CHARACTERIZATION OF THE BRINE LOSS ZONE AND DEVELOPMENT OF A POLYMER GEL PLUGGING AGENT TO REPAIR LOUISIANA OFFSHORE OIL PORT (LOOP) CAVERN 14

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Abstract

After the LOOP Cavern 14 failed a routine mechanical integrity test, extensive testing determined that the failure resulted from brine escaping from a geometric anomaly on the south wall of the cavern mid-way in the cavern body at a depth of 2170 feet (660 meters). Data from injection tests, involving the controlled injection of more than 200,000 barrels (32,000 m^3) of brine, indicated that the leak was into a porous formation outside the salt dome.

A unique formulation of an aqueous Cr(III)-carboxylate/acrylamide-polymer gel of the type used extensively in oilfield applications to shut off water production was developed for the Cavern 14 repair. The gel was mixed in saturated brine and included a density-control agent to render it neutrally buoyant in the brine inside the cavern. Gelation time was controlled to allow the gel to partially penetrate the formation before fully maturing. Laboratory testing confirmed the gel would be highly effective in plugging either a porous material or a fracture.

A three-dimensional finite difference reservoir model was constructed to represent the cavern geometry, contact with the porous leak zone and behavior of the plugging agent inside the cavern. Calibration of the model to three months of brine injection and pressure fall-off data predicted a cavern wall to porous formation contact face which closely matched the geometry of the solution anomaly observed in sonar surveys. Model simulations concluded that an extremely accurate density match between the cavern brine and the gel plugging agent was required and the gel must be placed from a close proximity to the leak face. Gel volumes required to affect a seal increased exponentially as the point of injection became more distant and became impractical at distances greater than 25 feet (7.6 meters). This conclusion led to the development of a remote operated vehicle (ROV) which could be employed to convey the gel directly to the leak face from within the cavern.