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The effect of roughness on the onset of nonlinear flow in fractures
DAVID CUNNINGHAM, Rutgers University, HAROLD AURADOU, UMR FAST 7608 CNRS, SHAHAB SHOJAEI-ZADEH, National Science Foundation, GERMAN DRAZER, Rutgers University — In fractures where surface fluctuations are large compared to their aperture (*narrow fractures*) the flow is forced to move in tortuous paths that produce additional viscous friction and may affect the importance of inertia effects. We consider the relation between the magnitude of surface roughness and the onset of inertial effects in the pressure driving the flow through a single open fracture. We performed experiments systematically varying the average aperture of the open fracture and covering a wide range of Reynolds numbers. For each aperture, we analyze the data in terms of the Forchheimer equation and show that the critical Reynolds number, defined as the Reynolds number at which inertial effects contribute 10% of the total pressure losses is highly correlated with the roughness of the surface. We show that inertial effects appear at lower Reynolds numbers as the relative magnitude of surface roughness increases. We present results showing that the magnitude of the deviations in the pressure field compared to a linear profile, taken at different points in the fracture along the flow direction, are also directly related to the relative magnitude of surface roughness in the fracture. Finally, we present computational results in simple sinusoidal fractures to explore the role of the relative wavelength of the surface fluctuations on the onset of inertial effects.

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