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# Study of Insulation of Power transformer with the aid of vegetable oils

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**Abstract -** The transformer is one of the most critical pieces of equipment in an electrical power supply. The majority of transformers utilise oil as a cooling medium, with petroleum-based oil being the most prevalent.The reason for using petroleum-based oil as transformer oil is that it has excellent dielectric strength and cooling properties. Mineral oil, on the other hand, has an environmental impact due to its non-biodegradability and non-renewability. As a result, a renewable resource such as vegetable oil has been chosen to replace mineral oil as the transformer insulation liquid..

***Key Words***: High Voltage Insulation oil, transformer oil, vegetable oils

## 1.INTRODUCTION

Power transformers are critical components in electrical systems because typically manage voltage levels for safe electrical power generation from power stations to homes and businesses across the country. Dry-type and oil-immer-sed transformers are two different types of transformers used in the power sector. Choosing a distribution transformer for a household, commercial, industry, or utility usage has deep consequences.

The number of connected power transformers is expanding in tandem with the world's ever-increasing electricity needs. As a result, they are much more likely to be found around inhabited areas[1].

Ecological demands have prompted the electric power transmission and distribution sector to seek better solutions to mineral oil. Any ecologically suitable alternative has to be secure, cost-effective, and provide a high level of electrical efficiency beyond a prolonged period of time to be deemed reasonable. Natural ester insulators have lately seen a comeback in popularity due to its evident "eco" qualities.

The electric power transmission and distribution sector is looking for better alternatives to mineral oil due to environmental concerns. To be considered reasonable, any environmentally appropriate alternative must be safe, cost-effective, and deliver a high degree of electrical efficiency over a long length of time. Due to their obvious "eco" characteristics, natural ester insulators have recently witnessed a resurgence in favour. Vegetableoil was another most likely candidate for a biodegradable insulation system. Vegetable oil is readily available as a natural resource. It was supposed to be biodegradable as well as insulating . Vegetable oils are becoming much more popular as a mineral oil alternative

Vegetable oils offer features such as high biodegradability (495%), low cytotoxicity, highest yield points (4300 C), flame points (4300 C), decreased thermal conductivity, and are regarded environmentally beneficial liquids [7]. Furthermore, as contrasted to mineraloils, these natural fats retain greater humidity [10,11].

Mineral oil, which is derived from petroleum, has been used as transformer insulation oil for many years [4]. Because of its outstanding cooling performance, strong dielectric strength, low dielectric losses, low cost, good long-term performance, and availability as transformer oil, petroleum-based oil has been widely utilised till now [5].

A transformer leak might potentially result in an explosion, which would have a negative impact on the environment. Mineral oil, after all, is derived from a nonrenewable fossil fuel that will be depleted one day. As a result, given environmental concerns and a scarcity of its supply, a renewable, environmentally beneficial resource such as vegetable oil is the ideal replacement.

Vegetable oil is a biodegradable natural resource with a high burn point, making it suitable for transformer use [6].Three samples of vegetable oils which namely rice bran oil(Gemini brand) and sesame oil (Tilsona brand), in which first sample of 90% rice bran oil and 10% sesame oil, second sample of 80% rice bran oil and 20% of sesame oil and the third sample of 70% rice bran oil and 30% sesame oil are tested for breakdown voltage by standard process and result is compared as per IS-335:1993.

Regardless of how effective it is as an insulating oil, it has a negative environmental impact since it is not biodegradable.

Several studies have been conducted in the past, but the majority of them have focused on the characteristics of vegetables prior to their application in power transformers. The characteristics of vegetable oil before and after use in power transformers are presented in this study[3].

## 2. EXPERIMENT

The use of different fluids in the mixing of vegetable-based

insulation oils has been studied as a way to improve their characteristics. Investigation of the applicability of a combination of rice bran oil and sesame oil as an insulator fluid in a power transformer is considered.

Despite their high flash points (>220°C) and economic and environmental benefits, such composites show little synergy in enhancing physical characteristics such as pour point and viscosity, which are reliant on saturation level. It's also a good idea to use an addition to lower the pour points and enhance the oxidation stability of natural esters

Three samples of vegetable oils which namely rice bran oil(Gemini brand) and sesame oil (Tilsona brand), in which first sample of 90% rice bran oil and 10% sesame oil, second sample of 80% rice bran oil and 20% of sesame oil and the third sample of 70% rice bran oil and 30% sesame oil are tested for breakdown voltage by standard process and result is compared as per IS-335:1993.

- **Oil Testing Kit**


**Fig -1**: Oil Testing Kit

The accuracy of the findings from the transformer oil test kit is guaranteed. Transformer oils must be tested for stability on a regular basis using industry-standard procedures since they are designed to insulate electrically.

When testing transformer oil, the breakdown voltage is measured. As a result, the breakdown voltage's RMS value is reported. This is a fully risk-free treatment. To ensure enhanced operating efficiency, the test cell is enclosed in a transparent hood.

- **Infrared Thermometer**

An infrared thermometer uses a portion of the thermal radiation emitted by the thing being studied, commonly known as black-body radiation, to calculate temperature. They're also known as laser thermometers, non-contact thermometers, or temperature guns, which allude to the device's ability to measure temperature across a range.

By monitoring the amount of infrared radiation released infrared and its emission spectra, the temperature of an object can typically be estimated within a particular range of its real temperature. Infrared thermometers are included in the category of "thermal radiation thermometers."

A sensor with an adjustable emission spectra setting can be used to calibrate the detector for a specific surface or to assess the emission spectra of a surface. When a surface's temperature is precisely known (for example, using an interaction thermometer), the sensor's emissivity setting can be adjusted until the heat absorbed by the IR technique resembles the temperature quantified by the contact method; the transmittance setting will represent the surface's transmittance, which can be taken into account for subsequent measurements of comparable surfaces (only).

**Fig -2**: Infrared Thermometer

## 2.1 TESTING PROCEDURES

- **Breakdown Voltage Tests(BDV)**

Another term for it is dielectric strength value. It's the dielectric strength of the transformer oil. It is determined by the humidity level in the transformer oil. If the wet content in transformer oil is raised, the breakdown voltage will be lowered.

The breakdown voltage of an insulator is the minimum voltage that causes a portion of the insulation to become electrically conductive. The largest potential difference that may be applied across an insulator before it conducts is defined by its breakdown voltage.

The dielectric breakdown voltage of pure transformer oil is about 10 kV with a separation distance of 1 mm between electrodes. The spark of the breakdown voltage is shown in fig 3.

Breakdown tests frequently employ test cells. The tests used to evaluate pure liquids are small so that less liquid is used during the evaluation.

**Fig -3**: Spark of the break down voltage

The electrodes used to evaluate breakdown voltage range in size from 0.5 to 1 cm in diameter.

- **Flash Point Testing**

The flash point of transformer oil is the temperature at which a light hydrocarbon present in the oil begins to evaporate, causing a flash when a source is supplied under particular conditions. The flashpoint of transformer oil is a physical characteristic.

The flashpoint test of transformer oil determines the thermal characteristics of a substance or organic molecule. The transformer oil flashpoint test is a low-cost insulating-oil test that is extensively used.

The oil glows once the vapour and oxygen in the air mix. It's a crucial metric that needs to stay over 140 degrees Celsius at all times.

**Fig -4**: Spark of the Flash Point Testing

## 3. RESULTS

### 3.1 BREAKDOWN VOLTAGE TEST RESULTS

The dielectric strength value is calculated using the mean value of the breakdown voltage in this test.

- The graph plotting the values of breakdown voltage of sample 1 which is of 90% rice Bran oil and 10% Sesame oil is shown below in fig 5.It can be seen that average Breakdown voltage for sample 1 is 36.8 kV,

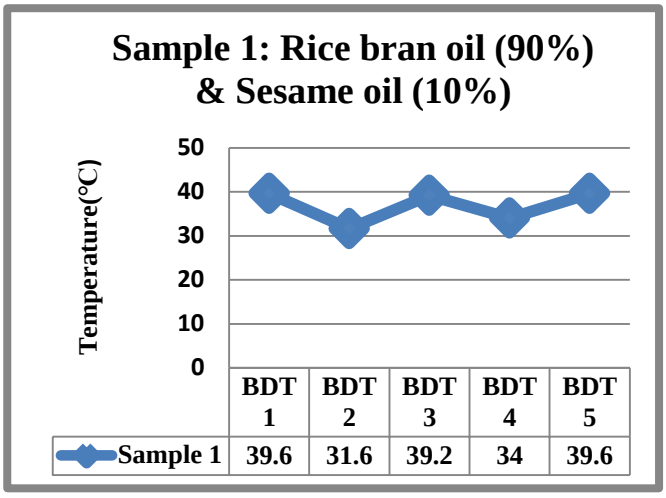


**Fig -5**: Breakdown voltage of Sample 1

The graph plotting the values of breakdown voltage of sample 2 which is of 80% rice Bran oil and 20% Sesame oil is shown below in fig 6. It can be seen that average Breakdown voltage for sample 2 is 39.76 kV, and sample 3 is 40.32 kV

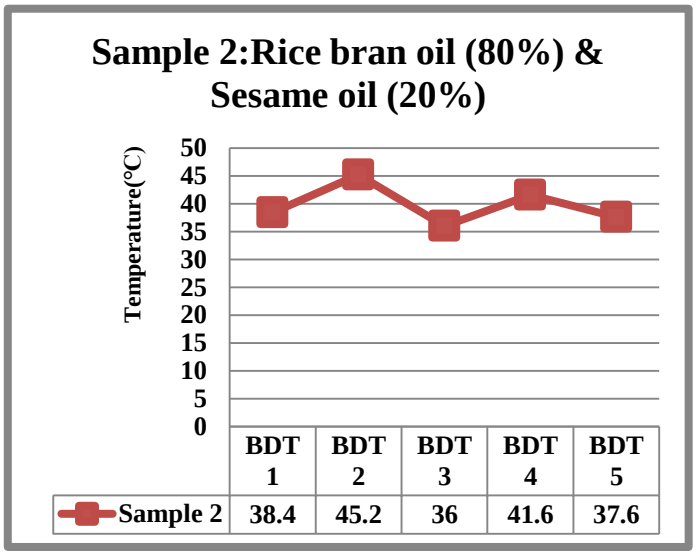


**Fig -6**: Breakdown voltage of Sample 2

The graph plotting the values of breakdown voltage of sample 3 which is of 70% rice Bran oil and 30% Sesame oil is shown below in fig 7. It can be seen that average Breakdown voltage for sample 3 is 40.32 kV

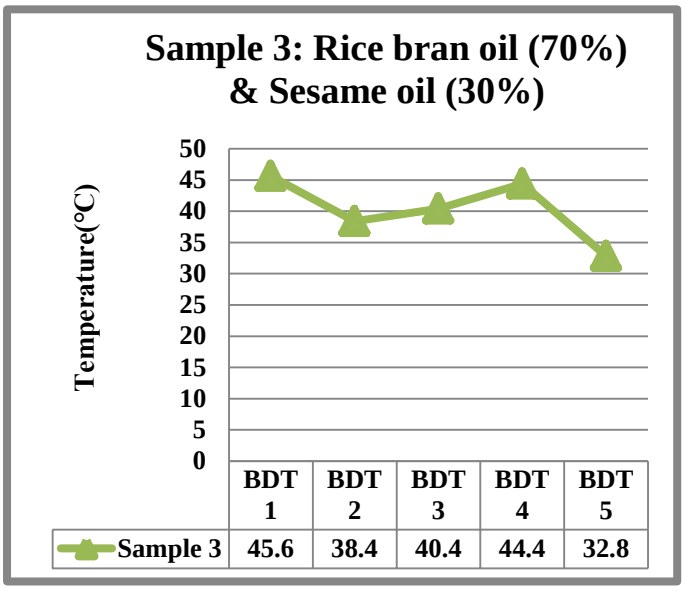


**Fig -7**: Breakdown voltage of Sample 3

The comparative analysis of the breakdown voltage of the three samples with the aid of graphical representation is shown in fig 8.at different temperatures.

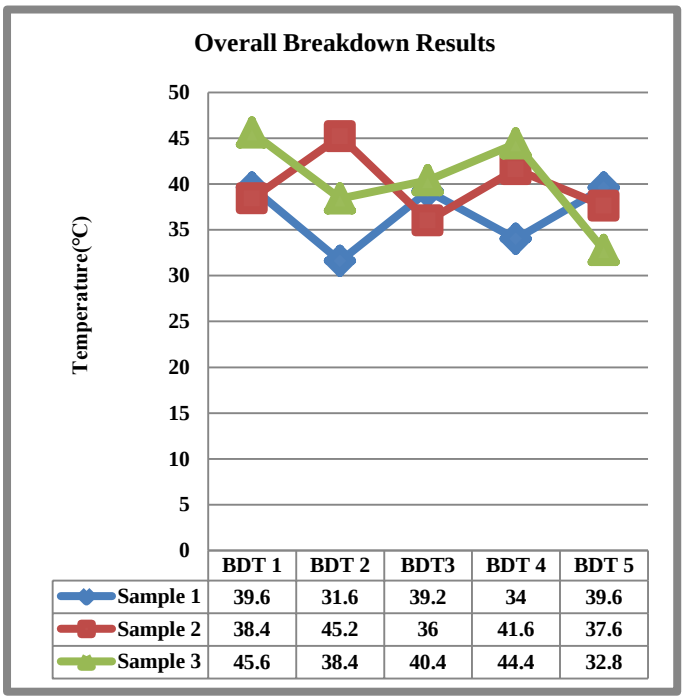


**Fig -8**: Breakdown voltage test result of Sample 1 sample 2 and sample 3

### 3.2 FLASH POINT TEST RESULTS

The flash point obtained for three different samples is shown with the aid of pie chart in fig 9.

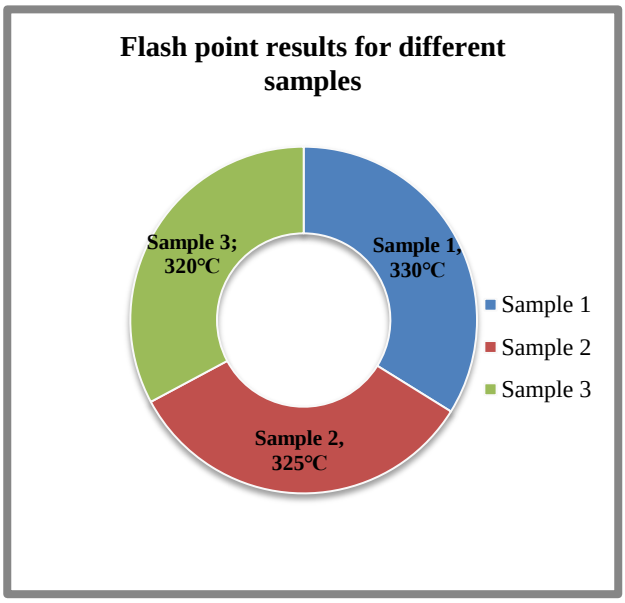


**Fig -9**: Flash point test result of Sample 1 sample 2 and sample 3

When compared to petroleum-based mineral oil, vegetable oil has a higher viscosity rating. In reality, insulating oil with a low viscosity is preferable.

The flow of oil through the transformer windings is slowed by high viscosity oil, which slows down the core and cooling equipment [10].

Vegetable oils, on the other hand, have a higher heat conductivity than mineral oils, making them more attractive.

## 3. CONCLUSIONS

The objective of this study was to determine the breakdown voltages of common vegetable oils so that they might be utilised as insulating oils in a range of high-voltage applications.

The findings can lead to the following conclusions: As indicated in the data, the average Breakdown voltage for sample 1 is 36.8 kV, sample 2 is 39.76 kV, and sample 3 is 40.32 kV. As a consequence, when compared to mineral oil, we can conclude that all samples are transformer-safe.Sample 1 has the highest flash point of 330°C, followed by sample 2, which has a flash point of 325°C, and sample 3, which has a flash point of 320°C. Because common mineral oil has a flash point of about 140°C, all three samples are suitable for transformers.

It also needs to be improved in terms of lifespan. Vegetable oil rapidly absorbs moisture and oxidises, causing transformer insulation oil to deteriorate.

As a result, a transformer oil tank that is completely enclosed may be considered.

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