Research

Mechanics Seminar

Near-contact approach of two permeable spheres

Rodrigo B. Rebouças
Northwestern University

29 September 2021

Time: 16:00

Microsoft Teams - https://tinyurl.com/semmec0121

Abstract.

Interest in the hydrodynamics of particles with permeable media is motivated by particle filtration processes where suspended particles interact with a porous filter or with a porous cake of captured particles. Other applications where the study of hydrodynamic interactions of permeable particles play a key role include enhanced mass transport in fluidized catalytic reactors and in chromatography columns. In this talk I will present an analysis for the axisymmetric lubrication resistance between permeable spherical particles in the asymptotic limit of weak surface permeability, $K = k/a^2 \ll 1$, where k is the arithmetic mean permeability and a is the reduced radius. In this regime, hydrodynamic interactions can be approximated by smooth spheres except for the near-contact motion. Even though particle permeability has a weak perturbative effect, it qualitatively alters the near-contact dynamics eliminating the classical lubrication singularity for smooth particles resulting in finite contact times under the action of a constant force. An integrodifferential equation incorporating Darcy's law for the intraparticle flow describes the non-local behavior of the flux of fluid across the permeable surface. Resistance coefficients are calculated and it is shown that permeable particles are hydrodynamically equivalent to rough spheres with roughness $\delta/a \approx K^{2/5}$.