Experimental Investigation on Tribological Behavior of Bio Based Lubricant as Metal Working Fluid in Machining Process

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***Abstract*—Metalworking fluid (MWF) is commonly used to reduce wear and friction, which in turn improves the productivity and quality of the components. However, theusage of conventional MWF made frommineral oil causes negative effects to the ecology and human health. Therefore, it is desirable to formulate sustainable MWFs as an alternative to petroleum-based oils. The crude Mahua oil (CMO) with various compositions with synthetic esters as per ASTM STD is formed and modified Mahuaoil (MMOs) were tested in the test specimens. The orthogonal cutting process carried out and the lubricants were supplied by using minimum quantity lubrication (MQL) technique. It was observed that theMMO exhibited an outstanding performance in terms of wear, friction and surface finish when compared to commercial syntheticester (SE). This works showed that MMO is a viable replacement for synthetic ester(SE) as a metal working fluid.**

***Keywords*—bio lubricant, mwf, mahua oil, biodegradability, Tribology.**

I. INTRODUCTION

Various kind of metalworking fluids (MWFs) are used for all machining operations. The sources of these fluids are from mineral oil-based, vegetable oil-based and synthetic oils based. The bio-based oil from vegetables oil has high biodegradation percentage and gives better lubrication performances in terms of physical and tribological behavior.

It was estimated that 52% of MWF is used for the machining purposein worldwide. The important function of MWF is to dissipate heat generated at the tool-chip interface in machining operation. Also, the MWF provides a thin layer between two contact surfaces to reduce wear and friction. The adequate lubrication effect of the MWF reduces the amount of required coolant to absorb the heat generated during the machining process.

Therefore, less friction occurred at the machining zone that contributes reducingthe energy consumption. The use of MWF from bio-based oil is due to the increasing concern about eco-friendly sustainable element in the machining process to avoid harmful effluents.

In addition, prolonged used of the conventional MWF from petroleum-based oils can cause environmental pollution and hazardous to human due to the toxic contains.It needs high processing cost to dispose the oil due to the low degradable percentage of 15 to 35%. The use of bio-based oil for lubrication purpose has been practiced in many applications such as in engine oil, hydraulic fluids, two stroke oils, grease and metalworking fluids**.** It was estimated that only 0.1% of the lubricant used from vegetable-oil based. There are two types of vegetable oil which are edible and non-edible.

Previously, the edible vegetable oil such as sunflower, rapeseed, soya bean and palm oil have been used as MWF in various machining process. However due to the increasing demand in food industry, non-edible oils such as Jatropha, Castor, Neem oil and Mahua oil have been used as the sources of bio-based lubricant. The use of bio-based lubricant from the vegetable oil improves the machining performances in terms of cutting force, cutting temperature surface roughness and tool wear. The main criteria of using vegetable oils is they are lack of thermal and oxidative stability due to the existing double bonds in their molecular structure.

There are several solutions to overcome this problem which is chemical modification process, additive reformulation and genetic modification from the oil seed. Therefore, this analysis mainly dealt with the experimental works at various machining parameters in order to investigate the tribological behavior of modified Mahua oil as an MWF for MQL method of lubricant. The machining performances consist of surface roughness to know the lubrication property of Mahua oil and 4 ball wear test to know the tool wear resistance analyzed in order to discover the potential of modified Mahua oil as a sustainable MWF.

II. PROBLEM DESCRIPTION

The conventional Metal Working Fluids are generally used in all machining processes globally. Due to the content of chemicals in petroleum based MWF the land pollution is abnormal and it is affecting the workers' health also.

The bio lubricants are highly bio degradable (93-98%) and not affecting the workers' health. When using Bio lubricants, it will increase the country's economy also. So, we will analyze the bio based MWF as a sustainable fluid to replace the conventional fluids.

FIG.2.1 METAL WORKING FLUID

III. EXPERIMENTAL WORK

3.1 Experimental Procedure:

In this experiment the mahua oil and reference cutting oil KOOL CUT 40 are taken as Coolant. In the centre lathe 4 specimens are under facing operation. The first specimen A the kool cut 40 only taken. Kool cut 40 litrewe can mix with 25 litre of water. So, for 1 litre of water 40 ml of kool cut 40 is taken mixed with water and facing operation taken place.

Then 20% of mahua oil that is 8 ml of mahua oil is mixed with 32 ml of coolant and blended with water to do the facing operation of cylindrical shaft and mentioned as B.

Then 40% of mahua oil-16 ml is mixed with kool cut 40-24 ml and mixed with water as a coolant and same operation is conducted with same feed speed and motor speed and the specimen marked as C.

Finally, 60% of mahua oil that is 24% of mahua oil mixed with 16 ml of kool cut 40 and the machining operation conducted and the specimen is marked as D.

All the four specimens are taken for surface roughness testing to fine the lubrication properties of mahua oil.

3.2. Bio Lubricant –Mahua Oil:

Madhuca longifolia

- *Madhuca longifolia is an Indian tropical tree found largely in the* central and north Indian plains and forests.
- It is commonly known as mahua, mahwa or Iluppai. It is a fast-growing tree that grows to approximately 20 meters in height, possesses evergreen or semi evergreen foliage, and belongs to the family Sapotaceae.
- It is adapted to arid environments, being a prominent tree in tropical mixed deciduous forests in India in the states of West Bengal, Chhattisgarh, Jharkhand, Uttar Pradesh, Bihar, Maharashtra, Telangana, Madhya Pradesh, Kerala, Gujarat, Orissa and Tamil Nadu.

3.3 Scientific classification

- Kingdom: Plantae
- (unranked): Angiosperms
- (unranked): Eudicots
- (unranked): Asterids
- Order: Ericales
- Family: Sapotaceae
- Genus: *Madhuca*
- Species: *M. longifolia*
- Binomial name
- *Madhuca longifolia*

3.4 Properties of Mahua Oil

- Specific Gravity - 0.904
- Density - 945 kg/m³
- Kinematic viscosity - 37.18 at 40° c
- Calorific Value - 38.96mj/kg
- Pour point - 15°C
- Flash point - 185°C
- Fire point - 250°C

3.5 Workdone:

- The first sample is marked as A and facing operation has done with 100% reference cutting oil made by Hindustan Petroleum Company.
- The second specimen marked as B and 20% mahua oil is mixed with cutting fluid and the same operation has done.
- The third sample marked as C and 40% of bio lubricant mixed with coolant and facing operation conducted.
- The fourth sample marked as D and 60% of mahua oil measured and mixed with coolant and facing operation conducted.

3.6 Observation:

- The surface finish is better in 60% of Mahua oil mixing and temperature conductivity is very good in sample D. There is no heat in the sample after machining.

EST SAMPLE	OPERATING SPEED(rpm)	CUTTING FEED(mm)	SURFACE FINISH	TEMPERATURE AFTER MACHINING
KOOL CUT 40	1200	2	good	Very high
20% M.OIL	1200	2	good	high
40%M.OIL	1200	2	v.good	medium
60%M.OIL	1200	2	smooth	low

TABLE 3.1 OBSERVATION OFEXPERIMENT

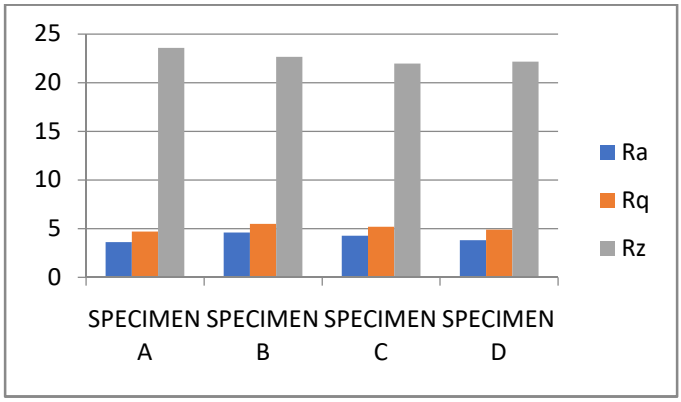
3.7 Specimens:

AFTER MACHINING

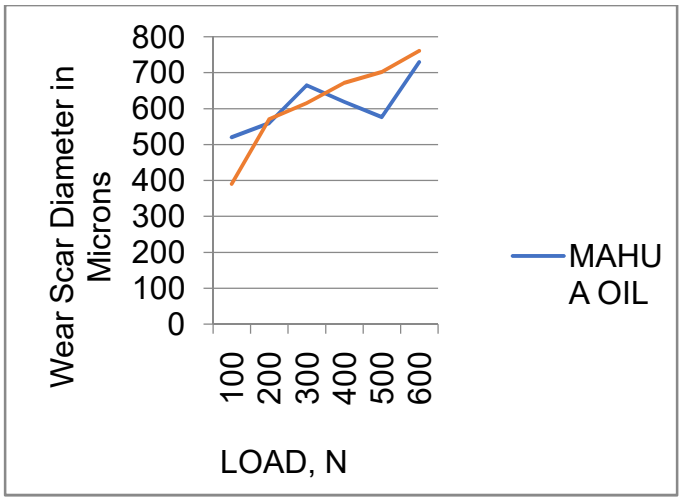
IV. DATA ANALYSIS

4.1 Surface Roughness

Comparison Chart:



4.2 Comparison Chart of Wear Scar Diameter of Mahua Oil:



V. DISCUSSION OF INVESTIGATION RESULTS

After conducting two tests the following points are observed. The surface roughness of the specimen A which we used only the coolant is more or less equal to the specimens which coolant is modified mahua oil mixture. the heat conduction is more in mahua oil mixture than the coolant. It is conducted more amount of heat in the specimen noticed by observation.

The specimens B and C are given slightly higher deviation in the surface roughness.

That is 60% of Mahua oil with coolant gives same surface finish in the specimen. Wear Scar diameter results shows that when load is increased the wear scar diameter is reduced while comparing kool cut 40 oil which is used as reference oil in the test.

The Mahua Oil is having good wear resistance as a lubricant to reduce the tool wear of the tool while machining operation.

VI. CONCLUSION

From the test and experimental investigation, we came to conclude that Mahua oil is a very good replacement for conventional synthetic coolants. It provided a very good surface finish and good lubricity between the tool tip and work piece. It was conducted more amount of heat than coolant by physical observation. The Tribological characteristics were tested and verified that we could use Mahua oil as a sustainable Metal Working Fluids in commercial purpose. It will save the environment pollution and workers health. And it will increase the economy of the formers also.

VI. FUTURE SCOPE

In this Experiment we conducted the tests for tribological characteristics of Mahua oil.

In future we can test the thermal conductivity parameters and whether it is suitable for maintenance lubricant in industrial field.

We can also test it may be acted as a rust preventive oil in the machined components.

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