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Analytical studies on lubrication properties of different vegetable oils blends at different temperatures

Kailas M. Talkit*[1], D. T. Mahajan[2] and V. H. Masand[2]

[1]*Department of Engineering Chemistry, DESS COET Dhamangaon Rly, India*
[2]*Departmentof Chemistry, V.B.M.V. Amravati, India*

ABSTRACT

Different vegetable oils viz. soybean oil, olive oil, almond oil, amla oil, castor oil, groundnut oil, cottonseed oil, coconut oil, sesame oil, sunflower oil, mustard oil were purchased from the local standard market. Different blends of vegetable oils were prepared in different proportions and lubrication properties like cloud point, pour point, flash point, fire point and % carbon residues were determined. From this study, it's found that given lubrication properties changes with changing vegetable oil blends. This study will help the lubricant producing industry to check out most ecofriendly, economical vegetable oil blends as industrial lubricant at lower as well as at higher temperatures.

Keywords: Vegetable oils, lubricant, blends, ecofriendly, temperature

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INTRODUCTION

Lubricants are most important products obtained from crude mineral oils. Lubricating oils have wide range of application including proper functioning of every machine, equipment and instrument. Lubricating oils aremainly known for their five essential functions like lubrication, coolant, carrier, protecting and sealant. Lubricating oil keeps parts of machine which touching each other and reduces friction of moving parts like bearings, etc. Zhang G. et al. [1]. As a coolant lubricating oil carries away the heat of friction and gas compression to keep machine at moderate temperature. Lubricating oil as a carrier removes wear particle and other particle in suspension results minimizing damage. These particle eventually removed by oil changes or filtration. As protectant, oil protects the machine from corrosion. Lubricating oil improve efficiency by creating deep ultimate vacuum in device like vacuum pumps. In lubricating market, most of the lubricants are made up from mineral oil. Lubricants made from mineral oil have many disadvantages after use. Itcauses environmental pollution like soil pollution, air pollution, water pollution etc. K.M. Talkit et al. [2]. Due to increasing use of mineral oil base lubricant leads to increasing concentration of greenhouse gases in atmosphere resulting in global warming effect. To minimize all given problems related to environment, worldwide lubricating industry has developing interest for the use of biolubricant. S. Kango et al. [3]. Vegetable oil base lubricant shows excellent biodegrability, low temperature stability, high viscosity index etc. due to all lubricating properties vegetable oils act as intimate substitute for mineral oil base lubricant. Many researchers have studied vegetable oil as industrial lubricants. L. A. Quinchia et al. [4]. An overview on cloud point extraction as sample preparation technique for trace element analysis was investigated by Nabil Ramdan Badera et al [5]. In this work, cloud point extraction, mechanism advantage, disadvantage and other some application have been discussed. Nadia Salih et al [6]. Carried study on biolubricant from chemically modified plant oil including ricinoleic acid base tetraester. From the above research, it's found that these derivatives have good antiwear and friction reducing properties at relatively low concentration and simply used as biolubricant base stocks.]. A. Gohari, Ardabili, R. Farhoosh and M. H. Haddad Khodaparast [7]. Investigate Chemical Composition and Physicochemical Properties of Pumpkin Seeds (*Cucurbitapepo*Subsp. pepo Var. Styriaka) Grown in Iran. From this study it revealed that pumpkin seed oil could be used as biodiesel. Studies on flash point of lubricating oil including engine oil and recycle lubricating oil by acid/clay treatment, distillation/clay acid treatment and activated charcoal/clay treatment have been done by J.D. Uddon [8] and Ihsan Hamawand [9]. M.I. Oseni et al [10] was determined extraction and analysis of physical and chemical properties of yellow oleander oil as lubricant from the result obtained its proved that given oil can be used as lubricant in environmental sensitive areas including marine ecosystem and total loss of lubrication with associated positive environmental and economic impact. Recycling of used engine oil as industrial lubricant by composite solvent method, acid treatment method and single solvent method was investigated by Rashid Abro et al [11]. From result obtained shows that by using this methods flash point, viscosity, pour point, specific gravity and ash percentage was improved and best result was shown by composite solvent method. O. G. Lgbum et al [12]. Studied variables in characteristics of methyl ester obtained from four virgin tropical seed oil in Nigeria. Performance of C.I. engine by using biodiesel prepared from mahuna seed oil investigated by sudhirnandi [13]. From the given study, it's proved that mohuna seed oil biodiesel could be used as economical biodiesel. From the above literature review, it's confirmed that lubrication properties of vegetable oils can beenhanced by using various methods. In the present research work, one such attempt has been made to evaluate lubrication properties of vegetable oil blends to find out such blends which show better lubrication properties at lower as well as higher temperatures.

MATERIALS AND METHODS

2.1 Test oils

In the measurement of lubrication properties, test vegetable oils used in this work were soybean oil, olive oil, almond oil, amla oil, castor oil, groundnut oil, cottonseed oil, coconut oil, sesame oil, sunflower oil and mustard oil and their blends in different proportion. During blending process soybean oil blends with other oils stirred continuously to ensure uniform mixing.

2.2Flash point and fire point measurements

Flash point of soybean oil and their blends with other vegetable oils was determined by clevends open cup flash point apparatus

The experimental procedure involves following steps:

1. Thoroughly clear and dry the oils
2. Fill the cup with sample so that the top of miniscus is exactly at the filling marks. If too much is added removed by pipetting.
3. Place the cup on heating stove and insert the thermometer in a vertical position with the bottom of bulb 0.4 mm from bottom of cup.
4. Light the test flame by adjusting the gas flow. Adjust it 3.2 to 4.8mm diameter.
5. Switch on heater and adjust regulator for heating such that temperature rise of sample is 15^0c per minute.
6. Record the flash point as the temperature when first flash appears at any point on the surface of oil.
7. In order to find out the fire point continue heating at the rate of 5^0c to 6^0c per minute.
8. Continue application of test flame as before until the oil emits and continues to burn for at least 5 second.
9. Record this temperature as fire point of oil.

2.2Cloud point measurements

Cloud point of soybean oil and their blends with other vegetable oils was determined by Cloud Point apparatus

The experimental procedure involves following steps

1. Bring the test oil to a temperature at least 14^0c above the expected cloud point.
2. In order to remove any moisture present in the sample, add preheated anhydrous sodium sulphate 1gm/50ml of sample. Keep like that at least for 10minutes and then filter through ordinary filter paper.
3. Pour this clean oil sample in to test jar to the level mark (5157 mm).
4. Tightly close the test jar by cork carrying test thermometer in vertical position in center jar with thermometer bulb resting on bottom of jar.
5. Place the disc in the bottom of jar and insert the test jar with ring gasket 25mm from bottom in jacket.

6. Maintained the temperature of cooling bath at -1^{0}c to +2^{0}c by wing crushed ice and water as cooling mixture.
7. After every 1^{0}c fall in temperature remove the test jar from jacket.
8. When oil does not show a cloud when cooled to -7^{0}c, place jar in third bath maintained at -26^{0}c with crystal ice and $cacl_2$ crystal for maintaining very low temperature both solid CO_2 and acetone or petroleum naphtha may use up to -57^{0}c.
9. When such inspection shows distinct cloudiness or haze at bottom of test jar record the reading of thermometer as cloud point.

2.3 Pour point measurements

Pour point of soybean oil and their blends with other vegetable oils was determined by Pour Point apparatus

The experimental procedure followed by following steps

1. Pour the oil in to test jar to height between 5-5.7 cm.
2. Close the jar with cork carrying test thermometer in vertical position with the bulb immersed about 3mm below surface of the oil.
3. Heat the oil sample to 46^{0}c without stirring and cool in air to 35^{0}c if expected pour point between +32^{0}c and -34^{0}c.
4. If expected pour point is above 32^{0}c heat the oil sample to 46^{0}c or to a temperature approximately 8^{0}c above expected pour point.
5. If expected pour point is below -34^{0}c heat the oil without stirring to 46^{0}c and cool to 16^{0}c.
6. Place the disc in the bottom of jacket and insert the test jar with ring gasket 25mm from bottom in jacket bath at -1 to 2^{0}c by using crushed ice and water only as cooling mixture.
7. Beginning at the temperature 12^{0}c above the expected pour point remove the test jar from jacket carefully, after ever 3^{0}c fall in temperature.
8. If the oil has not ceased to flow when temperature reached to 9^{0}c. Place the jar in second cooling bath maintained at -18^{0}c to -15^{0}c with crushed ice and sodium chloride crystals and if necessary to third bath maintained at -26^{0}c with crushed ice and sodium chloride crystal.
9. Continue the test in this manner till a point is reached when oil shows no movement when test jar is held in horizontal position for this is freezing point of oil.
10. Pour point is 3^{0}c more than freezing point.

2.4 % Carbon residue measurements

% Carbon residue of soybean oil and their blends with other vegetable oils was determined by Condrason carbon residue apparatus

The experimental procedure followed by following steps

1. Weigh the clean and dry crucible with two glass head
2. Weight about 10gm of the sample to the nearest 5gm.
3. Place this crucible in the center of skidmore crucible.
4. Level the sand in the largest sheet iron crucible and set the skidmore crucible in the center of the iron crucible.
5. Place the cover to the both skidmore and iron crucible.
6. Keep the crucible resting on the wire triangle which is supported on the tripod stand.
7. Cover the whole thing with iron hood.
8. Heat the burner adjusts the flame so that the preignition period is 10 ± 1.5 minute.
9. When smoke appear above the chimney move the burner to ignite vapour.
10. The period of burning the vapour is ± 13 minutes.
11. After the vapour ceases to burn heat the crucible to red heat for 7 minutes.
12. Remove the burner for cool the apparatus

% Carbon residue $= \frac{A \times 100}{W}$

Where, A= Weight of carbon residue in grams

W= Weight of sample in gram

Table 1 Shows cloud point, pour point, flash point, fire point and %carbon residue of different vegetable oils blends

Sr. No.	Test Sample	Mixture Ratio	Cloud Point	Pour Point	Flash point	Fire Point	% Carbon Residue
1	Soybean oil + Olive Oil	10+90	-6^{0}c	-15^{0}c	327^{0}c	358^{0}c	0.3723%
2	Soybean oil + Almond Oil	90+10	-10^{0}c	-22^{0}c	286^{0}c	330^{0}c	0.6309%
3	Soybean oil + Amla Oil	10+90	-5^{0}c	-7^{0}c	324^{0}c	352^{0}c	0.5271%
4	Soybean oil + Castor Oil	10+90	-11^{0}c	-15^{0}c	318^{0}c	332^{0}c	3.3764%
5	Soybean oil + Groundnut Oil	10+90	-5^{0}c	-10^{0}c	342^{0}c	355^{0}c	0.7942%
6	Soybean oil + Cottonseed Oil	30+70	-6^{0}c	-14^{0}c	322^{0}c	344^{0}c	1.3683%
7	Soybean oil + Coconut Oil	90+10	-5^{0}c	-19^{0}c	326^{0}c	342^{0}c	0.7653%
8	Soybean oil + Sesame Oil	10+90	-4^{0}c	-13^{0}c	332^{0}c	348^{0}c	0.7372%
9	Soybean oil + Sunflower Oil	70+30	-7^{0}c	-16^{0}c	334^{0}c	358^{0}c	1.2219%
10	Soybean oil + Mustard Oil	20+80	-5^{0}c	-18^{0}c	328^{0}c	345^{0}c	0.6626%

RESULTS AND DISCUSSION

3.1 Cloud point
Cloud point denotes as temperature at which crystallization of solid occur in the form of cloud when oil is cooled at specified rate in standard apparatus. Cloud point expresses low temperature stability of lubricating oil. From the above table shows that soybean castor oil blend possesses lower cloud point due to presence of large number of saturated fatty acid while soybean sesame oil blend possesses higher cloud point due to presence of more polyunsaturated fatty acid.

3.2 Pour point
Pour point is denoted as temperature at which oil is just ceases to flow when cooled at specified rate in standard apparatus. From above table and figure it’s found that soybean almond oil blend possesses low pour point increasing cis unsaturation or low molecular weight fatty acid while soybean amla oil blend possesses high pour point due to increasing high molecular weight fatty acid.

3.3 Flash point
Flash point of oil expressed as minimum temperature at which oil gives sufficient vapours to ignite momentarily when a flame of standard dimension brought near the surface of oil for a prescribed rate in apparatus of specified dimension. From above table it’s found that soybean groundnut oil blend shows high flash point due to presence of more unsaturation in fatty acid while soybean castor oil blend possesses low flash point due to presence of volatile matter andmore free fatty acid molecule.

3.4 Fire point
Fire point of oil expressed as minimum temperature at which oil give sufficient vapours to ignite momentarily at least 5 seconds when a flame of standard dimension brought near the surface of oil for a prescribed rate in apparatus of specified dimension. From the above table and figure it’s found that soybean olive oil blend possesses high fire point while soybean almond oil blend possesses low fire point than remaining vegetable oil blends. High fire point of given blend due to more stability of triglyceride at high temperature and low amount of free fatty acid form after heating. Low fire point of given blend due to more amount of free acid form after heating occur due to large degradation of triglyceride in to free fatty acid.

3.5 % Carbon residue
Carbon residue expressed in terms of percentage carbon that is left on evaporating known quantity of fuel under specified condition in specified apparatus. Carbon residue occurs mainly due to byproducts of fuel and lubricants. It’s mainly related to percentage of free fatty acid, glyceride, and polyunsaturated fatty acid. From the above table and figure it’s found that % carbon residue of soybean amla oil blend is lower while soybean castor oil blend is higher than other vegetable oil blends. Lower carbon residue due to decreasing amount of free fatty acid, glyceride and polyunsaturated fatty acid in given oil blends while % carbon residue increases due to increasing same.

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