Injecting Cooling Agents to Reduce Breakdown Pressure for Hydraulic Fracturing Treatment

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Abstract

Fracture initiation can be a challenging issue for hydraulic fracturing treatment in deep and tight gas reservoirs. The objective of this paper is to present an innovative new operation method to reduce the required breakdown pressure for fracture initiation. Horizontal wells are generally drilled for maximum reservoir contact. Also transverse hydraulic fractures are strongly desired, which suggest the horizontal part should be drilled in the minimal horizontal stress direction. In this situation, formation breakdown for initiating transverse fractures can be a challenging issue for zonal isolated open-hole multistage hydraulic fracturing treatment. In order to lower the breakdown pressure and initiate transverse fracture, cooling the borehole can be an efficient way. It is achieved by injecting cooling agents and flow to the target open borehole fracturing interval. The cooling agent can lead to a temperature drop in the open borehole formation. The near borehole formation will exhibit thermal contraction and accordingly tensile stress increases along the borehole axial direction. Simultaneously, the thermal contraction leads to compressive hoop stress increasing, which can inhibit the longitudinal fracture initiation. Eventually the breakdown pressure along the borehole axis direction can be reduced and becomes relatively easy, which boosts the chance for initiating transverse hydraulic fractures. The required axial tensile stress changes along the borehole axis always vary from well to well and reservoir to reservoir. For accurately estimating the required axial stress change along the borehole axis, a 3D fully coupled thermal-displacement finite element model was specifically developed for facilitating the cooling agent design. Criteria to terminate the cooling process and timing of the breakdown are offered. Numerical simulation is also provided to demonstrate the feasibility of the operation method can lower the breakdown pressure for open hole fracking.