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GYPSUM SCALING IN SOLUTION MINING WELLS: DETECTION, GEOCHEMICAL UNDERSTANDING AND MITIGATION OPTIONS

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Abstract

In January 2013, 1.1 mm thick Gypsum scale deposits on the leaching strings were responsible for a 2 months delay and additional costs in the leaching operations for the creation of a new gas storage cavern in Manosque, France. This delay was due to reduced flow rate and difficulties for pulling out a leaching string during a work-over. In May 2013, evidences of thicker scale deposits were identified on the same cavern, leading to the review of the options available for mitigating the risks of reduced leaching rate and being stuck during a work-over.

The present article presents methods for the early detection of the deposits, reviews the options for mitigating existing scale deposits and details the geochemical understanding of the Gypsum scale formation and ways to prevent it.

Early detection of the gypsum deposits is based on deducing the scale thickness from the continuous pressure and brine density monitoring and the resulting pressure loss computation. Frequent geochemical sampling and analysis did not prove useful for detecting the scaling formation.

Mitigating options can be grouped in mechanical action in the well or at the surface and chemical dissolution. In the well, the increase of pulling strength (possibly using a jack-up rig) and the lubrication of the deposits have been applied successfully, whereas in-situ removal using a scrapper or a coiled tubing jet have been considered. At surface, “hammer” cleaning on the outside of the casings and high pressure jet cleaning for the inside has been implemented. Laboratory analyses of scale dissolution by water, different brines and 4 chemical products available on the market suggest that the equilibrium concentration could be reached during in-situ circulation of water, which is more applicable than brine or chemical product based options.

The presence of Anhydrite and Langbeinite in the leached geological layer and the solubility increase of Gypsum with pressure and temperature are the main cause for scale deposits. Anhydrite and Langbeinite are dissolving into the cavern brine. From a Gyspum-saturated brine in cavern conditions, a supersaturation that deposits gypsum is obtained upon release of pressure when the brine is flowing out. This analysis is supported by the equilibrium results from the Pitzer model and database implemented in PHREEQC. In order to avoid this unwelcome Gypsum precipitation, implementing high leaching flow rates, avoiding stops in operation and minimizing injection in the sump are recommended. If not sufficient, lowering the concentration in the brine annulus can be achieved through casing perforation.

In June 2013, increasing the pulling strength was the first option implemented option and proved successful, revealing up to 8 mm thick scale deposits (4.5 mm in average) and 23 tons of Gypsum scale material on the leaching strings. In parallel, other options were ready to be implemented in order to avoid major inconvenience for the project.

Key words: Geochemistry, Manosque, Gypsum, scale, PHREEQC, Pitzer, solution mining.