Transient Marangoni convection in hanging evaporating drops

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A combined experimental and numerical analysis has been carried out to study Marangoni effects during the evaporation of droplets. The experiments are performed with pendant drops of silicone oils (with different viscosities) and hydrocarbons. The temperature of the disk sustaining the drop is rapidly increased or decreased in order to study transient heating or cooling processes. The velocity field in the droplet is evaluated monitoring the motion of tracers in the meridian plane, using a laser sheet illumination system and a video camera. Surface temperature distributions of the drops are detected by infrared thermocamera. The numerical model is based on axisymmetric Navier-Stokes equations, taking into account the presence of Marangoni shear stresses and evaporative cooling at the liquid-air interface. Marangoni flows cause a larger, more uniform surface temperature, increasing heat transfer from disk to droplet, as well as evaporation rate. When Marangoni effects are negligible, larger surface temperature differences occur along the drop surface and heat transfer is relatively small. The role of Marangoni and buoyancy flows in silicone oils with different viscosities and hydrocarbons is discussed and correlations are presented between experimental and numerical results.

Keywords: Viscosity of liquids; diffusive momentum transport, Evaporation and condensation, Surface tension and related phenomena, Flows in ducts, channels, nozzles, and conduits
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