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Technical Conference Paper

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Abstract

Life Extension - Phase II (LE2) site modernization projects for the U.S. Department of Energy (DOE) Strategic Petroleum Reserve (SPR) Bryan Mound (BM) and Bayou Choctaw (BC) sites are fully shutdown site outage events that last up to 12-months. LE2 work includes replacement of crude oil, brine, and raw water pipelines, storage tanks, pumps, and other site infrastructure. These projects render the cavern systems relatively inoperable. Therefore, proper cavern pressure management prior to LE2 outage was necessary to avoid additional fluid movements during outage to bleed-off cavern pressures due to cavern creep. This is a case study of properly managing cavern pressures and fluid transfers prior to a shutdown event, target pressure calculation methods used, tracking actual versus predicted results, and fluid transfer contingency plans.

Gulf Coast domal salt caverns creep continuously, resulting in cavern volume losses and increasing cavern wellhead pressures. Cavern creep rates vary between caverns and sites due to differences in cavern fluids, cavern depth intervals, cavern pressures, and domal salt characteristics. The primary objective for cavern pressure management prior the shutdown was to prevent cavern pressures from exceeding the maximum operating pressure limits, which would have delayed the site outage activities. To do so, cavern pressures were reduced below the minimum operating range limit and set to calculated target pressures. Target pressures calculations were based on recent historic cavern pressure build-up rates, cavern, and fluid compressibility, and expected outage duration.

Bryan Mound (BM) salt dome heterogeneity and different eras of cavern development and shapes result in variability of cavern creep rates across the BM dome. Caverns located in the southeast portion of the BM dome, historically have higher pressurization rates and cavern creep volume losses. Prior to outage, BM Site Operations bled-off cavern brine from all 19-active caverns to the site brine tank to reach respective target cavern pressures. Cavern wellhead pressures were reduced 40-50 psi lower than the calculated target pressure, as a safety factor. During the outage period, there were contingency pressure bleed-offs, using a vacuum truck or brine tank storage.

Cavern creep at Bayou Choctaw (BC) is very low due to shallower cavern depths, as demonstrated by low historic cavern pressurization rates. Prior to outage, BC Site Operations bled off cavern brine from all six active caverns to the brine pond and brine disposal wells to reach respective target cavern pressures. During the outage period, there were no contingency pressure bleed-offs, using a vacuum truck or brine pond. However, for operational reasons, BC Site Operations bled off brine from cavern 17, 18 and 20.

After reaching target pressures, the caverns were shut in for the duration of the outage, and actual cavern pressurization rates were compared with predicted rates. Analysis shows that for some caverns, the actual pressurization rates exceeded the calculated pressurization rates, leading to fluid movements. For example, for a given cavern, the predicted cavern pressurization rate was 0.56 psi/day, but the most recent 30-day average actual pressurization rate was 0.80 psi/day. Explanations for these differences result from early time cavern stabilization periods and cavern specific characteristics. Overall, this work has been effective, and this work contributed to the success of LE2 modernization.

Key words: Cavern pressure management during site outages, cavern de-pressurization rates, cavern pressure build-up rates, minimum & maximum operating pressure ranges, Strategic Petroleum Reserve (SPR), Gulf Coast Salt Domes, cavern creep, sweet & sour crude oil storage management techniques.

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