# Fracture permeability, size segregation, and screen-out: Recent learnings from high-fidelity simulations of a thimbleful of proppant

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**Thursday, September 19, 2024, 9 a.m. Central Time**

Dr. Christopher Leonardi is an Associate Professor in the School of Mechanical and Mining Engineering at The University of Queensland, Australia. He will speak on Thursday, September 19, 2024. The topic is “Fracture permeability, size segregation, and screen-out: Recent learnings from high-fidelity simulations of a thimbleful of proppant.”

## Abstract

The literature abounds with empirical, analytical, and numerical descriptions of proppant transport phenomena such as transverse migration, size segregation, screen-out, and fracture permeability. For many applications, such as naturally fractured coal seams or microproppant placement, existing models are not appropriate or inaccurate. Noting that experiments are difficult to interrogate and parametric sweeps are intractable, direct numerical simulation (DNS) has emerged as a powerful tool for quantifying both micro- and macroscale proppant behaviour.

In this talk, a computational framework for resolved simulations of proppant transport will be described along with its application to industrial problems. The framework incorporates the lattice Boltzmann method (LBM) for the fluid mechanics and the discrete element method (DEM) solver for the particle mechanics. This approach is able to fully resolve Navier-Stokes hydrodynamics, the mechanics of frictional particle-particle and particle-

boundary contact, two-way hydrodynamic coupling of forces and torques, electrostatic interactions (e.g. DLVO), and non-Newtonian fluid rheology.

Application of the LBM-DEM framework has generated fundamental new insights on proppant behaviour in narrow and or branching channels. A selection of these will be discussed in the talk, including (i) the influence of an angular, non-API proppant on fracture permeability, (ii) the performance of microproppants in the presence of electrostatic interactions, and (iii) the self-segregation of products with a wide size distribution.

## Biography

Christopher Leonardi is an Associate Professor within the School of Mechanical and Mining Engineering at The University of Queensland, Australia. He completed his PhD in computational mechanics at The University of Wales, Swansea, and his BE(Hons) in mechanical engineering at James Cook University, Australia.

Associate Professor Leonardi's research is focused on the development and application of computational models of complex fluid-solid interactions, including suspension transport, porous media flow, multiphase flows, and poromechanics. The outputs of his work inform industry partners on the complex characteristics of subsurface fluid and solid mechanics in gas production from unconventional reservoirs (e.g. coal seams) and mineral extraction from challenging orebodies. Current and recent projects include studies on hydraulic fracturing and proppant transport in coal seam gas (CSG) reservoirs, surface movement within and adjacent to CSG tenements, counter-current two-phase flow in CSG wells, and in situ recovery of minerals from low-permeability rocks.

Christopher and his group of postdoctoral researchers and postgraduate students possess expertise in a range of computational techniques, including the lattice Boltzmann, discrete element, finite element, and finite difference methods. His team collaborates closely with national computing facilities, such as Pawsey Supercomputing Centre, to development, implement, and apply these techniques to large-scale engineering problems.