Nonlinear Flow Behavior and Validity of the Cubic Law in a Rough Fracture

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Abstract : The Navier-Stokes equation is used to study nonlinear fluid flow in rough 2D fractures. The major goal is to investigate the influence of inertial flow owing to fracture wall roughness on nonlinear flow behavior. Roughness profiles are developed using Barton's Joint Roughness Coefficient (JRC) and used as fracture walls to assess wall roughness. Four JRC profiles (5, 11, 15, and 19) are employed in the study, where a higher number indicates higher roughness. A parametric study has been performed using varying pressure gradients, and the corresponding Forchheimer number is calculated to observe the nonlinear behavior. The results indicate that the fracture roughness has a significant effect on the onset of nonlinearity. Additionally, the validity of the cubic law is evaluated and observed that it overestimates the flow in rough fractures and should be used with utmost care.

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