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Unintended Brine Production in a Liquid Hydrocarbon Storage Cavern

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Abstract

Solution-mined caverns operated for liquid-hydrocarbon storage typically utilize brine to displace hydrocarbon product. Under normal conditions, brine flows in the hanging string and lower portion of a cavern while product flows external to the hanging string and in the upper portion of a cavern. However, under certain conditions, brine may unintentionally be produced up the annulus during product withdrawal. The unintentional flow of brine up the annulus can have detrimental effects on cavern well integrity and negatively impact surface infrastructure.

Under static conditions hydrocarbon product is separated from brine, where the lower-density product remains above the higher-density brine and the product-brine interface occurs on a horizontal plane. The shape of the product-brine interface under flowing conditions is controlled by the relative densities and viscosities of the cavern fluids, fluid flow rate, and cavern geometry. When product is withdrawn, the product-brine interface can become distorted, resulting in brine being produced from a cavern before the cavern is empty of product—this phenomenon is termed “water breakthrough.”

Water breakthrough may result in brine being pulled up through the product and being produced at surface. This paper presents a case study of a *water breakthrough* event where brine was unintentionally produced from a cavern that contained liquid product. A numerical model was developed to understand this phenomenon and simulation results are presented to aid in understanding the cause of *water breakthrough* and how future operations may be modified to prevent such an event from reoccurring.

Key words: Caverns for Liquid Storage, Fluid Dynamics, Water Breakthrough