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Compatibility of Transformer Insulating Paper (Kraft paper) with Nanofluid prepared from Neem Oil Ester

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Samson Okikiola Oparanti1, Andrew Adewunmi Adekunle2, Abdulsalam Ismaila Galadima2, Abdelghaffar Amoka Abdelmalik2
1. Université du Québec à Chicoutimi, 555, boulevard de l'Université, Saguenay, Quebec, G7H 2B1
2. Ahmadu Bello University Zaria Samaru Campus, Community Market, 810211,

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Zaria, Nigeria
Corresponding author e-mail address: samson-okikiola.oparanti1@uqac.ca

1. Introduction

Sustainable, reliable, and environmentally friendly source of energy is currently a major focus of humanity. This is captured among the sustainable development goals. Electrical power generation has been a critical endeavour toward achieving such goal. Among the important pieces of equipment used in power generation is a transformer which uses oil for its cooling and insulation. The commonly used insulating oil is mineral oil but it is not biodegradable. Current investigations show that oil from plants has the potential to completely replace mineral oil when further chemical modification and the addition of an additive to the oil are considered 1. The addition of nanoparticles to plant-based oil shows improvement in both physicochemical and dielectric properties 2 However, little attention was placed on the compatibility of the prepared nanofluid with the paper.

In this work, the compatibility of nanofluid prepared from neem oil methyl ester and kraft insulating paper is considered. The nanofluids were prepared by adding 0.1 wt.% to 0.5 wt.% of nanoparticles in step of 0.1 to the base oil. The addition of SiO2 nanoparticles (18 nm) to the base oil increases the dielectric constant and reduces the dielectric loss of the base fluid. At 30 oC and 60 Hz, the dielectric constant of the base fluid increases from 3.38 to 5.5 when 0.5 wt.% of nanoparticles were added to the base. Also, the dielectric loss of the oil decreases from 0.06 to 0.0023 when 0.5 wt.% nanoparticles were added to the base fluid. The dielectric loss and breakdown voltage of nanofluid-impregnated paper were determined, and the result is similar to the mineral oil-impregnated paper. The average breakdown voltage of mineral oil-impregnated paper is 16 kV and 15 kV for nanofluid-impregnated paper. The result indicated that nanofluid from methyl ester of neem oil has no negative effect on the performance of kraft paper. This nanofluid is a promising alternative to insulating oil in high-voltage equipment since it has good compatibility with solid insulating material.

1. Results The graph in Figures 1 and 2 shows the dielectric loss of impregnated kraft paper and the breakdown strength respectively. This result is similar to the one reported by Ref 2.

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   The sample codes are as follows; DP is dry paper, (MOP) mineral oil and paper, 0.1paper (nanofluid with 0.1wt.% nanoparticle and paper), EFP (methyl ester with paper), NFP (nanofluid with paper).

1 Abdelmalik, A. A. "Chemically modified palm kernel oil ester: A possible sustainable alternative insulating fluid." Sustainable Materials and Technologies 1 (2014): 42-51.
2 S. O. Oparanti, A. A. Khaleed, A. A. Abdelmalik and N. M. Chalashkanov, "Dielectric characterization of

palm kernel oil ester-based insulating nanofluid," 2020 IEEE Conference on Electrical Insulation and Dielectric Phenomena (CEIDP), 2020, pp. 211-214, doi: 10.1109/CEIDP49254.2020.9437477.

Primary authors: Mr OPARANTI, SAMSON OKIKIOLA (Université du Québec à Chicoutimi, 555, boulevard de l'Université, Saguenay, Quebec, G7H 2B1); Mr ADEKUNLE, Andrew Adewunmi (Ahmadu Bello University Zaria Samaru Campus, Community Market, 810211, Zaria, Nigeria); Dr GALADIMA, Abdulsalam Ismaila; Prof. ABDELMALIK, Abdelghaffar Amoka

Presenter: Mr OPARANTI, SAMSON OKIKIOLA (Université du Québec à Chicoutimi, 555, boulevard de l'Université, Saguenay, Quebec, G7H 2B1)

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