Investigation of the dielectric and thermal properties of non-edible cottonseed oil by infusing h-BN nanoparticles

ABSTRACT

Vegetable oils have emerged as insulating fluids in transformer applications and as a prominent and effective alternative for traditional dielectric fluids. However, most of vegetable oils are edible causing their application on a large scale to be limited. In the present work, a novel non-edible vegetable oil is developed as an insulating fluid. The developed oil is oxidation-inhibited cottonseed oil (CSO) based nanofluids. Tertiary butylhydroquinone was used as antioxidant. The concept of nanofluids was used to overcome the limited dielectric and thermal properties of cottonseed oil. Hexagonal Boron Nitride (h-BN) nanoparticles at low weight fractions (0.01 - 0.1 wt%) were proposed as nanofillers to achieve adequate dielectric strength and improved thermal conductivity. Stability of prepared CSO based nanofluids was analyzed using Ultraviolet-visible (UV-Vis) spectroscopy. Then, the prepared nanofluids were tested for dielectric and thermal properties under a temperature range between 45 °C and 90 °C. The dielectric properties include breakdown strengths under AC and lightning impulse voltages, dielectric constant, dissipation factor, and resistivity, while thermal properties include thermal conductivity and thermogram analysis. The dielectric and thermal properties were significantly improved in CSO based nanofluids. The creation of electric double layer at nanoparticle/oil interface and the lattice vibration of nanoparticles were used to clarify the obtained results. The proposed CSO based h-BN nanofluids open up a great opportunity in both natural ester insulating fluid applications and thermal energy management systems.

Keyword: Vegetable oils; Transformers; Nanofluids; Dielectric properties; Thermal properties