Cyclic Loading of a Rock Mass for Underground Gas Storage Applications

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The use of Underground Gas Storage (UGS) is expected to increase considerably in the near future due to various factors. Many of the UGS wells require sand control. Expandable Sand Screens (ESS) have many advantages as a completion option in UGS wells. But there has always been a concern on the effects on ESS due to cyclic loading. The paper deals with the changes in the borehole that would be caused during annual injection and production cycles from the storage reservoir. Specifically, the interest is in whether or not the deformation levels out to a constant or whether the damage continues evolving. Cycles can be either annual (production in winter / storage in summer) or far more frequent due to Peak shavering (production to cover peak usage, followed by top-up). Abaqus/Standard FEA Numerical modelling has been carried out on a rock sample with an 8.5" diameter wellbore that is lined with a 7" Expandable Sand Screen. The ESS was represented by a simple representation, a plain pipe, rather than a fully slotted system. The rock material has been assigned properties which weaken due to continuing cycles. Stresses were cycled to simulate a great number of years production and injection. The deformation of the ESS stabilised after a number of years. This shows that ESS is a viable completion option in UGS wells.

Keywords: include Geomechanics, Soil-Structure Interaction and Wellbore

1. Introduction

The objective of this study is to establish, using Abaqus/Standard Finite Element Analysis (FEA), the effect of cyclic loading on Expandable Sand Screens (ESS™), caused by alternating production and storage, in an Underground Gas Storage (UGS) reservoir.

The extraction of gas from a gas storage well causes a reduction in the reservoir pressure. This increases the effective stress on the rock formations and may lead to rock failure. Depending on circumstances, such as depth or extraction rates, the change in reservoir pressure can be of the order of 10-20MPa (1450-2900psi).

Reservoirs for gas storage wells need to have relatively high porosity and permeability. This type of formation can store high quantities of gas and have a high deliverability. However they also tend to be weak and have a propensity to fail and granulate during the pressure cycles inherent in the injection and extraction of the gas.

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