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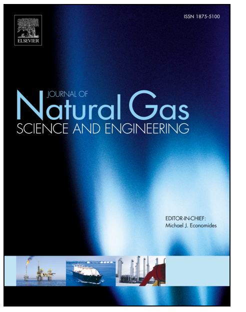

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Wellbore Breakouts: Mohr-Coulomb Plastic Rock Deformation, Fluid Seepage, and Time-Dependent Mudcake Buildup

Xiaorong Li[1], Hamza Jaffal[1], Yongcun Feng[2], Chadi El Mohtar[1], K. E. Gray[2]

1. Department of Civil, Architectural and Environmental Engineering, The University of Texas at Austin
2. Department of Petroleum and Geosystems Engineering, The University of Texas at Austin

Abstract

Borehole breakout is a time-dependent failure process which includes breakout initiation, propagation, and stabilization. Plastic rock deformation, fluid seepage, and time-dependent mudcake buildup on the wellbore wall affect the near-wellbore stress state and, therefore, the breakout behavior. In this paper, a hydro-mechanical model was developed for breakout prediction taking into account these factors. Filtration tests were conducted to obtain time-dependent permeability and thickness of mudcake, and the experimental testing results were incorporated to embody the dynamic mudcake buildup process. A sensitivity analysis was performed to investigate the effects of horizontal stress anisotropy, drilling mud pressure, and time-dependent fluid flow and mudcake buildup on breakouts in a vertical borehole. The simulation results show increased possibility of breakouts with larger horizontal stress anisotropy. Additionally, fluid seepage between the wellbore and the surrounding formation makes the breakout a time-dependent process. For low mud pressure, the initial breakout shape immediately after drilling is very similar to the final breakout shape after reaching steady state seepage. However, for high mud pressure, the wellbore may experience significant breakout propagation after drilling, owing to considerable fluid seepage associated with the larger differential pressure between the wellbore and the formation. Time-dependent mudcake buildup on the wellbore wall can effectively reduce the likelihood of borehole breakout by acting as a low-permeability barrier that mitigates fluid seepage across the wellbore wall and reduces changes in formation pore pressure. Disregarding the mudcake or considering a perfectly impermeable mudcake can lead to overestimating or underestimating the risk of borehole breakout, respectively. The proposed model provides a useful approach to understand and assess borehole breakout for drilling design.