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Preserving Stored Gas Reserves: Self Repairing Cement Sheath Protects Underground Gas Storage Investment

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Abstract

Underground gas storage (UGS) wells present unique challenges to well integrity. Often drilled across depleted formations that can be difficult to isolate, UGS wells are subject to cyclic stresses of injection and production as gas is stored during times of peak supply for use during times of peak demand. Repeated stress on the cement sheath and the formation in which the gas is stored can result in cement sheath damage or debonding and a loss of stored gas reserves. In addition to the loss of stored gas, the presence of surface gas leaks also poses a danger. UGS wells are placed near populated areas, where their stored energy-on-demand is most needed; as a result, any unwanted annular flows that might occur would present an unacceptable safety risk. Environmental and safety concerns often require that storage operations be suspended on wells with gas leaks to surface. This results not only in lost storage capacity, but also the additional expense of remedial operations or having to drill a new UGS well.

Our study involved the incorporation of a self-repairing sealant material as part of a large-scale UGS development in Northern and Southern Italy. To minimize the possibility of unwanted annular gas flows and the resultant loss of UGS capacity, self-healing cement (SHC) was pumped and placed as part of primary cementing operations. SHC is a unique isolation material with the built-in ability to self-repair. Whenever the cement sheath integrity is compromised by the formation of cracks or a debonding of the cement from the formation or casing (also known as microannulus), and gaseous or liquid hydrocarbon begins to flow through or around the cement sheath, SHC activates automatically, efficiently sealing leak paths and reestablishing well integrity.

In February 2007, the first deployment of SHC in Italy was performed during primary cementing operations on an UGS well. Within days, cement evaluation logs confirmed zonal isolation. SHC had effectively isolated multiple depleted reservoirs with differing formation pressures. This improved hydraulic seal prevents the loss of stored gas, as well as ensuring compliance with local regulatory requirements.

Since the start of the project, 16 wells have been successfully completed using SHC. The SHC slurry was lab tested according to recognized ISO/API procedures, and was mixed and pumped on the well site using standard cementing equipment. These wells have remained leak-free and the cement sheath has demonstrated improved zonal isolation when compared to traditional primary cementing systems.