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NUMERICAL PREDICTION OF TENSILE CASING FAILURE BY SALT CREEP FOR EVALUATING THE INTEGRITY OF CEMENTED CASINGS OF SALT CAVERNS

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Abstract

This paper summarizes the use of numerical modeling to predict tensile casing failure of cemented casings of natural gas storage caverns. Some aspects of cavern design (such as the cavern depth, diameter, and roof shape) can be controlled and used to limit casing strains and the potential for tensile casing failure. However, the creep rate of the salt cannot be controlled and can have a significant impact on casing strains. Additionally, the location of the casing shoe, minimum pressure, and characteristics of cemented casing completions can also impact casing strain. In this paper, geomechanical modeling was performed to investigate these aspects of gas storage and used to identify the most influential factors related to the integrity of cemented steel casings. The results of numerical modeling simulations are provided, and the results illustrate that tensile casing failure is predicted and more likely to occur under certain conditions.

As salt flows toward and into a cavern, it can drag and stretch the casing, resulting in axial tensions. Assuming the salt/cement and cement/casing interfaces remain bonded, elongation of the casing will continue until the tensile limit of the casing and/or connection is exceeded. The criterion used in this study to identify tensile casing failure relates to the linear elastic behavior of steel and assumes no plastic strain between yield and ultimate strain. Discussions on strain within the cement sheath and an appropriate strain limit for different types of casing completions and steel grades are provided, along with case studies where tensile casing failures have occurred. This paper also discusses the uncertainties associated with predicting casing partings, different types of casing connections evaluated such as threaded connections and welded connections, and methods used to monitor casing integrity and detect a leak in a natural gas storage cavern.

Key words: Casing Failure, Casing Integrity, Salt Creep, Salt Caverns