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Investigation of Vegetable Oil Blended with Mineral Oil

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Abstract

Oil-based commodities have long dominated the world's energy needs across a variety of industries.. Vegetable-based ester oil is provided as an environmentally friendly substitute for traditional mineral oil for fluid protection. In order to evaluate the essential characteristics of blended liquid as liquid insulation, various ratios of mineral and ester oil were combined in this study. Studies are being conducted on sunflower, safflower, and rice bran oils. Tests are carried out on viscosity, breakdown voltage, flash point, and pour point for different combinations in accordance with industry standards (IEC and ASTM). The study found that blended mixes exhibit quality fluctuations that suggest hopeful signs for mineral oil replacement.

Keywords: Vegetable Oil, Blending, Mineral Oil Transformers

1. INTRODUCTION

Electrical power transformers use transformer oil as its insulating fluid. It is made by processing crude petroleum after fractional distillation. Transformers are operated by combining the motions of the core and winding. An intense electric field causes heat to be generated inside the transformer. Therefore, the primary purpose of transformer oil is to avoid corona and arc discharges. To lessen pyrolysis, a coolant ought to be applied. Allowing insulation to come into contact with outside air is a bad idea. The elements carbon and hydrogen make up the majority of the molecules in mineral oil, which is a complex mixture of hundreds of different chemical compounds. Mineral oil comes in three distinct varieties. Straight-chain paraffin makes up normal paraffin.. Natural and synthetic ester-based dielectric fluids are being used more often by researchers and businesses worldwide who are interested in liquid dielectrics. Triglycerides are produced spontaneously when three fatty acids are etherified with tri-alcohol glycerol in vegetable oil. Two insulating liquids were combined to generate blended oil, a novel substitute for mineral oil. For its anti-aging qualities, blended oil is better than mineral oil. This mixed oil has low moisture content, low acid number, low degradation ratio, and low dielectric loss. However, this is dependent on the type of ester oil and acid concentration. The miscibility of the ester oil determines its performance characteristics. Biodegradability is an essential need for ester-based dielectric fluids. Consequently, it is absolutely essential.

1.1 Oil Samples

Soybean oil (SBO), rice bran oil (RBO), and have been chosen as vegetable oil samples for analysis based on factors such as cost, geographic accessibility, and previous study. Vegetable oil samples and raw mineral oil (MO) are acquired from a nearby factory.

1.2 Blended oil samples

A 500 mL glass spherical reactor with mechanical stirring, a thermostat, and a sample exit is used to conduct the process. The technique used is described in the sentences that follow. Once heated to 75°C to eliminate moisture, each vegetable oil sample is put to the reactor. Time zero for the reaction occurs when the reactor achieves the reaction temperature and the stirring system is activated. Every mixture is vigorously swirled and refluxed for the required duration.

2. Measurements and properties of oil samples

Important components including pour point, viscosity, and breakdown voltage are covered in this section along with experimental testing techniques. The breakdown voltage is the most important consideration when choosing whether or not to use oil as a transformer protection. Numerous factors, such as causticity, air pockets, strong particles, and moisture pressure, might alter the breakdown voltage.

Table -1: SAMPLEOILS

Base oil sample1	100% MO
Base oil sample2	100% **SBO**
Base oil sample3	100%RBO
Blended oil samples1	50%MO+50%SBO
Blended oil samples2	50%MO+50%RBO

The breakdown voltage is the most important consideration when choosing whether or not to use oil as a transformer protection. Numerous factors, such as causticity, air pockets, strong particles, and moisture pressure, might alter the breakdown voltage. The breakdown voltage of the examples was determined using an oil test unit at room temperature in accordance with IEC 60156 [13] standards. The estimation limit for the oil test pack is 60kV.

Fig:1 Breakdown voltage kit

In a liquid, shear stress produces a barrier known as viscosity.Differently thickened liquids as well as liquids with varying thicknesses can be carried successfully and problem-free. Since it is expected that an additional oil course would be added for cooling, the transformer oil should have a medium consistency.

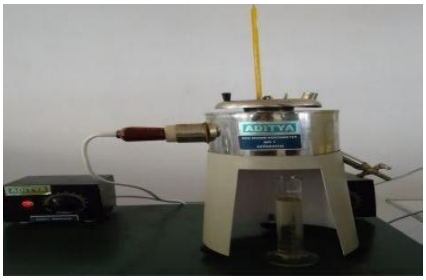

Fig 2: Redwood viscometer

One of the key elements demonstrating the effectiveness of fluid protection in cold climate zones is low temperature execution. The lowest temperature at which fluid streams permissibly is known as the pour point of fluid protection. This could be problematic because consistency further restricts the oil stream below the pour level.

Fig 3: Pour point Apparatus kit.

2. Properties of Base Oil Samples

Table 2: Properties of Base oil samples

Properties	MO	SBO	RBO
Breakdown Voltage (kV)	37	35	36
Viscosity at 40^0C (cSt)	13	54	52
Pour Point (^{0}C)	-7	10	7

Table 3: Properties of Mixed oil samples

Properties	50% MO + 50% SBO	50% MO + 50% RBO
Breakdown Voltage (kV)	37	37
Viscosity at 40^0C (cSt)	29	24
Pour Point (^{0}C)	4	5

The breakdown voltage of a liquid insulation is a critical component that determines its ability to tolerate the electrical stress generated inside the working transformer. According to IEEE guidelines, the breakdown voltage ought to be at least 35 kV. Each oil sample had a breakdown voltage greater than 35 kV, according to the primary study of the features of the samples chosen for this investigation. These results led to the conclusion that certain natural esters are appropriate as liquid insulation for use in transformers due to a critical breakdown voltage attribute. Vegetable oil-based liquid insulations usually have a higher viscosity than the standard mineral oil used in transformers. The observed viscosity values of the vegetable oil samples were similarly found to be substantially greater than the. The pour point of liquid insulation is one of the most important features that indicates a temperature range where free circulation is trouble-free. IEEE regulations state that -10°C is the minimum pour point temperature at which liquid insulation can be accepted.The pour point temperatures of all the samples are positive, the exception being mineral oil. These figures imply that oil samples could crystallize or freeze before the

temperature drops below zero. The findings suggest that the components of fatty acids affect pour point values. The researched natural esters' pour point temperature should be significantly lower than the obtained values for use in cold climates. On the basis of the literature on pour point reduction, many strategies ought to be used.

3. CONCLUSIONS

Today, the entire world is experiencing a change from products made of oil that are bad for the environment to products made of vegetable oils that are renewable and good for the environment. These infinite resources can be employed safely and have great dielectric properties. In this work, the features of mineral and typical ester oil-based mixed oils will be further examined. Testing on mineral oils shows that blended oil mixtures have superior qualities to mineral oil tests. Depending on the desired qualities and the application area, this mixed oil can be utilized in any electrical hardware.The researched mixed example has the potential to be a workable substitute for traditional mineral oil. The major problem is that regular esters cost more than mineral oil.

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