Evolution of Surface Area-to-Volume Ratio for a Water Meniscus Evaporating Between Contacting Silica Spheres

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Abstract

An experimental investigation was performed under isothermal conditions to quantify the rate of evaporation of water from a receding pendular meniscus connecting two silica spheres. Optically based measurements were used to determine the relevant meniscus dimensions, and the meniscus was modeled using a toroidal approximation. The rate of change of meniscus surface area and volume was then predicted using mathematical modeling software. The results demonstrated that once the meniscus transitioned from a relatively flat surface to one with an increasing radius of curvature, the rate of change of the ratio of surface area-to-volume was relatively constant over the range of water contents that were observable using the optical investigation techniques implemented in this study. Comparison of the flux of water from the meniscus surface demonstrated that the evaporation of bound water was four orders of magnitude slower than evaporation from a free water surface.

Keywords: evaporation; receding meniscus; silica; toroidal approximation; torous; wetting fluid