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Effects of Nano-Sized Al Particles on Evaporation of a Kerosene Droplet

Jisu Yoon and Prof. Seung Wook Baek
KAIST, Korea, The Republic of

This study experimentally investigated the effects of nanoparticles on evaporation rate of nanofluid fuel droplet based on kerosene liquid fuel in high pressure environment. The base liquid fuel was kerosene and aluminum (Al) nanoparticles with 70 nm diameter were selected. Evaporation behavior was recorded by high speed CCD camera and investigated by suspending the droplet on the silicon carbide (SiC) fiber with 100μm diameter in high pressure chamber. Oleic acid was used as a surfactant to synthesize the stable nanofluid fuels and the effect of oleic acid, of course, was investigated for comparison. The concentrations of aluminum nanoparticles were 0.1 % and 1.0 % by mass fraction and the ambient pressure was increased from 0.1 MPa to 2.5 MPa. The temperature range was from 300 ℃ to 700 ℃. The evaporation rates of droplets were determined by interaction of diffusion coefficient and heat of vaporization of the droplet. In high pressure environment the diffusion coefficient controlled the evaporation and in high temperature environment the heat of vaporization controlled the droplet life time. Moreover, nanoparticles had negative effects for droplet evaporation in low temperature due to its higher thermal conductivity than that of liquid fuel. The nanoparticles absorbed most of heat energy so they played as a heat sink. However, in high temperature region (500 ℃ - 700 ℃), the nanoparticles acted as a heat source rather than a heat sink so the nanofluid fuel droplets had higher evaporation rates than the pure kerosene droplets in all pressure ranges. Also, in high temperature region, 0.1 % and 1.0 % of aluminum-kerosene droplets showed different evaporation rates depending on the pressure. Distinct phenomenon of evaporation of nanofluid fuel droplet was a micro-explosion and it was observed at only atmospheric pressure environment.