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A phase-field approach embedded in the Theory of Porous Media for the description of dynamic hydraulic fracturing Part II: The crack-opening indicator

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Abstract

The well-known phase-field approach applied to fracturing solids has recently been embedded in the Theory of Porous Media for the description of hydraulic fracturing scenarios. This method has been found very convenient not only for the description of solid deformation and fracture but also for the transition of Darcy-type flow in the saturated porous-media domain towards Navier-Stokes-type flow in fractured zones. However, as a result of the monotonic evolution of the phase-field variable, the phase-field approach to fracture does not usually allow for the description of pre-existing closed fractures or of fractures closing after generation, where either only Darcy-type flow occurs or where Navier-Stokes-type flow turns back to Darcy-type flow. To tackle this issue, the present study concerns the introduction of a crack-opening indicator as an additional variable governed by the current deformation. By use of this procedure, not only opening but also closing fractures as well as pre-fractured domains can easily be included into the numerical simulation of fracking scenarios in saturated porous media. Proceeding from the finite-element analysis, the numerical results are found consistent with experimental observations presented in the literature.

Keywords: Hydraulic fracturing; Phase-field approach; Theory of Porous Media; Pre-existing cracks; Crack-opening indicator.

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