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Performance Characteristics of Blended With Vegetable and Mineral Oil

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Abstract

Oil-based commodities have long dominated the world's energy needs across a variety of industries. As an alternative to conventional mineral oil for fluid protection that is also eco-friendly, vegetable-based ester oil is offered. In this study, different mineral and ester oil ratios were combined to assess the key properties of blended liquid as liquid insulation. Research is being done on rice bran, safflower, and sunflower oils. According to industry standards (IEC and ASTM), tests are conducted on viscosity, breakdown voltage, flash point, and pour point for various combinations. According to the study, blended mixtures show variations in qualities that point toward encouraging indications for replacing with mineral oil.

***Key Words*: vegetable oil; blending ,mineral oil transformers**

1. INTRODUCTION

Transformer oil is the insulating fluid employed in electrical power transformers. It is produced by fractional distilling crude petroleum and then treating it. The core and winding motions are combined to operate transformers. Heat is produced inside the transformer when a strong electric field is applied. As a result, preventing corona and arc discharges is the main goal of transformer oil. A coolant should be used to reduce pyrolysis. It's not a good idea to let insulation come into contact with ambient oxygen. The majority of the molecules in mineral oil are made of the elements carbon and hydrogen, and it is a complex mixture of hundreds of different chemical compounds. There are three different kinds of mineral oil. Normal paraffin, which consists of straight-chain molecules similar to those in wax, and paraffins are two paraffinic crudes that contain a small amount of naphthenic hydrocarbons (branched paraffins). Naphthenic crudes have a number of advantages over these three oils, including the fact that they have a very low wax content. Naphthenic oils have a lower viscosity than paraffinic oils because they are thinner. Mineral oils must be evaluated in terms of their environmental impact even if they continue to be a great technological vs. cost solution. Researchers and enterprises interested in liquid dielectrics around the world are increasingly using natural and synthetic ester-based dielectric fluids. When the tri-alcohol glycerol is etherified with three fatty acids in vegetable oil, triglycerides are created on their own. A unique mineral oil alternative called blended oil was created by blending two insulating liquids. Blended oil is superior to mineral oil in terms of its anti-aging properties. Low dielectric loss, low degradation ratio, low acid number, and low moisture content are all characteristics of this blended oil. But it depends on the kind of ester oil and the amount of acid. The performance qualities depend on how miscible the ester oil is. Ester-based dielectric fluids must be biodegradable, which is crucial. Therefore, it is vitally necessary to update existing expertise and literature on these new insulating fluids.

1.1 Oil Samples

Based on geographic accessibility, cost, and prior research, Sunflower Oil (SUO), Safflower Oil (SAO), and have been selected as vegetable oil samples for examination. Samples of vegetable oil and unprocessed mineral oil (MO) are obtained from a neighbouring facility.

1.2 Blended oil samples

The reaction is carried out in a 500mL glass spherical reactor equipped with a thermostat, mechanical stirring, and a sample exit. The following sentences give a description of the method employed. Each vegetable oil sample is added to the reactor after it has been warmed to 75°C to remove moisture. When the reactor reaches the reaction temperature, the stirring system is turned on, making this moment time zero for the reaction. Each combination is stirred and refluxed strongly for the desired amount of time

2. Measurements and properties of oil samples

In this part, important elements including breakdown voltage, viscosity, and pour point are discussed along with experimental testing methods. The most crucial factor in deciding whether or not to use oil as a transformer protection is the breakdown voltage. The breakdown voltage is affected by a number of variables, including as causticity, air pockets, strong particles, and moisture pressure.

Table -1: SAMPLEOILS

Base oil sample1	100% MO
Base oil sample2	100% SUO
Base oil sample3	100%SAO
Base oil sample 4	100% PO
Blended oil samples1	50%MO+50%SUO
Blended oil samples2	50%MO+50%SAO
Blended oil samples3	50%MO+50%PO

The most crucial factor in deciding whether or not to use oil as a transformer protection is the breakdown voltage. The breakdown voltage is affected by a number of variables, including as causticity, air pockets, strong particles, and moisture pressure. According to IEC 60156 [13] guidelines, the breakdown voltage of the examples was calculated using an oil test unit at room temperature. The oil test pack's estimation limit is60kV

Fig:1 Breakdown voltage kit

A barrier called viscosity is created by shear stress in a liquid. Both liquids with different thicknesses and liquids with different thicknesses can be successfully transported without running into any problems. The transformer oil should be of a medium consistency because it is anticipated that an additional oil course would be added for cooling. The thickness of the oil depends on the temperature.

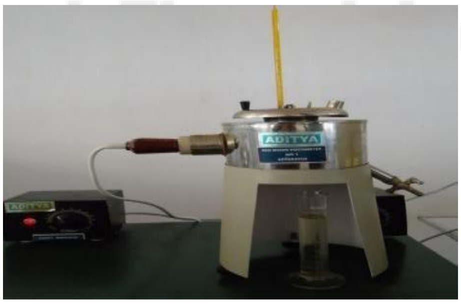

Fig 2: Redwood viscometer

Low temperature execution is one of the crucial factors illustrating the capacity of fluid protection in chilly climate zones. The pour point of fluid protection refers to the lowest temperature at which fluid streams legally. Consistency further limits the oil stream below the pour threshold, which could be troublesome.

Fig 3:Pour point Apparatus kit

2. Properties of Base Oil Samples

Table 2: Properties of Base oil samples

Properties	MO	SUO	SAO	PO
Breakdown Voltage (kV)	35	35	36	38
Viscosity at 40^0C (cSt)	12	52	50	56
Pour Point (^{0}C)	-6	9	6	12

Table 3: Properties of Mixed oil samples

Properties	50% MO + 50% SUO	50% MO + 50% SAO	50% MO + 50% RBO
Breakdown Voltage (kV)	35	35	36
Viscosity at 40^0C (cSt)	27	22	25
Pour Point (^{0}C)	3	3	6

A crucial factor that establishes a liquid insulation's capacity to withstand the electrical stress produced inside the operating transformer is its breakdown voltage. IEEE recommendations state that the breakdown voltage should be at least 35 kV. The main analysis of the characteristics of the selected oil samples for this examination revealed that all of the oil samples had a breakdown voltage more than 35kV. These findings lead to the conclusion that a crucial breakdown voltage property of some natural esters makes them suitable as liquid insulation for use in transformers.

Liquid insulations made of vegetable oil frequently have a higher viscosity than the regular mineral oil used in transformers. Vegetable oil samples' measured viscosity values were also found to be significantly higher than the experiment's declared standard value. If utilized directly, natural esters could have negative effects on cooling performance. In the literature, some methods for reducing viscosity values have been proposed. The natural esters that have been studied should therefore be applied as liquid insulation in transformers using viscosity reduction techniques.

One of the most crucial characteristics that identifies a temperature range where unrestricted circulation is hassle-free is the pour point of liquid insulation. The minimal pour point temperature for acceptance as liquid insulation is -10°C, according IEEE rules.With the exception of mineral oil, all of the samples' pour point temperatures are positive. These numbers suggest that oil samples may freeze or form crystals before it gets below zero degrees Fahrenheit. It may be deduced from the results that fatty acid components have an impact on pour point values. For application in cold areas, the pour point temperature of investigated natural esters should be much lower than the measured values. Several approaches should be followed based on the pour point reduction literature.

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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