

# **Replacement of Base Oil into the Vegetable Neem Oil Based Metal Working Fluid in Machining Application of Ferrous Metals**

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**ABSTRACT:** The increasing attention to the environmental and health impacts of industrial activities by governmental regulations and by the growing awareness level in the society is forcing industrialists to reduce the use of mineral oil-based metalworking fluids as cutting fluid. Cutting fluids have been used extensively in metal cutting operations for the last 200 years. In the beginning, cutting fluids consisted of simple oils applied with brushes to lubricate and cool the machine tool. As cutting operations became more severe, cutting fluid formulations became more complex. There are now several types of cutting fluids in the market and the most common types can be broadly categorized as cutting oils or water-miscible fluids.

In This Project, the applicability of vegetable Neem oil-based metalworking fluids in machining of ferrous metals has to be taken. The advantages of metalworking fluids and its performances with respect to the cutting force, surface finish of work piece, tool wear and temperature at the cutting zone have been investigated. It has been reported in various literature that metalworking fluids, which are basically vegetable oil-based such as castor oil, palm oil, soybean oil, rapeseed oil, jatropha oil, sunflower oil etc., Could be an environmentally friendly mode of machining with similar performance obtained using mineral oil-based metalworking fluids.

We have try to Use Vaccum Blending (or) mixing reactor in a closed system For example – Normal Heating and Blending Temperature of Neem oil up to 70 °c instead of using Vaccum means – Reduce the temperature up to 40°C. If the Temperature controlled means automatically odor not be evolved. And another benefit of using Vaccum, since it is bio product contains AZADIRACHTIN (natural chemical) Antibacterial activity. If the maintaining the low temperature 40°C AZADIRACHTIN cannot be degraded and also originality of the product. The neem cutting oil reduced the flank wear by about 72% and 56% as compared to dry turning and Base oil cutting respectively, while the soluble oil reduced the flank wear by 36% as compared to dry turning. Therefore, the neem seed oil is not only suitable for cutting fluid, but it is more effective as a cutting fluid than the soluble oil as a cutting fluid.

**KEYWORDS:** Neem oil, Vaccum Blending Unit, Cutting fluids, Azadirachtin, Vegetable oil, base oil, lubricant

## **I. INTRODUCTION**

Conventional mineral oil based lubricants are extremely harmful for the biosphere when they get into the environment. Due to their poor degradability mineral oils remain in the eco systems for a long time. Even in case of high dilutions there will be a fatal eco-toxicological effect. High sums which have to be spent for the elimination of damages clearly show that economy and ecology today have the same priority.

Oils and fats are water-insoluble substances derived from vegetable and animal sources. Over the years, oils and fats have been used and retained their importance as metalworking lubricants. However, due to the complexity and special requirements of the new age metalworking fluids, such as extreme pressure and corrosion resistance, these oils and fats need to be modified or compounded. The predominance of the mixed-film lubrication mechanism demands that boundary and extreme pressure lubricants be added to oils possessing viscous properties. Thus, almost all

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lubricants require further additives to impart other characteristics of a non-Tribological nature, such as oxidation resistance, corrosion protection, and detergency. Most metalworking lubricants, vegetable-based and petroleum-based, are compounded or modified to achieve these requirements. Several methods are available to modify these oil lubricants. The important and most commonly used methods are sulfurization and phosphate modification.

The growing demand for biodegradable materials has opened an avenue for using vegetable oils as an alternative to petroleum-based polymeric materials. Soy-based products constitute a major portion of US agricultural products. Soybean oil, widely used as a food material, has the potential to be used as a renewable resource in place of petroleum-based materials. Major disadvantages of vegetable oils are inadequate oxidative stability and problems associated with use in high or low temperature applications. The poor oxidative stability is typically due to the rapid reactions occurring at the double bond in the oil molecules.

Reactions like free radical oxidation, hydrogen abstraction, addition reaction, fragmentation, rearrangement, dis-proportionating reaction, and polymerization can reduce oxidative stability. These problems can be mitigated by the structural modification of vegetable oil by chemical reactions. Research conducted in our laboratory has shown that soy flour and soybean oil can replace petroleum-based polymer and polyurethane materials. To alleviate the problem of oxidative instability, ozone and sculpture modification were also conducted in our laboratory. Vegetable oil-based emulsions were also a part of recent research to produce stable emulsions to use as metalworking fluids and in other applications. Most attention has been given to vegetable oil-based emulsions, and few references are available on these emulsions as metalworking fluids. In the present study, we investigated vegetable oil emulsions containing modified and unmodified soybean oil. The use of vegetable oil in metalworking applications may alleviate problems faced by workers, such as skin cancer and inhalation of toxic mists in the work environments. This will also help to add value to a farm commodity, such as soy oil and other similar vegetable-based oils.

This Project deals with the development of a vegetable-based emulsion that can be used in the metalworking industry to replace partially or completely the commonly used petroleum-based emulsions. Vegetable oils have good lubricating ability and have been used for the formulation of rolling emulsions. However, certain limitations prevent their wide use in lubrication applications. They are easily hydrolyzed, and a thin layer is often formed on finished products. The objective of this study was formulation of vegetable oil emulsions, to replace synthetic esters commonly used as metalworking fluids.

This paper describes a method for the formulation of vegetable oil-in-water emulsions. These emulsions were prepared using various surfactants, and the stability of these emulsions was tested by varying the amount of surfactants. The effects of different surfactants used to produce emulsions with regular and modified soybean oil are discussed. The properties of these emulsions were tested by chemical and physical methods for stability and application as a metalworking fluid. Phase diagrams were created to determine the effect of oil, water, and surfactant ratios in the formation of emulsion. Cryo-SEM was used to probe the phase boundary and the bubble size.

Vegetable oils primarily consist of triglycerides, which are glycerol molecules with three long chain fatty acids attached at the hydroxyl groups via ester linkages. The fatty acids found in natural vegetable oils differ in chain length and number of double bonds. The fatty acid composition is determined by the ratio and position of carbon-carbon double bonds. The long carbon chain is generally held together with one, two, or three double bonds: oleic, linoleic, and linoleic fatty acid components respectively. Most of the plant based oils contain at least four and sometimes as many as different fatty acids. Table 1 shows the fatty acids structure of various vegetable oils. The proportions of each fatty acid depend not only on the type of plant, but also on the climate, the weather and the food available. It is reported that triglyceride structure provides desirable qualities for boundary lubrication. It is due to their long and polar fatty acid chains, which provide high strength lubricant films that interact strongly with metallic surfaces, reducing both friction and wear. The polarity of fatty acids produces oriented molecular films, which provides oiliness and imparts Antiwear properties. Fatty acids are thus believed to be key substances with regard to lubricity. Table 1.1 depicts the rheological properties of different vegetable oil.

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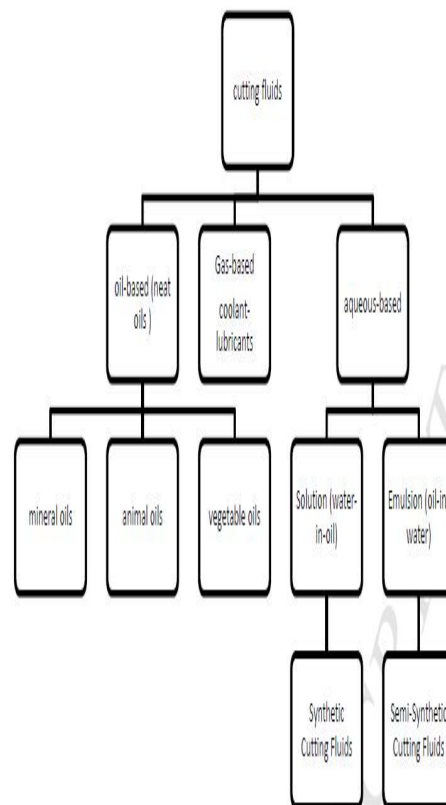
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**Table 1.1 Physical properties of Neem oil and their Sources**

Physical Properties	Results
Kinematic viscosity@40°C (cSt)	68.03
Kinematic viscosity@100°C (cSt)	10.14
Total acid value(moth)	23.00
Pour point(0°C)	9

Bio lubricants have many valuable and useful Physicochemical properties. They offer technical advantages unlike those of typical petroleum-based lubricants. Biolubricants have high lubricity, high VI, high flash point and Low evaporative losses. Overall, vegetable oil-based bio lubricants exhibit several excellent properties compared with mineral oils. Table 3 shows the comparative analysis result of properties of vegetable oils.

The Viscosity index indicates changes in viscosity with changes in temperature. A high VI indicates small changes in temperature; whereas a low VI indicates high changes in temperature. Vegetable oil-based bio lubricants have higher VI than mineral oils, which ensures that bio lubricants remain effective even at high temperatures by maintaining the thickness of the oil film. Hence, bio lubricants are suitable for a wide temperature range.



**Figure 1.1 Classifications of Cutting Fluids**

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An oil based lubricant (also called neat oils) is derived from mineral, animal, vegetable, and synthetic oils. Mineral oils (petroleum based) are the major type due to their desirable lubricating characteristics. These cutting fluids usually contain some additives to enhance their applications. For instance, the characteristics of naphthenic mineral oils and paraffinic mineral oils are usually enhanced through the addition of fatty lubricants, extreme pressure additive, odorants, thickness modifiers, and polar additives. Mineral-based lubricants are used to lubricate the tool-chip interface and consequently minimize the friction and friction induced heat at the cutting zone. As a result, low cutting forces are required to reduce the crater wear on the tool rake face. Besides, it is useful in lubricating the moving parts of the machine tool, as it prevents corrosion on the machined surface and machine tool. The advantages of neat oil lubricants are that they are excellent in lubrication, anti-seizure, and corrosion resistance. However, their main disadvantage is the high flammability as they are good in lubrication but poor in coolant. As a result, their characteristics become poor when machining in higher load and temperatures, resulting in mist and smoke. Hence, neat oil lubricants are used principally for low-speed operations where temperature rise is not significant. Chemical additives such as sulfur, chlorine, and phosphorous are always added in neat oil lubricants to form a thin solid salt layer on the hot and clean metal surfaces. This extreme pressure (EP) film reduces the friction between chip and tool in metal cutting effectively.

### 1.3.3 Aqueous-based Cutting Fluids

Usually, the aqueous-based products are provided in a concentrated form which must be mixed with water to the desired concentration prior to use. Once this aqueous-based product is mixed with water, the “emulsifiable” form an emulsion, while the “soluble” type forms a solution. The emulsion is formed by blending oil (usually mineral oil) in water with an emulsifying agent at a typical ratio of water to oil 30:1. The function of emulsifiers is to disperse the oil in water in order to form a stable oil-in-water emulsion. Stability of emulsion is the most vital property of soluble oils. The presence of water makes emulsions superior in cooling, while the presence of oil reduces the tendency of water to cause oxidation. Similarly, extreme pressure additives are used in this cutting fluid under extreme pressure conditions. The emulsion is recommended to be used in high speeds and low pressures operations where the temperature rise is significant.

The advantages of emulsions are that it has no fire hazard and lower rate of oil misting. Besides, the cost is reduced since it can be diluted with water. However, infestation by micro-organisms such as bacteria, yeasts, and fungi is the weakness of emulsions due to the high amount of water. The presence of bacteria causes separation in the emulsions. As a consequence, this uncontrolled growth of microbial may lead to corrosion, poor lubricating properties, and aesthetically unpleasant results. According to Klocke and Kuchle 2011, to provide a remedy to the unpleasant results about 0.15 % biocides can be added to the emulsion. Nevertheless, according to Kuram et al. 2013, antimicrobials and biocides are able to maintain the efficiency of cutting fluids but harmful to the operators because formaldehyde releases biocides which are potential carcinogenic.

Synthetic cutting fluid which is made of chemical with additives and diluted in water is free from mineral oil. They tend to have a clear, watery appearance, while dye may be added to make a clear green or yellow liquid. Synthetic cutting fluid forms transparent solutions and provides good visibility of the cutting operation. The addition of organic and inorganic chemical solutions in synthetics cutting fluid provides water softening, corrosion resistance, lubrication, reduction of surface tension and blending. Synthetic cutting fluid is a good coolant but it provides insufficient lubrication compared to other cutting fluids due to lack of oiliness. As a result, they are particularly used for low force operations where cooling is a primary requirement.

Semi-synthetic fluids are chemical emulsion, which contain mineral oil diluted in water with some additives to reduce the size of oil particles making it more effective lubricant. The only difference between synthetic and semi-synthetic fluids is that there is no oil present in synthetic cutting fluid. Semi-synthetic fluids contain mineral oils of concentration varying between 10 % and 50 %, proving more lubrication than synthetic oils. Both the synthetic and semi-synthetic fluids show good cooling property as they have a low corrosion rate with low vulnerability for bacteria growth, lead to a decrease in irritation to the skin and odor.

As we studied the cooling ability of cutting fluids during turning of AISI 1020 steels by measuring the cutting temperature using tool-work piece thermocouple method. The results showed that at lower cutting speeds, up to 110m/min, semi-synthetic cutting fluid demonstrated the best cooling ability followed by synthetic fluids and finally the emulsion-based cutting fluid. On the other hand, emulsion based cutting fluids show better cooling ability than synthetic cutting fluid when cutting speed is higher than 110 m/min. The authors figured out that there are two main

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factors must be considered as the cooling ability of a coolant. They are the ability of dissipating the heat and capability of reducing friction.

Due to the toxic effect of cutting fluids, the environmental factors associated with machining become an emerging problematic aspect in recent years. It is reported around 80 % of all occupational infections of the operators were due to skin contact with cutting fluids. This is because the complexity in the composition of cutting fluids may be an irritant or allergenic, even if the raw materials are safe. The International Agency for Research on Cancer (IARC) reported that petroleum-based cutting fluids which contain heterocyclic and polyaromatic rings is carcinogenic and exposure to it could result in occupational skin cancer. Owing to these hazardous substances, toxic and less biodegradability cutting fluids causes lots of techno-environmental problems and serious health problems like lung cancer, respiratory diseases, dermatological and genetic diseases

Besides, the bacterial growth in the cutting fluids significantly leads to the Presence of microbial masses and particularly endotoxin at the shop floor atmosphere. Thus, biocides additive are added in order to control the bacterial growth in the cutting fluids. However, discharging the cutting fluids containing biocides could affect the natural decomposition process and some municipalities forbidden the disposal of biocides into the sewage systems. Many of the available biocides are also found to release formaldehyde, which is a possible carcinogen.

Sometimes, chlorinated paraffin is used as additives in cutting fluids because of the advantageous properties such as chemical stability, viscosity, flame resistance, low acute toxicity. Nevertheless, cutting fluids containing chloroparaffin as extreme pressure additives are no longer legal to be used in future. This is because chlorinated paraffin in extreme pressure cutting fluid changes to dioxin by heat and pressure and could lead to chlorine acne. Besides, disposal of cutting fluids containing chlorinate is only allowed to be burned in special incineration sites since the toxic dioxins can lead to uncontrolled burning. Therefore, it is classified as hazardous waste to human life as well as to the environment. Additionally, cutting fluids containing chlorine additives are not suitable in machining titanium alloys as it can cause corrosion on the machined surface. Moreover, cutting fluids that vaporized and atomized due to high pressure and temperature in machining operations, resulting in formation of cutting fluid mist. Mist, fumes, smoke and odors generated by cutting fluids especially with chemical additives such as sulfur, chlorine, phosphorus, hydrocarbons and biocides can cause skin reactions and respiratory problems as well.

## II. MATERIALS AND METHODS

The seeds were grinded into fine particles and 60gms of the grinded seed was taken and a thimble was made. The soxhlet extraction method is best regarding higher percentage yield 320 ml of n-hexane is added to thimble from above. A soxhlet apparatus is only required when the desired compound has limited solubility in a solvent, and the impurity is insoluble in that solvent. Crushed neem seeds are used for extraction of oil by using soxhlet extractor apparatus depicted

**Table 3.1 Extraction of Neem oil by Neem seeds**

Fatty Acids	% age
Oleic acid	45.7
Palmitic acid	19.4
Stearic acid	18.3
Linoleic acid	14.4

After extraction of neem oil, solvent is removed by rotator evaporator at 50 °c, yielding the extracted compound that is neem oil. The fatty acid composition of neem oil. The refined neem oil obtained was subjected to Tran's esterification and then the Trans esterified oil was converted into partially hydrogenated oil and both were compared for their physico-chemical properties.

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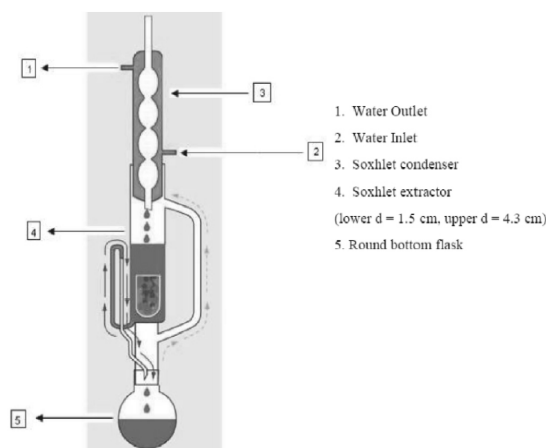
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**Table: 3. 2Chemical Analysis of Neem oil**

SI.No	Properties	Characteristics
1	Color	Yellowish green
2	Odor	Pungent
3	Specific gravity at 15°c	.0926 – 0.942
4	Refractive Index	1.470-1.477
5	Iodine Value	89-98
6	Acid Value	44mg KOH/gm of Oil
7	Sap Value	191 - 202

It is an alcoholysis reaction in which one alcohol displaces another alcohol from an ester. To 75gm of ethyl hexanol 1.4 gm of sodium was added until clear solution was obtained. 100gm of refined oil was added to the above solution and refluxed at 180 c for a period of 30hr. the product obtained was transesterified ethyl hexyl ester of neem oil (18) which was percolated through fuller’s earth to obtain yellow colored liquid. The oil was studied for its physico-chemical properties which is given in

**Figure 3.1 Soxhlet Extractor for extraction of oil Neem crushed seeds**



Ethyl Hexyl Ester of Neem Oil: To 100gm of transesterified ethyl hexyl ester of neem oil, 100gm of hexane and 1.6 gm of nickel catalyst was suspended in a reactor. In reactor hydrogen was passed at 200psi at 120°c for 45 minutes to obtain partially hydrogenated product. Contents were filtered to remove catalyst amount solvent was distilled off to obtain straw yellowish liquid. Hence partially hydrogenated transesterified ethyl hexyl ester of neem oil was obtained. Physico chemical properties of partially hydrogenated neem oil were compared with transesterified neem oil.

Since the additives and Neem oils are not mixing properly, it’s become a hazy kind of appearance displayed below figure and without proper heating lubricant blending process is improper in condition.

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Figure 3.2 Hazy appearances 1



Figure 3.3 Hazy appearances 2



Base oils taken into the 500 ml Beaker and mixed with additives at the required temperature to obtain a homogenous mix. There are several methods to achieve an optimum blend depending on the product and plant

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requirements. The blended product is then filtered and transferred to storage tanks from where it is taken to the filling station and packed in containers or barrels. The entire process can be carried out in a basic manually operated plant or automated plant. Controlled plants the lube oils are manufactured to API or other required specifications.

- Neem Oil - 85 %
- Antiwear additive - 3%
- EP additive -7%
- Anti-Oxidant -2%
- Corrosion Inhibitors -2.5%
- Antifoam additives -0.5%

**Figure 3.4 – Final product**



The equipment used in this study is: Centre Lathe Machine model XL 400, Uncoated Carbide Inserts Tool SNMG 120408-QM H13A (ISO designation) were clamped onto a tool holder for turning operation. Surface roughness tester ISR-16 type, and a digital vernier caliper were used to measure the surface roughness and the tool wear values respectively.

The experiments were performed in the workshop of mechanical engineering department, M/s. Chennai Forge Ltd. Ambattur. The neem seed oil and the soluble oil were used as the cutting fluids. The experimental set up is presented in Figure 3.1. The fatty acid profile and the Physicochemical Analysis of Neem seed oil are given in Table 1. The work piece was first and foremost faced and a Centre hole drilled and it was then supported by the tailstock Centre. Thereafter, it was turned to a 1mm depth to remove all the rusted and/or hardened surface prior to the actual turning operation. This was done in order to minimize any effect of inhomogeneity on the experimental results. After turning, the surface roughness of the work piece was measured using a surface roughness tester. ISO 4287 standard was followed during the measurements.

These measurements were repeated three times, on three different points on the work piece and the average values of the readings were recorded. The flank wears were measured with a digital vernier caliper shown in Figure 3.2. The flank wear was measured from the distance between the top of the cutting edge and the bottom of the area where flank wear occurs. The carbide turning tool was replaced when the width of the flank wear area reached the predefined limit of 0.76mm. The duration of machining was 8mins for each experiment. The flank wear measurements were repeated three times, the average values of the readings were taken.



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**Figure 3.5 - Lathe Machining**



**Figure 3.6 - Finished Component**



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Figure 3.7 - Surface Roughness Meter



### III. RESULTS AND DISCUSSION

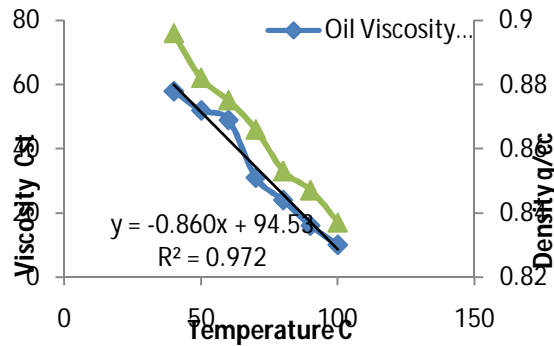
Vegetable oils were found to be promising alternative for mineral based oils due to their environmental friendly characteristics. These were utilized to develop biodegradable lubricants for various industrial applications. The trend was extended to formulate environmental friendly metal working fluids. The review is made in two approaches, one based on the desirable properties of vegetable oil as metal working fluid and other on the performance of these oils for various cutting and forming operations. Most of the studies found, were on soybean, sunflower and rapeseed oils. Finally, the review revealed that the vegetable oils have large scope to utilize them as metal working fluids. The researchers in the authors' group engaged in the study of stability and Tribological behavior of Pongamia pinnata and neem oils as metal cutting and forming fluids.

The usages of petroleum based products and their impact on environment has created an opportunity to produce eco-friendly biodegradable lubricants from agricultural feed stocks. Due to growing need, demand and great concern regarding pollution both industrial and automotive sector are paying interest in the lubricants derived from renewable resources derived from vegetable oils due to their excellent biodegradability low toxicity and environmentally benign nature. Many countries are leading in developing and marketing bio lubricants through legislation and due to population explosion there is shortage of edible and hence we have to depend on non-edible oil for production of bio lubricant and non-edible oils act as potential source as feed stock for bio lubricants. Being eco-friendly, easily available and resistant to drought conditions makes plantation of neem tree easier along with employment to poor people.

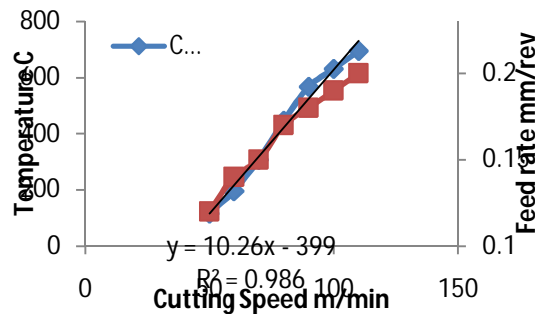
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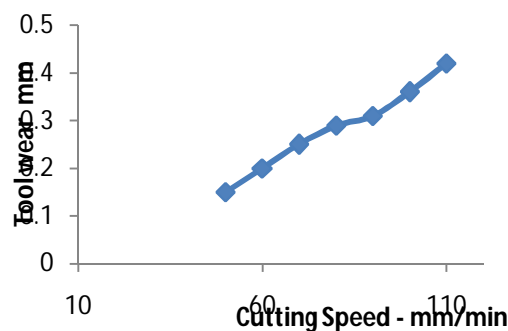
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**Inference:** The above graph is plotted between Oil temperature and its corresponding viscosity and density. It is clearly seen that the viscosity decrease as the temperature increases, so as the density. The variation is linear in nature given by the  $r^2$  value of 0.9723. For the cutting oil to perform it has to have a viscosity index in the range of 130 to 200 and for our neem based cutting oil it is found to be 160, which is in the optimum range.



**INFERENCE:** In the above graph we have the relation between the various cutting speed and its corresponding temperature and the feed rate. It is seen that, when the feed rate increase the cutting speed and hence the temperature increases. This is given by the linearity in the variation whose  $r^2$  values is 0.9861, basically neem oil having higher viscosity index compared a regular base oil, thereby the cutting temperature is well within the desired range of less than 600 C, and also we have the expected cutting performance as that of the base oil.

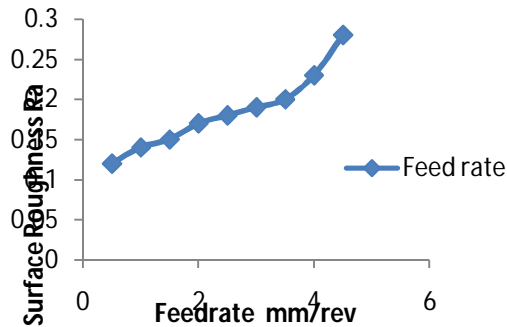


**INFERENCE:** The above graph is plotted between cutting speed and the corresponding tool wear observed. Tool wear is a property which is not desired, the lower the value better is the performance of our cutting oil. Now, the tool wear is a factor which depends on the type of material being cut and the nature, shape of the job work. In our experiment we have ASTM D -2266 standards, which was subjected to a highest cutting speed of 110 mm/min, which has given us a tool wear of 0.42 mm which is considerably less compared to petroleum based base oil.

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**INFERENCE:** The above graph is plotted between Feed rate of the material and the corresponding surface roughness. Surface roughness is not desired once a job is cut, the duty of the cutting oil is not only aid in cutting but also, provide a smooth surface finish at the areas of cut. This is expressed in terms of 'Ra - Value'. In the above graph for a minimum feed rate of 0.12 mm/min we have achieved lowest surface roughness of 0.5 Ra and for maximum feed rate of 0.28 mm/min the highest observed surface roughness is just 4.5 Ra. On scale of smooth we see that 0.12 Ra is as that of a mirror smooth finish.

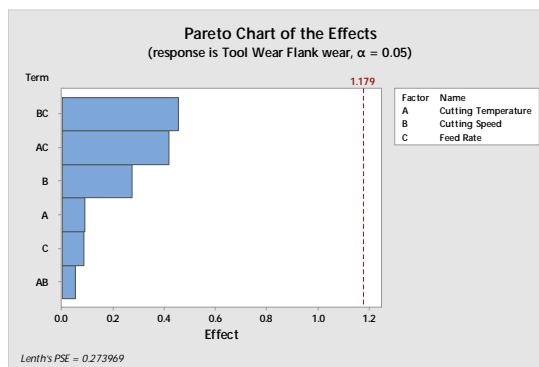
### OPTIMIZATION

#### Regression Equation

**Tool Wear Flank wear** = 1.636 + 0.1200 Cutting Speed - 75.2 Feed Rate + 0.001495 Cutting Speed\*Cutting Speed + 735 Feed Rate\*Feed Rate -2.130 Cutting Speed\*Feed Rate

### MODEL SUMMARY

S	R-sq	R-sq(adj)
0.0044721	99.96%	99.77%

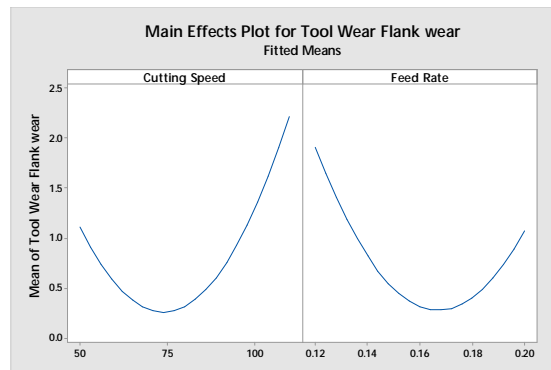


**INFERENCE:** The various parameters contributing to the tool flank wear is given above in the Pareto analysis. It is clearly seen that the combined effect of the cutting speed and the feed rate controls the quality of the tool flank wear. Hence it is important to optimize both the parameters. Followed by the point temperature on the tool and the feed the rate contributes to the lowest possible tool flank wear.

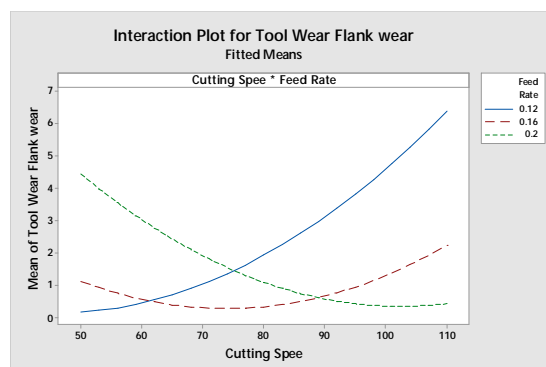
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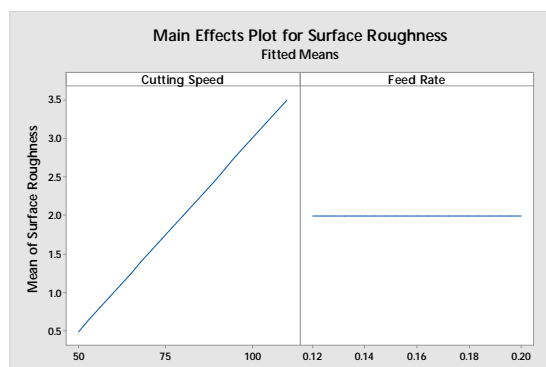
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**INFERENCE:** The plot above explains the main effects of the two governing parameter on the quality of the job work when we use neem based cutting oil. It is clear from the graph that the two factors are equally contributing to the quality of the cutting when using a neem based cutting oil.



**INFERENCE:** The graph above is the interaction plot between the two factors namely the cutting speed and the feed rate. The plots are not parallel indicating there is significance between their interactions. The cutting speed is a factor of the feed rate. At a cutting speed of 50 m/min and feed rate of 0.12 mm/rev the tool flak wear is found to be low 0.15 mm. As wen the feed rate increased, so also the cutting speed it is seen the tool wear is proportionally low. This graph explains the effectiveness of the cutting oil in maintain lowest possible tool wear, when the two governing parameters namely cutting speed and feed rate is varied.

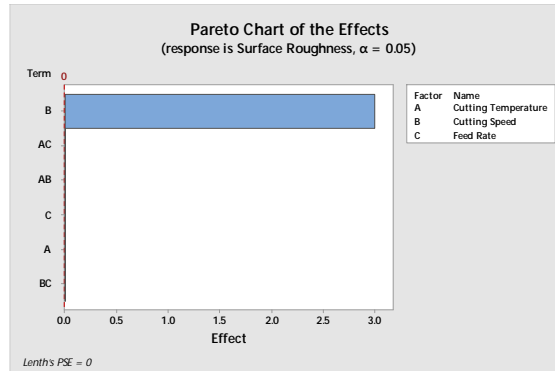


**INFERENCE:** The interaction study indicates that there is not much relation between the cutting speed and the feed rate on te surface roughness of the finished job work. The cutting speed alone controls the quality of the surface smoothness.

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## Characteristics for pilot Plant study



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DIST. THIRUVELARUR, PIN CODE 625 002  
TOLL FREE: 1800 208 9184/9185  
FAX: 1 + 91 0523 2768 3962  
E-Mail: apar\_chem@apar.com  
URL: www.apar.com

### SAMPLE TEST REPORT

APAR/QC/01

Date of report:	02.06.16		
Product :	Neem Cutting Oil		
Type :	Fresh oil		
Sample sent by.:	K. Santosh		
Quantity:	500 ml		
Sr. No	CHARACTERISTICS	METHOD ( ASTM )	TEST RESULT
1.	Appearance	Visual	Clear Liquid
2.	Color, ASTM	D-1500	3.0
3.	Density @ 29.5°C, gm/cc	D-1298	0.896
4.	Kinematic Viscosity @ 40°C, cSt	D-445	58
5.	Kinematic Viscosity @ 100°C, cSt	D-445	10
6.	Viscosity Index	D-2270	135
7.	Total Acidity, mgKOH/gm	D-974	0.05
8.	Flash Point, °C	D-92	210
9.	Sap Value	D-94	8.6
10.	Sulfur Content, % wt.	ED XRF	0.47
11.	Weld Load, kg	D-2783	250 kg
12.	Wear Scar, mm	D-2266	0.5

Remarks:  
1) The results pertain to sample submitted only.  
2) Thus Neem Cutting Oil having better viscosity index compare to regular base oil.

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The results of the effect of spindle speed on the surface roughness under the following Conditions: spindle speed (N) = 250 - 500rpm, feed rate (f) = 1.52mm/rev, depth of cut (d) = 1.0mm are presented. Comparison between Regular Base oil Vs. Neem Cutting oil Finished Component surface roughness value

Table 4.1 the surface roughness under various spindle speeds.

Sl.No	Spindle Speed (rpm)	Surface Roughness (µm)	
		Base Oil	Neem Oil
1	250	1.456	0.467
2	355	1.355	0.433
3	500	1.243	0.352
<b>Total Average</b>		<b>1.351</b>	<b>0.417</b>

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The results of the effect of feed rate on the surface roughness under the following conditions: feed rate (f) = 1.05 – 2.10mm/rev, depth of cut (d) = 1.0mm, spindle speed (N) = 355rpm are presented in Table 4.2.

SI.No	Feed rate (mm/rev )	Surface Roughness ( $\mu\text{m}$ )	
		Base Oil	Neem Oil
1	250	1.234	0.433
2	355	1.119	0.412
3	500	1.023	0.407
<b>Total Average</b>		<b>1.125</b>	<b>0.421</b>

## IV. CONCLUSION

In This Project, the concluded applicability of vegetable Neem oil-based metalworking fluids in machining of ferrous metals has to be taken. The advantages of metalworking fluids and its performances with respect to the cutting force, surface finish of work piece, tool wear and temperature at the cutting zone have been investigated. We have try to Use Vacuum Blending (or) mixing reactor in a closed system For example – Normal Heating and Blending Temperature of Neem oil up to 70 °c instead of using Vacuum means – Reduce the temperature up to 40°c and benefit of using Vacuum, since it is bio product contains AZADIRACHTIN (natural chemical) Antibacterial activity. If the maintaining the low temperature 40°c AZADIRACHTIN cannot be degraded and also originality of the product.

In this work, the suitability of neem cutting oil as cutting fluid and its effect on surface roughness of mild steel and tool wear during were confirmed in terms of selected parameters such as spindle speeds, feed rates, and depths of cut. Therefore, the following conclusions are being drawn

- The minimum surface roughness (best surface quality) was obtained using neem cutting oil as cutting fluid compared to base oil cutting fluid during the turning operation.
- Vegetable based Neem cutting oils are highly degradable, non-toxic, good physical properties. Neem based metalworking fluid is being recognized as having superior lubricating properties compared to other based-oil.

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