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Pre-abandonment Mg-salt cavern monitoring for leak-off events

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Abstract

Nedmag operates a magnesium chloride solution mining plant in Veendam. The eldest well and cavern (Veendam 1 or VE-1) was drilled in 1972 and operated until 1984 and contains about 170,000 m^3 of carnallite-saturated brine in the Zechstein-III 2b/3b formations. The cavern height is about 60 m. The well and cavern have only seen a few operations since 1984, for instance to relieve cavern pressure or to remove the corroded tubulars. The last pressure relieve operation was performed in 2019, after which the cavern and well were left untouched. In the first years the cavern showed a slow cavern pressure increase, mainly the result of (carnallite) salt creep at the ambient (salt and brine) temperature of 70 °C. Thermal heat expansion is most likely irrelevant at this time. Starting 2022 the cavern VE-1 was displaying periodic leak-off behaviour, where every half year the pressure dropped with on average 2-3 bars with an estimated leak-off of 75 to 150 m^3 during a time frame of about 1 month. The compressibility was estimated at 30-40 m^3/bar from a 2019 bleed-off test. After a bleed-off period, the leakage path apparently closes once more and a pressure build-up is seen during 4-6 months. With a leak-off rate of 200 m^3 per year the cavern creep-closure half-time (50% volume reduction) will be more than 500 years, assuming the leak-off rate is proportional with the remaining cavern volume.

It is realised that carnallitic or bischofitic magnesium chloride brine has a higher potential of clogging micro-fractures by cool-crystallisation than sodium chloride brine, so it cannot be guaranteed that the intermittent cavern leak-off is similar to post-abandonment behaviour of halite embedded caverns. A complete steady state brine outflow is however not a given either, given the observed VE-1 data.

Key words: cavern leak-off, fractures, abandonment, magnesium salt, bischofite, carnallite, cavern abandonment, cavern monitoring