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AN ADVANCED METHODOLOGY FOR PREDICTING WELLBORE STABILITY IN CHALK

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In the past few decades, due to the need of constructing complex geometry boreholes (deviated, horizontal wellbores, radial drilled laterals) that are noncolinear with the principal stress directions, the traditional approach to the problem of borehole stability has been revisited. Traditionally, the stability of a well is determined using models based on linear elasticity; however, this approach does not provide realistic evaluation of stability as with elastoplastic models. With the improved understanding of the micromechanisms of the rock microstructe failure subjected to a tangential stress around the wellbore, advanced models that incorporate softening of the strength are developed.

The workflow for the advanced wellbore stability modelling builds upon a methodology illustrated in Figure 1. Traditional numerical back analysis of standard triaixal tests fails to obtain accurate softening and dilatancy parameters after post-peak. This can be overcome if the triaxial test is modelled in 3D, where discrete shear band can be modelled introducing heteregeneity of material properties within the tested specimen. However the derived parameters needs to be verified as the thickness of the shear band may not be representative of the lab test. The key experiment in this methodology is testing of a specimen replicating horizontal borehole under conditions close to a near wellbore. Back analysis of the single hole test with 2D/3D modelling is used to verify the dilatancy and softening parameters as well as Cosserat length from 3D modelling. Computed Tomography imaging is used to visualise the breakout development around the horizontal hole. The aim of this workflow is to reduce the uncertainity of the material parameters back analysed with single element approach which is although time-efficient, but when used in borehole stability analysis underestimates the stability of the open hole. Extended numerical backward modelling with 2D/3D is important for reliable estimate of the stability of open hole.

Multiphysics modeling of porous media acid dissolution

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An OpenFOAM solver has been developed, capable of modeling buoyancy, advection, diffusion, and reaction of acid in geometries consisting of both fully fluid and heterogeneous porous media regions. Furthermore, the dissolution of porous media and with it the transition from Darcy-Forchheimer to fully fluid flow is accurately captured. With this solver, along with meshing schemes capable of constructing geometries consisting of fully fluid, porous media, and unaffected solid regions from three-dimensional CAD drawings, the impact on wormhole formation and directionality is shown to depend heavily on: Fluid properties, flow characteristics, and domain geometry. The importance of modeling three-dimensional domains, as opposed to two-dimensional domains is also observed. Full well completion models, including liner, perforations, and heterogeneous porous media, were analyzed to assess the feasibility of affecting wormhole directionality with heavy acids.

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