SPH Model For Droplet Flow in a Fracture

A. M. Tartakovsky[1], J. Kordilla[2], and T. Geyer[2]

[1]*Pacific Northwest National Laboratory, Richland, WA, USA*
[2]*University of Goettingen, Goettingen, Germany*

ABSTRACT: Unsaturated flow in individual fractures plays an important role in the vadoze zone transport in fractured rock formations. Given the complexity of multiphase flow, robust numerical methods are needed to capture the highly dynamic interfaces and flow intermittency. In this work we present microscale free-surface flow simulations using a three-dimensional multiphase Smoothed Particle Hydrodynamics (SPH) code. Pair-wise solid-fluid and fluid-fluid interaction forces are used to control the wetting behavior and cover a wide range of static and transient contact angles as well as Reynolds numbers encountered in droplet flow on rock surfaces. We validate our model via comparison with existing empirical and semi-analytical solutions for droplet flow. We use the model to investigate the occurrence of adsorbed trailing films of droplets under various flow conditions and its importance for the flow dynamics when films and droplets coexist. We show that flow velocities are higher on prewetted surfaces covered by a thin film, which is qualitatively attributed to the enhanced dynamic wetting and dewetting at the trailing and advancing contact line.