Breakdown Strength of Transformer Oil Filled with (TiO2 and AL2O3) Nanoparticles

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Abstract— This article study the dielectric strength of mineral oil-based Nanofluids, Two types of Nanoparticles materials with the same size and surface modification were prepared, including (semiconducting TiO2 and insulating Al2O3) Nanoparticles. The results show that the Nanoparticles enhance the insulation properties of mineral oil, and the degree of enhancement depends on the Nanoparticle concentration.

Keywords—Nanofluids , Nanoparticles, Mineral oil, Breakdown Voltage.

I. INTRODUCTION

The transformer is one of the equipment's used for transmission and distribution of power transmission lines. So, this is the spirit of the system because it can convert voltage and current with stable power and frequency. Life span of Transformers are most important in terms of electricity, and electrical faults on the transformer will reduce its service life, due to the low level of electrical insulation of the transformer[1][2][3][4].The interior insulation of the transformer is very important, so it determines the effectiveness of entering service or removing it. Mineral oil is used to isolate and cool the transformer coils and offer internal status indications to determine its faults. Therefore, if there is a problem with the oil, it must be treated by replacing or refining the oil, and both methods are very costly [5][6][7]. Recent Nanotechnology offers vast opportunities for processing and producing materials with an average crystallite size of less than 50 nm. Compared with conventional heat transfer fluids, these fluids with (Nano-scale particle) suspensions provide meaningfully higher thermal performance. These Nanofluids have an extraordinary combination of two functions most needed for thermal engineering applications: extremely high stability and high thermal conductivity. Therefore, "Nanofluid" is new types of fluid, which uses the inappropriate size and volume fraction dispersion of fine metal particles in the liquid, thereby significantly improving the electrical insulation, dissolve gas, improve chemical properties and improve viscosity properties [8]. Nanoparticles of transformer oil have become as important as drugs to treat their diseases. (Al2O3 and TiO2) NPS is the most commonly used.

Compared with other metal elements, it is inexpensive, more stable, and easy to prepare [9]. And increase breakdown voltage [10][11]. This paper aims to study the influence of (Al2O3 andTIO2) Nanoparticles on the dielectric strength of transformer minerals oil.

II. EXPERIMENT METHOD AND TEST

A. NANOFLUID PREPARTION

THE DIALA MINERAL OIL AND A NANOPARTICLES WITH AN AVERAGE SIZE BELOW50 NM (WHICH WERE PURCHASED TRADITIONALLY) WERE USED FOR THE TESTS. THE MINERAL OIL WAS FILTERED TO ELIMINATE IMPURITIES AND MEET THE REQUIREMENTS OF PURE OIL, A CERTAIN AMOUNT OF SELECTED NANOPARTICLES (AL2O3, AND TIO2) WERE WEIGHED ACCORDING TO THE DESIRED CONCENTRATION. THE NANOFLUID WAS PREPARED BY DISPERSING THE NANOPARTICLES IN TRANSFORMER OIL BY USING ULTRASOUND. ALL PREPARED SAMPLES OF VARIOUS CONCENTRATIONS WERE PLACED IN A VACUUM OVEN IN LESS THAN 24 HOURS TO ELIMINATE THE EFFECT OF MICROBUBBLES FORMED DURING THE SONICATION PROCESS. THE BASIC PROPERTIES OF THE TWO KINDS OF **NANOPARTICLES SELECTED ARE SUMMARIZED IN TABLE 1.**

TABLE I. Mineral oil and Nanoparticles characterization

Material type	Transformer oil	AL2O3 particles	Tio2 particles
properties	Dielectric	Insulator	semiconductor
conductivity	10^{-12}	10^{-12}	10^{-11} ١٠
Density	0.89	3.97	4.3
Surfactant modification	-	Oleic acid	Oleic acid

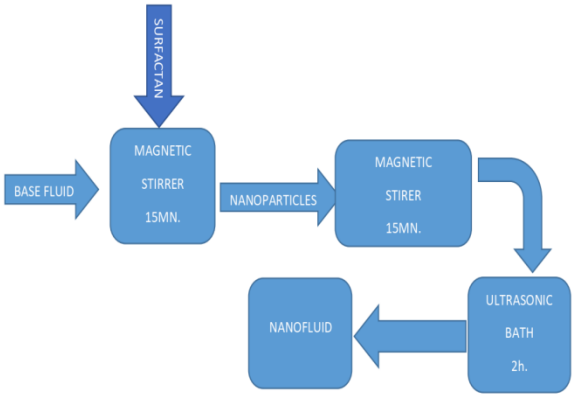

Fig I. stage of Nanofluid preparation

B. Breakdown Voltage Test

A NEW NANO-OIL WAS OBTAINED, BUT BEFORE IT COULD BE USED, ITS ELECTRICAL INSULATION HAD TO BE CHECKED. THE AC BREAKDOWN VOLTAGE WAS MEASURED IN ACCORDANCE WITH THE IEC 60156 STANDARD [12]. FIGURE 2 SHOWS THE BREAKDOWN VOLTAGE TESTER. THE TESTER CONSISTS OF A TEST CELL OF A (500) ML VOLUME AND AN OIL TESTER, ELECTRODE ARRANGEMENT CONSISTED OF TWO COPPER HEMISPHERES OF A (12.5) MM DIAMETER; THE GAP DISTANCE BETWEEN THE ELECTRODES WAS KEPT AT (2.50 ± 0.05) MM. THE CLEAN OIL IS PLACED IN A VESSEL. VOLTAGE IS APPLIED BETWEEN THE ELECTRODES BUT INCREASING GRADUALLY,

THE RATE OF RISING OF THE VOLTAGE IS CONTROLLED AT (2) KV / S AND THE VOLTAGE AT WHICH SPARKING BEGINS BETWEEN THE ELECTRODES IS OBSERVED. THE TESTER REPORTS SIX BURNS PERFORMED. THE AVERAGE VALUE WAS USED AS THE AC BREAKDOWN VOLTAGE VALUE. THE ENTIRE EXPERIMENT WAS CALCULATED AT ROOM TEMPERATURE.

Fig II. AC Breakdown tester

IV. DISCUSSION AND PROPOSED MECHANISMS

The main purpose of using nanofluids is to raise the breakdown voltage when the Nanoparticles are small. The average breakdown voltage is higher. This is due to the larger volume fraction of the interface in most Nanomaterials and the

interaction between the surface of the charged nanoparticles and the liquid molecules.

V. CONCLUSION

In this paper, Nanofluids are used to improve the breakdown strength of transformer oil; Nanofluids are prepared by using (AL2O3 TiO2) Nanoparticles and surfactants within transformer oil. For each Nanofluid sample, the breakdown strength was measured. It is found that the Nanofluid sample has a higher breakdown voltage compared with the base oil. A higher breakdown voltage is gained based on the electronegativity of Nanoparticles and their role in attracting fast-moving electrons, which impedes the propagation of the streamer. These electrons are captured and the breakdown process is delayed.

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