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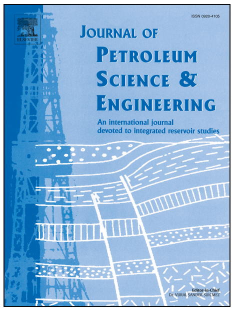

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Effect of Non-uniform Pore Pressure Fields on Hydraulic Fracture Propagation

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Abstract

In elastic materials, it is evident that the path of a propagating fracture is deflected from its normal course in presence of imperfections of the material or loading conditions. This paper aims at investigating hydraulic fracture deviation induced by non-uniformity of pore pressure fields with the use of a fully coupled poroelastic model based on the finite element method. The model includes a poroelastic domain in which pressurised hydraulic fractures are explicitly embedded, thus allowing to realistically model the fluid flow inside the fracture and to intrinsically consider the fracturing fluid load on the fracture walls as well as fluid leak-off into the formation. The latter process (fluid leak-off into the formation) controls both the length and the orientation of the fracture by changing the local pore pressure which in turn leads to a change in magnitude and direction of local principal stresses around the fracture tip. An innovative method, Mean Rotation Angle (MRA) is utilised for post-processing of evolving stress data at the vicinity of the fracture tip. The MRA predicts the potential growth path of pressurized fractures. In this paper pore pressure induced fracture reorientation is studied for a single fracture as well as closely spaced fractures. Results of this study indicate that presence of a pore pressure anomaly changes the growth path of a hydraulic fracture, towards or away from the anomaly. A higher than average pore pressure zone attracts the fracture while a lower pressure anomaly zone repulses the growing fracture. The fracture growth direction depends on the differential pressure and the distance between the anomaly and the fracture tip. Also in case of two simultaneously growing transverse fractures pressurized by injected fluid, it has been observed that the fluid leak-off controls the potential deviation angle of the fractures through changing the local pore pressure distribution pattern. It is shown that there are three distinct trends for the change of potential deviation angle due to fluid leak-off and that these three trends are linked to three corresponding stages of hydraulic communication between the two fractures. Furthermore, this study shows that change in matrix permeability, stress anisotropy, fracture half-length, spacing and the rate of leak-off influence the timing of each of the stages to the extent to which the corresponding stage of