IJIAET International Journal of Innovative Analyses and Emerging Technology

| e-ISSN: 2792-4025 | http://openaccessjournals.eu | Volume: 2 Issue: 12

Improving the Performance of Transformer with Oil Silica Nan Fluid

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Abstract: It is essential to study the inhacement of insulation oil because acids can accelerate the aging of oil-paper insulation systems. Therefore, nano fluids tend to form deposits, reducing their full potential in increasing electrical properties such as high AC breakdown strength. This led to the use of nan fluids to be one of the appropriate methods for improving the breakdown strength of transformer oil This study adopted the standard IEC60156 to study the effect of nano particle concentration and dielectric properties of transformer oil. The results of the nanofluid were compared with the results of commercially available mineral oils according to the percentages mentioned in succession 0.1% by weight, 0.05 by weight, 0.01% of the mass fraction to 100% by weight of the nanofluid.

Keywords: component; mineral oil; Transformer, breakdown performance;sio2.

Introduction

There are many researchers interested in studying the improvement of transformer oil and its electrical, physico-molecular properties under specific environmental conditions. Among the electrical equipment used in the electric power generation system is the electrical transformer whose work is to raise or lower the voltage, currentthe research deals with many dynamics that affect the physical properties on nanoparticles. Transformer oil was enhanced by adding nanosilica (Rafiq et al., 2021). As a result of the problems that appears in transformer insulation oil, which is one of the main and most expensive equipment in the electrical power system. Transformers need great attention to enhance their functional reliability (Bartley, 2006; Martin et al., 2018).

Background to Study

Electrical transformer oil is used to prevent bending or melting of transformers caused by high temperatures, so it is considered as a coolant that protects the transformer core and windings. Transformer oil also protects metal parts from corrosion, so the working conditions of transformers must be taken into account so that the oil temperature is always much lower than the limits that reach the oil breakdown voltage. To ensure that the basic properties of the insulators used in the transformer are not affected by temperature and humidity, some modifications are necessary in the design of the transformer. Recently, great progress has been made in improving the electrical breakdown strength and heat transfer of mineral oils by adding nanoparticles that way output a liquid namely nan fluid. The objective of the experiment is to know the driving breakdown strength analysis of sio2 nanofluids based on mineral oils NFS (Lamb, 2022; Mulkey & Wilks, 2017; Syed, 2017). Low percentages of

nanoparticles (0.1, 0.2, 0.3, 0.5, 0.7 and 1%) were used successively of the fractional size with Sio2 for agglomeration and sedimentation issues. In this test, spherically covered copper electrodes were used, and the breakdown voltage of alternating current was measured according to IEC60247 standard. Then, five series out of six ratings were taken for each sample prepared to obtain the break Electrodes were used between them with a gap of 2.5 mm and an initial settling time of 5 minutes before applying stress so that the bubbles could settle, and the time was one minute for each malfunction.down voltages. In this test, several measurements were taken to study the dielectric properties of transformer oil at room temperature. Then the results of mineral oils available in the commercial market were compared with the nanofluid results by adding the following ratios (0.1 wt%, 0.5 wt%, 0.01% wt in addition to 100 wt%) of the fluid. A magnetic stirrer mixes the mixture for 45 minutes to see the effect of the nanoparticle concentration. The nanoparticles are combined with the virgin mineral oil at a ratio of 0.05% by weight (Ambreen & Kim, 2020; Younes et al., 2015). It was observed when adding nanoparticles of Sio2 at a rate of 0.05% by weight to mineral oil led to raising the AC breakdown strength to 75%, which is 38% higher than that of virgin mineral oil 38%.

Statement of the Problem

It is essential to study the inhacement of insulation oil because acids can accelerate the aging of oil-paper insulation systems. Therefore, nano fluids tend to form deposits, reducing their full potential in increasing electrical properties such as high AC breakdown strength. Transformers need great attention to enhance their functional reliability, so the working conditions of transformers must be taken into account so that the oil temperature is always much lower than the limits that reach the oil breakdown voltage.

Purpose of the Study

It is essential to study the inhacement of insulation oil because acids can accelerate the aging of oil-paper insulation systems. Recently, great progress has been made in improving the electrical breakdown strength and heat transfer of mineral oils by adding nanoparticles that way output a liquid namely nan fluid. The objective of the experiment is to know the driving breakdown strength analysis of sio2 nanofluids based on mineral oils NFS.

Main Objective of the Study

To investigate and study the importance behaviours of nano-silica toTransformer oil , addationally,Transformer oil protects metal parts from corrosion, so the working conditions of transformers must be taken into account so that the oil temperature is always much lower than the limits that reach the oil breakdown voltage.

Guide Research Questions

1. Does the crushed is nano-silicanecessary to modifications of insulators in the design of the transformer.
2. what the results of compare to use nanofluid with transformer oil commercially

Significance of the Study

This tudy used to improving the electrical breakdown strength and heat transfer of mineral oils by adding nanoparticles

Justification of the Study

Show that a study on practical is to know the driving breakdown strength analysis of sio2 nanofluids based on mineral oils .Thus, promotes get great progress made to improve performance of the electrical breakdown strength.

Published under an exclusive license by open access journals under Volume: 2 Issue: 12 in Dec-2022

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Theoretical Framework

Nano silica is manufactured under specific conditions so that it has a high purity and a diameter between (10-50) as a base for nanoparticles, so nanosilica is not a by-product. The nano silica used in this work was produced in China using the deposition method in powder form which makes the nano silica of very high purity of about 99.96% and particle diameter (35 nm). Shows Figure 1 (Lamas et al., 2017) the XRD-ray divergence verification of nano-silica. and Figure 2 crushed nano-silica Table 1 indicates the advantages of nano-silica.

Figure 1. X-ray diffraction (XRD) spectra of nano-SiO2.

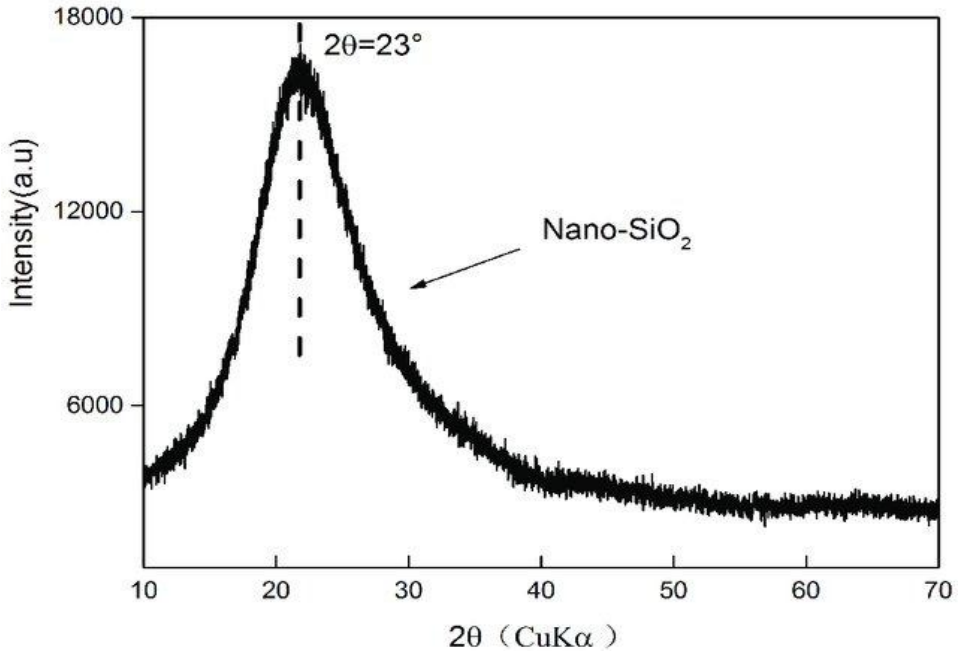

Figure 2: shows crushed nano-silica. Table 1 indicates the advantages of nano-silica.

Figure 2: Nano Silica.

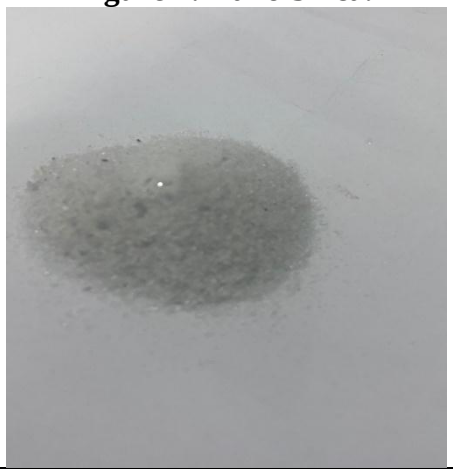

Table 1**:** advantages **of NS**

Properties	Specification
Sio2%	99.96
Material style	Crushed
Color	White
Particle size, mm	35
Surface area(m^2/g)	270

Based on the results of the simulation model, the nanoparticles are considered as electron scavengers, as they convert the high-moving electrons into slow-moving negative particles. So breaking strength is improved and transmitter start and relay disable (Pilarska et al., 2017; Zhang et al., 2020) . Nano fluids were prepared with different size concentrations of nanoparticles also flowchart for adding of mineral oil-based Nan fluids in Figure 3.

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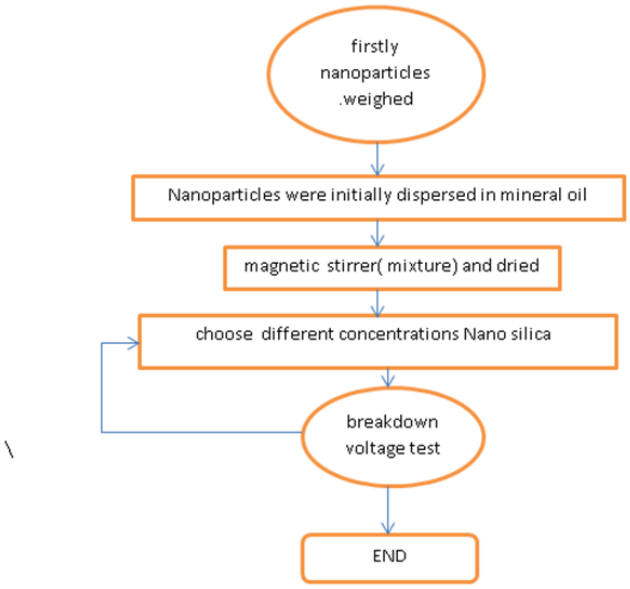

Figure 3: shows a flowchart for adding mineral oil-based nano-silica fluid

2. Working methodology

A.C Breakdown Voltage(KV) Results:

In this part of the experiment, the results of nano fluids are explained and discussed. Transformer oil results were taken for values of 6 readings between each (5-10) minute test during which the oil is stirred to calculate the AC breakdown voltage, Samples were tested at room temperature 17°C using atan Delta(OTD) device, a device that measures the relative permittivity and resistance of a dielectric fluid(Khan et al., 2021). Figure.4 illustrates this

Figure 4: Oil Tan Delta (OTD)

AC Breakdown Strength:

In Figure 5 shows the nanoparticles at (0.1, 0.3, 0.5, 0.7, 1%) of the volume of Sio2. Note that the AC breakdown voltage increased with the increase in the concentration of nanoparticles in the oil. Also, the overall improvement of AC breakdown voltage can be observed compared to mineral oil(Rafati et al., 2018).

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Figure 5: Breakdown voltages of silica nan fluids.

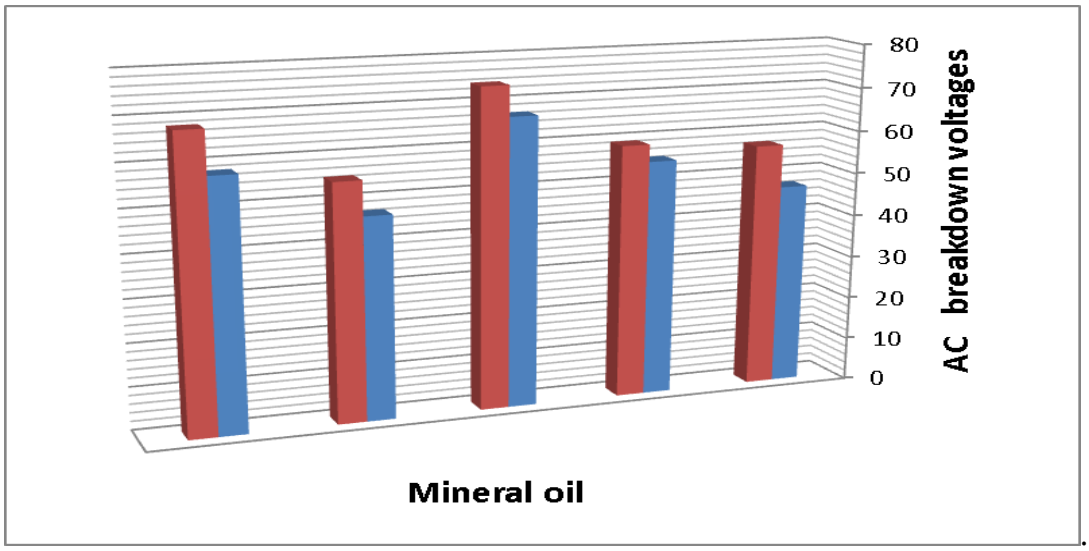

Figure. 6 shows the readings recorded directly from the voltage distribution device of the nan-silica fluids and indicates the addition of silica nanoparticles can enhance the AC breakdown strength of transformer oil

Figure 6: Breakdown voltages of silica nan fluids

The results of the alternating current voltage test for different sizes showed a significant improvement with the presence of nanoparticles, Figure.(7) illustrates this

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Figure 7: AC breakdown voltages measurement at different addition levels

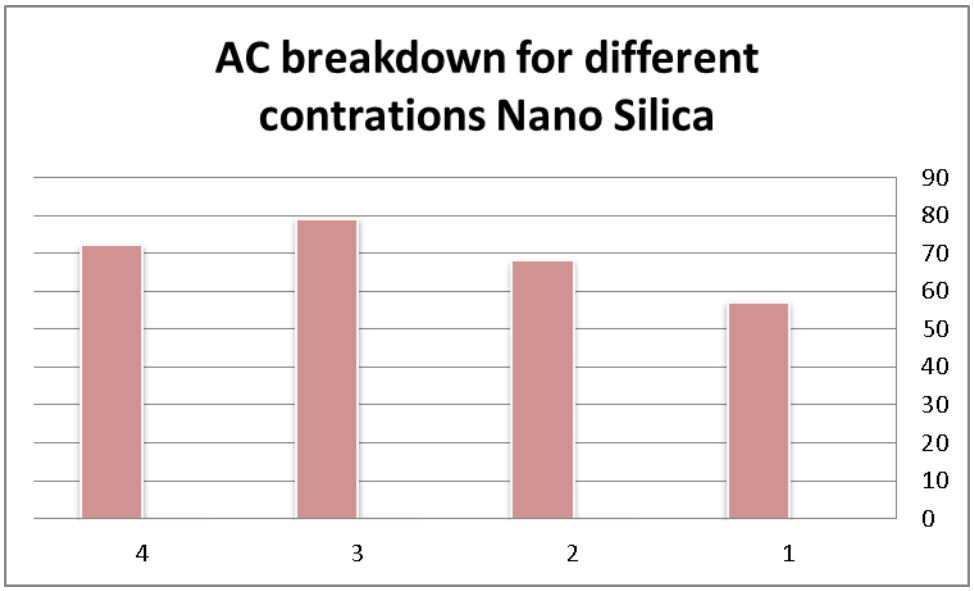

Table 2: **represents the various readings for the breakdown voltage measurement**

Sample sio2	0.0	0.01	0.05	0.1
AC breakdown voltage	58	69	79	72

Since the lightning pulse reveals the strength of the intrinsic collapse potential isolated from any contamination of the nanoparticles, the size of the nanoparticles is negligibly small(Taro et al., 2017; Viswanathan & Chandrasekar, 2019) .Showed that the addition ofsio2 nanoparticles to mineral oil will have an influence in reducing the partial discharge activity which will strengthen the dielectric insulation property which ensures reliable and safe operating conditions of power equipment.

Through the trapping properties of the interface between the base oil and the nanoparticles, the improvement of the dielectric strength of silica nanofluids compared to pure oil can be analyzed. At high electrical pressure, electrons are produced, which in turn causes the ionization state, which leads to the breakdown of the oil. So these high velocity electrons will be trapped and separated by the interface between the nanoparticles and the oil. The speed and energy transfer of these electrons will decrease due to the process of catching and capturing(Jalil et al., 2020; Rafiq et al., 2015).

3. Conclusions:

In this paper, the resistance to decomposition of mineral oil was investigated using silica nan fluids of different sizes. To find out the effect of the preparation method, especially the temperature of the nanoparticles on the dielectric strength of transformer oil, particles with a concentration of 0.05 were used. An enhancement in the breaking strength of nanofluids has been observed, so it is complete Oil breakdown strength at the preparation temperature of the interface properties. Provides the best insulating performance for nanofluids and provides a uniform electric field. From the point of view of the initial applications in the prototype transformer, encouraging laboratory results for the test of nanofluid breakdown voltage based on transformer oil.

Propositions

1. Study of effect three modes of heat transfer (conduction, convection, and radiation) using hybrid nano particles.
2. The use of a neural network to control the replacement of fuzzy logic control.

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