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Meeting Paper

Thermodynamic Evaluation of Sabine Gas Transmission Company's Cavern No. 2 at Spindel Top Salt Dome

by

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1.0 INTRODUCTION

1.1 BACKGROUND

How much gas is actually in a cavern when it is full, when it is empty, and at any time between, pretty much defines the earnings impact a gas storage business can have. Often these volumes are arrived at by making broad assumptions or by using cumulative in and out gas meter measurements. This can be the basis for a bad initial investment decision. It can lead to large, technically vague, inventory adjustments. It can effect a company's gas marketing strategy. It can dramatically change a company's estimate of cushion gas, which the IRS has ruled is a capitalized, nondepreciable asset.

Sabine Gas Transmission Company (SGT) initiated gas storage operation in 1992 in the Spindletop salt dome. SGT operated without routine downhole pressure-temperature (P-T) measurements. SGT also operated without the benefit of geomechanical information. The operating temperature in the caverns was estmated from temperature logs run just after drilling to be about 125°F. The cavern spatial volumes were arrived at primarily by carefully measuring initial cavern gas fill during dewatering operations.

In 1994 a downhole P-T survey, which happened to find the cavern temperature at 124°F and inventory to be within a few hundred million cubic feet of where it was expected to be. At this point SGT viewed inventory control to be relatively straightforward. By 1997, however, SGT had identified discrepancies in inventory of excess of 1 Bscf (on 100 Bscf of injection/withdrawal activity). Of greater concern, the working gas capacity of the caverns, which appeared to contain 12 Bscf of capacity, had declined from 6 to 4 Bscf, making the cushion gas appear to have changed from 6 to 8 Bscf. Clearly, there were problems.

SGT approached the problem of defining what happened to cavern performance in two steps. Step one was to identify the actual P-T response of the caverns by installing permanent downhole P-T probes. Step two was to incorporate the data gathered from the downhole probes into a comprehensive geomechanics study. SGT desired to establish a lower minimum operating pressure and to evaluate expected closure rates due to creep for various operating scenarios. For this study SGT Cavern No. 2 was used to address these issues. This cavern was selected since it has the longest operating history and the longest history with down hole P-T (Pressure-Temperature) probes.

The overall geometry's of both caverns are similar. They differ mainly in roof configuration. The SGT Cavern No. 1 is about 100 feet shallower. Since SGT Cavern No. 1 is very similar to SGT Cavern No. 2, the conclusions reached by this study are believed to also be apply to SGT Cavern No. 1.

Leaching of SGT Cavern No. 2 commenced on April 22, 1992 and de-watering was started on March 1, 1994. De-watering was finished on July 4, 1994 and the cavern was placed in service on July 13, 1994. The final volume was 4.1 MMbbls based on the final sonar survey. The well for the cavern was directionally drilled so as to avoid potential drilling problems due to previous sulphur mining in the caprock directly above the cavern location. The casing shoe is offset from the surface location 672 feet on a bearing of 200.34° from north. The casing shoe is at 4,051 feet TVD (4,114 feet MD) and the cavern roof is at about 4,127 feet TVD. The well was drilled to a total depth of 5,084 feet TVD with the top of the debris (mostly anhydrite sand) located at 4,782 feet TVD. Cores were obtained from 4,095–4,124 feet TVD and from 4,673–4,702 feet TVD. The maximum operating pressure for the cavern is 3,050 psig at the surface (3,355 psig at the casing shoe) and the minimum operating pressure was initially set at 1,200 psig at the surface (1,325 psig at the casing shoe).

The predictions of the geomechanics study (Chabannes, 1999) were checked to the extent possible by comparing predicted cavern volumes over time with cavern volumes calculated P-V-T field data. As a supplement to the geomechanics study, a thermodynamic study was performed the evaluate the P-V-T collected and to aid in defining inputs for the geomechanical study. This paper presents the results of this study as well as other operational observations.