Review and Studies of Geothermal Wells Cement Design from Well Integrity Perspective

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ABSTRACT

Cement sheath, placed between casing and formation, is an important barrier to provide a hydraulic seal and establish zonal isolation, preventing fluid communication in the wellbore. In geothermal wells, the temperature at the bottom hole is high. Thermal stress induced by temperature is one of the major considerations to trigger failure in the cement sheath. In geothermal CO2 -rich reservoirs, well barriers usually experience severe degradation. For this study, a setup similar to the production casing/liner program of a geothermal well was fabricated using two concentric pipes with elastomer and cement sheath to seal off the annular space. The sealing performance of a commonly used elastomer material (ethylene propylene diene monomer) was investigated at 1000 psi and 180°F under CO2 exposure. An autoclave was used for aging elastomer samples. Exposure to aging conditions caused cracks and blisters on elastomers. This resulted in failed sealability tests. A finite element model has been developed to simulate sealability tests. Simulation results have indicated the lack of sufficient sealability after CO2 exposure, showing good agreement with experimental observation.
For the cement barrier, the experimental setup was used to investigate cement bonding with casing (steel pipe). Even at room temperature, cement sheath exhibited weak bonding at the inner pipe interface. This caused a failure in the sealability test. Material properties of cement cured at elevated temperatures of up to 350°F were used in the finite element model to examine the effect of temperature and wellbore pressure on cement integrity. The stress levels developed in cement were analyzed to identify modes of failure.