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Prediction of Wellbore Failure Using an Equivalent Wellbore through the Combined Moment of Inertia Calculation

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Abstract:

Oil leaks were found in wellbores of Caverns 105 and 109 at the Big Hill Strategic Petroleum Reserve site. According to the field observations, two instances of casing damage occurred at the depth of the interface between the caprock bottom and salt top. A three dimensional finite element model, which contains wellbore element blocks and allows each cavern to be configured individually, is constructed to investigate the wellbore damage mechanism. The model also contains element blocks to represent the interface between each lithology and a shear zone to examine the interface behavior in a realistic manner. An equivalent wellbore was calculated using the combined moment of inertia of the areas of casings and annuli from the two wellbores per a cavern. This results in a mesh with fewer elements, of acceptable quality, and conserves CPU time consumption with comparable structural behavior as a model with two as-built wellbores. The causes of the damaged casing segments are a result of vertical and horizontal movements of the interface between the caprock and salt dome. The salt top subsides because the volume of caverns below the salt top decrease with time due to salt creep closure, while the caprock subsides at a slower rate because the caprock is thick and stiffer. This discrepancy produces a deformation of the well. The deformed wellbore may fail at some time. An oil leak occurs when the wellbore fails. A possible oil leak date of each well is determined using an equivalent plastic strain failure criterion. A well grading system for a remediation plan is developed based on the predicted leak dates of each wellbore.

Keywords: equivalent wellbore, oil leak, remediation plan, salt creep