

### *2.2 Methods*

#### *2.2.1 Design of Experiment for Turning Process*

Box-Behnken design (BBD) was used for the turning process. It is a design for multivariate optimization class of rotatable or nearly rotatable of three level incomplete factorial designs. In this study, the BBD was chosen because it is efficient and cost effective. A total of 15 runs were designed with variation of input parameters. Minitab Statistical Software (2020) was used to carry out the design matrix. The turning process variables, their levels and the design matrix are shown in Table 1 and Table 2.

**Table 1.** Turning Process Parameters and their Levels

| Parameter | Symbol | Level | | |
|---|---|---|---|---|
| | | Minimum | Medium | Maximum |
| Cutting speed (m/min) | (Cs) | -1 | 0 | +1 |
| Feed rate (mm/rev) | (Fr) | -1 | 0 | +1 |
| Depth of cut (mm) | (Doc) | -1 | 0 | +1 |

#### *2.2.2 Determination of Energy Consumption*

The Sumore lathe, a semi-automated was used for the turning process as shown in Figure 1. The power and energy consumption in turning operations can be determined by using a lathe tool dynamometer to measure the cutting forces acting on the cutting tool during turning operation or by using electrical devices such as watt meter to measure the power (Geo and D'cotha, 2014). In this study, energy consumption during the turning process was determined by electrical devices. Two digital clamp meters were used simultaneously to measure the respective voltage and current of one of the live lines supply to the three-phase motor of the Sumore lathe as shown in Figure 2. Thereafter, the voltage and current measurements were converted into average power used by three phase motor using the expression by Fleckenstein (2016) as in Eqn 1:

$$P = V.I. \qquad (1)$$

Where, P = the average power drawn by the three-phase motor of the lathe (Watts); V = the voltage (Volt) and I = the current (A).

**Table 2.** Box-Behnken Design Matrix for Turning Process

| Experiment No | Cs | Fr | Doc |
|---|---|---|---|
| 1 | 200 | 0.092 | 1.1 |
| 2 | 270 | 0.092 | 1.1 |
| 3 | 200 | 0.115 | 1.1 |
| 4 | 270 | 0.115 | 1.1 |
| 5 | 200 | 0.104 | 0.7 |
| 6 | 270 | 0.104 | 0.7 |
| 7 | 200 | 0.104 | 1.5 |
| 8 | 270 | 0.104 | 1.5 |
| 9 | 220 | 0.092 | 0.7 |
| 10 | 220 | 0.115 | 0.7 |
| 11 | 220 | 0.092 | 1.5 |
| 12 | 220 | 0.115 | 1.5 |
| 13 | 220 | 0.104 | 1.1 |
| 14 | 220 | 0.104 | 1.1 |
| 15 | 220 | 0.104 | 1.1 |

**Figure 1:** Turning process setup

In this study, the method used by Skoczyski *et al.* (2013). was adopted to determine the energy consumption during cutting operation. A constant length of 500 mm was measured along the workpiece (sample) and the tool-workpiece contact time for cutting along this length was recorded for each experimental run and it was used to multiply by the average power of the motor as expressed in Eqn. 2:

Energy consumption (EC) = P. t (2)

Where,

EC is the energy consumption (W/h)

P = the average power of the electric motor obtained during cutting process (Watt)

t = the tool - workpiece contact time for cutting along the given length.


**Figure 2.** Experimental setup using clamp meter to measure current

## 3.0 Results and Discussion

### *3.1 Experimental results and S/N Ratios*

The experimental results and their corresponding S/N ratios of the energy consumption of each cutting fluid are shown in Table 3.

**Table 3.** Experimental data for energy consumption

| Exp. Run | Ss (m/min) | F (mm/rev) | Doc (mm) | Energy Consumption (Wh) | | | S/N Ratios (Db) | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Jatropha | Rubber | Mineral oil | Jatropha | Rubber | Mineral oil |
| 1 | 200 | 0.092 | 1.1 | 103.65 | 103.22 | 103.89 | -40.31 | -40.28 | -40.33 |
| 2 | 270 | 0.092 | 1.1 | 73.00 | 72.28 | 77.73 | -37.27 | -37.18 | -37.81 |
| 3 | 200 | 0.115 | 1.1 | 74.89 | 71.87 | 75.75 | -37.49 | -37.13 | -37.59 |
| 4 | 270 | 0.115 | 1.1 | 60.80 | 57.22 | 63.00 | -35.68 | -35.15 | -35.99 |
| 5 | 200 | 0.104 | 0.7 | 87.27 | 82.71 | 87.54 | -38.82 | -38.35 | -38.84 |
| 6 | 270 | 0.104 | 0.7 | 65.47 | 65.45 | 66.92 | -36.32 | -36.32 | -36.51 |
| 7 | 200 | 0.104 | 1.5 | 93.29 | 88.64 | 98.06 | -39.40 | -38.95 | -39.83 |
| 8 | 270 | 0.104 | 1.5 | 66.31 | 63.37 | 68.31 | -36.43 | -36.04 | -36.69 |
| 9 | 220 | 0.092 | 0.7 | 85.95 | 85.25 | 86.85 | -38.68 | -38.61 | -38.78 |
| 10 | 220 | 0.115 | 0.7 | 70.96 | 68.94 | 70.98 | -37.02 | -36.77 | -37.02 |
| 11 | 220 | 0.092 | 1.5 | 86.95 | 85.25 | 86.65 | -38.79 | -38.61 | -38.76 |
| 12 | 220 | 0.115 | 1.5 | 72.82 | 71.11 | 73.99 | -37.25 | -37.04 | -37.38 |
| 13 | 220 | 0.104 | 1.1 | 77.54 | 77.55 | 78.87 | -37.79 | -37.79 | -37.94 |
| 14 | 220 | 0.104 | 1.1 | 77.58 | 77.76 | 78.65 | -37.79 | -37.82 | -37.91 |
| 15 | 220 | 0.104 | 1.1 | 77.65 | 77.73 | 78.98 | -37.80 | -37.81 | -37.95 |

Table 3 shows the experimental runs and their corresponding results for energy consumption of the three cutting fluids. It can be visually noticed that least values of energy consumption were obtained in experiment number 4 run for the different cutting fluids at high cutting speed of 270 m/min, high feed (0.115 mm/rev and moderate Doc 1.1 mm respectively. But maximum values of energy consumption 103, 103.22 and 103.89 Wh for JSO, RSO and mineral oil cutting fluids were recorded at experiment number 1 where the cutting speed was at lowest level 1 (200 m/min), feed at lowest level 1 (0.092 mm/rev) and Doc at level 2 (1.1 mm). It can be deduced that high cutting speed and high feed rate at moderate Doc reduces the energy consumption, while low cutting speed, low feed rate increases energy consumption because high speed and high feed result to increase of material removal rate at less time in turning process and this agrees with Ithipri *et al.* (2015) findings. The effect of various metal working fluids on energy consumption at different cutting speeds is presented in Figure 3..

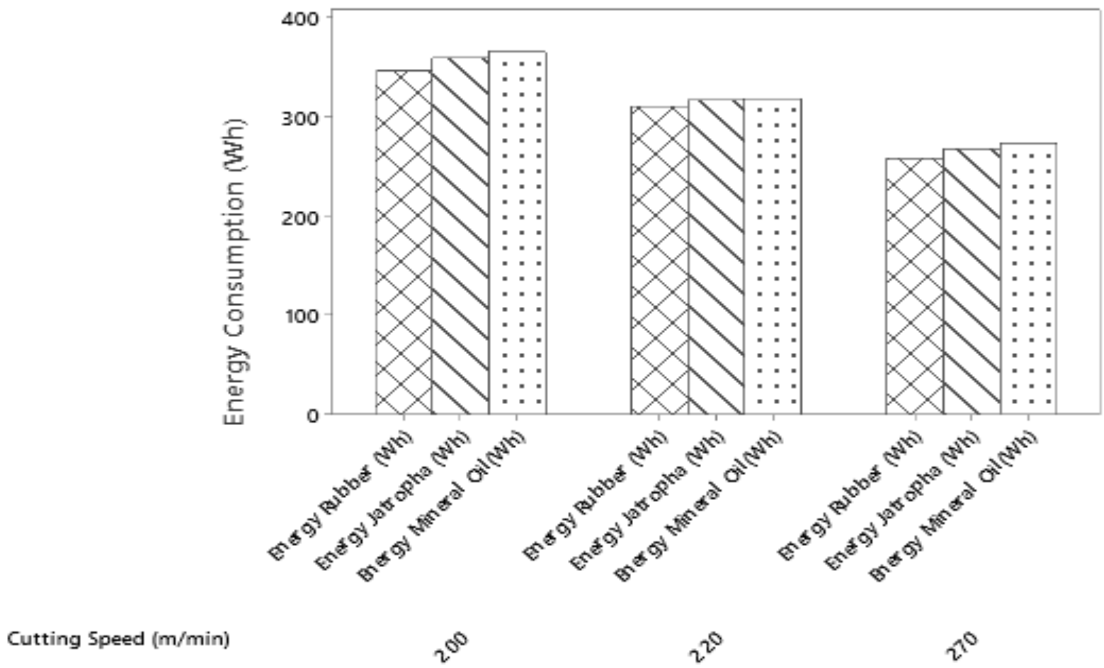



**Figure 3:** Effects on energy consumption at various cutting speeds, feed (0.104 mm/rev) Doc (1.1mm)

From Figure 3, it can be visually observed that the effect of the different cutting fluids on the energy consumption at various cutting speed with feed rate (0.104 mm/rev) and Doc (1.1mm) respectively. At low level of cutting speed (200 m/min), the energy consumption was at its highest peak but when the cutting speed increases to maximum level (270m/min) steady reduction of the energy consumption was observed irrespective of the cutting fluid type. However, it was observed that at low cutting speed 200 m/min, feed rate 0.104 mm/rev and Doc 1.1 mm, rubber and jatropha seed oils metal working fluids reduced the energy consumption by 5.15 % and 1.68 % respectively as compared to the mineral oil metal working fluid. At 220 m/min cutting speed, rubber and jatropha seed oils metal working fluids reduced the energy consumption by 2.05 % and 0.99 %. At 270 m/min speed, the percentage reduction on energy consumption by rubber and jatropha oils metal working fluids are 5.64 % and 2.18 %. It can be discovered that RSO metal working fluid with 4.25 $mm^2/s$ of viscosity showed more effect on the energy consumption than the jatropha metal working fluid with viscosity of 0.98 $mm^2/s$ and mineral oil metal working fluid with viscosity 0.75 $mm^2/s$.

The different behaviour of the developed nonedible vegetable metal working fluids can be credited to higher lubricity, viscosity and fatty acid configurations. It was also observed that the energy consumption decreases as the cutting speed and feed increase respectively. This is because increase in feed and speed takes lesser time to complete a cycle than at low feed and speed. It was noticed that the various metal working fluids exhibited similar behaviour at variation of the process parameters.

Therefore, it can be concluded that minimum energy consumption is obtained at increase in speed and feed in turning process due to high material removal rate at less turning time. This is in conformity with the finding by Ithipri *et al.* (2015), but different from the studies by Kolawole and Odusote (2013) as well as Odusote and Moshood (2016) which stated that to minimize energy consumption, low cutting speed and feed rate must be used. From the results, it can be established that the nonedible vegetable oil metal working fluids are more effective in reducing energy consumption during turning mild steel in comparison with mineral oil-based metal working fluid.

### *3.3 Main Effects for Energy Consumption of Nonedible Vegetable and Mineral Oil-Based Cutting Fluids*

The main effects plot for energy consumption (Ec) of jatropha, rubber and mineral oil-based cutting fluids are shown in Figure 4a-c.

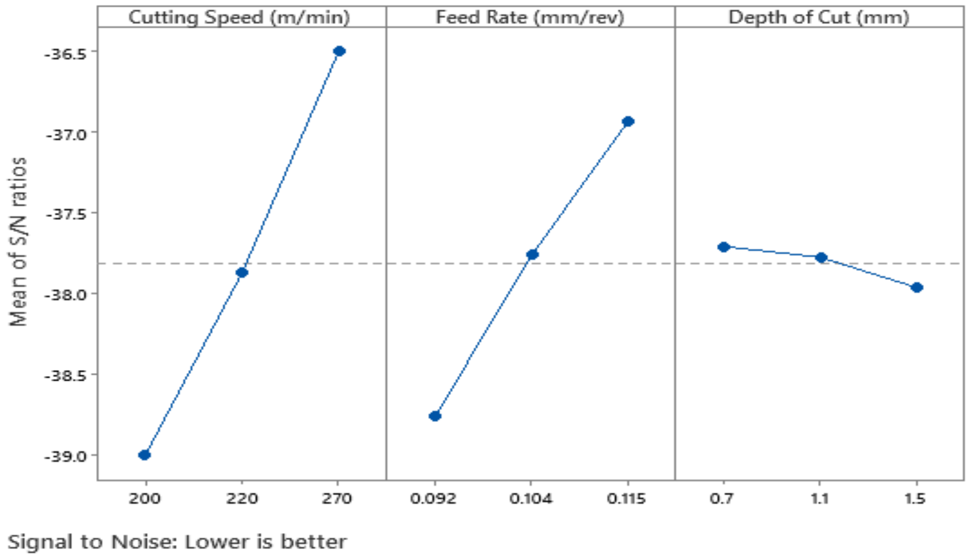



**Figure 4a**: Main effects plot for Ec of jatropha seed oil cutting fluid

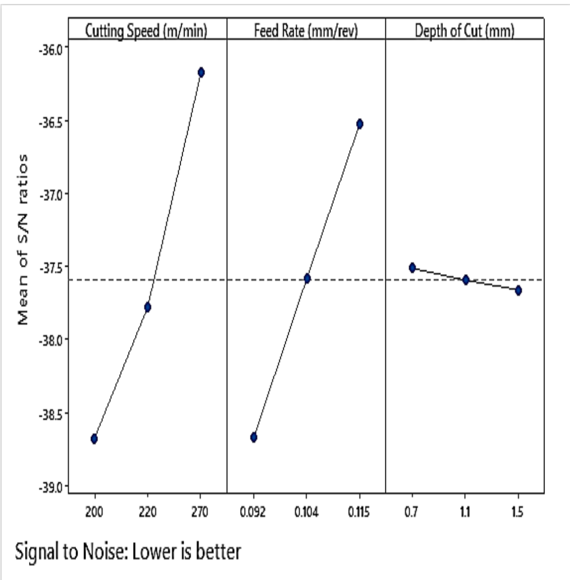



**Figure 4b**: Main effects plot of rubber oil

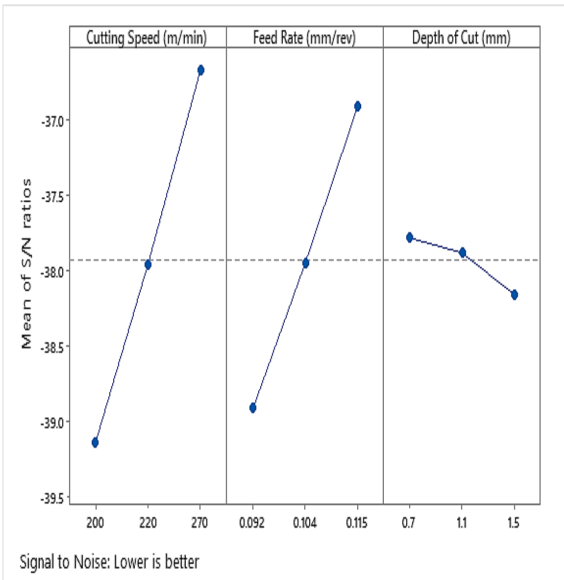



**Figure 4c**: Main effect plot of mineral oil

From Figure 4a-c, it can be observed that the optimal turning parameters for energy consumption was obtained at cutting speed of 270 m/min (level 3), feed rate of 0.115 mm/rev (level 3) and depth of cut of 0.7 mm (level 1) for jatropha seed, rubber seed and mineral oil- based cutting fluids during turning operations. It shows that minimum energy consumption could be obtained at high cutting speed and feed rate during turning operation at optimal setting of process parameters A3B3C1.

### 3.4 *Analysis of Variance*

The ANOVA for energy consumption of jatropha seed, rubber seed and mineral oil-based cutting fluids are shown in Table 5-7. From Table 5-7, the ANOVA for energy consumption using jatropha seed, rubber seed and mineral oil-based cutting fluids shows the percentage contribution of each input parameter as follow: For jatropha seed oil-based cutting fluid (Table 5) the cutting speed is (59.61 %), feed (33.18%) and Doc (0.73%) and for rubber seed oil-based cutting fluid (Table 6), cutting speed (53.36 %), feed rate (40.00%) and depth of cut (0.31%) respectively.

**Table 5:** ANOVA of energy consumption for jatropha oil metal working fluid

| Parameter | DOF | SS | MS | F-Value | P-Value | P% |
|---|---|---|---|---|---|---|
| Cutting speed (m/min) | 2 | 1042.42 | 521.210 | 36.78 | 0.00 | 59.61 |
| Feed (mm/rev) | 2 | 580.15 | 290.075 | 20.47 | 0.001 | 33.18 |
| Doc (mm) | 2 | 12.79 | 6.395 | 0.45 | 0.652 | 0.73 |
| Error | 8 | 113.37 | 14.171 | | | 6.48 |
| Total | 14 | 1748.73 | | | | |

**Table 6**: ANOVA for energy consumption of rubber oil-based cutting fluids

| Variable | DOF | SS | MS | F | P(%) |
|---|---|---|---|---|---|
| CS (m/min) | 2 | 986.37 | 493.184 | 33.7 | 53.36 |
| FR (mm/rev) | 2 | 739.4 | 369.737 | 25.3 | 40 |
| DOC (mm) | 2 | 5.75 | 2.873 | 0.2 | 0.31 |
| Error | 8 | 116.95 | 14.618 | | 6.33 |
| Total | 14 | 1848.5 | | | |

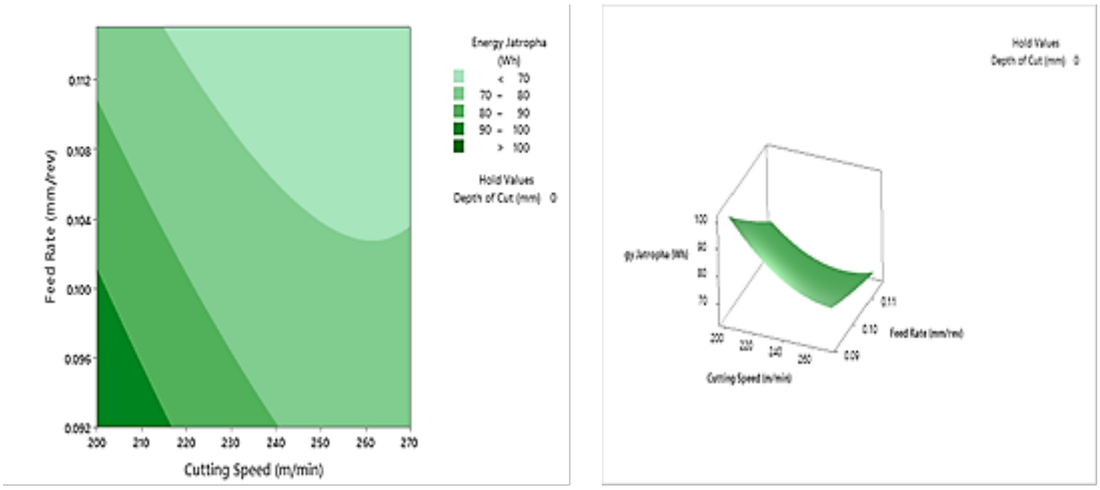
**Table 7:** ANOVA for energy consumption of mineral oil-based cutting fluids

| Variable | DOF | SS | MS | F | P(%) |
|---|---|---|---|---|---|
| CS (m/min) | 2 | 1047.63 | 523.816 | 38.04 | 56.21 |
| FR (mm/rev) | 2 | 677.13 | 338.567 | 24.59 | 36.33 |
| DOC (mm) | 2 | 29.02 | 14.512 | 1.05 | 1.56 |
| Error | 8 | 110.15 | 13.769 | | 5.9 |
| Total | 14 | 1863.93 | | | |

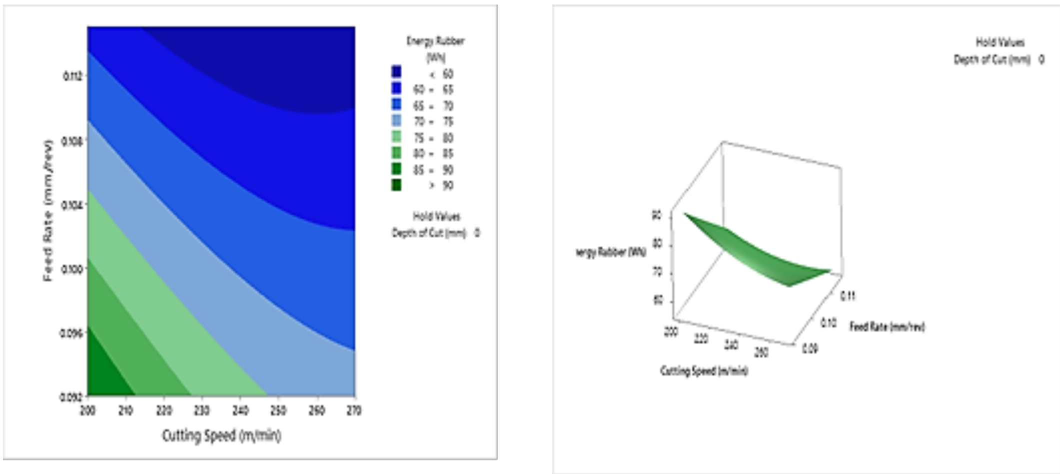
While the percentage contribution of each input parameter for mineral oil-based cutting fluid (Table 7) are as follow: cutting speed (56.21 %), feed rate (36.33%) and depth of cut (1.56%) respectively. It indicates that the cutting speed has the most significant effect on the energy consumption, followed by the feed rate and depth of cut respectively for the three cutting fluids. Therefore, it can be concluded that the cutting speed and feed rate have more significant effect on the energy consumption than the depth of cut in this study.

### 3.5 *Contour and 3D Surface plots for Energy consumption of Jatropha, Rubber and Mineral Oil-Based Cutting Fluids*

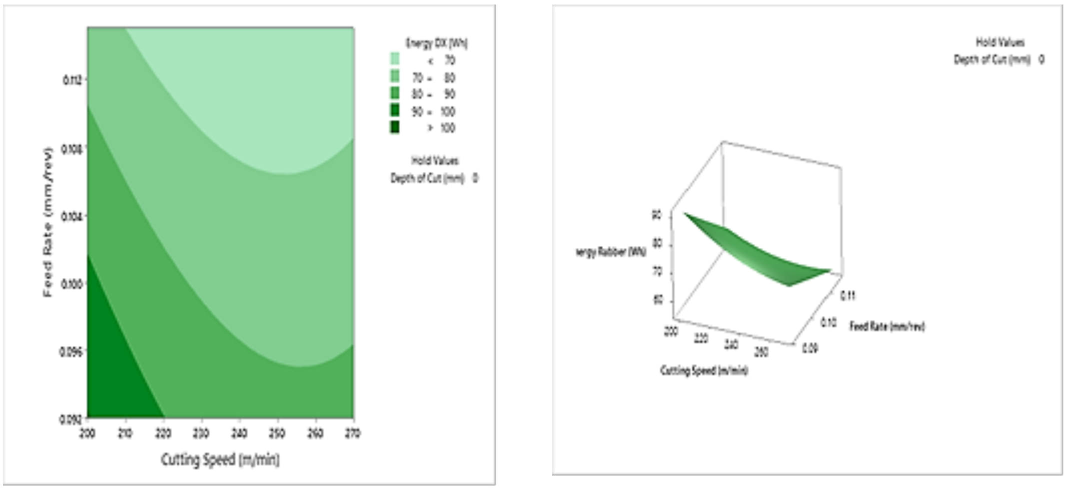
The contour and 3D surface plots for interaction effects of energy consumption for jatropha seed, rubber seed and mineral oil-based cutting fluids are shown in Figures 5-7. Figures 5-7 show how the interactions between feed rate and cutting speed affect the energy consumption for jatropha seed, rubber seed and mineral oil-based cutting fluids while depth of cut held constant during the turning process.




**Figures 5:** Contour and 3D Surface plots of energy consumption for jatropha oil cutting fluid




**Figures 6:** Contour and 3D surface plots for energy consumption of rubber oil




**Figures 7:** Contour and 3D surface plots for energy consumption of mineral oil.

Figures 5 for instance, when the cutting speed was at low level between 200 - 218 m/min and feed rate at low level between 0.092 - 0.101 mm/rev, the energy consumption for rubber oil-based cutting fluid was higher above 100 Wh, but when the cutting speed and the feed rate increase from low level to high level, the energy consumption gradually decreases to a value less than 70 Wh. In other words, the energy consumption is high at low cutting speed and feed rate but decreases with increase in cutting speed and feed rate for the different cutting fluids during the turning operations.

## Conclusion

The investigation of non-edible vegetable oil-based cutting fluids on energy consumption in turning of mild steel has been conducted. From the findings of this study, it was observed that very small amount of energy is what really required for the actual cutting of metal as compared to the sum of energy consumption during machining process. The non-edible vegetable oil-based cutting fluids proved more effective in minimizing energy consumption at different cutting speed conditions compared with mineral oil based cutting fluid and therefore, it can be deduced that the non-edible vegetable (rubber seed and jatropha seed) oil- based cutting fluids performed better than the mineral oil in energy consumption reduction during turning of mild steel which by extension, reduction of carbon dioxide emission during turning operations which implies minimization of energy usage, environment protection and cost effectiveness which is the basis of sustainability manufacturing.

The main effect plots indicate that the optimal process parameter setting condition for energy consumption for the various cutting fluids is A3B3C1 which has a cutting speed of 270 m/min, feed rate of 0.115 mm/rev and depth of cut of 0.7 mm respectively. The ANOVA results show that the cutting speed has the most significant effects on the energy consumption followed by the feed rate and depth of cut respectively. Further investigation is recommended to use same non-edible vegetable oils in this study or other non-edible vegetable oil-based cutting fluids for other materials and machining processes.

**Disclosure statement:** *Conflict of Interest:* The authors declare that there are no conflicts of interest.
*Compliance with Ethical Standards:* This article does not contain any studies involving human or animal subjects.

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