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Technical Paper

Use of Inert Cushion Substitutes in Salt Cavity Storage of Natural Gas

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USE OF INERT CUSHION SUBSTITUTES IN SALT CAVITY STORAGE OF NATURAL GAS

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Abstract - In underground storage, whether in porous, permeable reservoirs or in dissolved salt cavity environment, a significant portion of storage gas must remain continuously in the storage horizon to provide the pressure energy necessary for withdrawal of "top-gas" on demand. That quantity dedicated and committed to stay in the storage cavity for the duration of storage operations is called "cushion gas". The economic advantage of using a cheaper inert substitute for cushion gas was recognized more than a decade ago in U.S by the author and in France by M. J. Colonna, both working in aquifer storage research. This work resulted in development of new technology where 10 to 20 percent of cushion gas in depleted petroleum or aquifer storage reservoirs can be substituted with nitrogen. In underground storage in void-cavity environment, the use of a viable alternative for cushion gas is even more desirable for economic reasons related to the "cushion" and "top" gas quantities involved. While complete miscibility and resultant dilution of heating values rule out direct injection of nitrogen in a salt cavity, the idea of physically separating the cushion gas from the top gas by a membrane was advanced and suggested by the author during 1990. The use of a plastic film or membrane which would transmit the pressure but, at the same time, prevent mixing, resulted in an invention filed and announced during the October meeting of SMRI. Subsequently, the U.S. patent with some fourteen claims was approved to be granted. This paper describes engineering and economic aspects of using an alternative inert cushion in salt cavern storage of natural gas. It is shown that in salt cavities, a much larger fraction of cushion gas can be substituted with cheaper nitrogen than is possible in aquifers or depleted porous reservoirs.

Three major concepts related to either using a divider membrane, installing multiple baloons or designing a deployable bladder are described and discussed.

Engineering parameters related to design and construction, materials, operating conditions, installation, start-up and fail-safe requirements are presented. The performance of storage cavities with substitute cushion is analyzed and compared with present technology.

Principal economic considerations having impact on development of salt cavities for storage of natural gas with alternative cushion substitutes are shown to relate to cost of materials, installation, repairs, insurance, recovery and recharge. With the present and projected price structure of nitrogen and natural gas, net savings per cavern of about 1 BCF capacity is estimated to be approximately 1 to 2 million dollars.