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MODELLING 3D HYDRAULIC FRACTURE NETWORKS IN POROUS MEDIA USING FINITE ELEMENT ANALYSIS

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Abstract. Hydraulic fracturing (HF) or fracking is a common technique for enhancing hydrocarbon production. In Vaca Muerta formation HF is used to expand and connect pre-existent natural fractures and fill them with proppant to create a permeable network. HF process can be summarized in: fracture initiation and propagation in a compressed solid porous media by the injection of a highly pressurised fluid and then transport of proppant particles to enhance permeability in the fractured network. Due to problem geometry complexity, numerical simulations are key tools to understand this process. In present work to explore the interaction between the natural fractures, the fluid injection pattern and the proppant allocation, a coupled 3D finite element model (3D-FEM) is developed. This model incorporates data from geomechanical model into a finite element formulation to address porous solid behaviour in a confined domain belonging to Vaca Muerta formation. The geomechanical variables are: pore pressure, tectonic stress field, overburden and the mechanical properties of the sedimentary rocks that constitute the rock formation. The mesh is adjusted to capture different rock layers. To simulate fracture process, cohesive elements are used to describe fracture initiation and propagation, and element parameters are calibrated with measured actual properties. The governing differential equations in the solid are momentum conservation and the poroelastic behaviour which are coupled with Reynolds lubrication inside the fractures. The three equation sets are fully coupled and solved simultaneously to track fracture network evolution. Once established the network topology, proppant transport is addressed. As work outcome the proppant distribution and the resulting network are determined for several natural fracture networks orientations subjected to different pump operating conditions and fluid viscosities. Rock barriers and dams are added to analyze its effect on the fracture network. As closure, the proppant distribution is correlated to permeability to determine well production rate.