ABSTRACT

The integrity of cemented well casings was studied in the laboratory through a series of seven bench-scale tests designed to simulate the casing shoe of a generic well completion in salt, as well as the state of stress in the vicinity of the casing shoe. The bench-scale test specimens were prepared from large salt cores (13-inch diameters by 18-inch lengths) recovered from the Avery Island Dome, Louisiana. Each salt core was machined using a lathe to produce a thick-walled cylinder having an outer diameter of 12 inches (305 millimeters (mm)), an inner diameter of 6.5 inches (165 mm), and an overall length of 16 inches (406 mm). A steel casing, having an outside diameter of 4.5 inches (114 mm) and a wall thickness of 0.25 inch (6 mm), was cemented in the inner bore of each salt specimen. Then each specimen was placed inside a large pressure vessel and its outer surfaces uniformly pressurized to simulate the lithostatic stress condition that exists in the salt near a typical underground cavern. After the cement cured sufficiently (~7 days), the interior bore of the specimen was filled with brine and the brine was incrementally pressurized to determine the maximum brine pressure that could be applied before a loss of fluid containment was observed. Between successive pressure increments, the integrity of the cement seals, including the casing-cement-salt interfaces, was evaluated by measuring brine flow out of the interior bore. Brine fluid pressures approaching and even exceeding the simulated lithostatic stress were investigated.

Numerical analyses were performed to predict the stress states in the bench-scale models and to assist with the interpretation of the laboratory results. The modeling made use of the commercially available finite-difference code know as **FLAC**. The analyses were validated against the actual deformations measured in the tests to lend credence to the reliability of the stresses predicted for both the spatial and temporal domains.

INTRODUCTION

Underground caverns developed in salt are a popular and economical method for the storage of oil and gas, the disposal of oil field and hazardous solid wastes, and the production of brine for industrial applications. Entry into these caverns requires the completion of cased wells that extend from the surface through the nonsalt overburden and terminate at the casing shoe set in the salt above the cavern. In a typical entry well completion, the annulus between the outermost casing and the rock, as well as the annuli between smaller diameter inner casings and larger outer casings, are filled with cement. The cements used in the completions are those commonly available in the oil and gas industry. The technology for both the emplacement of the cement and the testing to assure correct emplacement is well developed.

Because of age considerations and/or stability problems, caverns are being taken out of production and abandoned. A common method for abandonment is simply to pull or cut the hanging string that provides access to the cavern and then to fill the inner casing or tubing with alternating intervals of concrete and cement grout plugs. In general, the cavern space left