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CAVERN CREEP CLOSURE: ANALYSIS OF U.S. STRATEGIC PETROLEUM RESERVE DOMAL SALT CAVERN VOLUME LOSSES DURING STATIC AND DYNAMIC CONDITIONS

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Abstract

The U.S. Strategic Petroleum Reserve (SPR) consists of 60 active domal salt caverns storing 713 MMbbl (113,357,945 m^3) oil at four salt dome storage sites. Over time, cavern volumes reduce in size as a result of cavern creep closure. Cavern creep closure is a function of differential pressure between the formation and the cavern hydrostatic pressure. Proper management of caverns and reducing cavern volume loss due to creep closure is one of the top priorities for cavern storage operators. Therefore, two improved cavern creep volume-loss methods (static and dynamic conditions) were developed by the SPR to estimate cavern volume losses due to creep closure. The static condition method relies on analyzing past cavern fluid transfers, cavern pressure changes, and historic cavern pressure buildups. The dynamic condition method is applied during workovers when cavern pressure is reduced to 0 psi surface pressure. This reduction in cavern pressure increases cavern creep closure rates and increases cavern volume losses. In 2020, 10 workovers were performed at the SPR. Creep volume losses during workovers are calculated by adjusting for net fluid transfers during the workover, incorporating historic cavern fluid compressibility, and comparing starting and ending cavern pressures. Estimates of individual cavern volume losses for static conditions and workovers are compared with previous estimates. Correlations with cavern creep closure are presented for cavern features and workover events; including the type of fluids stored in the cavern, the location of the caverns within the salt dome, the mid-cavern depths, different cavern operating pressure ranges, and duration of workovers. By better understanding these correlations, the following recommendations may help reduce cavern volume losses: keep cavern operating pressures in the upper range when the cavern is full of oil, adjust cavern fluid flow rates when de-pressuring and repressuring a cavern, and minimize the frequency of workovers and depressurization events. These recommendations aim to protect cavern storage volume, an important asset.

Key words: Department of Energy (DOE), Strategic Petroleum Reserve (SPR), caverns for hydrocarbon storage, cavern creep volume losses, domal salt caverns.

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