Chilling Natural Gas to Increase Salt Cavern Storage Capacity

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ABSTRACT

As part of the United States Department of Energy's (DOE) Federal Energy Technology Center "Advanced Natural Gas Storage Concepts Program", PB-KBB Inc. proposed the concept of storing chilled natural gas in underground conventionally mined hard rock storage caverns. While mined cavern storage is not a new and novel idea, chilling the natural gas to reduce the storage space required has not been applied. Chilling the gas to -20 degrees Fahrenheit reduces the required cavern space by about 45%, thereby reducing the mining cost a considerable amount.

Although the estimated design and construction cost for this concept is higher than solution mined salt dome storage, it has some advantages over other methods. By not using salt formations the caverns can be located in almost all areas of New England, the Mid Atlantic, the South Atlantic, the Pacific Northwest, or any area that has hard rock formations. At depths between 2,000 feet and 3,000 feet, hard rock formations can be found in most areas of the United States. The chilled gas mined cavern concept has the high withdrawal rates of domal salt storage and allows multiple cycles per year, unlike Liquid Natural Gas Storage, which is usually restricted to one cycle per year. PB-KBB Inc. completed a conceptual design, engineer's construction cost estimate, and operations and maintenance cost projections for the project. This includes all of the surface and subsurface facilities for compressing and chilling (refrigerating) the gas for injection into storage, and maintaining the chilled gas at its injection temperature in storage.

Refrigerated cavern gas storage has potential applications for existing and planned salt domes and bedded salt storage caverns, especially storage facilities in areas where cavern construction is limited by available brine disposal facilities. For an existing cavern, chilling the gas to -20 degrees Fahrenheit would increase the gas in storage by 93%, assuming the original storage temperature was 120 degrees Fahrenheit and a pressure of 1,600 psi. If a cavern had a spatial volume of 1,000,000 barrels at 120 degrees Fahrenheit, chilling the gas to -20 degrees Fahrenheit is equivalent to having a cavern with a spatial volume of 1,930,000 barrels.

The theoretical principles of chilling the natural gas for storage in a salt cavern and flow diagrams of the surface and subsurface chilling equipment are presented herein.