Abstract

Abundant and easily refined, petroleum has provided high energy density liquid fuels for a century. However, recent price fluctuations, shortages, and concerns over the long term supply and greenhouse gas emissions have encouraged the development of alternatives to petroleum for liquid transportation fuels. This current study presents the results of an experimental investigation, into the effect of nanoparticles (aluminum oxide and carbon nanotubes) in soybean biodiesel, on the evaporation time of a single droplet, on hot surfaces (stainless-steel). The biodiesel is produced from the soybean oil by standard transesterification process, and subsequently, the nanoparticles such as Alumina, CNT, and Alumina–CNT are blended with the biodiesel fuel with the aid of an ultrasonicator. The thermo-physical properties of the nanofuels, including density, viscosity, and heat capacity are also measured. The hot plate ignition tests are performed at atmospheric pressure, and the concentration of alumina is kept fixed at 30 ppm and that of CNT is kept fixed at 20 ppm. The wall temperatures ranging from 200–450 ℃, to cover the entire spectrum of heat transfer characteristics from evaporation to film boiling. The study is done for four fuel mixtures, namely, neat soybean biodiesel, biodiesel blended with CNT nanoparticle, biodiesel blended with alumina nanoparticle and biodiesel blended with CNT and alumina nanoparticle. For each type of fuel mixture, several droplets were dropped on the hot plate from a fixed height and under identical conditions, and the evaporation time of that fuel was recorded based on the difference between the impinging of droplet and disappearance of droplet from the hot surface. Results show that, qualitatively, the shapes of emulsion evaporation curves are very similar to that of pure liquids. Quantitively, there are significant differences. The total evaporation time, for the Nanoparticle mixed biodiesel is lower than that for neat biodiesel fuel. The value of the critical surface temperature (maximum heat transfer rate), decreases as nanoparticles are added to the biodiesel. In the film-boiling region, the evaporation time for the blended fuel droplets is reported to be lower than neat soybean biodiesel, at identical conditions. Furthermore, the hot-plate evaporation test confirmed a shorten ignition delay effect, and improved heat transfer rate associated with the nanoparticles blended biodiesel fuels, owing to their enhanced surface area/volume ratio, and heat conduction properties. The mechanism is probably due to liquid fuel boiling point elevation caused by nanoparticle accumulation at liquid–vapor interfaces.