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GENERALIZED FLUID-FLOW MODELING IN THE ENHANCED LOCAL PRESSURE MODEL FOR HYDRAULIC STIMULATION

E.A. Bergkamp*, J.J.C. Remmers, C.V. Verhoosel and D.M.J. Smeulders

Eindhoven University of Technology, Department of Mechanical Engineering, P.O. Box 513,
5600 MB Eindhoven, The Netherlands
*e.a.bergkamp@tue.nl

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In recent years the Enhanced Local Pressure (ELP) model was introduced by Remij et al. [1] to simulate hydraulic stimulation at early stages. The ELP model is based on the eXtended Finite Element Method (X-FEM). The porous formation is described by Biot's equations and the fluid flow in the formation is described by Darcy's law. The fracture is incorporated as a discontinuity in the finite element mesh by introducing an additional discontinuous displacement field at nodes surrounding the fracture. The opening of the crack is governed by the cohesive zone method.

The current ELP model is limited with respect to fluid dynamics. Primarily, the current ELP model does not include a two-way leak-off between the fracture and the porous formation. Instead, it considers an ad-hoc leak-off relation for which Terzaghi's law [2] is used. Furthermore, the current model does not consider the rheology of fracture fluids or the spurt losses expected at the crack tip [3].

In this contribution we systematically derive the fluid-flow equations for the ELP framework, leading to a rigorous coupling of the fluid flow inside the fracture with the poromechanical surrounding solid. The enhanced fluid-flow relations are incorporated in the ELP framework, and preliminary results demonstrating the enhanced capabilities of the fluid-flow model are demonstrated. Specifically, the enhanced leak-off relation is studied in detail and its performance is compared to the leak-off relation considered in [1].

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