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Improving the Performance of Transformer Oil Using silica nan fluid)

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***Abstract*— It is important to study the improve of insulation oil because acids can accelerate the aging of oil-paper insulation systems , by adding nano-SiO2 in oil to improve the dielectric properties oil. Although the, the nan fluids tend to form sediment which nullifies its full capabilities in increasing the electrical properties such as higher AC breakdown strength. So nan fluids have been identified to be one of the suitable approaches to increase the breakdown strength of transformer oil. Conformity with IEC 60156 standard. In order to study the insulation properties transformer oil the results of the nan fluid is compared with the results of commercially available mineral oil 0.1wt%, 0.05wt% and 0.01wt% mass fraction were added to the 100% by weight of base fluid to study the effect of nanoparticles concentration.**

Keywords-component; —mineral oil; breakdown performance;sio2 nanoparticles

1. Introduction

The transformer is being an opener element in the electrical power generation, transmission, and lastly, distribution .so Reliable power with high fineness is in great request for the economic development of any state. For providing reliable electrical power, it is indispensable to have highly reliable linked electrical equipment in the power system [1]

A transformer is the most fundamental and costly component of the power network. so there has been big attention to fostering functional reliability of these units due to insulation problems.[2].The conventional oil is used as an insulating medium to prevent the electric current from flowing between conductive parts and cooling medium and then to dissipate the heat out of the transformer by circulating oil so that heat circulates to the tank walls and then to the surrounding. voltage-gradients and working temperatures must always be kept well below the limits at which the risk of breakdown becomes appreciable, and great elaboration of design is sometimes necessary to ensure that the essential characteristics of the dielectrics employed are not adversely affected by temperature and humidity. 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 aim of this study is to analyze the impulse breakdown strength of mineral oil-based SiO2 nan fluids (NFs).

Nanofluids were prepared using SiO2, nanoparticles at 0.1, 0.3, 0.5, 0.7 and 1% volume fraction. However, due to agglomeration and sedimentation issues, nanofluid based on SiO2 nanoparticles was only found to be successful.

The AC breakdown voltage measurement was done according to IEC 60247standard.Five series of 6 breakdowns for every prepared sample were taken to obtain breakdown volta. The spherically capped brass electrodes were used for this test. The gap distance between electrodes used was 2.5mm. A 5 minute initial settling time was used before applying the voltage so that the bubbles can settle down. The stirring time after every breakdown was one minute. The experiment was performed at room temperature

In order to study the insulation properties of transformer oil the results of the nan fluid is compared with the results of commercially available mineral oil 0.1wt%, 0.05wt% and 0.01wt% mass fraction were added to the 100% by weight of base fluid to study the effect of nanoparticles concentration. the obtained nanoparticles are added to virgin mineral oil at 0.05%wt, as it gives optimal results in preliminary study works. The mixture is blended by a magnetic stirrer for about 45 minutes.[3]

The AC Breakdown Strength is 57 kV for pure mineral oil the addition of 0.05%wt of SiO2 nanoparticle to mineral oil have elevated the AC Breakdown Strength to 75kV which is 38% higher than virgin mineral oil

Nano Silica is not a processing byproduct. It is manufactured under specific conditions so as to have a rising degree of purity and a well-defined zone of diameter for the particles as a rule between (10-50) nm. Nano Silica used in this work was created in China by precipitation method in powder form making Nano Silica have a high degree of purity about 99.96% and diameter for the particles (35nm). Table (1) existent its properties. X-ray diffraction (XRD) of Nano Silica was investigated as illustrated in Figure (1).

.Fig (1) Nano Silica

Table 1 .Properties of NS

Properties	Description
% Sio_2	99.96
Physical form	Powder
Color	White
Particle size, mm	35
Surface area(m^2/g)	270

The pendent nanoparticles in oil are considered to act as electron scavengers, transforming high mobility electrons to slow negatively charged particles based on the results of the simulation model, so the initiation and migration of the streamer are disrupted, and the breakdown strength is improved [4].

Table 2 :Properties of oxides and their nan fluids [5].

	Thermal conductivity* W/(m·K)	Density (g/cm^3)	Crystalline	Viscosity (Cp) with 5.0 vol. % 30 ℃	Thermal conductivity enhancement of na.2nofluids (%) with 5.0 vol. %
MgO	48.4	2.9	Cubic	17.4	40.6
TiO_2	8.4	4.1	Anatase	31.2	27.2
ZnO	13.0	5.6	Wurtzite	129.2	26.8
Al_2O_3	36.0	3.6	Γ	28.2	28.2
SiO_2	10.4	2.6	noncrystalline	31.5	25.3

Nano fluids were prepared with different size concentrations of nanoparticles also flowchart for adding of mineral oil-based nan fluids in figure 2

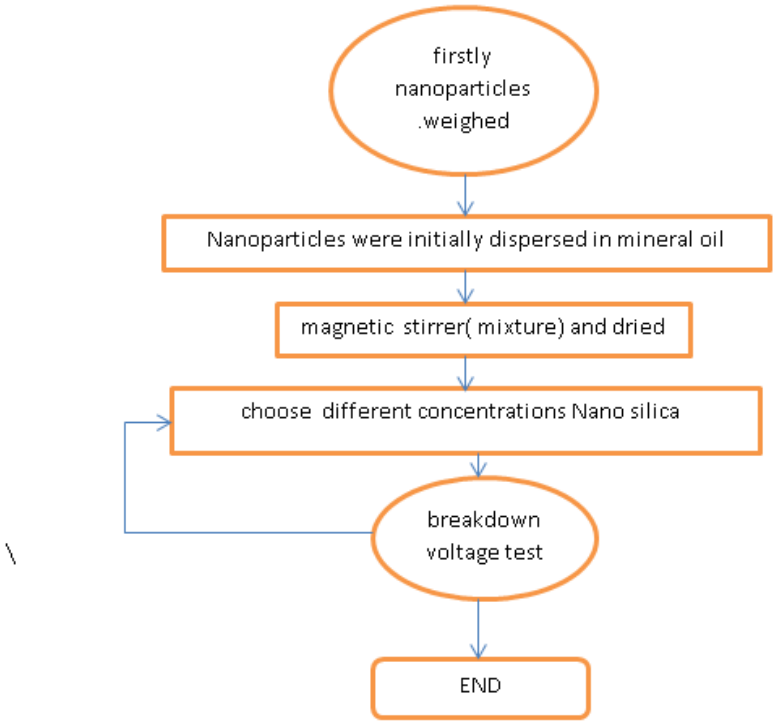


Fig 2 Flowchart for adding of mineral oil-based nan fluids

III. EXPERIMENTAL RESULTS

AC Breakdown Voltage Test Results

The results of nan fluid preparation are elaborated in this section along with the discussion on experimental results.

The test results of AC breakdown voltage were calculated by taking the average value of six readings[6]. The tests were performed with a sphere-sphere brass electrode arrangement at a 2.5mm gap spacing. Results of the samples were performed at a room temperature of 17°C. The Oil Tan Delta (OTD) is a laboratory instrument, which measures the Tan Delta, Resistivity and Relative Permittivity of insulating liquids Fig(3)

Fig(3) Oil Tan Delta (OTD)

AC Breakdown Strength

It can be distinctly seen that the AC breakdown voltage has increased with an increased amount of nanoparticle concentration in oil. The total enhancement of the AC breakdown voltage compared to pure mineral oil can be observed in Fig. 4. nanoparticles at 0.1, 0.3, 0.5, 0.7 and 1% volume fraction SiO2

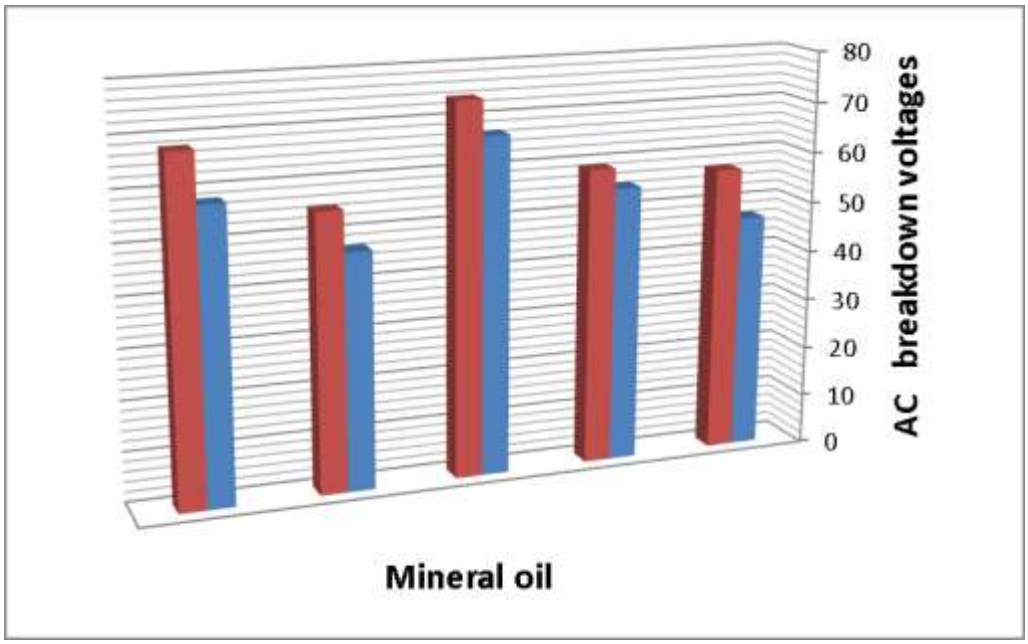
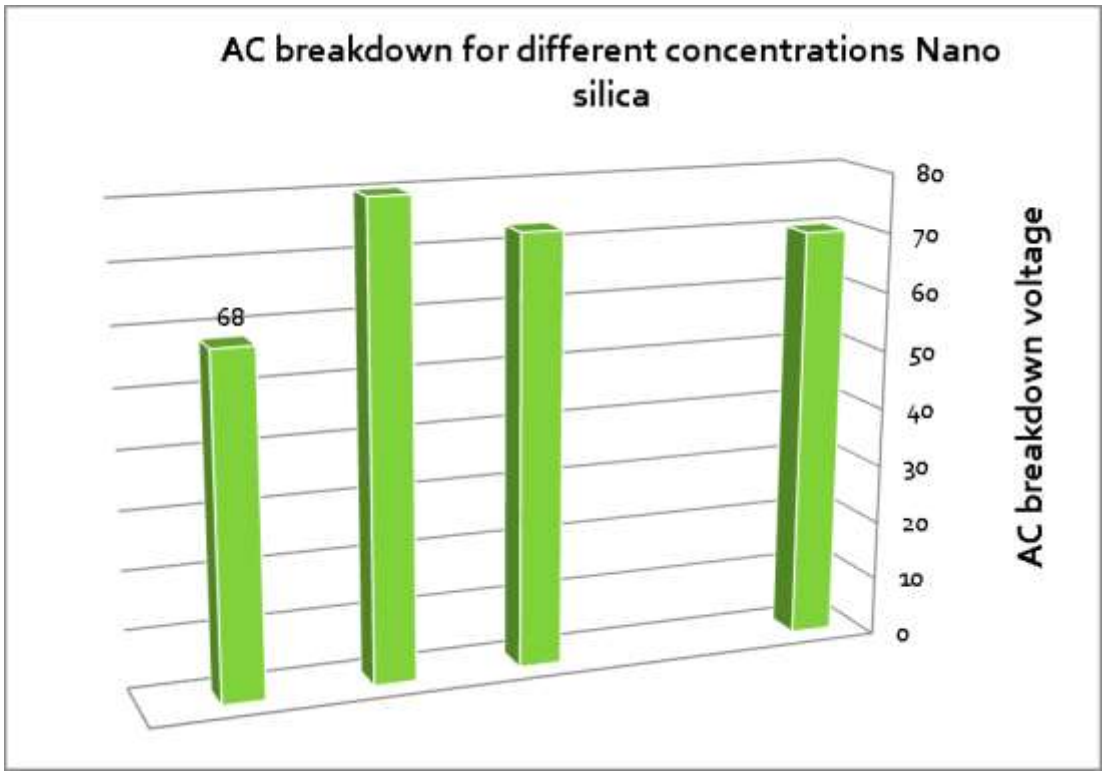


Fig. 4. Breakdown voltages of silica nan fluids

The test results indicate that the addition of silica nanoparticles can enhance the ac breakdown strength of transformer oil. Fig. 5. Shown the reading paper from instrument Breakdown voltages of silica nan fluids

Fig. 5. Breakdown voltages of silica nan fluids



sample sio2	o.o	0.01	0.05	0.1
AC breakdown voltage	68	70	79	72

Fig. 6 AC breakdown voltages measurement at different addition levels

The test results of AC breakdown voltages with different size shown in Fig. 6. It is noticed from the results that the ac breakdown voltage for nan fluids showed an enhancement with the existence of nanoparticles. the size of nanoparticles is negligibly small relative due to lightning impulse breakdown voltage reveals intrinsic breakdown strength independent of any particle contaminations [8,9]

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.

The insulating strength improvement of silica nanofluids as compared to pure oil could be explained by the trapping properties of the interface between base oil and nanoparticles. The electrons produced at high electric stress are largely responsible for ionization and hence breakdown in oil.

These high-speed electrons will be trapped and de-trapped by the interface between oil and nanoparticle. Due to this traping and de-trapping process, the energy transfer and velocity of these electrons will reduce. [10]

CONCLUSIONS

In this paper, the AC breakdown strength of mineral oil with use silica nan fluids at different sizes was investigated. the nanoparticles with 0.05 concentrations were used to see the effect of the preparation method especially the temperature of nanoparticles on the dielectric strength of transformer oil. The results showed improvement in the breakdown strength of nan fluids. So it is concluded, the preparation temperature the interface characteristics, and hence the breakdown strength of oil, provides a uniform local electric field and better dielectric performance of nan fluids. Experimental results of the breakdown voltage test of transformer oil-based Nano fluid were encouraging from the point of view of preliminary applications in a prototype transformer.

Propositions

۱. Study of the effect of three modes of heat transfer (conduction, convection, andradiation) by using hybrid nanoparticles.

2. Using a neural network to control on transformer replacing fuzzy logic control

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