Investigation on Critical Parameters of Blended Vegetable Oil

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Abstract
Petroleum products have long dominated the world's energy demands in a range of application industries. Natural-based ester oil is recommended as a good substitute for regular mineral oil when looking for a liquid insulation. Several ratios of vegetable ester oil were combined in this study in order to assess the typical properties of blended liquid as liquid insulation. Studies are being conducted on the oils derived from Ricebranoil, Soyabeanoil , and Cottonseed oil. According to standards, tests must be conducted using various combinations of viscosity, breakdown voltage, and pour point. According to the investigation, standard mineral oil samples may someday be replaced with individual oil samples. Furthermore, the blended varieties demonstrate that the blending of the samples causes modifications, indicating the need for additional study.

Keywords: Vegetable Oil; Blending; Liquid Insulation; Transformers

1. INTRODUCTION
Transformer oil is actually the insulating fluid used in electrical power transformers. Fractional distillation and additional processing of crude petroleum are used in its production. The transformer emits heat each time a strong electric field is applied. Therefore, the primary functions of transformer oil are to prevent direct contact between the insulation and surrounding oxygen, cool the transformer, inhibit corona and arc discharges, and minimise pyrolysis. Mineral oil is a complex mixture of hundreds of different chemical compounds, with the elements carbon and hydrogen making up the majority of its molecules. Three distinct types of mineral oil exist. Naphthenic hydrocarbons are present in trace amounts in paraffinic crudes, which are further classified as regular paraffin and o-paraffins. Naphthenic crudes have several benefits over these three oils, including as Mineral oils are still a great economical and technological option, but it's crucial to consider how they affect the environment. Their toxicity and biodegradability make them stand out as an excellent alternative to mineral oil. Triglycerides are created by etherifying tri-alcohol glycerol with three fatty acids in vegetable oil. Both synthetic and naturally occurring ester-based liquid dielectrics are becoming more and more well-liked among academic institutions and commercial enterprises worldwide. Especially for dielectric fluids based on ester, biodegradability is an essential feature. As a result, there is a pressing need for and chance to increase knowledge of these innovative insulating fluids. Blended oil, which is formed by mixing two insulating liquids, has recently been suggested as an alternative.

1.1 Oil samples
This study set out to investigate the properties of samples of pure natural ester oil and mixed natural ester

oil based on the literature. Based on factors such as cost, previous research, and geographic availability, vegetable oil samples such as soybean oil (SBO), Ricebran oil (RBO), and Cottonseed oil (CSO) were chosen for analysis. Samples of unrefined vegetable oil are taken from a neighbouring areas.

Table -1: SAMPLEOILS

Base oil sample1	100% SBO
Base oil sample2	100% RBO
Base oil sample3	100% CSO

1.2 Blended oil samples preparation

The sample preparation is done in a 500mL glass spherical reactor that has mechanical stirring and a thermostat. To eliminate moisture, each vegetable oil sample is added in line with the recommended samples after the reactor has been warmed to 75°C. When the reactor reaches the reaction temperature, the stirring system is activated, and this is when the reaction officially begins.

Table 2 : Blended oil samples

Sample	Oil quantity	Oil quantity	Oil quantity
Blended Sample1	250	250	-
Blended Sample2	225	150	125
Blended Sample3	250	175	250
Blended Sample4	175	125	250

1.3 Measurements and properties of oil samples

The importance of important variables including pour point, viscosity, and breakdown voltage is covered in this section along with experimental testing methods. The breakdown voltage of oil samples is determined at a certain voltage that causes breakdown between electrodes under specified test conditions by delivering a voltage across the electrode at a rising rate of 2 kV/s. The test is run five or six times to determine the dielectric breakdown voltage of oil samples.

Fig1 : Breakdown voltage kit

Viscosity can affect cooling and how cooling-related equipment functions. Viscosity may have an impact on cooling and the performance of cooling-related machinery. According to IEEE Standard C57.14 from 2018, a liquid's viscosity is a measurement of how resistant it is to flow. According to ASTM D445, the viscosity of liquid insulation is computed in a redwood viscometer. It is determined by timing the passage of 50 ml of oil samples through an aperture in a viscometer under carefully regulated conditions. A redwood viscometer is depicted in Figure 2.

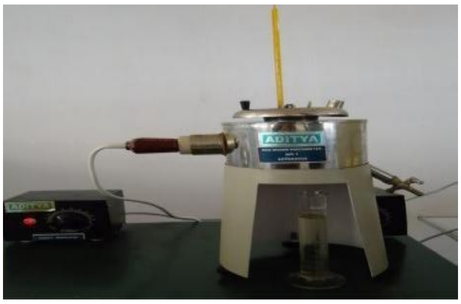

Fig2: Redwood viscomter

The pour point of liquid insulation is the lowest temperature at which liquid flows in a certain circumstance. Below the pour point, oil flow can be challenging, as viscosity restricts flow.

Fig 3: Pour point Apparatus kit

2. Properties of Base oil

For preliminary analysis on a few oils, breakdown voltage, viscosity, flash point, fire point, and pour point are tested in accordance with standards. Tables 3, respectively, contain values for the attributes of base oil sample and blended oil sample samples.

Table 3 : Properties of oil samples

Properties	SBO	RBO	CSO
Breakdown voltage(kv)	37	38	39
Viscosity(cst)	75	82	77
Pour Point(^{0}c)	-7	-5	-7

Table 4 : Properties of Blended Oil Samples

Oil samples	Breakdown voltage(kv)	Viscosity(cst)	Pour Point(^{0}c)
Blended sample 1	36	77	-7
Blended sample 2	35	78	-8
Blended sample 3	38	75	-9
Blended sample 4	36	77	-7

The breakdown voltage of a liquid insulation is an important consideration when assessing its capacity to tolerate the electrical stress generated within a transformer while it is in operation. IEEE guidelines state that a minimum breakdown voltage of 30 kV is appropriate. Based on the main evaluation of the features of the selected oil samples for this inquiry, all of the oil samples (both blended and base) had a breakdown voltage more than 30 kV. These results suggest that certain natural esters are attractive candidates for use as liquid insulation in transformers due to a critical breakdown voltage feature.

Fig -4: **oil sample**

The viscosity of the liquid has a major impact on the performance of the coolant and other liquid insulation-related components in the transformer. The IEEE guidelines for absorbing liquid insulation provide a maximum range of 50 cSt for the viscosity value of natural esters. The viscosities of liquid insulations based on vegetable oil are often higher than those of mineral oil, which is commonly used in transformers. This study demonstrates that the measured viscosity values for vegetable oil samples are also greater than the accepted reference value. Natural esters have the potential to reduce cooling efficacy when used directly.

The pour point of liquid insulation is an important feature that indicates a temperature range at which free flow is permitted. According to IEEE guidelines, -100C is the minimal pour point temperature at which liquid insulation can be accepted. More noteworthy pour point temperatures are found in all of the samples. These results imply that at very low temperatures, oil samples might crystallise or freeze. The findings show that the components of fatty acids affect pour point values. The studied natural esters' pour point temperature should be lower than the results in order to be used in cold climates. The research that is currently available suggests several approaches to reduce the pour point from its expected value to a range.

3. CONCLUSIONS

The world is currently moving away from polluting and hazardous petroleum-based goods and towards environmentally benign and renewable vegetable-based oils. These renewable resources have strong dielectric qualities and can be used risk-free. This study thus looks on the properties of mixed oils based on natural ester oil. The properties of blended oil combinations are superior to those of raw oil samples. This mixed oil can be used in any electrical equipment, depending on its intended use and essential characteristics. The mixed sample being studied could be a useful replacement for ordinary mineral oil. The price difference between mineral oil and natural esters is the only negative.

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