Hydraulic Fracture Propagation in Fractured Media

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Hydraulic fracture is commonly used to stimulate the gas production of low permeability formations such as tight gas sandstones, coal-bed methane or gas shales. It is also observed naturally especially in low permeability formations, when overpressure were generated due to specific diagenesis mechanisms which happened once the rock was deposited. However, these formations being brittle in nature are often fractured and discontinuous. Understanding the propagation of hydraulic fractures through natural interfaces or discontinuities is therefore an important topic to predict or interpret the fracturing of these complex media. One main issue is whether the induced fracture will cross a discontinuity, be arrested by it or reinitiates at a location not aligned with its initial direction. If an offset exists between the direction of the initial hydraulic fracture and the newly reinitiated hydraulic fracture, it is important to understand what parameters are controlling it.

The paper uses the state of the art in the modeling of the hydraulic fracture propagation in fractured media. When the hydraulic fracture does not cross directly a natural fracture and starts to follow the path of the natural fracture, the model checks whether the maximum tensile stress at any location along the natural fracture is high enough to initiate a new hydraulic fracture branch. The influence of various parameters on the presence or not of the offset and on its value is presented. These parameters include the rock strength, the inclination of the natural fracture with respect to the principal stress direction, its friction angle, the values of the far-field state of stress, the fluid injection rate and fluid viscosity.

The paper shows that tensile stress, if it occurs, occurs at the tip of the fluid pressurized zone which propagates in the natural fracture once the hydraulic fracture has intersected it. However, the value of this tensile stress depends on the position of this tip and may either increase with the length of the pressurized zone or decrease, depending on the input parameters. This behavior will control whether or not and where the hydraulic fracture might reinitiated from the natural fracture. All the parameters mentioned above control this behavior and their influences are presented. This includes the tensile strength of the rock which may vary along the natural fracture due to the presence of defects.