

## Effect of surfactants on the lightning breakdown voltage of palm oil and coconut oil based Al<sub>2</sub>O<sub>3</sub> nanofluids

### ABSTRACT

In this paper, the effect of different types of surfactants on the lightning breakdown voltages of palm oil (PO) and coconut oil (CO) based aluminium oxide (Al<sub>2</sub>O<sub>3</sub>) nanofluids is investigated. Three different types of surfactants were used in this study known as cationic (cetyl trimethyl ammonium bromide (CTAB)), anionic (sodium dodecyl sulfate (SDS)) and non-ionic (oleic acid (OA)). The volume percentage concentrations of Al<sub>2</sub>O<sub>3</sub> dispersed into PO and CO were varied from 0.001% to 0.05%. The ratio of surfactant to the nanoparticles was set to 50% from the volume concentration of nanoparticles which equivalent to 1:2. In total, two types of refined, bleached and deodorized palm oil (RBDPO) and one type of CO were examined for lightning breakdown voltage. The test was carried out based on needle-sphere electrodes configuration with 25 mm gap distance. The presence of Al<sub>2</sub>O<sub>3</sub> improves both positive and negative lightning breakdown voltages of RBDPO and CO. Under the positive and negative polarities, the CTAB does provide further improvements on the lightning breakdown voltages of RBDPOA (1st type of samples) and CO at most of the volume of concentration of Al<sub>2</sub>O<sub>3</sub>. SDS and OA could also further improve the lightning breakdown voltage of CO at certain volume concentration of Al<sub>2</sub>O<sub>3</sub>. On the other hand, the lightning breakdown voltage of RBDPOB based Al<sub>2</sub>O<sub>3</sub> nanofluid (2nd type of samples) does not further improve with the introduction of surfactants. At most of the volume concentration of Al<sub>2</sub>O<sub>3</sub>, the introduction of CTAB further increases the times to breakdown and decrease the average streamer velocities of RBDPOA under both polarities. The same finding is observed for CO under positive polarity with CTAB and SDS as well as under negative polarity in the presence of all surfactants. The streamer velocities and times to breakdown patterns of RBDPOB based Al<sub>2</sub>O<sub>3</sub> nanofluid are inconsistent in the presence of all surfactants. It is found that RBDPO and CO based Al<sub>2</sub>O<sub>3</sub> nanofluids have second mode of streamer whereby the streamer velocities are from 1 km s<sup>-1</sup> to 1.63 km s<sup>-1</sup> regardless with or without surfactants.

**Keyword:** Palm oil; Coconut oil; Lightning breakdown voltage; Al<sub>2</sub>O<sub>3</sub>; NanofluidsSurfactants