Geophysical Research Abstracts
Vol. 14, EGU2012-1490, 2012
EGU General Assembly 2012


# Simulation of film and droplet flow on wide aperture fracture using Smoothed Particle Hydrodynamics

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Fractured media provide rapid flow pathways for water percolating through the unsaturated zone. Film flow has been widely acknowledged as a major rapid flow process with average velocities of $3x10^{-7}$ m/s (Tokunaga, 1997). Further flow regimes such as droplets, rivulets and falling films may reach much higher velocities while coexisting with films (Ghezzehei, 2004). In order to establish a unified description of multiphase flow at such small scales simulation approaches have to be able to deal with the highly dynamical interfaces and reproduce the physical behavior dominated by capillary, surface tension and gravitational forces. In this work we show simulations of free-surface flow on inclined fracture surfaces using a Smoothed Particle Hydrodynamics (SPH) model (Tartakovsky, 2005). The three-dimensional Lagrangian code employs an interpolation kernel in order to solve the Navier-Stokes equation at an arbitrary set of points (particles). Pairwise fluid-fluid and solid-fluid interaction forces are used to simulate a wide range of wetting conditions and Reynolds numbers encountered in laboratory experiments. Model results are verified with empirical and semianalytical solutions. Contact angles of droplets in a critical state, i.e. at the verge of movement, are compared with laboratory experiments reported in literature. Transient droplet dynamics are shown to reproduce the linear scaling proposed by Podgorski (2001). Depending on Reynolds number and static contact angles droplets leave behind trailing films. In order to investigate the influence of adsorbed films on droplet flow surfaces are prewetted with a thin film and simulations repeated. The results indicate a strong dependence of droplet flow dynamics on the existence of adsorbed films with droplet velocities being tripled under certain conditions. Despite their relatively slow velocities, adsorbed films are shown to be an essential part of unsaturated droplet flow dynamics as they enhance the wetting and dewetting dynamics processes at the three-phase contact line.

**References:**

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