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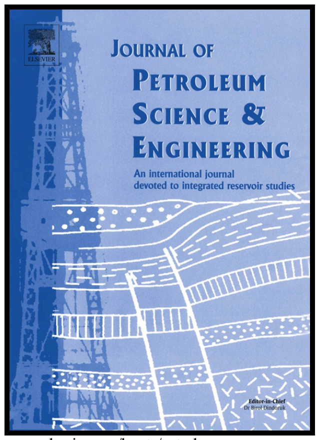

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Stress Redistribution and Fracture Propagation during Restimulation of Gas Shale Reservoirs

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Abstract

Restimulation of previously hydraulically-fractured wells can restore productivity to near original levels. Understanding the stress state resulting from the original hydraulic fracturing and subsequent depletion is vital for a successful refracuring treatment. The stress obliquity in the vicinity of the wellbore, due to production from a previously introduced hydraulic fracture, promotes a new concept – that of altered-stress refracuring which allows fractures to propogate into previously unstimulated or understimulated areas and therefore enhancing recovery. In this study, a coupled poromechanical model is used to define stress redistribution and to define optimal refrac timing as defined by maximizing the size of the stress reversal region. Key factors include the time dependency of the stress reorientation, the threshold stress ratio $\sigma_{hmax}/\sigma_{hmin}$ and the influences of permeability anisotropy/heterogeneity, pressure drawdown and rock-fluid properties. The results show that stress reorientation develops immediately as the reservoir begins to produce. This stress reversal region extends to a maximum extent before retreating as the direction of the maximum principal stress gradually returns to the initial state. The optimal refrac timing and the size of the stress reversal region are positively correlated with pressure drawdown and Biot coefficient, negatively correlated with stress ratio $\sigma_{hmax}/\sigma_{hmin}$ ratio and Poisson's ratio and ambiguously correlated with permeability anisotropy. Permeability magnitude and porosity have no influence on the size of the resulting zone but are negatively and positively correlated to the timing, respectively. Permeability heterogeneity has no influence on the size nor the timing. Coupled fluid flow and damage-mechanics simulations follow fracture propagation under the effect of stress redistribution during refracturing treatments. These results define the evolving path of secondary refracture as it extends perpendicular to the initial hydrofracture and ultimately turns parallel to the hydrofracture as it extends beyond the stress-reversal region. This discrete model confirms the broader findings of the continuum model.

Keywords: Hydraulic Fracturing, Refrac, Stress Redistribution, Stress Reversal Region, Fracture Propagation