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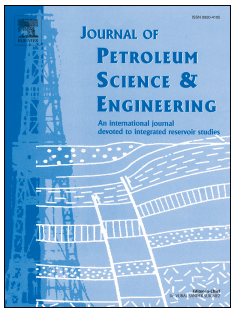

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Hydraulic Fracturing Test with Prefabricated Crack on Anisotropic Shale: Laboratory Testing and Numerical Simulation

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ABSTRACT

Due to the typical depositional environment and pre-existing microcracks, shale usually exhibits strong anisotropy. Characterizing crack propagation of shale with obvious stratification is crucial in the shale gas development. Therefore, this work aims at investigating the influence of stratification on the crack propagation of black shale in the hydraulic fracturing tests. First, prefabricated cracks with predefined direction (0°, 30°, 45°, 60°, 90°) to the bedding plane were made by diametrically cutting from the inner bore edge of hollow cylindrical samples. Then, the hydraulic fracturing test was conducted with Electro-Hydraulic Servo Dynamic Rock Triaxial Test System (GCTS RTR-1500). Third, numerical simulation was done in parallel to lab test, which enabled a detailed interpretation of the results. Finally, combined with the maximum circumferential tensile stress theory and anisotropic analysis of stress field on the crack tip, the initiation angle and equivalent stress intensity factor of the crack were obtained. The results indicate that the maximum pore pressure increases with the increase of the prefabricated cracks' angles when the samples rupture in the hydraulic fracturing test. Moreover, the fracture pattern has a certain degree of anisotropy with different predefined direction. This phenomenon could be explained by the pre-existing microcracks and preferentially oriented weaker plane. The result from the numerical simulation is well consistent with that from the lab tests. It contributes to the determination of the hydraulic pressure and perforation orientation and drilling direction.

Keywords: Black shale; Prefabricated cracks; Crack propagation; XFEM; Predefined direction; Hydraulic fracturing