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Early regimes of water imbibition in nanoslit silica channels[1]
ELTON OYARZUA, HARVEY ZAMBRANO, Universidad de Concepcion, JENS HONORE WALTHER[2], Technical University of Denmark, ANDRES MEJIA, Universidad de Concepcion — Capillarity is currently subject to a significant research interest. Attention is mainly paid to the late stage of the imbibition when a developed flow is reached and the Laplace pressure is balanced by the viscosity. Nevertheless, as the miniaturization of devices is reaching the nanoscale a thorough understanding of fluid flow in nanoconfinement is required. In nanofluidics, short timescales and surface characteristics dominate the flows. In this study, molecular simulations are conducted to investigate the early stage of water imbibition in silica nanochannels with heights of 4 to 10 nm. Results indicate that nanoscale imbibition is divided in three regimes. An initial regime with imbibition linearly dependent of time, where the capillary force is mainly balanced by inertia. Thereafter, a period, in which, the balance has contributions from both inertia and viscosity and, subsequently, a final regime, wherein, viscosity dominates the capillary force balance. Velocity profiles confirm the passage from an inviscid flow to a developed Poisseuille flow. The meniscus position as a function of time and air accumulation in front of the advancing meniscus are computed for different air pressures, the results reveal a systematic retarding effect of gas pressurization on the imbibition.

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